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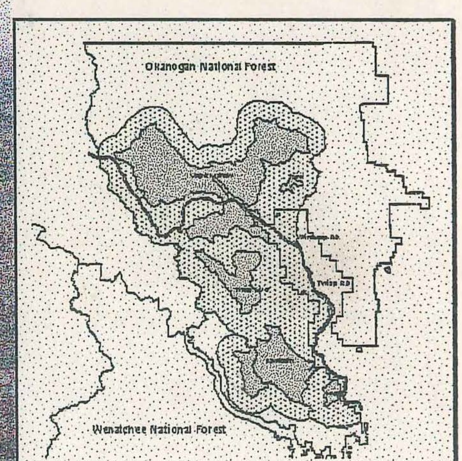
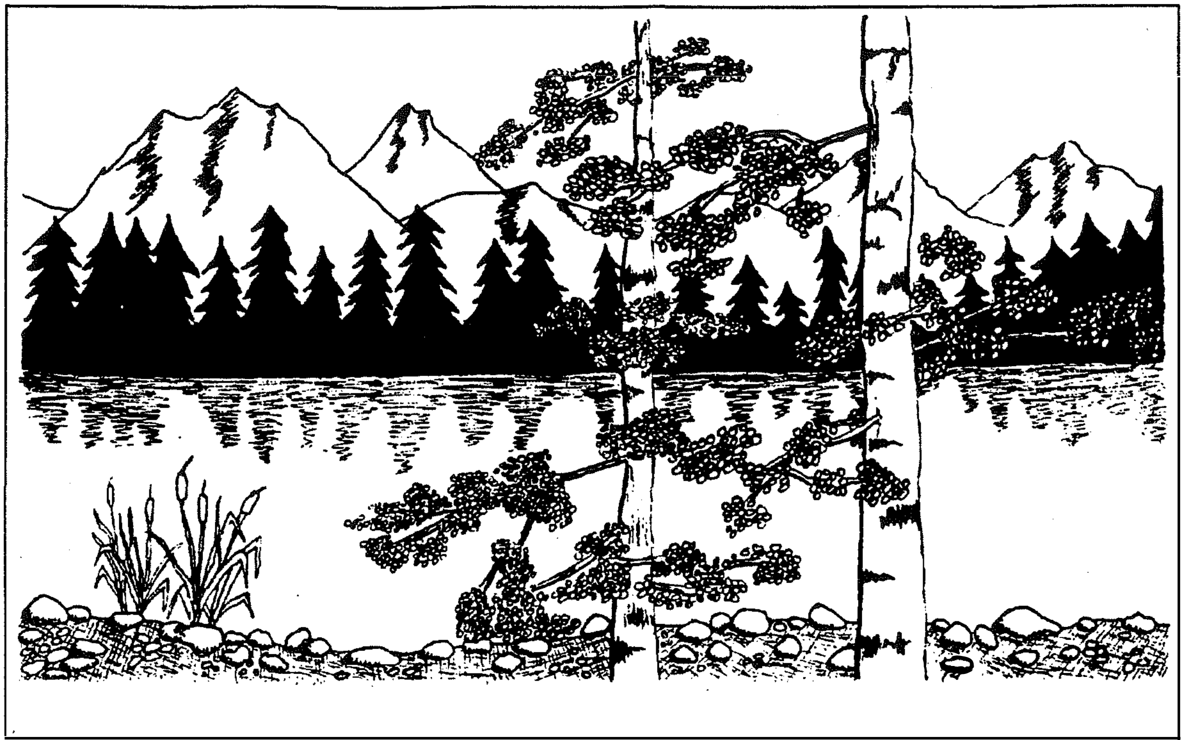
An Assessment of the Northeastern Cascades Late-Successional Reserves





An Assessment of the Northeastern Cascades Late-Successional Reserves

April, 1998

United States Department of Agriculture
Forest Service
Methow Valley Ranger District
Okanogan National Forest

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EXECUTIVE SUMMARY

This Late Successional Reserve Assessment (LSRA) discusses the current condition and management implications for a system of five individual Late Successional Reserves (LSRs) located in the North Eastern Cascades on the Methow Valley Ranger District, Okanogan National Forest, the Chelan Ranger District of the Wenatchee National Forest, and portions of the Mount Baker - Snoqualmie National Forest that are administered by the Okanogan National Forest. An assessment area of 896,158 acres, which encompassed all five LSRs (Hunter Mountain, Nice, Sawtooth, Twisp River, and Upper Methow) was delineated for study. This delineation allowed the Assessment Team to assess not only the functions and processes of the individual LSRs but also their function as interrelated units across the landscape and their relationship to large scale fire regimes and wildlife flows.

A vegetation classification scheme adaptable to analysis by linear programming models was developed and provided the basis for conclusions reached in this assessment. This system relied on grouping current vegetation, as determined by 1983 satellite imagery, into nine Plant Association Groups (PAGs). These PAGs were defined using a combination of vegetative associations and plant community responses to fire disturbance.

The current condition of the assessment area was described in terms of natural, social and economic influences. This examination showed that there were areas within the LSR system that had been affected by human activities to the extent that their role in a [illegible] limited. [illegible] are not large in extent and do not compromise functioning of the LSR system viewed as a whole. In general, current multiple use activities such as grazing, recreation, mining, special uses, and fuelwood gathering (currently prohibited in LSR except for incidental use by recreationists) within the LSR system are not in conflict with Northwest Forest Plan (NWFP) objectives. Mitigation and restriction of some human activities may become necessary in the future to protect and enhance Late Successional (LS) values within the LSR system.

An assessment of fire risk using a crown fire potential model shows that the current amount of LS habitat is not sustainable with present or foreseeable suppression resources.

The team identified 56 LS dependent or LS-associated terrestrial wildlife species that are either known to occur or suspected to occur within the assessment area.

Connectivity corridors to allow for movement of LS dependent and associated species within and between LSRs were determined to be vital to the proper functioning of the LSR system. As a result, corridors through matrix lands were identified for higher mobility species. In addition, the analysis assumed that lower mobility LS species would have their needs addressed by these corridors.

These corridors between LSRs were delineated by spatially grouping Riparian Reserves designated by the Northwest Forest Plan with existing stands of greater than 100 acres of interior LS habitat or future interior LS habitat (habitat with potential to develop LS characteristics based on site biophysical environment and current vegetative condition).

LS patches of greater than 100 acres were considered to be the smallest size that would provide at least marginal interior LS habitat. However, depending on their configuration and location, smaller patches also provide effective habitat for LS species. Thus, project proposals within connectivity corridor areas both within and outside of the LSRs must consider avoiding or mitigating impacts to any LS habitat.

In addition, LS enhancement treatments should be designed to develop areas of LS habitat approaching 300 acres. This patch size provides a more effective ratio of edge to interior habitat. However, this does not preclude treating and protecting smaller areas of LS habitat within LSRs or corridors.

Subwatersheds, which serve as native trout and salmon strongholds, constitute over 80 percent of the assessment area. Because all the LSRs lie within the range of the Endangered Upper Columbia steelhead trout, any activities within the LSRs must be reviewed for their effects on this species. The number and diversity of sensitive fish species in the LSR system make it an important contributor to Mid-Columbia Basin fisheries and, with some exceptions the aquatic habitat presently provided by streams draining the assessment area is good. However, to maintain this quality, LSR treatments must consider their effects on Riparian Reserves and aquatic habitat, particularly in strongholds.

Assessment results showed that 53 percent of the assessment area east of the North Cascades crest has a Fire Return Interval (FRI) less than 50 years. Fire suppression in these fuels has allowed development of seral stages at high risk of stand replacing fires.

Although much of the assessment area remains within historic fire return intervals, fire suppression has altered fuels distribution and created large areas of contiguous high crown fire risk. This has led to a corresponding increase in the risk of large (>10,000 acres) stand replacing fires and, to a lesser extent, [illegible] insect and disease outbreaks.

Past overstory removals in current lower and mid-elevation ponderosa pine and Douglas-fir LS stands has resulted in an increase in understory development over historic levels. In combination with fire suppression, this has created fuel ladders into the crowns of previously crown fire resistant stands, further increasing the risk of stand replacing fires in the assessment area.

The amount and type of LS habitat currently found in the assessment area is not sustainable over a long period (180-200 years). An overall loss of LS habitat to stand replacing fire over time is very probable. Some of this LS acreage will be replaced by the maturation of younger stands. However, assuming that current suppression and treatment levels continue over the next 200 years, development of these younger stands into LS habitat will not exceed destruction of present LS habitat by fire events.

An estimated 50,000 acres of the total LSR acreage of 304,674 acres was identified as being accessible for potential fire or silvicultural treatments. This acreage was defined as being within one-half mile of an existing road with a slope of less than 60 percent. Riparian Reserves were also excluded in this definition. With approximately two-thirds of the LSRs located within inventoried roadless areas, treatment opportunities are expected to remain limited in the future.

LSR treatment proposals designed to move stands between seral classes within PAGs to enhance LS development were formulated and evaluated against two criteria: accelerating early and mid-seral stands towards seral conditions identified as LS in character, and reducing stand replacing fire risk. No silvicultural treatments were proposed or evaluated for PAGs representing colder, high elevation forests. Treatments covered a wide range of options included pre-commercial thinning, thinning from below, thinning both for species selection and size increase, and the use of managed fire alone and in combination with other treatments to achieve LSR objectives.

A Fire Plan (Appendix F) was developed using fire history records, fuel modeling, and the crown fire risk potential model.

Summary of Key Findings of the Assessment

- Wildfire is the dominant disturbance element that shapes the LSR system and wildfire suppression has increased crown fire potential to a significant degree.
- Managing the LSR system to maximize acreage of late successional habitat will increase risk of catastrophic wildfire.
- There will probably be an increase in stand replacing wildfire accompanied by a decrease in LS habitat over the next 200 years. We cannot prevent this increase with current suppression resources.
- Lack of roaded access to the majority of the LSR system severely limits management activity options.
- Nice and Hunter Mountain LSRs do not currently provide suitable nesting or roosting habitat for northern spotted owls.
- Creating and maintaining connectivity between LSRs is critical for LS species dispersal. Management recommendations for areas identified as essential for connectivity should apply to both LSR and Matrix areas.
- Several areas between the Sawtooth and Twisp River LSRs provide interior habitat and serve as potential stepping stones for connectivity corridors. These areas are currently at high crown fire potential and therefore likely to be unsustainable. Protection of these areas is essential to maintaining connectivity between these two LSRs.
- The Upper Methow LSR has the highest quality late successional forest habitat as well as the most spotted owl activity centers. It also has the most urban fire interface and the most "high crown fire potential" acres of all the LSRs. An efficient allocation of resources is to give top priority to reducing risk and protecting the existing LS habitat in this area.
- Demands for special forest products and for recreational uses in the LSRs will continue to increase and must be continuously evaluated for their effects on LSR character. More emphasis on management of these uses will be needed.
- Development in the "peninsula" of private land in the Upper Methow LSR will exert a critical influence on surrounding LSR lands.
- In grazing allotments, development and maintenance of LSR characteristics may result in a substantial decline in available forage.
- The association of sensitive aquatic species such as bull trout with LS habitat should be considered when designing enhancement or protection projects in LSRs.

The following priorities were developed for management activities including full fire suppression strategies:

Priority One: Protection of human life.

Priority Two: Protection of property, and natural and cultural resources in the following priorities:

A. Protection of existing northern spotted owl nesting sites and adjacent foraging and roosting habitat.

B. Protection of other current LS habitat.

C. Enhancement of potential LSR habitat.

These priorities would be applied to LSR project planning and to allocate resources as they become available.

Suppression strategy for all ignitions in the LSR system, including connectivity corridors, will be cost effective and consistent with land and resource management objectives.

Fire planning also showed that with the exception of Hunter Mountain and Nice LSRs, lack of access dictates that for the majority of the LSR system, confinement and containment strategies within natural barriers and constructed fuel breaks is the only practical tool to produce significant risk reduction. This strategy could result in the loss of current LS habitat.

Risk to adjacent private lands from management for relatively high risk mid and late seral stages is particularly high in the Upper Methow and Twisp River LSRs.

The fire plan estimates that to achieve Priority One objectives, more than 10,000 acres of national forest adjacent to private land requires immediate risk reduction treatment by a combination of thinning and prescribed fire.

Application of a linear programming model (SPECTRUM) to a matrix derived from successional pathways developed for each PAG allowed a 20 decade view forward of PAG acreages. A projection forward using SPECTRUM was run with the goal of maximizing LS habitat over the assessment area. No constraints were applied to the amount of treatments to be applied during this time period.

Managing the LSR system to maximize LS habitat would require increasing the number of acres treated to reduce risk and enhance LS characteristics over 10 times above present day levels. This increase is so great that even accounting for errors in the model, it is doubtful that over the next 50 years resources would be available to prevent loss of LS habitat in the high fire risk system that would result from these treatments. The net result could be less LS habitat than is currently present in the LSRs. It is also possible that this management strategy could result in less LS habitat than was present in pre-European times.

A monitoring program tiered to existing Okanogan Forest Plan monitoring items which annually tracks acreages in LSRs and connectivity corridors for each seral stage was developed by the assessment team. The monitoring plan also identifies the Methow Valley Ranger District Monitoring Coordinator as the individual responsible for implementing LSR monitoring.

CHAPTER 1
Introduction

On April 2, 1993, President Clinton convened the Forest Conference in Portland, Oregon, to discuss federal land management policies in the forests of the Pacific Northwest. One outcome of this conference was a comprehensive ecosystem management strategy called the "Forest Plan for a Sustainable Economy and a Sustainable Environment." The "Final Supplemental Environmental Impact Statement and Record of Decision for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl" was made available to the public in February 1994. This plan, now known as the Pacific Northwest Forest Plan (NWFP), created a network of reserves designed to facilitate viability of species associated with older or "late-successional" (LS) forests. It called this network Late-Successional Reserves (LSRs) and further directed that a management assessment be prepared for each large LSR (or group of smaller LSRs) before habitat management activities were designed and implemented.

Late Successional Reserve Assessments

Prior to recommending and selecting solutions, effective ecosystem management requires clear problem definition, an understanding of management goals, objectives, trends and opportunities, and an assessment of biophysical and social conditions. In the case of this assessment, we adopted an approach that began with the primary assumption that "Late-Successional Reserves are to be managed to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth related species including the northern spotted owl. These reserves are designed to maintain a functional, interacting, late-successional and old-growth forest ecosystem" [Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl (ROD) C-11].

As required by the NWFP, this assessment provides information, criteria, plans, and priorities, but not decisions, for management actions. Proposed activities within the boundaries of the LSRs, including those in compliance with LSR management objectives as presented in the ROD, will be reviewed under the provisions of the National Environmental Policy Act (NEPA).

The Assessment Area

The assessment area covers over 896,000 acres (see Map 1-1) and includes all five LSRs created on the Okanogan National Forest and a small portion of the Wenatchee National Forest. The assessment team considered risk of large scale fire disturbances to this system of LSRs when delineating this area. Natural fire barriers such as major river systems and mountain crests were used as assessment area boundaries wherever possible. In the absence of these features, or in areas considered to be of special fire risk from adjacent lands, a three-mile "buffer" was added to the nearest LSR boundary. This buffer was included only for purposes of analysis and has no land management implications.

This choice of an assessment area was also intended to facilitate examination of large scale ecological flows, such as wildlife connectivity between individual LSRs and between individual LSRs and adjacent Matrix lands.

The assessment area is one of the most scenic areas of Washington State. The crest of the North Cascades mountain range lies within the assessment area; with rugged, glacier carved peaks providing a backdrop for panoramic views as well as serving as a significant barrier to precipitation carried in moisture laden winds from the Pacific Ocean. This dramatic rain shadow effect defines much of the ecology of the assessment area as annual precipitation declines quickly from the Cascade Crest towards the east. The result is an extremely diverse landscape with vegetation ranging from temperate rain forest (receiving over 100 inches of precipitation a year) in the west to semi-arid (receiving less than 15 inches of precipitation a year) shrub steppe vegetation in the east. The western boundary of the assessment area is the border of the North Cascades National Park just west of the Cascade crest. The eastern boundary is formed by the Chewuch and Methow river systems, which also defines the eastern-most extent of the range of the northern spotted owl. To the south, the assessment area is bordered by the Sawtooth Mountains and Lake Chelan. (Map 1-1)

Glaciation has played an important role in shaping the topography of the area. Landforms range from the steep and rugged ridges and valleys of the North Cascades to the more moderate relief of the lowlands and valleys which were scoured and rounded by the last continental ice sheet. Many soils in the assessment area are not locally derived, but instead are coarse glacial tills carried many hundreds of miles from the north and deposited as glacial out-wash and morainal features. Post-glacial eruptions from Glacier Peak located to the southwest of the assessment area contributed a significant amount of pumice and volcanic ash to the soils in the southern half of the assessment area.

Hydrologically, the assessment area contains portions of three major sub-drainages. The Chelan River system including Lake Chelan and its tributaries drains the southwestern portion of the area, the Methow River and its tributaries drains the majority of the area east of the Cascade Crest, and the land west of the Cascade Crest is drained by tributaries of the Skagit River.

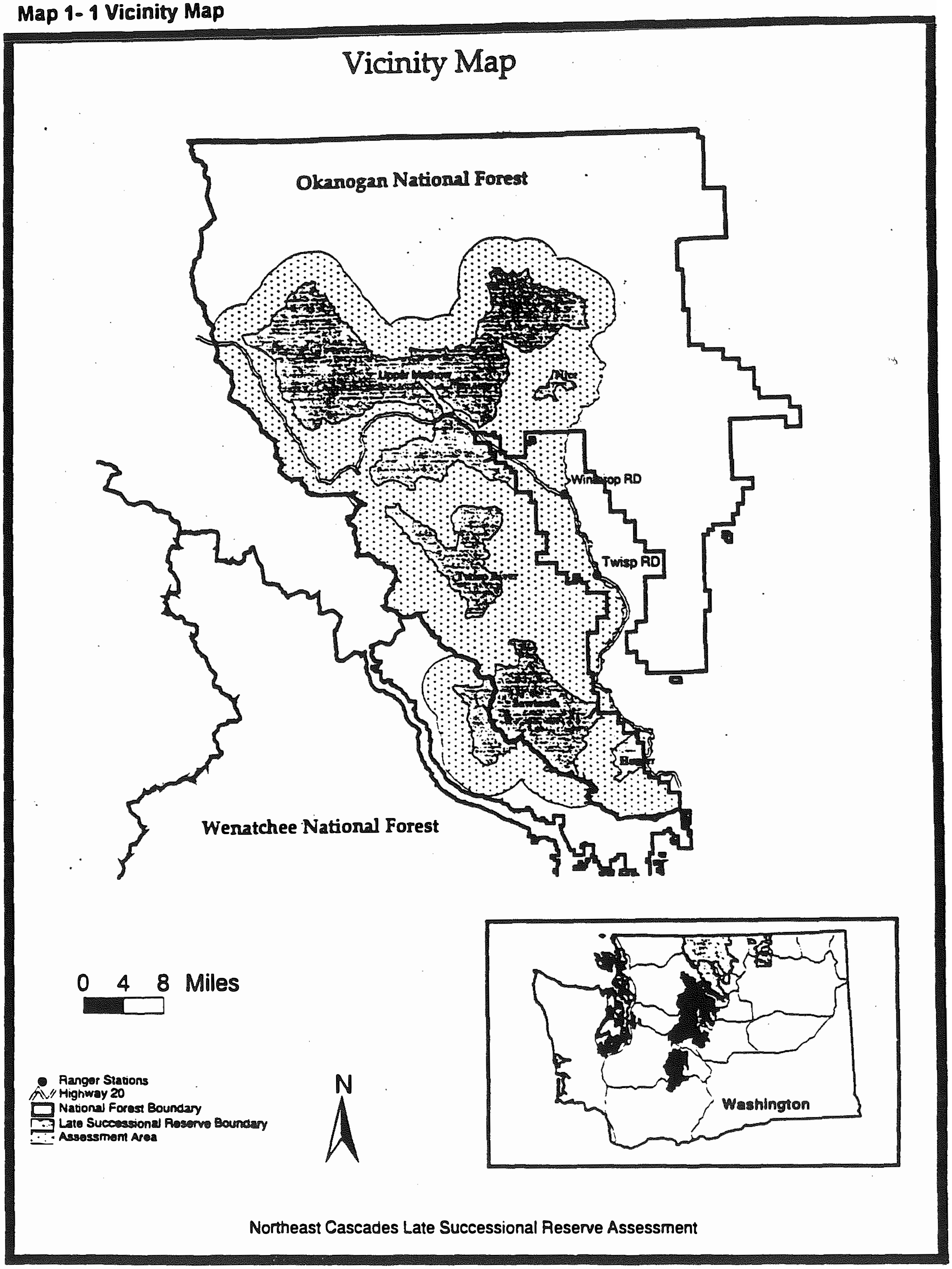
The majority of the human population in the assessment area lives in the Methow Valley, with the highest population densities occurring around Twisp and Winthrop. The towns from south to north are Pateros, Methow, Carlton, Twisp, Winthrop, and Mazama. In the last two decades, recreation/tourism and government have replaced natural resource based activities, such as farming, ranching, timber harvest, and mining, as the major elements in the area's economy. The North Cascades Highway (SR 20) bisects the assessment area and forms an important transportation link across the Cascade Mountains.

The assessment area incorporates five of the seven land allocation categories set forth in the NWFP. There is considerable overlap among designated areas and acreages displayed reflect this juxtaposition. There are no Adaptive Management Areas or Managed Late Successional Areas located within the assessment area.

Congressionally Reserved Areas comprise 186,610 acres, representing 21percent of the federal land within the assessment area. These lands have been reserved by act of Congress for specific land allocation purposes. Included are portions of the Pasayten and Chelan-Sawtooth Wildernesses.

Late Successional Reserves comprise 295,928 acres, representing 33 percent of the federal land within the assessment area. There are five LSRs within the assessment area: Hunter Mountain (RW 140) at 6,169 acres; Nice (RW 143) at 3,127 acres; Sawtooth (RW 139) at 59,029 acres; Twisp River (RW 141) at 36,266 acres; and Upper Methow (RW 142) at 191,337 acres. Individual LSRs will be referred to by their geographic name throughout this document.

Map 1- 1 Vicinity Map



Administratively Withdrawn Areas comprise 88,214 acres, representing 10 percent of the federal land within the assessment area. These areas are identified in the Okanogan and Wenatchee National Forest Land and Resource Management Plans, and include visual areas, back country, and other areas not scheduled for timber harvest. The largest area in this category is the North Cascades Scenic Highway Corridor.

Riparian Reserves comprise an estimated 84,639 acres, representing 9 percent of the federal land within the assessment area. The calculation of Riparian Reserves acreage is done for all categories of land allocation (except private land). Reserves are areas along all streams, wetlands, ponds, lakes, and unstable or potentially unstable areas where the conservation of aquatic and riparian-dependent terrestrial resources receives primary emphasis.

Matrix comprises 158,222 acres, representing 18 percent of the federal land within the assessment area. The Matrix is the federal land outside the four categories of designated areas described above. It is the area in which most timber harvest and other silvicultural activities will be conducted.

Private Lands (82,376 acres) make up 9 percent of the assessment area. Information about these lands is included in this assessment and its analysis process, but they are not affected directly by any treatment proposals developed as a result of this analysis.

Administratively, the assessment area falls almost entirely under the management of the Methow Valley Ranger District, Okanogan National Forest, with offices located in the towns of Winthrop and Twisp. The portion of the Sawtooth LSR located within the Lake Chelan sub-basin is managed by the Chelan Ranger District, Wenatchee National Forest in Chelan. Management of the Sawtooth LSR is coordinated between the two Ranger Districts.

The Upper Methow, Chewuch and Twisp River drainages are designated as Tier 1 key watersheds in the NWFP.

The Assessment Team

The assessment team was comprised of specialists from local Forest and District offices and the Wenatchee Office of the U.S. Fish and Wildlife Service (USFWS). Geographic Information System (GIS) specialists and an analyst supported the spatial, data processing, and modeling needs of the resource specialists. Additional support for modeling was provided by the Forest Service Pacific Northwest Regional Office Strategic Planning Staff.

The Assessment Objectives

Direction from the NWFP, the Okanogan LMP, and local Forest managers developed the following objectives for this assessment:

- Comply with the requirement to complete a management assessment for each LSR or group of LSRs as directed by the Record of Decision (ROD, C -11).
- Characterize the assessment area and individual LSRs, focusing on existing and potential late-successional characteristics.
- Provide a decision framework to propose actions that will maintain, enhance, or accelerate development of the maximum amount of reasonably sustainable late-successional habitat within each LSR, and ensure that other activities meet LSR objectives as identified in the NWFP.
- Develop and use analysis techniques which are adaptable to future planning efforts at project and forest levels.
- Incorporate best available new science and work within the "Framework For Ecosystem Management" outlined by the Columbia River Basin Project.

Key Decision Space Assumptions of this Assessment:

- This assessment considers only the effects of human management activities on LS Habitat. It does not analyze the effects of human presence that may result as a consequence of these management activities.
- This assessment considers a planning cycle of 200 years appropriate to describe change in the LSR system and to serve as a planning guide.
- Areas that are currently roadless will remain roadless with no significant new road construction within LSRs or connectivity corridors.

The Assessment Process

The assessment process begins with a description of landscape features, ecological processes and trends, and current management activities that effect the maintenance or enhancement of LS characteristics. This description centers around four broad functional groups: landscape, terrestrial and aquatic biology, social, and economic with primary emphasis on the first two. As part of the description, information needs were noted where appropriate.

To facilitate presentation of information and results, the assessment team elected to use two levels: the general assessment area, and the individual LSRs. Although some information, such as range allotments, is presented at a larger assessment area scale, this information is primarily relevant at the scale of the individual LSRs. Social information is presented at the scale of the assessment area as information for specific LSRs was generally not available.

The next step was to classify the physical attributes and processes of the assessment area as Biophysical Environments (BPEs) and the current vegetative condition of the area as Plant Association Groups (PAGs). These classifications provided the basic information for the analysis phase of the assessment. The assessment team used BPEs and PAGs to characterize ecological processes, to analyze and discuss effects of management activities such as fire suppression, observe trends from past management, and identify potential management treatments. The assessment team modeled and displayed the effects of proposed management treatments on connectivity of LS habitat between and within LSRs and the sustainability of LS habitat characteristics within individual LSRs.

Part of this analysis portion of the assessment also examined trends and cause and effect relationships between various social (human activities and uses) and biophysical elements. Some intrinsic characteristics made linking biophysical and social processes difficult. For instance, social process information was often available for a point in time or was described annually, while biophysical processes were often described at 10 year (decadal) intervals, or greater. In addition, biophysical processes were usually described by fixed spatial reference such as a ridge top or a stream reach, while social processes were a function of human populations, which have variable relationships with different spatial extents. For example, human interaction within the LSRs may be low to moderate across the assessment area, but high in the Upper Methow LSR where development of recreation opportunities is significant.

Results of the analysis were presented both for the entire assessment area and for individual LSRs when appropriate. These results, in the form of recommendations for the timing and nature of various treatments reported for each PAG, were then integrated into management recommendations, including Fire Plans for each LSR.

Finally, monitoring methods were proposed to validate the implementation and effectiveness of the management proposals over a long time span.

Assessment Structure

This assessment is organized into seven chapters.

Chapter 1 describes the purpose and objectives of the assessment, and describes the assessment area.

Chapter 2 describes the biophysical setting and important landscape dynamics within the assessment area. Implications for management of LSRs are included.

Chapter 3 describes the social and economic setting of the assessment area. A characterization of specific resources is provided, and implications for management of LSRs are included.

Chapter 4 describes important terrestrial species and their habitats. Implications for management of LSRs are included.

Chapter 5 describes aquatic species and their habitats.

Chapter 6 discusses the overall status of the individual LSRs by combining information on historic and existing conditions and trends from a variety of resource perspectives described in previous chapters. A summary of implications for management of individual LSRs is included.

Chapter 7 discusses the analysis of management options, establishes criteria for treatment, and includes a monitoring program which integrates current Okanogan National Forest monitoring activities and monitoring developed by the Regional Ecosystem Office.

Technical data and tables supporting the rationale contained in this assessment are included in the Appendices, following Chapter 7.

CHAPTER 2
Landscape Dynamics

Introduction

For the purposes of this assessment, landscapes, landscape processes, and their inherent disturbance regimes are defined using biophysical environments (BPEs). The BPEs developed for this assessment classify the landscape into potential vegetation groups that are restricted in their distribution by the physical attributes of the landscape and its associated climate. They have similar productive potential, and share similar disturbance regimes (see Appendix A for a detailed description). In this context BPEs can be considered the basic template of a dynamic landscape that describes a range of possibilities for future assessment area conditions.

There are two primary components that define a BPE as used in this assessment. First, BPEs have similar physical landscape characteristics such as aspect, slope, elevation, precipitation, and soil moisture (See Appendix B for a detailed description). These attributes were used to classify the assessment area into ecologically similar habitat types. Second, potential plant communities associated with these habitat types were defined using the plant associations described by Lillybridge and others (1995). This provides a framework for using BPEs to describe where potential vegetation can develop under similar climate patterns and disturbance regimes.

Biophysical environments, together with the influences of the inherent disturbance regimes, have shaped the way plant communities have evolved and the patterns they create across a landscape. Landscape patterns, along with the structure and composition of a plant community, change with changes in the types and intensities of a given disturbance. Changes in species composition, stand structure, and patch size are used to assess shifting landscape patterns that are linked to changes in the frequency, intensity, and duration of a given disturbance. These changes over time in the structure and composition of a plant community are referred to as successional processes.

To describe the successional processes of a plant community, Plant Association Groups (PAGs) were developed. The foundation of these PAGs are two fold. First, the potential climax forested series were used as a primary classification. These were: ponderosa pine, Douglas-fir, subalpine fir, pacific silver fir, western hemlock, mountain hemlock, whitebark pine, and subalpine larch. In some cases more than one series is represented within a PAG. This occurred when the different climax communities responded similarly to disturbance events (Pacific Silver fir/Mt. Hemlock PAG) or ecologically functioned as a complex of ecosystems (Subalpine Parkland PAG). In both cases the constraints of the data did not allow them to be easily separated. Second, the PAGs were classified based on a given disturbance regime, and the effect of that disturbance regime on the successional development or maintenance of the plant community. Including disturbance regimes into the PAG definitions used in this assessment provided more site specific predictive capability of a stand's development through time. It also made them somewhat different from previous

PAG classifications used by Lillybridge and others 1995. This difference can be a potential source of confusion to those accustomed to more traditional PAG systems based on climax vegetation and climate alone.

A detailed description of the process used to develop and describe the PAGs, their individual characteristics, disturbance regimes, and successional processes, is found in Appendix C.

The disturbance regime summary in Table 2-1 displays how disturbance regimes change with increasing elevation and/or moisture across the assessment area. Figure 2-1 shows the distribution of the PAGs within the BPEs and how they also change with increasing elevation and/or moisture. The ecological range of the various PAGs also corresponds to the disturbance regime described in Table 2-1. Each PAG expresses its dominance where the most suitable habitat exists within the BPEs. As the BPEs shift in elevation, aspect, moisture, and disturbance regimes, the distribution of PAGs within a biophysical environment also shifts. The suitable habitat for a PAG becomes more restrictive with the changing topographic features, limiting plant communities to microsites until the ecological range of a PAG is exceeded. Transition of dominance of one PAG to another between BPEs is the result of changing topography, climate, and the inherent disturbance regime (Figure 2-1 and Table 2-1).

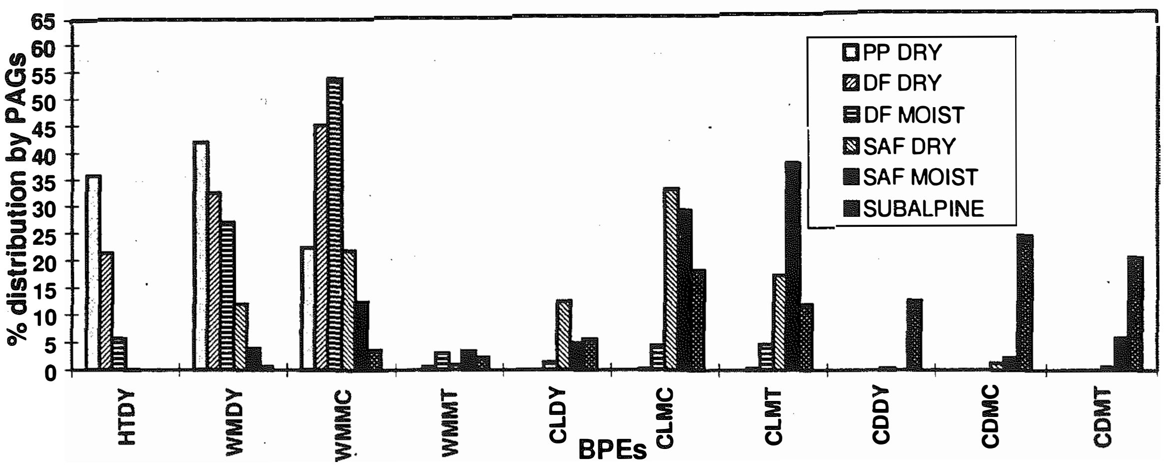
For example, the hot and dry Ponderosa Pine PAG corresponds to the disturbance regime with the most frequent fire return interval. As soil moisture increases from the hot dry to the warm dry environment, representation of the Douglas-fir PAG increases; however, as the available moisture and elevation increase in the warm mesic environment, the Ponderosa Pine PAG becomes more restricted to only the driest sites.

The successional sequence or "pathway" for each PAG is described in a general sense from the bare ground/shrub seral stage to a late successional community (see Figures C-1 through C-8 found in Appendix C). Vegetative changes through time are depicted without the influence of management.

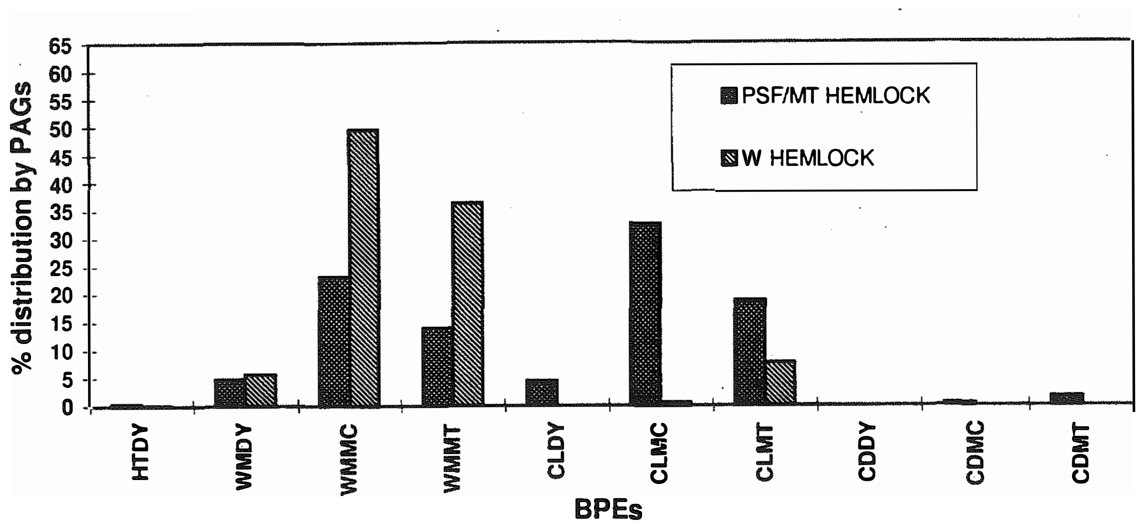
Late successional communities often result from the tendency of vegetation to equilibrate with the prevailing environment and disturbance regimes (Pickett and McDonnell 1989). This tendency for plant communities to equilibrate with both their environment and disturbance regimes drives the successional pathways in this model and thus emphasizes process rather than end point.

Figure 2-1

Distribution of Plant Association Groups (PAGs) within Biophysical Environments (BPEs) from the Cascade Crest East.



Distribution of Plant Association Groups (PAGs) within Biophysical Environments (BPEs) from the Cascade Crest West.



HTDY = Hot dry shrub/grass
WMDY = Warm dry shrub/herb
WMMC = Warm mesic shrub/herb
WMMT = Warm moist shrub/herb
CLDY = Cool dry grass
CLMC = Cool mesic shrub/herb
CLMT = Cool moist shrub/herb
CDDY = Cold dry shrub/herb
CDMC = Cold mesic shrub/herb
CDMT = Cold moist shrub/herb

Table 2-1 - Disturbance Regime Summary

Biophysical Environments	Fire Return Intervals (FRI) In years	Ecological Significance	Elevation Range	Effects of Fire Exclusion
Hot Dry Shrub/Grass	7.5 - 24 non-lethal	Ponderosa requires fire at least every 50 yr. for it to maintain dominance. Historic fires were not stand replacing. Fires also maintained adjacent shrub steppe and meadow communities.	< 4,000'	Large overstory trees are no longer vigorous and growing. Fire free period is 5X longer than anything these stands experienced historically. There is an increase in fire intolerant species. Mt. and western pine beetle is increasing the rate of mortality in the larger trees.
Warm Dry and Warm Mesic Shrub/Herb East Side	10 - 50 range 10 - 24 non-lethal 25 - 50 mixed	Nonlethal fires favor ponderosa. Mixed mortality mod. severity fires favor larch and in some places lodgepole. Severe FRI of 30-60 yr. maintained persistent shrubfields. Mix mortality fires brake up continuity of fuels reducing subsequent fire size.	1,200' to 5,200'	Increases in insect and disease outbreaks. Landscape is becoming more homogeneous and fuels more continuous. Loss of early seral shrub component. Increase in stand replacing fires. Loss of ponderosa and larch result in cyclic stand initiation phase of Douglas-fir.
Warm Dry and Warm Mesic Shrub/Herb West Side	<200 severe stand replacing 50 - 100 mod. severity mixed	Mod. severity fires favor Douglas-fir dominance in post fire stands. Probability of stand replacing disturbance prevents development of w. hemlock dominated stands. w. hemlock dom. stands are rare as a result.	<3,000'	Fire cycles are likely to episodic and related to climate shifts over centuries where w. hemlock climax stands exist. Wind, insects, and root disease are the key disturbance elements creating structural diversity.
Warm Moist Shrub/Herb West Side	50 - 100 mod. severity mixed 150 to 500 severe stand replacing. 100-200 typical range	Probability of stand replacing disturbance prevents development of w. hemlock dominated stands. Douglas-fir is a long lived seral dom. in these systems. When FRI range between 300 - 600 yr. a mixed dom. of Douglas-fir and w. hemlock.	<3,000'	When Douglas-fir's life span is reached (approx. 400 yr.), w. hemlock begins to attain greater dominance. Climax stands begin to develop between 600 - 1,000 yr. Fire cycles are likely to be less regular and more episodic than in the warm dry and warm mesic climates.
Cool Dry Grass	24 - 200 range 30 - 50 non-lethal to mixed. 52-200 lethal	Lodgepole pine dominates early seres and fir of 41 yr. maintains stand. Lodgepole frost tolerance allows forest development where nothing else can grow. Fires are important to maintain meadow openings, ponderosa pine, and western larch.	1,200' to 6,000' most common between 3,000' and 6,000'	FRI influenced by adjacent communities disturbance regime. Increase in stand replacing fires that are larger and more extreme. Regeneration is difficult due to climate extremes.
Cool Mesic Shrub/Herb	117 - 200+ range stand replacing fires are weather driven. mixed mortality fires of small size were most common.	Lodgepole pine dominates the early seres. Lush understory retards fire size. Fire is important to maintain meadow openings. Small patchy fires are commonly started from adjacent communities. These fires disrupted the continuity of the available fuels.	1,800' to 6,000' most common between 3,000' to 6,000'	Fire size and severity likely to be greater because of more homogeneous landscape. Has not been forced outside the historic natural fire regime. With increasing fire-free period w. larch will disappear and less fire tolerant species will increase (subalpine fir & Engelmann spruce). Fire exclusion removes an important source of landscape diversity.

Biophysical Environments	Fire Return Intervals (FRI) in years	Ecological Significance	Elevation Range	Effects of Fire Exclusion
Cool Moist Shrub/herb	typically < 400 100 - 300 drier end of range 300 - 600 moister end of range	FRI < 160 yr. favors lodgepole FRI 100-200 yr. favors Douglas-fir FRI 300-600 yr. favors spruce & subalpine fir High moisture content of these habitat types dampen or extinguish fire spread from lower elevations.	between 3,000' and 4,500'	Forested stands in this habitat type have not been forced outside the historic natural fire regime. Over centuries silver fir, mt. hemlock, and w. hemlock begin to attain greater dominance as seral species reach the end of their life span and die out.
Cold Dry Shrub/Herb Cold Mesic Shrub/Herb and Cold Moist Shrub/Herb	60 - 300 range Mixed mortality fires are common. Longer fir are more common on north aspects.	Irregularly spaced fires with an 80 yr. av. is important for maintenance of whitebark pine. Whitebark pine is shade intolerant. Early and late seres allows for higher intensity fires. Subalpine larch is most prevalent on north aspects and whitebark pine on the south.	6,000' to 7,200'	Loss of whitebark pine to overtopping of more shade tolerant species. Increased mortality to Mt. pine beetle and white pine blister rust. Increase in stand replacing fires. Severe sites difficult to reforest. Risk of loosing whitebark pine from the stand resulting in a lower of timberline.

Vegetation Dynamics

To infer landscape change between past and current vegetation, two points in time were available. The earliest data was a 1922 map which provided a "snap shot" representing pre-European settlement conditions. This map was developed from intensive forest field reconnaissance and depicts vegetation structure and composition of the dominant cover types at that time. The map legend used in mapping was established by the Regional Office with the intent that it be used on both sides of the Cascade range. This made correlation of mapped cover types with present nomenclature for eastside forests difficult.

The second point in time was developed from 1983 satellite (LANDSAT) images that were interpreted under an Okanogan National Forest contract by Earth Resources Data Analysis Systems, Inc. (ERDAS). The primary data used was the current structural status associated with each BPE.

For both periods in time, species composition was inferred from current ecological knowledge of species distribution within a given BPE, and the influence of the associated disturbance regime on species composition and structure (See Appendix A and B).

The structural classification of the 1922 and 1983 data is similar enough to allow comparison of ecological change across the landscape. Structural breaks used in this assessment between the 1922 and 1983 landscapes are described below.

Biophysical environments are based on the climatic and physical characteristics of the landscape that do not change readily over time, yet they share similar disturbance regimes. As a result they create ecological niches for similar plant associations that also do not readily change over time. This makes biophysical environments useful in assessing change over a relatively stable ecosystem between the two periods.

Inferences were made about the distribution of late successional forest habitats in 1922 based on structural patterns that evolved under the pre-European era disturbance regime. Comparing the current landscape pattern with that of 1922, changes in landscape patterns could be inferred. This comparison also provides some idea of how sustainable a given habitat is into the future.

This method was not intended to display absolute change on any given acre but to infer change in landscape pattern based on large scale processes. Because landscapes are dynamic systems that change in both space and time, the 1922 landscape only depicts one point in time within the natural range of variability of the assessment area. The structural changes displayed in Table 2- 2 represent several disturbance events in both time and space within each BPE. Because Table 2- 2 displays the cumulative sum of several disturbances within a biophysical environment, the comparative value increases and landscape trends can be traced.

For the 1983 landscape:	**For the 1922 landscape:**
IMMATURE: Stand Initiation phase dominated by seedlings and saplings (<5 inches DBH).	IMMATURE: trees less than 4 inches DBH
YOUNG: Stem Exclusion (open and closed canopy), Understory Reinitiation, and Multi-stratum without large trees. Dominant trees in these stands are pole size (5-14 inches).	YOUNG: trees were between 4 inches and 11 inches DBH
MATURE: Multi-stratum with large trees and Single-stratum with large trees. Large trees are defined as trees greater than 14 inches DBH for the 1983 data.	MATURE: trees were greater than 11 inches DBH.
NONFOREST: All meadows, shrub steppe, rock, ice, woodlands, and hardwood cover types.	NONFOREST: All treeless meadows, shrub steppe, rock, ice, and hardwood cover types.
SUBALPINE: Communities nearing the upper elevation timberline that were not described structurally in the 1983 data. Instead they were described as a forest meadow complex where 25 percent to 40 percent of the area was in alpine meadow.	RECENT BURN: Forested areas recently burned that were in the herbaceous or shrub seral stage. These were areas identified for reforestation needs. In the 1983 coverage this acreage would be included in the Immature classification.

Table 2- 2 Landscape Changes in Structural Characteristics Between 1922 and 1983

BPE	% Area	% Distribution 1922 Vegetative Structure					% Distribution 1983 Vegetative Structure			
		Non-forest	Recent burn	Seed / Sap	Young	Mature	Non-forest	Seed / Sap	Young	Mature
Hot Dry	10.0	22.8	trace	0.7	1.0	75.5	29.7	5.6	43.7	21.0
Warm Dry	15.0	9.8	0.7	2.6	10.7	76.2	12.1	7.8	55.1	24.8
								SUBALPINE = .2		
Warm Mesic	28.0	8.7	0.8	4.7	19.3	66.5	7.2	7.0	50.3	35.1
								SUBALPINE = .5		

BPE	% Area	% Distribution 1922 Vegetative Structure					% Distribution 1983 Vegetative Structure			
		Non-forest	Recent burn	Seed / Sap	Young	Mature	Non-forest	Seed / Sap	Young	Mature
Warm Moist	2.0	26.0	5.0	4.0	51.0	14.0	26.3	6.6	41.5	20.9
								SUBALPINE = 7.7		
Cool Dry	4.0	13.0	2.2	9.0	50.7	25.1	25.1	4.4	26.6	35.5
								SUBALPINE = 8.3		
Cool Mesic	16.0	17.4	2.2	5.3	54.8	20.3	25.4	6.0	19.9	28.8
								SUBALPINE = 5.3		
Cool Moist	12.0	12.0	2.9	6.6	44.3	34.2	13.9	2.1	43.1	35.3
								SUBALPINE = 5.5		
Cold Dry	3.0	42.5	0.2	3.9	48.0	5.3	68.0	trace	1.2	0.9
								SUBALPINE = 29.9		
Cold Mesic	6.0	45.0	0.7	3.3	46.0	5.0	61.9	0.2	5.2	3.7
								SUBALPINE = 28.9		
Cold Moist	4.0	27.5	1.0	8.1	55.0	8.4	39.4	0.2	12.4	13.7
								SUBALPINE = 34.4		

Comparisons were made covering only those areas with data on both the 1922 map and the 1983 satellite map (726,439 acres). This excludes areas west of the Cascade range crest and a small portion along the north shore of Lake Chelan.

Results

The combined hot dry, warm dry, and warm mesic environments make up 53 percent of the area east of the Cascade Crest. These ecosystems are highly dependent on frequent, non-lethal fires for their sustainability and are considered fire climax communities (see Table 2-1 for disturbance regime details).

Twenty-five percent of the assessment area falls within the hot dry and warm dry BPEs. Forested stands evolved under a frequent, low-intensity fire regime and are considered fire climax communities. Size class distributions within these environments demonstrates the stability of a fire climax community. Over 75 percent of the area was maintained in a late successional state. Ponderosa pine was the dominant mature tree species. Abundance of mature trees with gnarled limbs and dead tops provide important habitat for various wildlife species. Between two and fourteen percent of the landscape supported other than mature stands of trees. The percent composition of stands less than 11 inches DBH demonstrates the rare nature of a stand replacing fire event in these environments (Table 2- 2). Fire return intervals that averaged 7.5 years and rarely exceeded 18 years maintained the open parklike stands of mature ponderosa pine within the hot dry and warm dry BPEs (Ohlson 1996).

Twenty-eight percent of the area falls within the warm mesic environment; covering the largest acreage in this assessment area. With fire return intervals typically ranging between 10 and 50 years, a mosaic of landscape structures were maintained. These are also fire climax communities that evolved under a more moderate fire regime. Small pockets of lethal severity fires occurred within larger blocks of non-lethal underburns. Over 60 percent of the area was maintained in a late successional habitat with "low to moderate" intensity fires. The 1922 data shows the landscape supported nearly twice as much area in young structural classes over the hot dry and warm dry environments. This indicates that these communities evolved under a more moderate fire regime compared to the hot dry and warm dry environments. Ponderosa pine along with Douglas-fir dominate the stand composition because of the slightly longer fire return interval.

Today, there has been a 47 to 72 percent reduction in the mature, late successional forests in the hot dry, warm dry and warm mesic environments as compared to the 1922 landscape. This loss is attributed to past logging practices that selectively logged the large old ponderosa pine from the stands along with the increased loss of the large pine to beetle attacks. Since fire exclusion, dense, multi-stratum canopies are developing under the open parklike, mature ponderosa pine stands. Fuels are becoming more contiguous horizontally and vertically with development of the understory canopy. Fires will likely be lethal and stand replacing when they occur in the future, leaving large blocks burned. The over stocked nature of these stands will also accelerate the loss of the large, old tree component as a result of insect attacks, further reducing the amount of late successional habitat. Under current direction to reduce smoke emissions and aggressively extinguish fires in these environments, there is no way to sustain or increase the amount of late successional forest habitat. In order to be sustainable, these fire climaxes require frequent, low-intensity fires to thin stand densities and reduce fuels. With continued fire exclusion and without an aggressive thinning program, late successional ponderosa pine forests will continue to diminish at an increasing rate with the increasing fire-free period.

Frequently recurring low intensity fires maintained large contiguous blocks of open forests habitat with few snags and little coarse woody debris. In the upper elevations associated with the moister sites, where moderate intensity fires occurred, small pockets of refugia likely provided greater structural and species diversity across the landscape.

Sixteen percent of the assessment area is within the cool mesic environment. This environment supports the richest diversity of forested communities ranging from moist Douglas-fir to pacific silver fir and mountain hemlock (Table 2-1). Fires are typically stand replacing in nature, with fire return intervals between 117 and 200 years. Lodgepole pine dominates the early seral stages. Fire return intervals are frequent enough to perpetuate a landscape dominated by lodgepole pine. This is inferred by the dominance of stands between 4 inches and 11 inches DBH since lodgepole pine rarely exceeds 11 inches DBH before reburning. If fire return intervals exceed 160 years, other species such as Douglas-fir, subalpine fir, mountain hemlock, or pacific silver fir become co-dominant with lodgepole pine. These stands likely account for the 20.3 percent of the landscape supporting mature stands.

Today, there is an increasing trend toward mature stands and a reduction in young stand structures. Since 1922 there has been a 63 percent reduction in stands between 5 and 14 inches DBH. This suggests lack of fire in this environment may have allowed large acreages of mature lodgepole pine to develop across the landscape. These stands are beginning to break up as the lodgepole pine senesces giving way to the climax species in the understory. Fire-free periods for the large scale fire events are within their historical ranges at the landscape scale. However, with fire exclusion, the periodic small patch fires that occurred between the large stand replacing fire events are typically now being suppressed. This has resulted in the loss of structural and species diversity across the landscape as well as increased the homogeneity of the fuels and the crown fire potential.

The cool moist environment makes up 12 percent of the assessment area. Pacific silver fir and mountain hemlock plant associations are the only plant associations found in this environment. This environment represents the lower elevation range where Pacific silver fir and mountain hemlock communities are found. Douglas-fir is an important seral dominant in these stands. With a fire-free period ranging between 100 to 300 years, these stands are structurally diverse and support a rich diversity of species. The largest blocks of contiguous multi-structured habitat is likely associated with this environment. Coarse woody debris is abundant in those plant associations associated with the cool moist environments.

Today the structural characteristics of the landscape are virtually unchanged from the 1922 conditions. These stands are well within their inherent fire regimes. The plant communities in the cool moist environment are not likely to change significantly over the next 50 years. Fire risk is low in these environments except under extreme weather conditions which are more episodic than in the previously discussed BPEs.

The cool dry environment makes up only four percent of the assessment area. It covers a wide elevation range from mid-elevation to near timberline and is typically associated with southerly aspects and cold air drainages. Because of the narrow ecological range associated with the cool dry environment, it is frequently a small inclusion within a larger environment. Fire return intervals vary considerably within this environment, and they are closely linked to the adjacent environment's disturbance regime. Fire return intervals were typically less than 200 years, rarely allowing climax communities to develop. Lodgepole pine and Douglas-fir dominate the early seral stands and were maintained by fire.

The cold dry, cold mesic, and cold moist environments make up 13 percent of the assessment area. All are cold, high elevation (>5,000') environments. These communities are open parklike stands with large alpine meadows interspersed between equally large blocks of forest. Fire plays an important role in the maintenance of these meadow systems and ensures adequate planting sites are available for the perpetuation of whitebark pine. Like the ponderosa pine fire climax communities, the whitebark pine communities are also fire climax communities. Fire return intervals are irregular, ranging between 100 to 300 years with an average fire return interval of about 80 years. This type of fire regime results in "low to moderate" intensity fires where whitebark pine is able to survive. Because this is such a harsh environment, growth is slow and trees remain small throughout their life. Mature, late successional characteristics develop in stands 8 inches DBH and larger. Over 50 percent of the forested area was maintained as mature, late successional forest historically. Whitebark pine is a keystone species in ameliorating the harsh timberline environments, allowing a diversity of species to establish in its understory.

Fire

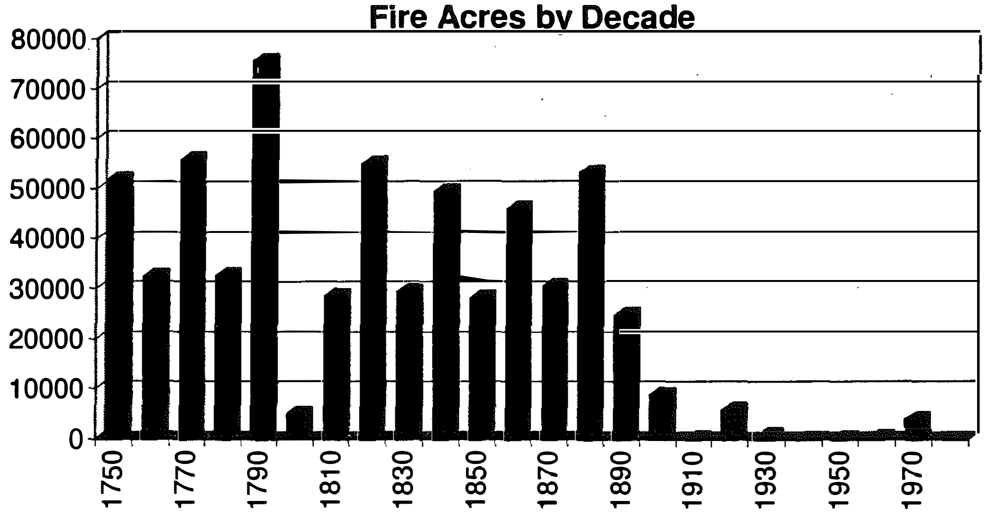
Trends

Vegetation trends have influenced fire trends, particularly severity. As the warmer, drier sites developed with more stand density due to successful fire suppression, the stands became more prone to crown fires. There is more homogeneity present now, which fails to provide changes in fuel types and leads to larger, more severe fires. These changes are more apparent in the ponderosa pine stands at lower elevations than in the mixed conifer/ subalpine fir stands in the higher elevations. Several fire intervals have been missed on the ponderosa pine sites whereas few or none have been missed at the subalpine fir sites. However, the subalpine fir sites are losing diversity, particularly in structure, as a result of lack of fires to provide a mosaic of stands. Subalpine fires are infrequent, averaging about 130 years on south slopes and ranging from 107 to 200 years and greater on north aspects. Because of this, fires are often more intense than typical frequent underburns of the low country, but smaller in size (3,000 acres as opposed to 30,000 acres) (Schelhaas, D. work in progress). Recent fire records (since 1910) indicate that about 62,000 acres burned in the assessment area in the 1920s. Since then there has been little fire activity. More aggressive fire suppression efforts have resulted in fewer fire escapes. When fire weather is extreme, fire escapes are more likely. These conditions occurred in the 1970s when 11,000 acres burned and during the 1980s when about 10,100 acres burned. During the last nine years 6,100 acres have burned in the assessment area.

Forty percent of the 1920 fires occurred in the Ponderosa Pine and Dry Douglas-fir PAG, with an additional 23 percent occurring in Moist Douglas-fir PAG. Most of the remaining fire acres occurred in the Subalpine Fir PAGs. The fires occurring in the Ponderosa Pine and Dry Douglas-fir PAGs would have been primarily low intensity fires. From the 1970s until present, the fires in these PAGs have been higher intensity fires consisting of a lot of crown fire and consuming most of the trees within the fire perimeters. Research in progress in the Entiat watershed on the Wenatchee National Forest (Schellhaas, D. work in progress) has determined that from 1700 through 1860, defined as "pre-settlement", nearly 100 percent of the 40,000 acre watershed was consumed by fire every decade. There was no detectable difference in burning patterns from north to south aspects or within riparian areas in the ponderosa pine-Douglas-fir community type. From 1860 to 1910, or the "settlement" period, approximately 80 percent of the watershed was consumed by fire every decade. During the "fire suppression" years of 1910 to 1990, only 4 percent of the watershed burned per decade.

Figure 2- 2

Entiat/Mud Creek Ponderosa Pine/Douglas-fir Community Type Fire Acres by Decade



The research data from the "suppression" years matches the data from the LSR assessment during the same period of time. It is safe to assume that the Ponderosa Pine and most of the Dry Douglas-fir PAGs, and some of the Moist Douglas-fir PAG were also consumed by fire every decade within the LSR Assessment area. Since 1970, in the LSR assessment area, fire has increased in size in spite of our best suppression efforts. This can be attributed to the increase in biomass and ladder fuels in the understory, which increases stand density and susceptibility to crown fires. This trend is expected to continue until the stand densities are reduced in the Dry Douglas-fir and Ponderosa Pine PAGs. Fire maintains the early seral, fire resistant species in these communities and is necessary to maintain ecosystem stability. If these dry climate PAGs continue on their present course without the influence of fire, the early seral species (ponderosa pine) will be virtually eliminated from the landscape within 100 years. Fire size and intensity will continue to increase making it difficult to offer fire protection to late successional stands and other valuable improvements both on and off forest lands. Risks to firefighters attempting to suppress these fires and the associated suppression costs will also continue to rise with less success than was witnessed in the mid 1900s.

Fire History

Actual fire records were used to determine recent fire history from 1910 to present. Expected number of fire ignitions per year for the LSR assessment are six and the expected number of acres burned per year are 976. Expected acres burned per fire per year are 155. Pre-settlement conditions burned an average of approximately 1,600 acres per fire in the ponderosa pine-Douglas-fir community type.

Natural fire rotations are 907 years for the assessment area in present times. This means it will take 907 years to burn the entire acreage once.

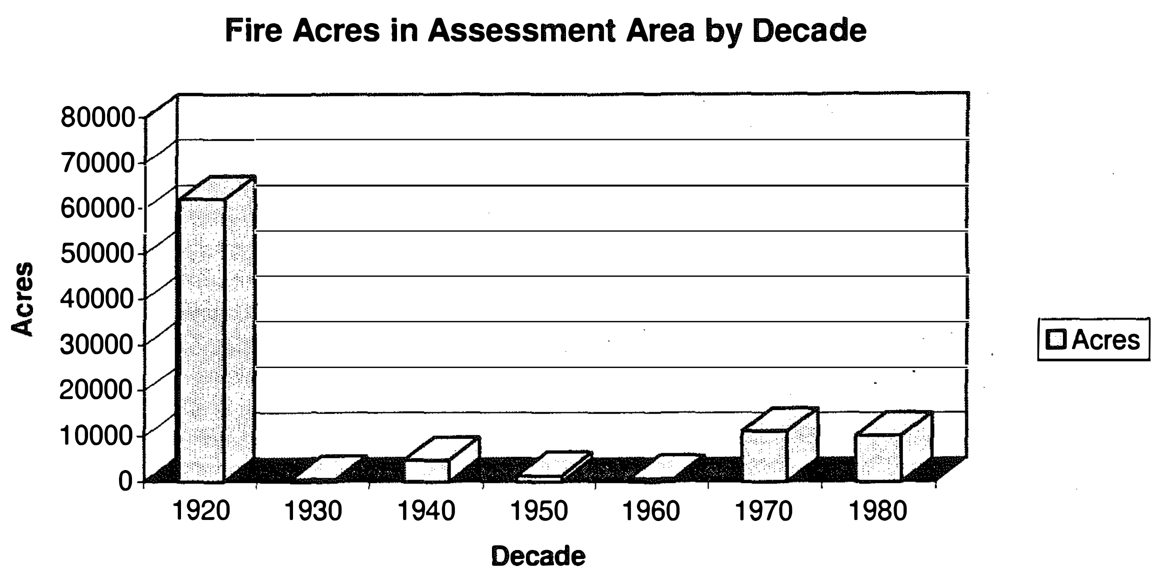
The pre-settlement natural fire rotation is about 12 years with an average fire-free period of seven years for the ponderosa pine-Douglas-fir community types. Maximum fire return intervals expected for the plant association groups are: <50 years for Ponderosa Pine, <50 years for Dry Douglas-fir, >50 years for Moist Douglas-fir, <200 years for Dry Subalpine fir, >200 years for Moist Subalpine Fir, 60-300 years for Whitebark Pine/Subalpine Larch, >200 years for Pacific Silver Fir/Mt. Hemlock, and 100-200 years for Western Hemlock.

Fire Risk

The assessment of the risk of stand replacing fires within the LSRs is based on crown fire potential, or the likelihood that surface fires will move into the crowns of the trees and sustain an active crown fire. An active crown fire requires surface fire intensities high enough to initiate crown fire, considering the height of the crown and ladder fuels. Crown closures greater than 75 percent and heavy fuel loadings will enable a crown fire to continue to spread horizontally. There are years when fuel and weather conditions combine to create critical fire conditions which promote the spread of large-scale (10,000 acres and greater) fires. It is recognized that during these conditions, most presuppression efforts to reduce the threat of these events will not be effective. However, most years, these same presuppression efforts will offer protection from stand-replacing fires. In the assessment area about 18 percent of the stands have a high rating. This can be considered a high percentage of the stands in jeopardy of being lost to fire. However, the more significant question is where do these ratings occur? For example, high crown fire potential stands occurring in high elevation stands on north slopes in the Moist Subalpine Fir Plant Association Group is not alarming, but expected. In these areas it is more important to identify low ratings which could be utilized as possible fuel breaks where there is an opportunity to contain a fire where it is expected to leave the crowns and return to a surface fire. This is when suppression activities are most likely to be successful. In these stands fires normally burn in the crowns as stand replacing fires, and the suppression strategy in LSRs should be to limit the acres involved by taking advantage of natural barriers and stands with "low" crown fire potential. Early seral conditions are lacking in most of the high elevation PAGs. Fires of 5,000 to 10,000 acres will provide an opportunity to provide this seral condition and the associated diversity to the LSRs. A good example of this is the Camas Fire area in the Sawtooth LSR. When considering crown fire potential on more arid, low elevation sites associated with ponderosa pine, a crown fire potential of "moderate to high" may be of concern. It would indicate a lack of normal fire intervals due to successful suppression activities over the last 60 years. The result is an increase in stand density and structure, but not an increase in surface fuels. Therefore, the crown fire potential rating may not be "very high to extreme", but "high" for this particular site. Crown fires would be more likely to occur today than they would have historically when shorter fire-free intervals maintained more open stands. Therefore, it is important to consider the crown fire potential for each of the PAGs within the LSRs to assess whether or not it should be a concern.

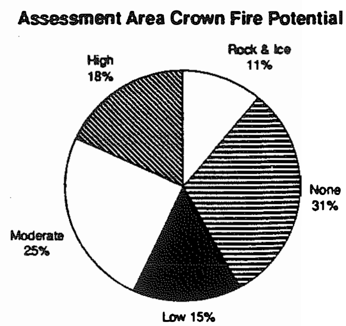
Crown fire potential ratings used in this assessment are: NONE, LOW, MODERATE, and HIGH. NONE is an indicator that the area can burn, but will not involve crown fire in the flaming front. These areas are grasslands, brush fields and open woodlands with less than 30 percent crown closure. The trees may torch, but will only involve one tree or a small group of trees. A LOW crown fire potential rating indicates that the canopy closure is greater than 30 percent and the stand is probably single layered. Fuels are light enough that it is unlikely that fireline intensities will reach the level required to initiate crown fire. Fires will primarily be a non-lethal underburn. MODERATE crown fire potential will have more canopy closure and probably involve a second layer in the stand, contributing to ladder fuels. Fuel loadings are moderate and fires will occasionally involve some crown fire and torching activity. It will not usually sustain an active crown fire. These areas will burn with a combination of non-lethal underburning intensities and lethal intensities which may consume crowns. Areas with HIGH crown fire potential can be expected to support running crown fires when fuel moistures are low enough to allow surface fire spread. Many of these ratings occur at high elevations on north slopes that have a short drying season. On average years these stands may provide fire barriers due to their high moisture content.

Figure 2-3



When the fuel moisture is low enough to support combustion and fire spread, the intensities will be high enough to readily move the fire through the ladder fuels and into the crowns.

Figure 2- 4



Smoke

A modeling analysis has been conducted by the USDA Forest Service, Region 6, PNW Research Station, and Earth Tech, to estimate the impacts of wildfire and prescribed fire on air concentrations of particulate matter and visibility in the Interior Columbia River Basin (Scire, J and Tino, V, 1996). The predicted concentrations for the prescribed burn scenarios were substantially lower than wildfire scenarios for several reasons:

1. The acreages burned with prescribed fires are generally lower.
2. Dispersion conditions during the spring and fall prescribed episodes are better.
3. Emissions per acre from prescribed burns are less than wildfires because they are burned at higher fuel moisture content.
4. There are large numbers and a larger spatial distribution of prescribed fires resulting in better dilution of the fire emissions.

A study is being undertaken to determine the level of prescribed fire treatment necessary to minimize smoke from both wildfire and prescribed fire. The model is complete and runs have been analyzed. Results from the model runs indicate there is a slight "U" shaped curve, and that prescribed fires are shown to decrease total emissions over time. This model can be used to help determine the level of prescribed fire activity necessary to reduce total emissions, and also to define the upper limits of this activity to minimize the likelihood of an increase in emissions through use of too much prescribed fire.

An assessment of the landscape, in the Interior Columbia River Basin, over time with regard to fuel load, fuel hazard, and smoke production was completed (Quigley, T., Haynes, R., and Graham, R., 1996). Ten of the 13 ecological reporting units indicated an increase in fuel loading, fire behavior potential, crown fire potential, and smoke production over time. It was determined that prescribed fires produce 50 percent less smoke than wildfires.

The implications of these studies and modeling results to the LSRs are that without any further fuel modifications, wildfires will continue to increase in size and intensity. The emissions from these fires will also continue to increase. It is possible to develop an aggressive prescribed fire program which will effectively reduce total emissions resulting from a combination of wildfire and prescribed fire.

Roads

The Forest road system was primarily constructed to access timber and now provides secondary benefits for many other forest management activities. These roads allow access for activities such as reforestation, timber stand improvement, prescribed fire, and for controlling wildfires. Roads are a key recreational resource in the area, providing opportunities for scenic viewing and access to the outstanding variety of recreational opportunities the area has to offer. (See Chapter 3, Recreation/Tourism for information on heavily used roads.)

Forest road construction alters the landscape by removing vegetation and disrupting hydrologic continuity. These alterations may benefit some terrestrial vertebrates while it adversely affects others. Road construction may result in the creation of wetlands, or impoundments, and may incorporate bridges and culverts. These features provide habitat for nesting waterfowl, swallows or roosting bats. Road corridors may also increase the amount of edge which provides for species diversity. However, these benefits are almost always outweighed by the negative effects.

Roads directly impact wildlife species by reducing or fragmenting suitable habitats. Connectivity between remaining suitable habitats may be reduced or blocked through fragmentation of travel corridors. This is evident in connectivity between the Sawtooth and Twisp River LSRs. Habitat effectiveness is reduced because roads alter an individual or species behavior and how the habitat is used. Populations of some species in an entire watershed may be reduced or eliminated through displacement brought about by forest road construction.

Poorly designed roads also directly affect aquatic habitat within the LSRs by increasing sediment delivery to streams. This is an underlying reason for no new road construction in key watersheds as identified in the Aquatic Conservation Strategy. This direction affects the Nice, Upper Methow, and Twisp River LSRs, and is an important consideration in planning management of these areas.

The system of forest roads also indirectly effects terrestrial vertebrates for a number of reasons. These may include increasing competition between individuals and species, increasing predation, increasing human disturbances, increasing removal of snags and down logs, and providing for a source of fire ignitions.

Increased human access in the forest significantly increases human disturbances resulting in greater vulnerability of wildlife to harassment and mortality. Human-caused mortality brought about by vehicle collisions, illegal killings, trapping and excessive hunting pressures may impact entire populations. Open road densities exceeding one mile per square mile are known to impact several wildlife species. Research has indicated that gray wolves do not regularly occur where road densities exceed 0.9 miles per square mile (Mech etal,1988).

Indirect effects of forest roads also increase the likelihood of removing specific late-successional forest attributes such as snags and down logs. Easier human access for fuelwood gathering, which includes the cutting of standing dead trees and removing down logs, reduces available habitat for species dependent or closely associated with these attributes. These losses may be significant in late-successional forests where management for habitat of dependant and closely associated species emphasizes retention of these components. One mile per square mile may also affect grizzly bear use patterns (Frederick 1991).

Open road densities vary from roadless (making up about 516,080 acres or 58 percent of the assessment area) to over 5.0 miles per square mile. Analysis of currently roaded areas with densities greater than 2.1 miles per square mile in the assessment area account for about 26,415 acres or 3 percent. There are about 75,780 acres or 8 percent with road densities of 0.1 to 1.0 miles per square mile and 77,890 acres or 9 percent with densities of 1.1 to 2.0 miles per square mile. Map 6, Appendix H, provides locations of all system roads and trails.

A watershed analysis has been completed for all the watersheds located within the LSRs. Specific direction and recommendations for road management are contained in these documents.

Insects & Diseases

Each change agent discussed in this section is organized into three parts. The first looks from the present, back 17 years. The purpose of this is to gain some understanding of what some of the biotic and abiotic change agents are, and what their magnitude and distribution has been. The second part looks at trends given the cyclical nature of populations and the distribution of habitat/host species. The third part estimates the potential or risk of spread.

Detection surveys have been conducted throughout the Region and Okanogan National Forest since the late 1940s. This information has been digitized for four primary insect groups for the period 1980-1996. These groups are:

1. Western spruce budworm (Choristoneura occidentalis, Freeman);
2. Fir beetles in general which include Douglas-fir beetle (Dendroctonus pseudotsugae, Hopkins), Fir engraver (Scolytus ventralis, LeConte), Douglas-fir engraver (Scolytus unispinosus, LeConte), and western balsam bark beetle (Dryocoetes confusus, Swaine)

3. Pine beetles in general which include mountain pine beetle (Dendroctonus ponderosae, Hopkins), western pine beetle (Dendroctonus brevicomis, LeConte), and pine engraver beetles (primarily Ips emarginatus, LeConte)
4. Other damage which includes Engelmann spruce beetle (Dendroctonus rufipennis, Kirby), lodgepole pine needle cast (Lophodermella concolor, Dearn), balsam woolly adelgid (Adelges piceae, Ratzeburg), larch needle cast (Meria laricis, Vuill), slides, red belt, wind, fire, and water.

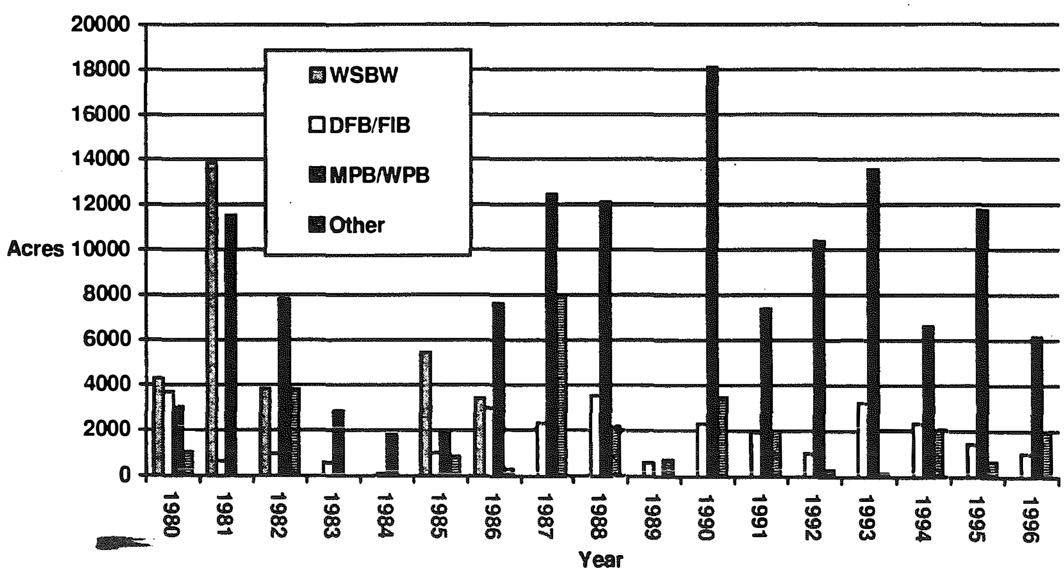
Table 2-3 and Figures 2-5 through 2-9 show the acreage affected by the respective forest insect or damaging agent. These data are based on aerial detection surveys conducted during the period 1980 through 1996.

Table 2-3 - Summary Of Insect And Other Damage Agents Observed During The Period 1980-96.

(Values displayed are acreage per year. The intensity of occurrence is available in LSRs project files)

	Spruce Budworm	Doug-fir Beetles	Pine Beetles	Other Damage
Total	27119	29617	73970	27290
Average	1595	1742	4623	1605
Range	0-13850	92-3711	1770-18098	0-7923
Median	6925	1902	9934	3962

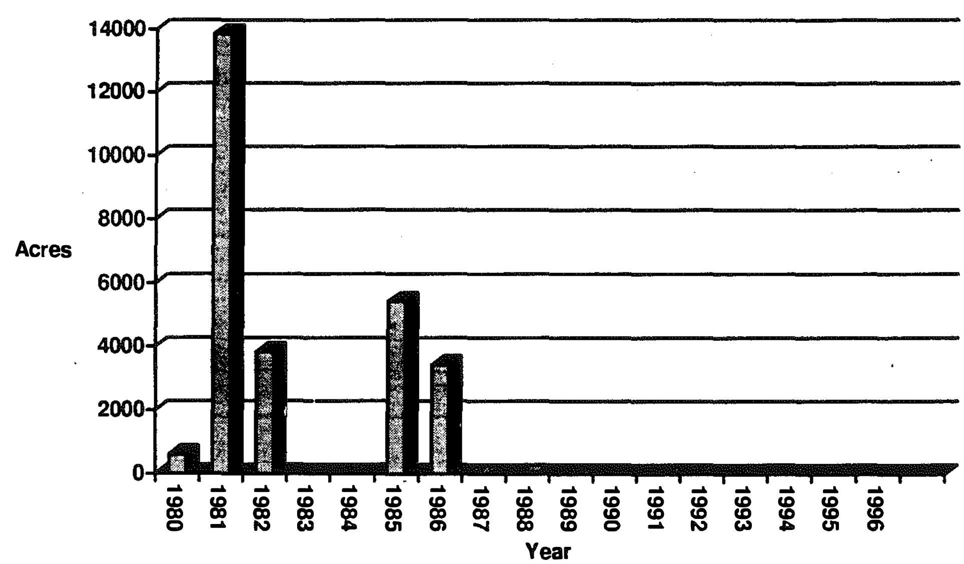
Figure 2- 5 - Graphical Summary of Aerial Detection Survey for Western Spruce Budworm, Douglas-Fir and Fir Engraver Beetles, Mountain and Western Pine Beetles, and Other Damaging Agents for the Period 1980-1996.



Discussion

Western Spruce Budworm: has steadily declined since the late 1970s when aggressive campaigns were conducted to control outbreak conditions. This is not to say that the aerial spray programs are to be entirely credited with the collapse of the outbreak (climatic conditions during early larval instars are also significant in population control), but rather to give an indication that the incidence of observation has declined. Based on work conducted throughout Washington and Oregon from 1947-1979 (Dolph, 1980) spruce budworm has been recorded at levels ranging from 240-353,980 acres on the Okanogan National Forest. The peaks of the cycles occurred in 1947 and again in 1976 with the Twisp River drainage being at the center of some of the major outbreaks. Data recorded since 1979 Indicated population levels that went from 239,770 acres to less than 4,000 acres in 1980. The increase in 1981 to almost 14,000 acres was followed by a decrease to present day where no noteworthy incidents of budworm activity are being monitored. Currently, the incidence of spruce budworm activity is low. Activity centers occur where Douglas-fir and Subalpine fir form contiguous forests over large areas. These contiguous forests are generally well distributed throughout the assessment area north to south. During the period between 1980 and1990, the primary centers of defoliation were in the following drainages (working from the south): Main Fork Gold, Prince, Libby, Scaffold/Buttermilk, Upper Twisp River, Huckleberry, Goat, Gate, Lost River, Trout, and Canyon on the northern boundary. Canyon Creek is also the area where the most noticeable activity had been during this period. Nearly 3,000 acres were defoliated, but have since recovered.

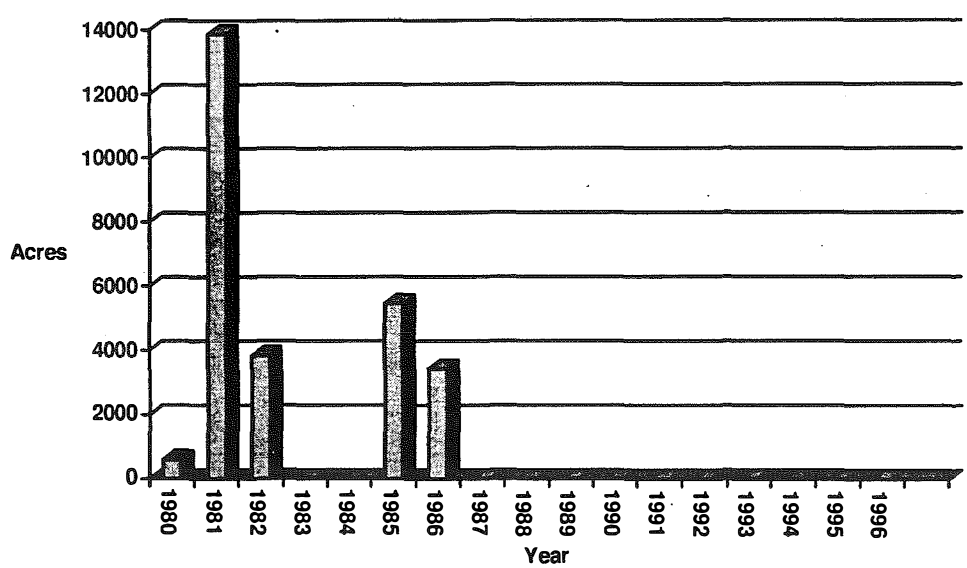
Figure 2- 6 - Western Spruce Budworm Observations Within the Assessment Area 1980-1996.



Based on the distribution of available host species, th[redacted]sk of another outbreak ranges [redacted]n host [redacted]another outbreak is "high" on 7 percent of the area (63,000 acres), "moderate" on 13 percent of the area (117,000), and "low" on 10 percent (89,600 acres), based on PAG mapping. The are approximate due to the nature of modeling and accuracy of the base data. Other factors, such as elevation, canopy closure, tree size, and stand structure, also contribute to the overall risk rating. The highest risk areas are where the primary hosts (Douglas-fir and Subalpine fir) are found on lower elevations below 3,600 feet, easterly aspects, and are multi-canopy stands comprised of larger trees that are more densely stocked. Western Spruce Budworm has the potential to be a major disturbance agent, especially in the Dry Douglas-fir PAG. Understory trees are the most vulnerable, usually leaving the larger overstory trees intact. Severe outbreaks tend to reduce the structural diversity of a stand and increase fuel loading, which results in increased fire severity. Repeated defoliation predisposes the surviving trees to bark beetle attack. The areas that are within the assessment area that meet these criteria are most commonly found in the following drainages: Canyon/Granite, Lost River/Goat, Eightmile/Falls, Wolf, Twisp River, and Libby/Gold/Black Canyon Creeks. (See Map 7, Appendix H, of Western Spruce Budworm Risk.)

Fir Beetles is a general label that for purposes of this report include Douglas-fir beetle and fir engraver. They have been observed throughout the area in relatively low levels since the early 1980s. The nature of these insects is to attack trees that are already weakened by biotic causes such as root disease or defoliation. There is a strong linkage between root disease and fir engraver beetles (Flanagan, 1994). Abiotic causes, such as windthrow, drought, or fire, also predispose Douglas-fir and true firs to bark beetle attack. Drought and fire can provide landscape level conditions that promote fir beetle attack as well. Windthrow conditions typically don't exist over large expanses. Trees less than 12 inches are rarely attacked by Douglas-fir beetle, and individual trees or small groups of trees are usually effected. Fir engravers typically top kill their hosts unless populations are in sufficient numbers to kill the tree. Neither of these species produce outbreaks of sufficient size to be a concern. In fact they serve an important role in producing snags and adding to the structural diversity. Most of the higher incidence of Douglas-fir bark beetle activity has been observed in the following drainages: Canyon, Robinson, Lost River, Gate/Roundup, upper Wolf, and War.

Figure 2-7 - Douglas-Fir and Fir Engraver Beetle Observations Within the Assessment Area 1980-96



Conditions that lead to attack are sporadic and random. Trends can be difficult to analyze and risk can be difficult to predict because outbreaks also follow this pattern. The duration of an outbreak is usually short, lasting about 2-3 years, but the numbers of trees affected can be significant. Following the first year of an outbreak, four times as many trees may be affected during the second year, and 25 times as many again being affected the third year.

Predicting the risk of an outbreak can be difficult due to the uncertainty of physical environmental stresses. However, because of the linkage to other biological stress factors, outbreak potential can be correlated to host species distribution and other forms of stress such as defoliation. The highest risk areas within the assessment area are located in relatively small centers throughout; however, some concentrations occur near the confluence of Canyon and Granite Creeks, in upper Eightmile Creek, Lookout Ridge, and along the Twisp River.

Fir engraver:

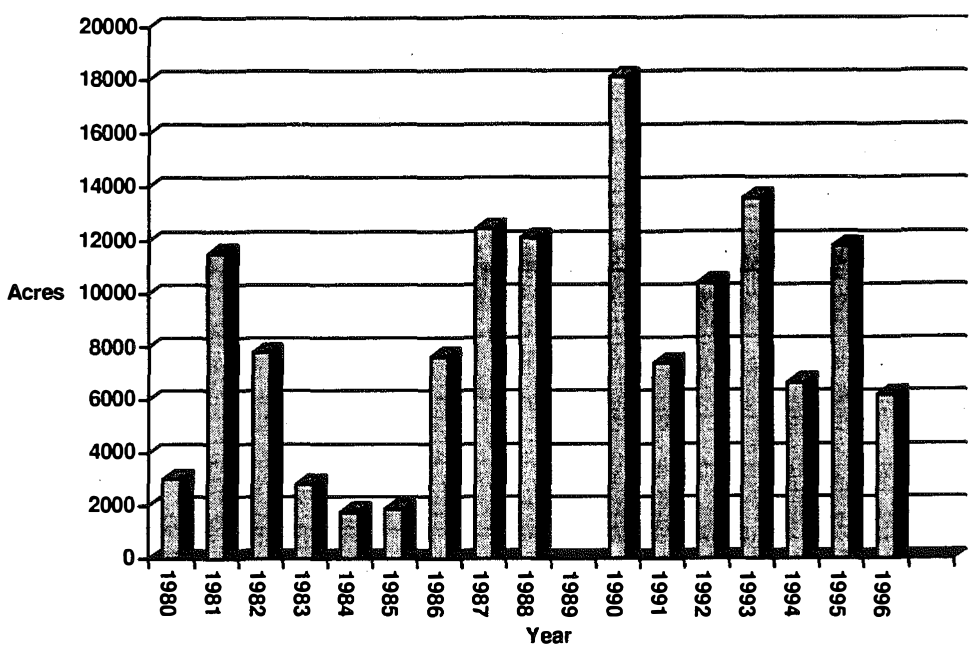
Low	3%	29,471 ac.
Medium	22%	196,893 ac.
High	4%	37,595 ac.
Very Low	70%	619,288 ac.

Douglas-fir beetle:

Low	3%	24,051 ac.
Med.	11%	97,364 ac.
High	2%	13,138 ac.
Very Low	84%	748,694 ac.

Pine Beetles is a general label for two species of pine beetle. One is the mountain pine beetles which attack lodgepole pine, ponderosa pine, and whitebark pine. The other is western pine beetle which attacks ponderosa pine. Both are well distributed throughout the forested portions of the assessment area where lodgepole and ponderosa pine are present. Most of the observed incidence has been since 1986, and located in the following areas: Canyon Creek, the Chewuch River and tributaries, Goat Creek, Wolf Creek, War Creek, and along the eastern front of the Sawtooth LSR from Crater Creek south through Black Canyon Creek.

Figure 2-8 - Mountain and Western Pine Beetle Observations within the Assessment Area, 1980-96.



The general trend has been toward an increase in distribution and intensity over the past decade when compared to the previous 10 years. Stand and environmental conditions that increase stress and competition for moisture predispose pine species to bark beetle attacks. Due to the expansive acreages that were burned during the late 1920s in the pine type, stand conditions have become in recent years more susceptible to population increases. Average stand diameters, stocking and age are combining to place forested areas with pine components at relatively high risk of bark beetle attack.

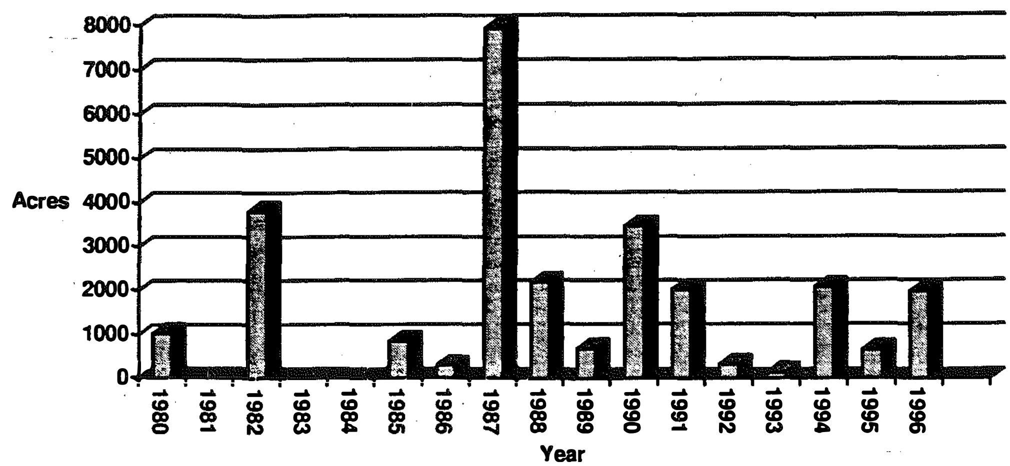
Mountain pine beetle is a major disturbance agent in lodgepole pine stands causing significant mortality. When significant lodgepole pine cover is killed, the stands become predisposed to stand replacing, high severity fires, or loss of the early seral species promotes successional development of the stand by releasing the late seral species in the understory. Outbreaks can be serious in whitebark pine stands where removal of the trees in these harsh, high elevation sites may result in a major species conversion on the site and loss of a coniferous overstory. Mountain pine beetle is most likely a chronic problem in young ponderosa pine stands because the largest trees are continually removed from the stand. Development of a mature stand of ponderosa is unlikely because the stress created from the overstocked condition of these stands continually perpetuates ideal conditions for pine beetle activity.

Western pine beetle is a serious threat to mature ponderosa pine. Losses of large, old pines are chronic and significant because of the overall lack of the large old trees across the assessment area. Outbreaks can be severe resulting in species conversions on some sites. Western pine beetles normally breed in large, old trees, in windfalls, or trees weakened by root disease, drought, overstocking or fire.

Risk modeling indicates that these same areas mentioned above will continue to provide "moderate to high" risk habitat for pine beetles. This is because stand densities will continue to increase, and cause environmental stresses which predispose trees to attack. (See Map 8, Appendix H, for Pine Bark Beetle risk.)

<u>Other Damage:</u> includes Engelmann spruce beetle, lodgepole pine needle cast, balsam woolly adelgid, larch needle cast, slides, red belt, wind, fire, and water. These insects and diseases can have dramatic effects on a forested landscape as many are a function of a climatic event that can have swift and large scale distribution. Extensive Engelmann spruce stands on the order of those documented in parts of western Montana or eastern Oregon are not found in the assessment area. There has been, however, a history in this area of localized events that have affected significant acreages, or have caused widespread winter desiccation, resulting in large patches of red or dead trees across the forested slopes.

Figure 2-9 - Other Damage Observations within the Assessment Area, 1980-96.



Dwarf mistletoe (Arceuthobium douglasii Engelm.) occurs in the Douglas-fir component throughout the area. Ponderosa pine also shows infections of Areceuthobium campylopodum Engelm.; however, the occurrence is most often found toward the southern extent of the assessment area. Arceuthobium americanum Nutt. ex Engelm. is also present in the lodgepole pine, but has not been found to cover large areas of the component. Only dwarf Douglas-fir mistletoe poses a serious threat to the long term sustainability of the forests where it is found.

In the absence of landscape level fire events, the east slope of the Cascade range has experienced a steady increase in the distribution and abundance of Douglas-fir and dwarf Douglas-fir mistletoe. This parasite is a major agent that effects the long term sustainability of the forests where it is found. This is especially true for those forests in the Dry Douglas-fir PAG. Effected trees are either killed or weakened sufficiently to allow other insects or pathogens to come in for the final kill. The large mistletoe brooms produced by infected trees help to set up the forest for high intensity, stand replacing fires.

Dwarf Douglas-fir mistletoe was once kept at minimal levels because historically the more frequent fires maintained Douglas-fir at lower densities and removed most dwarf mistletoe infected trees from the stand. With continued fire exclusion, Douglas-fir will continue to increase in abundance as will Douglas-fir dwarf mistletoe.

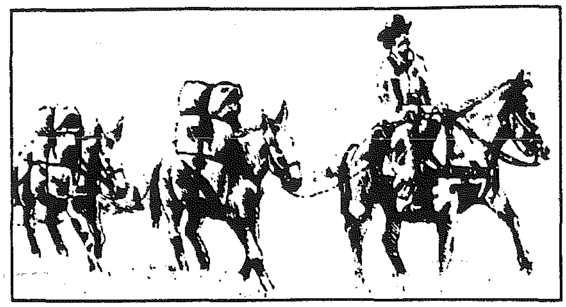
This species is an obligate parasite causing infections that are most often systemic resulting in significant growth reductions, and predisposition to fire. Severely infected trees also provide security habitat in the large brooms that result from branch deformities, and cavity feeding/nesting opportunities in top killed trees for many species of birds. (See Map 9, Appendix H, for Dwarf Mistletoe risk.)

Conclusion

Considering the large size and diverse composition of the vegetation of the assessment area, the risk of catastrophic stand-replacing insect and disease outbreaks is low compared to the risk of catastrophic fire. Most outbreaks will be limited naturally to areas less than 1,000 acres in extent.

Centers of insect and disease mortality have an important function in LSR ecosystem processes even though they are limited in extent. Because outbreaks result in increased fuel loadings, they create an extremely high crown fire potential for an area. These areas can serve as ignition "hot spots". Dying and dead canopies will burn with higher intensities and thus project firebrands and other ignition sources well beyond the fire perimeter. This, combined with the more intense radiation and convection heating associated with these fires, increases their probability of igniting large stand replacing fires in adjacent fuels. Mortality from pathogens and insects alone is insignificant, but when considering the effects on landscape scale fire disturbances, they significantly contribute to the potential increase in a catastrophic fire event. The Ponderosa Pine, Dry Douglas-fir, and Moist Douglas-fir PAGs are the most likely to be significantly altered, both structurally and compositionally, by forest pathogens and insects. Management strategies need to focus on breaking up stand density by reducing the number of immature trees, especially Douglas-fir, in the understory on the drier sites. Benefits are two fold. First it will reduce the stress on the remaining large, old trees. Second, it will break up the continuity of the fuels both vertically and horizontally thus reducing the risk of crown fires. Dwarf mistletoe spread needs to be managed in such a way to reduce the risk of large scale crown fires.

CHAPTER 3
Social and Economic Setting



Introduction

"People are part of the ecosystem, both in the sense of being another species that depends on other ecosystem components and because humans determine how ecosystems are socially defined, studied, and managed."
"Status of the Interior Columbia Basin: Summary of Scientific Findings."

Human Settlement

According to oral tradition, the assessment area has been occupied since about 13,000 years ago when the retreat of the last continental glaciers permitted human travel and habitation. There is physical evidence of human occupancy within the assessment area dating to a period lasting from 8,000 to 4,000 years ago.

Beginning about 4,000 years ago, the climate became cooler and wetter than the previous period. The range of artifact material demonstrates extensive trade networks, and seasonal to semi-permanent occupied habitations. This period is characterized as a "semi-sedentary foraging" pattern. These people were the ancestors of the American Indians encountered by the historic-era explorers and settlers.

The historic range of the Methow Indians includes virtually the entire Methow River Drainage and lands along the Okanogan and Columbia Rivers. Some hallmarks of these people are the use of semi-subterranean earth lodges, a reliance on salmon, an industry for processing salmon and native root plants for long-term storage.

Despite being the ancestral land of the Methow Indians, much of the assessment area was included as part of the Moses Reservation, established on April 18, 1879 for Chief Moses and his band, but most of his people never resided on the reservation. On July 4, 1884, the Moses Reservation was restored to the public domain and on May 1, 1886, the assessment area was opened for settlement and mineral claims. Methow Indian descendants continue traditional practices on ancestral lands within the assessment area, including the seasonal collecting of numerous plants (Appendix G).

The Euro-American settlement period officially began with the opening of the public domain, even though fur trappers, military expeditions, and railroad exploration expeditions traversed the assessment area long before. These people used the well-trodden routes established by the native inhabitants. These routes are still used today and cross prominent landmarks at Washington Pass, Twisp Pass, War Creek Pass, and Cascade Pass.

Miners and prospectors were the first Euro-American occupants to have an impact in the area, exploring virtually every draw and rock face for gold and silver. Homesteaders soon followed, setting-up ranches and farms in an attempt to scratch a living from dry-land orchards and crops, along with cattle and sheep. Some Indians also maintained cattle and horse herds.

Prior to the 1960s, the population within the assessment area grew at a slow, but steady pace. Much of the population outside of incorporated cities resided on large parcels of land which were used for farming and ranching. Three events occurred in the 1960s and early 1970s which have had a major effect on how private lands are currently being settled. These events included the proposal to develop a year-round destination downhill ski resort at Sandy Butte located within the Upper Methow LSR, which resulted in speculative land purchases and subdivision adjacent to the LSR; opening of the North Cascades Highway, which created quicker and easier summer access to the area from the Puget Sound population center; and the decision by the Town of Winthrop to adopt a western theme, which attracted more attention to the area for tourists.

This development pattern continues and has created a private land/national forest interface situation which will influence management actions on all but the Nice Late Successional Reserve. Presently, this influence is particularly critical on the peninsula of private land near Mazama that extends into the Upper Methow Late Successional Reserve (See Map 4, Appendix H). The influence is less critical for the Twisp River, Sawtooth and Hunter Mountain Late Successional Reserves.

The total estimated population within or immediately adjacent to the assessment area is 4,500 people. Additional steady growth is expected to be in residential and recreational residences such as second homes and vacation homes; as well as for recreation enterprise and year-round resort activities. Another central issue associated with population is consolidation of private ownerships and the increased public reliance on Federal lands for access to valued opportunities (ICBEMP, 1997). Demand for a variety of recreation opportunities, services and local forest products can be expected to increase.

Characterization of Multiple-Use Activities

Range

Grazing within the assessment area corresponds with early settlement in the latter part of the 19th century. Prior to this time much of the land had not been exposed to large ungulate grazing; native flora evolved under lighter grazing pressures. Since then vegetative composition has changed due to increased human activities in the area. When settlers first came to the area it was not necessarily for the production of red meat; this system of agriculture developed as communities grew. Later on as mining and timber activities decreased, emphasis on livestock production increased in the area.

Cattle production in the Chelan and Methow areas started in the late 1800s. Early, small home-based ranch operators were the primary users of rangelands available through private and public land grazing systems. Designation of the Forest Reserves (later to become National Forests) provided increased areas for grazing use. Many of the names from early settlement days are still involved with ranching operations.

In contrast to today's stocking rates and livestock type, sheep were once a major component of the grazing domestic livestock of the Sawtooth range and Methow Valley. Initially, sheep were not readily welcomed by some livestock operators in the Okanogan, but as time went on, several of these operators diversified into both cattle and sheep. Most sheep ranching operations wintered in the Columbia River basin and summered in the cooler mountainous areas. Such operator names were Drumheller, Trieber, Lauzier, and the Coffin Sheep Company. Higher elevations were primarily used for sheep grazing. These operations routed their sheep bands (1,000 ewes per band) through the mountains for a constant fresh forage supply. Sheep routes ran from the Lake Chelan area through the Buttermilk drainage over to the upper Methow River well into the higher Cascade range. Sheep use has diminished. Today, only a trace of the numerous sheep bands of the early 20th century remains.

Sheep grazing routes played a substantial role in development of travel routes through the Sawtooth range and Methow Valley. Many are used today as recreation trails accessing wilderness and back country areas. Several historic sheep bed grounds, broken down counting corrals, developed spring sources and herder camps can still be seen along these routes.

Given field observations and condition and trend transects on rangeland vegetation, in general, current grazing use within the LSRs (See Map 10, Appendix H and Table 3- 1) is not adversely affecting LSR objectives. Historic areas of past over-use have recovered, or are recovering, due to changes in grazing management such as non-use or grazing rotation strategies. Existing and proposed facilities and improvements are being reviewed as permits are renewed or where range related management activities are proposed to determine if LSR objectives will be adversely affected.

In allotments where development and maintenance of LSR characteristics significantly changes the amount of available forage, a substantial decline in available forage may result. Transitory range produced by timber harvest practices has been a substantial source of grazing forage within portions of the LSRs. If harvested acres are reduced or harvest practices changed, the likely result will be a reduction in carrying capacity for most allotments. This decline occurs as timber units grow back and the tree canopy begins to close. The estimated duration of most transitory range is 10-20 years after timber harvest. As the amount of available forage decreases in the forested uplands, livestock use will shift to lowland riparian zones where acceptable use is very limited, resulting in even lower carrying capacity and the necessity of further reducing stocking numbers.

Table 3- 1 - Current Range Allotments

Allotment	Total Acres	Acres Within Late-Successional Reserves*		# of Animals	Grazing Strategy
Harts Pass S&G	34,373	Upper Methow	19,515	1200 ewes w/ lambs	July 11-September 30 Receives rest alternating years with Chelan unit of Buttermilk S&G.
Fawn C&H	14,633	Upper Methow	2,811	173 cow/calf pairs (929 Animal Unit Months, (AUMs)	June 1- September 30. Deferred rest/rotation: (126 Cow/calf pairs in the 1995 season.)
Goat Creek C&H	18,126	Upper Methow	18,115	170 cow/cal pairs (913 AUMs)	June 1- September 30. Deferred rest/rotation, currently under rest until 1998 to allow recovery within the 1994 Whiteface wildfire area.
Wolf Creek C&H	35,115	Upper Methow Twisp River	7,800 41	210 cow/calf pairs (1109 AUMs)	June 1- September 30. Deferred rest/rotation involving intensive herding due to lack of movement controls such as fences and natural barriers

Allotment	Total Acres	Acres Within Late-Successional Reserves*		# of Animals	Grazing Strategy
Boulder C&H	7,801	Upper Methow	7,789	60 cow/calf pairs	June 1- September 30 Used as additional grazing unit in conjunction with Wolf Creek C&H to facilitate implementation of deferred rest/rotation.
Cub Creek C&H	63,498	Nice Upper Methow	3,056 34,978	195 cow/calf pairs 389 cow/calf pairs (Total 3392 AUMs)	June 1- September 30. June 1 - Oct 15. Deferred rest/rotation. A portion is currently under rest until 1998 to allow recovery within the 1994 Whiteface wildfire area
Little Bridge C&H	27,494	Twisp River	13,580	299 cow/calf pairs	May 16 - September 15 Deferred rest/rotation. There are two permittees on the allotment: one grazes the entire season with 112 cow/calf pairs and the other grazes 220 cow/calf pairs for half the season.
Newby C&H	10,361	Twisp River	1,631	100 cow/calf pairs	May 16 - September 30. Under the current deferred rotation the allotment is in a positive range condition and trend.
Buttermilk S&G	73,923	Twisp River Sawtooth	1,634 33,297	1200 ewes with lambs	May 16 - September 30 The grazing strategy incorporates three units and another permit. These are: South unit, North unit, Chelan unit, and Harts Pass allotment. The Harts Pass permit receives grazing rest on alternating years with the Chelan unit.
Libby C&H	23,967	Sawtooth	933	167 cow/calf pairs	May 16 - September 30 Deferred rest/rotation
Hunter-McFarland	61,817	Sawtooth Hunter Mountain	16,954 5,579	250 cow/calf pairs 300 cow/calf pairs	May 16 - October 15 east of Sawtooth Ridge (Methow side). May 1 - September 30 west of Sawtooth Ridge (Chelan side). To meet resource needs on the Chelan side the permittee has agreed to shift his livestock type to 1000 sheep and 50 cow/calf pairs to graze during permitted times.
Hungry C&H	4,832	Hunter Mountain Sawtooth	416 241	48 cow/calf pairs	May 26 - September 15. Deferred rest/rotation.
Horsethief C&H	3,392	Sawtooth	3,392	300 ewes/lambs	August 1 - September 30, even years only. Converted from cattle to sheep in 1994 to reduce long term impacts resulting from early historic grazing over-use.

*Acres are estimated

Timber Harvest

Timber harvest in the assessment area can be traced back to the late 1800s, prior to the development of the Forest Reserve System. This early harvest was for family owned and operated mills that produced lumber for settlement building purposes. Logs that were used by the mills came from timber stands located near the mills primarily in the Ponderosa Pine PAG. The harvest was very light, removing only enough trees to produce the limited amount of lumber in demand for local building purposes. This logging was done primarily by cross cut saw and horse drawn skidding.

The first records of timber sales from federally owned lands date back to 1909. After 1942 the commercial timber sales in the assessment area took a drastic jump in response to WWII demand. These timber sales through the next decades provided the opportunity and funding to construct a major portion of the existing road system. These roads accessed the Ponderosa Pine PAG and Douglas Fir PAGs in succession as supplies of lower elevation, more accessible trees were depleted.

Timber harvest practices have varied over the course of the years. They range from very light partial cutting in the years of early commercial harvest to clearcutting which was used extensively in the late 1970s through the mid-1980s.

Although the data is incomplete, 30 percent is a reasonable estimate of the percentage of the area within the assessment area affected by some form of past timber harvest. Of the LSRs themselves, the actual acreage affected by harvest is less than 5 percent. This is the result of the unroaded nature of much of the LSR system. Activities have been primarily concentrated in the Nice LSR and the Gold Creek area of the Sawtooth LSR.

By far the greatest change in structure and distribution of ponderosa pine communities has resulted from logging. Because of its high value as lumber and its circumstance distribution adjacent to or within agricultural and [illegible] ponderosa pine has been extensively harvested since the turn of the century. In 1949 alone, over 150 million board feet of ponderosa pine was sold from National Forest System lands within the assessment area. The total standing inventory of ponderosa pine prior to extensive harvesting is not available for the assessment area but an indication of the reduction of sawtimber-sized trees can be estimated by observing the change in species mix sold. The percentage of ponderosa pine volume sold dropped from roughly 75 percent in the 1940s to less than 25 percent in the 1990s.

Douglas-fir stand structure and distribution have changed considerably as the result of harvesting. Other than the unroaded portions within its distribution, Douglas-fir stands have been extensively modified from past selective harvesting or, within recent decades, from regeneration harvest. Lehmkuhl et al (1993) found that timber harvest had greatly reduced patch sizes within intensively managed areas. Using the Methow River basin as one of the study areas, the change in landscape patterns was drastic enough to show an overall decrease in mean patch size for the entire Methow basin within National Forest System lands.

The subalpine fir zone in the assessment area has had limited harvesting. Where harvesting has occurred, the resulting mosaic is not reflected elsewhere in this zone. How these logging disturbance patterns will affect successional stand and plant community development is unknown.

Recreation/Tourism

The importance of the recreation/tourism industry to the Methow Valley is evident by the increase over the past five years in the number of recreation enterprises and year round resorts developed or planned in or around the communities of Mazama, Twisp and Winthrop; and an increase in the diversity of recreation activities taking place.

The Methow Valley is considered one of the top year-round recreation areas in the State of Washington. The rural valley setting, drier eastside climate, clean air and water, diversity of wildlife and variety of recreation opportunities attracts visitors to the area. Recreation activities include camping, picnicking, hiking, fishing, hunting, viewing scenery, viewing wildlife, viewing nature, horseback riding, motorbiking, mountain biking, snowmobiling, skiing (alpine, cross country, Randonee and three pin telemark), photography, mountain climbing, rock climbing, mountaineering, ice climbing, snow climbing, snowboarding, back country ski touring and snowshoeing. People from all over the world visit the area to view the spectacular scenery of the North Cascades and to participate in a variety of recreational opportunities.

Use of the area has increased significantly since 1972 with the opening of the North Cascades Scenic Highway. A shorter summer driving distance was created between the Seattle/Puget Sound Area and the Methow Valley.

The area is noted statewide for its mule deer hunting opportunities and hosts the second largest nordic skiing complex in North America. The Methow Valley regularly hosts four major nordic ski races that draw people from a regional population and Canada. Major mountain bike events are also hosted annually. The Washington State Snowmobile Convention has been hosted in the Methow Valley several times in the past and will again be hosted in 1998. Special Clinics are also a part of the activity, particularly in the Upper Methow Valley. Ski clinics designed for racers, women, kids and older skiers are conducted on a regular basis. The Methow Valley Nordic Ski Team has sent skiers to the Junior Olympics the past three years. Team members use both private and National Forest System Lands within the assessment area to train and race.

Areas which are heavily used by visitors for primitive and semi-primitive recreation opportunities include the Pasayten and Lake Chelan Sawtooth Wildernesses, and unroaded portions of the North Cascades Scenic Highway, Upper Methow River, Pasayten River and Lower Sawtooth Range. These areas are characterized by steep slopes and high mountain peaks and are generally accessed by a system of Forest Development Trails (Map 6, Appendix H). That portion of the Sawtooth Range in the Foggy Dew Area is considered important to trailbike users because it contains 6 of 11 lakes in the Washington Cascade Range in an unroaded setting which can be closely accessed by trailbikes.

Roads are a key recreational resource in the area, providing opportunities for scenic viewing and access to the outstanding variety of recreational opportunities the area has to offer. Areas which are heavily used by visitors for roaded natural recreation opportunities include the North Cascades Scenic Highway, the Lost River/Harts Pass Road and in the Chewuch River, Eightmile and Twisp River drainages. Most developed sites are located in these areas and are accessed by well developed and maintained roads.

There are approximately 550 miles of trail within the assessment area, including an estimated 40 miles of the Pacific Crest National Scenic Trail. All trails are open to hiking use; many trails are open to stock use; and a few trails are open to motorized use. Trails which access the Pasayten and Lake Chelan Sawtooth Wildernesses are closed to motorized and mountain bike use. The Pacific Crest National Scenic Trail is also closed to motorized and mountain bike use. This puts additional demand on the remaining trails, especially for single track mountain bike use. The Rainy Lake, Washington Pass Overlook, Eagle Lakes, Blue Lake, Cedar Creek and Cutthroat Creek Trails are designated as National Recreation Trails. The Rainy Lake, Washington Pass and Lone Fir Trails are designed to accommodate people with disabilities and in general meet American With Disabilities Act standards.

Okanogan County maintains a system of groomed snowmobile routes along National Forest system roads in the Upper Methow, Twisp River, Buttermilk/Black Canyon, Chewuch and Eightmile/Goat Creek areas. Several of these routes tie into additional groomed routes on the Wenatchee National Forest. These groomed routes, along with several designated ungroomed routes through areas closed for wildlife purposes provide access to snowmobile play areas.

Methow Valley Sports Trail Association maintains a system of cross country ski and summer non-motorized trails on both private and National Forest System Lands in the Upper Methow Valley, Cub Creek/ Rendezvous Areas and in the vicinity of Sun Mountain Lodge.

Outfitter Guides are recreation service partners under Special Use Permit providing a variety of services year-round within the Analysis Area. Services provided include horseback rides, horse pack trips, burro pack trips, llama pack trips, hiking and backpacking, mountain bike tours, mountain climbing and mountaineering, rock climbing, ski instruction, ski tours, environmental education, helicopter assisted skiing, snowcat assisted skiing, hut rental, freight haul, sled dog tours, snowmobile rental, snowmobile tours, outdoor schools and children's camp. Additionally Special Use Authorizations are issued yearly for a variety of recreation events and activities.

Demand for various types of recreation opportunities within the assessment area has been steadily increasing. This trend is expected to continue particularly in the Upper Methow as construction of second homes and commercial and recreation development expands. The most pressure from human use will occur within 2-4 miles of the peninsula of private land which occurs in the Upper Methow LSR. This is particularly true for winter recreation activities, for outfitter guiding activities, for activities dependent on an unroaded setting, and for activities to complement recreation enterprise and year around resort development on private lands. Although the projected increase in recreation use will be significant in relationship to current use levels, the use levels will be minor when compared to more urban and more easily accessible National Forest System Lands west and south of the assessment area.

This expected increase in use levels poses potential risks to habitat, particularly recreation sites located in and adjacent to riparian reserves. More emphasis on management of use will need to be considered in order to address potential resource degradation (i.e. trails, riparian areas), increased user conflicts, and changes in quality of recreation experiences available. The need to maintain and upgrade existing facilities and to provide additional and adequate opportunities and facilities consistent with Late Successional Reserve and Aquatic Conservation Strategy objectives will be critical. Long term projections of local recreational uses, patterns and trends would be useful in designing a strategic plan for dealing with potential future needs and conflicts.

That portion of the Pasayten Wilderness from Canyon Creek to Andrews Creek is adjacent to the Upper Methow Late Successional Reserve. The Lake Chelan Sawtooth Wilderness is adjacent to portions of the Upper Methow, Twisp River and Sawtooth Late Successional Reserves. Access to wilderness is provided through roads and trails in many areas of these LSRs.

The variety of recreation opportunities within the assessment area is complemented by the scenery resource. Viewing scenery and driving for pleasure makes up approximately 30 percent of the recreation use within the assessment area. People from all over the world visit the area to view the spectacular scenery of the North Cascades. People living adjacent to the National Forest also consider the scenic appearance of the National Forest an important value.

The Washington State Wilderness Act of 1984 (PL 98-339) recognized this scenic quality by designating the 87,572 acre North Cascades Scenic Highway. Section 8 states, "...certain lands...have remarkable scenic values, representing a unique aesthetic travelway through the Cascade Mountains in the northern portion of the State of Washington" (U.S. Laws, Statutes 1984). The highway is bounded by the Upper Methow LSR along three-fourths of the corridor perimeter.

There are presently no Wild and Scenic Rivers within the assessment area. The Methow River, Chewuch River and Twisp

River are considered "Rivers of Statewide Significance" (Chapter 173-18 WAC; pg. 123 Washington SCORP). Under this classification, the State of Washington is to study these rivers for possible inclusion into the State of Washington Scenic Rivers System. To date, the Washington State Legislature has not passed legislation to include these rivers in the program.

Segments of the Methow, Chewuch, Twisp, Lost, and the East and West Forks of the Pasayten Rivers as well as Wolf Creek have been determined to be eligible and suitable for designation under the National Wild and Scenic Rivers System. These segments have been recommended for designation based on their being wild and free flowing throughout the major portion of the primary use season and because of outstandingly remarkable scenic, wildlife, fish and recreation values.

Segments of Canyon Creek, Granite Creek and Ruby Creek have also been determined to be eligible for designation but further study is needed to determine their suitability. Most of the remaining rivers and streams within the assessment area have been screened to determine their potential eligibility for designation.

Objectives of Wild and Scenic Rivers Management have been reviewed and are considered compatible with Late Successional Reserve objectives as long as the "outstandingly remarkable resource values" which make rivers potentially eligible for designation as Wild and Scenic Rivers are maintained.

Recreation Overview for each LSR

Hunter Mountain LSR

There are no developed recreation sites or system trails within the Reserve though Forest Road 4012100 from its junction with National Forest System Road 4013200 is a Designated Ungroomed Snowmobile Route. Most of the reserve is closed to motorized wheeled vehicles and snowmobiles from December 1 to March 31 to provide for deer winter range.

Most of the recreation use in the Reserve is dispersed camping and hunting in the fall; with some snowmobile use on the designated route in the winter. Overall recreation use levels are low. There are no current proposals to construct any developed sites or system trails in the Reserve.

Nice LSR

Developed facilities include Flat and Nice Campgrounds with a total 80 Persons At One Time (PAOT)capacity. There are no system trails within the Reserve.

Forest road #5130 provides access to Flat, Nice, Ruffed Grouse and Honeymoon Campgrounds and Billygoat Trailhead, which is a major jumping off point to the Pasayten Wilderness; and is also a Designated Priority 1 Groomed Snowmobile Route. National Forest System Road 5130100 is a Designated Special Event Groomed Snowmobile Route.

Most of the recreation use involves driving on main roads to access other sites outside the Reserve, camping at campgrounds, and some dispersed camping and hunting throughout the rest of the Reserve. Although the entire Reserve is open to snowmobile use, topography and vegetation limit most of the snowmobile use to roads. Overall recreation use levels are low to moderate.

There are no current proposals to construct additional developed sites or system trails in the Reserve. Upgrading of facilities at existing campgrounds is planned in the future. Cutting or topping of trees which are a public safety hazard in campgrounds and along heavily used roads would occur on a routine operation and maintenance basis; and could occur where reconstruction activities are involved. Planned maintenance and upgrading of facilities will not adversely affect LSR objectives.

Sawtooth LSR

Developed facilities include Foggy Dew and South Navarre Campgrounds (85 PAOT); Foggy Dew Trailhead and Crater Creek Trailheads (50 PAOT); and South Fork Gold Creek Snowpark (50 PAOT).

Motorized trails in the Reserve are important to trail bike users in this area because of the opportunity provided to closely access 6 of 11 lakes in the Washington Cascade Range in an unroaded setting. Many of these trails are also ideal for mountain bike use. Some of these trails provide important access to the southern portion of the Lake Chelan Sawtooth Wilderness.

National Forest System Road 4330 provides access to South Fork Gold Creek Snowpark and trail systems on the Wenatchee National Forest and is a Designated Priority 1 Groomed Snowmobile Route. National Forest System Road 4340 provides access to Foggy Dew Campground and ultimately to the Libby Creek and Twisp River drainages and is a Designated Priority 1 Groomed Snowmobile Route. National Forest System Road 4340200 provides access to Foggy Dew Trailhead. National Forest System Road 4340300 provides access to Crater Creek Trailhead. National Forest System Road 8200 provides access to South Navarre Campground and is a Groomed Snowmobile Route.

A wide variety of recreation activities occur within the Reserve during the snow free period. Several backcountry lakes are a major draw for many users. The rough terrain limits most of the winter recreation use to roads. Overall recreation use levels range from moderate to high.

There are no current plans to construct additional developed sites in the Reserve, though a proposal to expand the existing South Fork Gold Creek Snowpark is being considered. There is also a proposal to reconstruct Trail 418 as a motorbike trail via Bryan Butte and to extend the hiker only Summer Blossom Trail from Deadman Pass to Boiling Lake. From this connection point, various trail loop options could be considered. The purpose of this proposal is to reduce motorized and non motorized recreational traffic conflicts and the overuse the Horsehead Pass Area. The proposal would also create a loop trail between the Methow Valley and Lake Chelan Basin and tie together the trail system on the adjoining Wenatchee National Forest.

Upgrading of facilities at existing campgrounds and trailheads is planned in the future. Cutting or topping of trees which are a public safety hazard at existing developed sites and along heavily used roads and trails would occur on a routine operation and maintenance basis, and could occur where reconstruction activities are involved. Planned maintenance and upgrading of facilities will not adversely affect LSR objectives.

Twisp River LSR

The Twisp River LSR is a popular recreation area. Developed facilities include War Creek, Mystery, Poplar Flat, South Creek, and Roads End Campgrounds (225 PAOT); Twisp River Horsecamp (60 PAOT); Gilbert, Oval/Eagle Creek, Williams Creek, Scatter Creek, and War Creek Trailheads (122 PAOT).

National Forest System Roads 44 and 4440 provide access to all campgrounds and to Gilbert and Scatter Creek Trailheads and are Designated Priority 2 Groomed Snowmobile Routes. National Forest System Roads 4420, 4430 and 4435 provide access to Twisp River Horsecamp; Twisp River Snopark; and Oval/Eagle Creek, Williams Creek and War Creek Trailheads; and are Designated Priority 2 Groomed Snowmobile Routes. There is also a Designated Priority 2 Groomed Bypass Route west of Twisp River Snopark, which allows a portion of Road 4420 to be plowed as access to private land.

A wide variety of recreation activities occur within the Reserve on a year round basis. The proximity of the Reserve to the Lake Chelan Sawtooth Wilderness and the number of camping and trailhead facilities are major drawing cards for a majority of the visitors. Much of that portion of the Reserve north of Twisp River and east of Canyon Creek Ridge is closed to motorized use from October 1 to November 30 to provide additional non motorized access hunting opportunities. Overall recreation use levels range from moderate to high.

The only current proposal to develop additional developed site facilities in the Reserve involves a Heritage Resource Project. The proposal would involve leveling and graveling the existing parking area at War Creek Campground and installing an interpretive sign; enlarging by approximately 1/8 acre and leveling and graveling the existing parking area at Poplar Flat Campground and installing interpretive signs; and improving the existing road to the "Old Gilbert Townsite", widening and leveling of an existing parking area and installation of a toilet and interpretive signs. NEPA analysis will be conducted to determine the best way to meet the public's needs and minimize or mitigate possible adverse impacts. Upgrading of facilities at existing developed sites is planned in the future. Cutting or topping of trees which are a public safety hazard in developed sites and along heavily used roads and trails would occur on a routine operation and maintenance basis; and could occur where reconstruction activities are involved. Planned maintenance and upgrading of facilities will not adversely affect LSR objectives.

Upper Methow LSR

This area offers significant recreation opportunities year around. Developed facilities include; Honeymoon, Ballard, River Bend, Harts Pass, Meadows, and Early Winters Campgrounds (210 PAOT); Billygoat, Robinson Creek, Monument Creek ,Harts Pass, Cedar Creek, and Farewell Creek Trailheads (260 PAOT); Yellowjacket and Goat Creek Snowparks (90 PAOT); and Slate Peak Observation Site (20 PAOT).

State Highway 20 passes through the Reserve near Early Winters Creek and provides access to Early Winters Campground and Cedar Creek Trailhead. County Roads 1163 and 9140 provide access to private land near the Reserve and to Yellowjacket and Goat Creek Snoparks. National Forest System Road 5130383 provides access to Honeymoon Campground and Billygoat Trailhead. National Forest Road 5160 provides access to Farewell Creek Trailhead. National Forest System Roads 5400, 5400500, 5400600, 5400700 and 5400060 provide access to Ballard, River Bend, Harts Pass and Meadows Campgrounds; Monument Creek, Robinson Creek and Hart's Pass Trailheads; and Slate Peak Observation Site. Portions of Roads 5400, 5400060 and 5400600 are Designated Priority 1 or Designated Spring Season Only Groomed Snowmobile Routes. National Forest System Roads 52, 5200500, 5220100, 5225, 5225100, 5225200, 5225240, 5225600 are Designated Priority 1 Groomed Snowmobile Routes.

A unique characteristic of this Reserve is the influence from a peninsula of private land that extends approximately eight miles into the Reserve from Weeman Bridge to Lost River, near Mazama (See Map 4, Appendix H). This area has been experiencing significant growth in the number of year-round and seasonal residents. Existing and proposed resort developments will bring more visitors into the area on a year around basis. This increased development on private land is expected to result in increased impacts and demand for additional recreation facilities on those portions of the Reserve within a 2-3 mile radius around the private land. The scope of these impacts and their implications for urban interface fire management are yet to be determined as plan proposals are still being developed.

The forest is working as a partner to develop long range plans related to private land development as well as possible opportunities on National Forest System Lands within a 2-3 mile radius of the core private land development. Possible opportunities include upgrading/reconstruction of existing trails to accommodate expected increase in non-motorized recreation demand and minimize and mitigate adverse resource impacts; tying in of existing trails by constructing trail ties to create more loop opportunities and reduce resource impacts; construction of several new trails to enhance recreation opportunities and disperse use; construction of several day use shelters; and authorizing additional commercial operations such as snowcat skiing and para sailing. NEPA (National Environmental Policy Act) analysis will be conducted to determine the best way to meet the public's needs and minimize or mitigate possible adverse impacts.

Methow Valley Sport Trail Association has also been encouraged to develop long range plans which may propose additional activities within the Reserve.

A wide variety of recreational activities occur within the Reserve on a year around basis. The proximity of the Reserve to the Pasayten and Lake Chelan Sawtooth Wildernesses, scenic non-wilderness backcountry, camping and trailhead facilities, and quality cross country skiing and snowmobile opportunities are major drawing cards for a majority of the visitors. Overall recreation use levels range from moderate to very high.

The only currently approved project to develop additional facilities in the Reserve involves expansion and upgrading of the Early Winters Campground. This project would provide a more efficient campground to run, and rehabilitate areas within the Riparian Reserve along Early Winters Creek which have been impacted by past recreation use. There are proposals to more fully develop the Goat Creek Snowpark to allow better parking by both snowmobilers and cross country skiers and to construct a permanent snowmobile shelter in the vicinity of Yellowjacket Creek. NEPA analysis will be conducted to determine the best way to meet the public's needs and minimize or mitigate possible adverse impacts. Upgrading of facilities at existing developed sites is planned in the future. Cutting or topping of trees which are a public safety hazard in developed sites and along heavily used roads and trails would occur on a routine operation and maintenance basis; and could occur where reconstruction activities are involved. Planned maintenance and upgrading of facilities will not adversely affect LSR objectives.

Mining

Prospecting and mining for gold, silver, and copper has taken place in the assessment area since the earliest period of Euro-american settlement. With the exception of the Nice LSR, every LSR has experienced mineral development to some extent. Old mine workings, buildings, and waste rock dumps are all that remain as evidence that mining activity once took place in these areas.

At present there are no active mining operations taking place within the assessment area. A limited amount of exploration work involving small scale core drilling and surface sampling activities are being conducted on the over 400 unpatented mining claims currently staked in the area. Much of the assessment area has been identified as moderate to high potential for at least limited mining activity. In particular, the large copper deposit located near Flag Mountain in the Upper Methow LSR remains a candidate for future development.

The current low prices for metals, poor access, and the high financial and environmental costs of mining in ecologically sensitive areas all work against the possibility that any of this potential will develop into producing mines in the foreseeable future. However, mining by its very nature is an uncertain and opportunistic industry and it is impossible to say that mineral development within the LSRs will never occur. Any future exploration or other mining activity will be evaluated and conducted to ensure Late Successional Reserve objectives are met.

Land Exchanges

There are currently three land exchanges being considered within the assessment area. All are located within the Upper Methow LSR and are intended to eliminate inholdings, straighten boundaries or to facilitate management of lands adjacent to recreational and residential developments. After a Facilities Master Plan is developed in 1998, there is a possibility that some properties such as the Early Winters compound may be offered for sale as a cost cutting measure.

Fire Suppression and Prevention

In the late 1800s, while surveying the Eastern Washington Forest Reserve, and specifically the Methow Valley, Martin Gorman (1899) noted:

"*According to the testimony of settlers, some forest fires occur here every summer; for instance, during the present season, in addition to three simultaneous fires near Lake Chelan, there were also one on the Entiat divide and two in the*

Methow Valley. They further allege, apparently on good evidence, that this region has been burned over long before the first white settlers. This is well borne out by the scarred bases of the mature yellow-pine belt, nearly all of which show traces of more than one forest fire. There can be no doubt in the mind of any thoughtful observer who has traversed this region that it was once much better forested than it is at present. The numerous burnt stumps, the bare slopes of the west and southwest faces of the hillsides, the charred and dead trees, the burnt areas of different ages, and the paucity of humus outside of the moist ravines and valleys all attest that the region has been burned over not once, but several times."

The first Native Americans arrived in the Methow Valley 8,000-10,000 years ago (Portman, 1993). Their use of fire is not documented in the assessment area, though it is widely believed that they used fire on a landscape scale. Suspected uses include setting fire to promote the growth of plants for both human and animal use, and clearing fields of brush for easier access. Many fires in the 1800's were attributed to this practice

Euro-Americans used fire extensively. Gorman notes: *"Among the principle causes of forest fires may be named sheep herders, campers, hunters, prospectors, miners, trail and road makers, and the settlers. The first named are generally most culpable. Fires were rarely extinguished before the fall rain or until they burn out for lack of material on which to feed."*

In 1906 the Forest Service established a fire suppression policy. Steady advances in fire control including the use of telephones quickened the response time of organized fire fighting crews. From 1929 to 1939, Great Depression emergency programs contributed to fire control including construction of trails and roads, construction of lookouts, and stringing telephone wire all of which improved detection and reduced reporting time.

Establishment of the smokejumping program at the North Cascades Smokejumper Base in 1940 reduced previous travel times of up to two days to 15 minutes. Effectiveness of the smokejumping program is summarized in costs saved and reduced acreage lost to fire. Okanogan records state that yearly average acreage burned in the inaccessible North Cascades was 4,916 acres, compared to 644 acres since the onset of the program.

Smokejumpers, prevention programs, state of the art communication, aerial retardant, helicopters, fire detecting aircraft, sophisticated computerized dispatch, and line resources available throughout the U.S. and Canada, all helped to minimize acreage burned by wildfire in the assessment area.

Research, Rights-of-Way, Contracted Rights, Easements and Special Use Permits

Each of these uses of the assessment area have occurred over the past 70 years but none have affected LS characteristics to a significant degree. Special Use Permits for irrigation water ditches have been issued in the Upper Methow and Twisp River LSRs. Although there may be some effects on instream flows and fisheries , their direct effects of LS habitat are minimal other than the "artificial" riparian areas created by unlined ditch leakage. There are less than two miles of road easements, granted rights of way, or road Special Use Permits in the assessment area. Outfitter guide permits use only existing trails and roads.

Noxious Weeds

Noxious weeds are non-native species which can aggressively invade an area and become established. They compete with native species for nutrients and water and can change the floristic characteristics of the LSR system.

Soils are adversely affected by the decrease of natural vegetative cover as the weed species out compete the native plants. More bare ground can be exposed and becomes vulnerable to erosion and surface runoff. This in turn affects the water resources, especially if large contiguous infestations are up slope and within several hundred feet of a stream.

Soil disturbance from road construction encourages the establishment of weed species on cut and fill slopes and acts as a conduit to further infestation by movement of vehicles, livestock and people.

Riparian Reserves associated with flood plains are also vulnerable to invading weeds. Every flood event creates ground disturbance to some extent . Aquatic weeds can alter habitat and cause fish kill due to plant respiration and decomposition.

Wildlife can be directly affected by noxious weeds when palatable and nutritious grasses and forbs are replaced by invading weeds which change vegetative structure and cover opportunities. Food chains can be altered when herbivores decrease in numbers from loss of native food sources and as a result predator populations can be affected by losses in herbivore populations.

Noxious weeds occur to some extent in most recreation areas where human activity has impacted soils and vegetation. Wilderness within the assessment area presently does not have weed populations large enough to replace native plant communities. Most trailheads leading into portions of the Lake Chelan/Sawtooth and Pasayten Wildernesses in the Twisp and Chewuch watersheds do have small patches of weeds.

There are fifteen species of noxious weeds known to occur in the assessment area (Table 3- 2). The greatest infestations are not actually in the LSR themselves , but are located in the lower roaded portions of the Chewuch, Goat Creek and Libby Creek Watersheds, respectively. The Upper Methow has the greatest number of infestations but it also has the largest land area. The Twisp River LSR is second. Potential exists for increased encroachment of weeds into the LSRs from adjacent infestations.

The Okanogan National Forest has completed a Noxious Weed Environmental Assessment (EA) that provides direction for management of noxious weeds. As Table 3-2 shows, the present levels of noxious weed infestation within the LSR system does not appear to be great enough to significantly affect LSR characteristics. However, any LSR management activities could facilitate the spread of noxious weeds if they involve ground disturbance. These areas must be closely monitored for weeds and treated when necessary in accordance with the Noxious Weed EA preferred alternative.

Table 3- 2 - Current Extent and Distribution of Noxious Weeds in Late Successional Reserves

Species	Common Name	Occurrences	Acres
Acroptilons repens	Russian knapweed	30	
Cardaria draba	Whitetop, hoary cress	20	6.4.
Centaura diffusa	Diffuse knapweed	15	0.5
Centuea macrocephala	Bigheaded knapweed	17	1.1
Chrysanthemum leucanthemum	Oxeye daisy	3	0.3
Cirsium arvense	Canada thistle	57	4.1
Cirsium vulgare	Bull thistle	1	10.5
Ccynoglossum officinale	Common Houndstongue	2	0.2
Cytisus scopaparius	Scotch broom	2	0.2
Gypsophila paniculata	Baby's breath	35	4.7
Hypercium perforatum	St. Johnswort	35	4.7
Kochia scoparia	Kochia	3	0.3
Linaria vulgaris	Yellow toadflax	2	0.2
Senecio jacobaea	Tansy ragwort	7	1.3
Tanecetum vulgare	Common tansy	61	

Special Forest Products

Special Forest Products include but are not limited to posts, poles, rails, transplants, Christmas trees, boughs, mushrooms, cones and forest greens. Information on areas of specific interest for collection of these products is not available. However, collection is generally concentrated close to towns and along roadsides where access is easiest.

Posts, poles, and rails are permitted for specific areas, and usually target stands of green, very young, and excessively stocked trees. There will continue to be opportunities for collection of these materials within LSRs. Stands can be targeted for collection where the objectives of removal facilitate accomplishment of LSR objectives. It is important to identify areas relatively close to the population centers to encourage utilization.

Transplant materials are usually collected in small numbers and on a random basis causing minimal disturbance to natural resources. If large amounts of transplant materials are requested, collection should be directed and monitored to ensure LSR objectives are not adversely impacted.

Christmas trees, boughs, cones, and other forest greens are generally collected on a random basis. These materials are usually collected within easy access of roads but collection of these materials has not been significant. At times people have been directed to recommended Christmas tree areas though this has not been a consistent practice.

Recreational and commercial collection of mushrooms has been gaining in popularity for several years, with puffballs, morels, shaggy manes being the most common varieties collected in the area. Areas burned by wildfire are preferred and collection usually picks up significantly in the years following large fires.

Demand for special forest products continues to increase as the population realizes the potential income from these forest products. Permits are issued for most types of special forest products with specific guidelines and specifications for each type to ensure that LSR and Riparian Reserve objectives are met.

Fuelwood Gathering

Fuelwood gathering is a long-standing activity in the Methow Valley and the local population has historically depended on national forest lands as a primary source for fuelwood. Many people gather fuelwood as a part of traditional family outings. Others see cutting their own fuelwood as an opportunity to be self-sufficient in supplying their home heating energy needs and as a way to save money on winter heating costs, and still others are totally dependent on fuelwood for cooking and heating.

Fuelwood gathering is a source of income for some valley residents. Some mid to lower income families and those with wood heat as their sole heating source have become forced to either travel longer distances to alternative areas or purchase outright from a fuelwood vendor. Reduced accessibility to a local fuel wood source would affect the economic livelihood of these families.

An estimated 24,205 cords of fuelwood were acquired or consumed in the Methow Valley between 1985 and 1995. Prohibitions on fuelwood cutting in Late Successional Reserves and Riparian Reserves along with a significantly reduced timber harvest program within LSR's since 1994 has seriously impacted fuelwood availability while demand continues to increase.

With the establishment of Late Successional Reserves, fuelwood gathering has been prohibited in LSR's except in existing cull decks, where green trees are marked by silviculturists to thin, to remove blowdown blocking roads, recently harvested timber sale units where down material will impede scheduled post-sale activities or pose an unacceptable risk of future large-scale disturbances.

Managing compliance with this more restrictive fuelwood gathering policy will become more difficult for several reasons. There are already well-developed and maintained road systems close to population centers within the LSRs. Increasing demand for developed recreational opportunities is projected and could increase demands for fuelwood gathering in overnight recreation sites. And new prohibitions on traditional fuelwood gathering practices have been established.

Because of its socio-economic implications, it is important to provide for fuelwood gathering without adversely affecting LSR or Aquatic Conservation Strategy objectives. Opportunities should be offered while still complying with ROD standards and guidelines for salvage and silvicultural activities.

CHAPTER 4
Terrestrial Species and Habitats

Terrestrial Species and Habitats

Wildlife Setting

Habitat conditions and terrestrial vertebrates that occur in a forest environment vary with vegetative composition, structural diversity, and distribution over the landscape. The various habitat conditions that are present on the landscape are due in part to natural processes such as erosion, vegetative succession, and wildfires. Habitat conditions may also be due to human-caused processes from forest management activities and road construction. These processes, both natural and human-caused, create a diversity of vegetative conditions which provide for endemic terrestrial species habitat conditions.

More than 400 species of terrestrial vertebrates (amphibians, mollusks, reptiles, birds, and mammals) are known or suspected to occur on the Okanogan National Forest (West, 1976). Many of these species are present throughout the mixed coniferous forests of the Okanogan and may be found in the Late Successional Reserve assessment area. Some of these species have been identified in the Okanogan Land Management Plan and are emphasized in Forest management. Others are identified as Survey and Manage (S&M) species in Appendix J2 of the ROD. All species listed as S&M in the ROD will be inventoried, using appropriate survey protocol prior to project implementation. Species such as mule deer, mountain [redacted], raptors, and primary cavity [redacted]agement [redacted] Other species which are federally listed as threatened, or endangered by authority of the Endangered Species Act, or those listed as sensitive by the Forest Service in Region 6 may also occur in the assessment area. These species are managed to enhance or maintain their current populations and include peregrine falcon, bald eagle, northern spotted owl, gray wolf, grizzly bear, lynx, and wolverine. Other species which are present in the assessment area are managed for by providing a diversity of vegetative associations and seral stages to maintain viable population levels.

LS forests are essential in maintaining biological diversity and species richness by providing habitat for associated species. Structural diversity within LS forests may provide unique features that are required, preferred, or used by many terrestrial species for reproduction and/or feeding. Structural attributes such as large old-growth trees, standing dead or partially dead trees, fallen trees or logs on the forest floor, or in streams, and multi-layered canopies are requirements of species associated with LS forests (Map 11, Appendix H). The northern spotted owl, northern goshawk and pileated and white-headed woodpeckers are a few examples of species that are dependent upon LS habitats which provide one or more of these attributes (large trees, snags or multi-layer canopies). Other species such as the flammulated owl, three-toed woodpecker and northern flying squirrel are closely associated with the habitat characteristics of mature or LS forests for breeding and/or feeding. Still others may only seek LS habitats for cover, security, or seclusion and are not considered to be closely associated. Species such as mule deer, grizzly bear, gray wolf, and wolverine are a few examples.

Table 4-1

TABLE 39

DEPENDENT AND CLOSELY-ASSOCIATED LATE-SUCCESSIONAL SPECIES

SPECIES	STATUS	LSR					VEGETATION ASSOCIATION								ATTRIBUTES				SERAL STATUS		
Dependant and Closely Associated Species		Hunter Mtn.	Sawtooth	Twisp River	Upper Methow	Nice	Dry	Mesic	Wet	SAF/Spruce /Ldgple	Hemlock	Whitebark Pine	Riparian	Deciduous	Snags	Down Logs	Large Trees	Mult/Dense Canopy	Early	Mid	Late
AMPHIBIANS- 3 species																					
Northwestern salamander					x				x	x	x		x			x		x	R/F	R/F	R/F
Pacific giant salamander					x				x	x	x		x			x		x		R/F	R/F
Tailed frog	SM				x			x	x	x	x		x			x		x	R/F	R/F	R/F
REPTILES- 0 species																					
MAMMALS- 18 species																					
Shrew-mole			x	x	x	x		x	x	x	x					x		x	F	R/F	R/F
Yuma myotis		x	x	x	x	x	x	x	x						x		x				R/F
Little brown myotis		x	x	x	x	x	x	x	x	x					x		x				R/F
Long-eared myotis	SOC,SM	x	x	x	x	x	x	x	x	x	x				x		x		F	F	R/F
Fringed myotis	SOC,SM	x	x	x	x	x	x	x							x		x			F	F
Long-legged myotis	SOC,SM	x	x	x	x	x	x	x	x		x				x		x		F	F	R/F
California myotis		x	x	x	x	x	x	x	x		x				x		x				R/F
Silver-haired bat		x	x	x	x	x	x	x	x	x	x				x		x		F	F	R/F
Big brown bat		x	x	x	x	x	x	x	x	x	x				x		x		F	F	R/F
Hoary bat			x	x	x	x	x	x	x	x	x		x	x	x		x		F	R/F	R/F
American marten	SOC		x	x	x	x		x	x	x	x		x		x	x	x	x	F	F	R/F
Pacific fisher	SOC,SC		x	x	x	x		x	x	x					x	x	x	x	F	F	R/F
North Americanl lynx	FP,RS,ST		x	x	x	x		x	x	x	x					x	x	x	F	F	R/F
Townsend chipmunk		x	x	x	x	x	x	x	x	x	x		x	x	x				F	F	R/F
Douglas squirrel		x	x	x	x	x	x	x	x	x					x	x	x		R/F	R/F	R/F
Northern flying squirrel			x	x	x	x		x							x		x	x		R/F	R/F
Forest deer mouse			x	x	x			x,	x							x		x			R/F
Red-backed vole			x	x	x	x		x	x	x				x		x			R/F	R/F	R/F

STATUS:
FE - Federal Endangered
FT - Federal Threatened
FP-Federal Proposed
RS -Regionally Sensitive (USFS-R-6)
SOC -Forest Species of Concern
SE - State Endangered
ST - State Threatened
SC - State Candidate
SM - State Monitor
Blank -No Special Status

SERAL STATUS:
F - Foraging
R - Reproduction
R/F - Reproduction/Forage

VEGETATIVE ASSOCIATIONS:

Dry - PIPO, PSME Dry
Mesic - PSME Dry, PSME Moist, ABLA2 Dry
Wet - PSME Moist, ABLA2 Dry, ABLA2 Moist ABAM/TSME, TSHE
SAF/Spruce/Lodgepole - ABLA2 Dry, ABLA2 Moist, ABAM/TSME, TSHE
Hemlock - ABAM/TSME, TSHE
Whitebark Pine - PIAL/LALY

TABLE 39 (Con't)

DEPENDANT AND CLOSELY-ASSOCIATED LATE-SUCCESSIONAL SPECIES

SPECIES	STATUS	LSR					VEGETATION ASSOCIATION								ATTRIBUTES				SERAL ASSN.		
Dependant and Closely Associated Species		Hunter Mtn.	Sawtooth	Twisp River	Upper Methow	Nice	Dry	Mesic	Wet	SAF/Spruce /Ldgple	Hemlock	Whitebark Pine	Riparian	Deciduous	Snags	Down Logs	Large Trees	Mult/Dense Canopy	Early	Mid	Late
BIRDS- 35 species																					
Barrow's goldeneye				x	x		x	x	x				x		x				F	F	R/F
Bufflehead				x	x		x	x	x				x		x				F	F	R/F
Harlequin duck	SOC			x	x			x	x		x		x		x	x			F	F	R/F
Common merganser				x	x		x	x	x		x		x		x				F	F	R/F
Hooded merganser				x	x			x	x				x		x				F	F	R/F
Northern goshawk	SOC,SC		x	x	x	x	x	x	x	x	x				x	x	x	x		F	R/F
Bald eagle	FT,ST	x		x	x	x	x	x	x				x	x	x		x				R/F
Spruce grouse			x	x	x				x	x						x		x	F	R/F	R/F
Barred owl	SM		x	x	x	x		x	x	x	x		x	x	x	x	x	x			R/F
Northern spotted owl	FT,SE		x	x	x			x	x						x	x	x	x			R/F
Great gray owl	SOC,SM		x	x	x	x	x	x		x				x	x	x	x	x	F	R/F	R/F
Flammulated owl	SOC,SC	x	x	x	x	x	x	x							x		x			R	R/F
Northern pygmy owl	SOC	x	x	x	x	x	x	x						x	x		x		F	R/F	R/F
Vaux's swift	SC	x	x	x	x	x	x	x	x	x	x				x		x				R/F
Northern flicker		x	x	x	x	x	x	x	x	x				x	x	x	x		F	R/F	R/F
Pileated woodpecker	SOC,SC		x	x	x	x	x	x	x					x	x	x	x	x			R/F
Williamson's sapsucker		x	x	x	x	x	x	x	x	x					x		x				R/F
White-headed woodpecker	SOC,SC	x	x	x	x	x	x	x							x	x	x	x			R/F
Hairy woodpecker		x	x	x	x	x	x	x	x	x	x			x	x	x	x	x		R/F	R/F
Three-toed woodpecker	SOC,SM		x	x	x			x	x	x				x	x	x	x	x		R/F	R/F
Black-backed woodpecker	SC		x	x	x			x	x	x					x	x	x			R/F	R/F
Western flycatcher			x	x	x	x	x	x	x	x			x	x			x	x	F	R/F	R/F
Hammonds flycatcher			x	x	x	x	x	x		x				x			x	x	F	R/F	R/F
Chestnut-backed chickadee			x	x	x	x	x	x		x					x		x	x	R/F	R/F	R/F
Brown creeper			x	x	x	x	x	x						x	x		x	x		R/F	R/F
White-breasted nuthatch		x	x	x	x	x	x	x							x		x			R/F	R/F
Red-breasted nuthatch			x	x	x	x	x	x						x	x		x	x		R/F	R/F
Pymgy nuthatch		x	x	x	x	x	x	x							x		x	x			R/F
Winter wren		x	x	x	x	x		x	x	x			x			x	x	x	R/F	R/F	R/F
Golden-crowned kinglet			x	x	x	x		x	x	x							x	x	F	R/F	R/F
Varied thrush			x	x	x	x		x	x	x			x	x	x		x	x	R/F	R/F	R/F
Hermit thrush		x	x	x	x	x		x	x	x				x				x	F	F	R/F
Warbling vireo			x	x	x	x		x	x				x	x			x		R/F	R/F	R/F
Wilson's warbler			x	x	x	x		x	x				x	x				x	F	R/F	R/F
Red crossbill			x	x	x	x	x	x	x	x	x		x	x			x	x		F	R/F

Possibly over 80 of the 400+ species that are present in the assessment area may either occur in, or use the LS forested habitats to some degree. These species are considered to be associated with LS habitat. Although, as mentioned, this includes some species that are only associated with LS forests for cover, security and seclusion and not for forage or reproduction. A species is considered to be dependent or closely associated with LS forests if they occur almost exclusively in this habitat type, or are significantly more abundant there than in younger seral stages (Ruggiero et al. 1991). Of the species that either occur in, or use LS habitat on the Okanogan and in the assessment area, about 56 are known to be dependent or closely associated. These include three species of amphibians, 35 species of birds, and 18 mammals. Table 4-1 is provided for convenience of displaying dependent and closely associated LS species with specific vegetative associations, seral stages, and the Late Successional Reserves in which they occur.

Threatened, Endangered, Sensitive Species and Species of Concern

Five federally listed terrestrial species are known or suspected to occur in the assessment area. The five species include two listed as endangered; peregrine falcon (Falco peregrinus anatum), and gray wolf (Canus lupus), and three listed as threatened; bald eagle (Haliaeetus leucocephalus), northern spotted owl (Strix occidentalis caurina), and grizzly bear (Ursus arctos). Critical habitat, which has been designated for the northern spotted owl, also occurs in the assessment area and is included in the LSR's (Map 12, Appendix H). These species are present in, or use LS habitat and the LSRs for a particular purpose, although they may not depend upon or closely associate with this habitat type for their survival. Of these the northern spotted owl is an exception and is an obligate.

Some terrestrial species listed as sensitive by the U.S. Forest Service in Region-6 (USFS, 1991) occur in the assessment area. As with the federally listed species, these sensitive species are present in or use LS habitat for a particular purpose, but they may not necessarily be dependent upon or closely associated with this habitat for survival. Sensitive species include California wolverine (Gulo luteus), and North American lynx (Felis lynx canadensis). Lynx are considered to be closely associated with LS habitats, while wolverine are not. The lynx has been proposed for Federal listing as a threatened or endangered species in Washington State. This is based upon a small population, isolation, and lack of an adequate prey base (snowshoe hare). They are also a Survey and Manage component 3 species and a Protection Buffer species.

Still other terrestrial species, which are believed to be declining in numbers due to a loss of habitat, human disturbance, or for various other reasons, are also known or suspected to occur in the assessment area. Many of these species have been identified as a forest "Species Of Concern". They are primarily terrestrial species that are dependent upon or closely associated with LS habitat for survival. This includes the northern goshawk, (Accipiter gentilis), great gray owl (Strix nebulosa), some primary cavity excavators such as the pileated woodpecker (Dryocopus pileatus), white-headed woodpecker (Picoides albolarvatus), and the three-toed woodpecker (Picoides tridactylua). The great gray owl, white-headed, and black-backed woodpecker, flammulated owl and pygmy nuthatch are also protection buffer species. Many other species which are generally less visible in forest management are assumed to occur in the assessment area, but specific inventories and/or monitoring efforts have been limited to date.

The following information addresses habitat needs and known locations by LSR of all endangered, threatened, sensitive and forest species of concern that occur in the assessment area.

Endangered

Peregrine falcon

Peregrine falcons are typically found in open forested communities with associated cliffs or canyons. Nest sites are commonly located on sheer cliffs with caves, cracks, or overhanging ledges. Foraging habitat includes open forested areas near water, marshes, or shorelines where passerines, shorebirds, and waterfowl provide a source of prey.

There has not been any documented reports of potential peregrine falcon nesting within the assessment area, although specific inventories for their presence have been minimal to date. An occasional unconfirmed sighting of a foraging peregrine has been reported during the late-summer or early-fall months. These birds were probably seen during migration to wintering areas.

Goat Wall, which is located in the Upper Methow LSR, has been identified as a potential nesting, or hacking site (Pagel, 1993) for recovery goals as addressed in the Forest Plan. Other potential nesting or hacking sites occur in the Upper Methow, as well as the Twisp River and Sawtooth LSRs. Nice and Hunter Mountain LSRs probably do not provide suitable nesting habitat for peregrines.

Gray wolf

Key habitat components for gray wolves include a year-round prey base, suitable areas for denning and rendezvous sites, and minimal human disturbances. The primary prey for gray wolves on the Okanogan is thought to be ungulates, predominately deer, but may include beaver, marmots, and snowshoe hare. Denning sites are secluded and usually located on knolls, ridges or other well-drained areas with nearby forested cover. Rendezvous sites are resting and gathering areas used by wolves after they leave the den site and until pups are mature enough to travel with the adults. Wolves are susceptible to human disturbances near den and rendezvous sites. Research has indicated that wolves do not regularly occur where road densities exceed 0.9 miles per square mile
densities exceed 0.9 miles per square mile
(Mech, 1988).

Gray wolves have been suspected to occur on the forest for many years. Their presence and reproduction was confirmed in 1990 in the Upper Methow LSR (Almack, pers. com.). Numerous sightings or vocalizations of gray wolves have been reported for many other parts of the assessment area. They are also suspected to occur in the Twisp River and Sawtooth LSRs. Since they are a wide-ranging carnivore they may be present in all LSR's.

Threatened

Bald eagle

Bald eagles are typically found in forested communities near a body of water. Nests are usually located in open stands of large ponderosa pine, Douglas-fir, or cottonwoods within one-half mile of a lake or large river, (Methow), where they primarily prey upon fish and waterfowl. Wintering bald eagles will also be found near a lake or large river with nearby coniferous forest for roosting. Highways and livestock calving areas may provide a source of food for wintering bald eagles.

Bald eagles have not been confirmed to breed in the assessment area. A few occasional sightings have been reported during the spring and summer months in the lower Methow Valley, but these may be birds that nest along the Okanogan or Columbia Rivers. There has not been any nesting activities reported for any other areas of the forest. Potential for nesting in or near the Upper Methow, Twisp River, Nice and Hunter Mountain LSRs does exist.

Wintering bald eagles are commonly seen in the Methow Valley along the Methow and Chewuch Rivers from November through March. There are no communal winter roosting areas known to occur in the assessment area, but winter roost sites are known to occur along the Methow River, north and south of the town of Methow and also just north of the town of Twisp. Potential may also exist for winter roosting to occur in or near the Upper Methow, Twisp River and Hunter Mountain LSRs.

Northern Spotted Owl

Northern spotted owls typically require the stand structure commonly found in LS ponderosa pine/Douglas-fir communities (Dry Douglas-fir and Moist Douglas-fir PAGS) below 5,000 feet for their nesting, roosting and foraging needs. These mixed coniferous forested communities are characterized by mature, multi-layered, dense canopy overstories, with large diameter trees and numerous snags and down logs. These habitat components that spotted owls require provide food, cover, nest sites and protection from the weather and predators (Map 12, Appendix H). Nest sites vary from cavities of primary excavators, or those created by structural decay, or damage. Nests are also found in dwarf mistletoe, or in old stick platform nests that have been constructed by other birds or mammals. Spotted owls have large home ranges, the size of which varies from summer to winter and are probably dependent upon the availability of prey.

The Okanogan National Forest represents the extreme northeastern range of the northern spotted owl. Northern spotted owls and suitable habitat are both limited and poorly distributed in the assessment area. Extensive inventories for spotted owls on the forest began in the late-1980s and continued through 1992. Inventories are still conducted but are limited and primarily associated with project proposals near suitable spotted owl habitats. Known sites are monitored annually.

There are 11 known spotted owl activity centers (known sites with a history of occurrence) on the forest (Map 12, Appendix H). All known activity centers occur singularly or in clusters of three. There are no "mega populations" on the Okanogan. Ten of these activity centers are located in the assessment area. Eight occur in the Upper Methow LSR, one activity center occurs in the Twisp River LSR, and the other occurs in the Sawtooth LSR. The remaining activity center occurs entirely within the Pasayten Wilderness. Northern spotted owls have not been reported and are not known to occur in the Nice or Hunter Mountain LSRs. These LSRs do not currently provide suitable nesting or roosting habitat for spotted owls.

Critical habitat was designated for the northern spotted owl in the Federal Register (USDI,1992). Critical habitat is divided into Critical Habitat Units (CHUs) and are the specific areas which include ecological features important to the conservation of the species. CHUs provide required breeding habitat and connectivity within the range of the northern spotted owl. They insure the protection of the required elements (nesting, roosting, foraging, dispersal), and are important for range-wide distribution of the species.

Three Critical Habitat Units designated for the northern spotted owl occur in the assessment area; all are within LSRs. Two occur in the Upper Methow LSR and one occurs in the Twisp River LSR (Map 12, Appendix H).

Grizzly bear

Grizzly bear inhabit vast areas of relatively undisturbed mountainous habitats with a high level of topographic and vegetative diversity (USF&WS, 1993). When they emerge from their dens, which are usually steep, north-facing slopes above 4,000 feet in elevation, they seek low elevation, snow-free areas in search of nutritious food sources. These spring habitats include ungulate winter ranges, low elevation valley bottoms, low gradient stream bottoms, south-facing avalanche chutes, riparian areas, wet meadows, and marshes, where they feed upon winter-killed ungulates, roots and tubers. During the spring and summer months high elevation meadows, avalanche chutes, subalpine ridgetops, talus slopes, whitebark pine stands and shrubfields are important areas where they forage primarily upon grasses, sedges, forbs, roots, berries, fruits and nuts. Dense forest vegetation is important as hiding or security cover. Open road densities above one mile per square mile are known to limit use by grizzly bears (Frederick, 1991).

The assessment area and the entire Methow Valley Ranger District of the Okanogan National Forest lies within the North Cascades Grizzly Bear Ecosystem and Recovery Area. A recent multi-agency study in the North Cascades confirmed that a small number of grizzly bear are present in the ecosystem (Almack, 1993). This report indicates several observations of grizzly bear throughout the forest and many are located within the assessment area.

Since grizzlies are a wide-ranging carnivore, they may potentially occur in all LSRs for at least a part of the year. Many of the habitat components that they require are present in the LSRs. The greatest potential for their occurrence is in the Upper Methow and Twisp River LSRs. Potential denning may occur in the Upper Methow, Twisp River and Sawtooth LSRs.

Sensitive

California wolverine

Wolverine are wide-ranging carnivores that inhabit the more remote, undisturbed mountainous areas with large tracts of wilderness, and limited human activity. They are known to use mature mixed coniferous timbered stands for security and travel. Subalpine fir stands appear to be preferred in relation to other vegetative types. Wolverine seek sheltered sites of talus slopes, large boulders, rock crevices, or caves for denning. Wolverine habitat is more a factor of prey availability rather than any particular vegetative or topographic type (Hornocker and Hash, 1981; Hatler, 1989). Wolverine are primarily scavengers of carrion, but may prey on snowshoe hare, birds, and rodents. Human disturbances associated with forest roads and recreational activities may contribute the most to adverse effects on wolverine.

Wolverine are known to occur in the assessment area. Reported sightings have occurred in the Upper Methow LSR, Twisp River LSR, and the Sawtooth LSR, as well as other areas of the assessment area. Since they are a wide-ranging carnivore, there is potential for them to occur in all of the LSRs. The possibility of wolverine using the Hunter Mountain LSR is very low due to the present vegetation composition and current human disturbances.

North American lynx

On the Okanogan, lynx primarily inhabit mixed coniferous stands of lodgepole pine, Engelmann spruce and subalpine fir (Dry and Moist Subalpine Fir PAGS) above 4,500 feet in elevation (Koehler and Brittell,1990). Three primary habitat components for lynx are: (1) Denning habitat. Lynx denning sites were located in 200+ year old stands of spruce, subalpine fir and lodgepole pine on north to northeast aspects with heavy components of large down logs (Koehler, 1990). (2) Foraging habitat; Early seral stages (15-35 year old) of lodgepole pine, spruce and subalpine fir are important habitats for snowshoe hare, primary prey for the lynx. Lynx may be limited by the availability of snowshoe hare, which appear to be limited by the suitability of winter habitat (early seral stages) (Rodrick and Milner, 1991). (3) Dispersal/travel cover. This component is variable in vegetative composition and structure and is generally considered to be a minimum of 180 stems per acre. Past excessive trapping and incidental mortality from hunting of other species have depressed populations and may have been detrimental to the local population on the forest. High road densities provide access to hunters and trappers and may be related to lynx mortality.

Lynx were originally identified as a Survey and Manage component 2 species in the Standards and Guidelines of the Record of Decision, Northwest Forest Plan (C-5). The component 2 category (survey prior to ground-disturbing activities) was later amended to a component 3 (extensive surveys) species (July 16, 1996). Lynx are also identified as a protection buffer species for matrix areas within the range of the northern spotted owl (C-47). Lynx is the only terrestrial vertebrate survey and manage species known to occur in the assessment area.

Lynx are known to occur throughout the assessment area primarily in the Upper Methow, Twisp River, Nice, and Sawtooth LSRs. They are not known, nor is there habitat potential for them to occur, in the Hunter Mountain LSR.

Species Of Concern

Northern goshawk

Northern goshawks are typically found in mature, mixed coniferous forested communities with dense canopy closures. These requirements may be present in LS ponderosa pine and Douglas-fir communities (Dry and Moist Douglas-fir PAGS) but may also be present in Dry and Moist Supalpine Fir PAGS and the Pacific Silver Fir/Mt. Hemlock PAG. The habitat components provide food, cover, nest sites, and protection from the weather and predators that goshawks require. Nest sites are usually located in large, live trees with numerous snags and down logs in close proximity for perching and plucking. Snowshoe hares and forest grouse are some common prey species.

Northern goshawks are present throughout the assessment area and are known to nest in or near most LSRs. Currently, there are 20 territories known to occur in the LSRs, of which 13 were active in 1996. Seven of these currently active territories occur in the Upper Methow LSR, and six occur in the Sawtooth LSR. Territories are also known for the Twisp River LSR, but they were not active in 1996.

Great gray owl

Great gray owls can be found in a wide variety of habitat types such as ponderosa pine, Douglas fir, lodgepole pine, and deciduous types. Nest sites tend to be in unlogged, mature or older stands with a fairly open understory and dense overstory (60% or greater canopy closure) (Bull, 1990). Great gray owls do not build their own nests but rely on abandon raven, northern goshawk, or red-tailed hawk stick nests. Broken-topped snags or live trees, and mistletoe brooms may also provide opportunities for nesting. They tend to select nest sites near natural meadows or other forest openings that have sufficient prey. Leaning trees and dense cover are important habitat components for fledglings. Main prey items are voles and pocket gophers.

Great gray owls have not been confirmed to occur in the assessment area although specific inventories for their presence has been minimal to date. Occasional sightings or vocalizations are reported, but follow-up visits have not confirmed their presence. Greatest potential for great gray owl nesting include Twisp River, Upper Methow, and the Sawtooth LSRs. Great gray owls have been identified as a protection buffer species (C-21) for nest locations in Matrix areas of the Plan.

Primary Cavity Excavators

At least three species of primary excavators, which are closely associated with LS forests, are considered to be a Forest Species Of Concern. These include the pileated, white-headed, and three-toed woodpeckers. They occur in a wide variety of LS habitat types. All of these species excavate their own nest and roost cavities in dead or live trees which usually have some degree of heartwood decay which facilitates cavity excavation. Pileated woodpeckers feed to a large extent on carpenter ants in dead standing trees or down logs. White-headed woodpeckers forage primarily upon seeds of ponderosa pine but also pries away loose bark in search of insects and larvae. Three-toed woodpeckers scale the trunks of recently dead trees for bark and wood-boring beetles. The three identified primary excavators may be present in all LSRs.

Protection Buffer Species

The great gray owl, white-headed and black-backed woodpecker, pygmy nuthatch and flammulated owl have been identified as a protection buffer species in the Standards and Guidelines of the Record of Decision (C-45, C-46). All species require maintaining adequate numbers of large snags and green-tree replacements for future snags within the four species' ranges in appropriate forest types.

Species-Environment Relationships

All terrestrial species use one or more habitat types to meet all or a portion of their seasonal habitat requirements. They can be associated with a particular vegetative association or seral stage, or they may be totally or partially dependent upon a specific habitat component of an association or seral stage for a part of their life cycle. For example species such as the lynx are associated with the early seral stages of lodgepole pine stands where they hunt for snowshoe hare. Lynx are also associated with LS stands of spruce and lodgepole with abundant down logs for denning. Another example would be mule deer which may be associated with early seral stages of mixed coniferous forests where they seek desirable shrubs for foraging. Still other species may be totally or partially dependent upon vegetative structure or a specific habitat component (attribute) for a part of their life cycle needs. Attributes such as large trees, multi-storied canopies, snags, hollow trees, or down logs may provide required breeding and/or feeding sites for these species.

Large-diameter live trees provide branch structure many closely associated LS species require for nest construction. Mistletoe brooms, which may be found on large diameter trees provide nest structures for northern spotted owls and great gray owls. American martens are also known to use mistletoe brooms as nest sites. Several species of woodpeckers are dependent upon large-diameter ponderosa pine for foraging. Sloughing bark and natural cavities found on large diameter trees provide nest sites, cover and roosting habitat for the brown creeper, white-breasted nuthatch and bats. Large diameter trees also provide larger snags, logs, and higher quality habitat for a greater number of species, for a longer period of time than do smaller diameter trees.

Standing dead or partially dead trees provide nesting and foraging habitat for many primary cavity excavators. This habitat component is necessary for primary excavator species like the pileated, three-toed, and black-backed woodpeckers, or northern flicker. Previously excavated cavities also provide nest and roost sites for a variety of secondary cavity users that do not excavate their own cavities. Secondary cavity users include the northern pygmy owl, flammulated owl, and northern flying squirrels. Hollow snags provide denning and nesting sites for martens, and some species of bats. Broken-topped snags may provide nest sites for great gray owls.

Fallen trees and down logs provide suitable temperature and moisture levels which are necessary for many closely associated species. This habitat component provides breeding, feeding and cover requirements for Pacific giant salamanders, winter wrens, and red-backed voles. Lynx seek areas with heavy accumulations of down logs for maternal denning. Down logs in streams are essential for travel by martens.

Multi-layered canopies provide secure habitats, a variety of perching opportunities, dispersal, and travel routes for many birds and arboreal mammals. Species like the northern spotted owl, western flycatcher, and Douglas squirrel are closely associated with this habitat component.

Riparian vegetation and hardwood stands provide required habitats for several closely associated species such as the marten and western flycatcher. The value of riparian areas is provided by the presence of water, more mesic micro-climate, a greater diversity of vegetative species and structure, and the contrast or edge between riparian and LS habitats.

Implications for Management of Late Successional Reserves

Management actions that sustain, enhance, or reduce the risks of loosing LS habitats through wildfires, insect epidemics, or diseases, will potentially benefit many dependent and closely associated terrestrial vertebrates.

Although these benefits may only be realized in the distant future. It is also anticipated that some management actions will have a short-term adverse affect upon dependent and closely associated species.

The most important consideration when planning management actions to sustain, enhance or reduce risks in LS habitats is to maintain and protect all suitable nesting, roosting and foraging habitats in the vicinity of all known northern spotted owl activity centers. Since spotted owls are limited and poorly distributed in the assessment area, it is important to maintain all known individuals. This precaution should maintain viable populations of all dependent and closely associated species (USDA, 1992)

Unique Habitats

Unique habitats are often lands with microsite variations within a stand association. These areas could be unusual due to a geological formation, soil type or hydrological feature. In the case of the Northeastern Cascades LSR system, many of the these "unique" habitats consist of non-forested areas of various types within the LSRs. This explains the large percentage of acres of "unique" habitats found in Table 4-2. Aspect, elevation, past management activities or disturbance actions may also play a role in developing these special habitats. These microsite variations often occur on small sites and on particular types of substrate (rock, snags) and cannot be easily analyzed on a landscape basis. These sites currently provide habitat for many species of special status including federally listed and proposed species, Regional Forester sensitive species, State species of concern, and survey and manage, and protection buffer species as defined by the Northwest Forest Plan (NWFP). Despite their small size, these unique habitats greatly contribute to the overall biodiversity of the landscape.

Unique areas require special considerations in the design and implementation of all projects. Reference should be made to the applicable resource specialist in order to determine how best to protect these significant areas. A preliminary list of these habitats would include, but are not limited to, the following:

- Deciduous tree sites
- Hydrologic sites: seeps, springs, bogs, riparian forest interface, and wetlands.
- Rock cliffs, talus slopes or other rock formations in forest situations.
- Natural meadows or edges interfaced with or interspersed in forest lands (shrub fields).
- Sites occupied by or providing specific habitat needs for special status species.
- Microsites - large hollow pines and caves.
- Areas with high contrasting elevations (mountain tops and canyons).
- Pockets of disjunct forest communities out of sync with surrounding associations..
- Snag patches, old growth remnants in young stands, refugia, etc.. . .

Thirty-six percent (nearly 318,000 acres) of the assessment area are potentially unique habitats. Most of these habitats occur in Wilderness areas, although some portion of this percentage does include agricultural and other private lands. Approximately one-third of this acreage (90,000 acres) occurs in the LSR system itself. Three groups make up the majority of these habitats; 10 percent are meadow complexes, 11 percent are rock outcroppings and 8 percent are grass and shrub steppe. The remaining 62,000 acres include riparian habitats, shrub fields, glaciers, krumholz, water, hardwoods, and agricultural lands.

Unique habitats within the LSRs are described in Table 4-2. Hunter Mountain LSR has the highest amount of what could be considered unique habitats at 70 percent; 50 percent of which is grass and shrub steppe. At the other end of the scale is Nice LSR, which is composed of 14 percent unique habitats, mostly riparian vegetation and meadows. The other three LSRs have between 16 and 37 percent unique habitats, mostly rock and meadows. These percentages reflect the amount of non-forested ground of all types that occurs within the LSRs

There are no identified unique geological areas in the assessment area. There are several areas that have been identified as Research Natural Area (RNA) areas in the assessment area. These areas exemplify typical or unique vegetation and associated biotic, soil, geologic, and aquatic features. These areas are set aside to preserve a representative sample of an ecological community primarily for non-manipulative scientific and education purposes. One existing RNA is located at Wolf Creek and two potential RNA sites are located at Harts Pass and July Creek. A recently identified bog area, at Falls Creek, may also have the potential to be designated as an RNA.

Table 4-2 - Amount & Type Of Unique Habitats Within Each LSR

	Upper Methow R9 W-142, 11,537a		Twisp River RW-141, 36,275a		Sawtooth RW-139, 65,902a (2000a)		Nice RW-143, 3,128a		Hunter RW-140, 6,170a	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Shrub fields	4,827	2.5%	400	1%	3,070	5%	86	3%	852	14%
Riparian Veg	1,563	<1%	1,008	3%	1,225	3%	267	9%	294	5%
Grass shrub	887	<1%	887	2%	2,041	3%	0	0	3,085	50%
Meadows -(Total)	20,730	11%	1,420	4%	11,799	18%	68	2%	0	0
Wet	8	<1%	0	0	0	0	63	2%	0	0
Dry	788	<1%	509	1%	200	<1%	5	<1%	0	0
Alpine	10,468	5.5%	504	1%	4,911	7%	0	0	0	0
Whitebark pine	95	<1%	0	0	0	0	0	0	0	0
Subalpine larch	192	<1%	8	<1%	42	<1%	0	0	0	0
Mixed	9,179	5%	399	1%	6,646	10%	0	0	0	0
Alder	196	<1%	0	0	0	0	0	0	0	0
Rock	24,425	13%	2,169	6%	5,983	9%	0	0	0	0
Water	62	<1%	0	0	132	<1%	3	<1%	0	0
Agriculture	3	<1%	0	0	288	<1%	0	0	118	2%
Glaciers	8	<1%	0	0	3	<1%	0	0	0	0
Krumholz	2,198	1%	0	0	0	0	0	0	0	0
Totals	54,899	29%	5,884	16%	24,541	37%	424	14%	4,349	70%

Connectivity

Providing suitable connectivity corridors between landscape attributes allows for species to move uninhibited throughout the landscape. This ensures that genetic material is exchanged and provides dispersal habitat for juveniles. Because LS habitat is fragmented over the assessment area, having adequate connectivity corridors between useable habitat patches is critical. Connectivity corridors minimize the number of local extinctions and provides movement between habitat patches reducing genetic isolation (Harris 1984, Noss and Harris 1986). The LSR system was established to partially provide for some of these concerns.

The two major benefits of wildlife corridors in biological conservation are to (1) provide dwelling habitat for plants and animals; and (2) serve as a conduit for movement (Noss 1983). For LSR system managers, the problem is determining what elements on the landscape will provide for these essential habitats and how to interconnect them. Different species have different essential habitats. Of great importance is determining what target species to manage the corridors for. For our purposes here, species with lower mobility needs would likely have them addressed by the higher mobility species requirements except in microsite variations. These sites will be managed using site specific information and management recommendations appropriate to the site.

Numerous authors (Noss 1983 & 1993, Bright 1993, Wilcove et al 1986 and Harris 1984) have identified the following variables to consider when determining the effectiveness of movement corridors. These variables are: (1) corridor width and length, (2) habitat quality, (3) adjacency to human activities, and (4) distance between habitat patches.

Unfortunately, dispersal patterns for most species are not available. A landscape view of the assessment area was examined and the following corridors were identified (Appendix H, Map 13). Each of the corridors mapped has at least one of the following attributes: (1) High quality habitat is currently present and corridors have a high likelihood of being used; (2) LS habitat is of marginal utility for providing safe movement of species between habitat patches. With time it has potential to become better with management; (3) Poor existing LS habitat but the area is critical to facilitate movement of species. Some ways exist to improve these linkages.

The following key considerations on developing and defining corridors should be used in evaluating the value of corridors; (1) Habitat for the targeted specie(s) must exist within the corridor; (2) Corridors may provide movement areas for non-targeted species and even competitors; (3) Narrow corridors are most likely edge habitat and therefore increase the number of edge species that will use them, (4) Any corridor that also contains interior habitat is also more valuable to a wider range of species.

A corridor would still exist if it consisted of only dispersal habitat and was a thin linear strip. However, the quality of the corridor would not be as high as one with all identified components of habitat and interior forest. Additionally, stepping stones or circular patches of habitat that retained interior habitat within a corridor of lesser quality habitat would be more beneficial to the target species than longer corridors with no interior patches.

Various researchers (Harris 1984, Marcot, pers comm. 1983, Spies et al, 1990) have all reported on the effects of edge on an interior stand. Unfortunately, there is no magic number that one arrives at in order to ensure habitat quality and utility of interior stands. The effects vary depending upon what you are concerned with; vegetative species, microclimate, parasitism, competition, wind, temperature, light, humidity. Aspect, slope, wind direction, and the presence of frost pockets add to the cumulative effect an edge has on the size and quality of the interior habitat. Actions which alter the canopy or sub-canopy may result in micro and macro site changes that could change the value of the stand as interior habitat. These microsite changes could be instigated by temperature (heat, rain, cold) or wind changes and/or habitat changes which may increase predation and competition.

Generally speaking, edge effects may extend as far into a forest stand as 600 feet, or two or three tree heights into the patch on all sides of the stand. For this assessment, edge habitat will be defined as the area extending 600 feet or two to three tree heights from the outer edge of the patch into the interior of the stand. The interior habitat would be the core area or island left in the center of the patch after the edge habitat is defined. In order to function as interior forest habitat, the core area must be at least 300 acres.

For example, a stand 1,200 feet (26 acres) in diameter would have no core area because the wind speed entering a patch would not dissipate as it traveled through the stand, and would effect habitat quality throughout the stand. As a result the central core of the patch would not be very useful to wildlife. As the patch increases in size, say 200 acres, the core area or interior habitat would increase to 25 percent of the total acreage. By increasing the patch size to 7,000 acres, 90 percent of its total acreage would be usable as interior habitat. In order to provide for some equitable level of core area or interior habitat, a stand would have to be 300 acres with a radius of around 2,000 feet. This would mean 50 percent of the area would function as edge habitat, and 50 percent of the area would provide interior forest habitat. The edge habitat that is closest in species composition and structure to the desired LS habitat is best.

Methodology For Identifying Connectivity Corridors

The entire assessment area was evaluated for areas where linkages appeared to indicate problems for high mobility species. Species, for the most part, disperse randomly. By providing avenues of safe passage for target species, we can increase the potential for successful migration, emigration and immigration. Corridors may be of different levels of quality. The best corridors would provide all of the types or elements of habitat necessary for the life history of a species. In addition, the interior habitat would allow movement between habitat patches. The quality of the corridor would be reduced if: (1) all components necessary for life history of target species were not present; and, (2) no core area or interior habitat was available.

To identify existing linkages in the assessment area, existing interior habitat was identified. These were areas unfragmented by roads or trails and future habitat that has the potential to grow into interior habitat. This was also based on the current condition of the vegetation, environmental factors, and PAG associations that could be used as stepping stones between LS habitat and corridors (Appendix H, Map 13). Additionally, riparian reserves were scrutinized. to determine sustainability and potential of a site to retain LS character. Detailed identification of corridors, movement areas, and interior patches was restricted due to the broad scale application of the available data. In all cases, site specific project analysis should be used to more closely identify these corridors on the ground and validate the areas identified in this assessment.

Existing interior habitat patches (>100 acres) were identified. Generally, these areas were either naturally fragmented or fragmented by forest management actions and roads.

Within LSRs

Corridors are provided for by riparian reserves and other ROD Standards and Guidelines, except as noted below.

Hunter Mountain LSR
Corridors within this LSR follow the ridgelines and riparian areas. No interior habitat exists within this LSR. See the Map 13, Appendix H for general locations.

Nice LSR
[redacted]SR are riparian [redacted] Creek and Falls Creek. Interior habitat could be substantially improved in this LSR by reducing road densities and managing for interior habitat near Nice Campground and Buck Mountain. See Map 13, Appendix H for general locations.

Sawtooth LSR
Within this LSR connectivity is limited because the landscape is naturally fragmented, patchy, and not contiguous. One area may potentially meet the minimum patch size for interior habitat at the confluence of the Middle Fork of Gold Creek and the mainstem of Gold Creek, and also at Buckhorn Canyon. Additional interior habitat could be developed as “stepping stones” near Hungry Mountain, Vinegar Lake, and South Fork Gold Creek. Connectivity corridors could be grown and maintained at upper Foggy Dew and Navarre Coulee. See Map 13, Appendix H, for general locations.

Twisp River LSR
The key corridors for movement within this LSR are the West Fork of Bridge Creek and the North Fork of the Twisp River. Interior habitat could be developed in Buttermilk Creek. See Map 13, Appendix H, for general locations.

Upper Methow LSR
Connectivity in the Upper Methow LSR is impaired by the “peninsula” of private land undergoing development. The narrowest portion of the LSR is also bisected by the State Route 20 highway corridor, a major transportation route with a clearing distance of 200 feet.

The key corridors are riparian areas (South Fork Slate Creek, Upper Methow River) and stringers across the private lands between the eastern and western portions of the LSR. Interior habitat is very high quality in South Fork Slate Creek, Ruby Creek, Canyon Creek, and Granite Creek watersheds. Interior habitat parches could be improved along the Methow River, Weeman area, McGee Creek, Calloway, and parts of lower Goat Wall. See Map 13, Appendix H, for general locations.

Between LSRs

Manage the following areas to improve corridors and interior habitat.

Hunter Mountain LSR

- *West*: see "east" discussion in Sawtooth LSR.

- *North:* build and retain connectivity in riparian areas to the south and along Squaw Creek Ridge to Black Canyon. South Fork Gold has serious difficulties with roads. Information regarding Hunter LSR indicates an abundance of non-forested habitat.

Nice LSR

- *West:* see "east" discussion in Upper Methow LSR . Low potential for mobility in this location. Available habitat quality is diluted due to high human use.

Sawtooth LSR

- *North* See "south" discussion in Twisp River LSR

- *South*: Maintain connectivity links in Falls Creek and South Navarre Creek. Develop connectivity in Safety Creek. High densities of roads contribute to low quality of connectivity habitat in Falls and Coyote Creek.

- *West*: grow and develop corridors and stepping stones in Miner's Basin, Ferry's Park, and East Fork Prince Creek. Maintain and build upon interior habitat in Prince Creek.

- *East*: Develop a corridor from McFarland Creek to ridge area of Hungry and Hunter Mountains through Mulloghan Gulch.

Several areas between the Sawtooth and Twisp River LSRs provide interior habitat and serve as potential stepping stones for connectivity corridors. These areas are currently at high crown fire potential and therefore li[illegible] to be unsustainable. Protection of these areas is essential to [illegible] between these two LSRs.

Twisp River LSR

- *North:* Riparian corridors are critical, especially the north fork of the Twisp River and the upper Twisp River. There is a need to manage for older trees here since the majority of Twisp River riparian is young forest.

- *South*: Connect stepping stones across the landscape through ridgelines and riparian corridors: Buttermilk, Newby, Shady Nook Basin, Poorman Creek, Lookout Ridge, and Horse Gulch. High numbers of roads limit the value of any interior habitat in these areas.

- *West:* Riparian corridors of south fork Twisp River, South Creek, War Creek, south fork War Creek, and Eagle Creek should be managed to provide for connectivity over the landscape.

- *Interior Habitat*: Restore and maintain interior habitat in War Creek, Black Ridge and Duckbill Mountain. Along the Twisp River maintain and develop ponderosa pine LS habitat. South of the Twisp River connectivity is naturally fragmented.

Upper Methow LSR

- *North*: Maintain corridors in Hurricane Creek and Sunset Creek.

- *South*: See "north" discussion in Upper Methow LSR.

- *East*: Riparian corridors in Cub Creek, Cabin Creek and Falls Creek.

- *West*: Look at the potential to grow mature forest and avoid further fragmentation from trails and roads, especially in areas of Liberty Bell Mountain, Slate Creek, Copper Pass, and Twisp Mountain.

- *Interior Habitat*: Develop, maintain, and restore interior habitat in Junior Creek, Chris Creek, north Snake Creek, Dodge Creek, Butte Creek, Sunshine Creek, and the Lost River Gorge (at Sunset and Hurricane Creeks).

Observations:

According to PAG mapping, the moist Subalpine Fir PAGs are likely to provide corridors between Wilderness areas and LSRs. Low passes vegetated with these PAGs were identified as important for movement of terrestrial species These areas also provide the most LS habitat in the high subalpine zone. In lower areas, the Douglas-fir PAGs make up the bulk of interior habitat..

Roads analysis identified significant problems with high road densities in some areas necessary to manage for connectivity. Trails were not specifically addressed in this analysis because complete information was not available

The assessment area landscape, in general, is highly fragmented by topography, aspect, climate and human activities. Riparian Reserves are intended to provide habitat conduits for dispersal of spotted owls and genetic interchange for LS species. However, within the Northeast Cascades LSR system, these areas provide very marginal connectivity habitat but do connect interior patches. Within the LSRs, lack of connectivity appears to be more of a vegetation and topography problem. Management in these areas should provide habitat for species based on the potential vegetation association in this area.

Recommendations for Management of Connectivity Corridors

1) Maintain canopy closure, and interior quality of stand. Prevent additional loss of effective edge buffers.
2) For management within connectivity corridors, no further degradation.
3) Block up potential future interior habitats where appropriate. Enhance or enlarge these areas by thinning and planting where appropriate.
4) Reduce road and trail miles when they interfere with connectivity functions. Evaluate currently used roads and trails; obliterate and revegetate non-system road and trails.
5) Consider land exchanges where necessary to improve connectivity.
6) Evaluate all projects regarding their impact to connectivity corridors, avoiding areas identified as necessary for movement or for providing existing or future interior habitat.

SURVEY AND MANAGE PLANT SPECIES

Appropriate survey and manage species presented in the Northwest Forest Plan ROD are listed in Table 4-3 below. In Appendix J2 of the ROD, rare or locally endemic plant species were identified as candidates for special consideration and conferred status as survey and manage species. The primary list (Table C-3 in the ROD) has been modified in **Error! Reference source not found.** to include only those species known to occur, or with a reasonable probability of occurrence on lands administered by the Okanogan National Forest. It should be noted that these species lack adequate information on range and distribution on the forest. In addition, knowledge regarding management strategies that ensure viable populations is incomplete. Further information will be generated with survey and manage treatment of these species of concern. Surveys for these species will be completed as specified in Table 4-3. Primary habitat is characterized and survey strategy listed for each species below. Management activities are described in the ROD and summarized after Table 4-3.

Table 4-3

SURVEY AND MANAGE PLANT SPECIES OF THE OKANOGAN NATIONAL FOREST

Species	Common Name	Primary Habitat	Survey Strategy [a]	Mitigation [b]
VASCULAR PLANTS				
Allotropa virgata	Sugar stick	Dry forested sites with woody debris	1, 2	1, 2, 3, 4
Botrychium minganense	Mingan moonwort	Shaded mesic sites and riparian zones	1, 2	2, 3, 6
Botrychium montanum	Mountain grape-fern	Shaded mesic sites and riparian zones	1, 2	2, 3, 6
Cypripedium fasciculatum	Clustered lady's slipper	Broad range of habitats in mid-montane forests	1, 2	1, 2, 3, 4
Cypripedium montanum	Mountain lady's slipper	Broad range of habitats in mid-montane forests	1, 2	2, 3, 6, 7
LICHENS				
Bryoria tortuosar	Foliaceous Lichen	Trees in LS stands	1, 3	1,2,3,5
Calicium abietinum	Pin Lichen	Trees in LS stands	4	2, 4, 5
Calicium adaequatum	Pin Lichen	Trees in LS stands	4	2, 4, 5
Calicium adspersum	Pin Lichen	Trees in LS stands	4	2, 4, 5
Calicium glaucellum	Pin Lichen	Trees in LS stands	4	2, 4, 5
Calicium viride	Pin Lichen	Trees in LS stands	4	2, 4, 5
Chaenotheca brunneola	Pin Lichen	Trees in LS stands	4	2, 4, 5
Chaenotheca chrysocephala	Pin Lichen	Trees in LS stands	4	2, 4, 5
Chaenotheca ferruginea	Pin Lichen	Trees in LS stands	4	2, 4, 5
Chaenotheca furfuracea	Pin Lichen	Trees in LS stands	4	2, 4, 5
Chaenotheca subroscida	Pin Lichen	Trees in LS stands	4	2, 4, 5
Chaenothecopis pusilla	Pin Lichen	Trees in LS stands	4	2, 4, 5
Cyphelium inquinans	Pin Lichen	Trees in LS stands	4	2, 4, 5
Hydrothyria venosa	Waterfan	Clear, cold streams with stony bottoms	1, 3	2, 6
Lobaria linita	Cabbage Lung	Mossy rocks at high elevation	1, 2, 3	1, 2, 3, 5, 6
Lobaria oregana	Lettuce Lung	Shaded conifers	4	2, 3, 5
Lobaria pulmonaria	Lungwort	Trees and mossy rocks	4	2, 3, 5
Lobaria scrobiculata	Textured Lung	Trees & moss covered outcrops	4	2, 3, 5
Microcalicium arenarium	Pin Lichen	Trees in LS stands	4	2, 4, 5
Mycocalicium subtile	Pin Lichen	Trees in LS stands	4	2, 4, 5
Nephroma bellum	Cat Paw	Trees and mossy rocks	4	2, 3, 5
Nephroma helveticum	Dog Paw	Trees and mossy rocks	4	2, 3, 5
Nephroma parile	Powder Paw	Trees and mossy rocks	4	2, 3, 5
Nephroma resupinatum	Blister Paw	Trees and rocks	4	2, 3, 5
Pannaria leucostictoides	Petalled Mouse	Conifers & deciduous trees	4	2, 3, 5
Pannaria mediterranea	Blue-eyed Mouse	Conifers, mossy rock, and soil	4	2, 3, 5
Pannaria saubinetii	Pink-eyed Mouse	Conifers and deciduous trees	4	2, 3, 5
Peltigera collina	Tree Pelt	Shaded conifers & moss covered rocks	4	2, 3, 5
Peltigera neckeri	Frog Pelt	Soil, mossy rocks, & decaying logs	4	2, 3, 5
Peltigera pacifica	Frog Pelt	Soil, moss, and moss covered logs	4	2, 3, 5
Pilophorus nigricaulis	Rock Lichen	Rock outcrop and talus in LS stands	1, 3	2, 5, 6
Platismatia lacunosa	Crinkled Rag	Conifers, deciduous shrubs, and rock	4	2, 3, 5, 6
Pseudocyphellaria anomala	Netted Specklebelly	Conifers and deciduous trees	4	2, 3, 5
Pseudocyphellaria anthraspis	Dimpled Specklebelly	Conifers and deciduous trees	4	2, 3, 5
Pseudocyphellaria crocata	Yellow Specklebelly	Trees and shrubs in old growth stands	4	2, 3, 5
Ramalina thrausta	Riparian Lichen	Deciduous trees & confirers in riparian areas	4	2, 3, 5, 6
Stenocybe clavata	Pin Lichen	Trees in LS stands	4	2, 4, 5
Stenocybe major	Pin Lichen	Trees in late successional stands	4	2, 4, 5
Sticta arctica	Arctic Moon	Moss and rock in alpine locations	1, 3	2, 5, 6
Sticta beauvoisii	Blue Moon	Deciduous trees, conifers, and mossy rock	4	2, 3, 5
Sticta fuliginosa	Peppered Moon	Deciduous trees, conifers, and mossy rock	4	2, 3, 5
Sticta limbata	Powdered Moon	Deciduous trees and moss covered rocks	4	2, 3, 5
Tholurna dissimilis	Tholuma	Subalpine conifer stands	1, 3	1, 2, 5, 6

SURVEY AND MANAGE PLANT SPECIES OF THE OKANOGAN NATIONAL FOREST (cont'd)				
Species	**Common Name**	**Primary Habitat**	**Survey Strategy**	**Mitigation** [b]
LIVERWORTS				
Diplophyllum albicans	Striped folded leaf	Cool humid places on organic matter, mineral soil, or rock on both sides of the Cascades.	1,3	1, 2, 4
Diplophyllum plicatum	Giant folded leaf	Cool humid places on rotten wood, mineral soil, or rock. Western slopes of the Cascades where fog occurs.	1, 2, 3	1, 2, 4, 5, 7
Douinia ovata	Douinia	Conifers and rock out-crops in riparian areas and ridges	4	2, 5, 6
Herbertus aduncus	Common scissor leaf	Montane habitats on moist exposed rocks.	1,3	1, 2, 7
Kurzia makinoana	Slender clawleaf	Organic substrates in bogs	1, 2	1, 2, 3, 7
Marsupella emarginata var. aquatica	Stream ladderwort	Rocks in perennial montane streams	1, 2	1, 2, 3, 7
Tritomaria exsectiformis	Tritomaria	Soil and rock of mesic, shaded riparian areas	1, 2	2, 3, 6
MOSSES				
Antritrichia curtipendula	Hanging moss	Cold air drainages in cool moist coniferous forests.	4	1, 2, 3, 5
Bartramiopsis lescurii	False apple moss	Cool, humid canyons and stream terraces at low elevations on rock, soil over rock, and cliffs.	1,3	1, 2, 3, 4, 5
Buxbaumia viridis	Green bug moss	OM or soil in shady and humid coniferous forests from low elevation to subalpine.	PB	1, 2, 4, 5, 6
Rocomitrium aquaticum	Awnless wet wavy-cell moss	Moist rocks and cliffs along shady streams, often in splash zones.	1,3	1, 2, 3, 7
Rhizomnium nudum	Naked round moss	Mid to high elevation forests with late persisting snow.	PB	1, 2, 3, 5, 6, 7
Schistostega pennata	Luminous moss	Old-growth mesic forests	1,3, PB	1, 2, 6, 7
Scouleria marginata	Margined black knotmoss	Rocks in the splash zone of streams and waterfalls.	4	1, 2, 3, 6
Tetraphis geniculata	Bent-kneed four-tooth moss	Low to mid elevation forests in shaded, humid locations on well rotted logs.	1,3, PB	1, 2, 4, 5, 6
FUNGI				
Gastroboletus turbinatus	Bolete	Old-growth mesic forest	3	4, 5, 6
Boletus pulcherrimus	Bolete	High montane, old growth conifer forest	1, 3	1, 2, 4, 5
Gastroboletus ruber	Bolete	Old-growth mountain hemlock stands	1, 3	1, 2, 3, 6
Thaxterogaster pingue	False Truffle	Old-growth mesic forest	3	4, 5, 6
Rhizopogon evadens var. subalpinus	False Truffle	Old-growth mountain	1, 3	1, 2, 5, 6
Chamonixia pacifica sp. nov 12768. #Trappe	Truffle: Undescribed Taxa	Old-growth mesic hemlock stands	1, 3	1, 2, 5, 6
Cantharellus formosus	Chanterelle	Old-growth mesic forest	1, 3	1, 2, 3, 4, 5
Polyozellus multiplex	Chanterelle	High-elevation forest silver fir stands	1, 3, PB	2, 4, 5, 6
Cantharellus cibarius	Chanterelle	Old-growth mesic forest	3, 4	1, 2, 3, 4, 5
Cantharellus subalbidus	Chanterelle	Old-growth mesic forest	3, 4	1, 2, 3, 4, 5
Cantharellus tubaeformi	Chanterelle	Old-growth mesic forest	3, 4	1, 2, 3, 4, 5
Gomphus bonarii	Chanterelle - Gomphus	Old-growth mesic forest	3	1, 2, 4, 5, 6
Gomphus clavatus	Chanterelle - Gomphus	Old-growth mesic forest	3	1, 2, 4, 5, 6
Gomphus floccosus	Chanterelle - Gomphus	Old-growth mesic forest	3	1, 2, 4, 5, 6
Gomphus kauffmanii	Chanterelle - Gomphus	Old-growth mesic forest	3	1, 2, 4, 5, 6
Ramaria abietina	Coral Fungus	LS mesic forests of Tsuga, Abies Pinus, Picea, and Pseudotuga	3	1, 2, 4, 5, 6

SURVEY AND MANAGE PLANT SPECIES OF THE OKANOGAN NATIONAL FOREST (cont'd)

Species	Common Name	Primary Habitat	Survey Strategy	Mitigation [b]
Ramaria araiospora	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria botryis var. aurantiiramosa	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria concolor f. tsugina	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	3	1, 2, 4, 5, 6
Ramaria coulterae	Coral Fungus	LS mesic forests of Tsuga, Abies,Pinus, Picea, and Pseudotuga	3	1, 2, 4, 5, 6
Ramaria var. sparsiramosa fasciculata	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria gelatiniaurantia	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria largentii	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria rubella var. blanda	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria rubrievanescens	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria rubripermanens	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria suecica	Coral Fungus	LS mesic forests of Tsuga, Abies,Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria thiersii	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria amyloidea	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria aurantiisiccescen	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria celerivirescens	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria claviramulata	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria concolor f. marri	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	3	1, 2, 4, 5, 6
Ramaria cyaneigranosa	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria hilaris var. olympiana	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria lorithamnus	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria maculatipes	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria rainierensis	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria rubribrunnescens	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria stuntzii	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria verlotensis	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria gracilis	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Ramaria spinulosa	Coral Fungus	LS mesic forests of Tsuga, Abies, Pinus, Picea, and Pseudotuga	1, 3	1, 2, 4, 5, 6
Phaeocollybia attenuata	Phaeocollybia	Low-elevation to montane LS coniferous forest	3	1, 2, 3, 4, 5, 6
Phaeocollybia califomica	Phaeocollybia	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 3, 4, 5, 6
Phaeocollybia carmanahensis	Phaeocollybia	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 3, 4, 5, 6
Phaeocollybia dissiliens	Phaeocollybia	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 3, 4, 5, 6

SURVEY AND MANAGE PLANT SPECIES OF THE OKANOGAN NATIONAL FOREST (cont'd)				
Species	**Common Name**	**Primary Habitat**	**Survey Strategy**	**Mitigation** [b]
Phaeocollybia fallax	Phaeocollybia	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 3, 4, 5, 6
Phaeocollybia gregaria	Phaeocollybia	Low-elevation to montane LS coniferous forest	3	1, 2, 3, 4, 5, 6
Phaeocollybia kauffmanii	Phaeocollybia	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 3, 4, 5, 6
Phaeocollybia olivacea	Phaeocollybia	Low-elevation to montane LS coniferous forest	3	1, 2, 3, 4, 5, 6
Phaeocollybia oregonensis	Phaeocollybia	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 3, 4, 5, 6
Phaeocollybia piceae	Phaeocollybia	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 3, 4, 5, 6
Phaeocollybia pseudofestiva	Phaeocollybia	Low-elevation to montane LS coniferous forest	3	1, 2, 3, 4, 5, 6
Phaeocollybia scatesiae	Phaeocollybia	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 3, 4, 5, 6
Phaeocollybia sipei	Phaeocollybia	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 3, 4, 5, 6
Phaeocollybia spadicea	Phaeocollybia	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 3, 4, 5, 6
Catathelasma ventricosa	Gilled Mushroom	Low-elevation to montane LS coniferous forest	3	1, 2, 4, 5, 6
Cortinarius azureus	Gilled Mushroom	Low-elevation to montane LS coniferous forest	3	1, 2, 4, 5, 6
Cortinarius boulderensis	Gilled Mushroom	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 4, 5, 6
Cortinarius cyanites	Gilled Mushroom	Low-elevation to montane LS coniferous forest	3	1, 2, 4, 5, 6
Cortinarius magnivelatus	Gilled Mushroom	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 4, 5, 6
Cortinarius olympianus	Gilled Mushroom	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 4, 5, 6
Cortinarius spilomius	Gilled Mushroom	Low-elevation to montane LS coniferous forest	3	1, 2, 4, 5, 6
Cortinarius tabularis	Gilled Mushroom	Low-elevation to montane LS coniferous forest	3	1, 2, 4, 5, 6
Cortinarius valgus	Gilled Mushroom	Low-elevation to montane LS coniferous forest	3	1, 2, 4, 5, 6
Dermocybe humboldtensis	Gilled Mushroom	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 4, 5, 6
Hebeloma olympiana	Gilled Mushroom	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 4, 5, 6
Hygrophorus caeruleus	Gilled Mushroom	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 4, 5, 6
Hygrophorus karstenii	Gilled Mushroom	Low-elevation to montane LS coniferous forest	3	1, 2, 4, 5, 6
Hygrophorus vernalis	Gilled Mushroom	Low-elevation to montane LS coniferous forest	1, 3	1, 2, 4, 5, 6
Russula mustelina	Gilled Mushroom	Low-elevation to montane LS coniferous forest	3	1, 2, 4, 5, 6
Chroogomphus loculatus	Gilled Mushroom	LS conifer forest	1, 3	1, 2, 3, 4, 5, 6
Cortinarius canabarba	Gilled Mushroom	LS conifer forest	1, 3	1, 2, 3, 4, 5, 6
Cortinarius rainierensis	Gilled Mushroom	LS conifer forest	1, 3	1, 2, 3, 4, 5, 6
Cortinarius variipes	Gilled Mushroom	LS conifer forest	1, 3	1, 2, 3, 4, 5, 6
Tricholoma venenatum	Gilled Mushroom	LS conifer forest	1, 3	1, 2, 3, 4, 5, 6
Albatrellus ellisii	Ecto-Polypore	Old-growth mesic conifer forest	3	1, 2, 4, 5, 6

SURVEY AND MANAGE PLANT SPECIES OF THE OKANOGAN NATIONAL FOREST (cont'd)				
Species	**Common Name**	**Primary Habitat**	**Survey Strategy**	**Mitigation** b
Albatrellus flettii	Ecto-Polypore	Old-growth mesic conifer forest	3	1, 2, 4, 5, 6
Albatrellus avellaneus	Ecto-Polypore	Old-growth mesic conifer forest	1, 3	1, 2, 4, 5, 6
Hydnum repandum	Tooth Fungus	LS conifer forest	3	1, 2, 3, 4, 5
Hydnum umbilicatum	Tooth Fungus	LS conifer forest	3	1, 2, 3, 4, 5
Phellodon atratum	Tooth Fungus	LS conifer forest	3	1, 2, 3, 4, 5
Arcodon fuscoindicum	Tooth Fungus	LS conifer forest	3	1, 2, 3, 4, 5
Sarcodon imbricatus	Tooth Fungus	LS conifer forest	3	1, 2, 3, 4, 5
Baeospora myriadophylla	Gilled Mushroom	Saprobic species of LS forests	3	1, 2, 3, 4, 5, 6
Chrysomphalina grossula	Gilled Mushroom	Saprobic species of LS forests	3	1, 2, 3, 4, 5, 6
Collybia bakerensis	Gilled Mushroom	Saprobic species of LS forests	1, 3	1, 2, 3, 4, 5, 6
Fayodia gracilipes (rainierensis)	Gilled Mushroom	Saprobic species of LS forests	3	1, 2, 3, 4, 5, 6
Gymnopilus puntifolius	Gilled Mushroom	Saprobic species of LS forests	1, 3	1, 2, 3, 4, 5, 6
Mycena hudsoniana	Gilled Mushroom	Saprobic species of LS forests	1, 3	1, 2, 3, 4, 5, 6
Mycena lilacifolia	Gilled Mushroom	Saprobic species of LS forests	3	1, 2, 3, 4, 5, 6
Mycena marginella	Gilled Mushroom	Saprobic species of LS forests	3	1, 2, 3, 4, 5, 6
Mycena monticola	Gilled Mushroom	Saprobic species of LS forests	1, 3	1, 2, 3, 4, 5, 6
Mycena overholtsii	Gilled Mushroom	Saprobic species of LS forests	1, 3	1, 2, 3, 4, 5, 6
Mycena quinaultensis	Gilled Mushroom	Saprobic species of LS forests	1, 3	1, 2, 3, 4, 5, 6
Mycena tenax	Gilled Mushroom	Saprobic species of LS forests	3	1, 2, 3, 4, 5, 6
Mythicomyces corneipes	Gilled Mushroom	Saprobic species of LS forests	3	1, 2, 3, 4, 5, 6
Pholiota albivelata	Gilled Mushroom	Saprobic species of LS forests	1, 3	1, 2, 3, 4, 5, 6
Stagnicola perplexa	Gilled Mushroom	Saprobic species of LS forests	3	1, 2, 3, 4, 5, 6
Clitocybe subditopoda	Gilled Mushroom	LS moist conifer forest	1, 3	1, 2, 3, 4, 5, 6
Clitocybe senilis	Gilled Mushroom	LS moist forest	1, 3	1, 2, 3, 4, 5, 6
Rhodocybe nitida	Gilled Mushroom	LS moist forest	1, 3	1, 2, 3, 4, 5, 6
Rhodocybe speciosa	Gilled Mushroom	Moist LS forest	1, 3	1, 2, 4, 5, 6
Tricholomopsis fulvescens	Gilled Mushroom	Moist LS forest	1, 3	1, 2, 4, 5, 6
Bondarzewia montana	Bondarzew's Polypore	High-elevation LS Abies forest	1, 2, 3, BP	1, 2, 3, 4, 5, 6
Aleurodiscus farlowii	Resupinate & Polypore	Coniferous forest	1, 3	1, 2, 3, 4, 5, 6
Dichostereum granulosum	Resupinate & Polypore	Coniferous forest	1, 3	1, 2, 3, 4, 5, 6
Aleuria rhenana	Cup Fungus	LS coniferous forest	PB	1, 2, 3, 5, 6

SURVEY AND MANAGE PLANT SPECIES OF THE OKANOGAN NATIONAL FOREST (cont'd)				
Species	**Common Name**	**Primary Habitat**	**Survey Strategy**	**Mitigation** [b]
Bryoglossum gracile	Cup Fungus	Saprobe on moss in wet, high-elevation conifer sites	--	1, 2, 3, 5, 6
Helvella compressa	Cup Fungus	Riparian low- to mid-elevation wet forest	1, 3	1, 2, 3, 6
Helvella crassitunicata	Cup Fungus	Riparian low- to mid-elevation wet forest	1, 3	1, 2, 3, 6
Helvella elastica	Cup Fungus	Riparian low- to mid-elevation wet forest	1, 3	1, 2, 3, 6
Helvella maculata	Cup Fungus	Riparian low- to mid-elevation wet forest	1, 3	1, 2, 3, 6
Neoumula pouchetii	Cup Fungus	LS wet conifer forest	1, 3	1, 2, 5, 6
Pithya vulgaris	Cup Fungus	Abies twigs at mid- to high-elevation	1, 3	1, 2, 3, 5, 6
Plectania latahensis	Cup Fungus	Subalpine conifer forest	1, 3	1, 2, 3, 5, 6, 7
Plectania milleri	Cup Fungus	Subalpine conifer forest	1, 3	1, 2, 3, 5, 6, 7
Phlogiotis helvelloides	Jelly Mushroom	Riparian conifer forest	3, 4	1, 2, 3, 4, 5, 6, 7
Clavulina cinerea	Branched Coral Fungus	Late successional forest	3, 4	2, 3
Clavulina cristata	Branched Coral Fungus	Late successional forest	3, 4	2, 3
Clavulina ornatipes	Branched Coral Fungus	Late successional forest	3, 4	2, 3
Sparassis crispa	Cauliflower Mushroom	Late successional forest	3	2, 3
Asterophora lycoperdoides	Parasitic Fungus	Parasitic on fruiting bodies of other fungi in LS forest	3	1, 2, 3, 4, 5, 6
Asterophora parasitica	Parasitic Fungus	Parasitic on fruiting bodies of other fungi in LS forest	3	1, 2, 3, 4, 5, 6
Collybia racemosa	Parasitic Fungus	Parasitic on fruiting bodies of other fungi in LS forest	3	1, 2, 3, 4, 5, 6
Cordyceps capitata	Parasitic Fungus	Parasitic on fruiting bodies of other fungi in LS forest	3	1, 2, 3, 4, 5, 6
Cordyceps ophioglossoides	Parasitic Fungus	Parasitic on fruiting bodies of other fungi in LS forest	3	1, 2, 3, 4, 5, 6
Hypomyces luteovirens	Parasitic Fungus	Parasitic on fruiting bodies of other fungi in LS forest	3	1, 2, 3, 4, 5, 6
Clavariadelphus ligula	Club Coral Fungus	Late successional hardwood, conifer, or mixed forest	3, 4	1, 2, 4, 5, 6
Clavariadelphus pistilaris	Club Coral Fungus	Late successional hardwood, conifer, or mixed forest	3, 4	1, 2, 4, 5, 6
Clavariadelphus truncatus	Club Coral Fungus	Late successional hardwood, conifer, or mixed forest	3, 4	1, 2, 4, 5, 6
Clavariadelphus borealis	Club Coral Fungus	Late successional hardwood, conifer, or mixed forest	3, 4	1, 2, 4, 5, 6
Clavariadelphus lovejoyae	Club Coral Fungus	Late successional hardwood, conifer, or mixed forest	3, 4	1, 2, 4, 5, 6
Clavariadelphus sachalinensis	Club Coral Fungus	Late successional hardwood, conifer, or mixed forest	3, 4	1, 2, 4, 5, 6
Clavariadelphus subfastigiatus	Club Coral Fungus	Late successional hardwood, conifer, or mixed forest	3, 4	1, 2, 4, 5, 6
Cyphellostereum laeve	Moss Dwelling Mushroom	Associated with moss in moist, LS forest	3	1, 2, 4, 5, 6
Galerina atkinsoniana	Moss Dwelling Mushroom	Associated with moss in moist, LS forest	3	1, 2, 4, 5, 6
Galerina cerina	Moss Dwelling Mushroom	Associated with moss in moist, LS forest	3	1, 2, 4, 5, 6
Galerina heterocystis	Moss Dwelling Mushroom	Associated with moss in moist, LS forest	3	1, 2, 4, 5, 6
Galerina sphagnicola	Moss Dwelling Mushroom	Associated with moss in moist, LS forest	3	1, 2, 4, 5, 6
Galerina vittaeformis	Moss Dwelling Mushroom	Associated with moss in moist, LS forest	3	1, 2, 4, 5, 6
Phytoconis ericetorum	Mushroom Lichen	Woody debris of forest edges	3, 4	2, 3

SURVEY AND MANAGE PLANT SPECIES OF THE OKANOGAN NATIONAL FOREST (cont'd)				
Species	**Common Name**	**Primary Habitat**	**Survey Strategy**	**Mitigation** [b]
Clavicorona avellanea	Coral Fungus	Woody debris in moist LS forest	3	1, 2, 3, 4, 5, 6

Survey Strategies

1. Manage known sites.
2. Survey prior to activities and manage sites.
3. Conduct extensive surveys and manage sites.
4. Conduct general regional surveys.

PB Protection Buffer Species. Surveys are required prior to any ground disturbing activities.

Recommendations for Management

1. Describe environmental parameters limiting distribution.
2. Survey high probability habitat.
3. Monitor prescribed burning, grazing, gathering or other disturbance effects on populations.
4. Maintain standing and down coarse woody debris in habitat.
5. Protect old growth stands or emphasize clumped tree distribution in matrix lands.
6. Protect known sites with appropriate buffers
7. Avoid soil and organic layer disturbance of site.

Threatened, Endangered, And Sensitive Plant Species

Table 4-4 below displays the Region 6 Sensitive Plant Species with documented occurrences in the Late Successional Reserve Assessment Area. Additionally, two taxa are identified as species of concern on the Okanogan National Forest; they are not currently on the regional list. The 30 taxa listed below occur across broad environmental gradients: 21 are found in meadows, bogs, fens, carrs and marshes; 13 occur in riparian zones, seeps, springs, and pond and lake margins; 8 are documented in wet to moist forested plant associations; five are found on alpine and subalpine rocky ridges, fellfields and openings; 4 taxa occur on rock outcrops and cliffs; and 1 taxa occurs in open forested habitats. Most occur in special and unique habitats or riparian reserves in the assessment area.

Management alternatives should recognize the importance of these habitats in maintaining viable populations of sensitive plants in the assessment area. Treatments should be developed with emphases on monitoring population responses to supplement our limited autecological knowledge of these sensitive taxa.

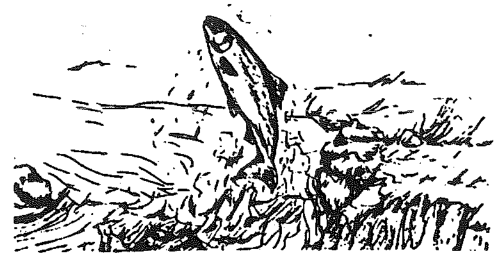
Table 4-4 Sensitive Plant Species of the LSR Assessment Area

Sensitive Plant Species of the LSR Assessment Area Okanogan National Forest
(Taxa with Documented Occurrences)

Species	Common Name	Primary Habitat
Vascular Plants		
Agoseris elata	Tall agoseris	Low- to high-elevation meadows and open forests in the mountains
Botrychium ascendens [1]	Ascending moonwort	Wet to moist meadows, open forests, and riparian sites
Botrychium crenulatum	Crenulate moonwort	Wet forested sites, springs, and wet meadows
Botrychium lanceolatum	Lance-leaved grape fem	Wet to moist meadows, forests, and rocky slopes in cold, subacid soils
Botrychium lunaria	Moonwort	Wet to moist meadows and riparian sites in cold, acid to neutral soils
Botrychium minganense	Mingan moonwort	Shaded mesic sites and riparian zones
Botrychium montanum	Mountain grape-fem	Shaded mesic sites and riparian zones
Botrychium pinnatum	St. John's moonwort	Shaded mesic sites, riparian zones, and moist meadows
Botrychium simplex	Little grape fem	Moist meadows, rocky slopes, and forested sites in subacid soils
Carex atrata var. erecta	Erect blackened sedge	Subalpine and alpine wet meadows to dry, open slopes
Carex buxbaumii	Buxbaum's sedge	Fens, carrs, bogs, and wet meadows
Carex chordorhiza [1]	Sedge	Fens and wet meadows at mid-elevations
Carex norvegica	Scandinavian sedge	Mid- to high-elevation riparian sites, seeps, and moist meadows
Carex paupercula	Poor sedge	Sphagnum bogs and sedge meadows
Carex saxitalis var. major	Russet sedge	Wet meadows and stream or pond margins
Carex scirpoidea var. scirpoidea	Canadian single spike	High-elevation moist meadows and rocky slopes sedge
Carex scopulorum var prionophylla.	Saw-leaved sedge	Wet to moist meadows and riparian sites
Cryptogramma stelleri	Steller's rockbrake	Moist cliffs and ledges at mid- to high-elevations
Draba aurea	Golden draba	Subalpine to alpine rocky slopes and moist meadows
Eritrichium nanum var. elongatum	Pale alpine	High-elevation open, rocky sites forget-me-not
Listera borealis	Northern twayblade	Riparian sites with Engelmann spruce swamps or shrubs
Mimulus suksdorfii	Suksdorf's monkey	Low- to high-elevation wet to dry open sites flower
Parnassia kotzebuei	Kotzebue's grass of Parnassus	Moist, north-facing, granitic cliffs
Poa grayana	Gray's bluegrass	Alpine to subalpine open ridges, meadows, scree slopes, and riparian sites
Polemonium viscosum	Skunk polemonium	High-elevation openings with coarse rock and sandy soils; occasionally, on talus slopes
Potentilla nivea	Snow cinquefoil	Alpine ridgetops, slopes, meadows, and scree slopes
Salix tweedyi	Tweedy's willow	Mid-elevation moist to wet meadows
Sanicula marilandica	Black snake root	Moist forested sites and wet meadow margins
Saxifraga cemua	Nodding saxifrage	Streambanks, seeps, and moist rocks and cliffs
Saxifraga debilis	Pygmy saxifrage	Alpine talus slopes and moist rock crevices and cliffs

[1] These taxa are identified as species of concern for the Okanogan National Forest

CHAPTER 5
Aquatic Habitats and Species



Introduction

Aquatic habitat within the assessment area has been altered by human activity since the mid-1800s when trapping depleted beaver populations. The subsequent failure of unmaintained beaver dams produced an overall increase in stream erosive capability as the ponds behind them disappeared. (Wismarr, McIntosh, et al). Tree harvesting along stream banks and in-stream wood removal for flood control and improved fish passage were other effects of an increased human presence. Cattle ranching brought grazing along stream banks which affected riparian vegetation and bank structure. In recent years construction of flood control structures such as levees and rip rap along banks, roads built beside streams and in riparian zones, and residential construction in or near river flood plains have all had a growing effect on aquatic systems. The greatest amount of habitat alteration of this type has occurred in the low gradient (gradient < 2%) segments of the large streams which flow through the wide valley bottoms of the Methow, Chewuch and Twisp Rivers on private land (Map 14, Appendix G). As a result, many low gradient reaches in the mainstem Methow River are deficient in woody material, and have fewer and shallower pools and side channel habitat when compared to other North Cascades streams.

However, streams that flow through the five Late Successional Reserves and other LS habitat on National Forest Lands currently provide high quality water and woody debris to important fish habitat in the Methow, Twisp and Chewuch Rivers. One possible exception is Canyon Creek and its tributaries which [illegible] River via the Ross Lake Reservoir. This drainage has experienced increased sediment loading as a result of mining activities and road construction in its headwaters. Because of the drainage's high precipitation (>60 inches annually) and steep topography, natural slope failures are also common.

Fish Species of Concern

The number and diversity of sensitive fish species in the assessment area make the Northeast Cascades LSR system an important contributor to fisheries in the Mid-Columbia Basin. Significant habitat strongholds for salmon and trout species within the Mid-Columbia Basin have been mapped by the Interior Columbia River Basin Project (Map 15, Appendix H). The Skagit River drainage west of the Cascade Crest will be surveyed for sensitive fish species and habitat quality in 1997 and 1998.

The Methow River and its tributaries which drain the assessment area support populations of spring and summer/fall chinook salmon, sockeye salmon, bull trout, rainbow/steelhead trout (including native redbands), westslope cutthroat trout, and non-native brook trout. Efforts are being made by the Yakama Indian Nation to reintroduce coho salmon.

Spring chinook salmon stocks are at seriously low levels. In 1995, 72 spring chinook returned over Wells Dam, prompting the Washington Department of Fish and Wildlife to collect all returning spring chinook at the dam in 1996 for use as hatchery brood stock. Upper Columbia River steelhead trout stocks are severely depressed in the Methow Basin.

These stocks were listed as an Endangered species on October 17,1997. Any future management activities in the LSRs system must be evaluated for its effects on this species. Bull trout are also proposed for listing.

Areas of restricted human access and influence comprise the majority of the lands where LS habitat is currently found. The remaining populations of bull trout in the assessment area are found primarily in streams flowing through these relatively undisturbed LS habitats. On the other hand, historic populations of bull trout have been extirpated largely or entirely from streams in heavily managed watersheds within the assessment area such as Eightmile Creek (Upper Methow LSR) and Gold Creek (Sawtooth LSR).

This evidence indicates that bull trout and possibly other aquatic species dependent upon similar habitat conditions are in some ways associated with LS forests. Thus management activities designed to enhance or protect LS forests should also have a beneficial effect on sensitive fish species found in the assessment area. This association should be considered when designing enhancement or protection projects in LSRs.

Aquatic Habitat Management

"Key watersheds are a system of large refugia comprising watersheds that are crucial to at-risk fish species and stocks and provide high quality water" (ROD, B-11). All of the watersheds within Late Successional Reserves above the Libby Creek Watershed in the Methow Valley District have been designated as Tier 1 Key Watersheds, including the Chewuch River, Upper Methow River, Twisp River, Lost River, Early Winters Creek, and Goat Creek. (see Map 14, Appendix H)

This LSR Assessment was coordinated with watershed analyses completed for watersheds within the assessment area. These watershed [illegible] detail on aquatic and riparian habitats within both the assessment area and the individual LSRs. Analyses for all watersheds are expected to be substantially complete by Fall 1998, and discuss specific resource conditions as well as identifying opportunities for restoration and enhancement of riparian and aquatic habitat.

Stronghold watersheds are watersheds where salmon and trout species of concern spawn. Areas downstream of stronghold watersheds should be considered as habitat for rearing and migration for these species. Management treatments in LSRs which encompass stronghold watersheds should consider the effects of these treatments on stronghold values.

Management activities within the LSRs will be conducted in a manner which will not retard or prevent attainment of Aquatic Conservation Strategy objectives. Such activities could possibly include those that increase sediment delivery to streams, reduce stream canopy cover, reduce amounts of large woody debris, degrade water quality, or increase poaching or harassment of fish.

Habitat changes that favor brook trout, an introduced species, such as increased sediment delivery to the streams should be avoided, as brook trout have a genetically adverse effect on bull trout, and also affect native fish by competing for food and habitat.

Existing Conditions of Major Streams and Riparian Reserves:

Hunter Mountain LSR

Black Canyon Creek

Black Canyon Creek is a small, class 2 stream that enters the Methow River at river mile 8.1. The first 0.8 miles flow through private land. Steelhead spawn in the lower 0.4 miles (Mullan) while rainbow and brook trout are the only fish species in upper Black Canyon Creek. The drainage has been heavily roaded and managed for timber and cattle grazing. Beaver activity is prevalent in its middle reaches. The stream has very high amounts of fine sediments while woody debris levels and pool habitat are very low, possibly a result of the large fires that have burned virtually all of the drainage in the past 50 years. .

Nice LSR

Chewuch River: Tier 1 Key Watershed

The Chewuch River flows entirely through private land for its first eight miles above river mile 45 where it empties into the Methow River. Spring chinook salmon spawn and rear up to river mile 31, and westslope cutthroat trout and native redband trout are found in its upper reaches.

Up to 75 percent of the Chewuch's flow is diverted at about river mile 8 for agricultural use in late summer and early fall (net ecosystem reduction of between 37 percent to 51 percent in August, September and October after return flow to the river system) (Mullan). In-stream large woody material was found to be greatly lacking below Lake Creek during a stream survey in 1993, but subsequent storms resulted in tree blowdown along the stream and these trees have since added to in-stream woody debris levels. The Chewuch River is heavily used by dispersed campers and the Forest Service has recently modified or eliminated many of these dispersed campsites to prevent additional stream bank erosion and subsequent sediment loading into the river.

Falls Creek: Tier 1 Key Watershed

Falls Creek enters the Chewuch River at river mile 13.5. Rainbow/steelhead are found below waterfall barriers near its mouth while nrook trout are the dominant fish species above the falls and cutthroat trout are found above Alex Creek (river mile 6). Riparian and aquatic habitat was considered good during a stream survey conducted in 1992. Chinook salmon spawn in the Chewuch River near the mouth of Falls Creek.

Eightmile Creek: Tier 1 Key Watershed

Eightmile Creek flows into the Chewuch River at river mile 11.2 and contains rainbow/ steelhead and rainbow/cutthroat hybrids in its first mile. Brook trout dominant the habitat to river mile 15 while cutthroat trout are found in its headwaters. Bull trout have been extirpated from Eightmile Creek. Chinook salmon spawn in the Chewuch river at the mouth of Eightmile Creek, which is an important cool water (summer) and warm water (winter) source for the Chewuch River.

Past and present beaver dams have created extensive marshlands and are trapping large amounts of sediment along many segments of the stream. The Eightmile Creek drainage is part of a range allotment and cattle grazing has severely trampled the banks from river mile 12.7 to 14.2. Large amounts of fine sediment were seen entering the Chewuch River from Eightmile Creek during turbidity studies conducted in the spring of 1995.

Sawtooth LSR

Gold Creek Basin

Gold Creek enters the Methow River at river mile 21.8 with the mainstem and the lower three miles of the South Fork flowing through private land. Irrigators use Gold Creek for agricultural and domestic use. The stream goes dry in some years below the irrigation diversions and the lower diversion at river mile 0.2 is a possible barrier to both adult and juvenile spring chinook salmon migration (Easterbrook).

Portions of the drainage are heavily managed for timber, including the headwaters of the North Fork. Many large slope failures are found in the North Fork and South Fork drainages and road construction and timber harvests may be responsible for some of these failures. All the streams in the Gold Creek drainage are severely lacking in large woody debris.

Anadromous steelhead use the lower reaches of the South Fork while limited numbers of spring chinook spawn in lower Gold Creek in some years Although bull trout have historically been found in the North Fork, none were seen during fish snorkeling inventories conducted in 1996. Foggy Dew Creek has habitat suitable for bull trout, but none were seen during fish snorkeling inventories in 1996. Westslope cutthroat are presently found in upper Foggy Dew Creek. Active beaver dams were found in the South Fork and near the mouth of Crater Creek and evidence of past beaver use was seen throughout the basin.

Libby Creek

Libby Creek enters the Methow River at river mile 26.4 with most of its mainstem flowing through private land where there are unscreened irrigation diversions. Steelhead spawn and rear below a beaver dam at river mile 1.2 making Libby Creek an important steelhead spawning and rearing tributary. Spring chinook salmon, rainbow, and brook trout also use the mainstem of Libby Creek for spawning. Although bull trout habitat exists in the North Fork of Libby Creek, only cutthroat trout have been found in the stream. Rainbow, cutthroat and rainbow/cutthroat hybrids are found in the South Fork.

Twisp River LSR

Twisp River - Tier 1 Key Watershed

The Twisp River flows through private land for the first 13 miles from where it enters the Methow River at river mile 40.2. It is a very important anadromous fish stream because spring chinook salmon and steelhead spawn and rear in the Twisp River for almost its entire length. Spring chinook in the Twisp River are genetically distinct from other spring chinook populations in the Methow Basin. Fluvial bull trout spawn in the upper reaches of the Twisp River and westslope cutthroat are found above a waterfall barrier at river mile 29. Several areas of natural mass-wasting and eroded banks were found between river miles 8 and 25. One very large erosional site at river mile 8 was adding considerable amounts of sediment to the river during a turbidity study conducted in 1995. Large woody debris is greatly lacking in the lower 20 miles of the stream, due to channel clearing for flood control, and to the removal of trees along its banks for agricultural use and timber harvest. The upper 15 miles of the stream are rich in side channel habitat.

Fire plays an important role in the recruitment of large woody debris to the stream. Debris torrents following fire (i.e.; Reynolds Fire) are an important influence for large woody debris recruitment.

Buttermilk Creek

Buttermilk Creek enters the Twisp River at river mile 12.7. The first half mile of the mainstem flows through private property. Steelhead use the mainstem of Buttermilk Creek and the first mile of both the East and West Forks. Bull trout also spawn in both forks. The West Fork is unique in that it supports a native redband trout population in addition to bull trout. The cutthroat trout above the fish barriers on the East Fork (river mile 3.6) are thought to be westslope cutthroat (K. Williams). A beaver dam failure on Black Pine Creek (a tributary to the East Fork) has been adding large amounts of sediment to Buttermilk Creek and the Twisp River since 1994. Outside of the Lake Chelan-Sawtooth Wilderness, the Buttermilk Creek drainage has been heavily affected by human activities such as road construction for timber harvest and cattle grazing. Large slope failures are found in the mainstem, and in both forks. Some of these slope failures (largely a result of a flood event in 1948) are adding sediment to the stream. Riparian areas along the mainstem consist of young trees due to scour during the 1948 flood. As a result, large woody debris levels and recruitment potential are low. Bull trout and rainbow/steelhead have been observed in an unscreened irrigation ditch scheduled for screening.

Little Bridge Creek - Tier 1 Key Watershed

Little Bridge Creek enters the Twisp River at river mile 9.0. Diversion structures for irrigation ditches at 0.5 and 2.1 miles are low flow barriers to adult fish and barriers to juvenile fish year around. Bull trout and native redbands are found in the creek while steelhead use only its lower two miles. Human activities in the drainage include timber harvest and cattle grazing. Grazing effects contributing to bank erosion were noted during a stream survey in 1992. Large logs were placed in the stream in order to increase the quality of pool habitat in 1991 and 1992 as part of a Forest Service stream restoration program. Valley bottom roads constructed in tributary riparian areas have altered Little Bridge Creek's flow regime.

Eagle Creek: Tier 1 Key Watershed

Eight-five percent of the Eagle Creek drainage lies within the Lake Chelan-Sawtooth

Wilderness and it enters the Twisp River at river mile 15.3. A series of waterfall fish passage barriers are found at river mile 0.5. Upper Eagle Creek supports a population of essentially genetically pure westslope cutthroat trout while rainbow/cutthroat hybrids are found below the barrier. There is no fish screen on an irrigation diversion at river mile 0.3.

War Creek - Tier 1 Key Watershed

War Creek enters the Twisp River at river mile 16.3 with about 90 percent of its drainage within the Lake Chelan-Sawtooth Wilderness. A large waterfall barrier is found at river mile 1.8 with pristine habitat found above this barrier. Chinook salmon juveniles rear in the lower half mile of War Creek, and rainbow/ steelhead trout and a small population of brook trout are found below the waterfall barrier. Introduced rainbow trout, cutthroat trout and eastern brook trout are found above the falls. A maintained campground and several dispersed campsites are found near its mouth.

Reynolds Creek - Tier 1 Key Watershed

Eight-five percent of the Reynolds Creek drainage lies in the Lake Chelan-Sawtooth Wilderness. The stream enters Twisp River at river mile 20.9. Bull trout spawn up to a barrier at river mile 0.5. Large steelhead were observed in the pool below this barrier and brook trout were found below a culvert just upstream of the mouth. This culvert is a barrier to further upstream brook trout migration. Removal of the barrier could affect the bull trout population above the culvert.

South Creek: Tier 1 Key Watershed

South Creek enters Twisp River at river mile 24.4 and about 90 percent of its drainage lies within the Lake Chelan-Sawtooth Wilderness. A limited number of spring chinook salmon spawn in South Creek near its mouth below a waterfall barrier at river mile 0.5. A population of westslope cutthroat trout exist above the barrier.

North Creek: Tier 1 Key Watershed

North Creek enters Twisp River at river mile 26.1 with about 80 percent of its drainage within the Lake Chelan-Sawtooth Wilderness. Bull trout rear in the lower half mile of North Creek while above a barrier at river mile 0.5 there is a population of westslope cutthroat trout. A 9 inch pipeline was diverting an estimated 20 percent of the flow in August of 1994.

Upper Methow LSR

Upper Methow River - Tier 1 Key Watershed:

The Upper Methow River and its tributaries have the strongest population of bull trout in the assessment area. In addition, roughly 20 percent of the spring chinook salmon in the Methow Basin spawn in the river from the Weeman Bridge (river mile 59) to Lost River (river mile 73). This 15 mile segment of the river usually flows subsurface in low precipitation years. Westslope cutthroat are found above a barrier falls at river mile 83.2.

The upper Methow Valley could undergo extensive development in the near future, with much of the construction occurring on the valley floor between Early Winters Creek and Lost River. Increased fishing pressure and recreational uses of riparian and aquatic habitat can be expected. Sediment levels are currently low to moderate, but could be worsening below Lost River (evidenced during high flow turbidity observations made by the U.S.F.S. in the spring of 1995). Large woody debris are scarce below Trout Creek, due to past channel clean-outs and bank tree removal to clear land for agricultural use. Pool habitat is very low in the low gradient segments of the stream (below Lost River), due in part to the lack of large woody debris in the channel and because the Methow River is naturally very high in coarse bed load.

Avalanche chutes above Rattlesnake Creek are a primary source for recruitment of large woody material to the channel. Flooding is also a mechanism for wood recruitment.

Early Winters Creek - Tier 1 Key Watershed

Early Winters Creek flows into the Methow River at river mile 67 and contains a strong population of bull trout above a fish barrier at river mile 8.0.while fluvial bull trout are found below the barrier. Chinook salmon spawn to river mile 4.0. A westslope cutthroat population is found in the headwaters and in Cutthroat Creek where the stream has very cold water temperatures, with up to 44 percent of the summer flow from glacial melt (Mullan). Nearly all of the drainage is allocated as an Administratively Withdrawn Area (Scenic Highway Corridor). Habitat is in good condition with the exception of the half mile above the mouth which has been channelized.

Avalanche chutes above much of the stream are a primary source of large woody material and sediment.

Lost River: Tier 1 Key Watershed

The stream flows into the Methow River at river mile 73. It flows underground for several miles above the confluence with Monument Creek (river mile 7.7), above which bull trout use the entire stream, with a very strong population below the outlet of Cougar Lake (near the origin of Lost River). Chinook salmon spawn to river mile 4.0, adding to the stream's population

Because 95 percent of the watershed lies within the Pasayten Wilderness, the stream is pristine with the exception of the first mile above its mouth, which flows through private property where owners have constructed dikes to protect their homes. Amounts of woody debris are naturally low below Monument Creek.

Fire and forest disease have both played roles in adding woody material to the river in the past. Avalanche/debris torrents are important sources of organic and inorganic debris.

Goat Creek: Tier 1 Key Watershed

Goat Creek flows into the Methow River at river mile 63.2 and is unique in that it supports a native redband population in its lower reaches and a westslope cutthroat population near its headwaters.

A population of resident bull trout is found between the two fish populations, mainly above the road crossing at river mile 7.5. The half mile above the mouth goes dry in summer, which is probably a natural event as the delta of Goat Creek is floored with glacial till (Mullan). The lower eight miles of the Goat Creek drainage is heavily managed for timber and cattle grazing. While sedimentation does not currently appear to be a problem in the creek (due partly to stream energy), large amounts of sediment from unknown sources were observed entering the Methow River from Goat Creek during turbidity studies conducted in the spring of 1995.

Large woody material is recruited in the stream by past fires creating streamside snags and the very steep side slopes above the creek.

Lake Creek: Tier 1 Key Watershed

This tributary enters the Chewuch River at river mile 23 and has over 75 percent of its drainage within the Pasayten Wilderness. Chinook salmon spawn and rear to river mile 5. A strong population of bull trout is found to river mile 9.2 where there is a 30 foot waterfall barrier. Cutthroat trout are found above the barrier. Habitat in most of Lake Creek above the West Chewuch Road (Road 39) is pristine.

Chewuch River: Tier 1 Key Watershed

See the narrative under the Nice LSR.

Eightmile Creek: Tier 1 Key Watershed

See the narrative under the Nice LSR

Falls Creek: Tier 1 Key Watershed

See the narrative under the Nice LSR.

CHAPTER 6

Summary of Management Implications and Current Condition of Individual LSRs

Introduction

The assessment team reviewed the findings presented in the preceding chapters and discussed implications for management of the assessment area. The next step in the assessment was to take a more detailed look at each of the individual LSRs. These discussions led to the formulation of Management Implications to be considered as managers plan LSR management activities. *These Management Implications are key points which should be included in individual LSR management planning.*

General Management Implications

Although the individual LSRs are unique in character, there are several management Implications that apply to all of the LSRs. To prevent repetition, these are presented at this point in the assessment.

Range allotments are part of every LSR. Range improvements are critical to proper range management, both within and outside of LSR boundaries. Effects of projects adjacent to or within the LSRs may bring about the need for additional range improvements (e.g., strategic drift fences, livestock watering facilities/development, corrals, etc.). LSR enhancement or protection projects affecting even small isolated watering trough sites, fence lines, or other sites could affect livestock use patterns and reduce the effectiveness of a grazing management plan or strategy.

Scenery is an important attribute along heavily traveled roads in LSRs. These roads include the North Cascades Scenic Highway, Pateros to Lost River, Lost River to Slate Peak, Chewuch River, Eightmile Creek, Twisp River, Alta Lake, Buttermilk to Blackpine Lake, North Fork Gold Creek to Libby Creek, Foggy Dew, Libby Creek to Blackpine Lake, Harts Pass to Chancellor, Fox Peak to Cooper Mountain and South Fork Gold Creek. Because of the importance of the scenic resource to many people, activities planned to meet Late Successional Reserve objectives will need to be designed with consideration for the significance of this resource.

Ground disturbance from management activities in the LSRs, especially on mid to lower elevation dry site PAGs, encourages noxious weed establishment and spread. Because small populations of weeds are much more easily eradicated or controlled than large infestations, early treatment of new invaders will be essential in maintaining and protecting native LS plant communities.

Decreases in *road density* may substantially increase the value of LS interior habitats and connectivity corridors. Project level analysis should evaluate on a case by case basis whether or not existing roads, trails or other proposed developments may lead to a loss of connectivity value.

Accessible Acres

The tables in this chapter provide information about "Accessible Acres". Map 16, Appendix

H, shows that because of the roadless character of much of the LSR system, it is important to consider how much of the system is actually available for management by conventional means. To provide a measure of this feature, the team defined accessible acres as those areas within one-half mile of an existing road exclusive of Riparian Reserves, slopes of greater than 60 percent, and known mass-wasting sites.

Hunter Mountain Late Successional Reserve

Hunter Mountain LSR at 6,169 acres is the fourth largest of the five LSRs in the North East Cascades LSR system. It is the most southerly of the LSRs, and at the easternmost limit of the range of the northern spotted owl as defined by the ROD. No occurrences of this species have been noted in this LSR. Extensive surveys, however, have not been done because of the unpromising nature of the available habitat. It is located well to the east of the Cascade Crest which results in the LSR averaging less than 15 inches of precipitation annually. The LSR consists of ice-sculpted mountains which range from 3408 feet at Hunter Mountain down to 1400 feet in the valley of Squaw Creek. This creek is the principle stream that traverses the LSR. Table 6-1 and Map 1, Appendix H display the characteristics of current vegetation found within the LSR, which is dominated by the Dry Douglas-fir PAG. It is also important to note that 53 percent of the LSR area is considered non-forested supporting ponderosa pine/ shrub-steppe woodlands and shrub-steppe communities. These communities are characteristic of the hot-dry BPE which makes up 57 percent of the LSR. Although there is a Ponderosa Pine PAG component to its vegetation, it comprises only 1 percent of the area and averages only 5 inches to 14 inches DBH (diameter breast height). The majority of current LS habitat is within the Dry Douglas-fir PAG and much of this has a "moderate to high" crown fire potential.

Old mine workings located on Hunter Mountain were excavated on a series of gold-bearing veins worked as recently as 1947. Mineral exploration by major companies has occurred periodically in the recent past, and a possibility of mineral development consistent with Record of Decision direction (ROD, C-34) continues to exist in the LSR. Timber harvesting has been limited because few trees of merchantable size remained after the area was nearly completely burned over in the 1920s. Recreation use is low except during hunting season and does not substantially affect the LS characteristics of the LSR. In pre-settlement times 80 to 100 percent of the LSR would have been expected to burn every decade (Schellhaas, work in progress).

Table 6-1

Hunter Mountain LSR Current Vegetation					
PAG & Seral Stage	Total Acres	% of Total Acres	Accessible Acres	Current LS Acres	% of Total LS Acres
Ponderosa Pine	85	1%	39	6	0%
L1	2		0		
L2	77		33		
LU3	6		6		
Dry Douglas Fir	2735	44%	2206	851	14%
L2	129		128		
L3	410		350		
M1	851		734		
M2	904		665		
M3	441		329		
Moist Douglas Fir	103	2%	71	16	0%
E1	24		14		
L2	63		43		
L3	16		14		
Dry Subalpine Fir	12	0%	10	0	0%
E3	4		4		
M2	8		6		
Moist Subalpine Fir	9	0%	10	0	0%
E3	9		10		
RIPARIAN	22	0%			
NONFOREST	3203	53%			
TOTALS	6169		2336	873	14%

Hunter Mountain LSR Biophysical Environment (BPE)		
BPE	Total Acres	% Total Acres
htdry	3521	57%
wmdy	1333	22%
wmmc	1315	21%

Crown Fire Potential

The distribution of crown fire potential ratings in the Hunter LSR (See Map 17, Appendix H) reflect the large areas of grass and brush, and the significant amount of Ponderosa Pine and Dry Douglas-fir PAGs present. Applying the crown fire potential model to historic vegetative mapping (see Chapter 2, Historical Range of Variability), shows that in 1922 this entire LSR rated at "low" crown fire potential.

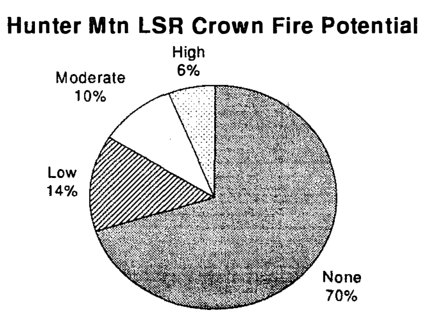
Managing crown fire potential means reducing ladder fuels and surface fuel loadings to reduce potential for high intensity fires. This can be achieved by maintaining at least 20 foot spacing between crowns (crown bulk density of 0.10) to create a "crown - fire safe" condition (Agee 1996). North slopes can be maintained in "high" crown fire potential provided that south slopes and flat areas are reduced to primarily low crown fire potential. Fires can still be expected to burn rapidly from south to north slopes given proper conditions given proper burning conditions.

High potential for stand replacing crown fires should be reduced whenever possible throughout the LSR, except on high crown fire potential north slopes. This strategy has the advantage of retaining these stands which may currently provide at least limited LS characteristics.

This entire LSR can be expected to burn as the result of natural ignition within the next 70 years. Prescribed fire and silvicultural treatments, such as machine thinning, should be utilized as much as possible to reduce crown fire potential and thus the risk of stand replacing fires.

There are 532 acres of non-Forest Service ownership within the Hunter Mountain LSR boundary. Approximately 60 acres of this private ownership is presently rated "moderate to high" crown fire potential. A half mile buffer of Forest Service land around this area of concern adds almost 200 acres of urban interface treatment areas. In order to protect life and property on lands adjacent to the Hunter LSR, these urban interface areas must be maintained at a low crown fire potential rating.

Figure 6-1



Management Implications

High fire risk and low acreages of current or potential LS habitat combine to make the Hunter Mountain LSR a poor candidate for effective LS treatments. There is a high probability that treatments designed to protect or enhance LS habitat in both dry and moist Douglas-fir stands would be ineffective as these stands are subjected to stand-replacing fires over within the next 70 years.
LS ponderosa pine stands of an open park-like nature can be sustained by a frequent low intensity fire regime that mimics pre-settlement forest disturbance patterns. The present dominance of mid-seral stands in the Dry Douglas-fir PAG (Map 1, Appendix H and Table 6-1) are primarily due to fire exclusion since 1910 which has increased the amount of less fire tolerant Douglas-fir in areas once dominated by mature ponderosa pine.

With continued fire exclusion the risk of crown fires will also increase creating higher crown fire risk potential across the landscape. In the event of an ignition, the fire would likely destroy much of the LS habitat in spite of our best suppression and treatment efforts.

An estimated 2,000 acres of the Dry Douglas-fir PAG is accessible from the present road system. Treatments other than fire such as thinning from below may be applicable within this accessible area. These silvicultural treatments should be designed to decrease LSR crown fire potential. More sustainable LS characteristics can be enhanced by managing for mixed ponderosa pine and Douglas-fir stands.

ROD Standards and Guidelines for managing fire risk east of the Cascade range (ROD, C-12,13) allow management to achieve the more open conditions characteristic of LS ponderosa pine stands. Our ability to manage the Hunter Mountain LSR to meet LS habitat needs for the northern spotted owl is limited by the LSR's BPE. Put simply, the biological potential is not there.

Nice Late Successional Reserve

The Nice LSR, at 3,127 acres, is the smallest of the LSRs in the Northeast Cascades system. It lies primarily within the drainage of Eightmile Creek although the eastern portion is drained by a small unnamed sub-drainage of the Chewuch River. It covers an elevation zone from approximately 2,000 feet at the valley floor to 4,490 feet at Buck Mountain on the southwest border of the LSR. The area was rounded by several continental glaciations that also left large deposits of glacial till and glacial outwash cobbles along the valley floors and on benches above the present stream levels. It is bisected by the Chewuch-Pasayten Fault, a prominent geological feature which divides the granitic rocks and soils of the Okanogan Highlands on the east side of Eightmile Creek from the sedimentary rocks of the Methow graben on the west. This creates quite different soil and growing characteristics for the east and west portions of the LSR.

Surveys have produced no evidence for the presence of the northern spotted owl in the LSR.

Map 2, Appendix H and Table 6-2 shows the area is dominated by the Dry Douglas-fir PAG (44%). The Ponderosa Pine PAG comprises another 18 percent of the Nice LSR. Within these two PAGs, only 29 percent is currently characterized as LS habitat. Low intensity, frequent fires once maintained 75 percent or more of the landscape in LS habitat. These stands have important visual value to recreationists along the paved Eightmile Creek Road. The southwest portion of the LSR contains significant amounts of both dry and moist LS Douglas-fir stands. These stands are located for the most part on a steep northeasterly slope that was not previously harvested because of steep terrain. Early to mid-seral stages dominated by lodgepole pine make up a large portion of the remaining landscape.

Road density is an issue. Nice is the most heavily roaded of the LSRs and in some places the connectivity function of Riparian Reserves is possibly affected by high road densities. The LSR provides for important wildlife movement both lengthwise up the Eightmile Riparian Reserve and vertically to the higher ridges on either side of the main valley.

Nice is also the most accessible of the LSRs and therefore most available for management strategies designed to protect or enhance LS characteristics. Of all the LSRs, Nice has had the highest percentage (approximately 40%) of its area affected by past timber harvest. Recreation use is heavy along the Eightmile Road corridor and at Flat and Nice Campgrounds. Fuelwood gathering for local domestic use was a significant use of the area prior to the creation of the LSR system. A recreational fishery exists in Eightmile Creek which is located in a Key Watershed.

Fire exclusion in the Nice LSR has allowed Douglas-fir to become established in the understory, promoting higher intensity fires. Fire ignition point mapping (Knott, unpublished report) shows that the Nice LSR is in one of the highest ignition probability areas from both lightning and human sources. High human ignitions are primarily the result of heavy recreational use during hunting season.

Figure 6-2 Nice Late Successional Reserve

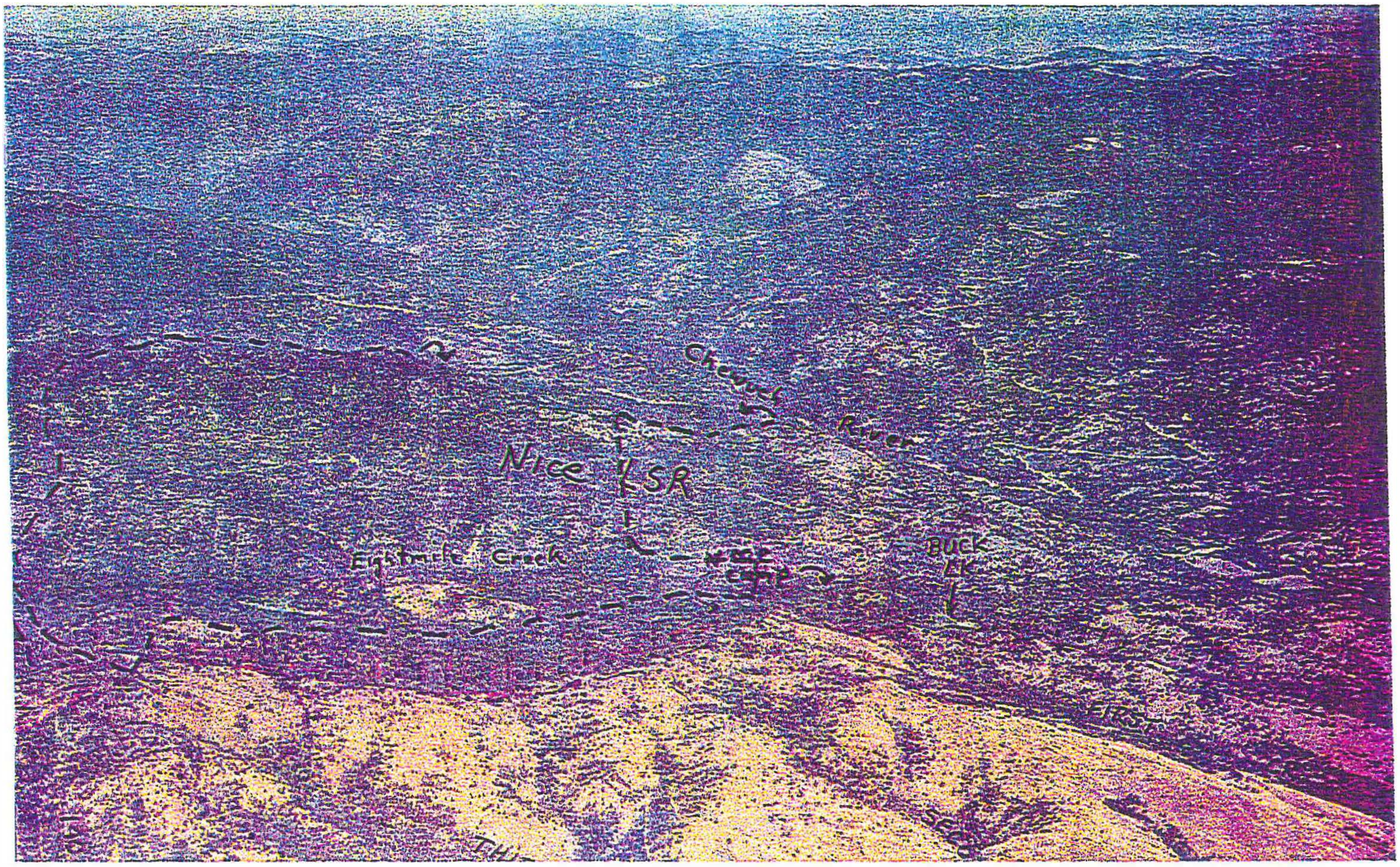


Table 6-2

Nice LSR Current Vegetation					
PAG & Seral Stage	Total Acres	% of Total Acres	Accessible Acres	Current LS Acres	% of Total LS Acres
Ponderosa Pine	539	18%	268	271	9%
L1	268		0		
LU3	271		268		
Dry Douglas Fir	1356	44%	1356	641	20%
L2	46		46		
L3	78		78		
M1	5		5		
M2	664		664		
M3	563		563		
Moist Douglas Fir	728	24%	727	187	6%
E2	1		0		
L2	332		332		
L3	135		135		
M2	208		208		
M3	52		52		
Dry Subalpine Fir	139	5%	144	1	0%
E1	14		14		
E2	43		43		
E3	43		43		
M2	41		44		
M3	1		0		
Moist Subalpine Fir	179	6%	178	0	0%
E2	90		90		
E3	88		88		
L2	2		0		
M2	1		0		
Pacific Silver Fir/Mtn. Hemlock	86		0	0	
E3	86		0		
RIPARIAN	32	1%			
NONFOREST	66	2%			
TOTALS	3127		2673	1100	35%

Nice LSR Biophysical Environment (BPE)		
BPE	Total Acres	% Total Acres
htdy	914	29%
wmdy	1232	40%
wmmc	945	30%
clmc	3	0%
clmt	33	1%

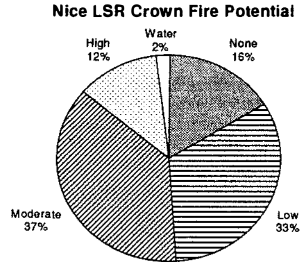
Crown Fire Potential

The distribution of crown fire potential ratings in the Nice LSR reflect the mixture of PAGs ranging from ponderosa pine to moist subalpine fir (see Map 17, Appendix G and Table 6-2). In 1922, this LSR had a crown fire potential rating of low. Current fire potential can be seen in Map 17, Appendix H. The Ponderosa Pine and Dry Douglas-fir PAGs make up 60 percent of the LSR. This area was once maintained in open park-like stands of ponderosa pine under a frequent fire regime. Under this disturbance regime surrounding areas also benefited from periodic fires to reduce the understory fuels. Currently, only about one-third of the area retains a low crown fire potential rating. Objectives to manage risk are to reduce ladder fuels and surface fuel loadings, and to minimize high intensity fire potential by maintaining at least 20 foot spacing between crowns, (crown bulk density of 0.10). North slopes can be maintained in "moderate" to high crown fire potential although fires would still be expected to burn rapidly from south to north slopes given proper conditions given proper conditions

Efforts should be made to break high crown fire areas into smaller blocks whenever possible. This can be accomplished by developing fuel breaks that connect natural barriers, and "low" crown fire potential areas together. This will help prevent a crown fire from consuming the entire LSR.

There are no urban interface issues in this LSR.

Figure 6- 3



Management Implications

Accessibility and the presence of effective LS habitat make the Nice LSR a good area to apply protection and risk reduction treatments. In addition, this access presents an opportunity to restore or accelerate stand development into LS habitat.

Another point to consider is that the Nice LSR is a small area in the midst of high crown fire potential stands. Thus, any treatments designed to protect or enhance LS values within the LSR should be linked closely to management activities outside the LSR. Buffering the LSR from fires ignited outside its boundaries should be an important factor in planning management activities for adjacent lands. If these activities are not coordinated, there is a risk that stand replacing fires could consume most of the LSR in the next 200 years.

Management of the Nice LSR should also consider its important role in habitat connectivity. Risk reduction measures may temporarily inhibit this function. The long term benefits of risk reduction should be carefully weighed against the short term loss of connectivity. Road density is also important. Each road should be reviewed for its role in accomplishing LSR objectives.

Recreation and range activities in the Nice LSR Riparian Reserves should also be periodically reviewed for compliance with ROD direction for LSR management.

Sawtooth Late Successional Reserve

The Sawtooth LSR, which is 59,029 acres, is characterized by ridges and mountain tops rounded by the last continental ice sheet. Elevations range from approximately 2,000 feet in the valley of Gold Creek to over 7,000 feet along the crest of the Sawtooth Range. Much of the LSR is covered by remnant layers of volcanic ash deposited by an eruption of Glacier Peak 70 miles to the southeast. This ash layer contributes significantly to the soils of the LSR.

The LSR is located to the east of the crest of the main Cascade range and thus is affected by its rain shadow. Precipitation levels vary from 20 inches per year at low elevations to over 60 inches per year at higher elevations. The majority of the LSR drains into the Methow River via Gold Creek and its tributaries. Approximately one-fourth of the LSR is located in the Lake Chelan watershed and drains south into Lake Chelan.

The fire regime is mainly a blend of mixed mortality and stand replacement fire regimes across the landscape. Historically, these types of fire events created a rich diversity of patches varying in age, structure, and species composition. The 40,000 acre Camas burn in 1928 is an example of this type of fire regime. Late successional habitat is largely confined to fire refugial areas in the mid to upper elevations. These are areas which escaped stand replacing fires for a variety of reasons, including higher soil moistures, northerly aspects, or chance occurrences during the fire event. Lower elevations dominated by the Ponderosa Pine and Dry Douglas-fir PAGs would have been maintained as LS habitat by low intensity, frequent fires that rarely produced fire refugia. As these drier PAGs begin to grade into the moister ones, the fires become more intense, resulting in greater mortality in fire refugia areas throughout the landscape.

All eight PAGs are represented to some extent within the LSR. Fifty-four percent of the LSR is within the moist Douglas-fir and Subalpine fir PAGs, which are characteristic of mixed mortality and stand replacing fire regimes.

Studies based on historic oblique aerial photographs indicate that between 15-20 percent of the LSR remained as refugia after the Camas burn. The difference between the fire return intervals of the refugia (180-200 yr.) and the surrounding landscape (50-70 yr.) has created a dynamic landscape marked by shifting refugial areas as large stand replacing fires swept the area.

Currently, 18 percent of the LSR is identified as LS habitat. Most of these areas (12%) are within the Douglas-fir PAGs. The mixed ponderosa pine/Douglas fir mid-seral stages greater than 5 inches DBH are the most common seral stages. The Subalpine fir PAGs are mostly early seral lodgepole greater than 5 inches DBH.

Fire suppression activities have increased the chance of stand replacing fires occurring in the Douglas-fir PAGs as ladder fuels and understory development have reached levels outside of historical ranges. Although the subalpine fir PAGs are within their previous fire return intervals at the landscape level, fire exclusion has increased the risk of large scale conflagrations by creating large contiguous blocks of even aged stands. Historically, periodic small fires within larger landscapes altered the distribution of fuel types and likely resulted in smaller fire sizes. The risk of larger, stand replacing fires has increased because the fuels across the landscape have become more homogeneous and contiguous with fire exclusion.

Most of the LSR has remained unaffected by past timber management practices. Lack of roaded access, and the fact that most of the area represented relatively small diameter regeneration from large fires, made the LSR, as a whole, an unattractive candidate for timber harvest. Some sales were conducted along the main stem of Gold Creek (and more recently in the South Fork of Gold Creek) and are primarily in the Ponderosa Pine and Dry Douglas-fir PAGs, but their limited acreage has had little effect on the overall vegetative characteristics of the LSR.

LS habitat connectivity within the LSR is provided by Riparian Reserves along streams. Connectivity is interrupted to some extent by the trail system which parallels every major drainage in the LSR. There is not enough information to assess the effects of the trail system on LS habitat at this time. Connectivity between current LS patches is generally poor because of their small size and dispersal over the LSR.

Recreational use of the trail system is presently moderate to high. Mining claims near the head of the South Fork of Gold Creek are currently being actively explored and there is a for future minerals development in accordance with ROD Standards and Guidelines. Ore deposits along Gold Creek itself have been explored in the past but are currently not claimed under the 1872 Mining Law.

Figure 6-4 Sawtooth Late Successional Reserve

Table 6-3

Sawtooth LSR Current Vegetation					
PAG & Seral Stage	Total Acres	% of Total Acres	Accessible Acres1	Current LS Acres	% of Total LS Acres
Ponderosa Pine	1623	3%	857	285	1%
L1	168		72		
L2	1170		682		
LU3	285		103		
Dry Douglas Fir	9933	17%	4719	3333	6%
E1	926		219		
L2	1810		882		
L3	765		450		
M1	296		155		
M2	3568		1749		
M3	2568		1264		
Moist Douglas Fir	9673	16%	3087	3692	6%
E1	1424		380		
E2	268		51		
L2	4291		1478		
L3	3692		1178		
Dry Subalpine Fir	11070	19%	2157	1136	2%
E1	1025		32		
E2	4012		600		
E3	2282		486		
L3	205		47		
M2	2614		759		
M3	931		233		
Moist Subalpine Fir	11078	19%	1354	1765	3%
E2	2621		521		
E3	3701		664		
L2	1515		137		
L3	379		13		
M2	1476		8		
M3	1386		11		
Pacific Silver Fir/Mtn. Hemlock	2156	3%	0	149	0%
E1	2007		0		
M3	149		0		
RIPARIAN	72	0%			
NONFOREST	13424	23%			
TOTALS	59029		12174	10360	18%

Sawtooth LSR Biophysical Environment (BPE)		
BPE	Total Acres	% Total Acres
cddy	2362	4%
cdmc	3542	6%
cdmt	1771	3%
clmc	8854	15%
clmt	10625	18%
cldy	590	1%
htdy	5903	10%
wmdy	4722	8%
wmmc	20660	35%

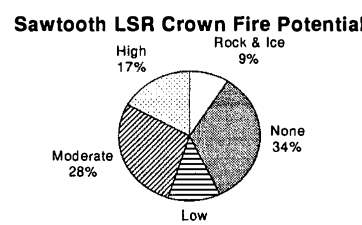
Crown Fire Potential

The distribution of crown fire potential ratings in the Sawtooth LSR reflects a mixture of PAGs and a mix of fire regimes. Landscapes shaped under a mixed fire regime make it more difficult to predict what the post-fire landscape will be following a fire event. Several things can be done to reduce the effects of a large scale fire across the landscape. Risk of stand replacing fires can be reduced by managing ladder fuels and surface fuel loadings on south slopes in the Ponderosa Pine and Dry Douglas-fir PAGs, and by maintaining at least 20 foot spacing between crowns, (crown bulk density of 0.10). North slopes could be maintained in "moderate to high" crown fire potential. Fires could still be expected to burn rapidly from south to north slopes given proper conditions. However, the lower fuel levels on the managed drier sites will help keep the fire on the surface and reduce the risk of a contiguous stand replacing fire. Diversification of the landscape structure in strategic areas may help create fuel breaks, and bring fire out of the crowns during a fire event. This will result in a more structurally and compositionally diverse landscape following a fire event.

High crown fire potential areas should be broken into smaller blocks whenever possible by developing fuel breaks that connect natural barriers or areas of low crown fire potential. This will minimize the risk of a crown fire consuming large acreages.

Urban interface areas need to be maintained at a low crown fire potential rating. There are 72 acres of non-Forest Service ownership within the Sawtooth LSR. Twenty-seven acres of this has a "moderate to high" crown fire potential rating. Almost 500 additional acres in "moderate to high" crown fire potential areas in the urban interface need treatment to protect private lands adjacent to the LSR.

Figure 6-5



Management Implications

Management of this LSR to maximize dry and moist Douglas-fir LS habit presents a challenge over the long term because of the large scale fire disturbances that seem almost inevitable. The 18 percent LS habitat currently identified likely represents the LS habitat the landscape was capable of sustaining historically. Many of these stands and adjacent stands are now approaching high crown fire potential ratings as ladder fuels increase and crowns close. Without large scale intervention in the form of increased suppression, thinning, and underburning, it is probable that over the next five decades fire will destroy many of these stands and decrease the net amount of LS habitat available in the LSR. A realistic management strategy should consider sustainability as a key issue in developing long-term LS acre targets. Managers need to develop a better understanding of where on the landscape fire refugia have the highest probability of being sustainable. Risk reduction treatments focus on creating buffers around potential refugial areas. Only in this way will we be able to maximize LS habitat in these mixed fire mortality fire regimes.

Management plans must also consider the extremely limited road access available in this LSR. Because of this limited road access, all fuels and silvicultural treatments will be more difficult and expensive to implement. Much of the LSR will not be treated for crown fire potential.

Vegetation in portions of the LSR has developed into a condition that precludes effective underburning without risking a stand-replacing fire. This limits opportunities for reducing crown fire potential by using fire as a management tool, and leaves few options for preservation and enhancement of LS stands.

One option to consider is to employ a fire management strategy for natural ignitions that utilizes a system of natural and constructed fuel breaks to limit fire size in the LSR (See Map 18, Appendix H). These treatments would mimic the landscape mosaic that was present prior to fire exclusion. Although this strategy would be combined with an aggressive suppression strategy to protect known northern spotted owl activity centers and existing LS habitat, it is likely some loss of LS habitat would be inevitable in the event of a fire. Some impediments to implementing this strategy are current fire suppression direction and smoke management issues based on air quality regulations.
Because LS habitat is highly fragmented by past burn patterns, it is important that human travel routes be managed to prevent any further fragmentation of LS habitat. In addition, the present transportation system should be examined to assess its effects on the effectiveness of LS habitat.

Twisp River Late Successional Reserve

The Twisp River LSR is 36,266 acres in size and occupies the valley of the Twisp River and the headwaters of Little Bridge Creek, a large tributary. As with the Sawtooth LSR, it experiences a range of precipitation from over 60 inches per year to less than 20 inches annually. Glaciated U-shaped valleys with steep sidewalls rising to rocky peaks with permanent snowfields are the dominant landforms of the LSR.

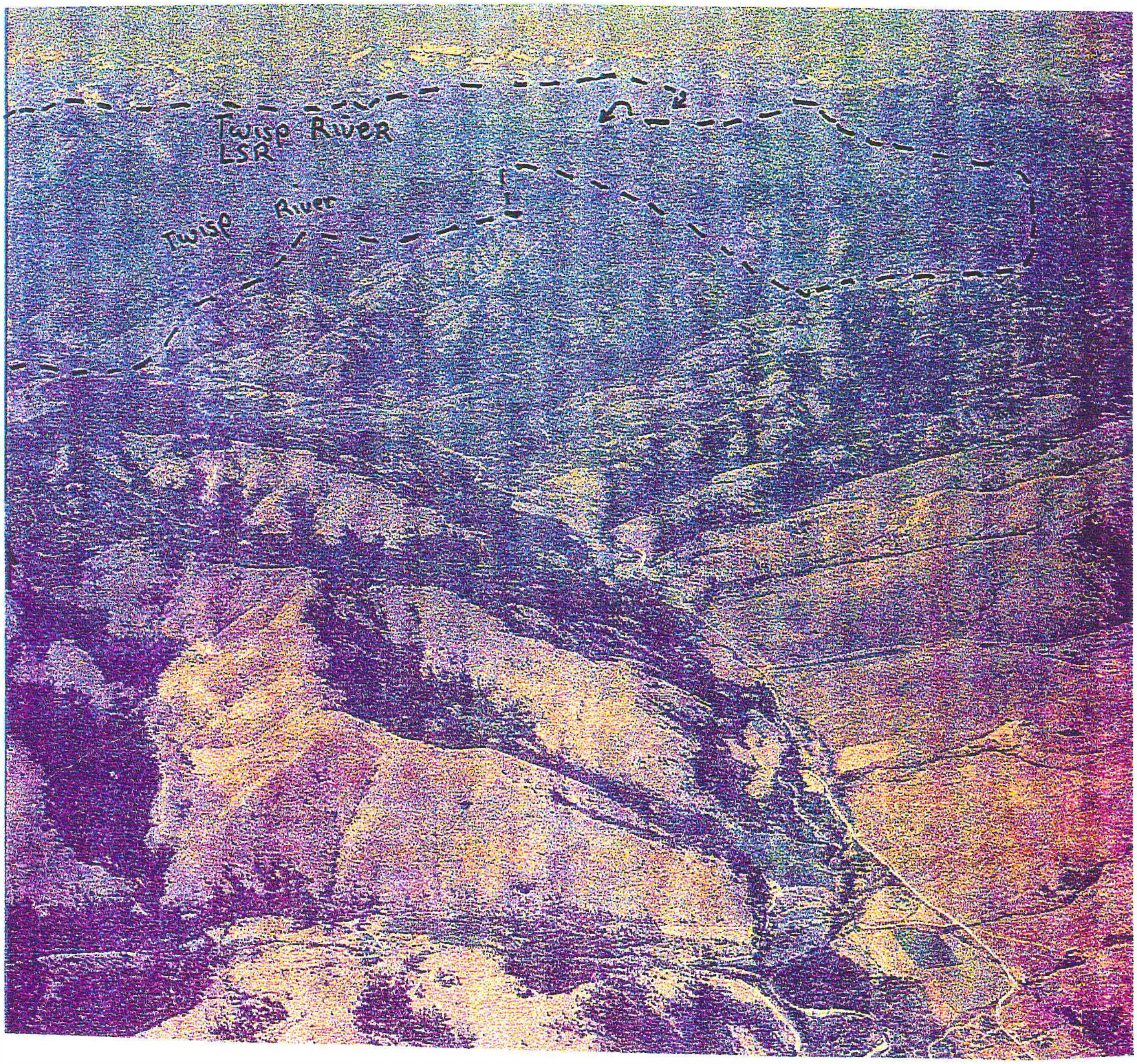
Elevation and steep valley walls combine to make aspect a very important factor in determining the distribution of vegetation in the Twisp River LSR. This is particularly true in the Little Bridge Creek drainage with its main stem flowing north to south and its incised tributaries flowing east to west. This has produced a fragmented vegetative distribution that consists of bare or nearly bare south slopes with an abrupt transition to heavily forested northerly aspects

Figure **6- 6**). The rugged southern slopes north of the main Twisp River aspect have overcome the effects of elevation, resulting in mixed ponderosa pine and Douglas-fir predominating several thousand feet higher than on the north aspects directly across the valley. On these north slopes there has been a corresponding drop in the vegetation zones for the Subalpine fir PAGs which extend nearly to the valley floor at the head of the Twisp River.

The presence of large fire-scarred ponderosa pine and Douglas fir throughout much of Little Bridge Creek drainage and the Twisp River valley provide evidence that more open stands of large trees once dominated these sites. The north aspects dominated by the Subalpine fir and Moist Douglas-fir PAGs sustained LS habitat in the form of migrating fire refugia.

The higher and wetter upper reaches of Bridge Creek, and the northern aspects of the Twisp River valley, are dominated by the Subalpine fir and Moist Douglas-fir PAGs. These areas support large (> 5,000 acres), contiguous blocks of homogeneous fuels that have developed, in part, due to fire exclusion. Historically, smaller fires (such as the Reynolds Fire at approximately 500 acres) broke up the continuity of the fuels from the valley bottom to the ridge top and functioned as a fuel break for a period of years within the larger landscape. With current direction to aggressively suppress these types of fires, the structure of the fuels have become more homogeneous. This will result in a greater risk of larger stand replacing fires than where historically experienced.

Figure 6- 6 Twisp River Late Successional Reserve



The drier sites at lower elevations are dominated by the Ponderosa Pine and Dry Douglas-fir PAGs and make up 38 percent of the landscape. Historically, frequent fires maintained much of these areas in LS ponderosa pine habitat. Loss of this habitat is especially evident in the Dry Douglas-fir PAG where much of the area, would have been maintained as open ponderosa pine parkland (E3) by frequent fires. The less fire tolerant Douglas-fir is now the dominant species in these stands and the younger trees are now growing into the crowns of the large old ponderosa, which increases the risk of stand replacing crown fires.

The flat floor of the Twisp River valley provides significant amounts of riparian habitat and suitable growing sites for a mixed conifer forest that in the past has developed into extensive stands of large (> 20 inches DBH) ponderosa pine, Douglas-fir, and Engelmann spruce. Considering the LSR as a whole, 24 percent of the vegetation is currently LS habitat.

Some of these stands have been designated as Critical Habitat Units (CHUs) to protect known activity centers for the northern spotted owl. Other stands have been harvested and regenerated by past management activities, which date to the earliest part of the century with the construction of Camp Gilbert (a temporary mining community at the head of the Twisp River).

The Twisp River valley and Little Bridge Creek are well roaded. These roads were constructed for mining, logging and recreation access. Accessibility is limited to 25 percent of the area in the LSR, and 88 percent of the accessible acres are within the Ponderosa Pine and Douglas-fir PAGs. There is an extensive trail system which serves as access to the surrounding Lake Chelan-Sawtooth Wilderness. The Twisp River Trail, which connects campgrounds and trailheads along the upper Twisp River valley, was constructed in the past decade and designed to avoid Riparian Reserves and disturbance to LS habitat as much as possible.

The watershed of the Twisp River serves as important habitat for many aquatic species, including steelhead trout and other anadromous fish. This, and the variety of scenery and hunting opportunities, has lead to its increasing popularity as a recreational area. Abandoned mine workings throughout the LSR testify to a rich history of mineral exploration (none of which resulted in a producing mine). Exploration continues sporadically at present, but the limited extent and values of currently delineated deposits make the possibility of other than incidental mineral activity, such as panning or small-scale recreational dredging, remote.

The Twisp River has traditionally served as an important source of fuelwood for the residents of the lower Methow Valley, as well as a source of berries, mushrooms and other edible plants. As the population of the Methow Valley grows, public pressure to continue these established uses will increase.

With relatively dry habitats dominating in the lower elevations, more frequent, low intensity fires are to be expected. Approximately one-third to one-half of the acreage in this LSR should burn in a decade for the ecosystem to function as it did historically. Thirty-eight percent of the LSR is within these dry habitats. Risk of fire starts are high because of the increasing recreation use, high probability of lightning caused fire ignitions, and the excessive ladder fuel development since fire exclusion.

Table 6-4

Twisp River LSR Current Vegetation					
PAG & Seral Stage	Total Acres	% of Total Acres	Accessible Acres	Current LS Acres	% of Total LS Acres
Ponderosa Pine	1817	5%	425	1137	3%
L1	11		5		
L2	669		144		
LU3	1137		276		
Dry Douglas-fir	12030	33%	4944	3051	8%
E1	127		31		
L2	3011		1404		
PAG & Seral Stage	Total Acres	% of Total Acres	Accessible Acres	Current LS Acres	% of Total LS Acres
L3	332		173		
M1	135		82		
M2	5706		2138		
M3	2719		1116		
Moist Douglas-fir	7788	22%	2495	3620	10%
E1	112		48		
E2	1		0		
L2	4055		1236		
L3	3620		1211		
Dry Subalpine Fir	4862	14%	1093	254	1%
E1	25		6		
E2	1403		323		
E3	939		193		
L3	147		19		
M2	2241		543		
M3	107		9		
Moist Subalpine Fir	4941	14%	1123	594	2%
E2	2072		707		
E3	1575		365		
L2	330		22		
L3	166		9		
M2	370		5		
M3	428		15		
Pacific Silver Fir/Mtn. Hemlock	161	0%		13	0%
E1	148				0%
M3	13				
RIPARIAN	193	0%			
NONFOREST	4474	12%			
TOTALS	36266		8957	8669	24%

Twisp River LSR Biophysical Environment (BPE)		
BPE	Total Acres	% Total Acres
cddy	64	1%
cdmc	379	1%
cdmt	526	1%
cldy	349	1%
clmc	2191	6%
clmt	4046	11%
htdry	4654	13%
wmdy	6458	18%
wmmc	17453	48%
wmmt	146	0%

Crown Fire Potential

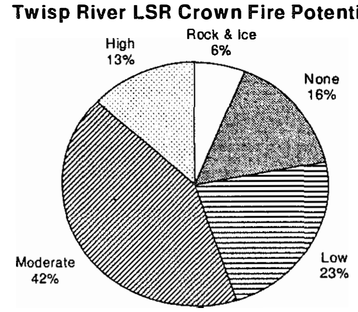
The distribution of crown fire potential ratings in the Twisp River LSR (see Map 17, Appendix H) reflects a mixture of PAGs ranging from ponderosa pine to moist subalpine fir. Most of the southerly slopes and valley bottoms are in the Ponderosa Pine and Douglas-fir PAGs. Risk reduction objectives focus on these PAGs. The objectives are to reduce ladder and surface fuel loadings in order to reduce potential for a high intensity fire, by maintaining at least 20 foot spacing between crowns (crown bulk density of 0.10). North slopes could be maintained in "moderate to high" crown fire potential. Fires could still be expected to burn rapidly from south to north slopes given proper conditions; however, maintaining lower crown fire potentials between these areas will reduce the risk of a stand replacing event.

Fifty percent of the Twisp River LSR supports the Douglas-fir and Subalpine fir PAGs. Given these areas typify a mixed mortality/ stand replacing fire regime, diversification of the landscape structure in strategic areas may help create fuel breaks and bring fire out of the crowns during a fire event. This will result in a more structurally and compositionally diverse landscape following a fire event while helping to reduce the overall size of a fire. Areas of "moderate to high" crown fire potential ratings should be broken into smaller blocks whenever possible by developing fuel breaks that connect natural barriers, and areas of "low" crown fire potential to reduce the risk of large, stand replacing crown fires.

Urban interface areas need to be maintained at a "low" crown fire potential rating within a half mile buffer of private lands adjacent to the LSR.

Figure 6-7

Twisp River LSR Crown Fire Potential



Management Implications

The Twisp River LSR can be viewed as a bowl, the rim of which is designated Wilderness. Because of the high probability of a fire burning uphill into the Wilderness, this proximity must be considered when developing management plans that involve use of fire as an LSR treatment. This will involve integration of the fire plans for the two areas, especially in the case of natural ignitions burning from the LSR into Wilderness.

Recreational use is currently high and expected to increase. Developed recreation sites consist of campgrounds and trailheads. These existing facilities do not presently appear to have a significant effect on the LS characteristic because of the limited acreages involved. The cumulative effects of increasing use should be carefully considered. Proposed projects need to meet both the LSR and Aquatic conservation Strategy objectives.

LS habitat fragmentation in most of the LSR has been historically high because of the aspect-driven nature of the vegetation. As a result, northerly aspects more conducive to development of LS habitat are separated from each other by comparatively open areas of park-like stands on southern aspects. This "natural" fragmentation has been increased by the addition of a road and trail system which has created openings in what were previously uninterrupted canopy closures. A notable exception has been the bottom of the Twisp River valley which appears to have served as a long-term relatively undisturbed continuous section of LS habitat.

There is little site and/or species-specific information available on the effects of fragmentation on LS habitat in the Twisp River LSR. The transportation system should be carefully evaluated in the context of its compliance with LSR management objectives. The Twisp River Watershed Analysis has identified a need to close and reshape roads in the Twisp River valley. This ongoing work should meet LSR management objectives.

The fragmented nature of LS habitat in the Twisp River LSR makes LS habitat connectivity issues important management considerations when planning activities or projects. Some fire refugia in the Little Bridge Creek, Lime Creek, and Canyon Creek drainages are contiguous with areas of high crown fire potential in Matrix lands. In order to protect these fire refugia and stands approaching LS characteristics, management of adjacent Matrix as low crown fire potential should be a priority.

The traditional use of the Twisp River for fuelwood gathering by local residents must be considered when planning vegetation management activities within the LSR. When LSR and Aquatic Conservation Strategy objectives can be met, treatment areas should be considered as high priority for creating designated fuelwood areas. Fuelwood will either be as pre-piled excess down woody debris from treated areas, or as marked standing green trees.

Upper Methow Late Successional Reserve

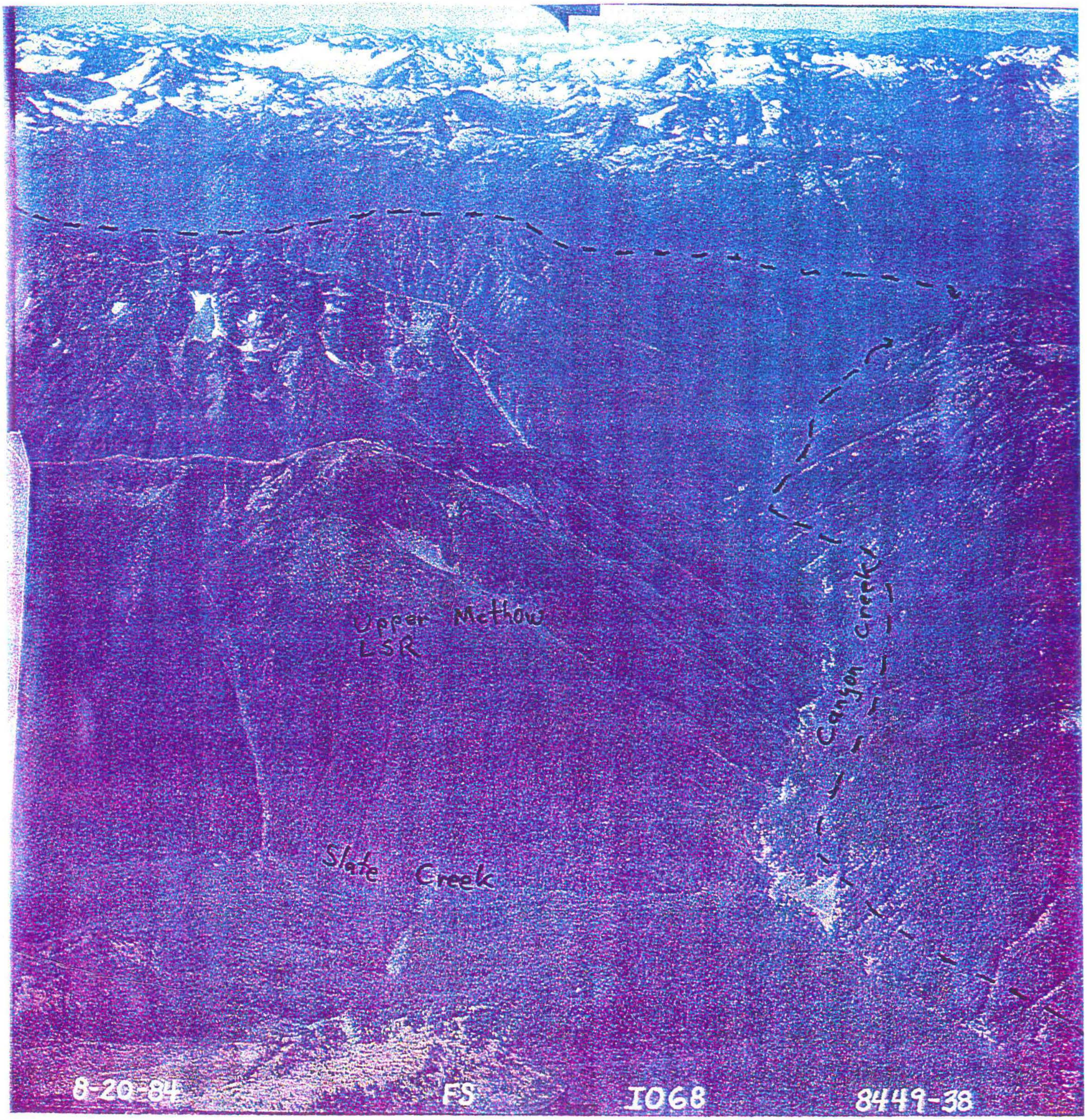
The Upper Methow LSR is 191,337 acres in size. It spans the crest of the Cascade range encompassing both west and east side environments. It represents the easternmost range of the northern spotted owl and thus is the most diverse as well as the largest of all the LSRs in the Northeast Cascades LSR system. The area is very rugged, ranging from glaciated peaks in the western portion of the LSR to more gentle rolling topography in the east that was shaped by the last continental ice sheet. Many of the soils located on the lower one-third of the generally steep valley sidewalls are derived from glacial outwash streams or morainal deposits left as the ice sheet receded. Other soils are derived from the local bedrock which is extremely varied over an area of this size.

Precipitation also varies greatly ranging from over 90 inches annually in the LSRs western portion to under 20 inches annually in the east. The rain shadow effect of the Cascades range is dramatically illustrated by the fact that the decrease of precipitation is approximately one inch per mile as one moves east away from the Cascade Crest.

The area to the east of the Cascade Crest drains into the Methow river and then into the Columbia river system. The principle tributaries in the eastern half are Robinson Creek, Goat Creek, and the Lost River. West of the Cascade Crest the LSR the main tributaries are Canyon Creek and Slate Creek which drain into the Skagit River system. The difference in precipitation, and to a lesser extent the variation in topography, lead to a distinct ecological break located roughly along the Cascade Crest. West of this break the BPEs and vegetation are more typical of those communities encountered on the west side which are represented by the Pacific Silver Fir/Mtn. Hemlock and western hemlock PAGs.

Figure 6-7 Upper Methow (East) Late Successional Reserve

Figure 6-8 Upper Methow (West) Late Successional Reserve



These two PAGs also provide the best suitable northern spotted owl habitat of any of the LSRs. This area makes up 18 percent of the Upper Methow LSR. East of Robinson Creek the landscape is more typical of the eastern slope of the Cascades range and the rest of the LSRs in the Northeast Cascades LSR system.

Because much of the LSR is located above 5,000 feet the Moist Douglas-fir and Subalpine fir PAGs are the dominant (43%) plant communities found in the LSR. The Ponderosa Pine and Dry Douglas fir PAGs make up 12 percent of the LSR and this is also the most accessible area.

Roads constructed for timber harvest and recreation allow access to most of the area north of the Methow River and east of Lost River. North of the Methow River and west of Lost River, there is only one road accessing this portion of the LSR. This is the Harts Pass road which is narrow and winding. It is used primarily for recreational and mining access. State Route 20 is a major summer transportation and scenic route through the North Cascades. Other than these roads, the vast majority of the LSR is not accessible.

Disturbance regimes for the LSR are characterized once again by a distinct division between east and west. In the east the burn patterns already described for the Twisp River predominate. In the west, fires are much less frequent (FRI >200 years). Because of this, insect and disease mortality play a major role in successional processes.

Miners in the early part of the century burned out almost the entire Canyon Creek and Slate Creek drainages to expose bedrock veins. This is why 72 percent of the Pacific Silver Fir/Mountain Hemlock PAG and 31 percent of the Western Hemlock PAG stands are classified as less than 14 inches DBH. Over 90 years of recovery from these human caused fires has not been sufficient to produce LS habitat in many stands above 4,000 feet in elevation.

Increased subdivision of large, old homesteads has accelerated the real estate sales of small tracts of land throughout the upper Methow valley. Recreational development in the past two decades has made it apparent that private lands located in the upper Methow valley, near the town of Mazama, continue to increase. The recreational opportunities are attractive to families seeking a place to build a second home, and these same opportunities are drawing large scale development projects into the area. These private lands are located in a narrow peninsula (see Map 4, Appendix H) along the flat, valley floor and constitute a significant urban interface in terms of fire protection. If development continues to occur at its present pace, the juxtaposition of these lands and the surrounding LSR will become very important to all parties. Increased risk of fire, increased recreational use, and the resulting increased impacts on adjacent LSRs and Riparian Reserves contribute to the complexity of this issue.

In addition, known northern spotted owl activity centers have been surveyed in the upper Methow Valley, resulting in the creation of two CHUs. The largest is located near a major recreational development, Arrowleaf Resort.

Patented mining claims located during the 1898 gold rush to the Barron area west of Harts Pass now constitute inholdings of about 200 acres in the western portion of the LSR. Although gold reserves still exist in this area and in the area of the Azurite Mine 10 miles to the southwest, a short mining season and difficult access make development improbable at this time. A large low grade copper deposit near Flag Mountain in the eastern portion of the LSR has been delineated by extensive exploration work over the past three decades. Although present market conditions preclude mining, there is a possibility of a large scale mining operation developing this deposit at some time in the next 200 years. There is also a possibility that higher grade ores will be discovered as exploration continues.

Subalpine habitat types have longer fire return intervals (100 to 200 years) and the fires are smaller than those experienced in the low elevation arid sites. However, these fires are typically stand replacing in nature when they do occur. These areas are within their natural fire cycle over the larger landscape, but are loosing the structural diversity that was once created by smaller more frequent fires. These smaller fires at high elevations typically will extinguish themselves. Those fires that grow to a large size create a mosaic across the landscape that supports a diversity of species and structures. Patches of early seral communities can function as fuel breaks to reduce the size of large landscape scale fires. Fire has not been allowed to function in creating these smaller landscape patches due to aggressive fire suppression policies over the last 80 years.

Table 6-5

Upper Methow LSR Current Vegetation					
PAG & Seral Stage	Total Acres	% of Total Acres	Accessible Acres	Current LS Acres	% of Total LS Acres
Ponderosa Pine	2053	1%	1038	1337	1%
L1	82		23		
L2	634		263		
LU3	1337		752		
Dry Douglas-fir	21165	11%	8875	6035	3%
E1	1422		123		
L2	4365		1466		
L3	764		252		
M1	12		5		
M2	9331		4345		
M3	5271		2684		
Moist Douglas-fir	23061	12%	6595	13044	7%
E2	28		10		
L2	9756		2975		
L3	11379		2831		
M2	233		19		
M3	1665		760		
Dry Subalpine Fir	28524	15%	7552	831	0%
E1	900		326		
E2	9348		2721		
E3	7663		2667		
L3	542		9		
M2	9782		1794		
M3	289		35		
Moist Subalpine Fir	29780	16%	6523	6627	3%
E2	8338		2479		
E3	5715		1465		
L2	2225		651		
L3	1552		528		
M2	6875		581		
M3	5075		819		

Upper Methow LSR (cont'd) Current Vegetation					
PAG & Seral Stage	Total Acres	% of Total Acres	Accessible Acres	Current LS Acres	% of Total LS Acres
Pacific Silver Fir/Mtn. Hemlock	33200	17%	0	9427	5%
E1	3452				
E2	2464				
E3	3704				
M2	17851				
M3	5199				
L3	524				
Western Hemlock	2563	1%	0	1772	1%
E1	196				
E2	172				
M2	299				
M3	1698				
L2	124				
L3	74				
NONFOREST/RIPARIAN	50991	27%			
TOTALS	191337		30583	39073	20%

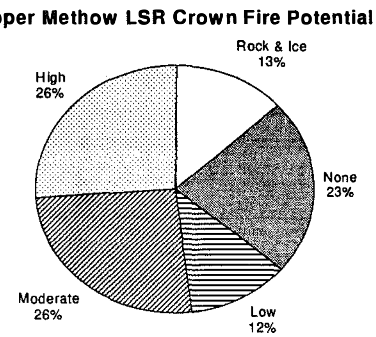
Upper Methow LSR Biophysical Environment (BPE)		
BPE	Total Acres	% Total Acres
cddy	5695	3%
cdmc	11515	6%
cdmt	6057	3%
cldy	12922	7%
clmc	41086	21%
clmt	26791	14%
htdy	25389	13%
wmdy	22870	12%
wmmc	29877	15%
wmmt	9135	5%

Crown Fire Potential

The distribution of crown fire potential ratings in the Upper Methow LSR reflect a mixture of all PAGs. Risk of stand replacing fires can be mitigated by reducing ladder and surface fuel loadings on south slopes in the Ponderosa Pine and Dry Douglas-fir PAGs. In order to minimize the risk of a high intensity fire stands should be maintained with at least 20 foot spacing between crowns (crown bulk density of 0.10). North slopes can be maintained in "moderate to high" crown fire potential.

Higher crown fire ratings should be broken into smaller blocks whenever possible by developing fuel breaks that connect natural barriers and areas of low crown fire potential. This will prevent a crown fire from consuming large acreages by a stand replacing fire. Urban interface areas need to be maintained at a low crown fire potential rating. There are 1,184 acres of non-Forest Service ownership within the Sawtooth LSR. Three hundred acres of this is has a "moderate to high" crown fire potential rating. The high risk urban interface treatment area provides a half mile treatment area buffer around these private tracks of land. By doing this, the Forest Service has identified almost 2,850 additional acres needing treatment in the "moderate to high" crown fire potential category.

Figure 6- 9



Management Implications

For management purposes the Upper Methow should be considered as essentially two separate LSRs.

The western portion of the LSR provides the most suitable northern spotted owl habitat. The main disturbance regimes that define the structural diversity within a stand and across a landscape are tied to insects and disease cycles. Fire events tend to stand replacing when they do occur, and tend to reset the successional clock back to a shrub/herb community.

Except for State Highway 20, there is almost no roaded access to this western portion of the LSR. Management tools are limited to various forms of fire management where road access is not necessary. Implementation of current fire management and suppression policies will have a major influence on future ecosystem function. The abundance of high rocky ridges that provide natural fire breaks and the limited fire season will increase the likelihood there will always be a relatively high percentage of LS habitat in the western portion of the LSR.

In one sense the western portion of the Upper Methow LSR is the least complicated of the LSRs to manage ecologically. It is well within its natural disturbance regime and little or no management is necessary to meet LSR objectives. With increasing recreational demands in the area, future management will need to focus on mitigating recreational uses while maintaining the integrity of the LS habitat for those species dependent on it.

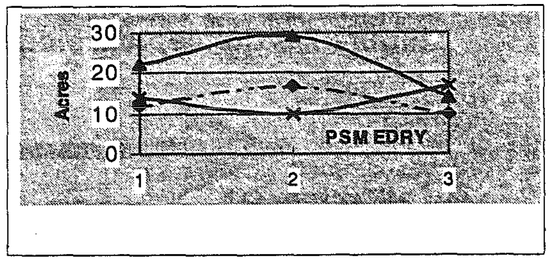
The eastern portion of the LSR presents a much more complex set of management issues. In addition to extensive recreational development occurring within the urban interface, there are North American lynx, gray wolves, and steelhead trout in the streams. Northern spotted owls are also known to live in this area.

In the eastern portion of the Upper Methow LSR road access is relatively good, providing good opportunities to mitigate risk in the urban interface, enhance LS habitat in the northern spotted owl CHU, and restore ecosystem function. Therefore, this area should be considered as the highest priority area for vegetation management among the LSRs. This strategy will yield the highest short term return for resources expended in LSR management.

New proposals for recreational development that require use of LSR lands should be carefully evaluated on two levels. First, project proposals must not diminish the overall integrity of currently functioning LS habitat, or result in the loss of viable populations that are dependent on these ecosystems. Another important aspect of evaluating project effects is on other economically important species in the area such as mule deer.

Second, projects should be designed to integrate multiple resource objectives to minimize the effects of activities on the surrounding vegetation and its habitat quality. For example, combining creation of fuel breaks that will double as trails or access other proposed developments while still preserving the integrity of the LS habitat. Managers need to be remain aware that these NEPA analysis of any proposal. In addition, LSR and Aquatic Conservation Strategy objectives must be met when considering the cumulative effects of small scale developments in the LSR.

CHAPTER 7 Management Options



Introduction

The Management Implications developed by the assessment team (see Chapter 6) were used to develop a list of appropriate LSR management treatments and to develop a schedule for treatments. The purpose of this analysis is to take the available information presented in the previous chapters and use it to develop and evaluate LSR management scenarios.

This analysis is based on a classification system at two levels: Biophysical Environments (BPEs) and Plant Association Groups (PAGs) (see Chapter 2). BPEs are based on physical and environmental conditions in the assessment which remain relatively constant over time. Because of this characteristic, they constitute a baseline against which to measure disturbance processes and assess the resulting changes. PAGs are based on groups of climax communities, which are generally adapted to similar environments and disturbance regimes. PAGs are further subdivided into "seral stages" which describe stages in natural succession. This classification system provides a framework to track successional processes and to study the ripple effects of disturbance or human intervention at any stage of succession.

Because seral stages can also describe habitat, some wildlife species can be loosely associated with seral stages within PAGs. or groups of PAGs, allowing us to assess the effects of treatments on these species. For example, the association of North American lynx with early seral stages of lodgepole pine allows us to evaluate the effects of treatments such as burning or thinning on lynx habitat by examining the successional diagram for the PAGs of which include the lodgepole pine seral stages.

This classification system can be portrayed as a 3x3 matrix (Figure 7-1). The vertical axis of this simplified successional pathway model portrays a seral stage progression of vegetation from early (E) to late (L). An example of this progression would be the initial regeneration of predominately lodgepole pine after a disturbance in the dry subalpine fir PAG. This would represent the "E" seral stage of this PAG. As the result of a number of natural processes, lodgepole pine would be replaced over time with subalpine fir, given that another disturbance of this succession such as fire did not "reset" the successional process. The end result would be a predominately subalpine fir forest which is represented by the "L" classification. The intermediate mixed species stage is represented by the "M" classification. Not only does species composition change as stands age but they also increase in average size. This is represented on the horizontal axis of the matrix by the three size classes from 1 to 3.

A 3x3 matrix was used because it simplified modeling, and because it best fit the size classifications available from the satellite imagery used to describe PAGs and obtain acres and distribution.

A successional pathway can be described for any vegetation cover using this matrix. In

Figure 7-1 Conceptual Model of Successional Pathway Matrix

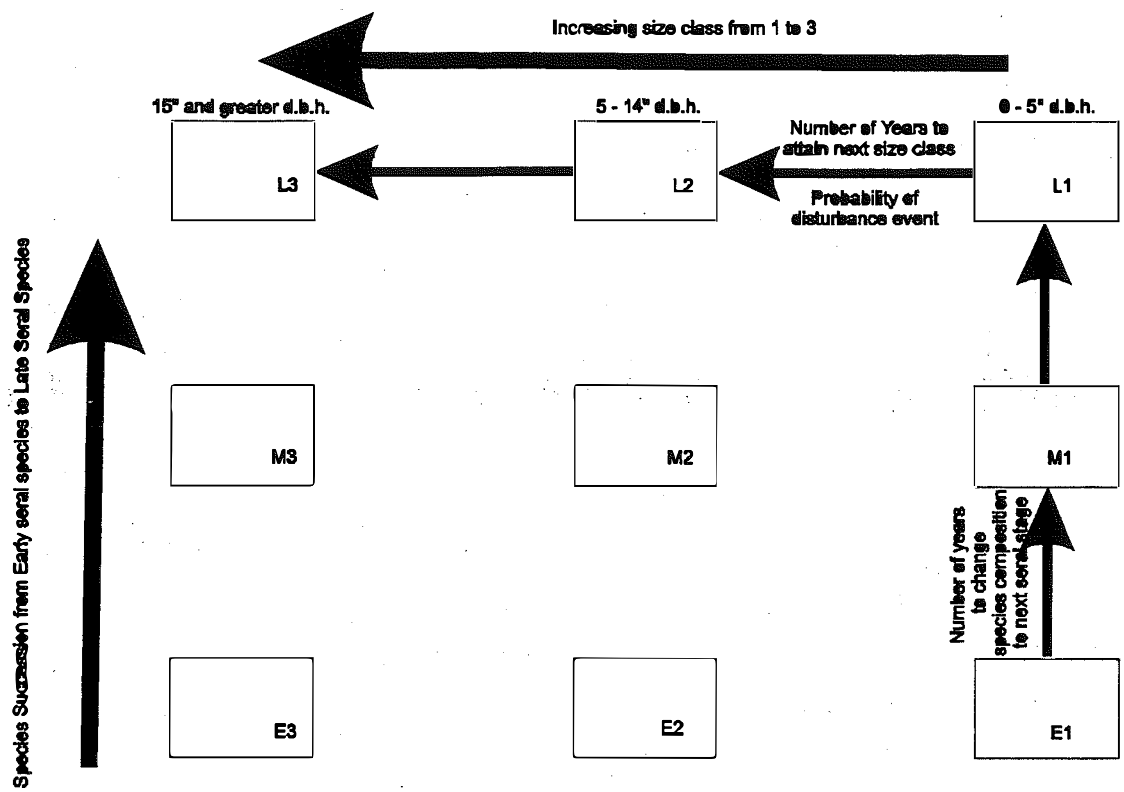


Figure 7-1, the smaller arrows follow stand development through the "E" stages arriving eventually in the upper left hand corner in a mature "L" stand. At each intersection of the matrix is a box representing a possible combination of size and species composition or a "seral stage". In reality not every intersection or seral stage occurs for every PAG in nature.

To provide a more detailed description of the interactions between seral stages, two values can be assigned to the "movements" of stands between the intersections of the matrix. We can estimate the length of time required for the majority of the stand to acquire the characteristics of a seral stage located either horizontally or vertically adjacent to it in the matrix can be estimated. In addition, in PAGs where disturbance elements such as fire or insect and disease attacks play a major role in determining natural succession, these events can be portrayed by separate paths and their effects estimated by assigning a probability based 0.0 percent mortality per decade to each movement between seral stages driven by disturbance. Fire, insect and disease risk probabilities were derived for each movement between seral stages within a PAG using SYSDYN, a stochastic fire prediction model. Fire hazard ratings were also derived for each seral stage. These hazard ratings resulted from application of a crown fire potential model (CFP) developed on the Okanogan National Forest and applied to this analysis by the assessment team.

This natural successional matrix lends itself to analysis using linear programming models such as the SPECTRUM forest planning model.

Management Options

After defining PAG successional pathways, a list of treatments was derived, which intended to move stands between seral stages within a PAG. The purpose of these treatments is expressed in terms of how they move stands between seral stages. The effects of these treatments can be incorporated into the matrix by altering the length of time a stand remains in a seral stage. For example, a stand of young ponderosa pine, which would normally be expected to take 20 years for the average DBH to increase to the next size class, could have this increase accelerated by thinning. This new value would be applied to the succession model. This is an example of a horizontal movement through the matrix. Vertical movements are also possible. For instance, a stand of lodgepole pine could be thinned selecting for species rather than size by preferentially cutting lodgepole over subalpine fir. This would result in a species composition movement vertically through the matrix.

Many of the treatment options have the dual purpose of enhancing LS stand development and reducing risk to areas either currently having the attributes of LS habitat (ROD B-5) or having the potential to develop into LS habitat in the future. Thus, for the purpose of modeling, no distinction was made between these types of treatments which can be similar in nature but applied for different purposes. In addition, no modeling distinction was made between machine treatments (saw thinning and fire treatments like underburning because their successional effects can be similar.

Table 7-1 displays silvicultural treatment options for the Ponderosa pine, dry Douglas-fir, moist Douglas-fir, dry subalpine fir, and moist subalpine fir PAGs. Treatments were developed only for these "management" PAGs. In these PAGs, past experience shows that vegetation responds satisfactorily to these treatments. Because the ultimate objective of these treatments is moving stands between seral stages, either fire or mechanical means may be used at the discretion of the manager to apply the treatments in this table.

Treatments will be applied to stands based on observed seral stages of development, not estimated stand age. Fuels treatments included in Table 7-1 describe the most likely treatment to be applied. Other fuels treatments may be applied on a site specific basis.

Table 7-1

LSR Silvicultural Treatments List		
Ponderosa Pine (PIPO) PAG Treatments		
Treatment	**Seral Move**	**Treatment Objectives**
Thin from below followed by prescribed fire (underburning) to manage post treatment fuels and thin understory stems.	L2 to LU3	1. Prevent stand stagnation. 2. Provide adequate growing space for dominant trees to allow stand to attain mature size class one to three decades following treatment. 3. Reduce bark beetle and wildfire susceptibility. 4. Manage tree diseases, snags, and coarse woody debris at desired levels.
Maintain mature stand by thinning from below followed by prescribed fire (underburning) to manage post treatment fuels and thin understory stems.	LU3 to LU3	1. Release and maintain vigor of mature trees. 2. Reduce density of understory to maintain vigorous trees in overstory canopy gaps. 3. Maintain stand resilience to bark beetles and wildfire. 4. Manage tree diseases, snags, and coarse woody debris at desired levels
Restore parklike stand by thinning from below, individual tree selection, and/or group selection followed by prescribed fire (underburning) to manage post treatment fuels and thin understory stems.	L3 to LU3	1. Restore parklike stand conditions. 2. Release and maintain vigor of mature trees. 3. Create stands which are more resilient to bark beetles and wildfire and more sustainable than the L3 stage. 4. Manage tree diseases, snags, and coarse woody debris at desired levels.

Dry Douglas-fir (PSMEDry) Treatments		
Treatment	**Seral Move**	**Treatment Objectives**
Thin saplings to favor development of early seral species.	M1 to E2	1. Favor the growth and development of early seral species in stands with mid seral species composition. 2. Provide growing space for residual trees to enable the stand to develop into the next larger size class one to three decades following treatment.
Thin saplings to maintain early seral species.	E1 to E2	1. Maintain the growth and development of early seral species in stands with early seral species composition. 2. Decrease the amount of time required for thinned stands to develop into the next larger size class by at least one decade.
Thin saplings to maintain mid seral species.	M1 to M2	1. Maintain the growth and development of mid seral species in stands with mid seral species composition. 2. Decrease time required for thinned stands to develop into the next larger size class by at least one decade.
Thin stand to favor development of early seral species. Utilize prescribed fire to manage post treatment fuels levels and/or thin understory stems.	M2 to E3	1. Favor growth and development of early seral species in stands with mid seral species composition. 2. Maintain existing mature trees. 3. Enable stands to develop into early seral, mature size class 1 - 3 decades following treatment. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Thin stand to maintain development of early seral species. Utilize prescribed fire to manage post treatment fuels levels and/or thin understory stems.	E2 to E3	1. Maintain growth and development of early seral species. 2. Maintain existing mature trees. 3. Decrease amount of time required for thinned stands to develop into mature size class by at least one decade. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Thin stand to maintain development of mid seral species. Utilize prescribed fire to manage post treatment fuels levels and/or thin understory stems.	M2 to M3	1. Maintain the growth and development of mid seral species. 2. Maintain existing mature trees. 3. Decrease the amount of time required for thinned stands to develop into the mature size class by at least one decade. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Thin stand to favor development of mid seral species. Utilize prescribed fire to manage post treatment fuels levels and/or thin understory stems.	L2 to M3	1. Change tree species composition to the more diverse, mid seral species mix. 2. Create stands which will provide LS habitat and are more sustainable than late seral species, mature stands. 3. Increase stand resilience to insects, disease, and wildfire. 4. Manage snags and coarse woody debris at desired levels.
Thin stand to maintain development of late seral species. Thin understory stems if needed. Utilize prescribed fire to manage post treatment fuels levels.	L2 to L3	1. Maintain the growth and development of late seral species. 2. Maintain existing mature trees. 3. Decrease the amount of time required for thinned stands to develop into the mature size class by approximately five decades. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Regenerate stagnated stands with no potential to attain mature size class and provide LS habitat. Utilize prescribed fire to manage post treatment fuels levels and provide favorable site conditions for stand reestablishment.	E1, E2, M1,M2, or L2 to M1 or E1	1. Replace stagnated stands affected by overstocking, high disease levels, and/or past management activities. 2. Create stands with potential to attain mature size and provide LS habitat. 3. Retain existing stand components which will enhance future stand structure. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Maintain mature stand of early seral species with thinning from below, individual tree selection, and/or group selection followed by prescribed fire to manage post treatment fuels and/or thin understory stems.	E3 to E3	1. Maintain mature trees by reducing competition with understory trees. 2. Maintain early seral species mix. 3. Reduce density of understory to maintain vigorous trees in overstory canopy gaps. 4.Maintain stand resilience to insects, disease, and wildfire. 5. Manage snags and coarse woody debris at desired levels.
Maintain mature stand of mid seral species with thinning from below, individual tree selection, and/or group selection followed by prescribed fire to manage post treatment fuels and/or thin understory stems.	M3 to M3	1. Release and maintain mature trees. 2. Maintain mid seral species mix. 3. Reduce density of understory to maintain vigorous trees in overstory canopy gaps. 4. Maintain stand resilience to insects, disease, and wildfire. 5. Manage snags and coarse woody debris at desired levels

LSR Silvicultural Treatments List		
Dry Douglas-fir (PSMEDry) Treatments (cont'd)		
Treatment	**Seral Move**	**Treatment Objectives**
Restore mature stand of early seral species with thinning, individual tree selection, and/or group selection followed by prescribed fire to manage post treatment fuels and/or thin understory stems.	M3 to E3	1. Change tree species composition from mid seral to early seral species mix. 2. Promote establishment and development of early seral species. 3. Reduce density of understory to maintain vigorous trees in overstory canopy gaps. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Moist Douglas-fir (PSMEMoist) Treatments		
Thin saplings to maintain early seral species.	E1 to E2	1. Maintain the growth and development of early seral species in stands with early seral species composition. 2. Decrease the amount of time required for thinned stands to develop into the next larger size class by at least one decade.
Thin saplings to maintain mid seral species.	M1 to M2	1. Maintain the growth and development of mid seral species in stands with mid seral species composition. 2. Decrease time required for thinned stands to develop into the next larger size class by one to two decades.
Thin saplings to favor development of late seral species.	M1 to L2	1. Change tree species composition to late seral species mix. 2. Decrease time required for thinned stands to develop into late seral species stands by one to three decades following treatment. 3. Set treated stands on a successional path to develop into a mature, late seral species stand.
Thin saplings to favor development of early seral species.	M1 to E2	1. Favor the growth and development of early seral species in stands with mid seral species composition. 2. Provide growing space for residual trees to enable stand to develop into next larger size class 1 to 3 decades following treatment.
Thin saplings to favor development of mid seral species.	E1 to M2	1. Favor growth and development of mid seral species in stands with early seral species composition. 2. Set thinned stands on a successional path which should decrease time required to develop into a mature, mid seral species stands which provide LS habitat by several decades
Thin stand to maintain development of early seral species. Utilize prescribed fire to manage post treatment fuels levels and/or thin understory stems.	E2 to E3	1. Maintain growth and development of early seral species. 2. Maintain existing mature trees. 3. Decrease time required for thinned stands to develop into mature size class by 1-2 decades. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Thin stand to maintain development of mid seral species. Thin understory stems if needed. Yard tree tops attached or utilize prescribed fire to manage post treatment fuels levels.	M2 to M3	1. Maintain growth and development of mid seral species. 2. Maintain existing mature trees. 3. Decrease time required for thinned stands to develop into the mature size class by 1-3 decades. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Thin stand to favor development of mid seral species. Thin understory stems if needed. Yard tree tops attached or utilize prescribed fire to manage post treatment fuels levels.	E2 to M2	1. Favor the growth and development of mid seral species in stands with early seral species composition. 2. Remove majority of lodgepole pines prior to mountain pine beetle outbreak. 3. Direct stands into a successional pathway which will decrease the amount of time required to develop LS habitat. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels
Thin stand to maintain development of late seral species. Thin understory stems if needed. Utilize prescribed fire to manage post treatment fuels levels.	L2 to L3	1. Maintain the growth and development of late seral species. 2. Maintain existing mature trees. 3. Decreased the amount of time required for treated stands to develop into LS habitat by several decades (up to 10 decades). 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.

LSR Silvicultural Treatments List		
Moist Douglas-fir (PSMEMoist) Treatments (cont'd)		
Treatment	**Seral Move**	**Treatment Objectives**
Regenerate stagnated stands with no potential to attain mature size class and provide LS habitat. Utilize prescribed fire to manage post treatment fuel levels and provide favorable site conditions for stand reestablishment.	E1, E2, M1, M2, or L2 M1 or E1	1. Replace stands affected by overstocking, high disease levels, and/or past management activities. 2. Create stands with mature size potential and provide LS habitat. 3. Retain existing stand components which enhance future stand structure. 4. Manage insect, disease, and wildfire susceptibility, snags. and coarse woody debris at desired levels.
Thin stand to favor development of late seral species. Thin understory stems if needed. Yard tree tops attached or utilize prescribed fire to manage post treatment fuels levels.	M2 to L2	1. Favor growth and development of late seral species in stands with mid seral species composition. 2. Remove majority of lodgepole pines prior to mountain pine beetle outbreak. 3. Direct stands into a successional pathway which will decrease the amount of time required to develop into mature, late seral species stands by 1 - 4 decades. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Restore mid seral species composition with thinning, individual tree selection, and/or group selection followed by prescribed fire to manage post treatment fuels levels.	L2 to M3	1. Favor growth and development of mid seral species mix in stands with late seral species composition. 2. Promote establishment of lodgepole, ponderosa, and western white pine in the understory to increase species diversity. 3. Provide growing space for residual trees to enable stand to develop into mature size class 3-5 decades following treatment. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Maintain mature stand of early seral species with thinning, individual tree selection, and/or group selection followed by prescribed fire to manage post treatment fuels and/or thin understory stems.	E3 to E3	1. Release/maintain mature trees. 2. Maintain early seral species mix. 3. Reduce density of understory to maintain vigorous trees in overstory canopy gaps. 4. Maintain resilience to insects, disease, and wildfire. 5. Manage snags and coarse woody debris at desired levels.
Maintain mature stand of mid seral species with thinning, individual tree selection, and/or group selection followed by prescribed fire to manage post treatment fuels and/or thin understory stems.	M3 to M3	1. Release and maintain mature trees. 2. Maintain early seral species mix. 3. Reduce density of understory to maintain vigorous trees in overstory canopy gaps. 4.Maintain resilience to insects, disease, and wildfire. 5. Manage snags and coarse woody debris at desired levels.
Dry subalpine fir (ABLA2Dry) PAG Treatments		
Thin saplings to maintain early seral species.	E1 to E2	1. Maintain the growth and development of early seral species in stands with early seral species composition. 2. Decrease the amount of time required for thinned stands to develop into the next larger size class by two decades.
Thin saplings to maintain mid seral species.	M1 to M2	1. Maintain the growth and development of mid seral species in stands with mid seral species composition. 2. Decrease the amount of time required for thinned stands to develop into the next larger size class by one to two decades.
Thin saplings to favor development of mid seral species.	E1 to M2	1. Favor the growth and development of mid seral species in stands with early seral species composition. 2. Enable stands to develop into the next larger size class with a mid seral species composition in three to four decades following treatment. 3. Set thinned stands on a successional path which should decrease time required to develop into mature, mid seral species stands that provide LS habitat by several decades.
Thin saplings to restore mid seral species composition.	L1 to M2	1. Change the tree species composition from late seral to the more diverse mid seral species mix. 2. Enable stands to develop into the next larger size class with a mid seral species composition in 3 -4 decades following treatment.
Thin stand to maintain development of early seral species. Mechanically treat slash or charred residual fuels to manage post treatment fuels levels.	E2 to E3	1. Maintain growth and development of early seral species. 2. Maintain existing mature trees. 3. Decrease risk of bark beetle outbreaks and enable thinned stands to develop into mature size class 1-3 decades after treatment. 4. Manage disease and wildfire susceptibility, snags, and coarse woody debris at desired levels.

LSR Silvicultural Treatments List

Dry subalpine fir (ABLA2Dry) PAG Treatments (cont'd)

Treatment	Move	Treatment Objectives
Thin stand to maintain development of mid seral species. Yard tree tops attached or utilize prescribed fire to manage post treatment fuels levels.	M2 to M3	1. Maintain the growth and development of mid seral species. 2. Maintain existing mature trees. 3. Decrease time required for thinned stands to develop into the mature size class by two to six decades. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Thin stand to favor development of mid seral species. Thin understory stems if needed. Yard tree tops attached or utilize prescribed fire to manage post treatment fuels levels.	E2 to M2	1. Favor the growth and development of mid seral species in stands with early seral species composition. 2. Remove majority of lodgepole pines prior to mountain pine beetle outbreak. 3. Direct stands into a successional pathway which will decrease time required to develop LS habitat. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Maintain mature stand of mid seral species with thinning, individual tree selection, and/or group selection followed by prescribed fire to manage post treatment fuels and/or thin understory stems.	M3 to M3	1. Release and maintain mature trees. 2. Maintain mid seral species mix. 3. Reduce density of understory to maintain vigorous trees in overstory canopy gaps. 4. Maintain stand resilience to insects, disease, and wildfire. 5. Manage snags and coarse woody debris at desired levels.

Moist subalpine fir (ABLA2Moist) PAG Treatments

Treatment	Seral Move	Treatment Objectives
Thin saplings to maintain early seral species.	E1 to E2	1. Maintain growth and development of early seral species in stands with early seral species composition. 2. Decrease time required for thinned stands to develop into the next larger size class by at least 1 decade.
Thin saplings to maintain mid seral species.	M1 to M2	1. Maintain growth and development of mid seral species in stands with mid seral species composition. 2. Decrease of time required for thinned stands to develop into the next size class by at least 1 decade.
Thin saplings to favor development of mid seral species.	E1 to M2	1. Favor growth and development of mid seral species in stands with early seral species composition. 2. Enable stands to develop into next size class with a mid seral composition in 3 -4 decades following treatment. 3. Set thinned stands on successional path which should decrease time required to develop into mature, mid seral species stands that provide LS habitat by several decades.
Thin saplings to maintain late seral species.	L1 to L2	1. Maintain development of late seral species stands. 2. Decrease time required for thinned stands to develop into next larger size class by at least 1 decade.
Thin saplings to restore mid seral species composition.	L1 to M2	1. Change species composition from late seral to more diverse mid seral species mix. 2. Enable stands to develop into next larger size class with a mid seral species composition 3 - 4 decades following treatment.
Thin stand to maintain development of early seral species. Mechanically treat slash or charred residual fuels to manage post treatment fuels levels	E2 to E3	1. Maintain development of early seral species. 2. Maintain existing mature trees. 3. Decrease risk of bark beetle outbreaks and enable stands to develop into mature size class 2 -3 decades after treatment. 4. Manage disease and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Thin stand to maintain development of mid seral species. Mechanically treat slash or charred residual fuels to manage post treatment fuels levels.	M2 to M3	1. Maintain growth and development of mid seral species. 2. Maintain existing mature trees. 3. Decrease time required for thinned stands to develop into the mature size class by at least one decade. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels
Thin stand to favor development of mid seral species. Thin understory stems if needed. Yard tree tops attached or utilize prescribed fire to manage post treatment fuels levels.	E2 to M2	1. Favor growth and development of mid seral species in stands with early seral species composition. 2. Remove majority of lodgepole pines prior to mountain pine beetle outbreak. 3. Direct thinned stands into a successional pathway which enables them to develop into mature, mid seral species stands (that provide LS habitat) within 5 - 6 decades after treatment. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.
Thin stand to maintain development of late seral species. Yard tree tops attached to manage post treatment fuels levels.	L2 to L3	1. Maintain growth and development of late seral species. 2. Maintain existing mature trees. 3. Decrease time required for treated stands to develop into LS habitat by 1 - 2 decades. 4. Manage insect, disease, and wildfire susceptibility, snags, and coarse woody debris at desired levels.

Management Priorities

During strategic planning, these management priorities should be applied over the entire LSR system rather than separately to individual LSRs. At the individual project level, the order of these priorities may be adjusted in response to funding opportunities and unexpected circumstances such as salvage operations to mitigate an increase in risk brought about by disturbance.

Prior to selecting treatments, the following priorities should be applied when planning LSR management activities.

1. Protection of life and property adjacent to and within LSRs from fire.

2. Protection of existing Northern spotted owl sites from stand-replacing fire.

3. Maintenance, enhancement, and protection of present LS habitat.

4. Maintenance, enhancement, and protection of stands currently approaching LS characteristics, particularly stands adjacent to present LS habitat.

5. Restoration of previously managed stands to a seral stage leading eventually towards LS habitat.

Post - fire risk reduction salvage should be considered a high priority when the following conditions exist:

1. Post-fire fuel loadings present an undesirable risk to existing or adjacent LS habitat, or;

2. Post-fire conditions result in an undesirable level of insect and disease mortality that increases fire risk to existing or adjacent LS habitat

(See **Salvage** section for more details

Criteria for Treatment Selection

Table 7- 1 represents a comprehensive list of possible treatments that could be used to move stands through the successional matrix with the intention of enhancing LS habitat characteristics. Treatments are also listed which could serve to protect LS stands either by fire risk reduction treatment in the LS stand itself or by risk reduction treatment of adjacent high fire-risk stands. Managers should refer to the PAG Tables found in Appendix C for specific information on the characteristics of each seral stage and select an appropriate treatment to move a stand in the desired direction.

The primary criterion for selecting from this list of treatments is that application of a treatment must serve a function in succession that either moves the stand towards desirable LS characteristics as described in Appendix C and the ROD B-5, or protects and maintains these characteristics in the stand. In general, treatments selected to protect LS habitat by managing adjacent stands should also meet this criterion. Only in rare cases of extreme adjacent fire risk or urban interface issues would a treatment not lead towards eventually increasing the patch size of the adjacent LS habitat. An example of this situation is found in many places along the peninsula of private land undergoing extensive development adjacent to the Upper Methow LSR.

In the dry Douglas-fir, moist Douglas-fir, and dry subalpine fir PAGs, there are treatments intended to maintain mature stands with mid-seral species mix (seral move M3 to M3). These treatments will be applied primarily to improve the sustainability of LS habitat. Maintaining mid-seral species mixes in these stand types will increase their resiliency to insect and disease outbreaks and decrease the effects of wildfire. These treatments should maintain stands which provide LS habitat by imitating the low to moderate intensity wildfires which historically shaped these stands.
Some treatments listed in Table 7-1 favor mature stands dominated by early seral species. These types of treatments are

designed to restore mature parklike stands historically dominated by ponderosa pine typical of the ponderosa pine and dry Douglas-fir PAGs. The objective of these treatments is to improve the sustainability of mature ponderosa pine stands by reducing risk of insects and wildfires. These treatments once again should move stands towards more sustainable LS habitat by imitating the low to moderate intensity fires in which these stands evolved.

Regeneration treatments may only be applied in areas where previous overstory removal or selective harvesting has resulted in stand stagnation. In these cases existing stand structure, particularly overstory trees, will be retained to the greatest extent possible when achieving treatment objectives. Regeneration treatments may not be applied to established ponderosa pine plantations in areas where biophysical environments are more appropriately suited to Douglas-fir. If these types of regeneration treatments are indicated by stand conditions, proposals must be submitted to the Regional Ecosystem Office on a case-by case basis.

The LS and PAG characteristics outlined in Appendix C will be updated as more site specific data becomes available. Presently, the best available data at present is from the Interior Columbia Basin Ecosystem Management Project (ICBEMP). In its Eastside Draft Environmental Impact Statement, Volume 1, Table 3-5 Objectives and Standards (Williams and Zielinski 1997) conditions are described across the range of ecosystems found in the Interior Columbia River basin prior to European settlement. These are interim standards that will be revised in the final ICBEMP document.

Much of the data used in this analysis is equally coarse in scale and was used for the purpose of defining past and present large scale landscape conditions. Additional validation of the landscape attributes and condition of seral stages is needed prior to project implementation. Both on-site examination and additional air photo interpretation will be needed during project planning to best describe current landscape conditions.

Much better information is needed on sustainable levels of coarse woody debris, particularly in the drier, fire-prone environments. In addition, a better understanding of the ecological role the non-vascular plants play in these ecosystems is needed; again especially in drier, fire-prone environments.

Salvage

Salvage conducted under the guidelines listed in the ROD, C-13, 14, and 15 is also an acceptable Northeastern Cascades LSR treatment. Risk reduction to the LSR system is the only appropriate justification for salvage. Risk reduction salvage in the LSRs should especially be considered in two cases:

1. As discussed in Chapter 2, the risk of large scale stand replacing insect and disease outbreaks in the system is small. However, pockets of tree mortality can create high risk ignition points for large scale fires. When such an ignition point is created by insect or disease mortality, it may contribute towards an increasing risk to LSR objectives. If this risk increase is found to be substantial, then salvage is needed. Such salvage activities will reduce fire risk in an area but need not eliminate the risk entirely. Examples of unusually high risk situations include, but are not limited to, mortality pockets located adjacent to private land holdings or known northern spotted owl sites, or pockets located below a LS stand on a slope. Pockets of mortality that pose no risk will not be removed.

2. Where tree density exceeds the Appendix characteristics for a seral stage for a PAG, salvage of burned trees may be appropriate to reduce future fuel loadings and to enhance natural forest regeneration. Appropriate snag and coarse woody debris levels contained in the Appendix C guidelines must be maintained in any salvage treatment and Aquatic Conservation Strategy objectives must be met. The Whiteface Fire salvage (1994) is an example of the how the intent

of these guidelines was successfully applied.

Mortality pockets are part of a natural landscape and will be retained in LSRs whenever possible regardless of their size and commercial salvage value. These mortality pockets be considered for salvage only under situations where a higher than normal fire risk results. This is especially true where pockets of mortality create an increased risk to existing LS habitat. Green tree thinning treatments which could select for infested or diseased trees as part of a silvicultural prescription would not normally be conducted under the salvage guidelines. Under these conditions, prescriptions will not specify removal of all infested or diseased trees.

Analysis of Management Options

Introduction

A SPECTRUM model was built to analyze effects of possible management options within the assessment area. SPECTRUM is an optimization model that uses linear programming algorithms and is used most often for strategic planning purposes. SPECTRUM was chosen for this analysis because of its capability to model ecological systems and their succession, its ability to emphasize a desired future condition, its ability to select activities to meet management objectives, and its usefulness toward evaluating tradeoffs between alternative management scenarios.

The management objective modeled within SPECTRUM was to maximize LS habitat within the assessment area over a 200 year time horizon. The basic inputs for the model included the following:

- a successional pathway for each PAG within the assessment area;

- current condition acreages derived from satellite images of each PAG by seral stage and by LSR, including NWFP matrix areas;

- possible treatments to alter movement along successional pathways; and

- unit monetary benefits and costs associated with each possible treatment.

SPECTRUM is a deterministic model. As a result, the probability of an event occurring (such as a stand replacing fire) was converted to acres per decade. For example, if a particular PAG pathway states that there is a 0.016 probability of a stand replacing fire occurring within a 150 year, E3 seral stage, then the input for SPECTRUM became 0.016 percent of the chance that seral stage would burn at that age.

Management Treatments in SPECTRUM

Four treatments categories were developed for SPECTRUM. These include:

- no treatment
- commercial thinning
- precommercial thinning
- prescribed burning

These treatments are an aggregation of the treatments listed in Table 7-1.

Use of the terms "pre-commercial" and "commercial" thinning primarily reflects the relative size of the seral stage and does not assume that a particular monetary value was assigned to these classifications. Also, it does not assume that "commercial" treatments will result in a net return above implementation costs.

If no treatment is applied to an acre, then that acre "moves" along in the PAG pathway diagrams. That acre is also susceptible to stand replacing fires, low intensity fires, insect and disease outbreaks. If a particular acre received a treatment, then its movement along the pathway is altered and also would not be susceptible to fires, insect and disease.

Maintenance treatments, such as thinning from below or selective harvest of seral stages considered to have LS structure, were not modeled. In addition, the effects of prescribed natural fires were not modeled because these are random events which SPECTRUM cannot consider directly. This is an important limitation of the SPECTRUM model.

Treatments were modeled for the Ponderosa pine, dry Douglas-fir, moist Douglas-fir, dry subalpine fir, and moist subalpine fir PAGs. The Pacific silver fir/mountain hemlock, western hemlock, and subalpine PAGs did not receive treatments in the model.

Management Scenarios in SPECTRUM

The assessment team developed a range of management scenarios for SPECTRUM analysis. These varied primarily with respect to treatment access to LSR and matrix lands and by stand replacing fire acreages. These scenarios were developed to evaluate relationships between types and acres of treatments and acres of LS habitat. Some were also used to determine model sensitivity to varying inputs. The scenarios were not developed to identify a specific set of treatments to apply to the landscape.

Current Direction

The Current Direction scenario approximates current levels and mixes of treatments including current fire suppression policies, current treatment access to LSR and matrix areas with no new road construction, and current probabilities of events occurring along each PAG pathway when no treatment is applied. Only areas within ½ mile of a current road, less 60% slope and outside riparian reserves were considered as suitable for treatments.

Constraints on Accessible Acres within LSRs

PAG and LSR Area	Access Acres
Ponderosa Pine-Hunter Mt.	39
Ponderosa Pine-Nice	539
Ponderosa Pine-Sawtooth	857
Ponderosa Pine-Twisp River	425
Ponderosa Pine-Upper Methow	1037
dry Douglas-fir-Hunter Mt.	2206
dry Douglas-fir-Nice	1356
dry Douglas-fir-Sawtooth	4719
dry Douglas-fir-Twisp River	4944
dry Douglas-fir-Upper Methow	8875
moist Douglas-fir-Hunter Mt.	71
moist Douglas-fir -Nice	727
moist Douglas-fir-Sawtooth	3087
moist Douglas-fir-Twisp River	2495
moist Douglas-fir Upper Methow	6645
dry subalpine fir-Hunter Mt.	10
dry subalpine fir -Nice	144
dry subalpine fir -Sawtooth	2157
dry subalpine fir Twisp River	1093
dry subalpine fir-Upper Methow	7552
moist subalpine fir-Hunter Mt.	10
moist subalpine fir -Nice	178
moist subalpine fir-Sawtooth	1354
moist subalpine fir-Twisp River	1123
moist subalpine fir -Upper Methow	6523

A maximum treatment constraint of 30,000 acres/decade for all treatments was applied to the model. This treatment level reflects current budget and activity levels.

Minimum Intervention

This scenario shows the effect of not treating during the 200 year analysis period. Fire suppression would not continue and no risk reduction treatments would be applied. To reflect the increase in risk brought about under this scenario, stand replacing fire probabilities were increased.

New Stand Replacing Fire (SRF) Probabilities

Ponderosa Pine	.068
Dry Douglas-fir	.033
Moist Douglas fir	.011
Dry subalpine fir	.067
Moist subalpine fir	.040
Pacific silver fir/ mountain hemlock	.033

Maximum Access

This scenario models the LS habitat which results if access to treatment acres was not limited as in the Current Direction and other scenarios. It assumed full road building capability when access for treatment was needed. All other constraints and probabilities remained the same as Current Direction. (See Table 7-2)

Maximize Late Succession Acres

This scenario evaluated the changes to LS habitat that would result if current treatment mix and acreage constraints were removed. The assumption is that virtually unlimited funding and resources would be available for LS habitat management.

Fire suppression probabilities and access acres, a reflection of the acres available for treatment under the current road system, remained the same.

Increased Stand Replacing Fire

This scenario is similar to the Current Direction scenario, except for an increase in catastrophic stand replacing fires occurring at decades 3, 10, and 17 and at a probability of occurrence that is 5 times the what was modeled for all other scenarios. These fires were modeled for just the dryer site, Ponderosa pine, Douglas-fir, and subalpine fir PAGs.

Current Direction Minimize Hazard

The Current Direction Minimize Hazard scenario was developed to evaluate tradeoffs between increasing LS habitat and the associated risk of potential crown fires,. This scenario incorporates the goal programming feature of SPECTRUM. While the primary objective was to maximize LS habitat, a secondary goal was to minimize risk or hazard. This scenario utilized the fact that each seral stage was assigned a crown fire risk rating of "High" "Medium" or "Low" based upon grouping Crown Fire Potential ratings into these categories

Table 7-2
Comparison of Management Scenarios

Scenario	Goal	Fire Management	Constraints on Treatment Acres	Treatment Access
Current Direction	Maximize LS habitat in 200 years	Current fire probabilities	Prescribed Burning <=20,000 acres/decade Pre-commercial thin <= 8,000 acres/decade Commercial Thin <= 2,000 acres/decade	Only areas within ½ mile of a current road, less 60% slope and outside riparian reserves considered for treatments.
Minimum Intervention	Maximize LS habitat in 200 years	Increased Stand Replacing Fire probabilities	No treatments of any kind	Current road access
Maximum Access	Maximize LS habitat in 200 years	Current fire probabilities	No constraints on treatment levels	Remove all accessible acres constraints
Maximum LS Habitat	Maximize LS habitat in 200 years	Current fire probabilities	No constraints on treatment levels	Only areas within ½ mile of a current road, less 60% slope and outside riparian reserves considered for treatments.
Increased Stand Replacing Fire	Maximize LS habitat in 200 years	Increase fire probabilities by 5x periodically for selected PAGs	Prescribed Burning <=20,000 acres/decade Pre-commercial thin <= 8,000 acres/decade Commercial Thin <= 2,000 acres/decade	Only areas within ½ mile of a current road, less 60% slope and outside riparian reserves considered for treatments.
Current Direction Minimize Hazard	Primary goal = maximize LS habitat Secondary goal = minimize SRF risk	Current fire probabilities	Prescribed Burning <=20,000 acres/decade Pre-commercial thin <= 8,000 acres/decade Commercial Thin <= 2,000 acres/decade	Only areas within ½ mile of a current road, less 60% slope and outside riparian reserves considered for treatments.

All management scenarios, except Minimum Intervention and Increased Stand Replacing Fires, assumed that there would be no change in current fire suppression levels. In terms of the model, this meant that the probabilities of stands changing seral stages as the result of fire were unchanged from the original probabilities provided by analysis of the PAG successional pathways with the SYSDYN stochastic model.

SPECTRUM Model Results

No treatments were modeled for the Pacific silver fir/mountain hemlock, western hemlock, and subalpine PAGs. As a result, individual display of these PAGs has been excluded from all charts and tables showing model outputs. However, reference to total LS amounts includes the contribution of these PAGs which remained constant for each scenario.

SPECTRUM LS Habitat

Figure 7-2 shows the accumulation or sum of LS habitat acres for each period or decade while Figure 7-3 shows the average acres per decade of LS habitat over the 200 year time horizon. As expected, the Maximum Access scenario produced the most cumulative LS habitat.

The Maximum LS scenario produced nearly as much LS habitat, even with its Current Direction level of constrained access. This result reflects the fact that most of the current road system accesses for the most part the ponderosa pine and Douglas-fir PAGs because its primary function was timber harvest in these areas. Treatments resulting in LS habitat are limited in the dry subalpine fir PAG and eliminated completely in the moist subalpine fir PAG. Thus, in the model, extending the road system into these areas and the remaining inaccessible areas of the ponderosa pine and Douglas-fir PAGs would result in an increase in cumulative LS habitat, but this increase is essentially matched by not restricting treatments in already roaded areas.

Figure 7-4 shows acres of LS habitat per decade. Comparing Minimum Intervention with any of the other scenarios suggests that treatments are the most effective strategy to increase or even maintain current LS habitat levels.

Figure 7-2 Cumulative LS Acres by Decade

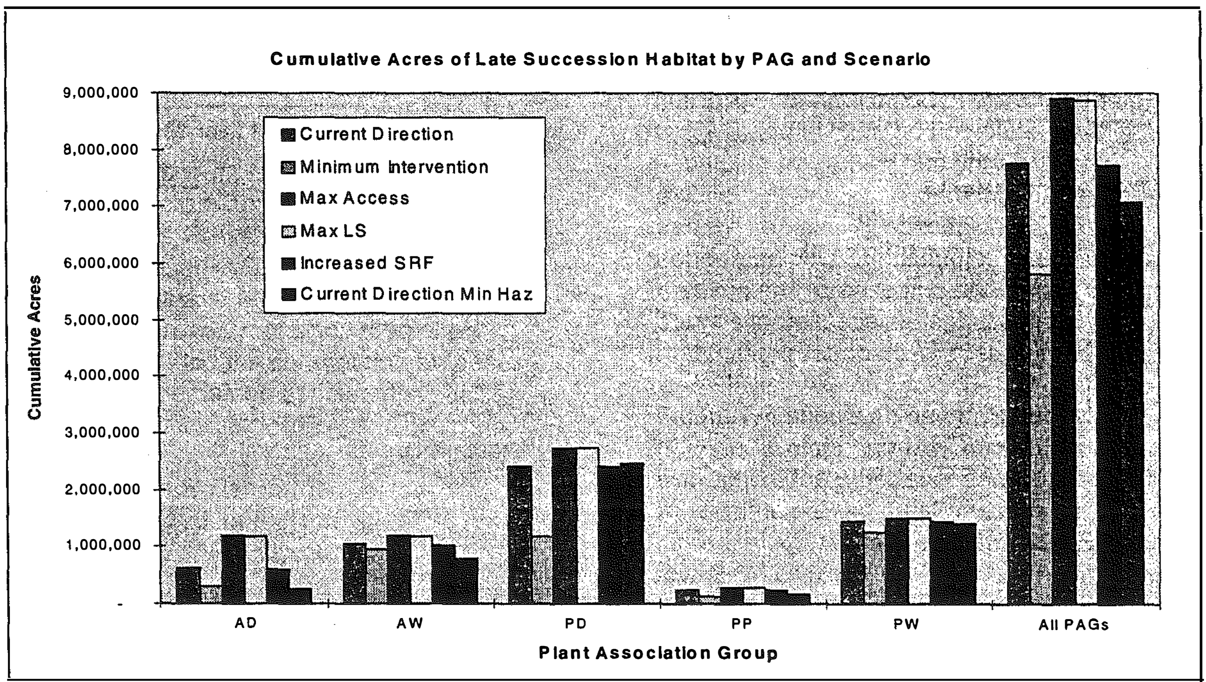


Figure 7-3 Average Late Successional Acres by Period

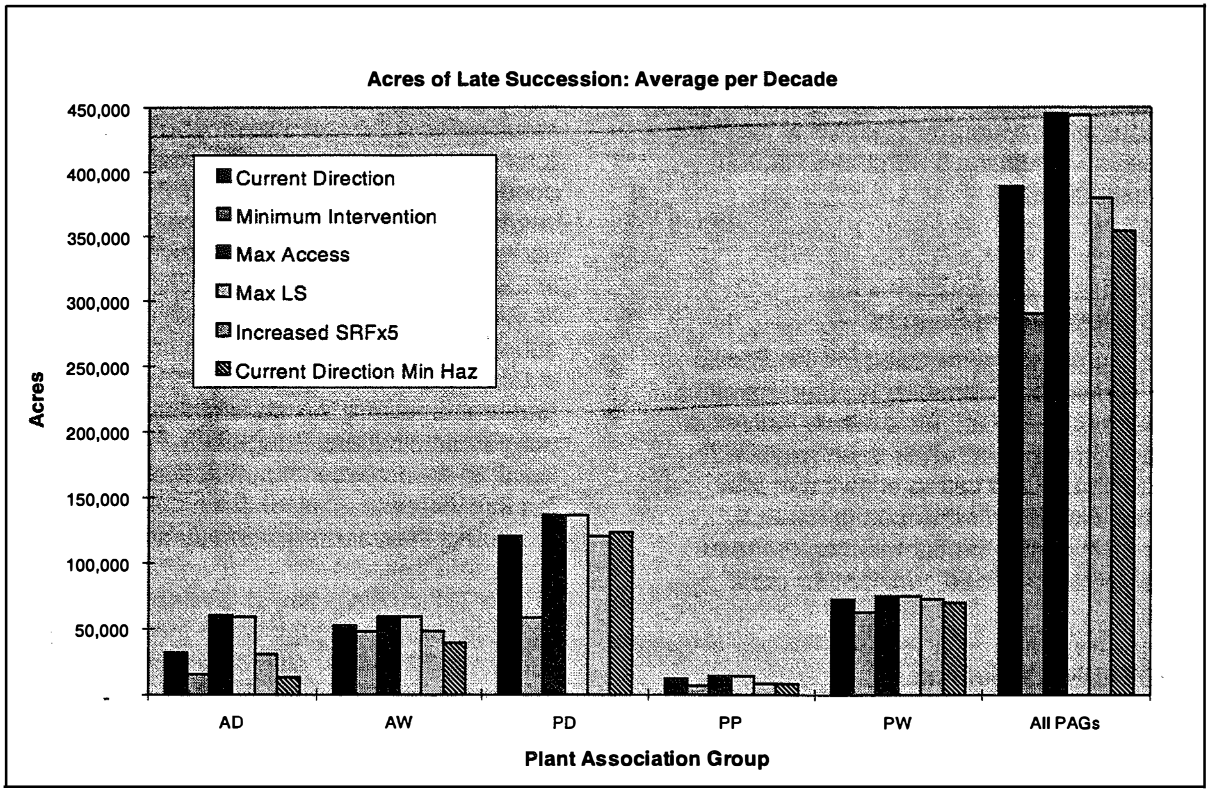
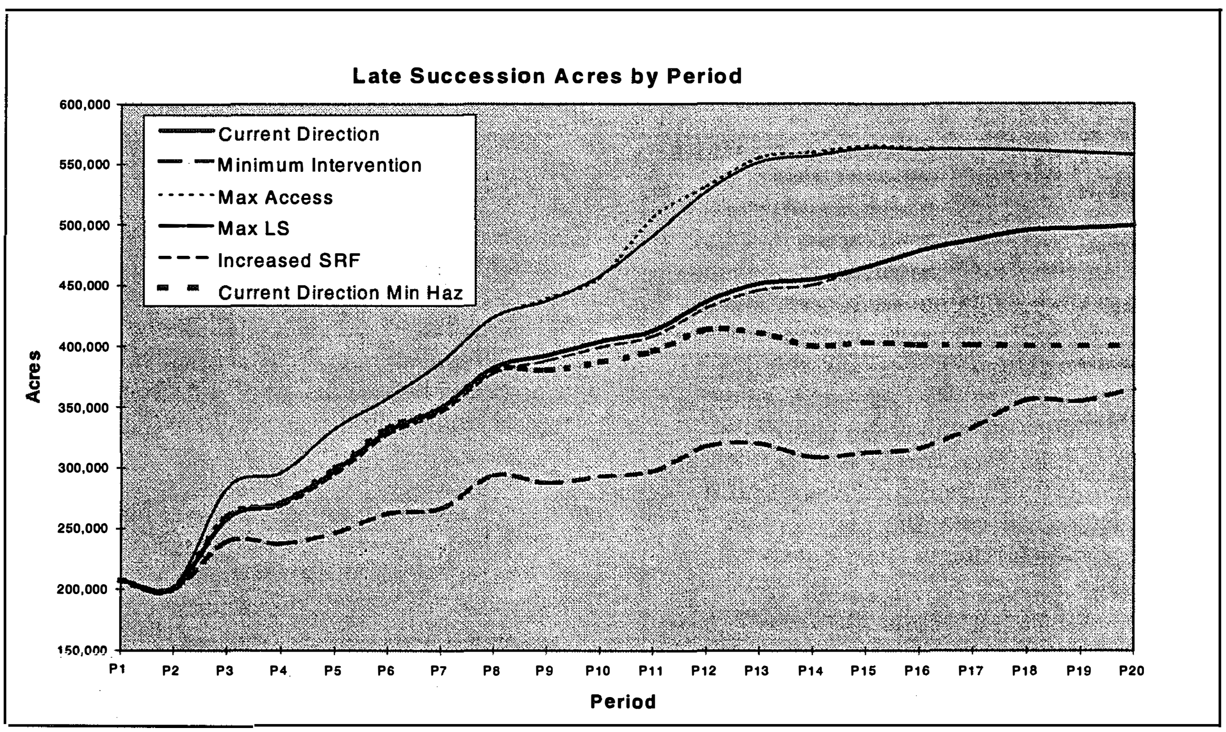


Figure 7- 4 LS Habitat Acres per Decade



In order to evaluate the need for immediate treatment implementation, the SPECTRUM model was run using the assumption that no treatments would take place in the first decade. Figure 7-5 compares the results of this run (Current Direction CD) which excludes treatments during the first decade, but otherwise is identical to the Current Direction scenario with the Current Direction scenario. After the first 2 decades, the Current Direction CD scenario appears to reduce LS habitat levels for each decade over the 200 year analysis decade. This reduction is about 25,000 acres in 20 decades.

Figure 7-6 shows the average acres of treatments per decade over the 200 year analysis period. The dry Douglas-fir received the most treatments per decade for all scenarios implying that this PAG is the area where treatments would have the greatest effect.

A comparison of the Current Direction and Current Direction Min Hazard scenario shows a substantial increase in the number of moist subalpine fir acres treated and a reduction in the number of dry Douglas-fir acres treated.

Figure 7-5 Acres of LS Habitat by Decade: No 1st Decade Treatments

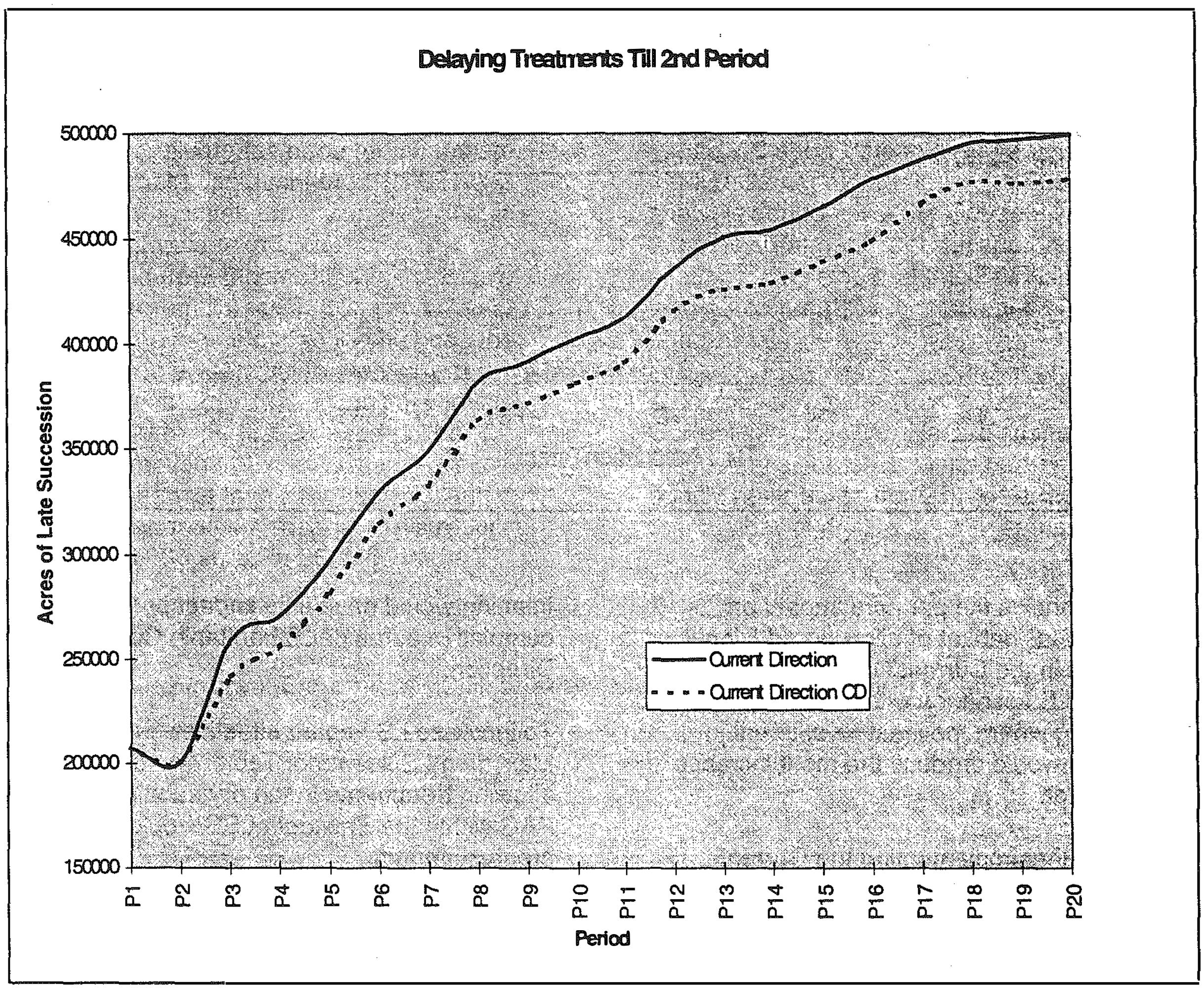


Figure 7-6 Average Acres of Treatment per Decade

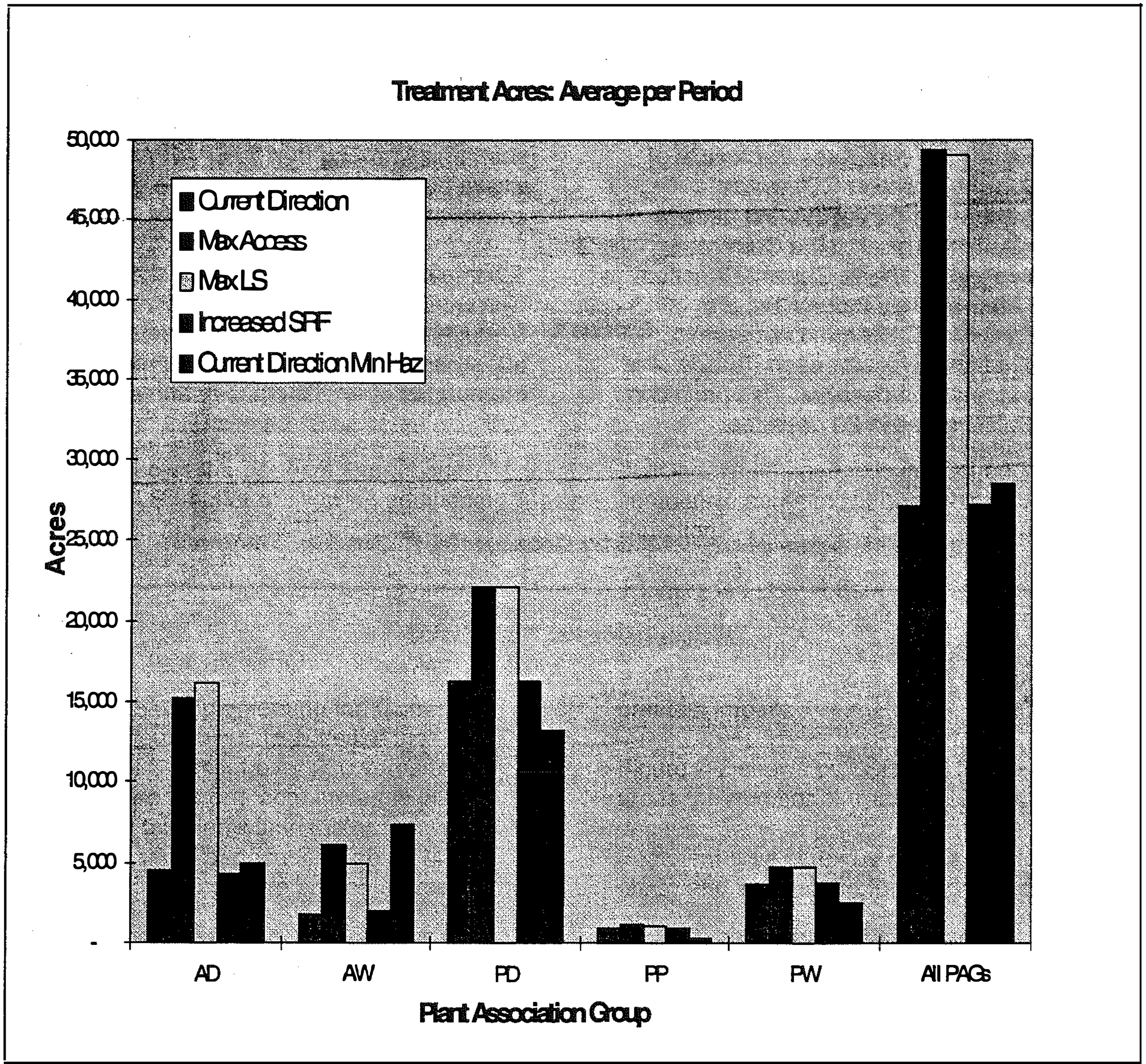


Table 7-4 shows the per acre impact on cumulative LS habitat of allowing additional treatments in the Current Direction and Maximum LS scenarios with the objective of determining where the least investment in treatments would produce the most increase in LS habitat.

It appears that implementing the Current Direction scenario would increase the cumulative LS habitat over 200 years time by 10 acres for each one acre increase in commercial thinning within the assessment area during the first decade. Table 7-4 also shows that allowing more precommercial thinning would have little impact on cumulative acres of LS habitat in Current Direction.

To increase LS habitat effectively under the Maximum LS scenario, Table 7-4 shows that allowing treatments in the dry subalpine fir PAG within the Sawtooth LSR would have the greatest impact.

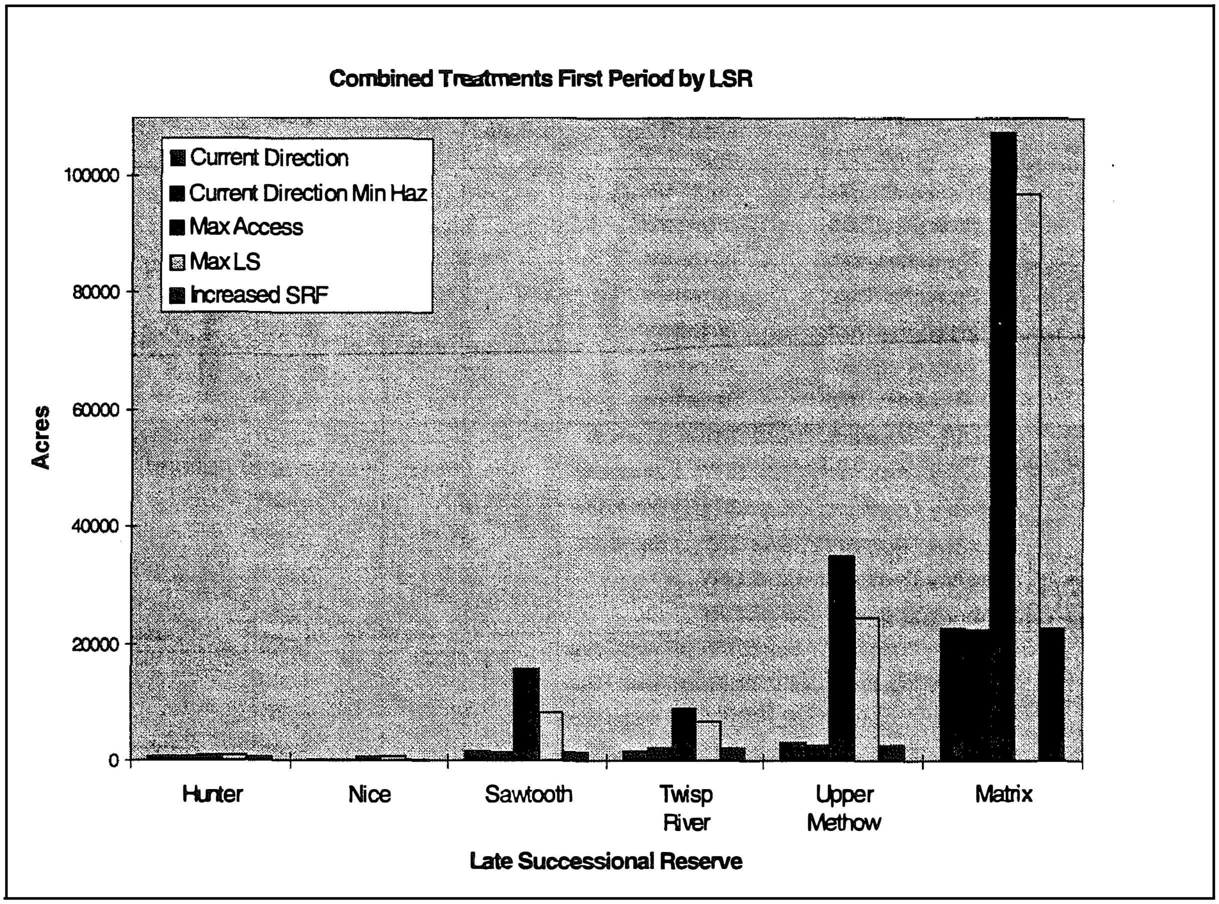
Figure 7-7 shows by LSR and for the matrix areas the number of treatments for the first decade. Table 7-5 shows, by scenario, treatment type acres by plant association group and seral stage for the first 5 decades.

Table 7-4
Per Acre Impact on Cumulative LS Habitat of Additional Treatments

Scenario	Type of Treatment	Where to Apply Treatment	Decade to Increase Limit	Current Limit	Impact on Cumulative LS Habitat
Current Direction	Comm. Thin	Anywhere	1	2,000	10
	Comm. Thin	Anywhere	3	2,000	8
	Comm. Thin	Anywhere	5	2,000	8
	Comm. Thin	Anywhere	10	2,000	6
	Comm. Thin	Anywhere	15	2,000	2
	Prescribed Bum	Anywhere	1	20,000	6
	Prescribed Bum	Anywhere	2	20,000	5
	Prescribed Bum	Anywhere	3	20,000	3
	Prescribed Bum	Anywhere	4	20,000	2
	Prescribed Bum	Anywhere	5	20,000	2
	Precomm. Thin	Anywhere	1	8,000	2
Maximum LS	Allow Any Treatment	ABLA2 DRY in Sawtooth	1	2,157	1.2
	Allow Any Treatment	ABLA2 DRY in Sawtooth	1	2,157	1.2
	Allow Any Treatment	ABLA2 DRY in Sawtooth	2	2,157	1.2
	Allow Any Treatment	ABLA2 DRY in Sawtooth	2	2,157	1.2
	Allow Any Treatment	ABLA2 DRY	1	33,669	0.9
	Allow Any Treatment	ABLA2 DRY	1	33,669	0.9
	Allow Any Treatment	ABLA2DRY in Twisp River	1	1,093	0.9
	Allow Any Treatment	ABLA2DRY in Twisp River	1	1,093	0.9
	Allow Any Treatment	ABLA2DRY in Twisp River	2	1,093	0.8
	Allow Any Treatment	ABLA2DRY in Twisp River	2	1,093	0.8
	Allow Any Treatment	ABLA2 DRY in Upper Met	1	7,552	0.8
	Allow Any Treatment	ABLA2 DRY in Upper Met	1	7,552	0.8
	Allow Any Treatment	ABLA2 DRY in Upper Met	2	7,552	0.8
	Allow Any Treatment	ABLA2 DRY in Upper Met	2	7,552	0.8
	Allow Any Treatment	ABLA2 Moist in Sawtooth	1	1,354	0.7
	Allow Any Treatment	ABLA2 Moist in Sawtooth	1	1,354	0.7
	Allow Any Treatment	ABLA2Moist in Twisp River	1	1,123	0.7
	Allow Any Treatment	ABLA2Moist in Twisp River	1	1,123	0.7
	Allow Any Treatment	Ponderosa pine in Twisp River	1	425	0.6
	Allow Any Treatment	Ponderosa pine in Twisp River	1	425	0.6

Note: "Allow Any Treatment" means to allow SPECTRUM to pick the treatment. The same applies to "Anywhere." A more thorough sensitivity analysis would have to be performed to be able to specify which type of treatment and where for these "any" categories.

Figure 7-7 Treatment Acres Decade 1 by LSR and Matrix



SPECTRUM Risk Assessment

Each acre within the assessment area was assigned an attribute with respect to it crown fire potential, or hazard. Three categories were developed, Low, Medium and High. The level of hazard was a function of several variables, but within the SPECTRUM model it varied with respect to plant association group and seral stage. This is not to be confused with the probability of an event occurring, such as a stand replacing fire. The description of hazard has no probability attached to it. It simply describes the potential for a crown fire if a fire did start.

Generally speaking, as late succession habitat increased, so did the level of hazard. Also, it can be inferred that as the level of hazard increases, the level or cost of fire presuppression would also have to increase...and if a fire did start the cost of fire suppression would be higher as well.

Figure 7-8 shows high hazard acres associated with acres of late succession habitat, for each scenario. Figure 7-9 shows high hazard acres as a percent of late succession acres. The Max Access and Max LS scenarios produced the greatest levels of hazard with Current Direction Min Hazard and Minimum Intervention producing the least. With Hazard acres shown as a percent of late succession, Minimum Intervention produced the most and Current Direction Min Hazard produced the least over time.

Table 7-6 shows a comparison between Current Direction and Current Direction Minimum Hazard scenarios with respect to cumulative late succession acres. When the secondary goal of minimizing hazard was invoked, the model produced fewer late succession acres in the ABLA2 PAGs and more late succession in the PSME PAGs. Doing so required almost 27 thousand more acres of treatments (see Table 7-7)

Figure 7- 9 Acres of LS with High Hazard

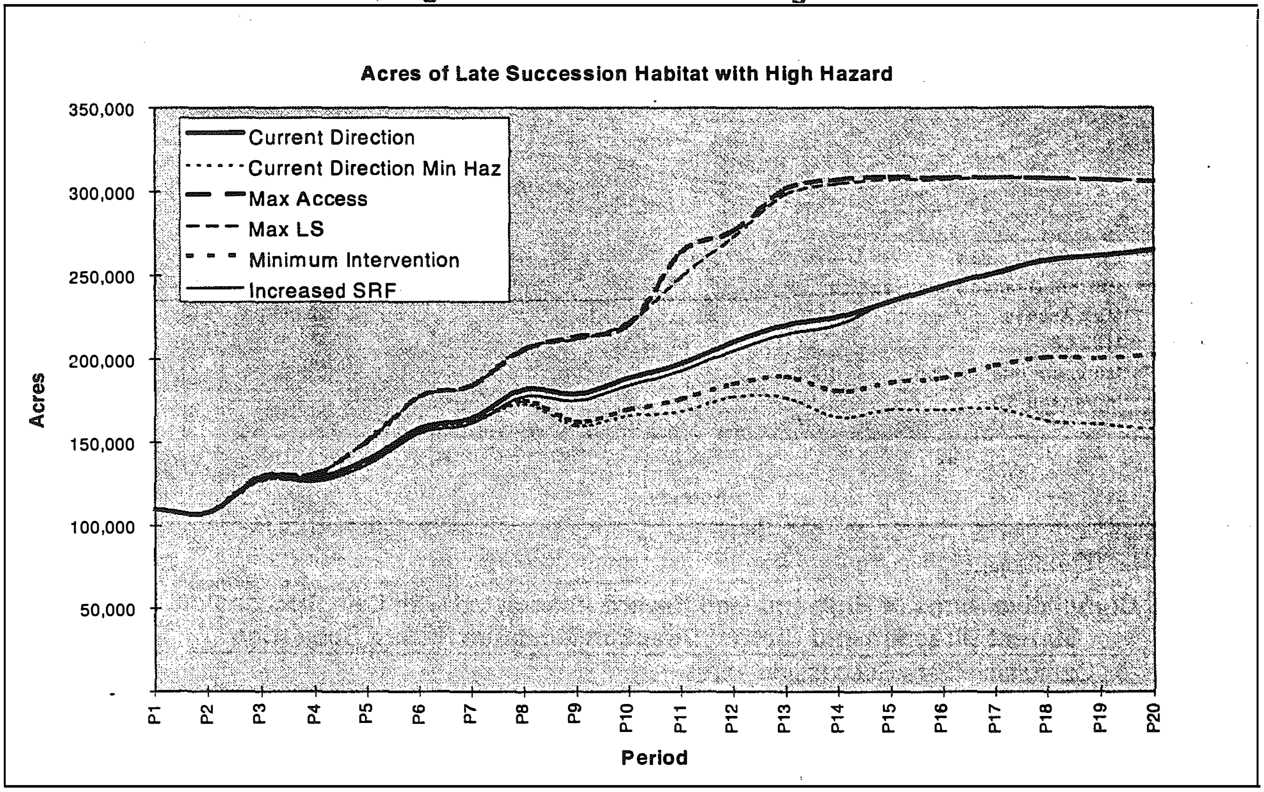


Figure 7- 10Acres of High Hazard as a Percent of LS Habitat

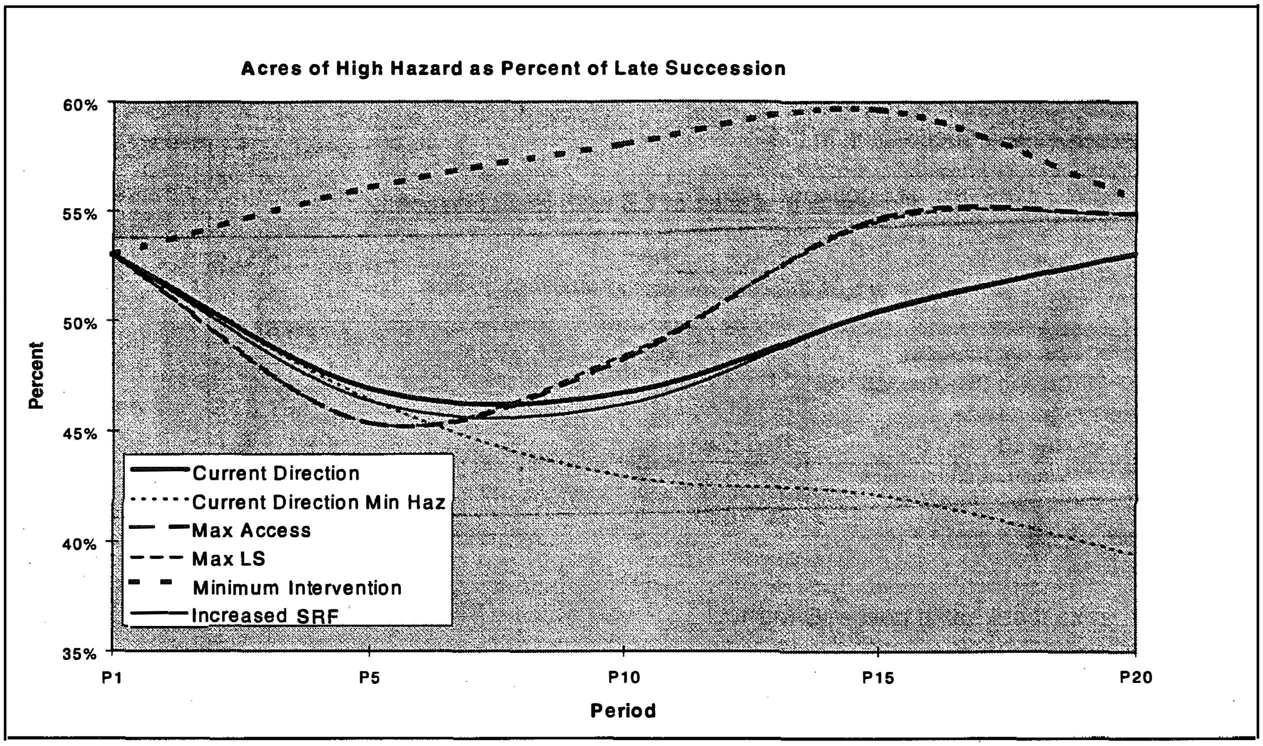


Table 7-6 Cumulative Acres of High and Med Hazard Associated with Late Succession, by PAG: Current Direction and Current Direction Minimum Hazard Scenarios

		Cumulative Late Succession Acres	
PAG	Hazard	Current Direction	Current Direction Min Hazard
AD	Med	-	-
AD	High	635,927	262,223
AW	Med	-	-
AW	High	1,046,217	793,560
PD	Med	2,405,630	2,475,343
PP	Med	243,194	169,177
PW	Med	1,256,249	1,325,646
Total Med		3,905,073	3,970,166
Total High		1,682,144	1,055,783

SPECTRUM Financial Assessment

Table 7-7 shows, for each scenario, the cumulative treatment acres, costs, net return, and the present net value over the 200 year time horizon. Table 7-8 shows treatment acres, costs, and net return for the first decade. Costs and revenues used for the SPECTRUM model relate only to the treatments and do not reflect estimates of actually implementing a particular scenario. Actual costs would be higher due to road maintenance and construction, associated fire presuppression, etc. Therefore, with respect to only the treatments, Current Direction is the least expensive scenario while Max Access yielded the greatest PNV over the 200 year time frame. A rough estimate of the impact on the Forest budget from implementing each scenario is shown in Table 7-6. Implementing Current Direction and Current Direction Min Hazard are somewhat feasible with respect to first decade costs. With an estimated first decade cost of $78 million one can readily see that even implementing a Max LS type of scenario would be almost impossible in light of Forest Service budget realities.

Table 7-7 Cumulative Treatment Costs, Net Return and PNV by Scenario ($)

Scenario	Cumulative Treatment Acres	Cumulative Cost	Cumulative Net Return	Cumulative PNV
Current Direction	543,709	54,110,610	(31,528,920)	(5,484,459)
Current Direction Min Haz	559,909	65,022,730	(40,068,560)	(5,788,040)
Max Access	986,549	281,898,770	88,226,320	47,574,488
Max LS	980,992	270,397,900	94,294,040	42,210,295
Increased SRF	546,338	58,249,960	(31,101,170)	(5,569,131)

Table 7-8 First Decade Treatment Acres, Costs and Net Return ($)

Scenario	Treatment Acres	Cost	Net Return
Current Direction	30,000	3,298,000	(2,427,990)
Current Direction Min Haz	30,000	3,298,010	(2,428,010)
Max Access	169,490	123,379,040	48,501,100
Max LS	138,499	78,403,970	34,766,800
Increased SRF	30,000	3,298,010	(2,428,010)

SPECTRUM Sensitivity to Varying Catastrophic Fire Scenarios

A problem with using a model such as SYSDYN (the model used to derive the fire occurrence probabilities and then converted to percentages for SPECTRUM inputs) is that the results do not account for the occurrence of extreme fire occurrence years. This section shows how changes in the occurrence and size of catastrophic fires affect late successional habitat. Catastrophic fires were added to the PIPO, PSME, and ABLA2 PAGs at varying periods and varying sizes.

Figure 7-10 shows the sensitivity of cumulative late succession habitat, over the 200 year time horizon, to changes in the size of catastrophic fires. These fires were modeled to occur in periods 3, 10 and 17. Catastrophic fires sizes ranged from a factor of 1 times the probability of a stand replacing fire occurring (the input for all other scenarios, including the Current Direction scenario) to 20 times the probability of a stand replacing fire occurring. As the probability or size of fire increased, the cumulative acres of late succession habitat decreased from period 3 and on.

Figure 7-11 shows the sensitivity of cumulative late succession habitat acres to changes in the periods in which the catastrophic fires occurred and to varying catastrophic fire size. Figure 7-11 shows that cumulative late succession habitat acreage is a function of both when the catastrophic fires occur and the size of the catastrophic fires. The period in which the fires occur becomes more relevant as the size of the fire increases.

Figure 7-10 Cumulative LS Habitat With Varying Probability of Catastrophic Fire Occurrence

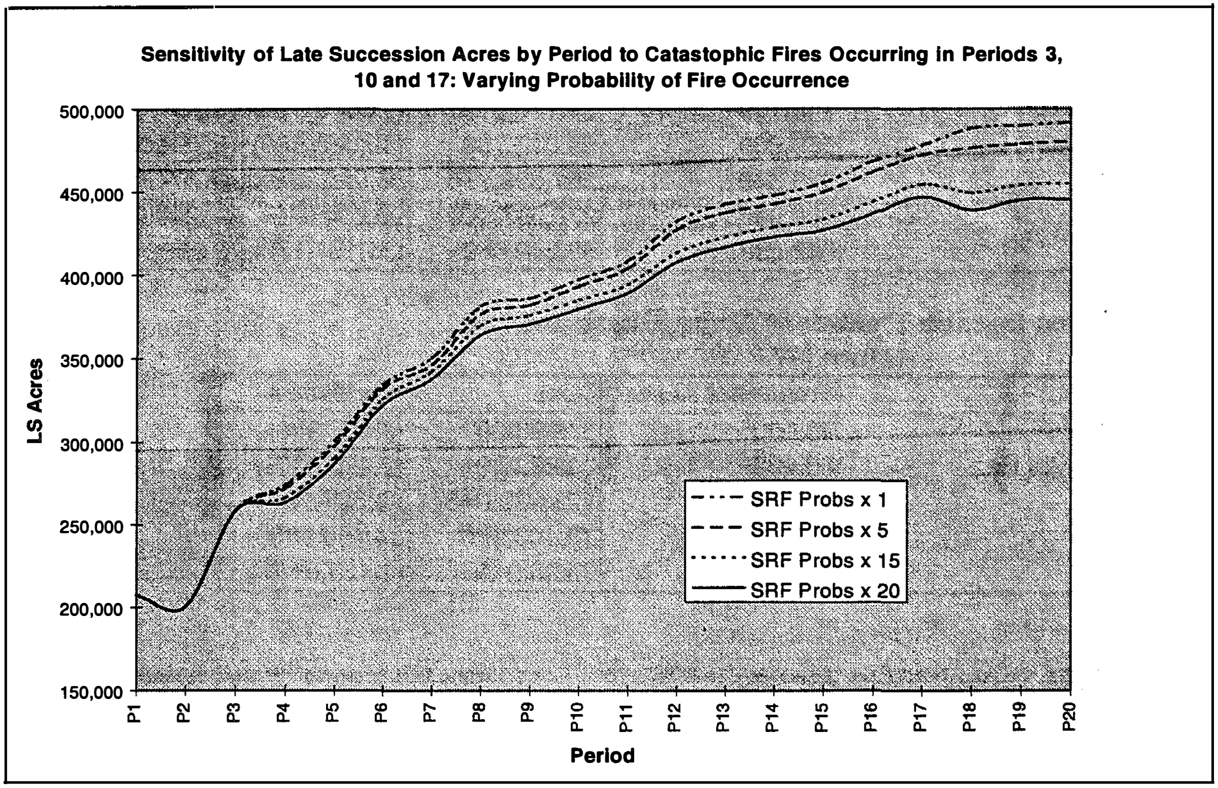
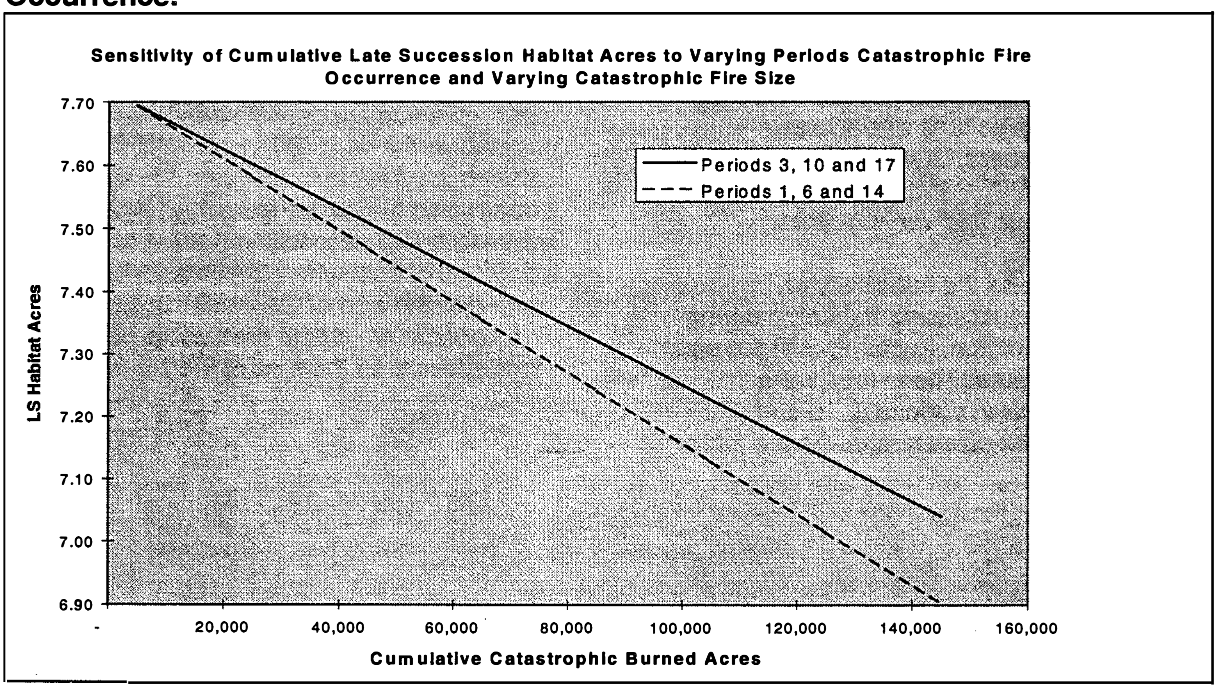


Figure 7-11 Cumulative LS Habitat With Vary Catastrophic Fire Size and Period of Occurrence.



Findings and Observations

These results should be only used to identify very generalized assessment area ecosystem trends and management needs. At this early stage of using these modeling methods as a tool for LSR management, results should not be used to define specific acreage or treatment targets. There is still no substitute for astute human evaluation of the complex mixture of cultural, economic, political, esthetic, physical, and biological forces that shape landscapes.

Examination of SPECTRUM outputs and other data contained in this assessment led to the following findings:

1. By substantially increasing the amount of acres treated, we can increase of LS habitat levels in the long term. This seems especially true in the case of the Dry Douglas-fir PAG.

2. This overall increase in LS habitat will be accompanied by an overall increase in crown fire potential as high risk LS stands are encouraged to develop in the absence of fire. This increase in crown fire potential will be followed by an increase in stand replacing fire acreages.

3. For the first 5 decades, an average of 45,000 acres/decade in the LSRs must be treated to maximize LS habitat in 200 years. These treatments must be implemented quickly to begin reducing risk in the LSRs and to have any effect in aiding conservation of the Northern spotted owl.

4. The number of acres needing treatment to maximize LS habitat exceeds the number of acres accessible by conventional means even if the assumption is made that the western portion of the Upper Methow LSR will be left relatively untouched.

5. Stand replacing fire acres will increase and LS habitat gains from fire suppression may be offset by LS habitat loss as high risk stands increase in size.

Sustainability and Accessibility

The last finding raises the question of what is sustainable in a dynamic, fire driven ecosystem? At present there is little beyond subjective expressions of what is sustainable and what isn't. However quantification of sustainability is crucial to effective management of ecosystems located on the eastern slopes of the Cascade Range in general and the Northeastern Cascades LSR system in particular. It lies far beyond the scope of this assessment to resolve this issue but generalized observations of the team can be presented to guide managers in planning treatments for the LSR system.

In the case of the Northeastern Cascades LSR system a useful starting point is the percentage of vegetation located in areas of fire return intervals less than 50 years that escape burning through at least two major fire events. This time interval allows for the development of LS habitat in refugial areas. These refugial areas would eventually be consumed in the random pattern of fire but the total acreage of LS habitat over landscapes would remain roughly the same. The exact location of these refugia would vary as potential refugia with similar BPEs escape fires in their turn and develop LS characteristics. The amount of refugia would remain roughly constant but the distribution changes. Preliminary research based upon examination of historic fire records and historic and modern aerial photograph interpretation (Ohlson and Gross, personal comm.) indicates that a range of 15% to 30% of these predominately PSMEDry PAGs fall into this category. Thus 15-30% of these PAG acreages could be assumed to be "sustainable" in an historic sense.

This percentage does not apply to the PIPO PAG or to the early seral stages of the PSMEDry PAG which generally represent the hotter and drier BPEs. These areas were historically maintained by frequent low intensity fires that only rarely would become stand replacing events. In this context, the concept of fire refugia does not apply because the majority of the stand would escape fire mortality over the long term. Because of the effects of fire suppression, many of these stands have had their crown fire potential increased significantly. As a result, the fire refugia concept is now applicable in many drier areas than before.

For areas typified by the Moist Douglas-fir and ABLA2 PAGs, the fire return interval is much longer and refugial areas are correspondingly older. Because of fuels accumulation between fire events and the structure of the vegetation which includes more fuel ladders to the crowns, large (greater than 5000 acres) stand replacing fires are much more common in these PAGs. Thus the concept of refugia could be modified to consider this different fire behavior. Much larger patches in the fire mosaic should be considered refugia rather than the smaller patches normally associated with a more dynamic disturbance regime. Preliminary examination of fire history records and local observations lead towards a range of 50 to 70 % of these PAG acreages surviving two fire cycles.

The remaining PAGs which are located in colder and wetter BPEs, burn so infrequently that in practical terms sustainability is not an issue although insect and diseases, and events such as natural mortality, windthrow, avalanches, and landslides play an important role. Under these circumstance a range of 90 to 100% could be considered sustainable.

PAG acreage distributions tell us that the present percentage of LS habitat in the PIPO, and PSMEDry PAGs exceeds the historic sustainable range. One interpretation of this finding is that the present PAG acreage distributions reflect the results of fire suppression and are presently unsustainable and quickly growing more so. The management implication of this finding is that continuation of presence resource expenditures will lead to an unsustainable system that resulting in a net loss of LS habitat. Tree densities, ladder fuels, ground fuels, and other indicators of ecosystem energy levels are higher on the average over the LSRs than at any time in the past. It is uncertain that the fire-driven "ecological reset" that will occur in these PAGs will return the landscape to historical refugial levels. It is possible that higher system energy releases reflected in higher fire intensities will consume areas that in the past would have escaped the fire cycle.

A similar situation is developing in the Moist Douglas-fir and ABLA2 PAGs. In this case much of their area is within a historical fire return interval although PAG acreage analysis shows that there is much less E1 and M1 acreage than in the past as a result of fire suppression. The net effect of this suppression activity was to suppress small fires even in wet years . These fires would have produced a fire that would have helped break the continuity of developing LS habitat. The end result would be a higher probability that some of these PAGs would be buffered against large stand replacing fires and a higher percentage of LS habitat would remain after a fire cycle.

These areas are accessible for the most part only by air. This renders treatment by machine prohibitively expensive and treatment by fire expensive, difficult , and dangerous. Even prescribed natural fire suppression strategies are difficult to implement in this situation.

The Northeastern Cascades LSR system is on an uncharted course to the future. The vast size of the system dictates that any management strategies to enhance and protect LS habitat as charged by the ROD must be equally vast in scope to have any real effects. Examination of the treatment acres in the SPECTRUM model gives a rough indication that the amount of treatment acres per acres must be increased almost 5 times above present levels to have a significant effect. The areas of urban interface alone which should be treated to protect adjacent life and property, and intrusion of fire from the interface onto the LSR's, would not be treated for at least 2 decades given our present level of thinning treatment activity.

Even if an assumption is made that the financial and material resources could be found to begin the long process of creating an ecosystem with LS habitat levels sustainable at higher levels than were historically present, there are two challenges to implementing this management strategy.

The first hinges on access. Treatment by either machines or fire of a majority of the LSR system is not possible because there is no access to allow these treatments to be performed economically or safely. Without intervention, the consequence of this situation will most probably be the destruction of large areas of untreated PSMEDry, Moist Douglas-fir, and ABLA2 PAGs over the next 200 years by wildfires of unprecedented intensity and size. This will result in a net loss of LS habitat over the LSR system and in an ecosystem with attributes that we cannot predict at the present time. Seventy years of fire suppression dictates that non-intervention based on lack of access will not result in a return to any known historical condition in the next 200 years.

The second challenge is based on smoke emissions. Historical accounts of the early Euro-American settlers are unanimous in reporting that summers on the east side of the Cascade Range were very smoky. Fire suppression has had the unexpected benefit of producing some of the cleanest air in this region that had ever existed prior to European settlement. It has also habituated several generations to an expectation of clear blue skies during the summer months.

Economics and a lack of access point towards prescribed fire in all its forms as being the primary management tool available to Northeastern Cascades LSR managers. Fire produces smoke and recent experience has already shown fire managers on the Okanogan National Forest that smoke management regulations are a severe impediment to efficient burning. Again SPECTRUM modeling shows that the amount of prescribed burning that must be done to even begin to restore the LSR system to a sustainable state (Fig. 7-4) requires a significant increase of smoke emissions. Given the present economic and technical situation, it is not possible to increase sustainable levels of LS habitat and to have clean air at the same time. Non-intervention will result in an even greater increase in smoke emissions as high risk seral stages develop and are consumed by wildfires. (see Chapter 2, Smoke). The present regulatory system can only alter this aspect of smoke emissions. It cannot affect the fact that these emissions will occur.

LSR Monitoring

Monitoring within the LSRs will follow the basic objectives of protecting, maintaining, and enhancing conditions for late-successional ecosystems and the habitats of late-successional species. Monitoring will primarily focus on the changes in vegetation that includes the size, location, spatial distribution, structure, species composition, and development of late-successional and old-growth forests.

Implementation monitoring will be conducted at the project level by District personnel as part of normal implementation monitoring associated with projects. The District Monitoring Coordinator will be responsible for LSR monitoring activity. Monitoring other than at the District level will include the Forest (Forest Plan implementation) and the Eastern Washington province team.

Implementation Monitoring

The focus of implementation monitoring will be at the project or activity level. Implementation monitoring will be used to determine if the Forest Plan standards and guidelines and specific guidance in the LSR assessment are correctly applied and followed. The question asked by implementation monitoring is: Does the project or activity follow guidance provided in the Forest Plan and the LSRA? Each planned project within any LSR requiring a Decision Notice or Memo will include a concise monitoring plan. Specific items in that plan will be determined by the project interdisciplinary team. As a guide, specific implementation monitoring questions for the LSR land allocation have been drafted by a work group for the Research and Monitoring Committee of REO. Tiering to existing Forest Plan monitoring items will occur as applicable.

Annual monitoring of LSR activities will be organized by PAGs and measured primarily by change in PAG acreages. Items that may influence these acreages include stand replacing fires, thinning, change in incremental tree growth, and change in crown fire potential. In addition to planned activities, natural activities such as wildfires, insect and disease outbreaks, and wind events will also be tracked.

On-going Forest Plan monitoring:

Several items included in the current Forest Plan implementation guide can be utilized within the LSR. They are listed below by item number.

10. Old growth ecosystems. Indicates LS habitat in general.

11, 12, 13. Primary cavity excavators. Indicates dead tree habitat availability.

14. Lynx. Indicate LS or spruce/lodgepole pine habitats that include seedling/sapling seral stages and down woody material components.

25. Northern spotted owl. Indicates LS habitats primarily multi-layered, dead tree, and large tree components.

26. Pileated woodpecker, three-toed woodpecker, and pine marten. Indicates LS habitats primarily large tree and down woody material components.

Effectiveness Monitoring

Effectiveness monitoring is used to determine if management practices, by following the applicable standards and guidelines, are appropriate to meet overall planning objectives. For this LSR assessment the question asked by effectiveness monitoring is: Does the planned management activity or project create, maintain, or restore habitat for late-successional species? The change in vegetation will be determined by satellite imagery, however, due to the scale of the LSRs this must be scheduled for five or ten year increments. At this wider scale, monitoring will determine whether the LSR is a functional, interactive ecosystem and whether or not management activities are having an effect on the LSR system as a whole. .

Validation Monitoring

Validation monitoring is used to determine if a cause and effect relationship exists between management activities and the indicators or resource being managed. This type of monitoring is used to validate the data and assumptions used in planning. For this assessment, validation monitoring asks the question: Do the overall goals and objectives of the Forest Plan lead to maintained or restored habitat conditions that support stable and well-distributed populations of late-successional species? Validation monitoring will be accomplished by the Regional Ecosystem Office.

APPENDIX A

Plant Associations Grouped by Biophysical Environment and Plant Association Groups.

Biophysical Environment	**N. Idaho Fire Group ****
Hot dry shrub/grass	**1**

PAG	COMMON NAME	SCIENTIFIC NAME
Ponderosa Pine	Ponderosa pine/ bluebunch wheatgrass	*Pinus ponderosa/Agropyron spicatum*
Ponderosa Pine	Ponderosa pine/ pinegrass-bluebunch wheatgrass	*Pinus ponderosa/Calamagrostis rubescens-Agropyron spicatum*
Ponderosa Pine	Ponderosa pine/ bitterbrush/bluebunch wheatgrass	*Pinus ponderosa/Purshia tridentata/Agropyron spicatum*
Ponderosa Pine	Ponderosa pine/bluebunch wheatgrass-podfern	*Pinus ponderosa/Agropyron spicatum-Aspidotis densa*
Dry Douglas-fir	Douglas-fir/bluebunch wheatgrass	*Pseudotsuga menziesii/Agropyron spicatum*
Dry Douglas-fir	Douglas-fir/ bluebunch wheatgrass-podfern	*Pseudotsuga menziesii/Agropyron spicatum-Aspidotis densa*
Dry Douglas-fir	Douglas-fir/pinegrass-bluebunch wheatgrass	*Pseudotsuga menziesii/Calamagrostis rubescens-Agropyron spicatum*
Dry Douglas-fir	Douglas-fir//bitterbrush/bluebunch wheatgrass	*Pseudotsuga menziesii/Purshia tridentata/Agropyron spicatum*
Dry Douglas-fir	Douglas-fir/common snowberry/bluebunch wheatgrass	*Pseudotsuga menziesii/Symphoricarpos albus/Agropyron spicatum*

Biophysical Environment	**N. Idaho Fire Group ****
Warm dry shrub/herb	**1, 2, and for # 8**

PAG	COMMON NAME	SCIENTIFIC NAME
Dry Douglas-fir	Douglas-fir/bearberry	*Pseudotsuga menziesii/Arctostaphylos uva-ursi*
Dry Douglas-fir	Douglas-fir/bearberry-bitterbrush	*Pseudotsuga menziesii/Arctostaphylos uva-ursi-Purshia tridentata*
Dry Douglas-fir	Douglas-fir/shrubby penstemon	*Pseudotsuga menziesii/Penstemon fruiticosus*
Dry Douglas-fir	Douglas-fir/mountain snowberry	*Pseudotsuga menziesii/Symphoricarpos oreophilus*
Western Hemlock	# Western hemlock/pinemat manzanita	*Tsuga heterophylla/Arctostaphylos nevadensis @*

Biophysical Environment	**N. Idaho Fire Group ****
Warm mesic shrub/herb	**1, 2, and for # 8**

PAG	COMMON NAME	SCIENTIFIC NAME
Dry Douglas-fir	Douglas-fir/common snowberry	*Pseudotsuga menziesii/Symphoricarpos albus*
Dry Douglas-fir	Douglas-fir/common snowberry/pinegrass	*Pseudotsuga menziesii/Symphoricarpos albus/Calamagrostis rubescens*
Western Hemlock	# Western hemlock/vine maple/vanilla leaf	*Tsuga heterophylla/Acer circinatum/Achylys triphylla****
Western Hemlock	# Western hemlock/vine maple/queencup beadlily	*Tsuga heterophylla/Acer circinatum/Clintonia uniflora****

Biophysical Environment	**N. Idaho Fire Group ****
Warm moist shrub/herb	**8**

PAG	COMMON NAME	SCIENTIFIC NAME
Western Hemlock	Western hemlock/vine maple/wild ginger	*Tsuga heterophylla/Acer circinatum/Asurum caudatum****
Western Hemlock	Western hemlock/wild ginger	*Tsuga heterophylla/Asurum caudatum*

Biophysical Environment	**N. Idaho Fire Group ****
Cool dry grass	**2, 3, and 4**

PAG	COMMON NAME	SCIENTIFIC NAME
Dry Douglas-fir	Douglas-fir/bearberry/pinegrass	*Pseudotsuga menziesii/Arctostaphylos uva-ursi/Calamagrostis rubescens*
Dry Douglas-fir	Douglas-fir/elk sedge	*Pseudotsuga menziesii/Carex geyeri*
Dry Douglas-fir	Douglas-fir/pachistima/pinegrass	*Pseudotsuga menziesii/Pachistima myrsinities/Calamagrostis rubescens*
Dry Douglas-fir	Douglas-fir/pinegrass	*Pseudotsuga menziesii/Calamagrostis rubescens*
Dry Douglas-fir	Douglas-fir/bitterbrush/pinegrass	*Pseudotsuga menziesii/Purshia tridentata/Calamagrostis rubescens*
Dry Douglas-fir	Douglas-fir/shiny-leaf spirea/pinegrass	*Pseudotsuga menziesii/Spirea betulifolia var.lucida/Calamagrostis rubescens*
Dry Douglas-fir	Douglas-fir/pachistima	*Pseudotsuga menziesii/Pachistima myrsinities*
Subalpine fir Dry	Subalpine fir/pinegrass	*Abies lasiocarpa/Calamagrostis rubescens*
Subalpine fir Dry	Subalpine fir/pachistima	*Abies lasiocarpa/Pachistima myrsinities*
Subalpine fir Dry	Subalpine fir/pachistima/pinegrass	*Abies lasiocarpa/Pachistima myrsinities/Calamagrostis rubescens*

Biophysical Environment	N. Idaho Fire Group **
Cool mesic shrub/herb	4, 5, and 7

PAG	COMMON NAME	SCIENTIFIC NAME
Douglas-fir Moist	Douglas-fir/dwarf huckleberry	*Pseudotsuga menziesii/Vaccinium caespitosum*
Douglas-fir Moist	Douglas-fir/low huckleberry	*Pseudotsuga menziesii/Vaccinium myrtillus*
Douglas-fir Moist	Douglas-fir/low huckleberry/pinegrass	*Pseudotsuga menziesii/Vaccinium myrtillus/Calamagrostis rubescens*
Subalpine- fir Moist	Subalpine fir/twinflower	*Abies lasiocarpa/Linnaea borealis var. longiflora*
Subalpine- fir Moist	Subalpine fir/dwarf huckleberry	*Abies lasiocarpa/Vaccinium caespitosum*
Subalpine-fir Moist	Subalpine fir/big huckleberry	*Abies lasiocarpa/Vaccinium membranaceum*
Silver fir Mtn. Hemlock	Pacific silver fir/vine maple	*Abies amabilis/Acer circinatum*
Silver fir Mtn. Hemlock	Pacific silver fir/big huckleberry-sidebells pyrola	*Abies amabilis/Vaccinium membranaceum-Pyrola secunda****
Silver fir Mtn. Hemlock	Pacific silver fir/big huckleberry-queencup beadlily	*Abies amabilis/Vaccinium membranaceum-Clintonia uniflora****
Silver fir Mtn. Hemlock	Mountain hemlock/big huckleberry	*Tsuga mertensiana/Vaccinium membranaceum*
Silver fir Mtn. Hemlock	Mountain hemlock/beargrass-low huckleberry	*Tsuga mertensiana/Xerophyllum tenax-Vaccinium myrtilus*
Western Hemlock	Western hemlock/Cascade Oregon grape	*Tsuga heterophylla/Berberis nervosa****
Western Hemlock	Western hemlock/pachistima/queencup beadlily	*Tsuga heterophylla/Pachistima myrsinites/Clintonia uniflora*

Biophysical Environment	N. Idaho Fire Group **
Cool moist shrub/herb	4 and 5

PAG	COMMON NAME	SCIENTIFIC NAME
Silver fir Mtn. Hemlock	Pacific silver fir/vanilla leaf	*Abies amabilis/Achlys triphylla*
Silver fir Mtn. Hemlock	Pacific silver fir/rusty menziesia	*Abies amabilis/Menziesia ferruginea*
Silver fir Mtn. Hemlock	Pacific silver fir/coolwort foamflower	*Abies amabilis/Tiarella trifoliata var. unifoliata*
Silver fir Mtn. Hemlock	Pacific silver fir/Alaska huckleberry	*Abies amabilis/Vaccinium alaskaense****
Silver fir Mtn. Hemlock	Mountain hemlock/rusty menziesia/big huckleberry	*Tsuga mertensiana/Menziesia ferruginea/Vaccinium membranaceum*
Silver fir Mtn. Hemlock	Mountain hemlock/Cascade azalea-Alaska huckleberry	*Tsuga mertensiana/Rhododendron albiflorum-Vaccinium alaskaense*
Silver fir Mtn. Hemlock	Mountain hemlock/Alaska huckleberry	*Tsuga mertensiana/Vaccinium alaskaense*
Western Hemlock	Western hemlock/vanilla leaf	*Tsuga heterophylla/Achylys triphylla*

Biophysical Environment	N. Idaho Fire Group **
Cold dry shrub/herb	3, 4, and 6

PAG	COMMON NAME	SCIENTIFIC NAME
Subalpine fir Dry	Subalpine fir/grouse huckleberry	*Abies lasiocarpa/Vaccinium scoparium*
Subalpine fir Dry	Subalpine fir/grouse huckleberry/pinegrass	*Abies lasiocarpa/Vaccinium scoparium/Calamagrostis rubescens*
Subalpine Parkland	Subalpine larch/Washington dryad	*Larix lyalli/Dryas octapetela*
Subalpine Parkland	Subalpine larch/common juniper	*Larix lyalli/Juniperus communis*
Subalpine Parkland	Whitebark pine/pinegrass	*Pinus albicaulis/Calamagrostis rubescens*
Subalpine Parkland	Whitebark pine/Washington dryad	*Pinus albicaulis/Dryas octapetela*
Subalpine Parkland	Whitebark pine/Idaho fescue	*Pinus albicaulis/Festuca idahoensis*
Subalpine Parkland	Whitebark pine/common juniper	*Pinus albicaulis/Juniperus communis*

Biophysical Environment	N. Idaho Fire Group **
Cold mesic shrub/herb	5 and 6

PAG	COMMON NAME	SCIENTIFIC NAME
Subalpine-fir Moist	Subalpine fir/cascade azalea	*Abies lasiocarpa/Rhododendron albiflorum*
Subalpine-fir Moist	Subalpine fir/Cascade azalea/smooth woodrush	*Abies lasiocarpa/Rhododendron albiflorum/Luzula hitchockii*
Subalpine-fir Moist	Subalpine fir/Cascade huckleberry	*Abies lasiocarpa/Vaccinium deliciosum*
Subalpine-fir Moist	Subalpine fir/grouse huckleberry/broadleaf arnica	*Abies lasiocarpa/Vaccinium scoparium/Arnica latifolia*
Subalpine-fir Moist	Subalpine fir/grouse huckleberry/smooth woodrush	*Abies lasiocarpa/Vaccinium scoparium/Luzula hitchockii*
Subalpine Parkland	Subalpine larch/little prince's pine/partridgefoot	*Larix lyalli/Chimaphila menziesii/Luetkea pectinata*
Subalpine Parkland	Subalpine larch/Cascade huckleberry/Merten's moss Heather	*Abies lasiocarpa/Vaccinium deliciosum/Cassiope mertensiana*
Subalpine Parkland	Subalpine larch/grouse huckleberry/smooth woodrush	*Larix lyalli/Vaccinium scoparium/Luzula hitchockii*
Silver fir Mtn. Hemlock	Pacific silver fir/Cascade azalea-big huckleberry	*Abies amabilis/Rhododendron albiflorum-Vaccinium membranaceum****
Silver fir Mtn. Hemlock	Pacific silver fir/dwarf bramble	*Abies amabilis/Rubus lasiococcus @*
Silver fir Mtn. Hemlock	Mountain hemlock/red mountain heath-Cascade huckleberry	*Tsuga mertensiana/Phyllodoce empetriformis-Vaccinium deliciosum*
Silver fir Mtn. Hemlock	Mountain hemlock/Cascade azalea-big huckleberry	*Tsuga mertensiana/Rhododendron albiflorum-Vaccinium membranaceum*
Silver fir Mtn. Hemlock	Mountain hemlock/grouse huckleberry/smooth woodrush	*Tsuga mertensiana/Vaccinium scoparium/Luzula hitchcockii*

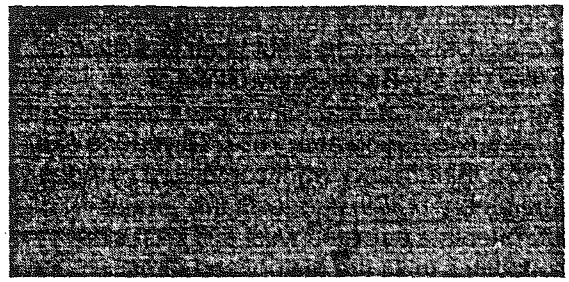
Biophysical Environment	N. Idaho Fire Group **
Cold mesic shrub/herb (cont'd)	**5 and 6**

Silver fir Mtn. Hemlock	Mountain hemlock/Cascade azalea	*Tsuga mertensiana/Rhododendron albiflorum*
Silver fir Mtn. Hemlock	Mountain hemlock/dwarf bramble	*Tsuga mertensiana/Rubus lasiococcus*
Silver fir Mtn. Hemlock	Mountain hemlock/smooth woodrush	*Tsuga mertensiana/Luzula hitchcockii*

Biophysical Environment	N. Idaho Fire Group **
Cold moist shrub/herb	**6**

PAG	COMMON NAME	SCIENTIFIC NAME
Subalpine-fir Moist	Subalpine fir/broadleaf arnica-skunkleaf polemonium	*Abies lasiocarpa/Arnica latifolia-Polemonium pulcherrimum*
Subalpine-fir Moist	Subalpine fir/smooth woodrush	*Abies lasiocarpa/Luzula hitchockii*
Subalpine-fir Moist	Subalpine fir/dwarf bramble	*Abies lasiocarpa/Rubus lasiococcus*
Subalpine Parkland	Whitebark pine/Merten's moss-heather-partridgefoot	*Pinus albicaulis/Cassiope mertensiana-Leutkea pectinata*
Subalpine Parkland	Whitebark pine/grouse huckleberry/smooth woodrush	*Pinus albicaulis/Vaccinium scoparium/Luzula hitchockii*

*Biophysical Environments and Plant Associations taken from Lillybridge and others (1995).
** Northern Idaho Fire Groups were taken from Kapler-Smith and Fisher (1995).
*** Plant associations that are similar or described by Henderson and others (1992).
@ Community types described by Lillybridge et al (1995).



APPENDIX B

Biophysical Environments

Biophysical environments are groups of plant associations that are found in similar physical environments, are similar in productivity, and respond similarly to disturbance. Biophysical environment approach to analyzing landscapes is preferred because it provides a way to classify a landscape that is consistent across an entire area, is linked to successional processes, and shares similar inherent disturbance regimes. As a result, biophysical environments provide a tool for assessing landscape function pre-European settlement, under current conditions, and are useful as a predictive tool to assess possible future conditions.

To begin defining the landscape into biophysical environments, a combination of physical characteristics of the landscape (aspect, slope, elevation, precipitation, and soils) and the plant associations most likely to be found in a particular environment were determined. Given the current knowledge of successional patterns and the autecological characteristics of major species within the plant associations, inferences about inherent disturbance regimes were developed. Most of the disturbance regime classification was adapted from "Northern Idaho Fire Groups" (Kapler-Smith and Fisher 1995), "Fire Ecology of Pacific Northwest Forests" (Agee 1993), and "Field Guide for Forested Plant Associations of the Wenatchee National Forest" (Lillybridge et al 1995.)

Landscapes are comprised of three major components that allow assessment of ecological processes. These are the physical attributes referred to as structure (which includes vegetative composition), process attributes referred to as function (successional processes and disturbance regimes), and the effect of the interactions between structure and function.

Disturbance Regimes:

The fire return interval alone does not define the fire regime of a community. A fire regime is a description of the role fire plays in an ecosystem, and is based on the characteristics of the disturbance, the resulting dominant vegetation, and the effects of fire on that dominant vegetation (Agee 1993). The following discussion focuses on the dominant indicator species within a biophysical environment and the affects of a given disturbance regime on that environment.

The ecological distribution of western larch is best represented in the area of the Okanogan/Methow divide with scattered disjunct pockets found west to the Chewuch river (Williams et al 1983). Western larch (*Larix occidentalis*) does not naturally occur west of the Chewuch river but has been planted following harvest activity so is included in reference to future conditions.

Grand fir (*Abies grandis*) is only found in a few disjunct populations in the analysis area. The habitat types where one would expect to find grand fir in the analysis area are slightly drier than those areas described by Lillybridge and others (1995). In these areas, Douglas-fir (*Pseudotsuga menziesii*) functions in the same successional capacity as grand fir in defining fire effects within a community.

Vegetation West of the Cascade Crest, within the analysis area, has not been classified in either the Mt. Baker-Snoqualmie or Wenatchee National Forest plant association guides (Hederson et al 1992, Lillybridge et al 1995). Fire history work completed by Agee and others (1989) suggests this area is intermediate between west and east side conditions in its fire history and forest successional patterns. As a result, descriptions of these areas are based on personal knowledge of the area and available literature.

The terms hot dry, warm moist, cool mesic and so on are relative terms. What is described as a dry environment in the Mt. Baker-Snoqualmie plant association guide (Henderson et al 1992) would be defined as the wettest environment east of the crest. For consistency, the classification and plant associations described by Lillybridge and others (1995) will be used throughout this document and assessment. Where necessary, discussions will separate processes unique to the west side of the Cascade Crest.

Western larch and ponderosa pine (*Pinus ponderosa)* have similar adaptations to fire, so they are discussed together in general terms. Where ponderosa pine, Douglas-fir, and in some cases western larch are found together, it is characteristic of a non-lethal, frequent, low-intensity fire regime where fires occur on average between 7.5 and 24 years. When Douglas-fir, lodgepole pine (*Pinus contorta*), and western larch are found, it is indicative of a cooler environment which experience slightly longer fire-free periods (25 to 50 years). More moderate-intensity fires (50 to 150 years) result in mixed mortality within the fire area and are often also dominated by Douglas-fir and lodgepole pine. Where lodgepole pine, subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), pacific silver fir (*Abies amabilis*), mountain hemlock (*Tsuga mertensiana*) and western hemlock (*Tsuga heterophylla*) are major late seral components of a stand, high-intensity, lethal fires typically occur. These species are indicative of habitat types experiencing the longest fire-free period (200 to over 500 years).

Hot Dry Shrub/Grass

Hot dry shrub/grass environments are most commonly found mid to low elevation (below 4,000 feet), primarily on the south and southwest aspects. Northern Idaho Fire Group One best describes the disturbance regime (Kapler-Smith and Fisher 1995). Ponderosa pine is dominant or co-dominant with Douglas-fir. Bluebunch wheatgrass (*Agropyron species*), pinegrass (*Calamagrostis rubescens*), and bitterbrush (*Pursia tridentata*) are the dominant understory species.

The hottest, driest portion of this environment is near the low elevation timberline often grading into the treeless, shrub steppe plant associations in the valley bottom. Historically, the forested plant associations grading into the shrub steppe experienced frequent low-intensity fires every seven and a half years with the longest period between fire events being 18 years. Ninety-five percent of all fires occurred within 15 years of one another (Ohlson 1996). With increasing moisture and elevation the average fire return interval increases. Finch (1983) Sampled selected stands within the Okanogan National Forest and established an average fire return interval at the upper end of this range to be 24 years. Kapler-Smith and Fisher (1995) describe Fire Group One as having a fire return interval between 15 and 20 years with the longest period between fires being 51 years. No stand replacement fires were detected under these low-intensity fire regimes in Kapler-Smith and Fisher's study indicating fires maintained mature forests prior to fire exclusion. Schellhaas and others (1996) determined a landscape scale disturbance occurred on average every 20 years with fire sizes ranging between 10,000 to 30,000 acres in this hot dry shrub/grass environment in the Entiat valley, and these fires were not stand replacing.

Fire was a critical element in maintaining these ecosystems. Arno et al (1995) suggests fire return intervals less than 50 years are necessary for the perpetuation of ponderosa pine as a major seral species where it is found as a mature component of the stand. Since fire exclusion in similar ponderosa pine environments in the southwest, current fire size is now about three times what it was historically, and fires are now likely to be stand replacing in nature (Covington and Moore 1994).

Frequent fires not only maintained mature forests prior to European settlement, but also maintained interspersed forest meadows and the shrub steppe below timberline. In the absence of fire, the trend is typically a reduction in the number and size of the forest associated meadows as trees gradually encroach into the meadow interface.

Lehmkuhl et al (1993) determined there was a 30 percent reduction in ponderosa pine in the southern portion of the assessment area, with the primary understory change being the loss of mature parklike and old-forest structural classes. The greatest changes occurred in the drier southwestern portions of the assessment area.

In the last 80 to 90 years fire exclusion has resulted in the development of a mid-canopy (4-16 inches DBH) that did not exist or was a minor component of the stand under a frequent fire regime. This segment of the canopy now comprises the largest proportion of these stands. Frequent fires thinned this portion of the stand reducing the risk of crown fires and also ensured the mature trees remained vigorous. Since fire exclusion the large, old, trees on the driest sites have shown as much as a 41 percent reduction in annual growth for ponderosa pine and an 81 percent reduction in annual growth for Douglas-fir (Ohlson 1996). Forested stands within this group have experienced fire-free periods up to five times longer than anything they experienced prior to European settlement of the valley.

Warm Dry and Warm Mesic Shrub/Herb

East of the Cascade Crest, this environment is typical of the low to middle elevations (1,200 feet to 5,200 feet) and is found on all aspects. Northern Idaho Fire Group One (discussed above) represents the disturbance regime associated with the drier end of this environment and grades into Fire Group Two with increasing moisture and elevation. Douglas-fir is often the dominant species in the overstory with ponderosa pine as a co-dominant in the warmest sites and western larch, where present, and lodgepole pine are codominant in the cooler moister sites. Lodgepole pine is also found as a minor component in some stands in the upper elevations the warm dry environment. Lodgepole pine and western larch are major early seral species in the warm mesic environments. Bearberry (*Arctostaphylos uva-ursi*), pachistima (*Pachistima myrsinites*), and common snowberry (*Symphoricarpos albus*) dominate the understory vegetation and are indicative of the increased moisture availability compared to the plant associations in the hot dry shrub/grass environment.

Western larch and ponderosa pine dominance, increased with increasing frequency of recurring low-intensity fires. Presence of western larch indicates a more moderate-severity fire regime. Douglas-fir survival following a fire event is a function of crown scorch and the ensuing insect damage while for lodgepole pine survival it is dependent on the degree of basal scorch (Agee 1993). Non-lethal to mixed mortality fires were typical. The lethal, higher severity fires were typically associated with root disease centers (Kapler-Smith and Fisher 1995).

Fire return intervals are variable in this group ranging from 10 to over 50 years (Kapler-Smith and Fisher 1995). Finch (1983) found fire return intervals of 12 to 52 years on parts of the Okanogan National Forest. Non-lethal fire return intervals of 10 to 24 year averages continue to be the dominant influence in maintaining the mature forests in Fire Group Two. Under the pre-settlement fire regime stand replacement fires occurred occasionally, often in patches within non-lethal burns creating a structurally diverse landscape. Regeneration within these patches usually established within 20 years of the fire on the moister sites and often longer on the drier ones.

Fire return intervals between 24 and 50 years resulted in a post-fire landscape made up of a mixture of non-lethal and lethal fire severities. These types of burns broke up the continuity of the landscape creating a highly diverse mosaic. In those areas where the fire was stand replacing in nature a rich diversity of species established. Post-fire landscapes were dominated by a high density of shrub cover. Under certain weather conditions this lush cover would retard fire spread across the landscape during subsequent fire events because of their high moisture content. As a result the extent of fires remained relatively small. Where recurring fires are higher severity and the fire return interval is between 30 and 60 years a seral shrubfield persists (Kapler-Smith and Fisher 1995).

Fire severities and intensities were variable throughout this environment. This mix of fire types played a critical role in diversifying the landscape structure by breaking up the continuity of the fuels as well as the stands. The mix of fuel types across the landscape likely reduced the size and severity of fires within this fire regime. Fire is also critical in maintaining ponderosa pine and western larch within the ecosystem. Both these species are shade intolerant and require bare mineral soil for germination. By breaking up the stand structure, density, and composition, fire limited the extent and duration of insect and disease outbreaks by reducing the size of a given habitat (Hessburg 1993).

With the exclusion of fire, a homogenous landscape is developing, increasing the extent and duration of insect and disease outbreaks. Ponderosa pine and western larch are beginning to disappear from the stands due to increased competition from the more shade tolerant Douglas-fir. In the absence of fire ponderosa pine will remain codominant with Douglas-fir longer than lodgepole pine. However, insect outbreaks will likely remove both lodgepole pine and ponderosa pine at the same time. Increased mortality will also occur in both ponderosa pine and lodgepole pine when they are stressed by the thick understory development of the more shade tolerant Douglas-fir (Agee 1993, Oliver and Larson 1990).

Where ponderosa pine and western larch have been excluded (either by harvest or competition), and Douglas-fir dominates throughout stand development, the stand initiation phase may be cyclic especially where large root disease centers occur (Kapler-Smith and Fisher 1995) or stand density favors insect outbreaks. The risk of very large, stand replacing fire events increases. As a result of a high-severity, high-intensity fire event, a type conversion from a forested community to a persistent shrubfield is likely. Higher severity fire extends the period required for tree establishment from around 20 years to several decades.

West of the Cascade Crest three plant associations within the western hemlock series are found in the warm dry shrub/herb and warm mesic shrub/herb environments. These plant associations are typically found below 3,000 feet in elevation. Northern Idaho Fire Group Eight best describes the disturbance regime and successional processes associated with these habitat types experiencing stand replacing fires less than 200 years. The important early seral species are Douglas-fir, lodgepole pine, western red cedar, western white pine, and western larch. Vine maple, Oregon grape, twinflower, and pachistima are the dominant shrubs with the dominant herbs being pinegrass and queencup beadlily.

In the warm dry shrub/herb environment, the western hemlock/pinemat manzanita (*Arctostaphylos nevadensis*) community type is found on soil types typically too dry to allow a closed canopy to develop and is a minor association within the western hemlock series (Lillybridge et al 1995). These sites support lodgepole pine and Douglas-fir as seral codominants. This association makes up small islands of vegetation across the landscape that are within larger ecosystems. As a result, the disturbance regime is influenced by the disturbance regime of the surrounding landscape.

Warm mesic habitat types found west of the Cascade Crest are floristically rich with vine maple as the dominant understory shrub. These stands are typically less than 200 years old suggesting a typical fire return interval between 100 and 200 years. Moderate-severity fires likely occurred ranging between 50 to 100 years favoring Douglas-fir as the seral dominant (Lillybridge et al 1995). Kapler-Smith and Fisher (1995) suggest fire return intervals between 200 and 250 years probably occurred prior to European settlement. Wind, insects, and root disease play an important role in creating opening within these stands.

The idea of a fire cycle or fire return interval of regular frequency within the western hemlock series is not as meaningful as it is in the drier forest types described in this section. Rarely is the fire record complete enough in these western hemlock habitat types to infer a cyclic pattern due to the climatic shifts that occur over centuries. Episodic is a better descriptor of the fire cycle in western hemlock forests (Agee 1993). However, with stand ages between 200 and 300 years, and lodgepole pine as a seral dominant in the stands, fire return intervals less than 200 years are suspected (Lillybridge 1995).

Warm Moist Shrub/Herb

The warm moist shrub/herb environment is characteristic of western hemlock climax forests typically below 3,000 feet in elevation. Northern Idaho Fire Group Eight best depicts the disturbance regimes and successional processes associated with western hemlock plant associations. Cascade Oregon grape (*Berberis nervosa*), vine maple (*Acer circinatum*), twinflower (*Linnaea borealis* var. *longiflora*), and wild ginger (*Asarum caudatum*) are important understory components of the plant associations found in this habitat type. Like the western hemlock plant associations found in the warm mesic environment, western red cedar and Douglas-fir are both important long-lived seral dominants. Douglas-fir is the most fire adapted of the common species and the composition of Douglas-fir in a stand is a reflection of the disturbance regime. Where this habitat type grades into the drier valley bottoms experiencing shorter fire-free periods, Douglas-fir is more prevalent in the stand. At the higher elevations this habitat type grades into the cool mesic pacific silver fir habitat types and successional patterns and disturbance regimes are more reflective of this group.

As before, episodic is a better descriptor of the fire cycle in western hemlock forests and fire return intervals are not as meaningful compared to the drier forest types (Agee 1993). Small, patchy moderate-severity fires were likely more common than higher severity fires. Moderate-severity fires likely occurred between 50 and 100 years with the higher intensity, stand replacing fires ranging between 150 and 500 years. Ages of the sampled stands did not exceed 200 years suggesting most fires occurred between 100 and 200 years (Lillybridge et al 1995). Douglas-fir is more abundant in these stands than less fire tolerant species suggesting a fire regime that favors Douglas-fir. Successional processes are slow to occur within the western hemlock series with western hemlock beginning to gain in dominance as Douglas-fir approaches the end of it's lifespan at about 400 years. Western hemlock will continue to gain in dominance for 700 to 1,000 years in the absence of fire. Since fires are likely to occur well within the lifespan of Douglas-fir, climax western hemlock stands are rare as are stands with western hemlock as the dominant species. Wind, root disease, and insects are important disturbance agents creating structural diversity within these stands and across the landscape.

Cool Dry Grass

The cool dry grass biophysical environment encompasses portions of the cooler moister end of Fire Group Two (discussed above) and grades into the lower, drier subalpine fir habitat types and the upper, moister elevation range in the Douglas-fir habitat types (Fire Group Four). This environment is commonly found from mid-elevation (3,000') to near timberline (6,000') but it can be found grading into the lower timberline (1,200') where it is associated with cold air drainages and frost pockets. Cool dry grass environments are depicted as an environment made up of cool, dry, often steep, southerly aspects. Pinegrass is the major understory constituent throughout the plant associations listed in this environment. The shrub component varies from bitterbrush at the drier end to pachistima at the cooler, moister end of this environment.

In the warm dry end of this environment's range ponderosa pine and western larch are frequently codominant with Douglas-fir. As moisture availability increases and the fire-free period lengthens, Engelmann spruce increases in dominance as a seral species. In the subalpine fir and upper elevation Douglas-fir habitat types lodgepole pine often dominates the early seral stand for about 150 years while the more shade tolerant species establish. Where lodgepole pine is not the early seral dominant post-fire regeneration is typically longer because the slower establishing Engelmann spruce, subalpine fir, and Douglas-fir are the early seral components in the subalpine fir habitat type.

Persistent lodgepole pine habitat types (Fire Group Three) occur in areas to harsh for subalpine fir to become dominant in the stand. These are typically areas of frost pockets, poor soils, or highly fluctuating, seasonal water tables. These sites have relatively low productivity and are structurally discontinuous both vertically and horizontally. Because of the discontinuity of the stand structure, large crown fires are likely only during severe fire conditions. Small openings created by fire, beetle kill, windthrow, and snow breakage are more typical of events that created structural diversity within these stands. Low-intensity, nonlethal fires averaged 41 years and are likely the most important component in maintaining the variation in stand structure (Kapler-Smith and Fisher 1995).

Stands in Fire Group Three are slow to develop due to the harsh growing environment where they are found. With increasing time since fire, increases in dwarf mistletoe infestations and mountain pine beetle infestations result. Because fire Group Three stands are likely to be small inclusions within other habitat types the adjacent landscape's fire regime strongly effects the fire return interval in this group.

Fire return intervals between 52 and 200 years resulted in stand replacing fires in Fire Group Four (Kapler-Smith and Fisher 1995). Early successional stages can be dominated by lodgepole. On the drier end of the range ponderosa pine, western larch, and Douglas-fir also colonize the area. With increasing moisture there is an increase in the Engelmann spruce as a seral component in the post-fire stand. With an increase in the fire-free period, Engelmann spruce also increases its representation as a seral dominant with ponderosa pine and western larch disappearing altogether. Fire Group Four, because of its cool dry nature, often is slow to reforest after a stand replacing fire unless protection from the elements is available from standing dead and downed logs, especially for young Engelmann spruce. Lodgepole pine often serves as "nurse trees" providing protection from severe climate extremes to regenerating subalpine fir and Engelmann spruce.

Historically, non-lethal fires were common in Fire Group Four with fire return intervals of 30 to 50 years. These fires were especially common where lodgepole pine and Douglas-fir dominated the stand. Frequent fires thinned out the fire susceptible subalpine fir and maintained Douglas-fir and lodgepole pine dominated stands. When fires occurred in the lower end of this range Douglas-fir and lodgepole pine were seral dominants with western larch. Ponderosa pine shows up occasionally as a minor component in some stands.

Fires are also an important disturbance element in the maintenance of subalpine meadows because fire thins encroaching trees around the meadow's edge while stimulating the herbaceous community. Severe-intensity fires often killed the shrub component, especially the huckleberry species. Because of this, more frequent fires of lower severity maintain a rich diversity of shrubs in the early seral stages, providing important summer foraging habitat for wildlife. The irregular fire occurrence with the wide range in fire intensities is likely to account for some of the floristic diversity within this environment.

Fire return intervals ranging from 24 to 200 years created a diverse landscape in this cool dry grass environment. The inherent fire return interval within this environment is closely linked to the interconnection between habitat types and their vegetative expression on the landscape.

Since fire exclusion, those plant associations that evolved with the shortest fire-free period are now becoming more homogeneous in nature creating a continuous fuel source both vertically and horizontally. When ignited, these stands now experience a more extensive and more intense fire situation. Those interspersed areas that historically functioned as fuel breaks are now also young stands of timber and will now be incorporated into the burn resulting in larger, hotter, and more intense fires than what occurred historically. Because of the higher intensity fire, a more complete burn will result. This will likely result in a temporary loss in the diversity of shrubs in the post-fire landscape. Tree establishment will be prolonged over larger areas due to increased competition from dense swards of pinegrass and those shrubs that quickly colonize a burn. Tree regeneration will be difficult due to temperature extremes experienced daily and seasonally in the higher elevations.

Cool Mesic Shrub/Herb

These environments are typically found on mid to higher elevation slopes (3,000' to 6,000') and sometimes lower on north aspects. There are four fire groups within the cool mesic shrub/herb environment, one is Fire Group Four (discussed above), Fire Group Five and Fire Group Seven. Fire Group Four environment is indicative of the subalpine fir habitat types in the lower portion of its elevational range. The higher, moister elevational range of subalpine fir, the pacific silver fir, and the mountain hemlock habitat types depict Fire Group Five, the upper elevational range of the Douglas-fir habitat type Fire Group Seven, and the western hemlock habitat type Fire Group Eight. Those plant associations both east and west of the Cascade Crest support huckleberry species as a major component in the understory. The dominance of huckleberry in these plant associations are what separate them out from those plant associations in the cool, dry, grass environment. Huckleberry species are often indicative of frost pockets and cold air drainage, especially grouse huckleberry (*Vaccinium scoparium*) and dwarf huckleberry (*Vaccinium caespitosum*). Herbaceous species diversity is greatest early in succession, while cover is greatest in mid to late seral stands.

East of the Cascade Crest, disturbance regimes associated with Fire Groups Four, Five, and Seven, typically experienced stand replacing fires. Stand replacing fires in the cool mesic shrub/herb environment range between 117 to over 200 years. When fire return intervals exceed 120 years, lodgepole pine can dominate early on in succession giving way to Douglas-fir, subalpine fir, and Engelmann spruce as it begins to reach maturity and drops out of the stand. Where the fire return intervals are greater then 30 years and less than 160 years, lodgepole pine likely dominates the stand or is codominant with Douglas-fir. Non-lethal fires were also common in the lower elevations with fire return intervals ranging between 30 and 50 years. Lodgepole pine and Douglas-fir are the dominant seral species were nonlethal fires regularly occurred. Regularly occurring nonlethal fires resulted in an uneven age stand structure where large remnant Douglas-fir dominated the overstory with younger lodgepole pine in the understory. Where high-severity reburns occur at less than 30 to 50 year intervals, scattered lodgepole pine and shrubfields dominate (Kapler-Smith and Fisher 1995). Western larch is a common seral dominant in habitat types with well drained soils. Ponderosa pine and western white pine are also present as minor seral species in these habitat types.

In the western hemlock plant associations (Fire Group Eight), fire return intervals less than 140 years resulted in stands dominated by Douglas-fir, along with western larch and western white pine. Western hemlock is a minor component in the stand when fire return intervals are less than 300 years. Fire return intervals between 300 and 600 years result in Douglas-fir, western hemlock or pacific silver fir as codominants in the stand (Agee 1993). Douglas-fir is most abundant between 50 and 150 years after disturbance. After which composition of western hemlock increases (Lillybridge et al 1995).

Fire regimes in the cool mesic shrub/herb are a complex interaction between fire, insects, and disease. Structural diversity is maintained by low to mixed-severity fires that often create opportunities for insects or decay organisms to colonization post-fire, especially in lodgepole pine, Engelmann spruce, and Douglas-fir. Fire exclusion in these habitat types reduces an important source of landscape diversity while increasing the risk of larger stand replacing fires in the future.

During most summers these plant associations support a lush understory that impedes fire spread from adjacent communities. After moderate-severity fires huckleberry species increase but are set back after high-severity fires. Under most conditions fires either burn small patches or burn through larger areas in a very patchy pattern. In most cases these cool mesic shrub/herb habitat types are difficult to burn. They typically burn only under extreme fire weather and the fire ignitions likely come from starts in the surrounding drier habitat types. Many stands are typically old with an uneven age structure.

Fire exclusion in these ecosystems typically has not exceeded the historic natural range of the fire-free period under which they evolved. As a result the composition and structure of these stands has not been altered appreciably over the last 80 years of active fire suppression. As the fire-free period increases, defoliating insects and root disease will begin to play a larger role in maintaining the structural diversity across the landscape. Suppression activities that have occurred during normal fire years in this environment likely reduced the size of a given fire start, thus reducing its effectiveness as a natural fire break in the event of a recurring fire in the area and will, over time, effectively reduce the structural diversity across the landscape.

Cool Moist Shrub/Herb

The cool moist shrub/herb environment is characteristic of the pacific silver fir and mountain hemlock climax communities along the Cascade Crest and to the west. Most sites are over 3,000 feet in elevation except in cold air drainages where they can be found as low as 2,000 feet in the pacific silver fire zone (Lillybridge et al 1995). These are mid elevation plant associations typically below 4,500 feet in elevation. Disturbance regimes of the subalpine habitat types described in the Northern Idaho Fire Groups Four and Five best depict the successional processes associated with this environment. The pacific silver fir dominates the lower drier elevations extent within this environment which than grades into mountain hemlock with increasing elevation and available moisture, which occurs mainly as snow. In the drier, higher elevations mountain hemlock grades into the subalpine fir climax communities. The understory species are dominated by huckleberry species, Cascade azalea (*Rhododendron albiflorum*), rusty menziesia (*Menziesia ferruginea*), vanilla leaf (*Achlys triphylla*) and coolwart foamflower (*Tiarella trifoliata* var. *unifoliata*).

Stand replacing fires are normally less than 400 years in the slightly drier pacific silver fir plant associations. At the drier end of this environment fire-free periods range between 100 to 300 years. Douglas-fir in an important early seral dominant where fires occur every 100 to 200 years in the pacific silver fir plant associations. At the moister, higher elevations, the fire-free period ranges between 300 to 600 years and Engelmann spruce and subalpine fir dominates early in succession. Where fire-free periods are less than 160 years, lodgepole pine likely dominates early in succession (Lillybridge et al 1995, Agee 1993).

Mountain hemlock and pacific silver fir share a broad overlap in their ecological distribution and are often hard to distinguish in the field. On the warmer, lower sites an early seral tree canopy is important in ameliorating site conditions allowing pacific silver fir establishment. Douglas-fir is more abundant on the drier sites along with noble fir (*Abies procera*). Pacific silver fir climax communities grade into mountain hemlock on cooler, moister sites with heavier snowpacks and also into western hemlock on the lower elevation, warmer sites. At the drier fringes at higher elevations, mountain hemlock climax communities grade into subalpine fir and whitebark pine (*Pinus albicalis).* However, western hemlock and Douglas-fir are the dominant seral species throughout most of the pacific silver fir habitat type, while pacific silver fir replaces Douglas-fir in importance as an early seral component in the mountain hemlock habitat type (Lillybridge 1995).

Fire exclusion in these ecosystems typically has not exceeded the fire-free period under which they evolved. As a result the composition and structure of these stands has not been altered appreciably over the last 80 years of fire suppression activities. These cool moist environments burn only under the most extreme fire weather conditions and typically dampen or extinguish fire spread from lower elevations. Because these environments are also typically associated with steep slopes with heavy snow loads, avalanche tracks also play an important function in limiting fire spread. Wind, snow breakage, root and stem disease are the key disturbance agents creating structural diversity within these habitat types.

Cold Dry Shrub/Herb

This environment is found in the high elevations (6,000 feet to 7,200 feet) mainly on ridge tops, shallow rocky soils, and in association with rock outcrops. Cold dry shrub/herb environments are depicted as windswept slopes, often on south aspects, that are cold and dry. Fire Group Three and the high elevational plant communities associated with Fire Groups Four and Six also grade into this environment. Persistent lodgepole pine stands associated with Fire Group Three are typically found in frost pockets restricted to drainage corridors, in the lower elevations. In the higher elevations they are likely less restricted in their range. Where subalpine fir is in association with grouse huckleberry as an abundant associate in the plant association, the site is indicative of frost pockets. These areas are difficult to regenerate following canopy removal because of the severe climate extremes. Only the most drought and cold tolerant plant associations are found in this environment. Whitebark pine is the most adapted to this environment and can be found where no other tree can grow. Subalpine larch plant associations are found within this environment but these plant associations are on the drier end of their ecological range and are associated with moister microsites within this environment.

Fire return intervals and fire severities are variable due to the open nature of these stands. Fires are typically weather driven when they do occur and mixed mortality burns are likely more common than total stand replacing events. Fire Group Six best describes the dynamics in these stands and is discussed in detail in the cold mesic and cold moist shrub/herb section below.

Cold Mesic Shrub/herb and Cold Moist shrub/herb

The cold mesic shrub/herb is commonly found within the same elevational range as the cold dry shrub/herb (6,000 feet to 7,200 feet). The cold moist shrub/herb environment has a larger ecological amplitude and may be encountered as low as 3,600 feet. Those plant associations in the cold mesic environment are also found on both sides of the Cascade Crest. Pacific silver fir and mountain hemlock plant associations dominate the landscape west of the Cascade Crest. Subalpine fir plant associations dominate the landscape east of the Cascade Crest. These subalpine fir plant associations, along with the cold dry shrub/herb communities, are high elevation communities frequently depicted as subalpine parkland habitat types east of the Cascade Crest. Those west of the crest are depicted as having a dense overstory canopy with a highly structured and diverse understory. Fire Group Six best describes the disturbance processes within these high elevation, cold environments east of the Cascade Crest while Fire Group Five best depicts the fire regimes and successional processes west of the Cascade Crest.

East of the Cascade Crest, whitebark pine increases with increasing elevation and site severity. Whitebark pine is also fire tolerant, often surviving low to moderate-intensity fire events. Subalpine larch is typically found on the more protected north aspects and requires moist soils throughout the growing season. It is not as fire tolerant as whitebark pine, but often escapes fire due to the sparse understory vegetation associated with subalpine larch. Lodgepole pine, subalpine fir, Engelmann spruce, and to a minor extent mountain hemlock are all components of these plant associations.

Fire return intervals range between 60 and 300 years in these systems (Kapler-Smith and Fisher 1995). Vegetation is typically sparse and discontinuous resulting in large expansive fires occurring only during extreme fire weather. Since weather is a driving force in the fire behavior associated with these sites, fires are typically of low or mixed-severity. Extensive fires are most likely early in succession when herbaceous fine fuels provide sufficient cover to carry a fire and late in succession when downed woody accumulation is high and understory regeneration provides ladder fuels into the mature canopy. After severe fire events succession is slowed due to the harsh exposed site conditions that restrict all but a few species from colonizing. Early colonizers (whitebark pine and subalpine larch) must ameliorate the climate extremes before additional species can establish.

Whitebark pine plays a critical role in the successional dynamics at timberline. Whitebark pine's ability to colonize cold, harsh environments makes it an important "nurse tree", ameliorating the site conditions so other more climate sensitive species can establish. Whitebark pine is shade intolerant, disappearing from the stand once it is over taken by more shade tolerant species.

Whitebark pine is long lived and can exceed 700 years of age, but in the absence of fire it will disappear as the more shade tolerant climax species shade it out. Fires recurring at irregular intervals that average 80 years are likely to maintain whitebark pine as a dominant species (Kapler-Smith and Fisher 1995). Under this fire return interval whitebark pine will dominate or be codominant with lodgepole pine. Fires occurring at regular 80 year intervals favor dominance of lodgepole pine.

Whitebark pine is fire resistant and most fires historically are mixed-severity fires favoring the regeneration of whitebark pine without removing the reproductively mature trees from the ecosystem. Stand replacing fires typically occur only during extreme fire weather events that occur every 200 to 400 years. Mixed-severity or non-lethal burns result from fire return intervals between 50 and 120 years. Stands dominated by subalpine larch rarely, if ever, experience stand replacing fires. Fire in these stands is typically a single tree event or affects a small cluster of trees creating the bare mineral soil necessary for seeding establishment. Fire also plays a critical role in maintenance of the subalpine meadow ecosystems.

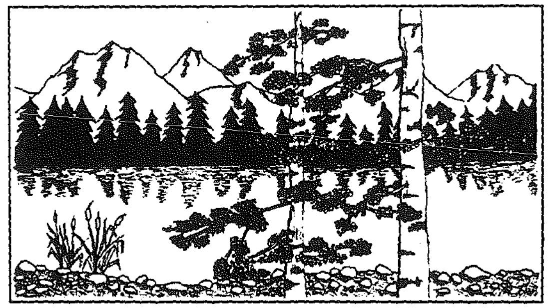
Whitebark pine and subalpine larch (*Larix lyalli*) are dependent on fires to create openings for seedling establishment. Whitebark pine is shade intolerant and is dependent on fire to periodically thin out the more shade tolerant and fire intolerant species that establish, especially at the lower elevations of its range. Fire exclusion favors the successional replacement of whitebark pine with subalpine fir in whitebark pine's lower elevational limits. Also, the introduction of white pine blister rust is now threatening whitebark pine throughout its range. In the absence of fire, older trees become susceptible to mountain pine beetle outbreaks as stand density increases at lower elevations and the food supply for migrating mountain pine beetle expands into these subalpine plant associations. Because whitebark pine requires up to 70 years before it reaches reproductive maturity, accelerated loss of mature trees is likely to result in its disappearance from the area. This can be attributed to whitebark pine's slow reproductive growth rate and lack of planting sites once produced by periodic fire.

Fire exclusion over the last 80 years has resulted in fewer fires reaching these higher elevation plant associations. The result is a landscape that is becoming more homogeneous in nature. The increases in stand density are resulting in increased insect activity and ladder fuels. The combined affect of fire exclusion, increased mountain pine beetle mortality, and blister rust has resulted in an accelerated loss of this species throughout whitebark pine's range (Keane et al 1990). Fires are now likely to be more severe and extensive than they were historically because of higher levels of mortality in the stand. Whitebark pine is a keystone species that holds these systems together in this cold, harsh environment. If this species continues to decrease in these ecosystems, the result will be that the timberline vegetation will drop in elevation below where whitebark pine is an early seral species.

West of the Cascade Crest, pacific silver fir, mountain hemlock, subalpine fir, and western red cedar are the dominant species. Fires are infrequent in these cold, snowy habitats, even though lightning strikes may be common. Fires are stand replacing when they do occur and have fire-free periods exceeding 100 years (Kapler-Smith and Fisher 1995). Lillybridge and others (1995) suggest the fire-free period ranges between 300 to over 500 years. Most historic fire return intervals have not been exceeded in these habitat types. Thus, the structure and composition of the landscape has not been appreciably altered.

At the highest elevations the mountain hemlock plant associations grade quickly into subalpine parklands. Early in succession Douglas-fir and western white pine dominate in the lower elevations, giving way to lodgepole pine and Engelmann spruce on the cooler, higher elevation sites (Kapler-Smith and Fisher 1995).

APPENDIX C



Plant Association Group Successional Pathways

A multiple-pathway, plant association group, successional model developed by the Ochoco National Forest (Simpson et al 1994) was adapted for this assessment. The 1983 satellite (LANDSAT) imagery provided the current vegetation data used in the classification of the seral stages described in each PAG. This was the best available data providing consistent and comparable data across the assessment area. It was field validated to be 85 percent accurate and appropriate for this large landscape scale assessment. Imagery classification was initially done to development a fire/fuels database for assessing potential fire intensity in a given area. This data broke the size classes into the following: less than 5 inches DBH for seedling/sapling, 5 inches to 14 inches for young trees, and greater than 14 inches for mature trees. In much of our area a stand of trees between 12 inches and 14 inches is often quite old and functions as late successional habitat. As a result, the team felt this assessment would slightly underestimate late successional habitat. At the treatment planning stage, more site specific data will be necessary to validate the site conditions defined in this model, especially since the data does not reflect harvest activity between 1983 and present.

Structural classifications and seral status were the foundation for the successional diagrams displayed in Figures C-2 through C-9. Each of the eight diagrams depict how a stand would develop if all successional sequences were completed starting from the bare ground/shrub seral stage to maturity without management. By depicting the successional sequence in this way the team was able to assess current vegetation condition, determine how various communities are likely to change over time, and develop management strategies to move community development in a desired direction. Mechanisms influencing the community development depend on the species present on the site prior to disturbance and the disturbance event. For each PAG these mechanisms are unique. That is to say the Ponderosa Pine PAG and the Dry Douglas-fir PAG evolved under a similar disturbance regime and the resulting mature forest is ponderosa pine. The vegetative expression of the mature forest under a frequent fire regime is similar, but the species composition of the two community types is different. Douglas-fir is a prolific colonizer following disturbance along with ponderosa pine in the Douglas-fir PAG but is absent or rare in the Ponderosa Pine PAG. With fire exclusion, the successional pathways of these two communities are different because succession is driven by the changes in species composition through time (Figures C-2 and C-3). Biophysical environments allow more specific classification of the landscape based on a broad scale disturbance regime. The PAGs describe how a particular group of plant associations would likely respond under a particular disturbance regime.

Each PAG diagram (Figures 2 through 9) describes the generalized developmental stages (seral stages) of the plant associations through time based on species composition and stand structure.

The 1983 satellite data limited how fine the species composition and stand structure could be defined. Size classes were restricted to three categories: seedling/sapling less than 5 inches DBH, young trees 5 inches to 14 inches DBH, and mature old trees greater than 14 inches. It would have been desirable to develop size class categories that matched the ecological conditions for each PAG. For example, in the colder higher elevations late successional habitats can be found where mature old trees are often smaller than 14 inches DBH; in the ponderosa pine zone mature stands are frequently greater than 20 inches DBH. In the Subalpine Parkland PAG and the Pacific Silver Fir/Mt. Hemlock PAG, species composition was more broadly lumped than was desired for this assessment. These things resulted in a more restrictive successional matrix than was desired.

Plant association groups (PAGs) were defined along an environmental gradient that is linked to an associated disturbance regime. This enhances the predictive capability of a stand's development through time. Along this environmental gradient the PAGs are defined from hot, dry, low elevation environments to cold, moist, high elevation environments along the Cascade Crest. These PAGs are Ponderosa Pine with a fire return interval less than 25 years; Dry Douglas-fir, with a fire return interval less than 50 years; Moist Douglas-fir, with a fire return interval greater than 50 years; Dry Subalpine Fir, with a fire return interval less than 200 years; and Moist Subalpine Fir, with a fire return interval greater than 200 years. Along the Cascade Crest west from the higher elevation to moister environments in the valley bottoms, there is the Pacific Silver Fir/Mt. Hemlock PAG with fire return intervals between 200 and 600 years and the Western Hemlock PAG with fire return intervals between 100 and 500 years (See Maps 1-5, Appendix H).

Each of the PAG diagrams share similar attributes in the way they are presented. The following narrative walks the reader through the PAG diagram format. This format classifies species composition into the seral stages. These are: (E) early seral species - those species that are colonizers following disturbance, climax species are absent or minor components of the stand; (M) mid seral species - comprised of a mix of early seral species and climax species that are co-dominant in the stand; and (L) late seral species - where the climax species are dominant and the seral species are less than 50 percent of the species composition. The one exception is in the Ponderosa Pine PAG where ponderosa dominates throughout succession. In this PAG, fire is important in creating the multi-aged, multi-stratum stand structure. To differentiate this, a LU classification is given to the uneven aged, fire influenced structures in the Ponderosa Pine PAG.

Classification of the structural classes are: (1) stands less than 5 inches DBH, (2) stands between 5 inches to 14 inches DBH, and (3) stands greater than 14 inches DBH. This structural classification is not well suited for truly reflecting the late old conditions of eastside communities because stands dominated by 12 inches to 14 inches DBH trees in many of these PAGs display late successional forest characteristics. As a result, this assessment is likely to be conservative in its assessment of late successional communities (Table C-1).

Species composition displayed in the seral stages for each PAG lists the dominant species in upper case and the minor species in lower case. The canopy is broken into those species found in the overstory (OS) and understory (US) (Figures C-2 through C-9).

These successional models are based on relative stages of community development. This is because the successional pathways that a community follows after a disturbance are highly dependent on the intensity of disturbance, seed source availability, and microsite conditions that favor the colonization of one species over another. The multiple-pathway model defines successional processes within a matrix structure where species composition is along one axis and size/structure is along another (Table C-1.) Given time and disturbance, forest development moves through different stages of species composition and structure. Following a disturbance, species that colonize the site or survive set the stage affecting the growth and reproductive success of individual species. The resulting species composition and structure then become the drivers of succession and are linked to the autecological characteristics of a species. Such characteristics are a plant's fire tolerance, shade tolerance, longevity, tolerance to temperature or moisture extremes, seed dispersal strategies, or its resistance to insects and disease. These characteristics allow predictions to be made on a broad scale that describe community change through time. Each seral stage defined in a PAG describes the unique species composition and structure of a stand at a given point in time. Seral stages can be identified in the field allowing a forested community to be placed along a successional time continuum. This allows prediction of the next plant community likely to develop given time and disturbance. It also provides a baseline that managers can use to predict effects of various management activities that will likely accelerate, arrest or set the successional clock back in time.

Table C-1 - Successional Matrix of Seral stages and Structural Stages.

	Structural Stage		
Seral stage	**Large Old trees >14" DBH (3)**	**Poles to Medium and Large trees 5" to 14" DBH (2)**	**Seedlings/Saplings <5" DBH (1)**
Late seral species (L/LU)	L3/LU3	L2/LU2	L1/LU1
Mid seral species (M)	M3	M2	M1
Early seral species (E)	E3	E2	E1
Post disturbance	Herbaceous shrub seral stage		

Ponderosa Pine Plant Association Group

Community development from the shrub seral stage to late successional habitat is depicted in Figure 2. General stand characteristics that describe the seral stage conditions are displayed in Tables C-2 through C-4. The information used in these tables was the best available information at the time of the assessment and may not be a true description of the conditions on the Okanogan. It is displayed for comparative purposes and should not be used as management criteria. Field data is needed to validate the assumptions made herein.

The Ponderosa Pine PAG is located in the hottest, driest environments found in the assessment area and makes up 4.7 percent of the forested habitat types within the assessment area. Because of the location of this PAG, it is too dry for successful reproduction of Douglas-fir. Douglas-fir is rarely found, establishing only accidentally when weather conditions are unusually favorable. Precipitation ranges between 15 and 30 inches. These sites are the low elevation timberline communities that grade into the treeless shrub steppe. At their upper elevation, they rarely exceed 4,000 ft. and are most commonly found on south to southwest aspects. These communities become more restricted to warmer aspects with increasing elevation and less restricted to aspect at the lower, drier elevations.

Fire plays a critical role in the development and maintenance of this PAG. Under a frequent low-intensity fire regime, a fire dependent community develops (L1->LU2->LU3). Ponderosa pine is shade intolerant and requires bare mineral soil to germinate. Frequent fires ensure opportunity for steady recruitment into these stands over time. These frequent fires regularly thin trees less than 4 inches DBH from the stand, thereby increasing available nutrients and growing space. The fire-free period rarely exceeds 24 years, and the fires are not stand replacing in nature (Finch 1983, Ohlson 1996, Kapler-

Smith and Fisher 1995). Fires burn in a mosaic pattern over large areas due to the sparse availability of adequate fuel to carry a fire. As a result, areas that burn in one fire event likely escape one or two fire cycles before reburning. This provides subsequent time for the ponderosa pine to develop and increase its likelihood of surviving the next fire event (L1 -> LU2).

The results of a fire history study (Ohlson 1995) conducted in the Methow indicate that under historical fire frequencies, young trees between 8 inches and 14 inches DBH are more vulnerable to recurring fires and continue to be thinned leaving only the larger dominant ones in the cluster. The lack of individuals in this size class created a gap in the vertical canopy structure reducing the risk of fire in the crowns of the largest trees. Once the surviving trees reach 14 inches to 16 inches DBH and 110 years old, they become stable in the stand surviving the frequent low-intensity fires and die as a result of senescence (LU2 ->LU3). This type of patch dynamics drives the development of the multi-aged, multi-stratum canopy with its large, widely spaced clusters of trees that is often referred to as the ponderosa pine "parkland" (LU3). As a result, the fire maintained ponderosa pine dominated communities are the most stable of any of the eastside forested communities under a frequent fire regime (Agee 1992). These fire maintained stands support fewer trees per acre that are larger in size than stands that develop in the absence of fire.

Herbaceous vegetation responds vigorously to the frequent fire regime producing a rich diversity of grass and forb species. The shrub component is scattered and sparse. Bitterbrush (*Pursia tridentata*) is the most abundant shrub in these communities. It is susceptible to fire, but can quickly resprout following low intensity, low severity fires. Colonization of bitterbursh via rodent caches is also common. There was likely less bitterbrush under a frequent low-intensity fire regime than is present today. However, frequent fires likely kept what bitterbrush was present from becoming decadent.

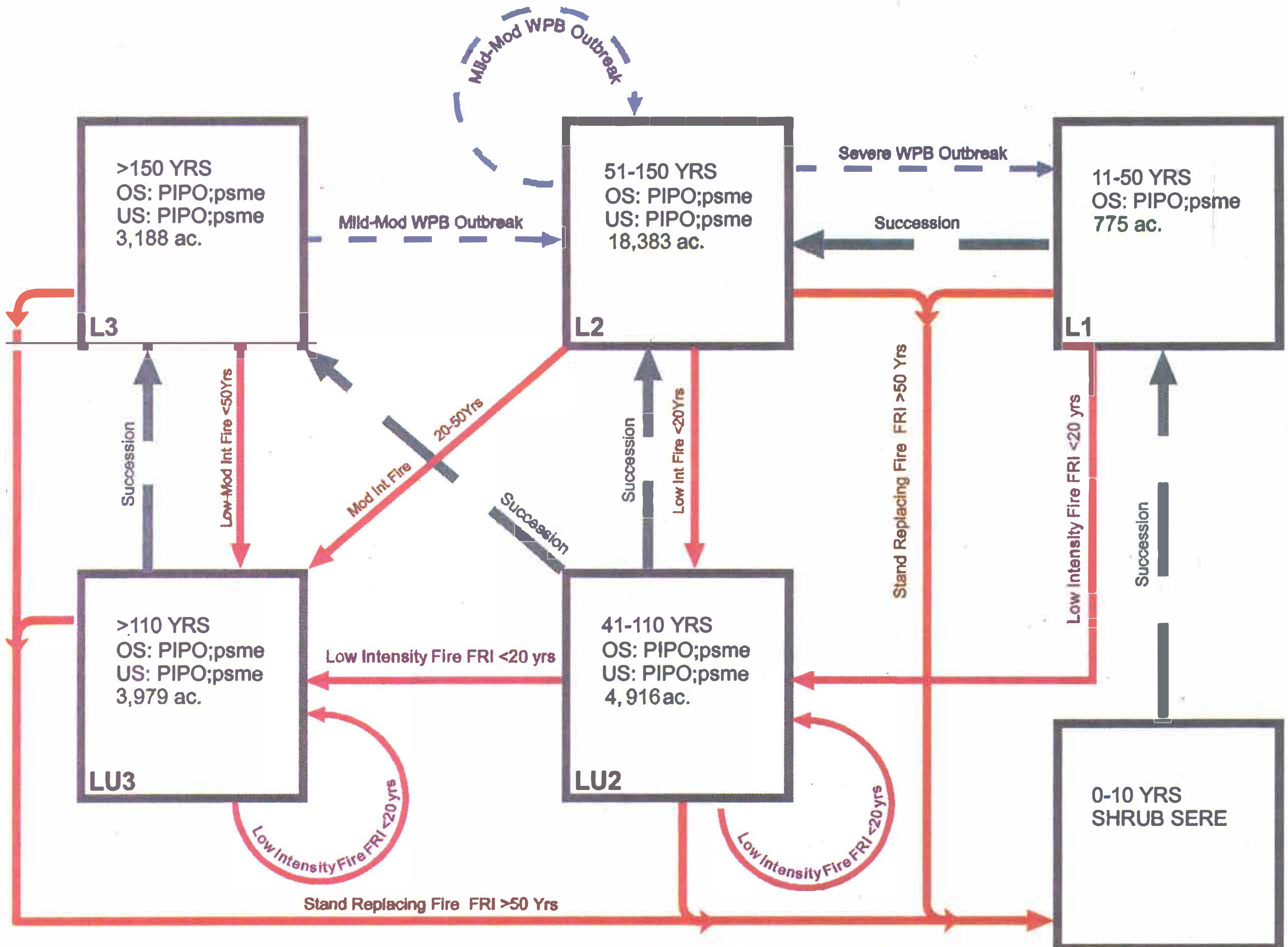
In the absence of fire (L1 -> L3), stands are not periodically thinned. Scarce nutrients are quickly tied up in the dense thicket of seedlings and growing sites are quickly filled. Growth is slower due to scarcity of soil nutrients and water. An even aged stand develops. Immediately following a ground disturbing activity, the understory vegetation is abundant (L1). As the fire-free period increases, many understory species become less abundant because they are shade intolerant. There is an increase in the composition of bitterbrush, but many of the plants are decadent and are less vigorous than under a frequent fire regime. Competition for scarce resources limits growth. The site is fully stocked and the stand stagnates. Growth can not occur unless nutrients and water become available. Only as trees die are additional scarce resources made available for residual tree grow. Stand structure is continuous both vertically and horizontally leaving these stands at higher risk for a catastrophic fire event. When trees exceed 8 inches DBH and about 70 square feet of basal area, they become high risk for western pine beetle and mountain pine beetle attacks. (Beetle killed trees contribute to the fuel loading further increasing the risk for a catastrophic fire.) The herbaceous and shrub understory vegetation is scarce. Mountain pine beetle kill the larger trees, thinning from above releasing the suppressed understory. Available growing sites are quickly occupied, once again locking up all the available nutrients and moisture in the above ground biomass and stagnating stand growth. Within 50 years the stand again has developed conditions putting it at high risk for mountain pine beetle attack and the cycle is renewed (L2). Because stand density exceeds the site's ability to sustain growth and mountain pine beetle continues to kill trees greater than 8 inches DBH, the stand is unable to develop a large (>14 inches DBH) tree component and cycles indefinitely in this state until a stand replacing fire occurs (L2). Snags created by bug kill have a shorter life span than the case hardened, fire snags and with time will continue to decrease in diameter since stand densities prevent trees from attaining the larger size classes before dying.

Fire exclusion in the LU2 and LU3 stands over the last 80 to 90 years has resulted in a shift from the open, clumped park-like forest to a multi-stratum, dense forested canopy. Disruption of the fire frequency increases tree survival in the understory of existing tree clusters bridging the gap between ground fuels and the upper tree canopy. As a result, tree canopies are becoming more continuous vertically and horizontally, stands are becoming fully stocked and stagnating. As mature stands become stressed and weakened from the competition of the developing understory, the risk of mountain pine beetle attack and catastrophic fire also increases (LU2 & LU3 -> L2 & L3). If no fires occur to thin the stand back to pre-fire exclusion conditions, the large trees will then be taken out by mountain pine beetle reverting the stand into the smaller size class (L3 -> L2). The shrub and herbaceous component of these stands is scarce displaying very little reproductive vigor. Most understory species are intolerant of shade and excessive accumulation of litter around vital growing points results in loss of individuals from the community.

The LU3 and L3 seral stages best describe late successional habitat in the Ponderosa Pine PAG. However, the L3 seral stage provides late seral habitat but it is not sustainable through time. Increased stand densities heighten the stress on the largest trees. These trees are the first to drop out of the stand and are not replaced due to stand stagnation.

In the Ponderosa Pine PAG, a stable and sustainable fire dependent community is described by the LU3 seral stage. In the LU3 seral stage there is little coarse woody debris. These stands are clusters of large old trees interspersed among openings with a rich diversity of herbaceous species and young, vigorously growing shrubs. Clusters of large, old trees that typically exceed 24 inches DBH and are over 200 years of age dominate the stand (Ohlson 1995). The tree tops are often infected with commandra blister rust (*Cronartium comandrae*) which slowly kills the top, one limb at a time. Old mature trees have flat tops and are often fire scarred or show evidence of lightening strikes on the bole. There is very little coarse woody debris on the forest floor. Death in the large, mature trees is random and they are scattered throughout the stand. When these snags fall they are short lived on the forest floor and are consumed by subsequent fire events. Younger fire killed trees are also short lived in the stand due to the fire frequency. There is a break vertically in the stand structure with the mature overstory trees towering 20-30 feet above the understory.

FIGURE 2: PONDEROSA PINE PAG



ac. = Assessment area acres by seral stage

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See appendix I for full names of species listed
OS = Overstory US = Understory
Upper case = Dominate species
Lower case = Minor species
WPB = Western Pine Beetle

Figure C-2

Table C-2 - Stand Characteristics of the Ponderosa Pine PAG.

	L1	LU2	LU3*	L2	L3*
Trees per acre (TPA)	45	40	30	100	50
Acres	775	4916	3979	18383	3188
Crown Closure %	30-70	1-30	1-30	70+	31-70
+Fuel loading tons/ac	10	13.8	8.4	15.6	
Crown fire risk	LOW	LOW	LOW	LOW	MOD

*Seral stages that provide late successional habitat.
+Derived from fuels photo series (Maxwell et al 1980, Fischer 1981).

Table C-3 - Late Successional (LS) Characteristics in the Ponderosa Pine PAG.

	DBH class	LU3*	L3
TPA for LS stands *	21"-30" 31"+ 21"+ range	10-13 2-3 18-47	10-13 2-3 18-47
#Crown Closure (%)		1-30	31-70
Green Tree Replacement & Snags TPA **	>21" >12"	2 8	2 8
CWD ***	12"+ !	120 lineal ft !	120 lineal ft !
CWD tons/ac **	>3"	5-8	5-8
Defective trees TPA at 10%-15% *	unknown	3-5	5-7

*Taken from R6 Interim Old Growth Definitions 6/93.
#Developed from the 1983 satellite imagery.
! As required by REO.
**Taken from ICBEMP Vol. 1 Table 3-5 1997.
***The objective is to retain the largest pieces available.

Table C-4 - Ponderosa Pine PAG Dominant Species* By Lifeform.

Trees +	Shrubs/Subshrubs +	Herbaceous +
PIPO, PSME	AMAL, CEVE, PUTR BEAQ SYAL ARUV	AGSP, FEID, CARU, CARO CACO, CAGE, KOCR, BASA, LUPIN, ACMI BRTE

Species that occur at least 50% of the time or are key plant association indicator species (Lillybridge et al 1995)
+ See Appendix H for full species names.

Dry Douglas-Fir Plant Association Group

Community development from the shrub seral stage to late successional habitat is depicted in Figure 3. General stand characteristics that describe the seral stage conditions are displayed in Tables C-5 through C-7. The information used in these tables was the best available information at the time of the assessment and may not be a true description of the conditions on the Okanogan. It is displayed for comparative purposes and should not be used as management criteria. Field data is needed to validate the assumptions made here.

The Dry Douglas-fir PAG is a dominant community type across the landscape, increasing in its distribution from the Hot Dry, Warm Dry, to Warm Mesic biophysical environments and makes up 24.7 percent of the forested habitat types within the assessment area (Figure 2-1, Chapter 2), shows the greatest percentage of the acreage is found within the Warm Mesic biophysical environment. Most communities are restricted to the warmer south to southeast aspects between 3,000 feet and 5,000 feet. Precipitation ranges between 25 to 40 inches. Except for the greater composition of Douglas-fir, those sites at the drier end of this PAG are similar to the Ponderosa Pine PAG. With increasing elevation and moisture there is a shift in species composition that is reflective of both increased soil moisture and slightly longer fire-free periods.

Like the Ponderosa Pine PAG, fire plays a critical role in the development and maintenance of this PAG. Seral stages E1, E2, and E3 are nearly identical to the Ponderosa Pine PAG in their successional sequence and fire regime with E3 representing a stable fire climax. The one primary difference is the Douglas-fir PAG is slightly moister, allowing Douglas-fir to successfully reproduce following disturbance. Fires still burn in a mosaic pattern over large areas and are not stand replacing in nature. Areas that burned in one fire event likely escape one or two fire cycles before burning again providing ample time for ponderosa pine to develop fire resistant characteristics but not for Douglas-fir. Ponderosa pine is able to survive frequent low-intensity fires once it exceeds 2 inches DBH while Douglas-fir does not develop fire resistant characteristics until it exceeds 6 inches DBH. (Hall 1990 and Kauffman 1990). With fire-free periods rarely exceeding 24 years ponderosa pine is favored and dominates (E1 -> E2). Biomass production between fire events is slightly more than in the Ponderosa Pine PAG. Fires are slightly more severe when they occur resulting in greater mortality in the trees between 6 inches and 16 inches DBH. A larger gap in the vertical canopy structure develops that prevents the higher flames from reaching into the upper canopy. Trees are larger and taller before they become a stable overstory component of the stand. Trees become stable overstory components of the stand when they are around 16 inches DBH and 110 years (E2 -> E3).

Frequent, low-intensity fire is still the key element driving the gap dynamics that shape this landscape. Rapid establishment of seedlings occur especially when a fire is followed by 4-5 years of favorable moisture. Douglas-fir is a prolific colonizer along with ponderosa pine but subsequent fires begin to thin the dense clusters of trees less than 4 inches to 6 inches DBH (E1 -> E2). Ponderosa pine is favored due to its superior fire tolerance. Fire continues to thin young trees between 6 inches and 16 inches DBH and creates small openings for new clusters of trees to establish. Douglas-fir begins to develop thick insulative bark between 40 and 70 years, but remains vulnerable to fire due to its dense needle arrangement, low growing limbs, and susceptibility to mistletoe. Ponderosa pine continues to be favored under a 7.5 to 25 year fire frequency (Ohlson 1996, Kapler-Smith and Fisher 1995). Portions of the landscape begin to develop the multi-aged, multi-stratum, "parklike" appearance characteristic of a ponderosa pine fire climax community (E2 -> E3). Gradually, Douglas-fir are able to survive long enough in the stand to develop fire resistant characteristics, making up about 30 percent to 45 percent of the species composition within 110 years (E1 -> E2 -> E3).

Once the trees become stable in the overstory, death is random and often isolated to a single tree or small cluster of trees. As a tree approaches senescence, it looses vigor which allows other agents such as heart rot and insects to eventually kill it. Mountain and western pine beetle outbreaks are limited to small clusters of overstocked ponderosa pine that have escaped previous fires or single trees nearing senescence. Frequent fires also keep the amount of Douglas-fir mistletoe to a minimum by thinning out the more fire prone mistletoe infected individuals in the understory and isolating the infection to the upper crowns where fire is unlikely to reach. These fire maintained stands support fewer trees that are larger and remain vigorously growing for centuries.

Herbaceous vegetation responds vigorously to the frequent fire regime producing a rich diversity of grass and forb species. The shrub component is scattered and sparse. Bitterbrush (*Pursia tridentata*) is the most abundant shrub in these communities. It is susceptible to fire, but re-colonizes the site via rodent caches or re-sprouting. As a result, frequent fires keep the bitterbrush in a vigorous state, preventing it from becoming decadent.

In those stands that evolved under a longer fire-free period (25-50 years), the composition of Douglas-fir is greater. This is because many of these sites are in the cool dry biophysical environment where ponderosa pine is reaching the upper elevational limits of its range. The fire-free period is of sufficient length to allow Douglas-fir a greater opportunity to develop fire resistant characteristics it needs to survive frequent fires. Lodgepole pine composition increases in these communities with increasing available moisture. All the major species associated with this PAG are fire dependent or resistant to frequent "low to moderate" intensity fires. This results in a slightly different fire climax than described for seral stages E1, E2, and E3. Lodgepole pine and ponderosa pine are shade intolerant requiring bare mineral soil for successful regeneration. Lodgepole pine has serotinous cones and is a prolific colonizer following fire and dominates the early seral stages when present in the stand prior to a fire event. Douglas-fir is moderately shade intolerant, establishing in the understory as the lodgepole pine stand begins to thin with age (Lillybridge et al 1995). Fires typically are more moderate in intensity with small stand replacing fires occurring within larger non-lethal burns. A diverse structural landscape mosaic develops. After a fire, a rich diversity of shrubs develop often suppressing subsequent fires because of the high moisture content of the vegetation that makes up this shrub seral stage.

Severe stand replacing fires occurring between 30 and 60 years will maintain this shrub sere indefinitely (Kapler-Smith and Fisher 1995). The diversity of stand structures help to break up the continuity of the fuels and fires are often small in size (M1 -> M2 -> M3). Fires that regularly occur between 25 and 50 years thin out the more fire sensitive lodgepole pine favoring Douglas-fir and Ponderosa pine. Stand densities are maintained below levels that would trigger large scale western and mountain pine beetle outbreaks. Trees are widely spaced and grow vigorously. Post fire landscape patterns also break up the continuity of the mountain and western pine beetle food supply, restricting the size of a given outbreak. These outbreaks are mainly restricted to overstocked patches that have escaped previous fires (M1 -> M2). Douglas-fir and ponderosa pine are the dominant species with lodgepole pine being a minor component. This is because lodgepole pine is the most fire intolerant of the species in this PAG, it is at the lower limits of its ecological range, and fires are frequent enough to maintain it as a minor component.

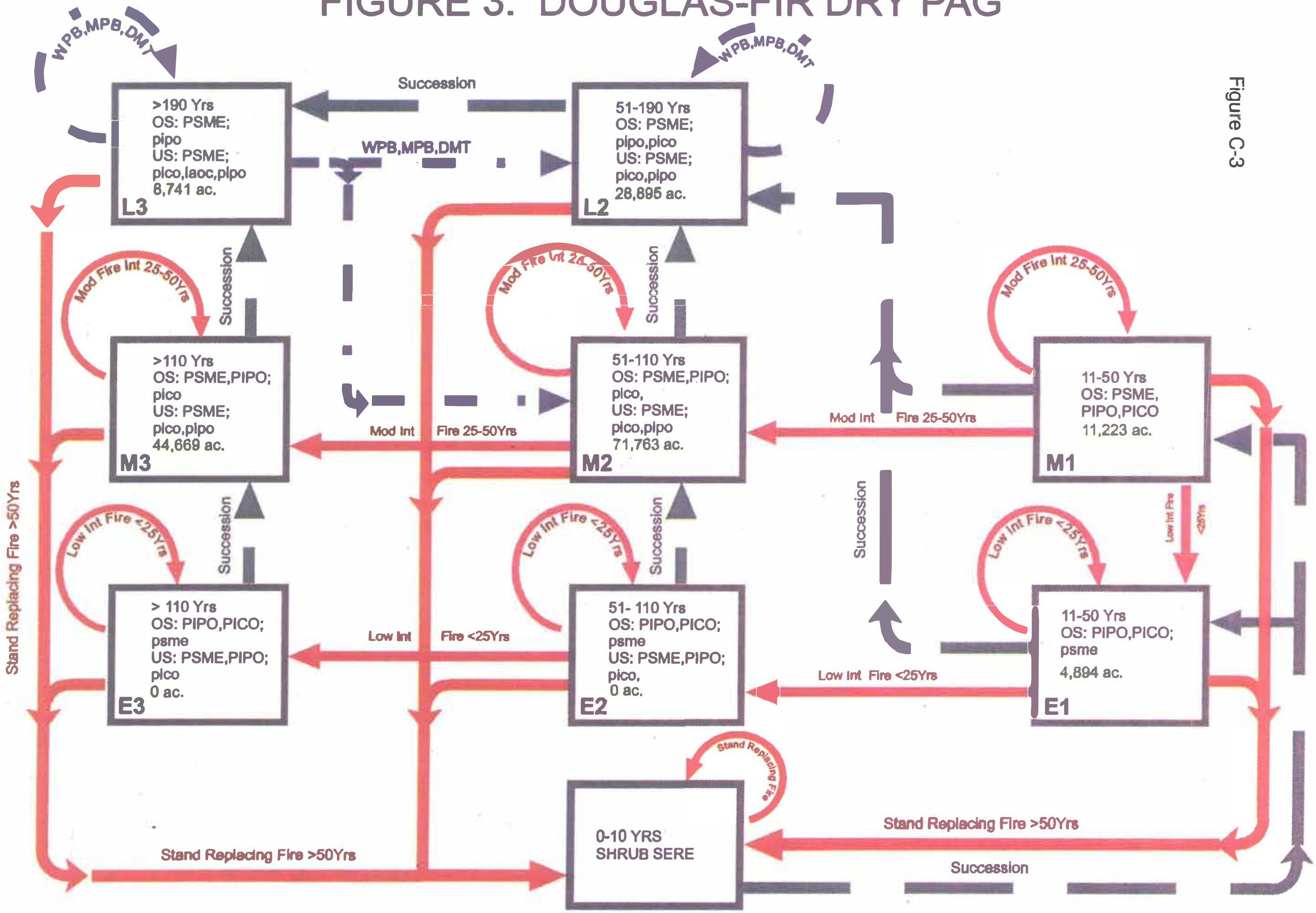
When fires are non-lethal in nature, the structural stand development for the M1 through M3 seral stages is similar to the E1 through E3 seral stages. Fires regularly thin the understory less than 4 inches to 6 inches DBH (M1 -> M2). Young trees between 6 inches and 16 inches continue to be thinned by fire because of the seedlings and saplings that grow up into the crowns between fire events. Trees between 6 inches and 16 inches DBH make up a small portion of the stand as a result and trees greater than 16 inches DBH dominate the stand (M2 -> M3) (Ohlson 1996). Fires also decrease the occurrence and spread of Douglas-fir dwarf mistletoe throughout the stand since infected trees are more flammable. Mistletoe in lodgepole pine and ponderosa pine are also more susceptible to fires but to a lesser degree than Douglas-fir.

Most herbaceous and shrub species are resistant to fires and respond vigorously following a fire (Volland 1981). The shrub component of these stands is more developed than in the E1 through E3 seral stages because there is a longer fire-free period that allows a greater expression of shrubs to develop. There is a rich diversity of species found in the shrub layer that persist in the understory of this fire regime. In the absence of fire, species abundance decreases with only bearberry (*Archtostaphylos uva-ursi*) and pachistima (*Pachistima myrsinites*) able to persist in any abundance.

With fire exclusion, stand growth slows with the increasing stand density that follows a longer fire-free period. Douglas-fir is the most prolific species, quickly filling in the interstitial spaces between the earlier established trees. This significantly increases the Douglas-fir composition in the stand (E1 and M1 -> L2). At about stand age 90 these mixed conifer stands begin to exceed 110 square feet of basal area, increasing the risk of mountain pine beetle attacks on ponderosa pine and lodgepole pine. Pine beetles thin the stands from above, selecting the largest trees in the stand. Within 50 years of the pine beetle outbreak, the stand is again reaching a stocking density that will trigger another outbreak. Around age 60 dwarf mistletoe begins to spread rapidly through the stand advancing about 15 feet per decade from an infection center. Beetle killed trees along with the increased incidence of dwarf mistletoe increases the risk of a catastrophic fire. The landscape diversity begins to disappear without period fires and the stands become more homogeneous across large acreages. Between 150 and 200 years lodgepole pine drops out of the stand. (L2 -> L3). Dwarf mistletoe infected Douglas-fir dominate the species composition. Eventually, the mistletoe infected Douglas-fir become weakened and those trees greater than 14 inches DBH are singled out and killed by Douglas-fir beetle and root disease (L3 -> L2).. Stand densities continue to fluctuate with outbreaks of western and mountain pine beetle which further reduce ponderosa pine in the stand. Beetle outbreaks become cyclic, occurring about every 50 years. When the Douglas-fir and pine beetle outbreaks occur, they cover large areas selecting trees greater than 6 inches DBH, and creating stands that are dominated by pole size trees (L3 -> L2 & M2). In the Dry Douglas-fir PAG there are two types of late successional forests that evolved prior to European settlement. One is described by the E3 seral stage and is characteristic of a fire climax with a fire return interval less than 25 years. The other is also a fire climax and is described by the M3 seral stage with a slightly longer fire-free period between 25 and 50 years. These are the two seral stages where stands of large, old trees are likely sustainable over the long term. The open grown stands and frequent fires likely maintained stands with little coarse woody debris or snags with the amount of coarse woody debris likely increasing with elevation. Dwarf mistletoe is common in the old scattered Douglas-fir and is isolated to the upper most portions of the crown. The mature ponderosa pine frequently have spiked or broken tops resulting from decades of commandra blister rust infection. From about 300 years on, the ponderosa pine begin to develop large, heavy limbs; gnarled crooked branches, and the lower limbs begin to die. The tops are irregular and often flat. Site specific data is lacking on the amount of coarse woody debris or snags that occurred in these stands historically or what occur currently.

FIGURE 3: DOUGLAS-FIR DRY PAG

Figure C-3



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WPB = Western Pine Beetle
MPB = Mountain Pine Beetle
DMT = Dwarf Mistletoe
ac. = Assessment area acres by seral stage

See appendix I for full names of species listed
OS = Overstory US = Understory
Upper case = Dominate species
Lower case = Minor species

Table C-5 - Stand Characteristics of the Dry Douglas-Fir PAG.

	E1	E2	E3*	M1	M2	M3*	L2	L3*
Trees per ac (TPA)	200-300	90-140	50-75	400	37	101	351	115-210
Acres	4894			11223	71763	44669	28895	8741
Crown Closure %	31-70	1-31	1-30	31-70	1-31	1-70+	1-31	31-70+
+Fuel loading tons/ac	14.2	2.5	7.8	6.8	15.6	26.7	10.8	20.4
Crown fire risk	LOW	LOW	MOD	LOW	LOW	MOD	MOD	MOD

*Seral stages that provide late successional habitat. +Derived from fuels photo series (Maxwell et al 1980, Fischer 1981)

Table C-6 -Late Successional (LS) Characteristics in the Dry Douglas-Fir PAG.

	DBH class	E3	M3	L3
TPA for LS stands *	21"-30" 31"+ 21"+ range	10-13 2-3 18-47	10-13 2-3 18-47	10-13 2-3 18-47
#Crown Closure (%)		30 +		
Green Tree Replacement & Snags TPA **	>21" >12"	2 8	2 8	2 8
CWD ***	12" !	120 lineal ft !	120 lineal ft !	120 lineal ft !
CWD tons/ac **	>3"	5-9	5-9	5-9
Defective (TPA) at 10%-15% *		5-10	10-15	11-30

*Taken from R6 Interim Old Growth Definitions 6/93.
#Developed from the 1983 satellite imagery.
! As required by REO.
**Taken from ICBEMP Vol. 1 Table 3-5 1997.
***The objective is to retain the largest pieces available.

Table C-7 - Dry Douglas-Fir PAG Dominant Species* By Lifeform.

Trees +	Shrubs/Subshrubs +	Herbaceous +
PIPO, PICO, PSME	ARUV BEAQ PEFR3 PUTR SPBEL SYAL HODI PAMY, CEVE, AMAL, HODI ROGY	BASA, ASDE LUPIN, ACMI, ARCO, AGSP, CARU, FEID, CAGE, CARO CACO LUNA2

* Species that occur at least 50% of the time or are key plant association indicator species (Lillybridge et al 1995).
+ See Appendix H for full species names.

Moist Douglas-Fir Plant Association Group

Community development from the shrub seral stage to late successional habitat is depicted in Figure C-4. General stand characteristics that describe the seral stage conditions are displayed in Tables C-8 through C-10. The information used in these tables was the best available information at the time of the assessment and may not be a true description of the conditions on the Okanogan. It is displayed for comparative purposes and should not be used as management criteria. Field data is needed to validate the assumptions made here.

Of the forested habitat types, 16.6 percent are in the Moist Douglas-fir PAG. Over 75 percent of the Moist Douglas-fir PAG is found within the Warm Dry and Warm Moist biophysical environments. The greater environment reflects the increased moisture associated with the plant communities in this PAG over the Dry Douglas-fir PAG (Figure 2-1, Chapter 2). Precipitation ranges between 35 and 65 inches annually. The Moist Douglas-fir PAG represents some of the most productive plant associations in the assessment area. With increasing elevation, the cooler climate and shorter growing season begins to limit the occurrence of Douglas-fir and it begins to grade into the higher elevation Subalpine Fir and Pacific Silver Fir/Mt. Hemlock PAGs. Douglas-fir has the greatest ecological amplitude of any of the forested series on the Okanogan National Forest, ranging from below 1,500 feet to over 5,000 feet. The Moist Douglas-fir PAG is typically found in the mid elevations between 3,000 feet and 5,000 feet in elevation. Fires are of a moderate intensity in the Moist Douglas-fir PAG. Lodgepole pine and ponderosa pine are early seral dominants in areas below 4,000 feet and Douglas-fir is a minor component in these stands after a disturbance (E1). On those sites over 4,000 feet lodgepole pine is a co-dominant with Douglas-fir and ponderosa pine as a minor component of the stand following fire (M1). Moderate intensity fires stimulate a rich diversity of species, especially favoring the huckleberry species

In the lodgepole dominated stands (E2) the denser canopies and higher stocking rates reduce the abundance and vigor of the understory species. Non-lethal, low-intensity fires commonly occurred at intervals between 30 and 60 years while more moderate-intensity, mixed-mortality fires occurred between 60 and 120 years. These fires thinned the lodgepole pine and young Douglas-fir favoring ponderosa pine (E2 -> E3). The understory tends to be to be comprised of Douglas-fir and lodgepole pine with Douglas-fir being favored by the low intensity fires and lodgepole pine and ponderosa pine by the moderate-intensity fires. Fire-free periods were long enough to allow Douglas-fir to develop its fire resistant qualities. Ponderosa pine is the dominant species below 4,000 feet while ponderosa pine and western white pine are maintained as minor components on sites above 4,000 feet and grow to large size. Dwarf mistletoe is restricted primarily to large fire resistant Douglas-fir and can be severe in lodgepole pine (E3). Low to moderate intensity fires maintain a rich diversity of shrubs in the understory as well as maintain the early species composition indefinitely (E3). In the absence of fire these stands quickly become over stocked (E2). Between 80 and 90 years mountain pine beetle attack the lodgepole pine that are 8 inches DBH and larger. Outbreaks are severe enough to change the composition of the stand releasing the Douglas-fir in the understory (E2 -> M1 and E2 -> M2).

Stands where Douglas-fir is dominant in the overstory (M2), fire-free intervals are typically longer, resulting in a more mixed mortality fire. As with the early seral stages (E1 through E2), Douglas-fir and lodgepole pine dominate stands above 4,000 feet while ponderosa pine becomes an important component of the stand below 4,000 feet. After about 80 years stand densities are sufficient to trigger an outbreak of mountain pine beetle which kills between 200 to 300 trees per acre of lodgepole further releasing the Douglas-fir in the stand (M2 -> L2). With the lodgepole pine component being significantly reduced, and without periodic fire Douglas-fir tends to be the primary understory species. Root disease and dwarf mistletoe become the primary disturbance agents creating structural diversity in these stands (L2). Less severe mountain pine beetle outbreaks thin about 100 trees per acre of lodgepole and allow lodgepole pine to remain a co-dominant in the stand (M2 -> M3). Moderate intensity fires shift the species composition in favor of ponderosa pine (M2 -> E3).

When lodgepole pine reaches the end of its lifespan (between 120 and 200 years) a multi-canopy stand develops favoring Douglas-fir in the understory (M3). Dwarf mistletoe is present in the overstory trees and is beginning to infect the young Douglas-fir in the understory. Laminated root rot and Douglas-fir bark beetles begin to cause mortality in small pockets of densely stocked trees. Flat topped and deformed Douglas-fir increase with increases in dwarf mistletoe. Ponderosa pine and lodgepole pine begin to drop out of the stand due to mountain pine beetle attacks (M3 -> L3). Periodic low to moderate-intensity fire reduces the risk of a stand replacing fire event and maintains these stands indefinitely (M3). Today, these stands are at the highest risk for catastrophic fires (Table C-98).

In the absence of periodic fire, lodgepole pine begins to disappear from the stand as a result of either mountain pine beetle outbreaks or senescence, which occurs between 160 and 200 years. This further favors Douglas-fir in the overstory (M3 -> L3). These stands (L3) are multi-storied as gaps in the canopy are created by mortality of mature trees. Dwarf mistletoe levels are high throughout the entire canopy creating flat topped and deformed trees. Periodic defoliation of Douglas-fir by western spruce budworm and Douglas-fir tussock moth weakens the trees increasing their susceptibility to Douglas-fir beetle and root disease. Root disease and bark beetles become the primary disturbance agents in the L3 seral stage. Mortality in the larger trees is high, with ponderosa pine and western white pine also being removed in bark beetle outbreaks. Large snags are likely to be abundant in the stand as a result the higher rates of mortality in the large tree component caused by insects and disease. The risk of a catastrophic fire increases as the fire-free period lengthens and fuels increase both vertically and on the forest floor (L3) (Table C-8). Over 40 percent of the acres in the Moist Douglas-fir PAG are in this late successional L3 seral stage and another 43 percent is in the L2 seral stage. Both these seral stages reflect stands that likely developed since fire exclusion in the last 80 to 100 years. It is likely that these types of stand conditions were restricted to post-burn refugia and were less abundant than today. Historically, the mixed mortality fires of small size associated with the M3 and E3 seral stages were common with the L3 and L2 seral stages being the post-burn refugia. The landscape was made up of a complex mosaic structure where insects, disease, and fire maintained a rich diversity of species and landscape structures. Since the plant associations in the Moist Douglas-fir PAG are some of the most productive sites on the Okanogan National Forest, these sites have the capacity to quickly change following fire exclusion. Today, insects and disease are the primary disturbance agents and the continuity of the fuels have become more homogeneous across large contiguous blocks of land.

Dense canopies reduce the abundance and diversity of species in the understory while increasing the risk for severe fires that often suppress the recovery of the understory species. Many of the associated species in the Moist Douglas-fir PAG are stimulated from periodic fire. Huckleberry are the dominant shrub species in this PAG and are among those species favored by a more frequent fire regime.

In the Moist Douglas-fir PAG there are several seral stages that function as late successional habitat. The E3, M3, and L3 seral stages all function ecologically as late successional habitat. Historically, the E3 seral stage was maintained by low to moderate intensity fires in a relatively open ponderosa pine dominated stand that are most abundant below 4,000 feet and is often associated with cooler microsites. Even the more open nature of these stands likely meet the minimum levels of coarse woody debris, snags, number of large trees, and canopy closure (Table C-9). The M3 and L3 seral stages with the abundance of dwarf mistletoe and multi-stratum canopies provide the ideal structural diversity to meet the needs of the northern spotted owl. Even the L2 seral stage provides suitable habitat for the northern spotted owl because of the abundance of mistletoe brooms. Everett and others (1991) found northern spotted owl successfully reproducing in trees as small as 11 inches DBH where canopy cover exceeded 70 percent and there was a multi-canopy stand. The L2 seral stage fits this description of usable habitat. It is also the seral stage with the greatest number of acres currently. This means that more than 90 percent of this PAG is capable of supporting the northern spotted owl. However, by managing to maximize stand structures in the E3, M3, and L3 seral stages, there will be less early seral lodgepole pine habitat available for lynx. Koehler and Brittell (1990) have established the lower elevational limits of lynx to be 4,500 feet which is well within the elevational range of the Moist Douglas-fir PAG.

FIGURE 4: DOUGLAS-FIR MOIST PAG

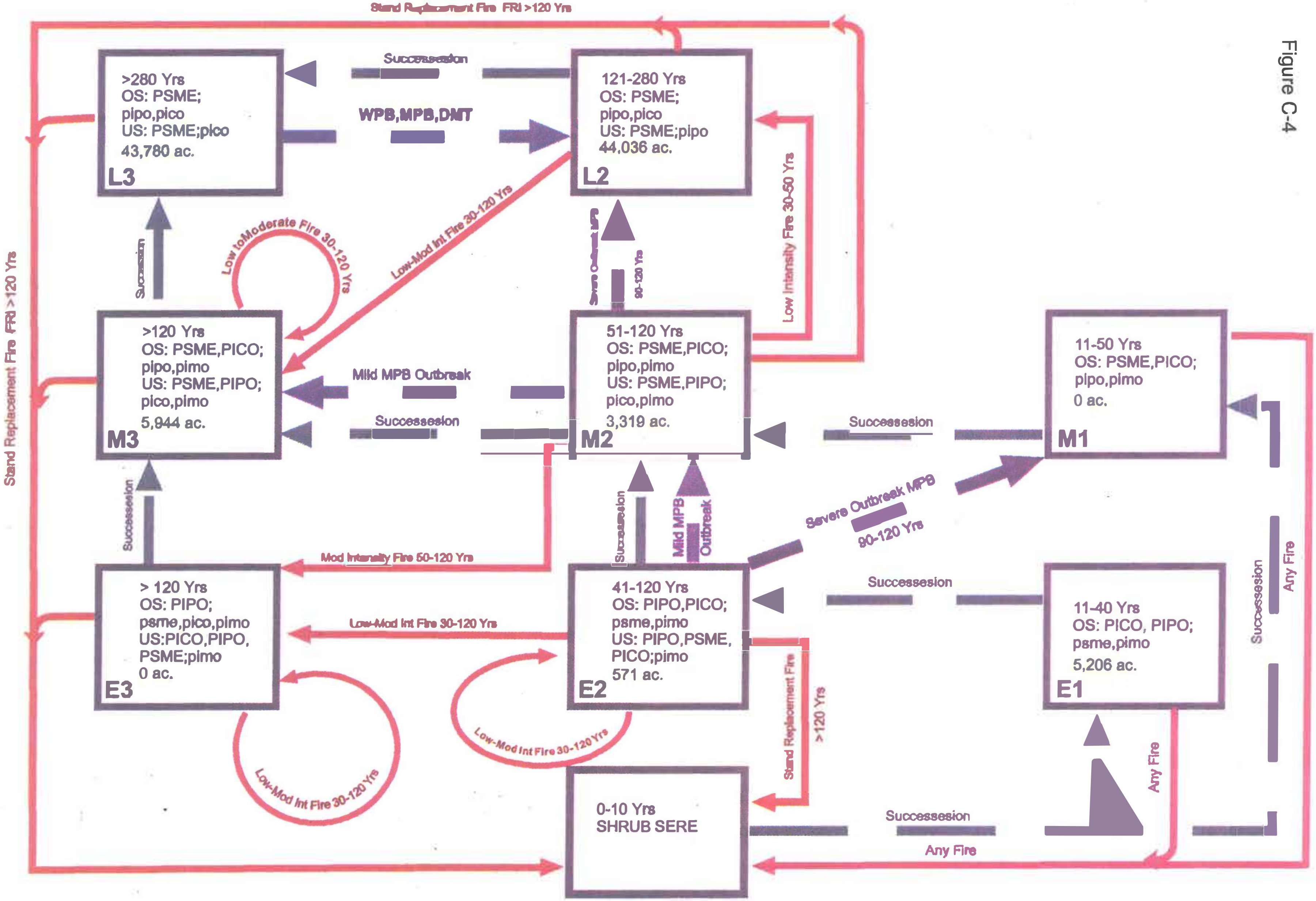


Figure C-4

Appendix C - 15

4/7/97

WPB = Western Pine Beetle
MPB = Mountain Pine Beetle
DMT = Dwarf Mistletoe
ac. = Assessment area acres by seral stage

See appendix I for full name of species listed
OS = Overstory US = Understory
Upper case = Dominate species
Lower case = Minor species

Table C-8 - Table Of Moist Douglas-Fir PAG Characteristics.

	E1	E2	E3*	M1	M2	M3*	L2	L3*
Trees Per Ac (TPA)	1000+	800	300	500	600	400	400	210
Acres	5206	571			3319	5944	44036	43780
Crown Closure %	70+	31-70			1-30	1-30 70+ equally split	70+	1-30 31-70 70+ equal mix
+Fuel loading tons/ac	7.6	16.8	10.4		20.4	31.8	11.1	31.8
Crown fire risk	Low	Low	Mod	Low	Mod	High	Mod	Mod

*Seral stages that provide late successional habitat.
+Derived from fuels photo series (Maxwell et al 1980, Fischer 1981).

Table C-9 - Late Successional (LS) Characteristics in the Moist Douglas-Fir PAG.

	DBH Class	E3, M3, and L3
TPA for LS stands *	21" +	8
#Crown Closure (%)		30 +
Green Tree Replacement & Snags TPA **	>21" >12"	6 12
CWD ***	12" + **	240 lineal ft **
CWD tons/ac **	>3" **	10-20 **
Defective trees TPA *		2

*Taken from R6 Interim Old Growth Definitions 6/93.
#Developed from the 1983 satellite imagery.
**Taken from ICBEMP Vol. 1 Table 3-5 1997.
***The objective is to retain the largest pieces available.

Table C-10 - Moist Douglas-Fir PAG Dominant Species* By Lifeform.

Trees +	Shrubs/Subshrubs +	Herbaceous +
PICO PIPO PIMO PSME	ARUV BEAQ CEVE CHUMO JUCO4 LIBOL PAMY PYSE SPBEL VACA VAMY VAME	ARCO CACO CARU CARO LUPIN

* Species that occur at least 50% of the time or are key plant association indicator species (Lillybridge et al 1995).
+ See Appendix H for full species names.

Dry Subalpine Fir Plant Association Group

Community development from the shrub seral stage to late successional habitat is depicted in **Error! Reference source not found.**. General stand characteristics that describe the seral stage conditions are displayed in Tables C-11 through C-13. The information used in these tables was the best available information at the time of the assessment and may not be a true description of the conditions on the Okanogan. It is displayed for comparative purposes and should not be used as management criteria. Field data is needed to validate the assumptions made here.

The Dry Subalpine Fir PAG makes up 15.5 percent of the forested habitat types in the assessment area. Over 50 percent of the Dry Subalpine Fir PAG is found within the Cool Mesic and Warm Mesic biophysical environments (Table 2-1,Chapter 2). Annual precipitation is typically between 40 inches and 50 inches. These communities range in elevation between 2,800 feet to over 6,000 feet with most communities occurring near or below 5,000 feet. Ponderosa pine is a minor early seral dominant species in seven of the plant associations represented in this PAG. It is suspected these plant associations represent the proportion of this PAG found in the Warm Dry and Warm Mesic biophysical environments.

Much of this PAG interfaces with the Dry Douglas-fir PAG at the lower elevations. Consequently, the fire regime associated with the Dry Douglas-fir PAG also influences the fire regime in the Dry Subalpine PAG. Lodgepole pine is the dominant early seral species when fire return intervals are less than 160 years (E1). Lodgepole pine is present throughout the development of these

stands, it quickly colonizes a site following disturbance due to it's serotinous cones and the young age at which it matures (12-20 years). As a result, the M1 and L1 seral stages rarely develop immediately following a fire disturbance.

Stand replacing fires frequently occur between 52 and 200 years while intermittent non-lethal fires occur between 30 and 60 years in many subalpine fir communities in Northern Idaho (Kapler-Smith and Fisher 1995). Shorter fire return intervals of 15 to 40 years have been documented for dry subalpine forested communities in the Central Washington Cascades (Woodard 1977). Fire return intervals between 15-60 years favor lodgepole as the dominant species and may result in an increased composition of ponderosa pine in those plant associations within the ecological range of ponderosa pine. Lodgepole pine and ponderosa pine are favored because fire return intervals are more frequent than the time necessary (40-70 years) for Douglas-fir to develop its fire resistant qualities. These intermittent, non-lethal to mixed mortality fires thin the stands keeping lodgepole and ponderosa pine from becoming overstocked and susceptible to large scale, severe mountain pine beetle outbreaks (E1->E3) (Kapler-Smith and Fisher 1995).

These E3 stands, in the absence of fire, are subjected to mountain pine beetle outbreaks about every 50 years. Depending on the severity of the outbreak and the species composition of the stand, the composition and structure of the stand shifts in favor of whichever species is dominant in the understory (E3 -> M1, M2, L1 or L2). When stand ages exceed 90 years without intermittent fire, mountain pine beetle outbreaks are likely severe enough to generally shift the species composition in favor of Douglas-fir (E2 ->M2 or M1). In these lodgepole dominated stands fires stand replacing fires are common resulting in a cycling of nearly pure lodgepole pine forests (E1, E2, E3 -> shrub sere -> E1).

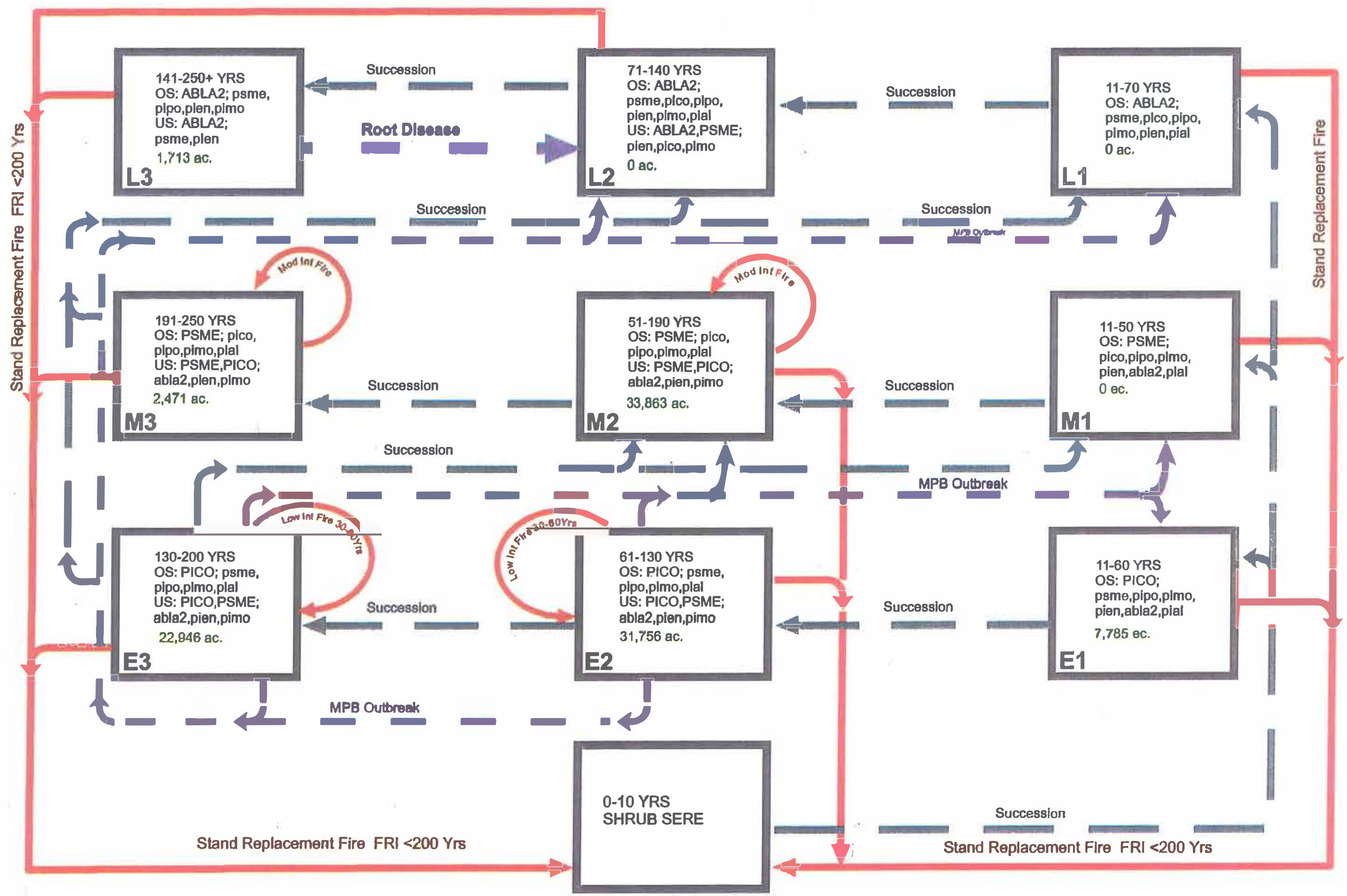
Douglas-fir dominance suggests longer fire-free periods (160-200 years) are associated with the M1, M2, and M3 stands. Fire return intervals greater than 160 years is sufficient time for much of the lodgepole pine to reach its life expectancy, reducing the available seed source following fire. This favors Douglas-fir as an early seral species following disturbance (M1). Under a moderate fire return interval resulting in mixed mortality in the stands (60-100 years), Douglas-fir can grow to sufficient size to become resistant to recurring low or moderate-intensity fires. Older trees that survive these more moderate intensity fires provide the seed source for post-fire seedling establishment. Lodgepole pine may also be a co-dominant, but pre-fire stand numbers are generally low, thereby restricting seed availability for dense establishment of lodgepole in the post-fire stand (M1 -> M2 -> M3). Fire return intervals associated with the Dry Subalpine Fir PAG occur more frequently than the time required (>200 years) for mature, climax subalpine forests to develop. As a result, there is very little of the climax subalpine forest across the assessment area. Climax subalpine fir stands likely developed in topographic setting that were less fire prone historically, such as north aspects or sites with higher soil moisture (Camp 1995).

In the understory, the species diversity is the richest in those seral stages experiencing the most frequent fire return intervals (E1 -> E3). Understory species either survive as underground roots or from surviving seed banks allowing a rich diversity of vegetation to quickly establish following a fire event. As the forest canopy develops, the understory becomes depauperate with only the most shade tolerant species persisting (E2, M2, L2). When the stands mature and begin to open up again, those species which are moderately shade tolerant become more abundant. Species diversity is the highest early in succession but cover is greatest in the mid to late seral stands (Kapler-Smith and Fisher 1995).

Late successional habitat is described by the M3 and L3 seral stages. Both M3 and L3 seral stages show the highest risk for stand replacing fires. This is because structural diversity of both the coarse woody debris and the canopy profile are greatest in these seral stages. Canopy closure often exceeds 70 percent, increasing the likelihood of crown driven fires. Sustainability of these stands over the long term is unlikely because the stands associated with the M3 and L3 seral stages are at nearly 200 years when late successional characteristics begin to develop. The E3 seral stage is not considered to provide sustainable late successional habitat because of the short lived nature of lodgepole pine. Late successional characteristics begin to develop between 120 and 150 years; however, with a lifespan of about 200 years, combined with the high risk of mountain pine beetle outbreaks, sustainability over a long period is unlikely. As these stands in E3 continue to senescence, the understory species are released and increase in dominance (E3 -> M2 or M1). Stands are currently at high risk to mountain pine beetle attack and the increased fuel loading associated with the beetle kill predisposes these stands to higher risk of catastrophic fire (E3 -> M2 -> M3).

Historically, non-lethal and mixed mortality fires were likely common, providing small scale structural diversity across the landscape. Stand replacing fire events were less common but shaped the large scale structural diversity associated with this landscape. Today the greatest percentage of this PAG is in the M2, E2, and E3 seral stages. There will continue to be a reduction in the early seral lodgepole pine communities (E1) as mountain pine beetle activity and continued fire exclusion moves these stands forward successionally. This PAG is characteristic of an ever changing landscape where fire frequently resets succession (M3, L3, E3 -> E1). Early lodgepole pine (E1) stands are critical winter foraging habitat for lynx. The Dry Subalpine Fir PAG is ideal lynx habitat because it is typically found between 4,000 feet and 6,000 feet and is associated with a fire regime that maintains a large percentage of the landscape in lodgepole pine dominated forests. No known spotted owls are reproductively active in this ecosystem. Structurally, the lodgepole pine is not suitable for nesting and most of this PAG is above the upper elevational limits of the spotted owl's range. If management in this PAG increases late successional characteristics, there will be a continued loss of critical lynx habitat and a possible reduction in the lynx population. The risk of larger, more severe fire events will also result as fuel loading increase.

FIGURE 5: SUBALPINE FIR DRY PAG



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ac. = Assessment area acres by seral stage

See appendix I for full names of species listed
OS = Overstory US = Understory
Upper case = Dominate species
Lower case = Minor species
MPB = Mountain Pine Beetle

Table C-11 - Table Of Dry Subalpine Fir PAG Characteristics.

	E1	E2	E3	M1	M2	M3*	L1	L2	L3*
Trees per acre (TPA)									
Acres	7785	31756	22946		33863	2471			1713
Crown Closure %	1-30 70+ equally split	31-70+	1-30		70+	31-70			70+
+Fuel loading tons/ac	7.6	17.8	35.1		10.8	35.1			31.8
Crown fire risk	Low	Mod	Mod	Low	Mod	High	Low	Mod	High

* Seral stages that provide late successional habitat.
+Derived from fuels photo series (Maxwell et al 1980, Fischer 1981).

Table C-12 - Late Successional (LS) Characteristics in the Dry Subalpine Fir PAG.

	DBH Class	M3	L3
TPA for LS stands *	13" - 21"	10	10
#Crown Closure (%)		31-70	70+
Green Tree Replacement & Snags TPA **	>21" >12"	6 12	6 12
CWD ***	10" - 12" **	240 lineal ft **	240 lineal ft **
CWD tons/ac **	>3"	10-20	10-20
Defective trees TPA *		2-4	2-4

*Taken from R6 Interim Old Growth Definitions 6/93.
#Developed from the 1983 satellite imagery.
**Taken from ICBEMP Vol. 1 Table 3-5 1997.
***The objective is to retain the largest pieces available.

Table C-13 - Dry Subalpine Fir PAG Dominant Species* By Lifeform.

Trees +	Shrubs/Subshrubs +	Herbaceous +
PICO ABLA2 PSME PIAL PIMO PIEN	SASC ARUV RIVI SHCA ARNE CHUMO PAMY PYSE ROGY SPBEL VAME VAMY VASC AMAL	ARCO CACO CAGE CARO CARU LUPIN

* Species that occur at least 50% of the time or are key plant association indicator species (Lillybridge et al 1995).
+ See Appendix H for full species names.

Moist Subalpine Fir Plant Association Group

Community development from the shrub seral stage to late successional habitat is depicted in Figure C-6. General stand characteristics that describe the seral stage conditions are displayed in Tables C-14 through C-16. The information used in these tables was the best available information at the time of the assessment and may not be a true description of the conditions on the Okanogan. It is displayed for comparative purposes and should not be used as management criteria. Field data is needed to validate the assumptions made here.

The Moist Subalpine Fir PAG comprises 16.6 percent of the forested habitat types in the assessment area. This ecosystem is depicted by a cool mesic to cool moist environment above 4,500 feet in elevation. Annual precipitation ranges between 45 inches and 60 inches. The understory is a rich diversity of both shrubs and herbaceous vegetation. Fires are stand replacing when they do occur. Fuel loading and crown fire risk is the highest of any of the PAGs (Table C-14). However, the potential for severe stand replacing fires is reduced due to the normally cool location these communities occur, the sparse understory fuels, and short fire season associated with these higher elevation sites. These moist subalpine fir plant associations frequently act as fuel breaks due to the lush, moist vegetation associated with them. However, under severe fire weather conditions these communities will burn catastrophically. Fires are infrequent with fire return intervals typically exceeding 200 years (Agee 1993). Lodgepole pine still remains the early seral dominant species (first 150 years) because of the slow establishment rate of Engelmann spruce and subalpine fir following disturbance. Lodgepole pine densities typically peak within 50 years of a fire disturbance while subalpine fir recruitment peaks between 75 and 125 years (Agee 1993). Lodgepole pine cone serotiny is less important in the re-establishment of lodgepole pine following disturbance when fire return intervals exceed 200 years. Other disturbances such as insects, root disease, and windthrow are more important in development of these stands than is fire in providing the structural diversity across the landscape.

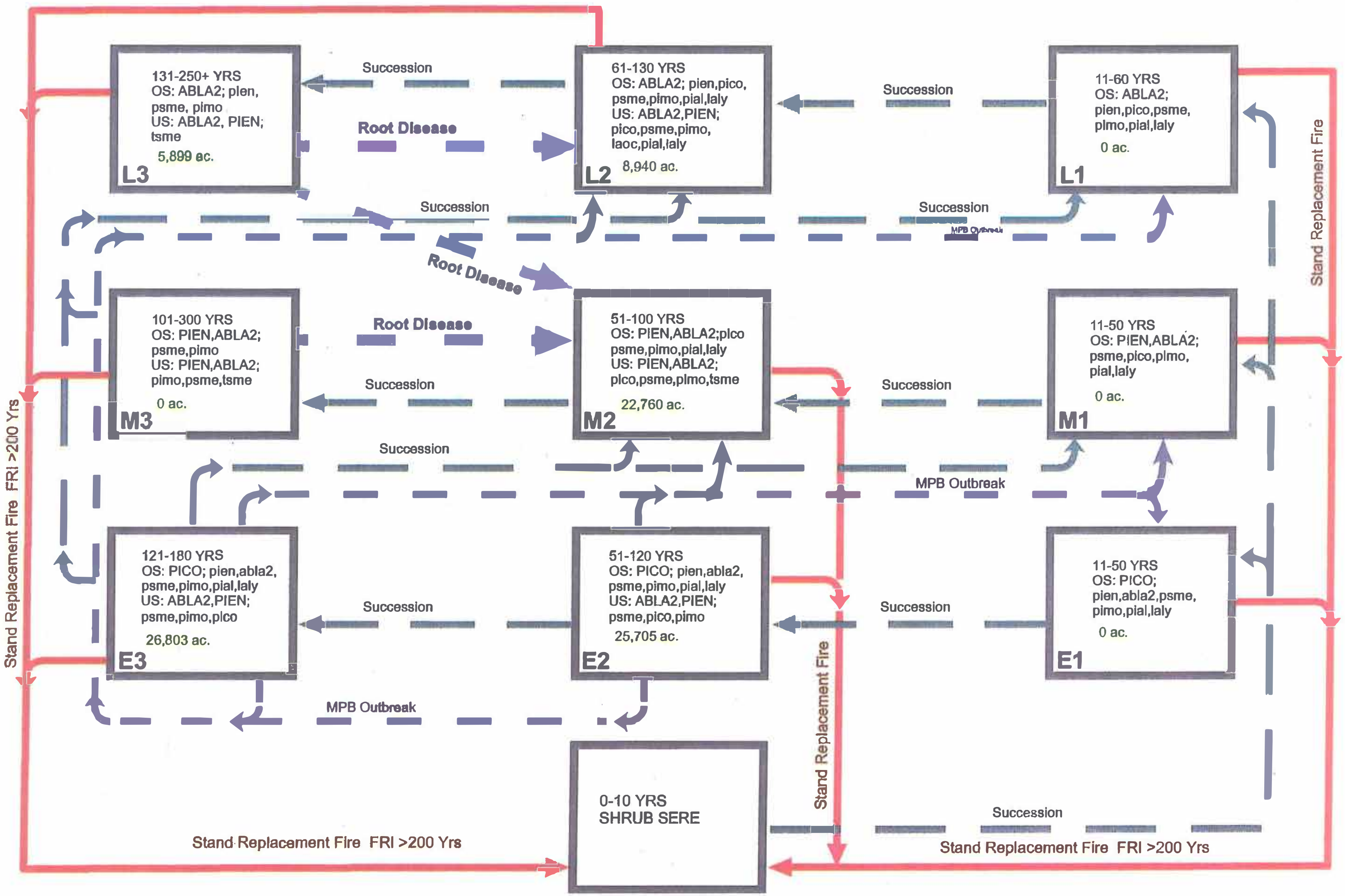
Much like the Dry Subalpine Fir PAG, lodgepole pine dominates following a fire event (E1). Under the cooler growing conditions it takes slightly longer (110 years Vs 90 years) for lodgepole pine stands to become dense enough to trigger a mountain pine beetle outbreak compared to the Dry Subalpine Fir PAG. Mountain pine beetle is the primary thinning agent in these stands with outbreaks beginning to cycle through the stands on average every 50 years. Severity of the outbreak and the species composition at the time of the outbreak dictates the resulting (E2, E3 -> M2, E1, L2, or L1).

Although subalpine fire tolerates shade as well as full sun, seedling survival is often associated with shade. This is because the subalpine fir plant associations in this PAG grow in the coolest and moistest conditions under which closed forested communities can grow. Lodgepole pine is more frost tolerant than either subalpine fir or Engelmann spruce. As a result, lodgepole pine is an important nurse tree, protecting both subalpine fir and Engelmann from extreme temperature variations associated with mid to high elevation habitats (E1 -> E3 and E3 -> M1, M2, L1, L2). Because of this, establishment of the M1 and L1 seral stages immediately following a fire event are rare. Exceptions are where cold temperatures, wet soils, and lush undergrowth occur, Engelmann spruce and subalpine fir are favored as post-disturbance dominants, especially if long fire-free periods have excluded lodgepole pine from the stand.

There is a rich diversity of understory vegetation found throughout stand development and canopy cover remains high, exceeding 70 percent (Tables C-5 and C-17). Late successional habitat defined by the M3 seral stage is the most stable of the seral stages providing late successional habitat. Late successional habitat defined by the L3 and E3 seral stages are not sustainable. Subalpine fir trees greater than 250 years are not abundant, because of their low tolerance to heartrot which results in high levels of mortality from disease after this age. Similarly, lodgepole pine is short lived rarely exceeding 200 years and it is at high risk for mountain pine beetle attack at this age. Engelmann spruce is longer lived and more disease resistant than either lodgepole pine or subalpine fir. This results in an abundance of stands with Engelmann spruce as a dominant species in the overstory that are stable over the long term (L3, M3 -> M2).

The plant associations in this PAG are above the elevational habitat limits for the spotted owl. Like the Dry Subalpine Fir PAG, the Moist Subalpine Fir PAG also provides critical habitat for lynx because post-fire landscapes favor lodgepole pine. Over the larger area, this ecosystem is not outside the natural fire return interval it evolved under. However, effective fire suppression has resulted in a loss of the fine scale structural and species diversity associated with the small pockets that periodically burned between the larger scale fire events. These communities have become homogeneous across the landscape resulting in a total loss of early seral structures (E1, M1, L1) (Table C-14). Along with this loss of early seral structures lynx populations are also likely to diminish. Mature seral stages (M3 and L3) provide important habitat for lichens , mosses, and a variety of fungi because of the longer fire-free period associated with these habitats.

FIGURE 6: SUBALPINE FIR MOIST PAG



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ac. = Assessment area acres by seral stage

See appendix I for full names of species listed
OS = Overstory US = Understory
Dominate species are in upper case, Minor species in lower case
MPB = Mountain Pine Beetle

Table C-14 - Table Of Moist Subalpine Fir PAG Characteristics.

	E1	E2	E3	M1	M2	M3*	L1	L2	L3*
Trees per acre (TPA)									
Acres		25705	26803		22760			8940	5899
Crown Closure		70+	70+		70+			70+	70+
Fuel loading tons/ac	12.7	32.8	23.0		20.4	31.8		11.1	20.9
Crown fire risk	Low	Mod	High	Low	High	High	Low	High	High

* Seral stages that provide late successional habitat.
+Derived from fuels photo series (Maxwell et al 1980, Fischer 1981).

Table C-15 - Late Successional Characteristics in the Moist Subalpine Fir PAG.

	DBH Class	M3	L3
TPA for LS stands*	13" - 21"	10	10
#Crown Closure (%)		30+	
Green Tree Recruitment & Snags TPA **	>20" >12"	2 15-18	2 15-18
CWD ***	10" - 12"	300 lineal ft	300 lineal ft
CWD tons/ac **	>3"	15-20	15-20
Defective trees TPA *		2-4	2-4

*Taken from R6 Interim Old Growth Definitions 6/93.
#Developed from the 1983 satellite imagery.
**Taken from ICBEMP Vol. 1 Table 3-5 1997.
***The objective is to retain the largest pieces available.

Table C-16 - Moist Subalpine Fir PAG Dominant Species* By Lifeform.

Trees	Shrubs/Subshrubs	Herbaceous
PICO PIEN PSME PIAL LALY TSME PIMO ABLA2	PYSE CHUMO VAMY VASC VAME PAMY JUCO4 RHAL LIBOL RULA VACA VADE	ARCO ARLA CAGE CARO CARU FEOC LUPIN PEBR PERA POPU VASI VIOLA SMILA LUHI

* Species that occur at least 50% of the time or are key plant association indicator species (Lillybridge et al 1995).
+ See Appendix H for full species names.

Pacific Silver Fir/Mountain Hemlock Plant Association Group

Community development from the shrub seral stage to late successional habitat is depicted in. General stand characteristics that describe the seral stage conditions are displayed in Tables C-17 through C-19. The information used in these tables was the best available information at the time of the assessment and may not be a true description of the conditions on the Okanogan. It is displayed for comparative purposes and should not be used as management criteria. Field data is needed to validate the assumptions made here.

The Pacific Silver Fir/Mtn. Hemlock PAG comprises 12.8 percent of the forested habitat types in the assessment area. These sites are typically over 3,000 feet in elevation and as low as 2,000 feet in cold air drainages from the Cascade crest west. This PAG is associated with cool to cold wet sites with annual precipitation between 65 inches and 100+ inches. Winters are long and snow packs typically range from 3-10 feet deep.

Northern spotted owls do not use this habitat for nesting due to the cold, snowy, harsh environment. However, this PAG grades into the Western Hemlock PAG at its lower elevational limits where three of the 10 owl sites are located. As a result the Pacific Silver Fir/Mt. Hemlock PAG provides for summer foraging areas in the vicinity of the nest sites.

Mountain hemlock and pacific silver fir share a broad ecological distribution in the Washington Cascades, and the two forested series are hard to distinguish in stands less than 300 years (Lillybridge et al 1995). As a result, the two series are combined into one PAG for this assessment. They are, however, ecologically different, with mountain hemlock occurring in the coldest, snowiest environments experiencing long harsh winters. Mountain hemlock is also more resistant to physical damage from heavy snows. Pacific silver fir sites also experience heavy snow packs with cool to cold temperatures being the norm. However, these sites rarely experience the intense, long-lasting cold temperatures (-0 degrees F) than pacific silver fir and is in the upper elevations. Both pacific silver fir and mountain hemlock are shade tolerant species and rarely colonize in pure stands or are the dominant species following a disturbance (M1, L1). In fact both are slow to establish in the understory of the early seral species and are the last species to invade the site often requiring 40 to100 years or more before establishing (M2, L2). In the stem exclusion seral stages (E2, M2, L2) understory species are often depauperate due to the dense canopy cover. Because of the shorter growing season associated with the mountain hemlock forests, reforestation typically takes longer than in the pacific silver fir forests. Western hemlock is a major early seral dominant in both forest types. In the pacific silver fir forests, Douglas-fir and western red cedar are also major early seral species while in the mountain hemlock type pacific silver fir and subalpine fir are dominant early seral species (E1).

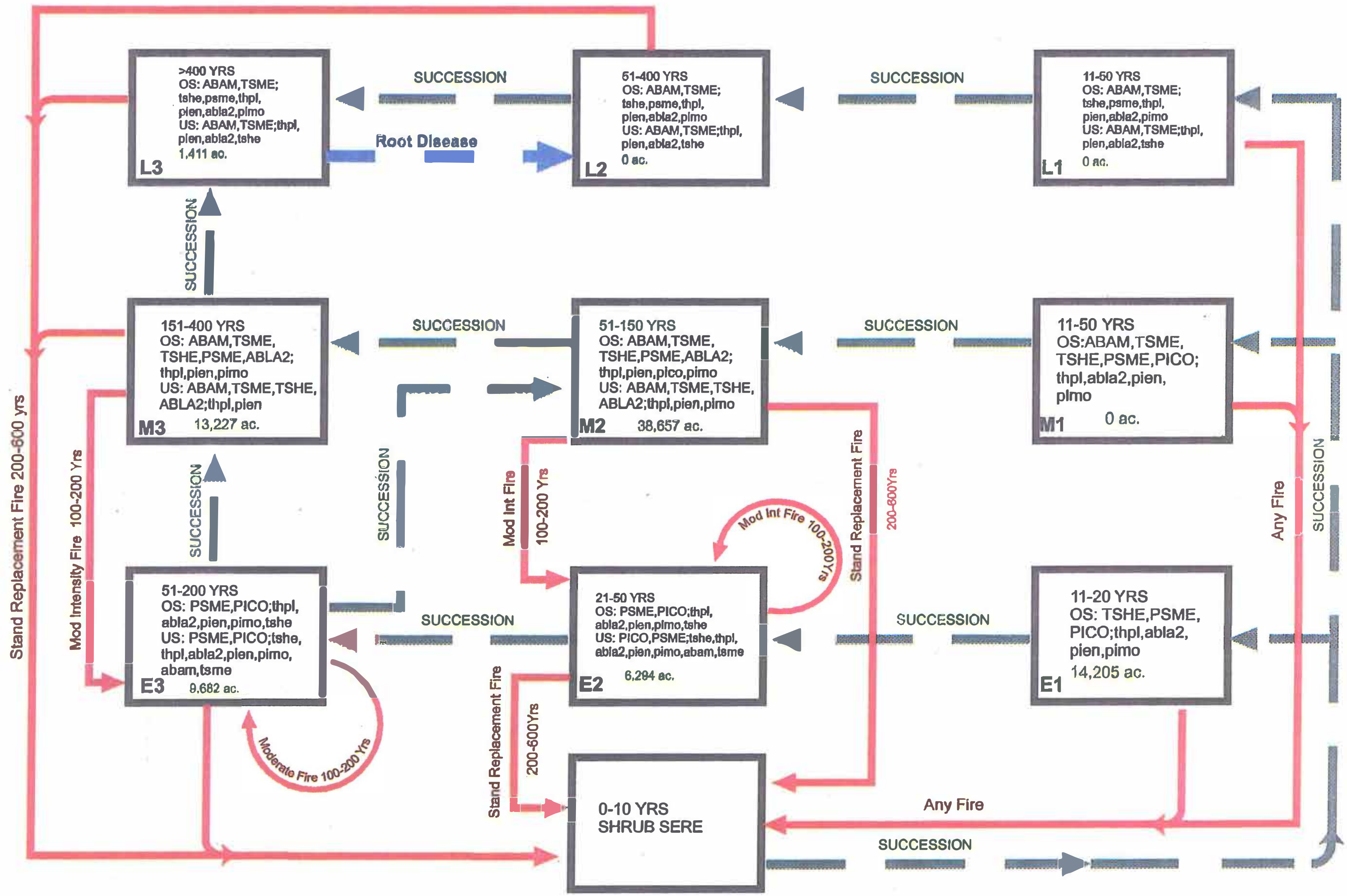
Windthrow and root disease are the key disturbance elements in this environment. After the stands reach 150 years root disease begins to create openings in the stands where pacific silver fir and mountain hemlock are dominant, because of their low tolerance to root disease (M2, L2, M3, L3). This increases stand structural diversity and opens the stand up increasing the understory species diversity as well .

Fires are typically stand replacing in nature and more erratic in their occurrence. In the pacific silver fir communities, the fire-free period rarely exceeds 400 years and at the lower elevation, drier end of this PAG fire-free periods typically range between 100 to 300 years (Lillybridge et al 1995, Agee 1993). When fires occur between 160 to 200 years Douglas-fir is favored and remains a long term seral dominant because it is more fire resistant. Large, old scattered Douglas-fir frequently survive these fire events. Western hemlock and lodgepole pine quickly recolonize the understory along with Douglas-fir. When the fires are less than 160 years, lodgepole pine dominates with western hemlock and Douglas-fir being co-dominants in the stand (E2, E3). Understory species are diverse and vigorous, especially the huckleberry, under the lower intensity fire regime associated with the E1, E2, and E3 seral stages.

With increasing elevation and moisture, the fire-free period to between 300 and 600 years (Agee 1993). Climax communities can develop in as few as 500 years in this PAG but rarely if ever develop because the fire return interval is typically shorter than this. This appears to be supported by the acreage distribution in the PAG. The fewest acres are in the L3 seral stage and are likely associated with areas that escaped the last fire disturbance. Most of the acres are within the M2 and M3 seral stages. This PAG is virtually unmanaged at this time and there are no current plans to manage these stands in the future which will allow natural development of late successional characteristics in the M2 stands with time. Late successional habitat is best described by the E3, M3, and L3 seral stages. Historically, the M2 and M3 seral stages likely dominated and continue to comprise the largest area across the landscape today. Since these sites are found in cold, harsh environments and growing seasons are short, it is likely the M2 seral stage may also function as late successional habitat. In the harsher environments tree sizes rarely exceed the minimum size of 22 inches DBH described in Table C-18. Canopy closures exceed 70 percent in most cases and the tons per acre of coarse woody debris also exceed the minimum standards for late successional characteristics for both the M2 and M3 seral stages.

At this time there are no known reasons why these stand conditions should change, except in the event of an extreme fire year. Fire return intervals are sufficiently long to provide ample time for late successional habitat to develop and continue to persist. Those species depending on this type of late successional habitat should find the majority of the PAG acres suitable for their lifecycle needs. This PAG will also continue to provide summer foraging and dispersal habitat for the northern spotted owl today and into the future.

FIGURE 7: PACIFIC SILVER FIR / MOUNTAIN HEMLOCK PAG



ac. = Assessment area acres by seral stage

See appendix I for full names of species listed
OS = Overstory US = Understory
Upper case = Dominate species
Lower case = Minor species

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Table C-17 - Table Of Pacific Silver Fir/Mtn. Hemlock PAG Characteristics.

	E1	E2	E3*	M1	M2	M3*	L1	L2	L3*
Trees per acre (TPA)	480-1248	248-344	309-364	480-1248	600-800	309-480	480-1248	153-344	248-480
Acres	14205	6294	9682		38657	13227			1411
Crown Closure %	31-70	31-70	70+		31-70 70+ equally split	70+			70+
+Fuel loading tons/ac	8.4	17.8	31.8		20.4	31.8		20.1	20.9
Crown fire risk	Low	High	High	Low	High	High	Low	High	High

*Seral stages that provide late successional habitat.
+Derived from fuels photo series (Maxwell et al 1980, Fischer 1981).

Table C-18 - Late Successional (LS) Characteristics in the Pacific Silver Fir/Mtn. Hemlock PAG.

	DBH Class	E3, M3, and L3 seral stages
TPA for LS stands *	22" - 26" all sizes	1-9 153-182
#Crown Closure (%)		70+
Green Tree Recruitment & Snags TPA **	>20" >12"	6-10 15-20
CWD ***	20"+ **	600 lineal ft **
CWD tons/ac **	>3"	30-60
Defective trees TPA *	-	-

*Taken from R6 Interim Old Growth Definitions 6/93.
#Developed from the 1983 satellite imagery.
**Taken from ICBEMP Vol. 1 Table 3-5 1997.
***The objective is to retain the largest pieces available.

Table C-19 - Pacific Silver Fir/Mtn. Hemlock PAG Dominant Species* By Lifeform.

Trees +	Shrubs/Subshrubs +	Herbaceous +
TSHE PSME PICO THPL ABLA2 PIEN PIMO ABAM TSME	*CHUMO GAOV MEFE PAMY PYSE RHAL RULA RUPE VAAL VAME VAMY VASC XETE PHME CLUN **acci bene coca libol opho tabr	*ARLA CLUN LUPIN MOSS POPU STRO TITRU VASI VIOLA ** actr cage gydr pebr smra smst trca3 #*CAGE LUHI PEBA*

* Species (upper case) that occur at least 50% of the time in both plant associations or are key plant association indicator species (Lillybridge et al 1995).
+ See Appendix H for full species names.
** Species (lower case) that occur at least 50% of the time in Pacific silver fir plant associations.
# Species (italics) that occur at least 50% of the time in Mt. Hemlock plant associations

Subalpine Parkland Plant Association Group

Community development from the shrub seral stage to late successional habitat is depicted in Figure C-8. General stand characteristics that describe the seral stage conditions are displayed in Tables C-20 through C-22. The information used in these tables was the best available information at the time of the assessment and may not be a true description of the conditions on the Okanogan. It is displayed for comparative purposes and should not be used as management criteria. Field data is needed to validate the assumptions made here.

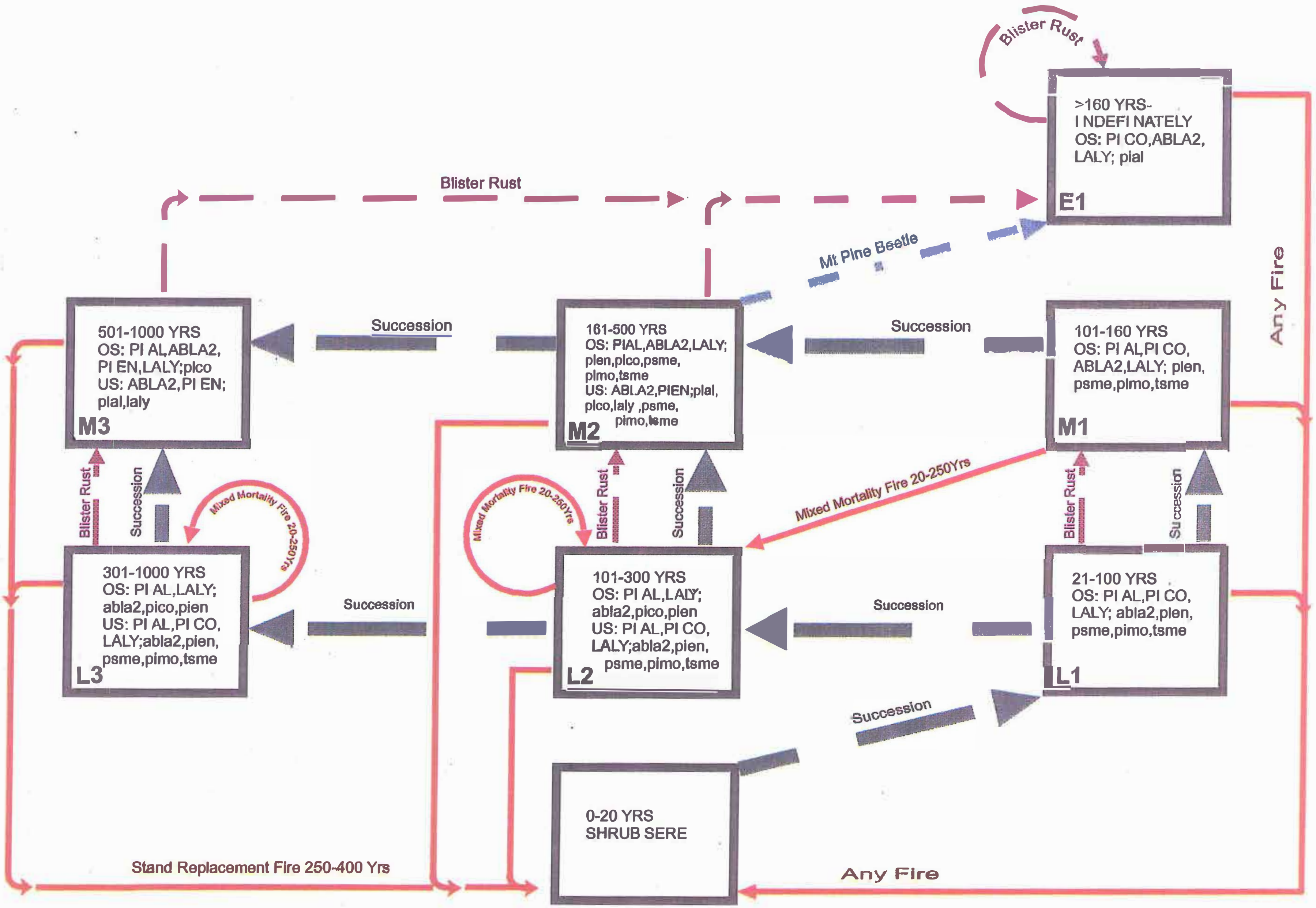
The Subalpine Parkland PAG comprises 7.9 percent of the forested habitat types in the assessment area. Over 50 percent of the Subalpine Parkland PAG is above 5,000 feet in elevation. These are the upper elevation timberline communities that are a mosaic of interspersed alpine meadows within forested communities. All these communities are above the elevational range of the northern spotted owl. Winters are harsh and the growing season is short. Frost is likely any time of the year and the plant communities are adapted to extreme variations in daily temperatures and are able to survive desecrating winds. Late successional whitebark pine communities are critical in helping to maintain vegetative cover at timberline by stabilizing soils on these often steep slopes and ameliorating the site for other less cold hardy species to establish. Whitebark pine communities provide an important source of high protein food for grizzly bears and other wildlife in the late fall. They are also an important component of most wildernesses and highly sought after for the recreational opportunities they offer. Fire exclusion, increased mortality from mountain pine beetle, and white pine blister rust are accelerating the loss of whitebark pine from this ecosystem and throughout its range.

Whitebark pine is the dominant species in these communities and is the only treeline species able to colonize the dry windswept slopes at timberline or establish under the extreme thermal extremes associated with these high elevation sites that are often over 6,000 feet in elevation. Annual precipitation typically exceeds 50 inches and comes primarily in the form of snow. Subalpine larch forms the other climax community associated with these alpine environments. Subalpine larch is of limited distribution being restricted to north aspects, moist talus slopes and rock slides where there is a continuous supply of moisture during the growing season. Both species are considered moderately fire resistant.

Fire plays an important role in these communities. For subalpine larch fires are typically single tree events or take out individual clusters of trees. This is due to the open nature of the stands, sparse ground fuels, rocky talus slopes, and moist conditions where they grow. Contrary to subalpine larch, whitebark pine is a fire climax community. Its survival strategies are dependent on recently burned areas desired by the Clark's nutcracker (*Nucigraga columbiana*), whitebark pine's nearly exclusive means of seed dispersal. Fire return intervals range between 60 to 300 years with the fire-free period increasing on the northerly aspects (Kapler-Smith and Fisher 1995). Like ponderosa pine, whitebark pine is shade intolerant. Stands dominated by whitebark pine typically burn on average every 80 years with highly irregular fire-free periods between fire events (L1-> L2 -> L3). Non-lethal or mixed mortality fire events commonly maintain stands of whitebark pine that exceeded 700 to over 1000 years of age by thinning the more shade tolerant and fire intolerant understory trees (L2, L3). These periodic fires stimulate a diversity of understory shrubs and herbaceous vegetation (Table C-22). Because of the extremely harsh environment, late successional characteristics begin to develop in stands that typically exceed 150 years old and are less than 10 inches DBH. Krumholtz stands are common.

When fires regularly occur with an average fire return interval of 80 years, lodgepole pine dominates (L1). At the upper treeline whitebark pine is the only species capable of colonizing a site. Once established it provides protection for less hardy seedlings to establish such as subalpine fir, mt. hemlock, Engelmann spruce, and to a lesser extent lodgepole pine (M1). On the driest sites whitebark pine is the only tree present throughout succession. On more mesic sites it maintains dominance in the stand even in the absence of fire (M1 -> M3), except where blister rust mortality is high (M1, M2, M3 -> E1). Whitebark pine is an extremely long lived species and will out live most other seral species which begin to senesce between 250 and 400 years (M2). Whitebark pine is susceptible to mountain pine beetle outbreaks, especially where fires have been excluded and a dense understory has developed (M2). Fires occur in these communities only during extreme fire years and are often started from fires in the lower elevations. By excluding fire in these adjacent communities they too become overstocked and stressed. Many of these adjacent forested communities are dominated by lodgepole pine and when mountain pine beetle outbreaks occur in these stands they quickly spread into the adjacent whitebark pine communities. Mountain pine beetle outbreaks significantly reduce the abundance of whitebark pine in the stand leaving a stand dominated by fire intolerant species (M2 ->E1). The introduction of white pine blister rust is further increasing the mortality in the whitebark pine. In the Northern Washington Cascades it appears about 10 percent of the whitebark pine are infected with blister rust and 30 percent of these trees are eventually killed by the infection (Hadfield 1997). Where blister rust infection rates are high, fire will convert these stands into shrub or herbaceous communities indefinitely. With continued fire exclusion in these stands there are few planting sites available to increase the numbers of genetic resistant individuals into the future. Harsh growing conditions result in slow maturing trees (50 to 75 years to reach reproductive maturity), irregular cone production that is further exacerbated by competition from increased stocking densities. Poor cone production, fire exclusion, increased mountain pine beetle mortality, combined with white pine blister rust will continue to eliminate stands of whitebark pine drastically altering the community structure of these alpine communities and may eventually result in a lowering of the timberline (E1).

FIGURE 8: SUBALPINE PARKLAND PAG *



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*Acres reflect species composition
not structural classification
E = 629 ac.
M = 41,890 ac.
L = 6,086 ac.

See appendix I for full names of species listed
OS = Overstory US = Understory
Upper case = Dominate species
Lower case =Minor species

Table C-20 - Table Of Subalpine Parkland PAG Characteristics.

	E1	M1	M2*	M3*	L1	L2*	L3*
Trees per acre (TPA)							
Acres	629	41890			6086		
Crown Closure %	1-30	1-30 & 70+ equally split			1-30 & 70+ equally split		
+Fuel loading tons/ac		6.8	20.4	31.8	6.8	10.8	20.9
Crown fire risk	Low	Low	High	High	Low	High	High

* Seral stages that provide late successional habitat.
+Derived from fuels photo series (Maxwell et al 1980, Fischer 1981).

Table C-21 - Late Successional Characteristics in the Subalpine Parkland PAG.

	DBH Class	M2, M3, L2 and L3 seral stages
TPA for LS stands *	data not available	
#Crown Closure (%)		Variable
Green Tree Recruitment & Snags TPA **	>20" >12"	6-10 15-20
CWD ***	10"	300 lineal ft
CWD tons/ac >3" **	20-30	
Defective trees TPA *	data not available	

*Taken from R6 Interim Old Growth Definitions 6/93.
#Developed from the 1983 satellite imagery.
**Taken from ICBEMP Vol. 1 Table 3-5 1997.
***The objective is to retain the largest pieces available.

Table C-22 - Subalpine Parkland PAG Dominant Species* By Lifeform.

Trees +	Shrubs/Subshrubs +	Herbaceous +
PIAL LALY ABLA2 PIEN TSME PICO PSME PIMO	VADE VASC JUCO4 DROC CAME LUPE	CARU FEVI ARLA CAGE LUHI LUPIN POPU

*Species that occur at least 50% of the time or are key plant association indicator species.
+ See Appendix H for full species names.

Western Hemlock Plant Association Group

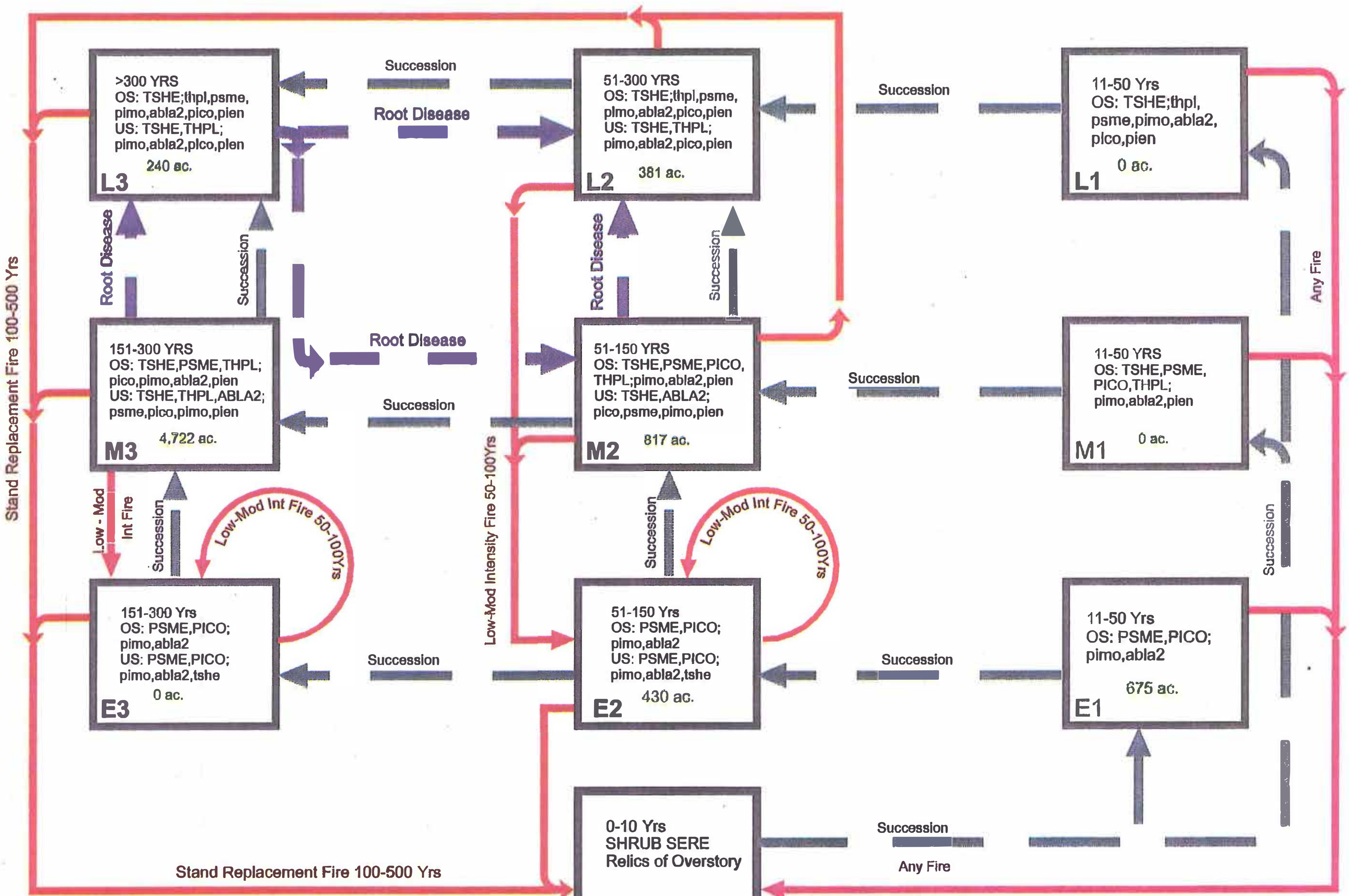
Community development from the shrub seral stage to late successional habitat is depicted in Figure C-9. General stand characteristics that describe the seral stage conditions are displayed in Tables C-23 through C-25. The information used in these tables was the best available information at the time of the assessment and may not be a true description of the conditions on the Okanogan. It is displayed for comparative purposes and should not be used as management criteria. Field data is needed to validate the assumptions made herein.

The Western Hemlock PAG makes up only 1.1 percent of the forested habitat types in the assessment area and is typically found along Granite and Canyon Creeks, both of which flow into the Skagit River drainage west of the Cascade Crest. Over 80 percent of this PAG is within the Warm Moist and Warm Mesic environments and below 4,000 feet in elevation. Annual precipitation ranges between 40 inches and 100+ inches. Three of the 10 spotted owl nest sites are located within this PAG. Douglas-fir and western red cedar are long lived, early seral dominants in the Western Hemlock PAG. Early seral stages support a rich diversity of herbaceous vegetation for the first three to five years followed by the development of a dense shrub cover that dominates the site for another 10 to 14 years. Once the young trees begin to grow above the shrub cover, they quickly form a dense closed canopy. The understory vegetation continues to thin until only the most shade tolerant species are able to persist (E1, M1, and L1 -> E2, M2, and L2).

Despite the fact summer lightning storms are common, these moist ecosystems rarely burn. Fires are almost always stand replacing when they do occur. Low to moderate intensity fires between 50 and 100 years create small openings providing structural and species diversity to a mostly homogeneous landscape. These small fires occur two to three times as often as the larger, catastrophic stand replacing fires. Root disease is common throughout this ecosystem. Wind damage and blowdown become increasingly more common in stands over 150 years old when root disease becomes more advanced in the stand. Root disease and wind damage are the primary disturbance agents in this environment. Late successional characteristics associated with the climax L3 seral stage are rare and likely occur only where they have escaped previous fire events. Most stands are between 100 and 200 years old suggesting stand replacing fire events occur frequently enough to prevent climatic old growth stands from developing (Lillybridge et al 1995). As a result, most late successional habitat is associated with the M3 seral stage. The greatest number of acres are in the M3 seral stage (Figure C-9).

At this time there are no know reasons why these stand conditions should change, except in the event of an extreme fire year. Fire return intervals of 200 to 500 years are sufficiently long enough for late successional habitat to develop in these warm, moist environments. The small percentage of area comprising the Western Hemlock PAG is in a portion of the National Forest system that experiences a high degree of recreational use during the summer months which may be disruptive to some species of wildlife. Those species depending on this type of late successional habitat should find the majority of the PAG ac. suitable for their lifecycle needs. Of all the ecosystems in this assessment area, the Western Hemlock PAG provides the most important, habitat for the northern spotted owl. No planned forest management activities are anticipated in this PAG or any of the adjacent PAGs.

FIGURE 9: WESTERN HEMLOCK PAG



ac. = Assessment area acres by seral stage

See appendix I for full names of species listed
OS = Overstory US = Understory
Upper case = Dominate species
Lower case = Minor species

Table C-23 - Table Of Western Hemlock PAG Characteristics.

	E1	E2	E3*	M1	M2	M3*	L1	L2	L3*
Trees per acre (TPA)	6,000-10,000	370	320	7,000	140	139-482	7,000	360	370
Acres	675	430			817	4722		381	240
Crown Closure %	31-70	70+			31-70	70+		31-70	70+
+Fuel loading tons/ac	10.8	11.1	55.8		10.8	31.8		10.8	31.8
Crown fire risk	Low	Mod	Mod	Low	Mod	High	Low	Mod	High

* Seral stages that provide late successional habitat.
+Derived from fuels photo series (Maxwell et al 1980, Fischer 1981).

Table C-24 - Late Successional (LS) Characteristics in the Western Hemlock PAG.

	DBH Class	E3, M3, and L3 seral stages
TPA for LS stands *	31" +	8
#Crown Closure (%)		70+
Tree Recruitment & Snags TPA **	>20" >12"	6-10 15-20
CWD ***	20"	600 lineal ft
CWD tons/ac **	>3"	40-60
Defective trees TPA *		

*Taken from R6 Interim Old Growth Definitions 6/93.
#Developed from the 1983 satellite imagery.
**Taken from ICBEMP Vol. 1 Table 3-5 1997.
***The objective is to retain the largest pieces available.

Table C-25 - Western Hemlock PAG Dominant Species* By Lifeform.

Trees +	Shrubs/Subshrubs +	Herbaceous +
PSME PICO THPL PIEN PIMO ABLA2	ARNE ACCI BEAQ CACO GAOV MEFE ROGY SPBEL SYMO TABR VAAL VAMY XETE PAMY OPHO BENE LIBOL RUPA RULA SYAL ROGY CHUMO VAME PYSE	SMST CLUN TROV ACTR GOOB SMRA ASCA3 LYAM CARU PTAQ STRO TITRU TRLA2 VIOR2 TRCA3 VIGL ATFI CACO EQUIS GYDR PERA

* Species that occur at least 50% of the time or are key plant association indicator species (Lillybridge et al 1995).
+ See Appendix H for full species names.

APPENDIX D

BPE Analytical Model

Physical Characteristics used to Classify the Physical Environment.

BIOPHYSICAL ENVIRONMENT*	ELEVATION RANGE (FT)	ASPECT
Hot Dry Shrub/Grass	<4,000'	S SE SW W
Warm Dry Shrub/Herb	3250 - 5200 <3250	S SE SW W N NE NW E
Warm Dry Shrub/Herb West of Crest	3250 - 5200	S SE SW W
Warm Mesic Shrub/Herb	<2600 2600 - 5200	N NE E SE W NW
Warm Moist Shrub/Herb	1950 - 4550	N NE
Cool Dry Grass	5200 - 6500	S SE SW W
Cool Mesic Shrub/Herb	3950 - 6550	W NW E SE
Cool Mesic Shrub/Herb West of Crest	3000 - 6550	W NW E SE
Cool Moist Shrub/Herb	3900 - 6500	N NW NE
Cool Moist Shrub/Herb West of Crest	3000 - 6500	N NW NE
Cold Dry Shrub/Herb	6500+	S SW
Cold Mesic Shrub/Herb	6500+	E SE W NW
Cold Mesic Shrub/Herb West of Crest	4000 - 6500	E SE W NW
Cold Moist Shrub/Herb	5850+	N NW E NE

*Biophysical Environment labels were taken from the Wenatchee NF Plant Association Guide (Lillybridge et al. 1995).

I. Tools used.

The table above is a summary of the physical parameters used to define the biophysical environments used in this assessment.

An Arc info platform was used.

The physical environment model developed by Tom Ketcham for the Chewuch Watershed Analysis was modified by the team for west side conditions and areas outside the watershed boundary.

The model used 5 inch precipitation bands from the map available in GIS.
A major break in precipitation at 50 inches closely paralleled the crest, and was used to distinguish vegetation east and west of the Cascade Crest.

Elevation was used to adapt the model to west side vegetation, since cooler moister environments are found at lower elevations west of the crest.

The Wenatchee Plant Association Guide, Plant Association Groups were used to assign the Biophysical Environment labels used in this assessment, and the plant associations described within each group were used to infer potential natural vegetation (PNV) across the assessment area.

Soil water holding capacity was used to increase the accuracy of labeling the physical environments where data was available.

Field knowledge of the geographic distribution of plant associations were used to help fine tune the physical environment classification. This increased the predictive accuracy of possible plant association groupings that would be associated with the BPE label.

Validation of this model was based on field knowledge of the various specialists that reviewed the classification at the various stages of its development.

II. Summary Statement

Landform is a critical component that needs to be incorporated into the development of the biophysical environment. Plant association groups have some inherent environmental factors associated with them. However, landform information is necessary to increase the predictive accuracy of the information.

Better soil typing information is another critical component that is necessary to increase the accuracy and predictability of the biophysical environment.

The team's classification of the physical environment and its associated vegetation is not a clean match with the Wenatchee PAGs described by Lillybridge et al (1995). Microsite conditions and landform need to be further incorporated into this model to improve its accuracy. Validation monitoring of plant association links with the BPE classification is needed to determine the accuracy of this landscape classification and the fire disturbance plant association groups used in this assessment. This validation monitoring should be completed during project planning.

APPENDIX E

Potential Fire Behavior and Crown Fire Potential Modeling

Relative Crown Fire Potential Modeling (CFP) Conditions that are potentially conducive to a crown fire are: dry fuel moisture, low humidity, high temperatures, heavy fuel accumulation, presence of ladder fuels, steep slopes, strong winds, unstable atmosphere, and a continuity of coniferous trees (Rothermel 19911a,b; Van Wagner 1977). Fahnestock (1970) recognized intrinsic crown attributes that make them vulnerable to fire crowning. Based on Fahnestock's work, tree species and their vertical and horizontal canopy distribution are used to assign a baseline, or intrinsic rate that identifies the relative vulnerability to crown fires of each vegetation pixel (grid). To account for those crown attributes Okanogan 1983 ERDAS LANSAT imagery attributes such as species, structural class, number of canopy layers (ladder fuels), and percent crown cover were identified as analogues to vertical and horizontal continuity.

Six relative crown fire potential classes were used to rate each of the 137 signature classes with respect to their intrinsic vulnerability to crown fires: none, very low, low, moderate, high, and very high. These were then applied to the assessment area on grid maps with 50 meter pixels. Two more classes, severe and extreme, are added later to assess the effect of fireline intensity on crown fire. Those classes were assigned an increasing relative vulnerability value from one to eight for analysis purposes. A rating of one corresponds to vegetation grids where a crown fire may not occur. The grids rated as class eight will be those with the highest vulnerability to crown fires. Table E-2 shows the dichotomous key used to classify vegetation grids into one of those six classes potential (Ottmar, Alverado et. al. September, 1996). Note that non-forested vegetation types are rated as not vulnerable to crown fires. As mentioned by Fahnestock, for low vegetation the fire rate of spread covers implicitly the crowning of brush. A total of less than 30 percent crown closure is also considered not susceptible to crowning. Although individual trees in these woodlands may crown out, the tree density is very low and most likely too sparse to allow fire propagation through the crowns.

For a crown fire to occur, tree crowns need to be able to be ignited and carry the fire through the crowns. There are two assumptions on which this approach is based. First, the surface fire intensity must be sufficient to ignite the crowns. Second, the rate of spread must allow direct surface-to-crown fire spread through ladder fuels. Therefore, this approach is dependent on the occurrence of a surface fire in the grid. The Crown Fire Potential (CFP) model estimates are based on the assumption that the entire 50 meter grid burns homogeneously in a fire. Therefore, a single relative CFP class is applied to the entire 50 meter grid.

To determine fireline intensities under wildfire conditions, spread runs were made in the BEHAVE program utilizing Northern Forest Fire Lab fuel models. Fuel loading is the most critical variable for computing the potential fire behavior of a landscape. Fuel loading for this assessment is defined as dead and downed woody material (twigs, branches, stems, boles of trees) shrubs, herbaceous material, and organic ground layer, in terms of weight of biomass per unit area. All of the biomass present may or may not be available for combustion during each fire episode.

Fuel loading is a very difficult variable to measure and has been the weakest link in all fire behavior assessments. Currently, methodologies to measure fuel loading at large scales directly from satellite imagery do not exist. To delineate ground fuel loading from the Okanogan 1983 ERDAS LANSAT imagery, the 13 NFFL fuel models were assigned to each of the 137 fuel signature classes in the 83 ERDAS vegetation layer, based on species, structural class, signature class definitions, and expert knowledge (Table E-1). Slope values are derived from intersections of each grid with the Forest slope cover, which were then input to BEHAVE - fuel moistures of 4 percent for dead woody material and 70 percent for live fuel moisture. Wind speeds were determined by examining NFDRS data for weather stations within the analysis area at the 90th percentile level. This data was then converted to mid-flame wind speeds. BEHAVE runs were then made with several mid-flame wind speed values for fuel models 9 and 10 to determine if the highest thresholds would be reached so there would be a full range of values across the assessment area. Mid-flame wind speed of nine miles per hour was selected and the resulting fireline intensities used in assigning additional ratings for passive and active crown fires. This allowed the team to estimate if a surface fire had a sufficient rate of spread and intensity to become either a passive or active crown fire. These values were then captured and applied to the intrinsic CFP values.

Based on work by Fahnestock (1970), Van Wagner (1977), Rothermel (1991), and Bessie and Johnson (1995), fire intensity thresholds are calculated that modify the intrinsic relative vulnerability index. That index has a one step increase if the fire rate of spread and intensity exceed a first threshold, which defines the potential to start a passive crown fire. A further step is added if a fire burns with the surface spread and intensity sufficient to sustain an active crown fire. Therefore, two more classes were added to the CFP classes: severe and extreme. For instance, a vegetation grid originally rated in the sixth class (very high) and considered capable of supporting a passive crown fire will have its rating increased to severe.

Table E-3 describes the procedure followed to define whether a surface fire may turn into a passive or an active crown fire. Table E-4 includes ladder fuel values from the Northeastern Oregon Trade-off Model (Schaaf et.al. 1996) that were used in the crown ignition calculations. Table E-4 was adapted to include ladder fuel values for the stand initiation structural class which was not represented in the original table. Ladder fuel values from mixed conifer were applied to cover types where other conifers different than pine species were dominant, such as true firs, Douglas-fir, hemlock, larch, and spruce. Ladder fuel values from lodgepole pine were applied to cover types where short needled pines and western white pine are dominant. Structural classes were matched to tree ages used in that table. The stand initiation class was matched with the stand initiation of the table. The mature tree class was matched with stem exclusion open canopies, stem exclusion closed canopies, understory re-initiation, and young forest multiple strata. The over-mature tree class was matched to old forest multiple strata and old forest single strata.

Table E-1. ERDAS Data

arcview	fuel class	structure	species	crown fire	nffl	ladder	crown ht	crit int lo	crit int le	fire int lb
1	FC1	1	1	1	5		1	8	285	0
2	FC3	2	1	1	2		8	186	326	0
3	FC4	9	10	3	9	y	6	121	284	0
4	FC5	9	10	2	8		0	0	0	0
5	FC6	2	1	1	9		8	186	284	0
6	FC7	2	1	1	9		8	186	284	0
7	FC8	2	1	1	9		8	186	284	0
8	FC9	2	1	1	9		8	186	284	0
9	FC10	5	1	3	9	y	9	222	284	0
10	FC11	5	1	3	9	y	9	222	284	0
11	FC12	2	1	2	9		8	121	284	0
12	FC13	2	1	2	9		6	121	284	0
13	FC14	5	1	2	9	y	9	222	284	0
14	FC15	7	1	2	9		15	478	284	0
15	FC16	6	1	3	9	y	6	121	284	0
16	FC17	6	1	3	9	y	6	121	284	0
17	FC18	6	1	3	9	y	6	121	284	0
18	FC19	6	1	3	8	y	6	121	407	0
19	FC20	7	1	2	9	y	6	121	284	0
20	FC21	6	1	2	9		15	478	284	0
21	FC22	5	1	2	9	y	6	121	284	0
22	FC23	5	1	3	8	y	9	222	407	0
	FC24	5	1	3	9	y	0	0	0	0
23	FC25	5	2	5	8	y	8	186	407	0
24	FC26	1	2	2	1		3	43	60	0
25	FC27	1	2	2	5		3	43	285	0
26	FC28	4	2	4	8		10	260	407	0
27	FC29	4	2	4	8		10	260	407	0
28	FC30	4	2	5	8	y	10	260	407	0
29	FC31	3	3	4	8		10	260	407	0
30	FC32	3	3	4	8		10	260	407	0
31	FC33	3	2	4	8		10	260	407	0
32	FC34	3	5	4	8		15	478	407	0
33	FC35	3	5	4	8		15	478	407	0
34	FC36	3	2	4	8		10	260	407	0
35	FC37	4	2	4	8		10	260	407	0
36	FC38	5	2	4	8	y	10	260	407	0
37	FC38A	4	2	5	8	y	10	260	407	0
38	FC39	3	7	4	8		15	478	407	0
39	FC40	3	7	4	8		15	478	407	0
40	FC41	7	3	2	10		12	342	975	0
41	FC42	6	3	5	8	y	6	121	407	0
42	FC43	6	1	2	8	y	6	121	407	0
43	FC44	6	3	4	10		12	342	975	0
44	FC45	6	2	4	10		12	342	975	0
45	FC46	6	2	4	8		12	342	407	0
46	FC47	6	2	4	8	y	6	121	407	0
47	FC48	6	2	5	8	y	6	121	407	0
48	FC49	6	7	4	10		12	342	975	0
49	FC50	6	7	4	10		12	342	975	0
50	FC51	4	3	4	8		10	260	407	0
51	FC52	6	3	4	10		12	342	975	0
52	FC53	6	2	5	10	y	6	121	975	0
53	FC54	6	3	5	10	y	6	121	975	0
54	FC55	6	7	5	10	y	6	121	975	0
55	FC56	5	3	5	8	y	8	186	407	0
56	FC57	5	3	5	8	y	8	186	407	0
	FC57A	5	4	5	8	y	0	0	0	0
57	FC58	5	4	5	8	y	8	186	407	0

Table E-2. Dichotomous Key to Determine the Relative Vulnerability of 1983 ERDAS Vegetation Attributes to Crown Fires.

Non-forested and Woodland Vegetation Cover Types

1) For vegetation cover types:

aspen/cottonwood-willow, woodland; or woodland structural classes = woodland stand initiation, woodland stem exclusion, woodland understory re-initiation, young multistory woodland, old multistory woodland, old single stratum woodland:

Intrinsic crown fire potential: None (1). If surface fire or passive or active crown fire intensity occurs, crown fire potential remains as None (1) (see Table E-3 for a description of passive and active crown fires).

2) For vegetation cover types:

rock, water, wet meadow/marsh, alpine meadow, dry meadow/grassland, shrubland, post-logging-bare ground/burned, post logging-bare ground/slumps and erosion, post logging-grass/forb stage, cropland, urban/rural, pasture, grassland, colline bunchgrass, montane bunchgrass, subalpine and alpine bunchgrass, colline exotic grasses and forbs, montane exotic grasses and forbs, subalpine and alpine exotic grasses and forbs, colline moist herbaceous, montane moist herbaceous, subalpine and alpine moist herbaceous, colline low-medium shrublands, montane mahogany, subalpine and alpine mahogany, colline tall shrub, montane tall shrub, colline wet shrub, montane wet shrub, subalpine and alpine wet shrub, montane beargrasss, subalpine beargrass.

Intrinsic crown fire potential: None (1). If surface fire or passive or active crown fire intensity occurs, crown fire potential remains as None (1) (see Table E-3 for a description of passive and active crown fires).

Forested Vegetation Cover Types

3) For vegetation cover types:

Interior Douglas-fir, grand fir or white fir, silver fir, Engelmann spruce-subalpine fir, western hemlock and western red cedar, mountain hemlock, red fir.

3.1) Structural stages: stem exclusion closed canopy, young forest multistrata, old forest multistrata, understory re-initiation.

3.1.1) Number of canopy layers: 2 or 3

3.1.1.1) Total crown cover ≥ 70 percent, Intrinsic crown fire potential: Very High (6)

3.1.1.2) Total crown cover < 70 percent, Intrinsic crown fire potential: High (5)

3.1.2) Number of canopy layers: 1

3.1.2.1) Total crown cover ≥ 70 percent, Intrinsic crown fire potential: High (5)

3.1.2.2) Total crown cover < 70 percent, Intrinsic crown fire potential: Moderate (4)

3.2) Structural stages: stand initiation, stem exclusion open canopy, old forest single strata

3.2.1) Number of canopy layers > 1, Intrinsic crown fire potential: Low (3)

3.2.2) Number of canopy layers: 1, Intrinsic crown fire potential: Very Low (2)

4) For vegetation cover types:

Ponderosa pine, western larch, lodgepole pine, whitebark pine and subalpine larch, western white pine.

4.1) Structural stages: stem exclusion closed canopy, young forest multistrata, old forest multistrata, understory reinitiation.

4.1.1) Number of canopy layers: 2 or 3.

4.1.1.1) Total crown cover ≥ 70 percent, Intrinsic crown fire potential: High (5)

4.1.1.2) Total crown cover < 70 percent, Intrinsic crown fire potential: Low (3)

4.1.2) Number of canopy layers: 1

4.1.2.1) Total crown cover ≥ 70 percent, Intrinsic crown fire potential: Moderate (4)

4.1.2.2) Total crown cover < 70 percent, Intrinsic crown fire potential: Very Low (2)

4.2) Structural stages: stand initiation, stem exclusion open canopy, old forest single strata

4.2.1) Number of canopy layers > 1, Intrinsic crown fire potential: Very Low (2)

4.2.2) Number of canopy layers: 1, Intrinsic crown fire potential: None (1)

For All Forested Vegetation Cover Types:

If a surface fire is likely to become a passive crown fire, then the vegetation intrinsic crown fire potential is increased one step in ranking.

If a surface fire is likely to become an active crown fire, then the vegetation intrinsic crown fire potential is increased two steps in ranking.

(See Table E-3 for a description of passive and active crown fires.)

Table E-3. Description of Passive and Active Crown Fire Initiation Models Used to Rank the Relative Vulnerability of Vegetation Polygons to Crown Fire Potential.

The description of the models is based on work by Van Wagner (1977), Rothermel (1995) and Bessie and Johnson (1995).

Two conditions must be satisfied for the initiation of a crown fire:

1. Crown fuel ignitions from a burning surface fire must occur. This is given by a fire intensity threshold. If the fire is burning over that threshold, it is assumed that the crowns may ignite.

2. Rate of spread must allow direct surface-to-crown fire spread, i.e., ladder fuels must allow fire propagation from the surface fire to the crown.

Crown fuel ignition occurs when surface fireline intensity > critical intensity, where the critical intensity is given by:

$$I_p = (0.01\ z\ Q_c)^{3/2}$$

Where:
I_p is the critical surface fireline intensity in BTU/ft/sec.
0.01 is an empirical constant
Q_c = heat of foliage ignition, held constant for this analysis at 1,316 BTU/pound.
z = lower crown base height.

Given these, critical intensity depends only on the ladder fuels. Table E-4 gives a complete set of critical values for the ladder fuel heights used in the analysis.

The next step is to calculate the passive crown fire initiation (C_p), given by the following ratio:

$$C_p = \frac{I_B}{I_p}$$

Where:
C_p = passive crown fuel variable (unitless).
I_B = surface fireline intensity (BTU's/ft/sec). For a given grid, this value is computed by BEHAVE and assigned to grids with the appropriate slope class.
I_p = critical intensity (BTU's/ft/sec).

When the ratio $C_p \geq 1$, crown ignition is likely to occur. If the ration $C_p < 1$, crown ignition is unlikely to occur.

Once the crown is ignited, potential crown fire spread is given by an active crown fire initiation ratio. It is assumed that crown to crown fire spread (active crown fire initiation) is achieved when the crown fire rate of spread exceeds the critical rate of spread (R_a), given in ft/sec. R_a is given by the following ratio:

$$R_a = \frac{S_o}{P_c}$$

Where:
R_a is the critical rate of spread in meters/second
S_o is the critical mass flow rate in kilograms/(squared meter. * second). For this analysis, this value was held constant at 0.05 kilograms/(squared meter. * second) (Van Wagner 1977).
P_c is the crown fuel bulk density in kilograms/cubic meter.

To simplify the analysis, an average R_a value of 0.35 meters/second (1.14 feet/second) from Van Wagner (1977) and Bessie and Johnson (1995) was used.

Conversion of the critical crown fire rate of spread (R_a) to a surface fire rate of spread (ROS) is done through the following equation:

$$ROS = \frac{R_c}{3.34}$$

Where:
I_a is the critical intensity for active crowning (BTU's/ft/second)
R_a is the critical rate of spread (feet/minute)
h stands for low heat of combustion, held constant for the analysis at 12,700 kilojoules/kilogram, (5463.54 BTU's/pound).
W_n is the net surface fuels load in pounds/square ft. from the Rothermel model.

Thus:

1) When $\frac{I_b}{I_p} < 1$, the fire burns at the surface only.

2) When $\frac{I_b}{I_p} \geq 1$ and $\frac{I_b}{I_a} < 1$, then the fire is likely to become a passive crown fire.

3) When $\frac{I_B}{I_p} \geq 1$ and $\frac{I_B}{I_a} \geq 1$, the fire is a true, or active crown fire.

Table E-4. Critical Surface Fire Intensity (I_p) for Crown Ignition, Based upon Ladder Fuel Values (z), Used to Model Vulnerability of Vegetation Grids to Crown Fire Potential for this Assessment. (Ottmar, Alverado)

	Single Layer Crown				Multiple Layer Crown			
	Ladder Fuel Height		Critical Fire Intensity		Ladder Fuel Height		Critical Fire Intensity	
Species and Age	meters	feet	kilowatts/ meter	Btu/feet second	meters	feet	kilowatts/ meter	Btu/feet second
Ponderosa pine								
Stand initiation	0.3	1	28.5	8.2	0.3	1	28.5	8.2
Immature	1.8	6	418.6	121	2.7	9	769.1	222.3
Mature	2.4	8	644.5	186.3	2.4	8	644.5	186.3
Overmature	4.6	15	1654.8	478.4	1.8	6	418.6	121
Mixed conifers								
Stand initiation	0.9	3	148	42.8	0.9	3	148	42.8
Immature	2.4	8	644.5	186.3	2.4	8	644.5	186.3
Mature	3.1	10	900.8	260.4	3.1	10	900.8	260.4
Overmature	3.7	12	1184.1	342.3	1.8	6	418.7	121
Lodgepole pine								
Stand initiation	0.3	1	28.5	8.2	0.3	1	28.5	8.2
Immature	2.7	9	769.1	222.3	2.7	9	769.1	222.3
Mature	4.6	15	1654.8	478.4	4.5	15	1654.8	478.4
Overmature	3.1	10	900.8	260.4	3.1	10	900.8	260.4
Western juniper								
Stand initiation	0.3	1	28.5	8.2	0.3	1	28.5	8.2
Immature	0.3	1	28.5	8.2	0.3	1	28.5	8.2
Mature	0.9	3	148	42.8	0.9	3	148	42.8
Overmature	1.5	5	318.5	92.1	1.5	5	318.5	92.1

Table E- 5. Descriptions of Forest Structural Classes Modeled in the Mid-Scale Ecological Assessment of the Interior Columbia River Basin (From Hessburg and others 1996)

Structural Class	Definition	Description
Stand Initiation	Growing space is reoccupied following a stand replacing disturbance (e.g., fire, harvest), typically by seral species	1 canopy stratum (may be broken or continuous); 1 cohort[2] seedlings or saplings; grasses, forbs, shrubs may be present with early seral trees
Stem Exclusion: Open Canopy	Occurrence of new tree stems is moisture limited; crowns are open growing; canopy is broken; may be maintained by frequent underburning or density management	1 broken canopy stratum; 1 cohort; trees excluding new stems through competition; poles, small, or medium trees; understory shrubs, grasses, forbs may be present
Stem Exclusion: Closed Canopy	Occurrence of new tree stems is mostly light limited; crowns abrading, canopy is closed	Continuous closed canopy; 1 or more canopy strata; a cohort; lower strata, if present, are same age as upper strata; poles, small or medium trees; understory shrubs, grasses, forbs, may be present
Understory Reinitiation	Second cohort established under older typically seral overstory; mortality in the overstory creates growing space for new trees in the understory	Broken overstory canopy, ≥ 2 canopy strata; 2 cohorts; overstory is poles, small or medium trees; understory is seedlings, saplings, or poles
Young Forest Multi-Story	Several cohorts have established under the influence of management or fires with mixed lethal and non-lethal effects, or by insect and disease group killing; seral overstory large trees are generally absent due to harvesting or other disturbance	Broken overstory canopy; >2 canopy strata; >2 cohorts; large trees are absent in the overstory; stands are characterized by diverse horizontal and vertical distributions of trees and tree sizes; seedlings, saplings, poles, small, and medium trees are present
Old Forest Multi-Story	Multi-cohort, multi strata stands with large old trees	Broken overstory canopy; >2 canopy strata; >2 cohorts; large trees dominate in the overstory; stands are characterized by diverse horizontal and vertical distributions of trees and tree sizes; all tree sizes may be present
Old Forest Single-Story	Single stratum stands of large, old trees. No or few young trees are present in the understory; parklike conditions resulting from non-lethal natural or prescribed underburning or other management are the dominant feature	Broken or continuous canopy of large, old trees; 1 stratum, may be single but usually multi-cohort; large trees dominate the overstory; understory absent or seedlings or saplings; grasses, forbs, and/or shrubs may be present in the understory

[2] Trees within a cohort share a common disturbance history; they are those initiated or released after a disturbance (natural or artificial). Tree ages within a cohort may span several decades.

Table E-6

Structural Code		Hessburg 1996		
Code	Description	X - Reference	Size Code	Size Code Name
1	Stand initiation	Stand initiation	1	Early
2	Stem exclusion open canopy	Stem exclusion open canopy	2	Young
3	Stem exclusion closed canopy	Stem exclusion closed canopy	2	Young
4	Understory reinitiation	Understory reinitiation	2	Young
5	Multi-stratum without large trees	Young forest multi-story	2	Young
6	Multi-stratum with large trees	Old forest multi-story	3	Mature
7	Single-stratum with large trees	Old forest single story	3	Mature
8	Shrubfields		4	Grass/shrub
9	Deciduous Woodland		9	Deciduous woodland
10	Grass shrub steppe		4	Grass/shrub
11	Wet meadow		5	Meadow
12	Dry meadow		5	Meadow
13	Alpine meadow		6	Alpine parkland
14	Pial alpine meadow		6	Alpine parkland
15	Laly alpine meadow		6	Alpine parkland
16	Mixed conifer alpine meadow		6	Alpine parkland
17	Rock outcrop		7	Rock and snowfield
18	Water		8	Water
19	Agriculture land		10	Agriculture
20	Glaciers		7	Rock and snowfield
21	Krumholtz		6	Alpine parkland

Species Groups				
Code	Group	Plant Associations	Grid Codes	
1	Pipo/Psme	Pipo, Pipo/Psme, Pipo/Psme/Laoc, Psme/Pipo	1,2,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,28,42	
2	Psme/Laoc	Psme/Laoc, Psme/Laoc/Pico	23,24,25,26,27,28,31,34,35,36,37,44,45,46,47,52	
3	Psme	Psme/Pipo, Psme/Pico, Psme/Abla2, Psme/Abla2/Laoc, Psme	29,30,40,41,43,50,51,53,55,56	
4	Pien	Pien, Pien/Pico, Pien/Abla2, Pien/Abla2/Abam/Pico/Pial, Pien/Abla2/Pico	57,58,59,61,62,63,64,65,66	
5	Pico	Pico dominated mixed forests	32,33,69,70,71,72,73,74,75,76,77,78,79,132,134,135,137	
6	Abla2	Abla2/Pien/Pico, ABla2/Pien, Abla2/Psme, Abla2/Abam/Pien	80,82,83,84,85,88,91,93,95,97	
7	Tshe/Abam	Pien/Abla2/Abam, Psme/Abla2/Abam, Abla2/Pien/Abam/Pico, Abla2/Pien/Abam, Abla2/Abam/Pien/Pico, Tshe/Abam, Psme/Tshe	38,39,48,49,54,60,67,68,86,87,89,90,92,94,96,98,99,100,101,102,103,104,105,106,107,108	
8		Alpine forest	81, 113, 115, 133	
9		Non forest	116, 117, 118, 119, 120, 121, 122, 123, 125, 127	
10		Deciduous woodland	3, 4, 110, 112	
11		Rock & Ice	128, 136	
12		Deforested shrubland	109. 111, 126	
13		Water	129	
14		Agriculture	130	

Table E-7

Intrinsic Crown Fire Potential Values From ERDAS 1983			Species Group A	Species Group B	
Str. Code	Description	% Crown Closure	DF,WF,SF,ES,SAF,WH,WRC,MH	PP,WL,LPP,WP,SAL,WWP,WJ,RMJ,HDWD	Ladder/ Layers
1&2	Stand initiation &	< 70%	2	1	1
1&2	Stem exclusion open canopy	>= 70%	3	2	>1
3 thru 6	Stem exclusion closed canopy	< 70%	4	2	1
3 thru 6	Understory reinitiation	>= 70%	5	4	1
3 thru 6	Multi-stratum without large trees	< 70%	5	3	>1
3 thru 6	Multi-stratum with large trees	>= 70%	6	5	>1
7	Single-stratum with large trees	< 70%	2	1	1
		>= 70%	3	2	>1

Table E-8

NFFL Fuel Model Net Surface Fuel Load Tons/acre and Kilograms/squared meter								
	Loading							
Model	1hr	10 hr	100 hr	Live	Tons/ac	Kilograms/sq.met	Ia (k/m)	Ia (btu/ft/sec)
1	0.7	0.0	0.0	0.0	0.7	0.16	208.53	60.29
2	2.0	1.0	0.5	0.5	4.0	0.85	1127.20	325.87
3	3.0	0.0	0.0	0.0	3.0	0.64	848.22	245.22
4	5.0	4.0	2.0	5.0	16.0	3.39	4517.24	1305.93
5	1.0	0.5	0.0	2.0	3.5	0.74	986.30	285.14
6	1.5	2.5	2.0	0.0	6.0	1.27	1690.79	488.81
7	1.1	1.9	1.5	0.4	4.9	1.03	1372.36	396.75
8	1.5	1.0	2.5	0.0	5.0	1.06	1409.00	407.34
9	2.9	0.4	0.2	0.0	3.5	0.74	980.66	283.51
10	3.0	2.0	5.0	2.0	12.0	2.53	3371.59	974.73
11	1.5	4.5	5.5	0.0	11.5	2.44	3243.51	937.70
12	4.0	14.0	16.5	0.0	34.6	7.32	9741.79	2816.35
13	7.0	23.0	28.1	0.0	58.1	12.30	16372.53	4733.30

Table E-9

Fireline Intensity (Btu/ft/s)						
NFFL Model		23%	32%	45%	64%	90%
		9 mile per hour midflame windspeed				
1		607*	607*	607*	607*	607*
2		1224	1257	1324	1463	1781
3		4775	4922	5220	5835	7025
4		13563	14006	14909	16759	20847
5		1099	1134	1205	1351	1634
6		889	919	978	1101	1338
7		877	905	963	1082	1311
8		22	23	24	[illegible]	[illegible]
9		215	221	234	259	309
10		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11						
12						
13						

* means you hit the wind limit

APPENDIX F

Fire Plan

The implementation of a fire management plan for the LSRs located within the Methow River drainage is a critical component of the LSR assessment. The ROD recognizes that fire plays an important role in the development and maintenance of vegetative diversity, especially in fire prone ecosystems east of the Cascade Mountain Range.

Fire suppression has increased the occurrence of, and in some cases created, those forest conditions which favor late successional species. As fire suppression continues to interrupt the recycling of nutrients and resetting of vegetative seres, the amount of late successional habitat will continue to increase. With this increase in desired habitat occurs an increase in risk of late successional habitat loss through larger and more intense fires. This is inconsistent with management direction in the ROD.

The increased fuels and their homogeneity has made fire fighting more challenging and dangerous to firefighters by increasing stand structure and density which increases the crown fire potential. These stands present special hazards to firefighters, including snags and green trees with rot and disease which ignite readily and fall without warning. This is especially true in late successional reserves where these conditions are encouraged.

This fire management plan describes what opportunities exist to provide for a reduction of the risk of stand replacing crown fires within the LSRs. Priority is placed on utilizing minimum impact suppression tactics and fuels reduction methods in accordance with guidelines for reducing risks of large-scale disturbances. All plans will emphasize maintaining late-successional habitat. During the Fire Situation Analysis and Escaped Fire Situation Analysis, fire managers will consult with resource specialists familiar with the area, this plan, the Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl, and their objectives to assure that habitat damage is minimized. The goal of wildfire suppression is to limit the size of all fires by applying an appropriate suppression response cost effectively, keeping in mind public and firefighter safety. Some natural fires may be managed to achieve risk reduction or LSR objectives.

An overall assessment of the risk of large scale stand-replacing fires was made by determining the crown fire potential across the assessment area. This helped to determine, along with fire suppression pre-attack plans, where natural barriers exist and where there are good opportunities to establish or strengthen fuelbreaks. Completed fuelbreaks in this plan refer to areas of reduced fuels that allow safe access for fire suppression crews and provide strategic locations for efficient and effective fire suppression. This may include reducing the continuity of canopies to less than 75 percent cover, pruning boles on residual trees, and reducing understory fuels.

In Dry sites (PIPO, PSMEDRY, & PSMEMOIST) these fuelbreaks take the form of proposed underburning areas. These areas have been strategically located to take advantage of south slopes which are already fairly open and linking areas with low crown fire potential ratings. They usually do not meet the definition of late-successional. Wildfires in stands that are managed by underburning are generally less severe, and the fire suppression effort is enhanced. To increase effectiveness, underburning should be implemented over large areas. Previously described fire history indicates that in these dry habitat types fires move from one aspect to another very readily. By pre-treating these areas with prescribed underburning, suppression resources will have a better opportunity to be successful in containing the fires on the south slopes.

In the wetter, higher (ABLA2DRY, ABLA2MOIST, ABAM-TSME, TSHE, and SUBALPINE) habitat types fuelbreaks will usually not be created by prescribed underburning. These stands are generally fire intolerant and will not survive most low intensity fires. Wildfires in these habitats spread through upslope, or wind driven runs, usually through the crowns, and aided by associated spotting. It is common for this spotting to occur up to a half mile from the main fire. North slopes and riparian areas may offer some dampening effect on fire spread, depending on the time of year of the fire and fuel moisture conditions. Fuelbreaks in these habitat types take advantage of natural barriers (rocky or snow covered ridges) and low crown fire potential ratings. These areas will need further field verification to determine their true potential. Removal of surface fuels and reduction of stand density will be important in reducing crown fire potential. Taking advantage of existing openings to widen the fuelbreaks and reduce the risk of long range spotting is important if the fuelbreaks are to be effective.

The urban interface creates special concerns. These areas usually have an increased activity level which increases the chance of human ignited fires. Private structures also increase the values at risk, including human welfare. Fuelbreaks need to be developed around this interface to reduce the crown fire potential to low. These treatments may include removal of trees to reduce stand density, and could include mechanical fuels treatments.

All of these risk reduction measures are designed to compartmentalize the LSRs into blocks where wildfire suppression efforts will have an improved chance of containing a wildfire under 10,000 acres.

Risk reduction opportunities and fuelbreaks are also identified in spotted owl activity areas and federally designated critical habitat. This is necessary to maintain the integrity and continuity of the risk reduction effectiveness. The habitat objectives of these areas will be considered a high priority over risk of loss to wildfire. This will be analyzed at the project level. It is important to consider the tradeoffs of reducing the quality of habitat in some areas to protect the area as a whole. Thus, managers need to seek a balanced approach that reduces the risk of fire while protecting large areas of fire-prone late-successional forest.

Wildfire Prevention/Presuppression

Prevention should focus on the urban interface and high recreation use areas. Educational opportunities need to be pursued to assure that landowners adjacent to the LSRs understand basic fire behavior and how to develop a "fire-safe" home and landscape. Assistance should be rendered whenever possible to develop cooperative efforts with private landowners and public agencies to reduce forest fuels adjacent to and in LSRs. This includes presuppression efforts to create fuelbreaks and crown fire resistant stands in recommended areas.

Presuppression planning should also include development of containment lines that can be utilized as indirect fire lines from which to execute burn-outs in the event of a large fire. This may include maintenance burning fuelbreaks on a regular basis. Fuelbreak construction and maintenance can take on many forms, and plans for these need to be site specific. They may include removal of trees to reduce stand density and thus, the high risk of crown fire.

Wildfire Suppression

Suppression of wildfire in LSRs in general is driven by objectives to protect these stands from being destroyed by high severity fires.

An appropriate suppression response will be applied which is cost efficient and consistent with land and resource management objectives. Conduct an FSA evaluating initial suppression action on each uncontrolled wildfire following the first burning period. If it is determined that the initial action response does not meet, or is anticipated not to meet, established fire management direction, the fire shall be declared an escaped fire. Conduct EFSA for each wildfire declared as an escape. A Rare Event Risk Analysis Process should be done to assess the potential for the fire to burn out of the drainage. Priorities for protection from fire remain human life, improvements, and resources. In LSRs the late-successional habitat is valued as the top resource priority. During the EFSA process consideration needs to be given to the fact that these fires will create diversity to the LSRs which is an important component of these ecosystems functioning properly. These new early seral stands have demonstrated how effective they can be in providing good barriers to future fires. This is evident in fire history records on the Okanogan National Forest and in the Entiat Watershed, Wenatchee National Forest Forestry Sciences Laboratory/USFS Cooperative Research Project. Potential containment areas should also be determined. Confinement and containment strategies are acceptable if they also meet the objectives of reducing total lost acres of late successional stands.

Indirect tactics, including burn-outs and backfires, from the identified containment lines are acceptable, providing these tactics have been determined to be the most likely to be successful to contain the fire within a given drainage, and thus reduce the likelihood that a fire greater than 10,000 acres will occur. Every option will consider the least loss to late successional stands. This includes the recognition that it may be necessary to consume some late successional stands during burn-out operations in an effort to save larger landscapes containing significant amounts of late succession.

Light hand on the land tactics will be used whenever possible.

Prescribed Fire

Prescribed fire needs to be used in areas identified on the fire plan map (Map 18, Appendix G) to create "crown fire safe" stands. These areas are suffering from 60 years of effective wildfire suppression practices and now have elevated crown fire risk ratings due to increased ladder fuels and stand density. Many of these stands are in an irretrievable condition. We are not capable of doing prescribed burning on acres required to treat all dry site stands at a landscape level in the LSRs. It is critical that efforts be made to apply prescribed fire to the stands identified to provide some breaks in the continuous fuels that presently exist.

Summary

Current fire size in the assessment area is three to ten times less than it was in pre-settlement times, depending on which PAG it occurs in. Due to lack of accessibility, only about 56,000 acres are available for mechanical treatments. This is a little over 10 percent of the total LSR area. Fire treatments could extend beyond these roaded areas. However, social and political concerns, and smoke management constraints, will not permit treatments on a scale that might have a significant impact across the LSRs. The alternative is to select areas that provide some hope in containing wildfires within an area that would prevent large scale high severity fires. This is the option displayed on the fire plan map (Map 18, Appendix G). The reality is that the flammability of the LSR stands is steadily increasing. We see an increase in the number of acres burning in wildfires in recent years, along with higher fire severity's. It is a matter of time and chance before the LSRs are impacted by these fires. Remaining ponderosa pine and dry Douglas-fir stands must be treated with prescribed fire as much as possible. Wildfires in the subalpine fir/mixed conifer stands should be used as a tool, when possible, to reduce the homogeneity of the present stands, thus providing a change in fuel continuity with early seral conditions and the opportunity to slow fire spread. Burn-outs from preplanned areas should be utilized to contain fires within

10,000 acres or less and reduce the cost of suppression, hazardous exposures for firefighters, and to reduce the acreage of late successional stands consumed. Wildfire risk assessments such as RERAP should be done to help in the decision making process when considering the use of confinement and containment strategies. These strategies could reduce cost, increase annual burned acres, and reduce the threat of landscape (10,000 acres and greater) fires.

Fire Plan for Individual Late Successional Reserves:

Hunter Mountain LSR

Hunter Mountain LSR presently has almost 900 acres of stands with late successional characteristics and no spotted owl activity centers or federally designated critical habitat . This is about 14 percent of the total acreage in the LSR. Most of this is found in PSMEDRY PAG. As previously described, it will be difficult to continue to maintain and protect this late successional acreage in its present condition.

Managing crown fire potential means reducing ladder fuels and surface fuel loadings to reduce potential for high intensity fires. This can be achieved by maintaining at least 20 foot spacing between crowns, (crown bulk density of 0.10) to create a crown-fire safe condition (Agee 1996). Proposed areas are shown on Risk Reduction Opportunity, Map 18. When these areas are treated, conditions will exist that will support low intensity fires which will reduce the risk of crown fires. The fuelbreaks will then be defined by ridge tops and existing barriers such as roads, trails, and open grassy areas.

Prescribed underburning is recommended in these areas to reduce crown fire potential and attempt to return these stands to a more fire tolerant condition. Some reduction of stand density may be necessary to reduce crown fire potential.

Urban interface acres in this LSR should be treated to a low crown fire risk rating to limit fire spread both on and off these developed areas. These are shown on the Risk Reduction Opportunities, Map 18.

All wildfires are to be fully suppressed. Indirect tactics may be utilized where appropriate to provide for firefighter safety, reduce suppression activity impacts, and reduce costs and losses of late successional stands.

Nice LSR

This LSR has about 33 percent of its area in late successional stands. The entire LSR is essentially accessible for mechanical treatment. There are no spotted owl activity centers or federally designated critical habitat .

Some of the best older ponderosa pine sites southeast of Lamb Butte to Falls Creek are at high risk to high intensity fire due to stand structure, steep slopes, and insects and disease. Underburn in the stand to increase its fire tolerance. Manage adjacent stands to buffer this stand (on east side of Lamb Butte). Treat west/southwest aspect of Lamb Butte to Eightmile Road.

Falls Creek, Nice and Flat Campgrounds need fuelbreaks around them to limit fire spread both on and off these developed areas.

West and southwest aspects contain primarily PIPO , PSMEDRY and PSMEMOIST PAGs. Prescribed underburning is recommended in these areas to reduce crown fire potential and attempt to return these stands to a more fire tolerant condition. Risk of stand replacing fires can be managed by reducing ladder fuels and surface fuels in these areas, and by maintaining at least 20 foot spacing between crowns (crown bulk density of 0.10). See Risk Reduction Opportunities, Map 18. Completion on these treatments will, in effect, create the proposed fuelbreak within the Nice LSR without any need for further treatment.

All wildfires are to be fully suppressed. Indirect tactics may be utilized where appropriate to provide for firefighter safety, reduce suppression activity impacts, and reduce costs and losses of late successional stands.

Sawtooth LSR

This LSR presents a special challenge in reducing the of risk of large scale, high severity fires. Large scale, high severity fire has occured in the recent past (Camas Burn 1929). Approximately 20 percent of the area is in late successional stands. Access is limited through most of the area. There is an even distribution of the PAGs across the LSR. There is one spotted owl activity center, and no federally designated critical habitat. Risk of stand replacing fires can be managed by reducing ladder fuels and surface fuel loadings on south slopes in the Ponderosa Pine and Dry Douglas-fir PAGs, and by maintaining at least 20 foot spacing between crowns (crown bulk density of 0.10). This should be done in those areas indicated on Map 18. When these treatments are accomplished, fuelbreaks adjacent to these areas will effectively be created

Fuelbreaks indicated on Map 18 that are not adjacent to risk reduction opportunity areas will require treatments to reduce the risk of stand replacing fires as described above. The width of these fuelbreaks will vary, depending on the steepness of the slope, stand structure and density. A maximum width of one-half mile is necessary to reduce crown fire potential due to spotting. The appropriate width needs to be determined on a project level basis. Fuels reduction and removal of ladder fuels is the priority in the fuelbreak treatment areas. Reduction of stand density to at least 20 foot spacing between crowns on ridge tops will be treated to a width not to exceed 300 feet. Reduction of surface fuels and removal of ladder fuels to a minimum of 300 feet, not to exceed a width of one-half mile. The objective is to open the canopy sufficient to stop a running crown fire, improve effectiveness of aerial attack resources, and reduce surface and ladder fuels adequately to inhibit the fire intensity from initiating crown fire. This will also slow the spread of spot fires.

The risk reduction strategy is to focus underburning primarily on south aspects where concentrations of late successional stands are not as likely to occur. These areas run east and west and can be utilized, in conjunction with ridge tops, to develop and strengthen fuelbreaks. The intent is to prepare the area for containment of wildfires within a given drainage.

Dry site PAGs should be considered for prescribed underburning. It is recommended in these areas to reduce crown fire potential and attempt to return these stands to a more fire tolerant condition. Some reduction of stand density may be necessary to reduce crown fire potential.

All wildfires are to be attacked with an appropriate suppression response cost effectively, keeping in mind public and firefighter safety. Indirect tactics may be utilized where appropriate to provide for firefighter safety, reduce suppression activity impacts, costs and losses of late successional stands.

Urban interface acres in this LSR should be treated to a low crown fire risk rating to limit fire spread both on and off these developed areas. Reduction of stand density to at least 20 foot spacing between crowns immediately adjacent to the Forest Boundary will not exceed 300 feet wide. Reduction of surface fuels and removal of ladder fuels will be a minimum of 300 feet, not to exceed a width of one-half mile.

Twisp River LSR

Approximately 29 percent of the area is in late successional stands. This area receives high recreation use. There is a spotted owl activity center and a federally designated critical habitat within this LSR. The objectives for the critical habitat need to be met by any presuppression activities. Suppression activities need to be done using light hand on the land tactics. Nearly 70 percent of this LSR contains dry PAGs.

Objectives from a risk standpoint are to reduce ladder and surface fuel loadings in order to reduce the potential for a high intensity fire, by maintaining at least 20 foot spacing between crowns (crown bulk density of 0.10). This should be done in areas indicated as Risk Reduction Opportunities on Map 18. When these treatments are accomplished, fuelbreaks adjacent to these areas will effectively be created.

Prescribed underburning is recommended in the dry PAG areas to reduce crown fire potential and attempt to return these stands to a more fire tolerant condition. Some reduction of stand density may be necessary to reduce crown fire potential.

Fuelbreaks indicated on Map 18 that are not adjacent to risk reduction opportunity areas will require treatments to reduce the risk of stand replacing fires as described above. The width of these fuelbreaks will vary, depending on the steepness of the slope, stand structure and density. Maximum width is one-half mile to reduce crown fire potential due to spotting. The appropriate width needs to be determined on a project level basis. Fuels reduction and removal of ladder fuels is the priority in the fuelbreak treatment areas. Reduction of stand density to at least 20 foot spacing between crowns on ridge tops will be treated to a width not to exceed 300 feet. Reduction of surface fuels and removal of ladder fuels will be a minimum of 300 feet, not to exceed a width of one-half mile. The objective is to open the canopy enough to stop a running crown fire, improve effectiveness of aerial attack resources, and reduce surface and ladder fuels sufficient to inhibit the fire intensity from initiating crown fire. This will also slow the spread of spot fires.

Urban interface areas need to be maintained at a low crown fire potential rating within a half-mile buffer of private lands adjacent to the LSR to limit fire spread both on and off these developed areas. Reduction of stand density to at least 20 foot spacing between crowns immediately adjacent to the Forest Boundary will not exceed 300 feet wide. Reduction of surface fuels and removal of ladder fuels will be a minimum of 300 feet, not to exceed a width of one-half mile.

Campgrounds in the LSR need fuelbreaks around them to limit fire spread both on and off these developed areas.

All wildfires are to be attacked with an appropriate suppression response cost efficiency, keeping in mind public and firefighter safety. Indirect tactics may be utilized where appropriate to provide for firefighter safety, reduce suppression activity impacts, costs and losses of late successional stands. Fires on either side of the Twisp River can be expected to be slope driven fires, which will attempt to burn to the ridge tops in long narrow runs. If wind plays a role in this spread, the fire width will be broadened. Most of these ridges are low crown fire potential, or are rock and ice barriers. Therefore, suppression objectives on the south side of the Twisp River are to contain any fires within the major side drainages. In many cases suppression efforts on the upslope side of the fires may not be necessary because they can be contained by natural barriers. On the north side of the Twisp River, the fuels are fairly light and the stands have retained some fire tolerance. By undertaking large scale underburning projects in this area, the fire tolerance of these stands can be improved. Then, when fire events occur, they can be contained by natural barriers at ridge tops and higher elevations. By pre-treating with underburning, the fire severity can be greatly reduced. Every option will consider the least loss to late successional stands. This includes the recognition that it may be necessary to consume some late successional stands during burnout operations in an effort to save larger landscapes containing significant amounts of late succession.

Upper Methow LSR

Approximately 22 percent of the area is in late successional stands. This area receives high recreation use. There are eight spotted owl activity centers and two federally designated critical habitat areas. The objectives for the critical habitat need to be met by any presuppression activities. Suppression activities need to be conducted using light hand-on-the-land tactics. PAGs are evenly distributed throughout this LSR. Development on the Methow valley floor is expected to continue in Mazama, Virginia Ridge, Lost River, and Flagg Mtn. Trout Creek drainage has major dead component from bugs. Ignition on an average day would result in a high fire intensity, threatening a major tourist site. Popular recreation areas (campgrounds and hiking trails) are located within an area that high to extreme fire potential. Access is limited by poor roads with limited turnouts for two-way traffic.

Risk of stand replacing fires can be reduced by reducing ladder and surface fuel loadings in order to reduce potential for a high intensity fire on south slopes in the ponderosa pine and dry Douglas-fir PAGs, and by maintaining at least 20 foot spacing between crowns, (crown bulk density of 0.10). This should be done in areas indicated as "Risk Reduction Opportuntities" on Map 18. When these treeatments are accomplished the fuelbreaks adjacent to these areas will effectively be created.

Prescribed underburning is recommended in the dry PAG areas to reduce crown fire potential and attempt to return these stands to a more fire tolerant condition. Some reduction of stand density may be necessary to reduce crown fire potential. These areas include the Methow River - east, west, and south sides, Lost River - south aspect, Goat Creek - south to west aspects, Rattlesnake Creek - south aspects, Wolf Creek, and Insulator Basin. Fuelbreaks indicated on Map 18 that are not adjacent to risk reduction opportunity areas will require treatments to reduce the risk of stand replacing fires as described above. The width of these fuelbreaks will vary, depending on the steepness of the slope, stand structure and density. Maximum width is one-half mile to reduce crown fire potential due to spotting. The appropriate width needs to be determined on a project level basis. Fuels reduction and removal of ladder fuels is the priority in the fuelbreak treatment areas. Reduction of stand density to at least 20 foot spacing between crowns on ridge tops will be treated to a width not to exceed 300 feet. Reduction of surface fuels and removal of ladder fuels will be a minimum of 300 feet, not to exceed a width of one-half mile. The objective is to open the canopy sufficient to stop a running crown fire, improve effectiveness of aerial attack resources, and reduce surface and ladder fuels enough to inhibit the fire intensity from initiating crown fire. This will also slow the spread of spot fires.

Urban interface acres in this LSR should be treated to a low crown fire risk rating adjacent to and including private homes, and Forest Service buildings at Early Winters, to limit fire spread both on and off these developed areas. Reduction of stand density to at least 20 foot spacing between crowns immediately adjacent to the Forest Boundary will not exceed 300 feet wide. Reduction of surface fuels and removal of ladder fuels will be a minimum of 300 feet, not to exceed a width of one-half mile.

This urban interface is the highest priority for treatment in all the LSRs.. This is due to the development occurring in the Mazama area, and the presence of owl activity centers and federally designated critical habitat areas adjacent to it.

There may be some firewood opportunities in the following campgrounds: Klipchuck, Early Winters, Honeymoon, Ruffed Grouse. These campgrounds need fuelbreaks around them to limit fire spread both on and off these developed areas.

All wildfires are to be attacked with an appropriate suppression response cost efficienty, keeping in mind public and firefighter safety. Indirect tactics may be utilized where appropriate to provide for firefighter safety, reduce suppression activity impacts, costs and losses of late successional stands. This LSR contains many natural barriers in the form if rock and ice and areas of low crown fire potential, especially west of the Methow River and Rattlesnake Creek. Consequently, fire within this area will be low priority for suppression in a multiple-ignition event. Many ignitions may be of no consequence here and could be suppressed with confine and contain strategies. Special consideration needs to be given to suppression strategies and their effects in critical owl habitat located on Sandy Butte and Driveway Butte. These areas will receive full suppression, unless firefighter safety will be compromised.

Fires being managed as prescribed natural fires under the Pasayten Fire Management Plan will normally require suppression action if they threaten to leave the wilderness. The only time that immediate suppression action will not be taken is if the benefits to the LSR conditions outweigh any losses which might occur, with the exception of life and property.

APPENDIX G

Common Plant Species Traditionally Utilized by American Indians

SPECIES	COMMON NAME	PRIMARY HABITAT	RESPONSE TO DISTURBANCE
TREES:			
Pinus albicaulis	White-bark pine	High elevation forest and woodlands.	Thin bark susceptible to hot surface fire. Regeneration and perpetuation result of fires.
Pinus contorta	Lodgepole pine	High elevation forest.	Thin bark susceptible to hot surface fire. Regeneration and perpetuation result of fires.
Pinus ponderosa	Ponderosa pine	Low elevation forest.	Fire tolerant.
Populous tremuloides	Quaking aspen	Riparian sites, seeps, springs, and upland forest.	Fire intolerant and responds by root suckering.
Populous trichocarpa	Black cottonwood	Riverine and streamside corridors.	Fire intolerant. May stump sprout following fire; seeds germinate on moist, bare soils.
Thuja plicata	Western redcedar	Riverine and streamside corridors.	Fire intolerant. Will readily establish under forest canopy.
SHRUBS:			
Alnus spp.	Alder	Upland sites and streamside habitats.	Fire resistant and increases following fire and other disturbances.
Amelanchier alnifolia	Serviceberry	Upland sites and streamside terraces.	Will increase following fire.
Arctostaphylis uva-ursi	Kinnikinnick	Mid- to high-elevation forest and rocky sites.	Susceptible to fire kill. Will survive low intensity fires. Invades burned areas.
Berberis spp.	Oregon grape	Mid- to high-elevation forest.	Moderately resistant to fire mortality.
Cornus stolonifera	Red-osier dogwood	Riparian habitats.	Top killed by fire. May increase with fire.

SPECIES	COMMON NAME	PRIMARY HABITAT	RESPONSE TO DISTURBANCE
SHRUBS:			
Prunus virginiana	Chokecherry	Mid-elevation forest.	Moderately resistant to fire mortality. Will increase following fire.
Ribes lacustre	Swamp gooseberry	Mid- to high-elevation forest.	Shrub top-killed. Can recover in low intensity burns.
Ribes viscosisimum	Sticky currant	Mid- to high-elevation forest.	Shrubs top-killed, seeds are heat scarified.
Rosa spp.	Rose	Low- to high-elevation forest.	Resistant to fire mortality.
Rubus parviflorus	Thimbleberry	Mid- to high-elevation forest.	Resistant to fire. Seed stored, will rapidly sprout after fire.
Salix scouleriana	Scouler's willow	Mid- to high-elevation forest.	Resistant to fire mortality. Resprouts after fire and seeds germinate on moist burned sites.
Sambucus cerulea	Blue elderberry	Mid- to high-elevation forest.	Fire top kills the shrub. Buried seeds respond to fire quickly.
Sambucus racemosa	Red elderberry	Mid- to high-elevation forest.	Resistant to fire mortality.
Shepherdia canadensis	Russet buffaloberry	Mid- to high-elevation forest.	Moderately resistant to fire mortality. Shrub component of fire sere.
Symphoricarpos albus	Snowberry	Low- to mid-elevation forest.	Moderately resistant to fire mortality. Increases with moderate fires.
Vaccinium caespitosum	Dwarf huckleberry	Mid- to high-elevation forest.	Able to survive light to moderate fires. Will be killed by hot fires.
Vaccinium membranaceum	Big huckleberry	Mid- to high-elevation forest.	Moderately resistant to fire mortality. Fires can stimulate rhizome sprouting.
Vaccinium myrtillus	Low huckleberry	Mid- to high-elevation forest.	Will sprout following all but high intensity fires.
Vaccinium scoparium	Grouse huckleberry	Mid- to high-elevation forest.	Moderately resistant to fire. Sprouting is enhanced by low and moderate intensity fires.
Achillea millefolium	Yarrow	Low- to high-elevation forests and meadows.	Fire resistant. Increases after fire and ground disturbance.
Allium spp.	Onion	Dry meadows and grasslands.	Fire resistant as corm.
Balsamorhiza sagittata	Arrowleaf balsamroot	Low elevation shrub-steppe and grasslands.	Resistant to fire kill. Increases after fires.

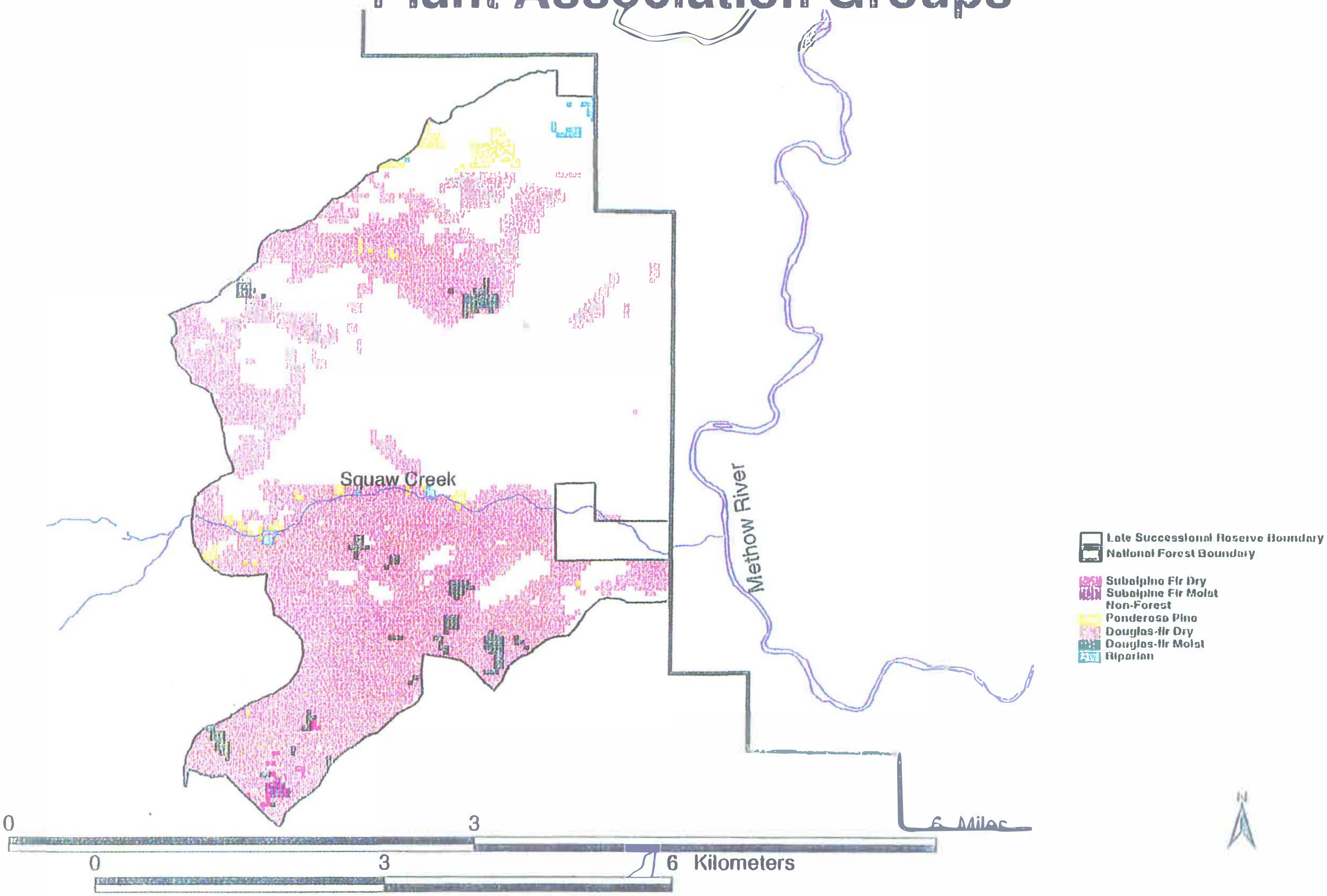
SPECIES	COMMON NAME	PRIMARY HABITAT	RESPONSE TO DISTURBANCE
SHRUBS:			
Calochortus macrocarpus	Mariposa lily	Low elevation shrub-steppe and grasslands.	Resistant to fire as a bulb herb.
Claytonia lancelota	Spring beauty	Low elevation shrub-steppe and grasslands.	Resistant to fire as a bulb herb.
Erythronium grandoflorum	Glacier lily	High elevation woodlands and openings.	Resistant to fire as a bulb herb.
Fragaria vesca	Strawberry	Mid- to high elevation forest and woodlands.	Susceptible to fire kill, but will increase with cool fires.
Fritilaria pudica	Yellowbells	Mid-elevation forest and meadow.	Resistant to fire as a bulb herb.
Heracleum lanatum	Cow parsnip	Springs, seeps, and riparian habitats.	Fire susceptible. Increase with canopy reduction.
Heuchera cylindrica	Alumroot	Rocky slopes in mid- to high-elevation forest.	Fire resistant roots.
Lewisia spp.	Bitterroot	Open, rocky ridges at mid-elevations.	Plant fire susceptible in bloom, no effect when burnt during dormancy. Fire may increase plant abundance.
Liguisticum canbyi	Lovage	Mid- to high elevation forest and woodlands.	Fire resistant as tuber.
Lilium columbianum	Tiger lily	Mid-elevation forest.	Fire resistant as deep bulbs. May increase in fire-killed vegetation.
Lomatium spp.	Bisquitroot	Low-elevation shrub-steppe and grasslands.	Fire resistant as tuber.
Mentha arvensis	Canada mint	Riparian sites and meadows.	Increases with disturbance.
Opuntia spp.	Prickly pear cactus	Low-elevation shrub-steppe and grasslands.	Fire tolerant. Increases with disturbance.
Perideridia gairdneri	Yampah	Mid- to high-elevation forest and openings.	Fire tolerant as deep tuber.
Typha latifolia	Cattail	Marshes and pond or lake margins.	Fire resistant. Regenerates from underground rhizomes.

SPECIES	COMMON NAME	PRIMARY HABITAT	RESPONSE TO DISTURBANCE
LICHENS:			
Bryoria fremontii	Black tree lichen	Low- to mid-elevation forest.	Fire tolerant to low and moderate intensity surface fires.
Cladonia spp.	Cup lichen	Mid- to high-elevation forest.	Fire susceptible as ground-dwelling lichen, but found in fire sere.
Letharia vulpina	Wolf lichen	Low- to mid-elevation forest.	Fire tolerant to low and moderate intensity surface fires.

APPENDIX H

List of Maps

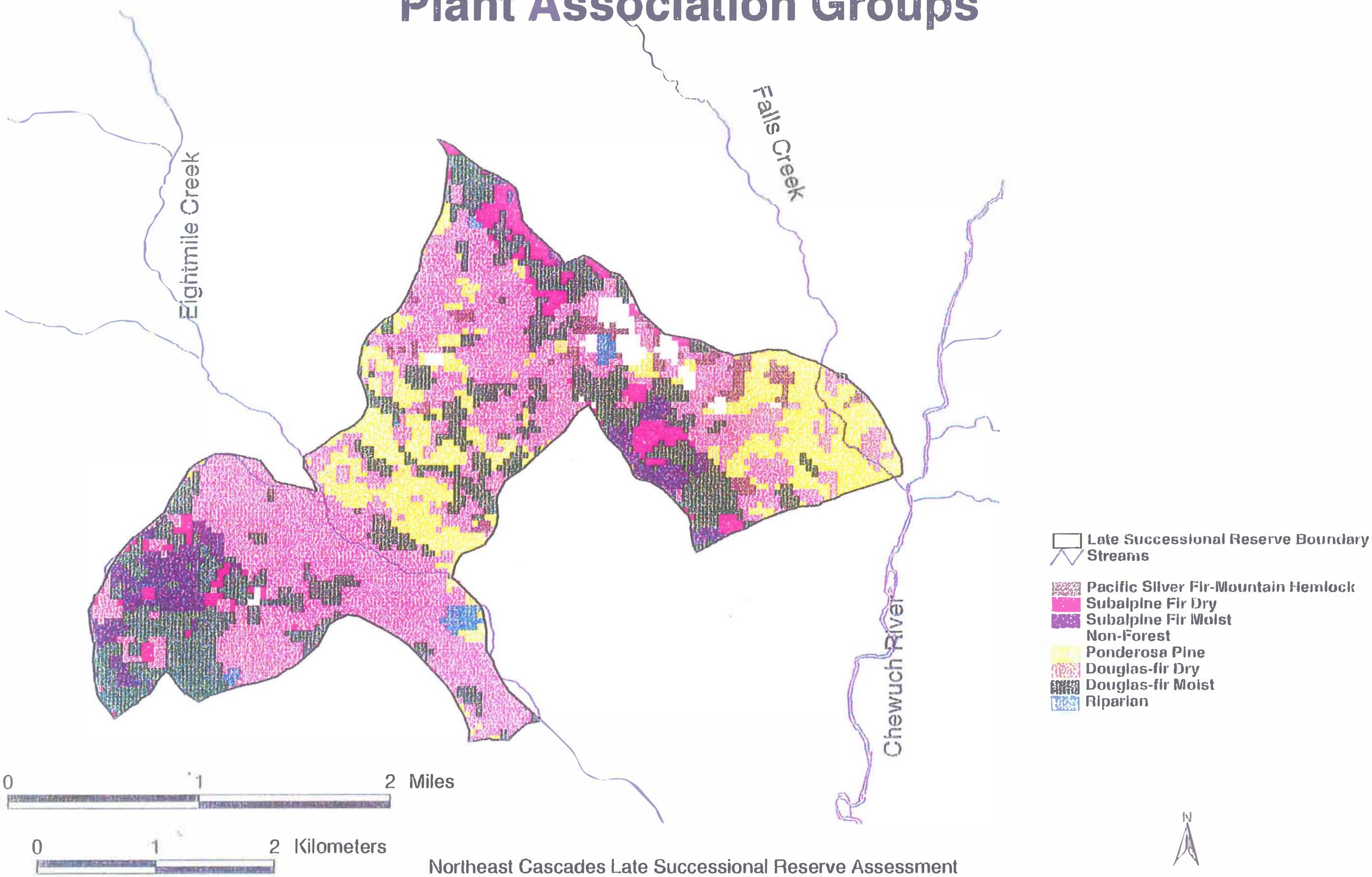
Hunter Mountain Late Successional Reserve
Plant Association Groups



Northeast Cascades Late Successional Reserve Assessment

Map 1

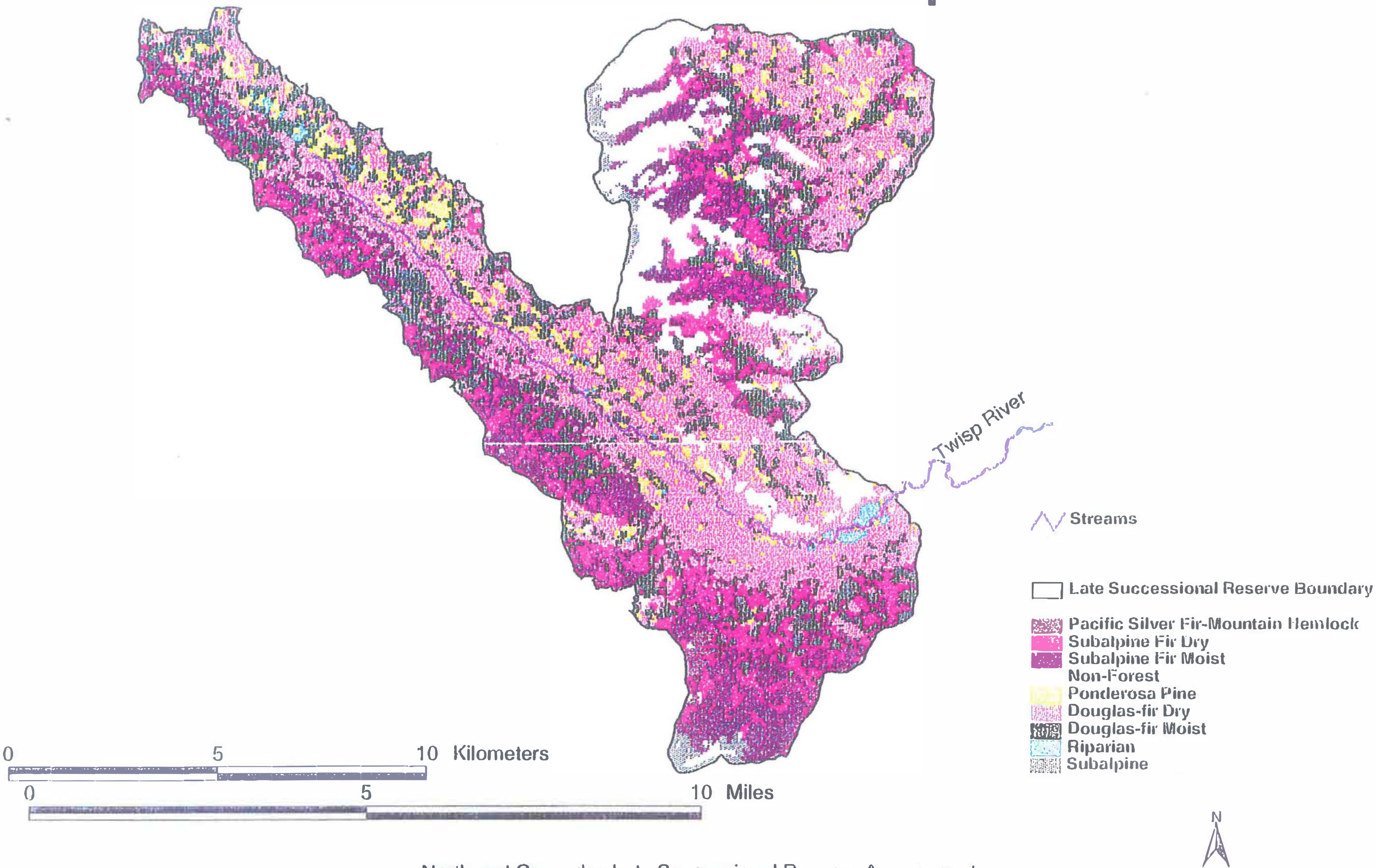
Nice Late Successional Reserve
Plant Association Groups



Northeast Cascades Late Successional Reserve Assessment

Map 2

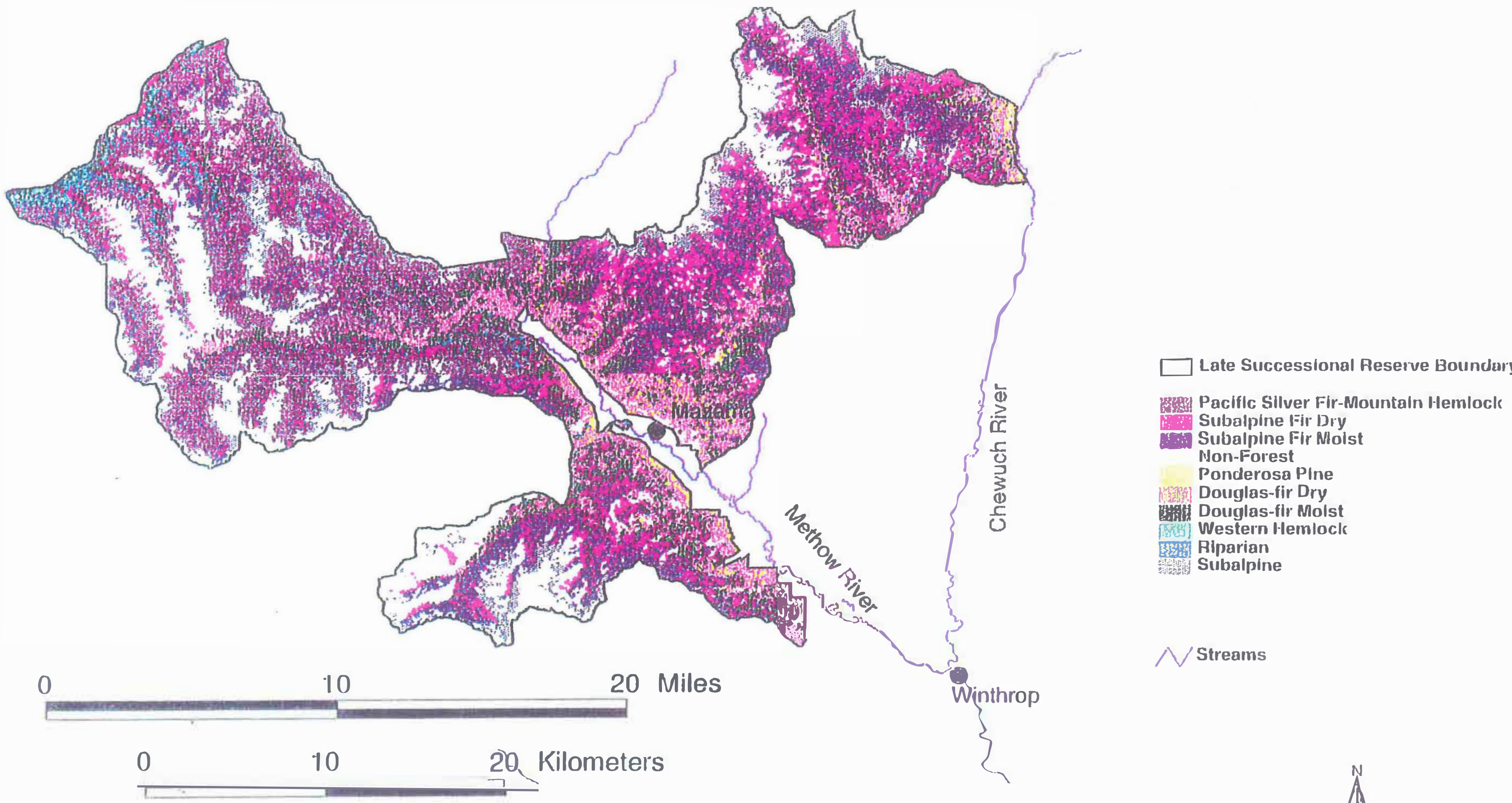
Twisp River Late Successional Reserve
Plant Association Groups



Northeast Cascades Late Successional Reserve Assessment

Map 3

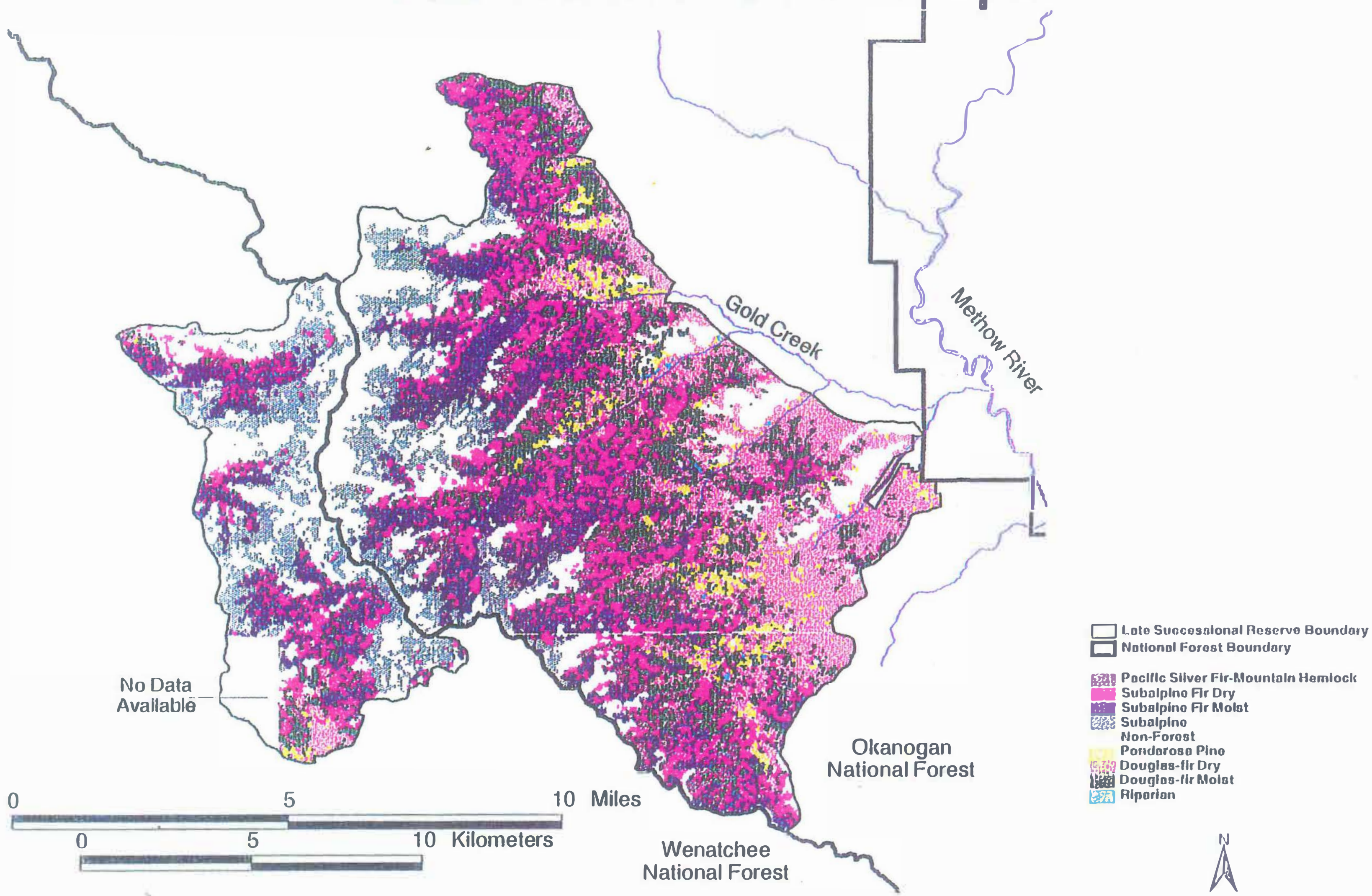
Upper Methow Late Successional Reserve Plant Association Groups



Northeast Cascades Late Successional Reserve Assessment

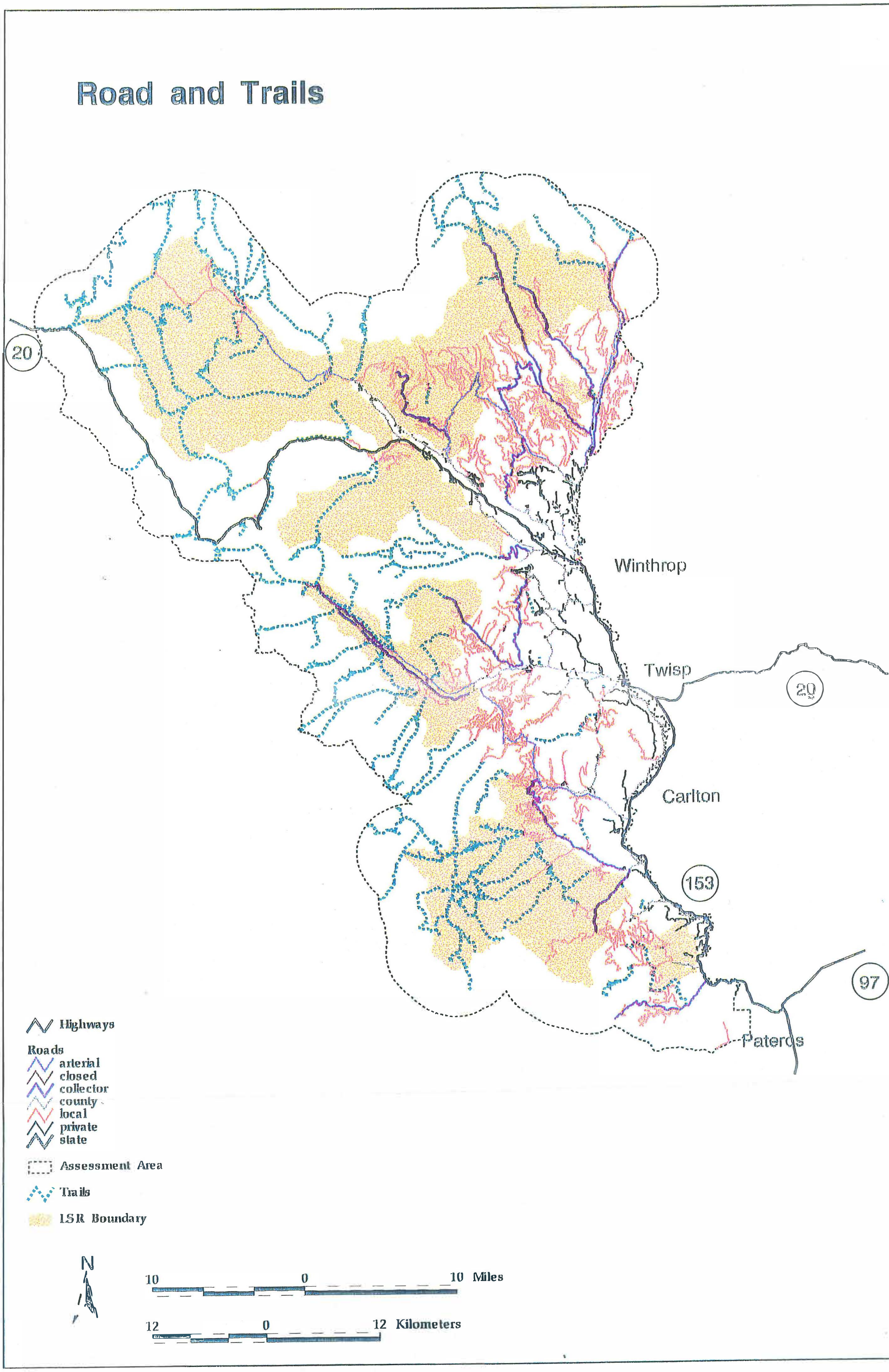
Map 4

Sawtooth Late Successional Reserve
Plant Association Groups



Map 5

Map 6


Road and Trails
Winthrop
Twisp
Carlton
Pateros
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97
Highways
Roads
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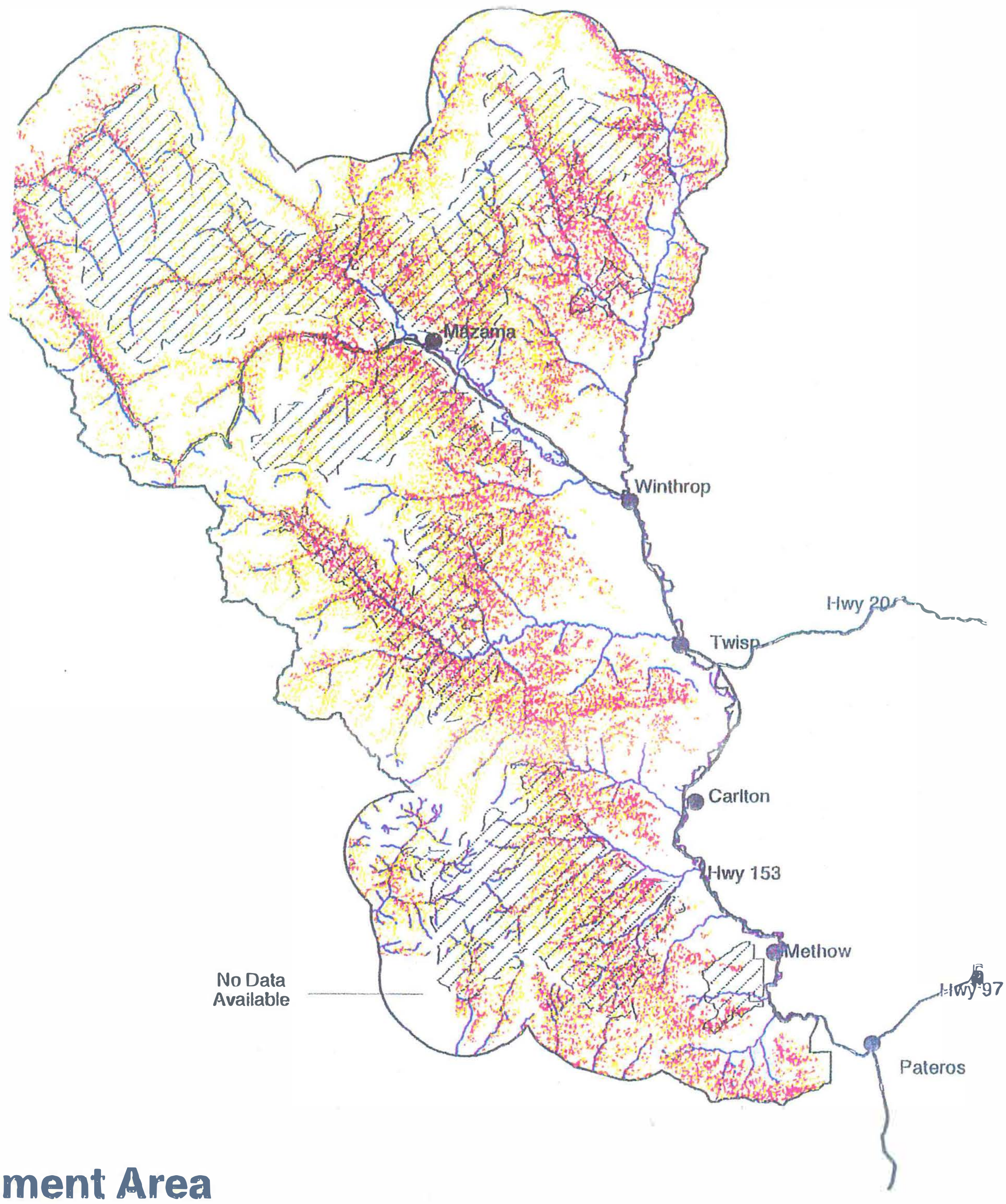

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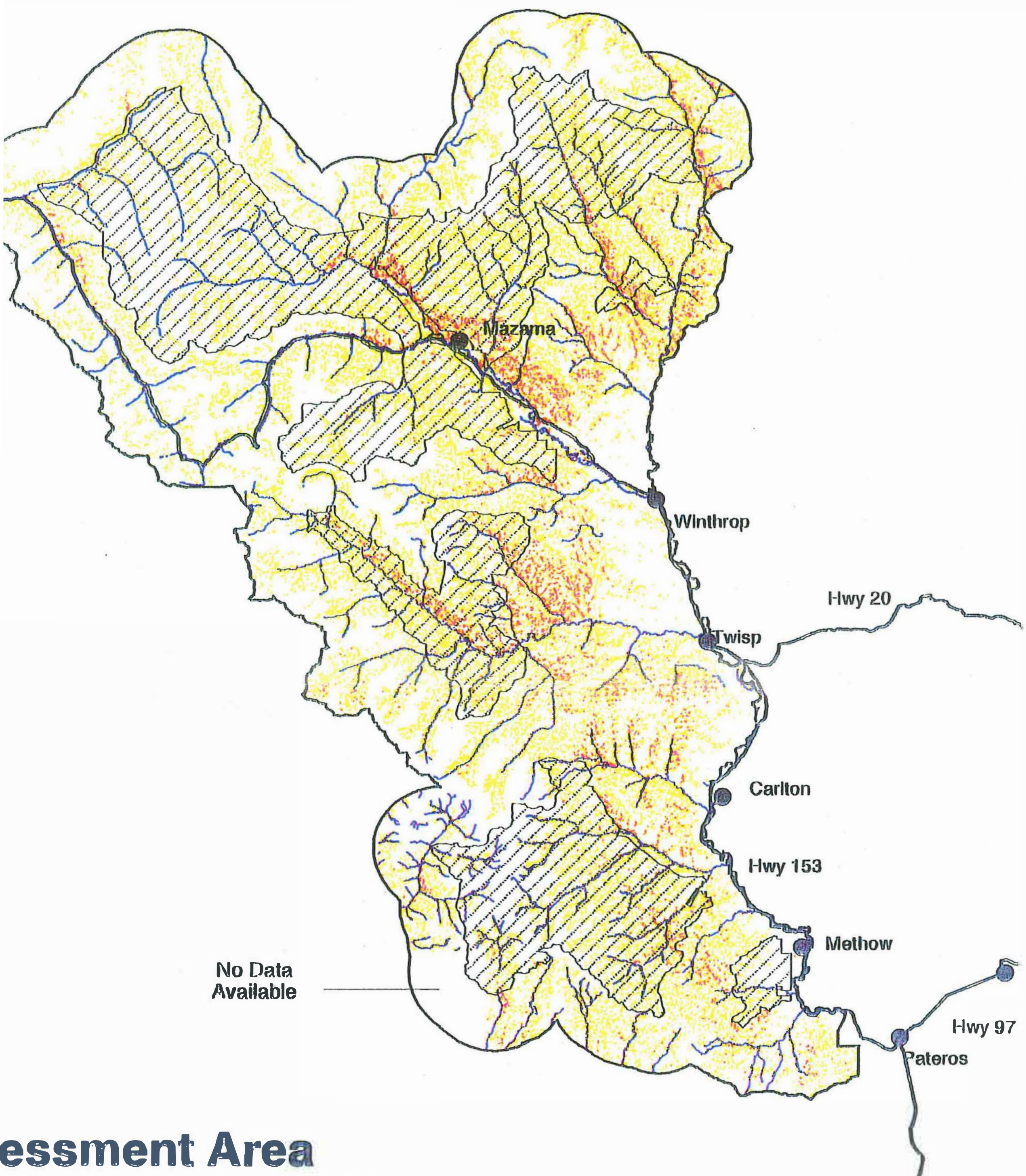
Pine Bark Beetle Risk



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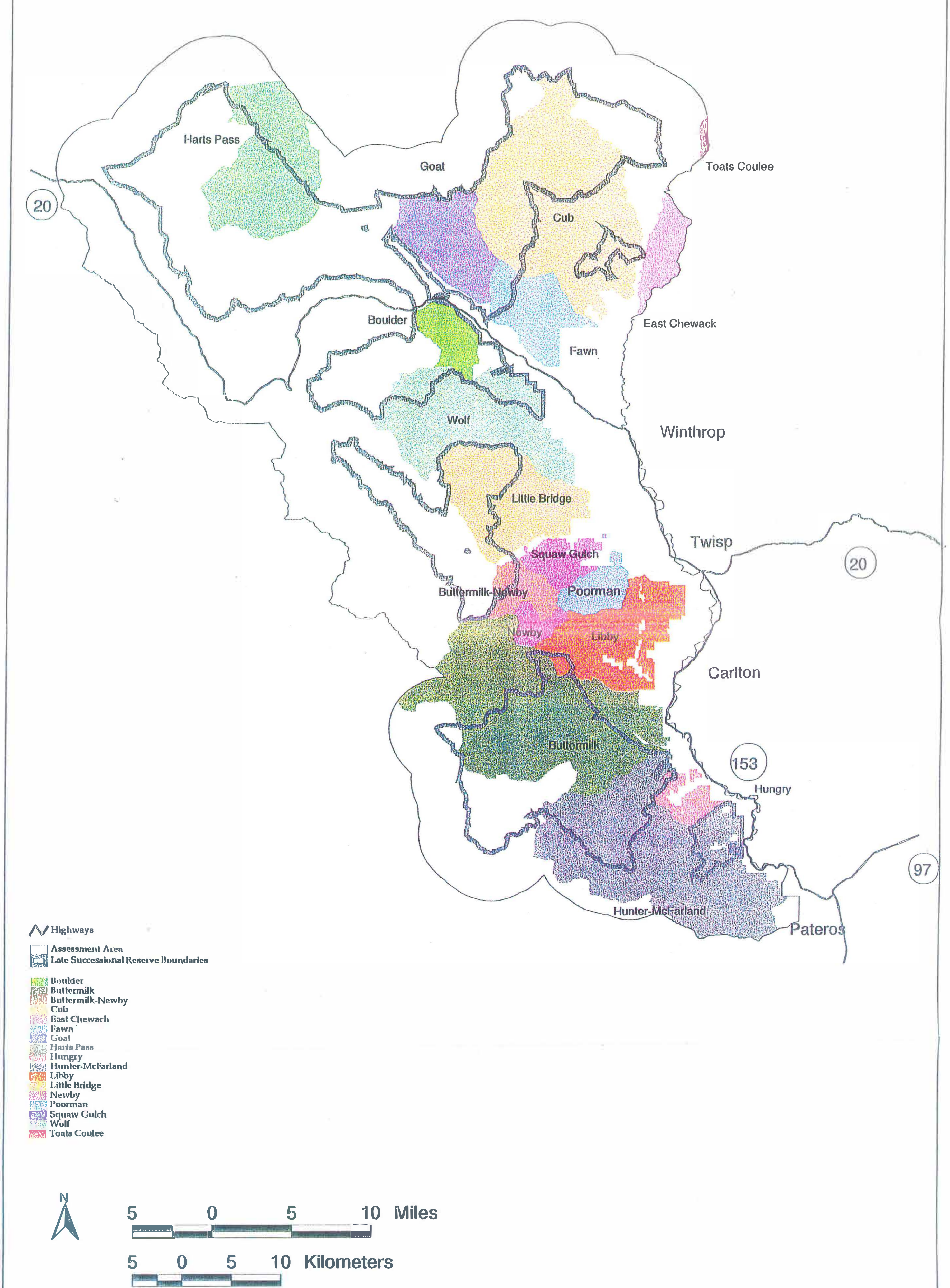
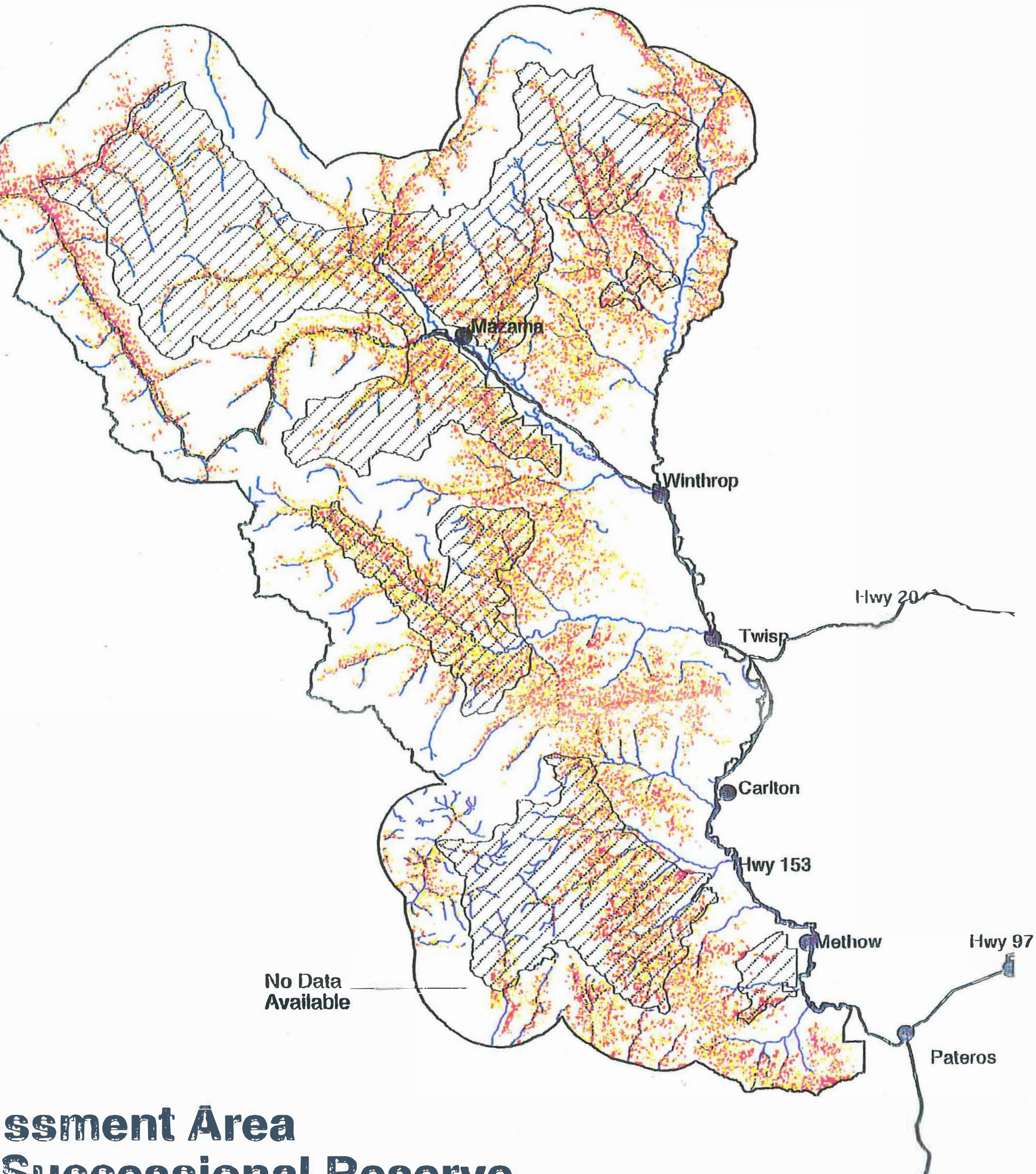
Range Allotment Boundaries



Dwarf Mistletoe Risk



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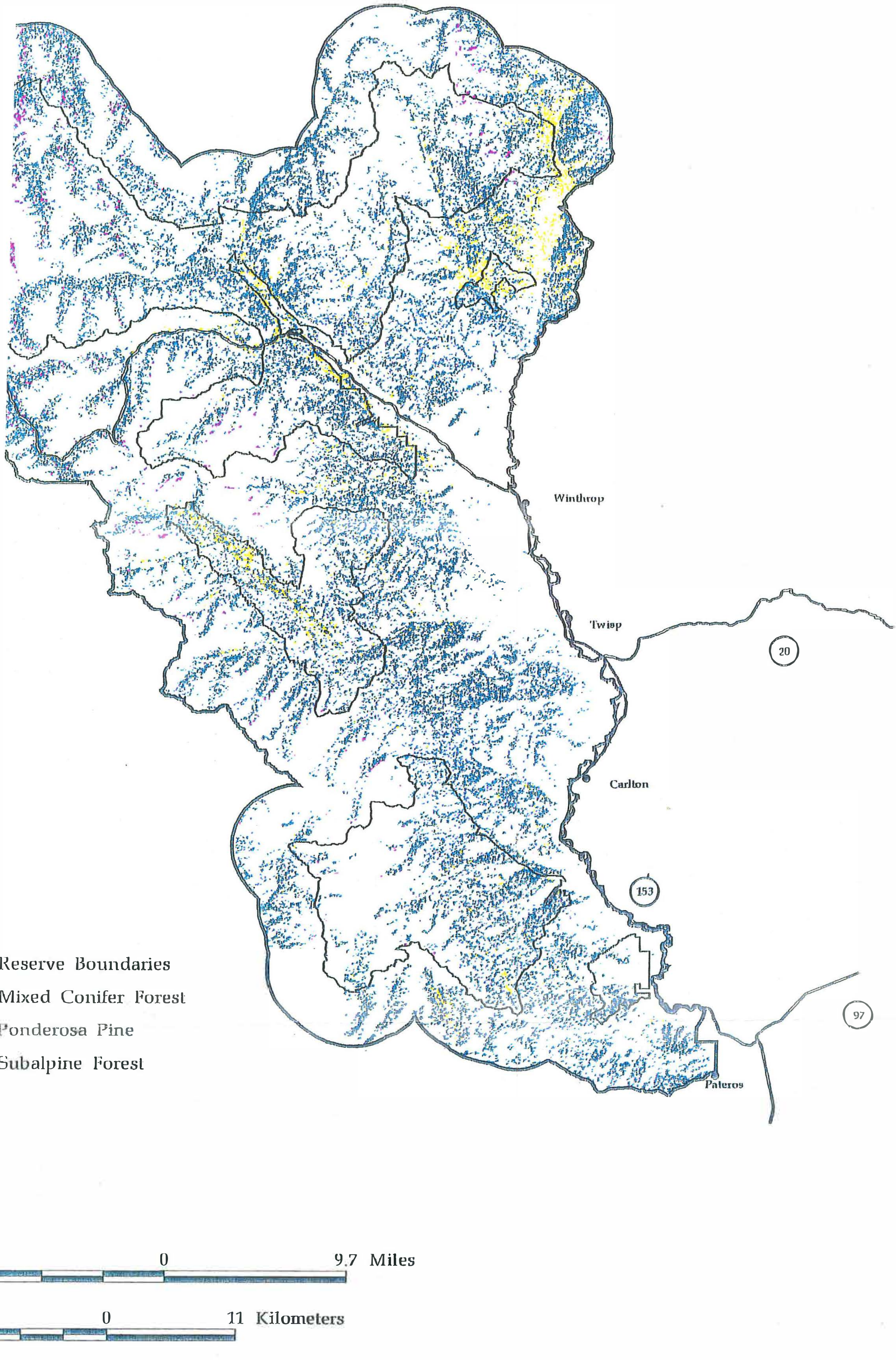
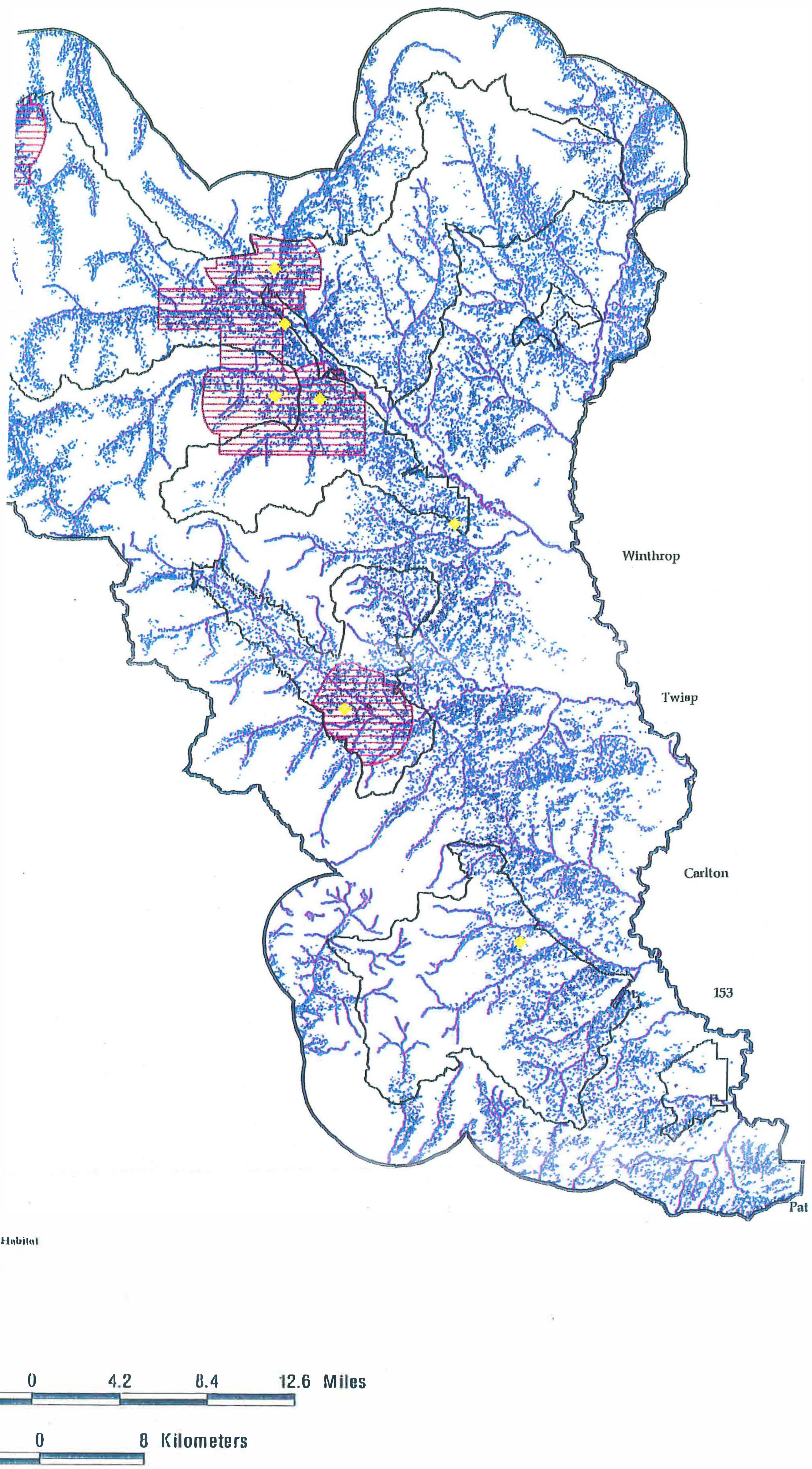


Northeast Cascades Late Succesional Reserve Assessment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Twisp
Carlton
153
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Habitat
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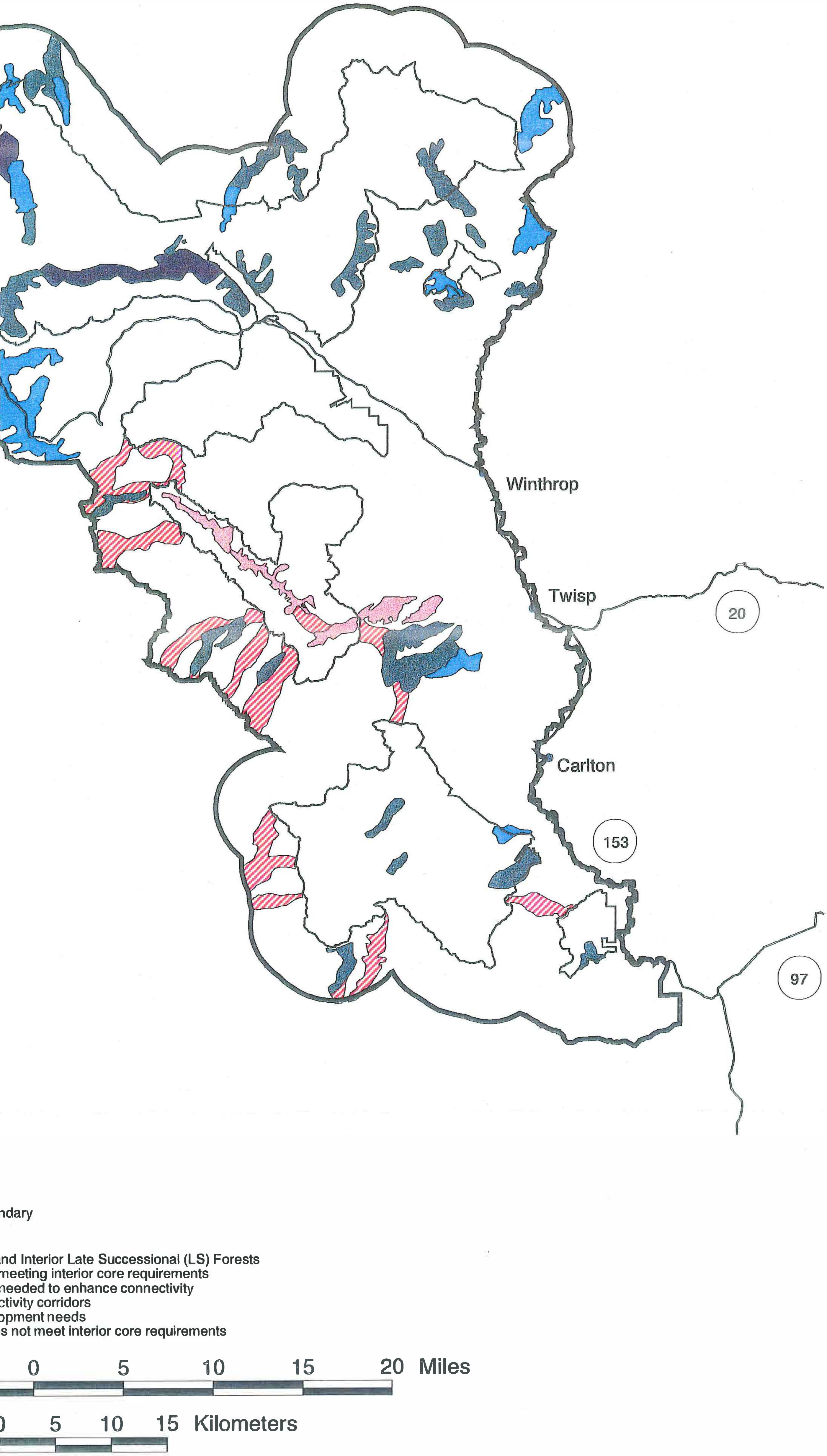
Winthrop
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and Interior Late Successional (LS) Forests
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0 5 10 15 20 Miles
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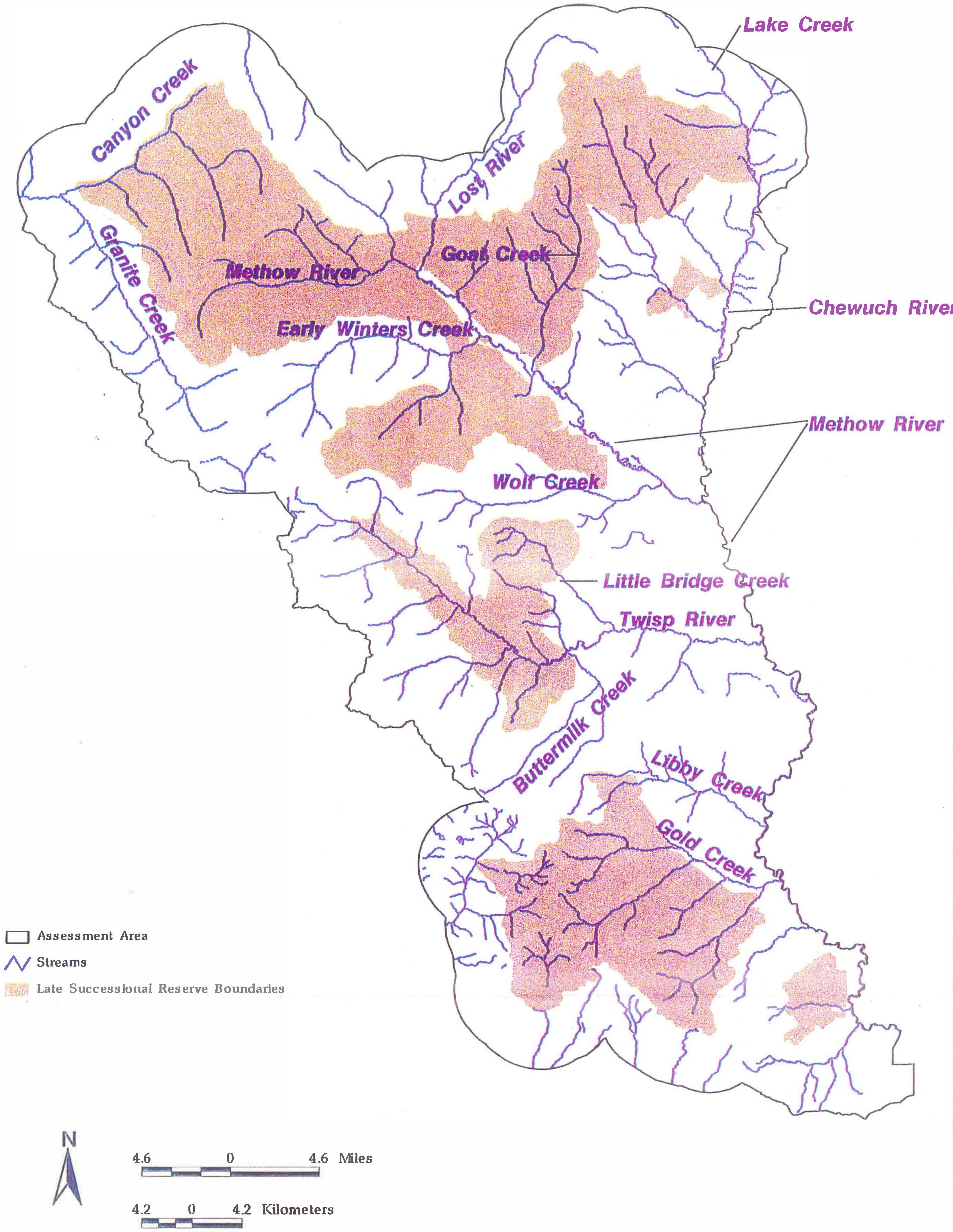
Streams


Lake Creek
Canyon Creek
Lost River
Granite Creek
Goat Creek
Methow River
Early Winters Creek
Chewuch River
Methow River
Wolf Creek
Little Bridge Creek
Twisp River
Buttermilk Creek
Libby Creek
Gold Creek
Assessment Area
Streams
Late Successional Reserve Boundaries
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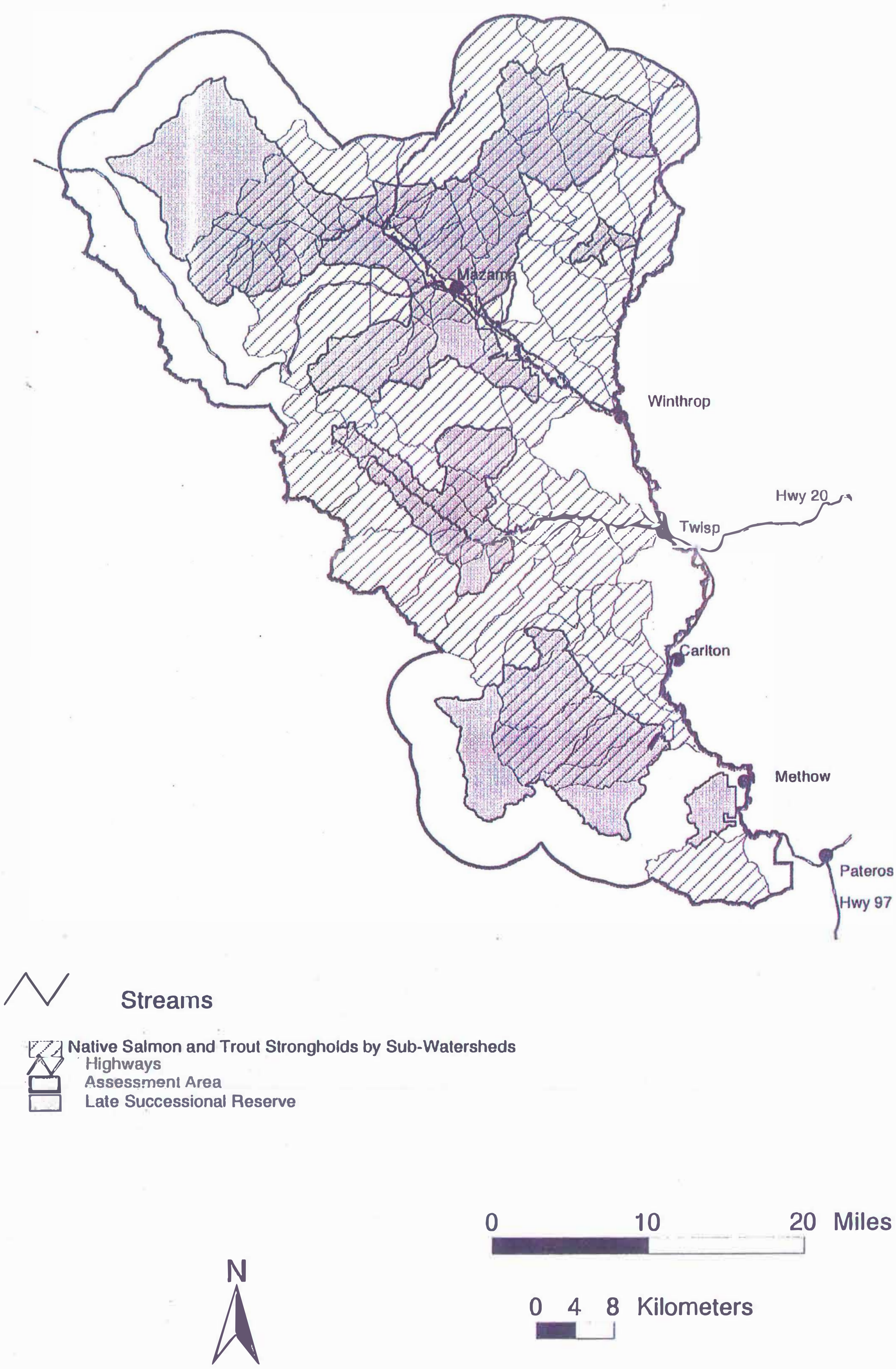
4.2 0 4.2 Kilometers

Map 15

Native Salmon and Trout Strongholds

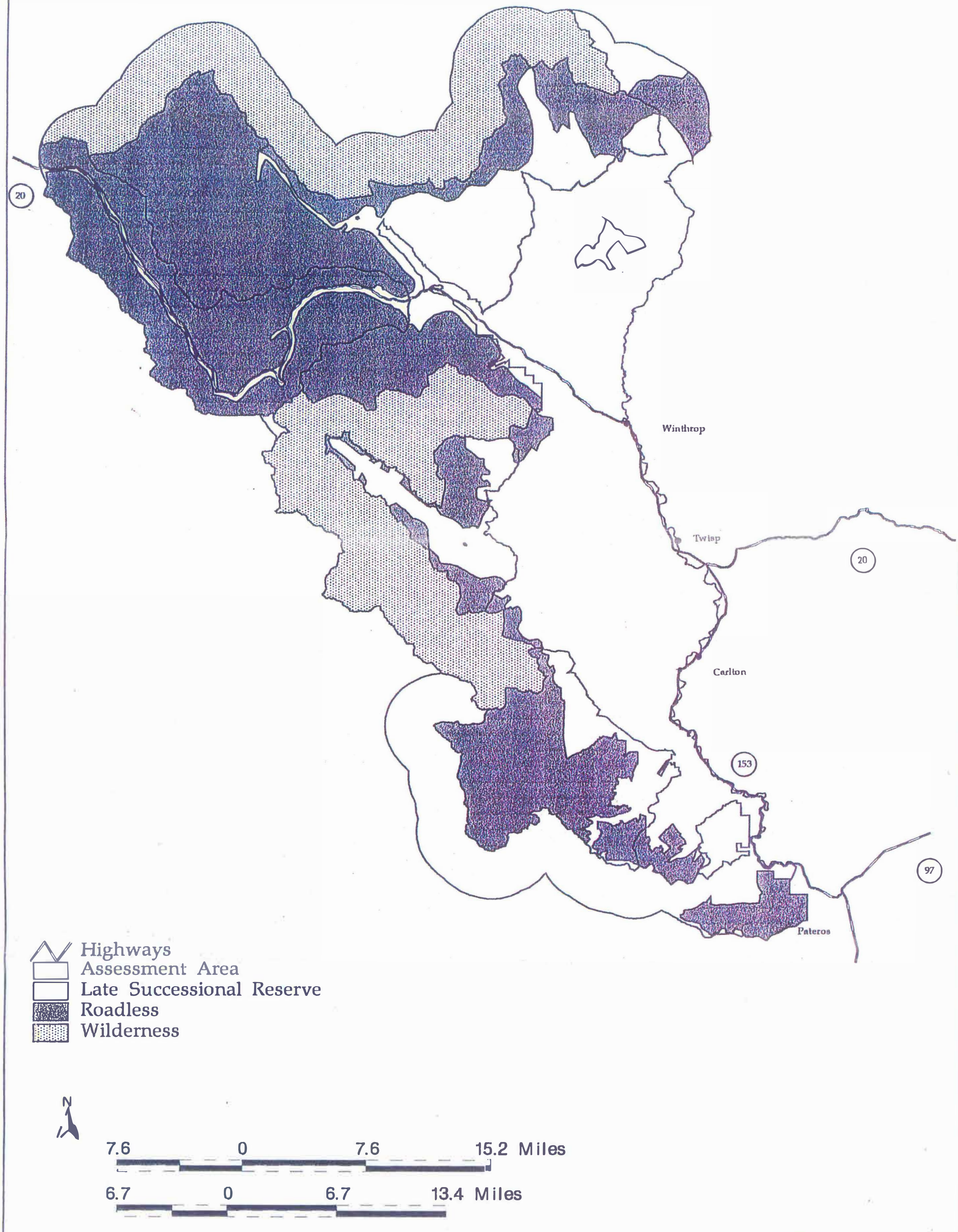
Spring Chinook Salmon, Summer/Fall Chinook Salmon,
Summer Steelhead Trout, Bull Trout, Redband Trout and Brook Trout



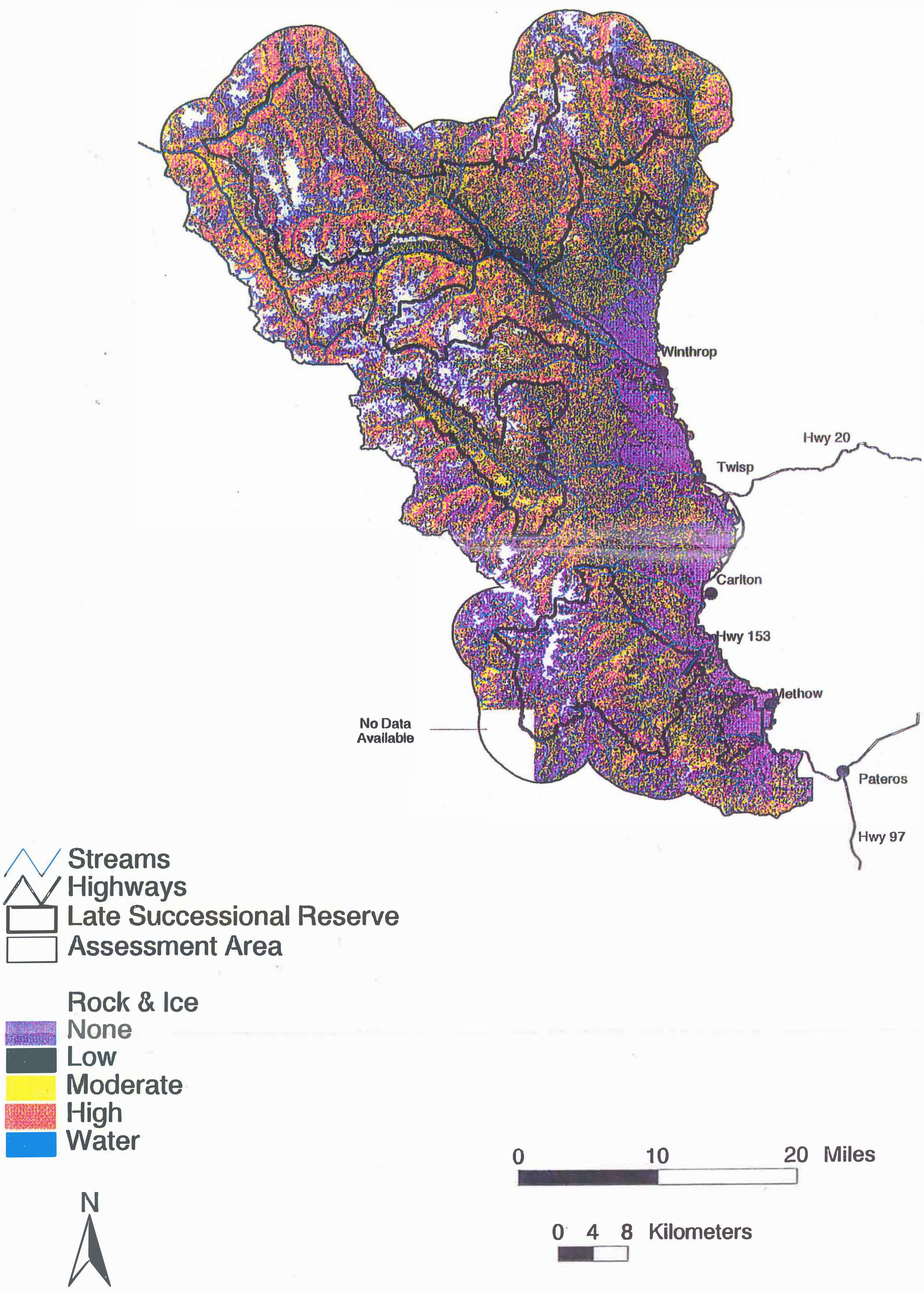
Northeast Cascades Late Successional Reserve Assessment

Map 16

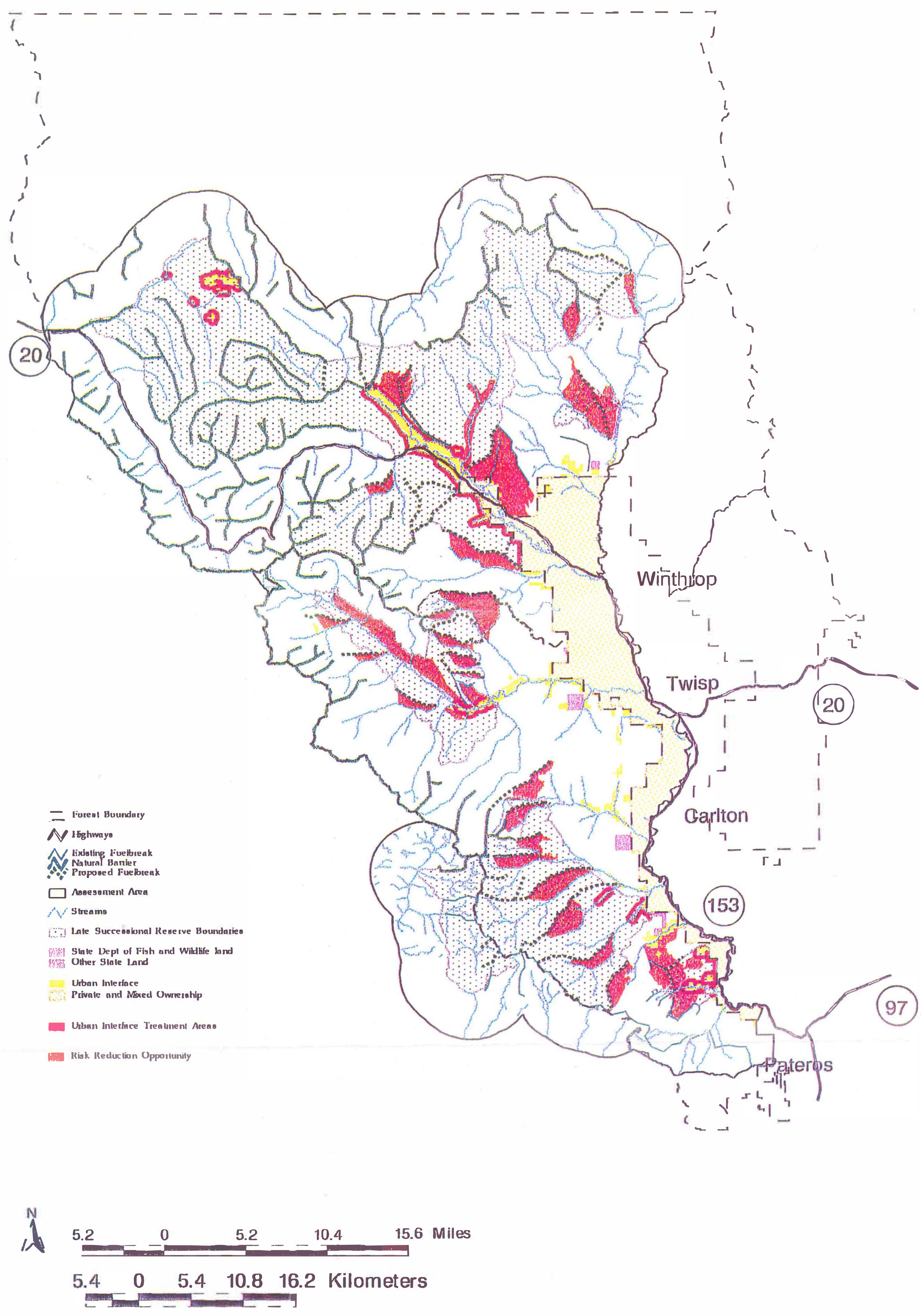
Roadless & Wilderness Areas
LSR Analysis Area



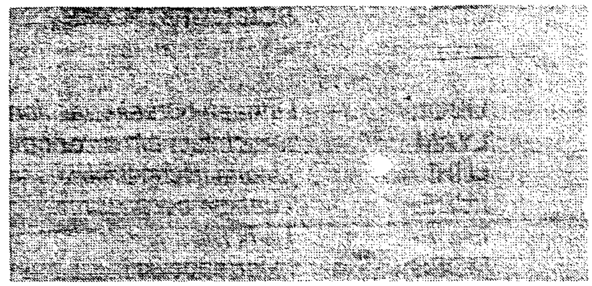
Distribution of Crown Fire Potential



Potential Fire Risk Reduction Opportunities



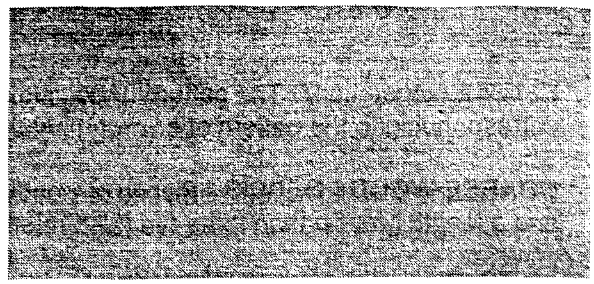
APPENDIX I



Index to the Species List and their Acronyms

CODE	SCIENTIFIC NAME	COMMON NAME
ABLA2	*Abies lasiocarpa*	Subalpine fir
ACCI	*Acer circinatum*	Vine maple
ACMI	*Achillea millefolium*	Yarrow
ACTR	*Achlys triphylla*	Vanillaleaf
AGSP	*Agropyron spicatum*	Bluebunch wheatgrass
AMAL	*Amelanchier alnifolia*	Serviceberry
ARCO	*Arnica cordifolia*	Heartleaf arnica
ARLA	*Arnica latifolia*	Broadleaf arnica
ARNE	*Arctostaphylos nevadensis*	Pinemat manzanita
ARUV	*Arctostaphylos uva-ursi*	Bearberry
ASCA3	*Asarum caudatum*	Wild ginger
ASDE	*Aspidotis densa*	Podfern
ATFI	*Athyrium filix-femina*	Ladyfern
BEAQ	*Berberis aquifolium*	Oregon grape
BENE	*Berberis nervosa*	Cascade Oregon grape
BASA	*Balsamorhiza sagittata*	Arrowleaf balsamroot
BRTE	*Bromus tectorum*	Cheatgrass
CACO	*Carex concinnoides*	Northwestern sedge
CAGE	*Carex geyeri*	Elk sedge
CAME	*Cassiope mertensiana*	Mertens' moss heather
CARO	*Carex rossii*	Ross sedge
CARU	*Calamogrostis rubescens*	Pine grass
CEVE	*Cenanothus velutinus*	Snowbrush ceanothus
CHUMO	*Chimaphila umbellata* var. *occidentalis*	Western prince's pine
CLUN	*Clintonia uniflora*	Queencup beadlily
DROC	*Dryas octapetela*	Washington dryad
EQUIS	*Equisetum* species	Horsetail species
FEID	*Festuca idahoensis*	Idaho fescue
FEOC	*Festuca occidentalis*	Western fescue
FEVI	*Festuca viridula*	Green fescue
GOOB	*Goodyera oblongifolia*	W. rattlesnake plantain
GYDR	*Gymnocarpium dryopteris*	Oak fern
GAOV	*Gaultheria ovatifolia*	Slender wintergreen
HODI	*Holodiscus discolor*	Oceanspray
JUCO4	*Juniperus communis*	Common juniper
KOCR	*Koeleria cristata*	Prairie junegrass
LUPIN	*Lupinus* species	Lupine species

CODE	SCIENTIFIC NAME	COMMON NAME
VAMY	*Vaccinium myrtillus*	Low huckleberry
VASC	*Vaccinium scoparium*	Grouse huckleberry
VASI	*Valeriana sitchensis*	Sitka valerian
VIGL	*Viola glabrella*	Pioneer violet
VIOLA	*Viola species*	Violet
VIOR2	*Viola orbiculata*	Round-leaved violet
XETE	*Xerophyllum tenax*	Beargrass



GLOSSARY

ALLOTMENT (grazing) - A rangeland and/or forestland area designated for the use of a prescribed number and kind of livestock under one plan of management.

ANADROMOUS FISH - Fish that hatch in fresh water, migrate to the ocean, mature there, and return to fresh water to reproduce; for example, salmon and steelhead.

ANIMAL UNIT MONTH (AUM) - The amount of dry forage required by one animal unit for one month based on a forage allowance of 26 pounds per day.

AQUATIC - Pertaining to water.

ASSESSMENT - The collection, integration, examination, and evaluation of information and values.

AUTECOLOGICAL - Of or relating to the ecology of a single species. That is to say the specific ecology of a species, its requirements, tolerances, and responses to its environment.

BASIN (river) - In general, the area of land that drains water, sediment, and dissolved materials to a common point along a stream channel. River basins are composed of large river systems.

BIOPHYSICAL - The combination of biological and physical components in an ecosystem.

CANOPY - In a forest, the branches from the uppermost layer of trees; in a shrub or grassland, the uppermost layer of shrubs; in a riparian area, the layers of vegetation that project over the stream.

CENTER OF ACTIVITY - The nest site of a breeding pair of owls or primary roost area of a territorial individual owl.

CRITICAL HABITAT UNIT (CHU) - Special areas within the geographical area occupied by a species on which are found those physical and biological features essential to the conservation of the species and that may require special management considerations or protection.

CLEARCUTTING (harvest) - A regeneration harvest method that removes all merchantable trees in a single- cutting except for wildlife trees or snags. A "clearcut" is an area from which all merchantable trees have been cut.

CLIMAX (community) - The stable community in an ecological succession which is able to reproduce itself indefinitely under existing environmental conditions in the absence of disturbance. The final stage of succession.

CLIMAX (species) - Species that are self perpetuating in the absence of disturbance.

HABITAT TYPE Defined originally by R. Daubenmire (1968) to mean: ``All the area that now supports, or within recent time has supported, and presumably is still capable of supporting, one plant association?" An aggregation of all land areas capable of supporting similar plant communities at climax (Pfister and others 1977).

HISTORICAL RANGE OF VARIABILITY (HRV) - The natural fluctuation of component of healthy ecosystems over time.

KEY WATERSHED - As defined by National Forest and Bureau of Land Management District fish biologists, a watershed containing (1) habitat for potentially threatened species or stocks of anadromous salmonids or other potentially threatened fish, or (2) greater than six square miles with high-quality water and fish habitat.

LANDSCAPE - All the natural features such as grasslands, hills, forest, and water, which distinguish one part of the earth's surface from another part; usually that portion of land which the eye can comprehend in a single view, including all its natural characteristics.

LANDSCAPE CHANGE - The alteration in the structure and function of the ecological mosaic over time.

LATE SUCCESSIONAL RESERVE - A forest in its mature and/or old growth stages that has been reserved.

LETHAL (stand replacing) FIRES - In forests, fires in which less than 20 percent of the basal area or less than 10 percent of the canopy cover remains; in rangelands, fires in which most of the shrub overstory or encroaching trees are killed.

MATRIX - Federal lands outside of reserves, withdrawn areas, and Managed Late Successional areas.

MESIC - Pertaining to or adapted to an area that has a balanced supply of water; neither wet nor dry.

MONITORING - A process of collecting information to evaluate whether or not objectives of a project and its mitigation plan are being realized.

MOSAIC - A pattern of vegetation in which two more kinds of communities are interspersed in patches, such as clumps of shrubs with grassland between.

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) - An act of Congress passed in 1969 declaring a national policy to encourage productive and enjoyable harmony between people and the environment, to promote effort that will prevent or eliminate damage to the environment and the biosphere and stimulate the health and welfare of people, and to enrich the understanding of the ecological systems and natural resources important to the nation, among other purposes.

NON-LETHAL FIRE - In forests, fires in which more than 70 percent of the basal area or more than 90 percent of the canopy cover survives; in rangelands, fires in which more than 90 percent of the vegetative cover survives (implies that fire is occurring in an herbaceous-dominated community).

SEDIMENT - Solid materials, both mineral and organic, in suspension or transported by water gravity, ice, or air; may be moved and deposited away from their original position and eventually will settle to the bottom.

SERE - The sequence of stages or communities that develop following a particular disturbance type; e.g., a fire sere.

SERAL STAGE - A step or identifiable stage of a successional sequence (the sere).

SEROTINOUS - Late in developing or blooming. In reference to the seed cones of lodgepole pine which open and drop their seed following a fire event. The heat of a fire event is needed to open the serotinous cones of the lodgepole pine.

SMOKE MANAGEMENT - Conducting a prescribed fire under suitable fuel moisture and meteorological conditions with firing techniques that keep smoke impact on the environment within designated limits.

SPECIES - A population or series of populations of organisms that can interbreed freely with each other but not with members of other species.

STAND COMPOSITION - The vegetative species that make up the stand.

STAND DENSITY - Refers to the number of trees growing in a given area, usually expressed in trees per acre.

SUBALPINE - A terrestrial community that generally is found in harsher environments than the montane terrestrial community. Subalpine communities are generally colder than montane and support a unique clustering of wildlife species.

SUBWATERSHED - A drainage area of approximately 20,000 acres, equivalent to a 6th-field Hydrologic Unit Code (HUC). Hierarchically, subwatersheds are contained within a 5th-field HUC), which in turn is contained within a sub-basin (4th-field HUC).

SUCCESSION - The sequence of vegetative change initiated when a previously colonized area is disturbed by natural or human caused events.

SUCCESSIONAL PATHWAY - The probable course of community development within a defined framework of seral stages for a particular disturbance regime.

TERRESTRIAL - Pertaining to the land.

TRANSITORY RANGE -

UNDERBURN - A burn by a surface fire that can consume ground vegetation and ladder fuels.

UNDERSTORY - Plants growing beneath the canopy of other plants. Usually refers to grasses, forbes, and low shrubs under a tree or shrub canopy.

UNGULATES - Hoofed, plant-eating mammals such as elk, deer, and cattle.

WATERSHED - The regional draining into a river, river system, or body of water.

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NOXIOUS WEED - A plant species designated by federal or state law a generally possessing one or more of the following characteristics: aggressive and difficult to manage; parasitic; a carrier or host of serious insects or disease; or non-native, new, or not common to the United States. According to the Federal Noxious Weed Act PL 93-639), a noxious weed is one that causes disease or has other adverse effects on man or his environment and therefore is detrimental to the agriculture and commerce of the United States and to the public health.

OLD FOREST - (a) Old single-story forest refers to mature forest characterized by a single canopy layer consisting of large or old trees. Understory trees are often absent, or present in randomly spaced patches. It generally consists of widely spaced, shade-intolerant species, such as ponderosa pine and western larch, adapted to a non-lethal, high frequency fire regime. (b) Old multi-story forest refers to mature forest characterized by two or more canopy layers with generally large or old trees in the upper canopy. Understory trees are also usually present, as a result of a lack of frequent disturbance to the understory. It can include both shade-tolerant and shade-intolerant species, and is generally adapted to a mixed fire regime or both lethal and non-lethal fires.

OVERSTORY - The upper canopy layer.

PARK-LIKE STANDS - Stand having scattered large overstory trees, few or no understory trees, and open growing conditions usually maintained by frequent ground fires.

PATCH SIZE - A small part (20-60 acres) of the forest. This term is often used to indicate a type of clearcutting (patch cuts) associated with the "staggered setting" approach to distributing harvest units across landscapes.

PLANT ASSOCIATION - A unit of a vegetation classification based on the projected climax community type. Often termed the climax community.

PLANT COMMUNITY - A general term for an assemblage of plants living together and inter acting among themselves in a specific location; no particular successional status implied.

PLANT ASSOCIATION GROUP (PAG) - A group of plant associations that support similar species, are similar in productivity, and evolved under similar disturbance regimes.

PRESCRIBED FIRE - Intentional use of fire under specified conditions to achieve specific management objectives.

PRESCRIBED NATURAL FIRE - A fire ignited by lightning but allowed to burn within specified conditions of fuels, weather, and topography, to achieve specific objectives.

REFUGIA - Areas that have not been exposed to a great environmental changes and disturbances undergone by the region as a whole; refugia provide conditions suitable for survival of species that may be declining elsewhere.

RESILIENCE - The ability of a system to return to an earlier state after being changed.

RIPARIAN AREA - Area with distinctive soil and vegetation between a stream or other body of water and the adjacent upland; includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

RIPARIAN RESERVES - Designated riparian areas found outside the Late Successional Reserves.

CLIMAX (vegetation) - The pattern or complex of climax communities in a landscape corresponding to the pattern of environmental gradients or habitats.

COARSE WOODY DEBRIS - Pieces of woody material having a diameter of at least three inches and a length greater than three fee (also referred to as large woody debris).

CONNECTIVITY - The arrangement of habitats that allows organisms and ecological processes to move across the landscape; patches of similar habitats are either close together or linked by corridors of appropriate vegetation. The opposite of fragmentation.

CORRIDOR - A defined tract of land, usually linear, through which a species must travel to reach habitat suitable for reproduction and other life-sustaining needs.

CROWN FIRE - A forest fire that burns in the crowns of trees.

DEBRIS - Logs, trees, limbs, branches, leaves, bark, etc., that accumulate, often in streams or riparian areas.

DENSITY (stand) - The number of trees growing in a given area, usually expressed in terms of trees per acre.

DIAMETER AT BREAST HEIGHT (DBH) - The diameter of a tree 4.5 feet above the ground on the uphill side of the tree.

DISTURBANCE - Refers to events that alter the structure, composition, or function of terrestrial or aquatic habitats. Natural disturbances include, among others, drought, floods, wind, fires, wildlife, grazing, and insects and pathogens. Human-caused disturbances include actions such as timber harvest, livestock grazing, roads, and the introduction of exotic species.

DISTURBANCE REGIME - A reoccurring set of disturbances that are distinctly associated with an ecosystem, that are similar in their intensities, frequencies, and the types of disturbances that occur.

DIVERSITY - The variation, distribution, and abundance of different plant and animal communities and species within an area.

ECOSYSTEM - A complete, interacting system of living organisms and the land and water that make up their environment; the home places of all living things, including humans.

ECOSYSTEM MANAGEMENT - A strategy or plan to manage ecosystems to provide for all associated organisms, as opposed to a strategy or plan for managing individual species.

FIRE REGIME - The characteristics of fire in a given ecosystem, such as the frequency, predictability, intensity, and seasonably of fire.

FUEL LOAD - The amount of combustible material present per unit of area, usually expressed in tons per acre.

GEOGRAPHIC INFORMATION SYSTEM (GIS) - An information processing technology to input, store, manipulate, analyze, and display data; a system of computer maps with corresponding site-specific information that can be combined electronically to provide reports and maps.

CODE	SCIENTIFIC NAME	COMMON NAME
LIBOL	*Linnaea borealis* var. *longiflora*	Twinflower
LYAM	*Lysichitum americanum*	Skunk cabbage
LUHI	*Luzula hitchcockii*	Smooth woodrush
LUPE	*Luetkea pectinata*	Partridgefoot
LALY	*Larix lylli*	Subalpine larch
MOSS	Moss species	Moss species
MEFE	*Menziesia ferruginea*	Rusty menziesia
OPHO	*Oplopanax horridum*	Devil's club
PAMY	*Pachistima myrsinities*	Pachistima
PEBR	*Pedicularis bracteosa*	Bracted pedicularis
PEFR3	*Penstemon fruticosus*	Bush penstemon
PERA	*Pedicularis racemosa*	Sickletop pedicularis
PHME	*Phyllodoce empetriformis*	Red mountain heath
CODE	SCIENTIFIC NAME	COMMON NAME
PIAL	*Pinus albicaulis*	Whitebarkpine
PICO	*Pinus contorta*	Lodgepole pine
PIEN	*Pinus engelmannii*	Engelmann spruce
PIMO	*Pinus monticola*	Western white pine
PIPO	*Pinus ponderosa*	Ponderosa pine
POPU	*Populus tremuloides*	Quaking aspen
PUTR	*Purshia tridentata*	Bitterbrush
PYSE	*Pyrola secunda*	Sidebells pyrola
PYAS	*Pyrola asarifolia*	Liverleaf wintergreen
PSME	*Pseudotsuga menziesii*	Douglas-fir
RHAL	*Rhododendron albiflorum*	Cascade azalea
RIVI	*Ribes viscosissimum*	Prickly currant
ROGY	*Rosa gymnocarpa*	Baldhip rose
RULA	*Rubus lasiococcus*	Dwarf bramble
RUPA	*Rubus parviflorus*	Western thimbleberry
RUPE	*Rubus pedatus*	Five-leaf bramble
SASC	*Salix scouleriana*	Scouler willow
SHCA	*Sheperdia canadensis*	Russet buffaloberry
SMILA	*Smilacina species*	Solomonplume
SMRA	*Smilacina racemosa*	Feather solomonplume
SMST	*Smilacina steltata*	Starry solomonplume
SPBEL	*Spirea betulifolia* var. *lucida*	Shiny-leaf spirea
STRO	*Streptopus roseus*	Rosy twistedstalk
SYAL	*Symphoricarpos albus*	Common snowberry
SYMO	*Symphoricarpos mollis*	Creeping snowberry
TABR	*Taxus brevifolia*	Pacific yew
THPL	*Thuja plicata*	Western redcedar
TITRU	*Tiarella trifoliata* var. *unifoliata*	Coolwort foamflower
TRCA3	*Trautvetteria caroliniensis*	False bugbane
TRLA2	*Trientalis latifolia*	Western starflower
TROV	*Trillium ovatum*	Trillium
TSHE	*Tsuga heterophylla*	Western hemlock
TSME	*Tsuga mertensiana*	Mountain hemlock
VAAL	*Vaccinium alaskaense*	Alaska huckleberry
VACA	*Vaccinium caespitosum*	Dwarf huckleberry
VADE	*Vaccinium deliciosum*	Cascade huckleberry
VAME	*Vaccinium membranaceum*	Big huckleberry