United States
Department of
Agriculture

Forest Service

Pacific Northwest
Research Station

General Technical
Report
PNW-GTR-360
October 1995

Forested Plant Associations of the Colville National Forest

Clinton K. Williams, Brian F. Kelley, Bradley G. Smith,
and Terry R. Lillybridge

AUTHORS

CLINTON K. WILLIAMS is forest ecosystems management analyst, Intermountain Region, U.S. Department of Agriculture, Forest Service, Ogden, Utah. BRIAN F. KELLEY is an ecologist, Area 2 Ecology Program, Pacific Northwest Region, U.S. Department of Agriculture, Forest Service, Colville, Washington. BRADLEY G. SMITH is a quantitative ecologist, Pacific Northwest Research Station, U.S. Department of Agriculture, Forest Service, Bend Silvicultural Laboratory, Bend, Oregon. TERRY R. LILLYBRIDGE is an ecologist, Area 2 Ecology Program, Pacific Northwest Region, U.S. Department of Agriculture, Forest Service, Wenatchee, Washington.

Copy prepared at the Colville National Forest

FORESTED PLANT ASSOCIATIONS OF THE COLVILLE NATIONAL FOREST

Clinton K. Williams
Brian F. Kelley
Bradley G. Smith
Terry R. Lillybridge

Published by:
U.S. Department of Agriculture, Forest Service
Pacific Northwest Research Station
General Technical Report PNW-GTR-360
October 1995

In cooperation with:
U.S. Department of Agriculture, Forest Service
Pacific Northwest Region
Colville National Forest

ABSTRACT

Williams, Clinton K.; Kelley, Brian F.; Smith, Bradley G.; Lillybridge, Terry R. 1995. Forested plant associations of the Colville National Forest. Gen. Tech. Rep. PNW-GTR-360. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 375 p. In cooperation with: Pacific Northwest Region, Colville National Forest.

A classification of forest vegetation is presented for the Colville National Forest in northeastern Washington State. It is based on potential vegetation with the plant association as the basic unit. The classification is based on a sample of approximately 229 intensive plots and 282 reconnaisance plots distributed across the forest from 1980 to 1983. The hierarchical classification includes 5 forest tree series and 39 plant associations or community types. Diagnostic keys are presented for each tree series and plant association or community type. Descriptions include information about plant association or community species composition, occurrences, distribution, environment, soils, forest productivity, management implications and relations to other vegetation classifications. Background information is also presented on the ecology, geology, soils, climate, and fire history of the Colville National Forest.

Keywords: Vegetation classification, climax plant communities, potential vegetation, plant association, vegetation series, forest ecology, fire, wildife, range, northeastern Washington.

Contents

Contents (cont.)

Contents (cont.)

List of Figures

Figures (cont.)

Figures (cont.)

Figures (cont.)

Figures (cont.)

List of Tables

Tables (cont.)

Tables (cont.)

Page

INTRODUCTION

Various forest-cover type and site classifications have been found inadequate to answer many questions being asked by resource managers today. "Management of natural resources on range and forested lands has become increasingly critical as a result of greater resource needs and increased public awareness. Nowhere is this more evident than in the management of public lands" (Williams 1978). Hall (1967) states that management of non-arable lands (forest and rangelands) is primarily concerned with deriving products from the natural vegetation, and as resource management intensifies, knowledge about vegetation must increase."

The recurrence of similar plant assemblages across a forest can be used to stratify the landscape (Daubenmire 1976, Pfister *et al.* 1977). The vegetation, soils, and physical characteristics can usefully indicate plant responses to management, productivity potential and future species composition of an area. However, not all questions about a piece of land can be answered by a plant community classification (Hemstrom *et al.* 1982).

Classification of plant associations allows one to:

- Plan management strategies -- evaluate resource condition, productivity, and responses to manipulation.
- Communicate -- record successes or failures of management actions, provide a common description of forest types and conditions for various disciplines.
- Apply research -- provide a direct link between research results and practical land management.
- Describe and delineate different environments which exist across a landscape based partially on plant association distribution patterns.

The classification of Daubenmire and Daubenmire (1968) for eastern Washington and northern Idaho has been useful to resource managers of the Colville National Forest. In time, managers became more skilled in the use of classifications and desired even more detail. They found that the Daubenmires' work was at times too generalized for their needs and that many sites, especially on the western half of the Forest, appeared to better fit preliminary types of Pfister *et al.* (1977) in western Montana. The Forest was mapped in 1973 using habitat types of Daubenmire and Daubenmire (1968) and Pfister *et al.* (1977) which created a confusing mixture of types.

The lack of "fit" of the Daubenmires' (1968) classification appears to have more than one cause: 1) Their main purpose was "to record the structure and composition of remnants of virgin forest vegetation that are rapidly disappearing" and "to provide a classification of this vegetation on an ecosystem basis" (Daubenmire and Daubenmire 1968). Much of the land that now makes up the Colville National Forest was homesteaded or burned during the last 100 years, making virgin stands relatively uncommon. Since their work was orientated towards climax or near climax stands, the Daubenmires' had relatively few sample plots on the Colville National Forest; 2) The Colville National Forest represents a transition area between an intense rainshadow in the west formed by the North Cascades and the inland expression of a maritime climate in the east caused by the convergence and uplifting of moist air masses. Thus, there is considerable east-west variation in precipitation from the Idaho border to the Okanogan County line.

The preceding comments are not intended to minimize the importance and value of the Daubenmires' work. Indeed we strongly recommend that all serious users of this guide should become familiar with their classic study. Their work has no equal for penetrating insight of ecological processes, keen field observations and lucid, concise language. Other pertinent studies include those of Pfister *et al.* (1977) for Montana and Cooper *et al.* (1991) for northern Idaho. The latter work is of particular interest because part of their study area adjoins the Colville National Forest, with a major topographic divide as the common boundary. While the two areas share many similar plant communities, there are some notable differences which are discussed in the descriptions. The work of Williams and Lillybridge (1983) and Clausnitzer and Zamora (1987) to the west and south, respectively, also share similar types and offer useful insights.

OBJECTIVES AND CONSTRAINTS

The objectives were to:

- Develop a vegetation classification based on relatively stable plant communities.
- Collect adequate data to characterize the physical attributes of each type, including soils, slope, aspect, microrelief and landform.
- Determine and present estimates of site productivity.
- Document the effects of disturbance and make management recommendations.

Because utilitarian administrative needs formed the impetus for the work; some assumptions and areas of emphasis differ from similar work done by universities or research agencies. Constraints of time, monies and staffing dictated that :

- Work will concentrate on commercial forest lands where management impacts are the greatest. This did not mean that other areas were not of concern. Other areas including riparian, meadows and other non-commercial forest lands will be studied later.
- Tree productivity estimates by plant association were needed.
- Classification units must be identifiable by field personnel with a minimum of training.

STUDY AREA

The Colville National Forest is located in northeastern Washington (Figure 1) and administers nearly 1.1 million acres of land. It lies within portions of Ferry, Stevens and Pend Oreille Counties.

Physiography

Easterbrook and Rahm (1970) refer to the area from the Okanogan River to the Idaho border as part of the Okanogan Highlands. The Okanogan Highlands are a geologically distinct area with closer affinities to the Northern Rocky Mountains in terms of climate and vegetation than with the Cascade Mountains to the west. Alt and Hyndman (1984) describe three major geological provinces in the Okanogan Highlands. From east to west they are: 1) the old North American continent, 2) the Kootenay arc, and 3) the Okanogan subcontinent. These three geological provinces have a profound influence on the topography of the forest and to a lesser extent the distribution of plant communities.

The Kootenay arc is dominated by heavily folded and partially altered sedimentary rocks that formed originally as the coastal plain of the old North American continent. The Okanogan subcontinent compressed and folded the old coastal plain sediments into the Kootenay arc when plate tectonics moved the subcontinent into its current position. The North American continent and Okanogan subcontinent are mainly composed of granitic rock types (see following geology section). The general topography of the area is characterized by north-south tending 5,000 to 7,000 foot mountain ranges with the intervening valleys of the Pend Oreille, Columbia, Colville, Kettle and San Poil Rivers.

The Kettle Mountain Range divides the Columbia River drainage from that of the San Poil River and is an extension of the Monashee Mountains to the north and is part of the old Okanogan subcontinent. The Republic graben divides the Okanogan subcontinent into three distinct areas. The Kettle dome is composed of granitic rocks which forms the Kettle Range, the Republic graben is dominated by volcanic rocks, primarily andesite flows, and granitic rocks characterize the Okanogan dome to the west of Republic. The Selkirk Mountains extend north-northeast from the area east of Chewelah to extreme northeastern Washington and are part of the old North American continent (Alt and Hyndman 1984). This range of mountains has a gap where the Pend Oreille River flows through and then the mountains continue north into Canada. The main Selkirk Mountain Crest lies east of the Colville National Forest in northern Idaho.

The Columbia River generally follows the boundary between the Okanogan subcontinent and the Kootenay arc. A triangular area of land between the Kettle and Columbia Rivers and south of the Canadian border (locally called "the wedge") is within the Kootenay arc and is part of the Huckleberry Mountains that extend south between the Colville Valley and the Columbia River. The boundary between the North American continent and the Kootenay arc is less clearly demarcated than that of the Kootenay arc and Okanogan subcontinent.

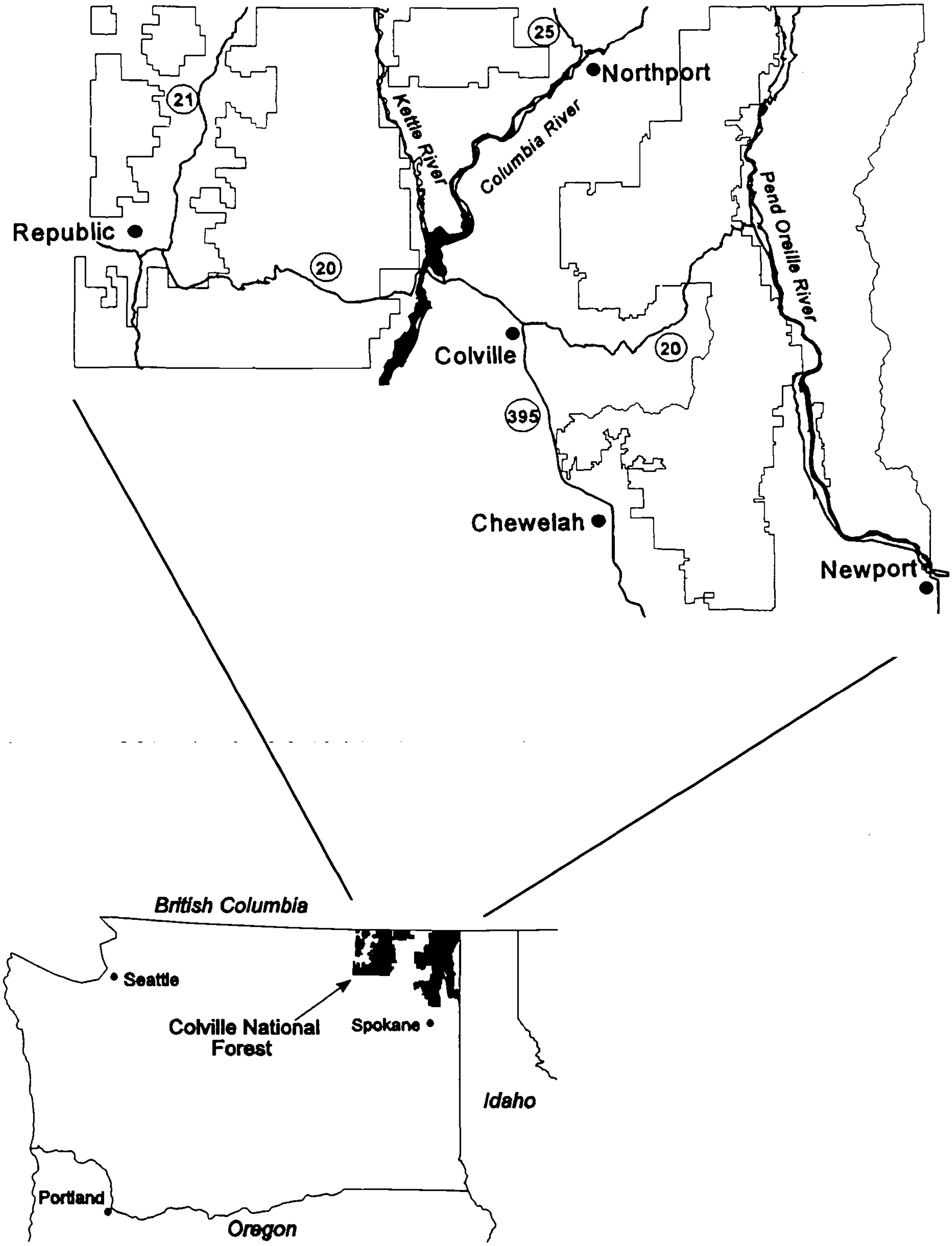


Figure 1. Location of the Colville National Forest.

During the Pleistocene all but the highest peaks were covered by a massive continental ice sheet that originated in the Cariboo Mountains of British Columbia (McKee 1972). At least two major advances of glacial ice have been documented (Richmond *et al.* 1965). Ice thickness varied from 7,000 feet or more near the Canadian border to 3,000 feet or less near the southern extent of the ice sheet (Richmond *et al.* 1965). The last retreat of glacial ice was approximately 12,000 years before the present (Alt and Hyndman 1984). Peaks which escaped the ice sheet (nunataks) often display characteristics associated with alpine glaciation. The continental glaciers produced the rounded summits and relatively gentle mountain slopes typical of this region. The broader valley bottoms are characterized by outwash and kame terraces and by lacustrine deposits. Many narrow drainages have remnants of similar deposits on lower slope positions but most have been removed or altered by subsequent fluvial action.

Alt and Hyndman (1984) give an interesting account of some of the major geologic patterns along major highways and relate them to plate tectonics. Vegetation patterns roughly follow some of their major geologic sections but matters of scale, glaciation and ash deposits often mask influences of bedrock geology upon vegetation.

*Geology***

The accompanying bedrock geology map of the Colville National Forest (Figure 2) is necessarily generalized and belies the complexity of the geology in this part of the State. This complexity results from the work of diverse geological processes which range from stable, continental-margin sedimentation to possible continental collision and accretion.

Approximately one-half of the Forest is underlain by medium-to-coarse grained rocks of granitic composition. East of the Columbia River these consist of numerous quartz monzonite, granodiorite, and granite intrusives which together make up the Kaniksu Batholith. The batholith intrudes older marine sediments which were deposited more than 400 million years ago on the margin of a stable land mass to the east. Deformation and metamorphism accompanying intrusion folded and faulted the sediments and converted them to siltite, argillite, quartzite, phyllite, and weakly recrystallized limestone and dolomite.

Contrasting with the slow, uniform accumulation of sediments to the east were conditions of rapid deposition and vulcanism west of the Columbia River. These processes produced conglomerates, dirty sandstones, tuffaceous sediments, minor limestone, and volcanic flow rocks of varied composition well into the Mesozoic Era (140 million years ago). Intense regional metamorphism toward the end of this period gently upwarped and recrystallized these rocks in the area of the Kettle Range. Where temperatures and pressures were greatest the sediments and volcanics were metamorphosed to feldspathic quartzite, mica schists, marbles, amphibolites and gneisses. Low grade metamorphism elsewhere produced meta-conglomerates, phyllites and greenstones.

** *(The "Geology" section and Figure 2 were contributed by Rod Lentz, U.S.D.A. Forest Service geologist, Okanogan and Colville National Forests.)*

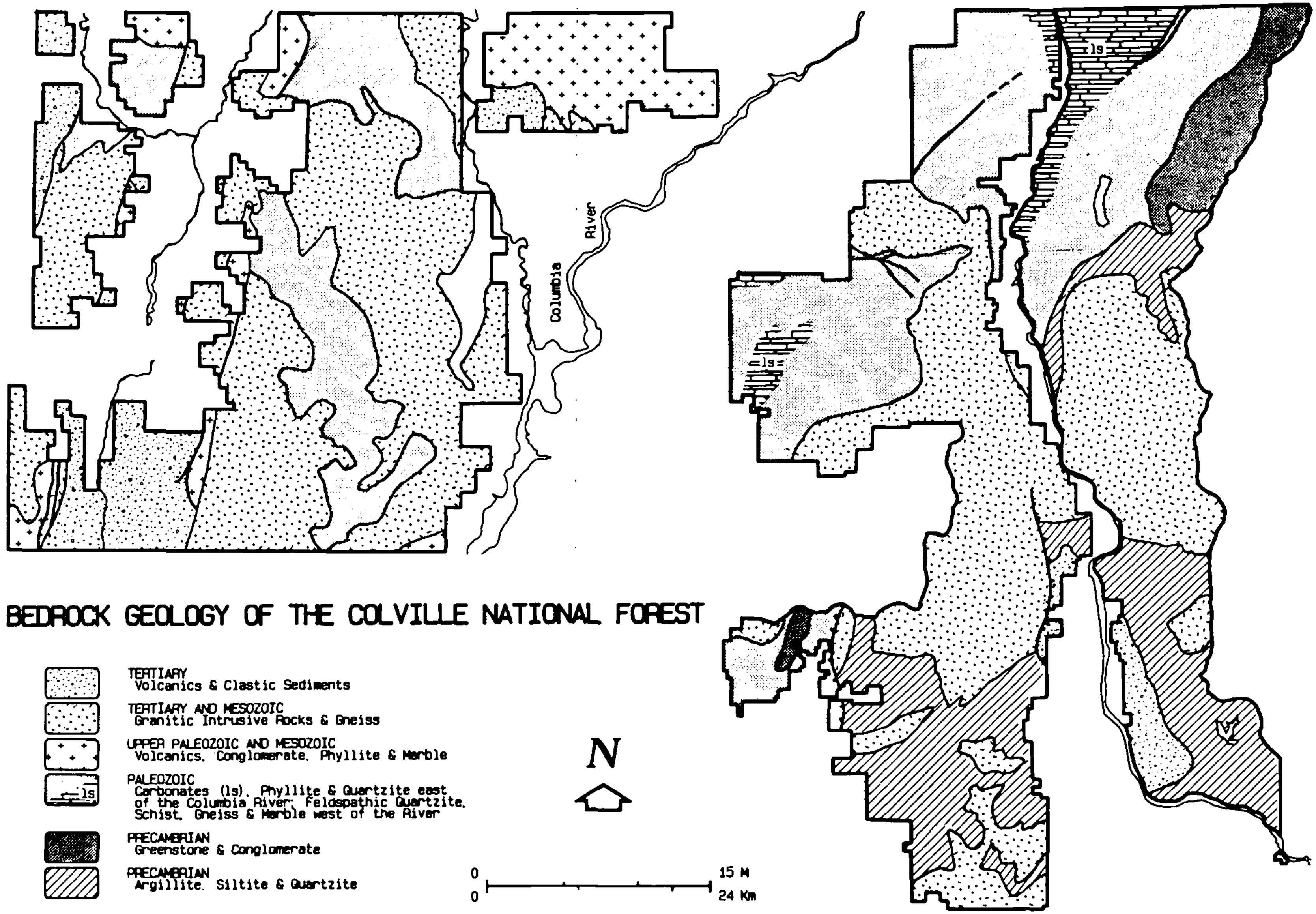


Figure 2. Bedrock geology map.

Contemporaneous with uplift came invasion by granitic plutons like those to the east. Included with these rocks on the map are younger granitic intrusives in the Republic/Curlew area and granitic gneiss of possible younger meta-sedimentary or meta-igneous origin.

During the Tertiary Period (beginning 63 million years ago) erosion and renewed volcanism filled continental basins such as the Republic graben and the ancestral valley of the Pend Oreille River with clastic sediments and volcanic flow and tephra deposits. More recently, continental glaciers scoured all but the highest peaks leaving a mantle of till and outwash deposited over much of the area, even at higher elevations. Ash falls from Cascade and local volcanic eruptions as recently as 15 years ago have also contributed to surficial deposits and soils in the region.

Climate

The forest has a climate with both maritime and continental characteristics because it receives air masses from the continent and the Pacific Ocean. The north-south tending mountain ranges and narrow valleys also create variations in climate (Phillips and Durkee 1972). The western portion of the Forest is under the influence of an intense rainshadow formed by the North Cascades, while the eastern portion has a moist, near-maritime climate created by the westerly air flow being forced over the 5,000 to 7,000 foot peaks of the Kettle River and Selkirk mountain ranges. Precipitation levels are enhanced in the northeast portion of the forest by additional moist air masses moving into the region from the north from Canada.

Throughout the year, maritime air from the Pacific exerts a moderating influence on temperatures while more extreme temperatures come with drier air from the interior of the North American continent. A interesting anomaly is the pattern of vegetation along the Kettle Mountains where the windward side of the mountain range is less maritime (more xeric vegetation) than the lee slopes. Apparently because maritime air masses move more readily up the Columbia River than over the mountains, the lee slopes support more mesic forest vegetation than do the windward slopes. This is the reverse of the typical pattern observed in the Cascade Range to the west.

Precipitation is greatest in winter and spring. Most valleys receive 15 to 25 inches of precipitation per year. Precipitation increases in the mountains to 30-40 inches along the higher ridges of the Kettle Mountain Crest and 50 inches or more in parts of the Selkirks (Figure 3). During the warmest summer months, afternoon temperatures in the valleys range from the mid to upper 80's and minimums range from the upper 40's to the mid-50's. In average years summer temperatures exceed 100°F for 1 to 5 days (Phillips and Durkee 1972). During an average winter afternoon temperatures are near freezing with minimums from 10°F to 20°F. while winter minimum temperatures below 0°F occur 5 to 12 nights a year.

The general climatic trends in the area can be characterized by increasing average annual temperatures and precipitation from west to east across Forest (Table 1). These differences in temperature and precipitation patterns are reflected in the distribution of current forest vegetation. Relatively dry, open Douglas-fir forests predominate along the Okanogan-Ferry County line while moist cedar-hemlock forests are the rule near the Idaho-Washington border.

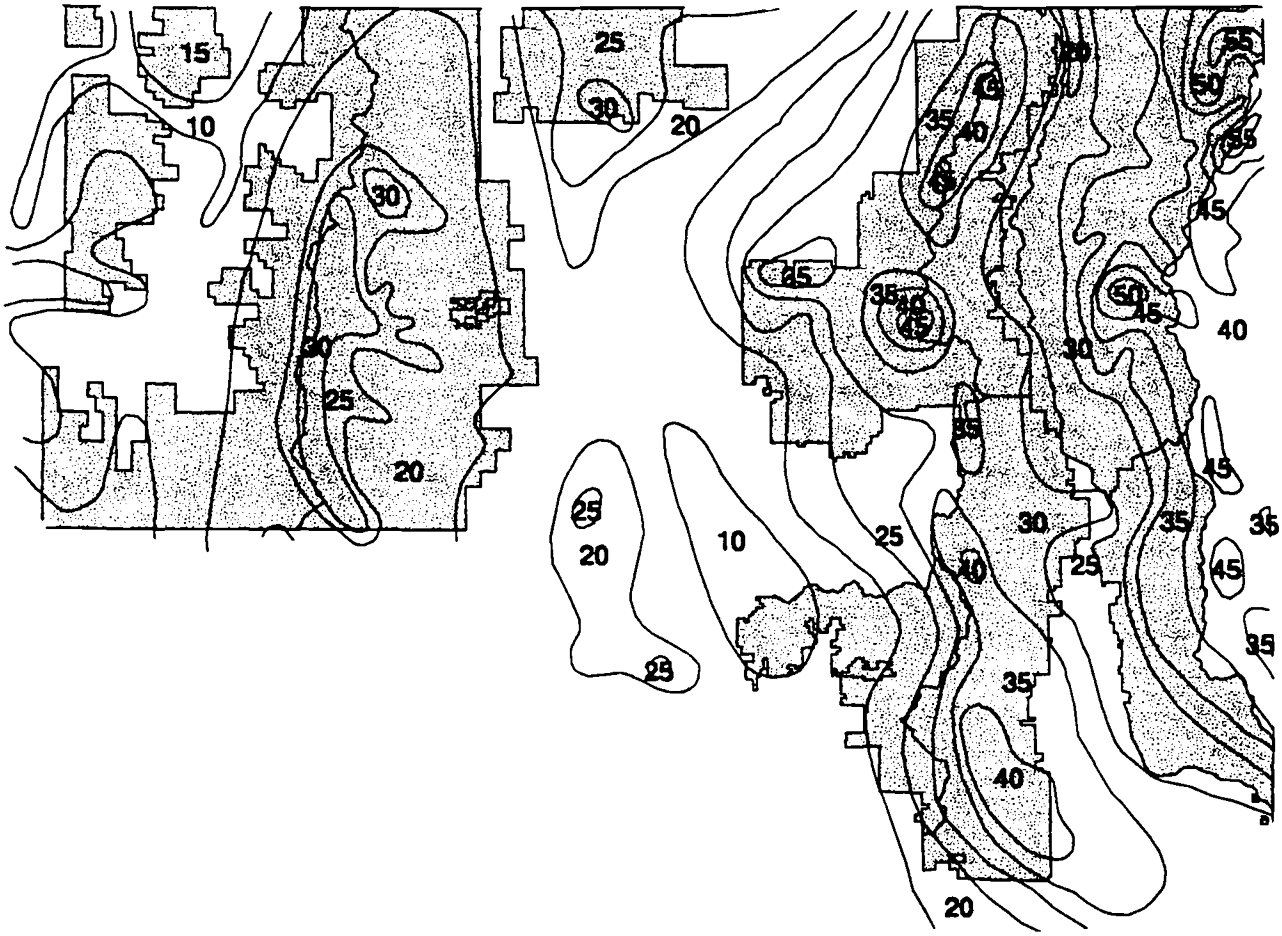


Figure 3. Precipitation patterns (inches) on the Colville National Forest.

Soils

Soils on the Colville National Forest formed mainly from glacial till, outwash, lacustrine deposits, colluvium and alluvium. Tills and outwashes can be influenced by a variety of rock types from the complex local geology. In addition, there is a mantle or admixture of volcanic ash which is present over much of the Forest. Volcanic ash mantles are up to several feet thick in some areas. Steeper south and west aspects normally have less evidence of ash deposition. The geologically recent glaciation and ash falls have resulted in relatively undeveloped soils, primarily Inceptisols, on forested sites. South and west aspects with grasses as the main type of vegetation have soils with a dark surface layer and higher base saturation (Mollisols).

The ashy surface mantle has important management implications. It provides an excellent medium for plant growth. Ash has a higher water holding and cation exchange capacity compared to the glacial deposits. Undisturbed, it is porous with weak granular or blocky structures and minimizes erosion. It is highly subject to erosion if disturbed. These soils are also easily compacted by heavy equipment, especially when moist. Additionally, forested sites have a thin "A" horizon that contains

Table 1. Mean annual snowfall, temperature and precipitation (inches) for selected locations in northeast Washington.

Location	Elevation (ft.)	Mean Annual Snowfall	Mean Annual Precipitation	Mean Annual Temperature
Omak	850	21.1	12.93	49.9
Chesaw	2850	48.1	13.41	41.7
Republic	2610	53.2	16.26	43.0
Colville	1640	41.4	18.46	46.9
Northport	1330	56.8	19.03	47.1
Laurier	1640	57.8	19.88	46.1
Chewelah	1670	44.1	20.82	45.9
Newport	2140	61.7	26.78	45.1
Metaline Falls	2110	87.0	27.25	45.1

the bulk of the organic matter and nutrients in the soil. The ashy surface soil layers have generally increased the productivity potential of soils in this glaciated area. Compaction or displacement of the ashy surface soil layers will reduce site productivity potential and increase the risk of run-off and erosion.

Glacial tills beneath the ash mantle are often compacted which limits root penetration and may contribute to windthrow of trees which have shallow root systems. Limited data suggest that soil moisture content generally begins to decline in July. The soil moisture pattern fluctuates until the more consistent late fall rains begin. Sites associated with the Douglas-fir series appear to experience greater moisture losses at the 12- and 20-inch depths than sites in other series.

VEGETATION OVERVIEW

Development of Current Vegetation

Daubenmire (1975) traces the development of the current flora through the Cenozoic Era (beginning 65 million years ago) for eastern Washington and northern Idaho. Hansen (1947) and Mack *et al.* (1978a and 1978b) discuss vegetation development at specific locations for approximately the last 12,000 years from pollen records in bogs from sites within or near the Colville N.F. These studies indicate a marked change in the flora over both geologic time scales and in the relatively short time since de-glaciation (beginning approximately 12,000 years before present). Interpretation of the pollen record of Big Meadow (T37N R42E S7, Willamette Meridian) suggests that the current forest composition developed about 2,700 years before present (Mack *et al.* 1978a). Interpretation of another pollen profile in the San Poil River drainage suggests that the current vegetation composition was established 2,400 years ago (Mack *et al.* 1978b).

Even with the uncertainties of pollen and fossil records (Pielou 1991), it is clear that flora (species) and vegetation (patterns of communities on the landscape) are dynamic. Vegetation appears stable only in the context of a human time scale. Vegetation change in response to climatic fluctuation and other environmental and biological conditions is certain. Whether the changes are beneficial or not is entirely a matter of perspective. Introduced biota are already major modifiers of the native vegetation. Climate has and does fluctuate. A recent example is the well documented "Little Ice Age" from about 1350 to 1870 (Pielou 1991). Such climatic fluctuations are evident in the present vegetation as relict distributions of species and communities unable to persist under the current climatic regime. With the accumulating evidence of an impending (some would say beginning even now) major global climatic change (*e.g.* "global warming") driven (at least in part) by man's activities, the future will likely bring unexpected changes in our flora and vegetation.

Climate plays a major role in the distribution of vegetation. But within a specific climate much spatial variation exists dependant on other factors such as geology, soils, microclimate and site history. Disturbance and ecosystem response are an integral part of vegetation ecology. Type, intensity and timing between disturbances are essential components of the ecology of individual species and plant communities. Factors often referred to as disturbances include (but are not limited to) fire, animals (including insects and predators), pathogens and man's activities. All of these factors affect the kinds and development of vegetation for a specific area. Human activities often alter vegetation in conspicuous ways but more subtle changes may have much more long-term importance. For example, a recent clear-cut is conspicuous, yet the introduction of an alien pathogen such as white pine blister rust (*Cronatium rubicola*), while not as readily noticed, may have more profound effects on forest composition than logging. Other examples include the long-term effects of air pollution, soil compaction, disturbance or displacement, changes in fire frequency or intensity, and introduction or extirpation of fauna or flora. All play important roles in the biology and sustainability of a forest community.

Both spatial and temporal scales are important considerations when looking at vegetation patterns and development. The overall forest composition of a large area may remain essentially stable for thousands of years while individual stands are a dynamic, ever shifting mosaic of composition, structure and pattern. A specific acre may support essentially the same plant community for centuries because disturbances passed it by (*e.g.* natural fires) and then may be repeatedly disturbed in a few decades.

Many patterns repeat themselves in time and space. Therein lies the value of vegetation classifications such as this. Essentially the same pattern may repeat itself on the same acre if environmental and biotic factors remain relatively constant. Some factors such as fire and insects operate in complex, inter-related cycles within a time sequence measured in decades to hundreds of years (Amman 1990). The net result is a forest landscape in dynamic balance with the local environment and biota. Introduced species and rapid climatic or other environmental change (*e.g.* acid rain) may drastically alter this dynamic balance and result in rapid change. Vegetation will adapt to the new conditions but may or may not do so in a manner humans find desirable.

Plant Succession

A simple definition of plant succession is the replacement of a species or a community by another. Generally it is somewhat orderly and predictable for a specific area. However it can and does vary according to a multitude of factors including: soils, climate, previous vegetation, adjoining vegetation, type and magnitude of disturbance, history of use, etc. Traditionally, succession has been termed "primary" or "secondary", with primary succession concerning the development of vegetation on sites that have not previously supported plants. Examples are strip mine spoils and bare rock. Managers commonly deal with secondary succession which refers to the development of vegetation on a site that previously supported plants. Much of secondary succession concerns the interaction of plants between and among themselves. Tolerance to shade, competition and various forms of disturbances are major considerations. Table 2 is a listing of the autecological characteristics of selected conifers found on the Colville N.F.

The list in Table 2 is approximate and placement of one species to another may vary somewhat, though the general order is correct. Over time, species more tolerant of shade will normally out-compete intolerant species in closed stand situations. Tolerant species often require more favorable site conditions in terms of soils and climate than do intolerant species. In part, intolerant species are favored by conditions of early succession where rapid establishment and early growth are important survival mechanisms. Tolerant species are better at competing with other plants for light, moisture and nutrients than are intolerant species. Fire tolerant species are more likely to survive a given intensity of fire until the fires are too intense for any species to survive. Appendix 1 contains a list of selected shrubs and herbs and their fire survival adaptation. Factors other than shade and fire tolerance are also important, but are generally less well understood. Resistance to diseases, animals, insects, mechanical damage, frost, annual heat and water budgets and chemical warfare by other plants (allelopathy) are just some of the characteristics important in determining the range and development of a species.

Allelopathy is an especially interesting process wherein chemicals exuded by plants directly or indirectly inhibit or prevent the growth and development of other plants. Engelmann spruce has been shown to limit survival and growth of other plants (including itself) with chemicals leached from the litter. Lodgepole pine is especially sensitive to Engelmann spruce leachates (Taylor and Shaw 1982). Other trees, shrubs and herbs have been shown to hinder the growth and survival of other plants. The most notable of these is bracken fern, where recent work in northern Idaho suggests that some non-forested openings may be partially or wholly the result of conifer regeneration being inhibited by this species (Ferguson and Boyd 1988). The tables on tree characteristics and appendix 1 provide useful information in predicting vegetation response from a given event such as a fire. They can also be used to make interpretations for other activities such as logging by providing information on reproductive strategies.

Much of the information on plant succession is discussed in the series descriptions. Patterns exist between climax tree series as well as between associations and different stands within an association. Table 3 shows the complex successional relationships between conifer species and the various plant associations found on the Colville N. F. This discussion should indicate to the reader that the forest community we see is extremely complex and inter-related. Linkages between and among communities

Table 2. Comparative autecological characteristics of selected Colville National Forest conifers. Data are compiled from various literature sources (Minore 1979) and field observations.

Species	Shade Tolerance[1]	Frost Tolerance[2]	Drought Tolerance[2]	Snow Damage Resistance[2]	Fire Resistance[2]	Root Rot Resistance[2]	Seed Weight[2]	Seed Crop Frequency[2]
ABGR	T	M	M	M	L	L	M	M
ABLA2	T	M	L	H	L	L	M	M
LAOC	VIT	M	M	M	H	M	L	L
PIEN	T	H	L	H	L	M	L	M
PIAL	VIT	H	H	H	L	U	H	M
PICO	IT	H	M	M	L	M	M	H
PIMO	I	H	M	M	M	M	M	H
PIPO	IT	L	H	L	H	H	H	L
PSME	I	L	M	L	H	L	M	M
TSHE	VT	L	L	H	L	M	L	M
THPL	VT	L	L	M	L	L	L	H

[1] VT - Very Tolerant; T - Tolerant; I - Intermediate; IT - Intolerant; VIT - Very Intolerant
[2] H - High; M - Moderate; L - Low; U - Unknown.

and species are greater and more complex than we imagine. In reality we know and understand only a small part of the complex biology of a forest stand.

Vegetation Zones

Vegetation patterns on the Colville National Forest differ from other National Forests in eastern Washington State. The west to east transition from intense rainshadow to moist maritime conditions is a major influence on plant species and community distributions. The locally common coniferous tree species differ from each other in their autecologic characteristics, ecologic roles, elevational and geographic distributions. Due to these factors, some plant species have limited distributions.

In order to better understand and describe the relationships between the environment and spatial vegetation patterns, a large-scale vegetation modelling project has been initiated on Area II forests. In order to accomplish this task, plant associations have been grouped into Vegetation Zones and Plant Association Groups (PAG). Vegetation Zones represent areas of land which are characterized by a single modal type of potential vegetation. These areas support the modal tree(s) species (and thus related plant associations) for which the zone is named. In theory, the Douglas-Fir/Grand Fir

Table 3. Distribution of tree species by type, showing their successional status.

	TREE SPECIES												
Association	TSHE	THPL	ABGR	ABLA2	PIEN	PSME	PIPO	PICO	PIMO	LAOC	BEPA	POTR	POTR2
TSHE/GYDR	C[1]	c	S	i	i	s	.	s	s	S	s	.	s
TSHE/MEFE	C	s	i	S	S	s	.	S	s	S	.	.	.
TSHE/XETE	C	S	.	S	S	i	.	S	s	s	.	.	.
TSHE/RUPE	C	c	i	S	S	i	.	S	S	S	s	.	s
TSHE/ARNU3	C	c	S	.	i	S	i	S	S	S	S	S	.
TSHE/CLUN	C	c	S	s	i	S	i	S	S	S	s	s	s
THPL/OPHO	c	C	S	.	.	s	.	s	.	.	s	.	s
THPL/ARNU3	i	C	S	.	S	S	s	s	s	S	S	s	s
THPL/VAME	.	C	S	s	i	S	.	S	s	S	s	s	.
THPL/CLUN	i	C	S	i	i	S	s	S	S	S	s	s	s
ABGR/ACGLD /CLUN	.	i	C	.	i	S	S	S	.	S	s	s	s
ABGR/VAME/ CLUN	.	I	C	I	I	S	s	S	s	S	s	s	.
ABGR/VACA	i	i	C	i	i	S	s	S	s	S	s	s	.
ABGR/PHMA	.	i	C	.	.	S	S	S	s	S	.	.	.
PIEN/EQUIS	.	.	.	c	C	s	.	s	.	.	s	.	s
ABLA2/RHAL-XETE	i	i	.	C	c	i	.	s	i	s	.	.	.
ABLA2/RHAL	i	i	i	C	S	s	.	S	s	S	.	.	.
ABLA2/COCA	i	.	.	C	C	S	i	S	i	S	s	s	s
ABLA2/TRCA	.	i	s	C	c	s	.	S	.	S	.	.	.
ABLA2/XETE	i	i	.	C	S	s	.	S	s	S	.	.	.
ABLA2/CLUN	i	i	i	C	c	s	.	S	s	S	s	s	.
ABLA2/VAME	.	i	s	C	S	S	.	S	s	S	s	s	.
ABLA2/VACA	.	i	i	C	c	S	.	S	s	S	i	s	.
ABLA2/LIBOL	.	.	.	C	C	S	.	S	s	S	s	s	s
ABLA2/VASC	.	.	.	C	c	i	.	S	.	i	.	.	.
ABLA2/CARU	.	.	.	C	s	S	.	s	.	s	.	s	.
PSME/PHMA-LIBOL	i	.	i	i	i	C	S	s	s	S	i	.	.
PSME/PHMA	.	.	i	.	.	C	S	s	.	.	.	i	.
PSME/VACA	.	.	.	i	i	C	s	S	.	S	.	s	.
PSME/VAME	i	.	.	i	i	C	i	S	.	S	s	s	.
PSME/SYAL	.	.	.	.	.	C	S	S	.	s	.	s	.
PSME/SYOR	.	.	.	.	.	C	S	.	.	S	.	.	.
PSME/CARU	.	.	i	i	.	C	S	s	.	S	.	.	.
PIPO-PSME/AGSP	.	.	.	.	.	c	C	.	.	.	.	.	.
PICO/SHCA	?	?	?	?	?	s	i	S	s	S	s	s	.

[1] C = major climax species; c = minor climax; S = major seral; s = minor seral; i = incidental; ? = unknown. Table format from Pfister *et al.* (1977).

Vegetation Zone (as defined here) represents an area of land which has the "potential" to support Douglas-fir or grand fir plant associations and all of the related successional seres. The Vegetation Zone is a concept similar to tree series, except that it refers to the land area where a particular series(s) occurs (Henderson *et al.* 1989, 1992). These zones can (and will) have inclusions of either drier or wetter vegetation than the described modal type. There are five Vegetation Zones which ecologists are currently delineating on the Colville National Forest: 1) Douglas-Fir/Grand Fir, 2) Western Hemlock/Redcedar, 3) Subalpine Fir, 4) Parkland and 5) Alpine. Figure 4 shows the first approximation of the distribution of these zones across the Forest. This map will be improved through time as more information on climate and vegetation becomes available, allowing the climatic (temperature, precipitation, etc.) and vegetation models to be calibrated more accurately.

Plant Association Groups (PAG)

Plant Association Groups (PAG) represent aggregates of plant associations based on similarities in floristics, environment, and productivity. This grouping represents a finer delineation of the environment than that of the Vegetation Zones. These groups are useful for mapping similar environments across a given landscape, and as such, are also useful in helping to describe other landscape attributes such as potential fire regimes. These groups, along with the corresponding Colville Plant Associations, are listed in Table 4. These groups will form the basic units for future vegetation modelling and mapping efforts on the Colville National Forest by Area II ecologists. A more detailed discussion of the PNV modelling effort will be available in the future in a separate document.

Fire History

Fire has played a major role in the development of forests in the Northern Rocky Mountains (Arno 1980, Gruell 1983, Shearer and Stickney 1991, Wellner 1970), so much so that Shearer and Stickney (1991) make the statement that "Fire has been the agent of the most extensive disturbances in the Northern Rocky Mountains." Their conclusion is valid for the Colville N.F., with virtually all Colville N.F. ecology plots containing evidence of past fire such as fire-scarred trees, charred logs, stumps or wood, or charcoal in the soil. Daubenmire and Daubenmire (1968) state that incidence of fire is a virtual certainty within 400 to 500 years in northern Idaho and eastern Washington. During this study (with sampling biased towards the oldest stands) 1,700 trees were aged. Only nine were more than 400 years old at breast height. Several of these were western redcedars located in sheltered, moist habitats. The oldest sampled tree was a 570 year old western larch that had survived multiple fires. A series of large fires has burned over much of the Colville N.F. in the last 100 years (Figure 5). The large gaps in fires shown in Figure 5 are a result of incomplete fire history data reported for those areas, but it is recognized that those areas have been impacted as well.

Additionally, a large proportion of national forest lands were homesteaded in the 1800's and early 1900's, with subsequent reversion to federal control following homestead failures during the Great Depression era. Because of these large scale disturbances, commercial logging has concentrated in the most accessible areas containing the largest (and generally oldest) trees. Consequently, old and

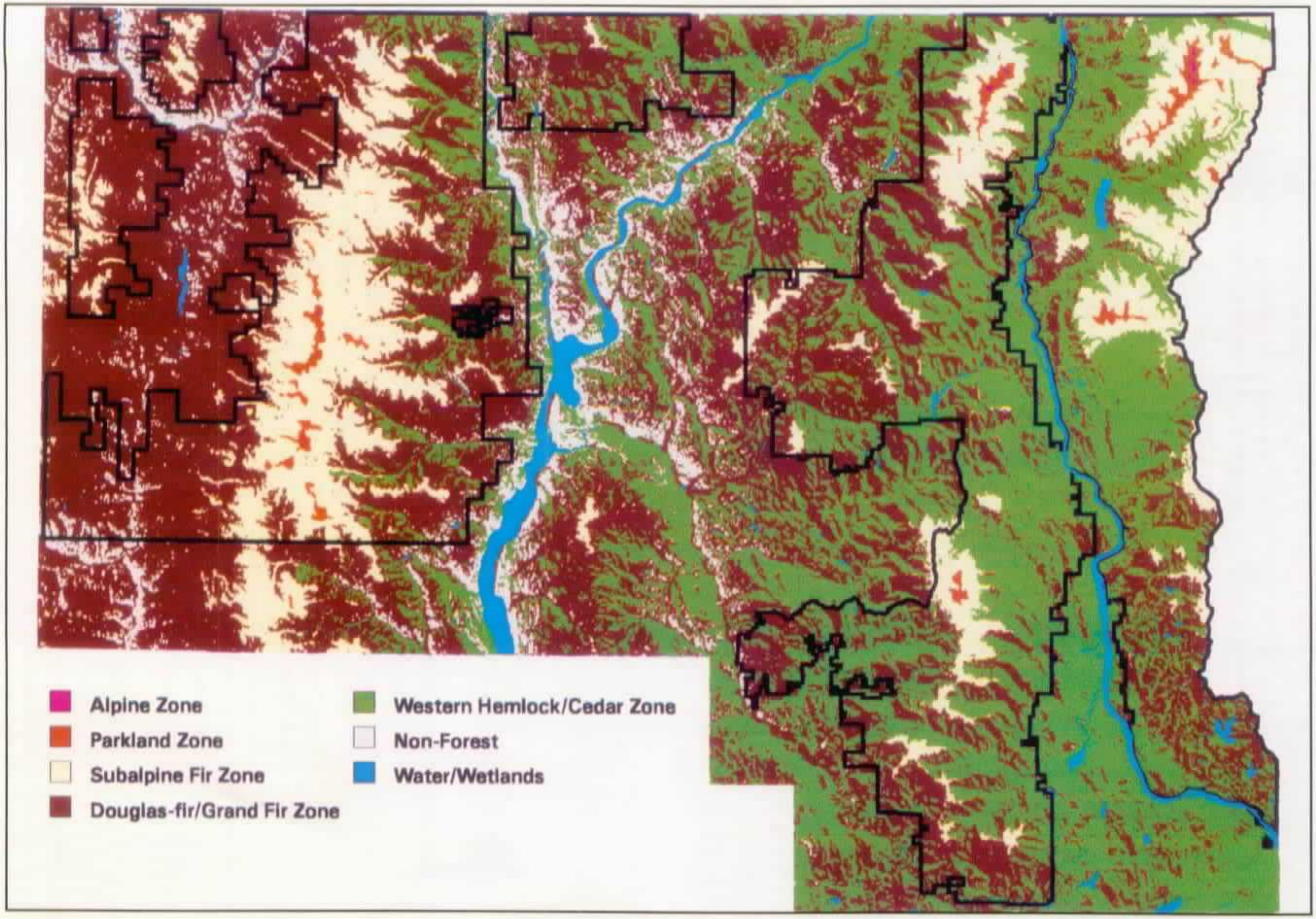


Figure 4. Distribution of Potential Natural Vegetation (PNV) Zones on the Colville National Forest (first approximation, May 1995).

Table 4. List of Plant Association Groups (PAG) and corresponding Colville Plant Associations[1].

Plant Association Group (PAG)

Hot, dry PIPO-PSME - bunchgrass

- PIPO-PSME/AGSP (D)

Warm, moist PSME - low shrub

- PSME/SYAL (I)

Warm, dry PSME-ABGR - tall shrub

- PSME/PHMA (D)
- PSME/SYOR (D)
- PSME/PHMA-LIBOL (D)
- ABGR/PHMA (D)

Cool, dry PSME - grassy

- PSME/CARU (I)
- PSME/ARUV (I)

Cool, mesic PSME-ABGR - low shrub

- PSME/VACA (M)
- PSME/VAME (M)
- ABGR/VAME/CLUN (M)
- ABGR/VACA (M)
- ABGR/ACGLD/CLUN (M)

Cool, dry ABLA2 - grassy

- ABLA2/CARU (I)

Cold, mesic ABLA2 - forb/shrub

- ABLA2/CLUN (M)
- ABLA2/LIBOL (M)
- ABLA2/VACA (M)

Plant Association Group (PAG)

Cold, dry ABLA2 - shrub

- ABLA2/XETE (I)
- ABLA2/VAME (I)

Very moist ABLA2 bottoms

- ABLA2/TRCA3 (M)
- ABLA2/COCA (M)
- PIEN/EQUIS (M)

Cold, mesic ABLA2 - tall shrub

- ABLA2/RHAL (M)
- ABLA2/RHAL-XETE (M)

Cold, dry ABLA2 - low shrub

- ABLA2/VASC (I)

Cool, mesic THPL/TSHE - forb/shrub

- THPL/CLUN (M)
- THPL/VAME (M)
- TSHE/CLUN (M)
- TSHE/XETE (M)

Cold, mesic TSHE - tall shrub

- TSHE/MEFE (M)

Very moist THPL/TSHE bottoms

- THPL/OPHO (M)
- THPL/ARNU3 (M)
- TSHE/RUPE (M)
- TSHE/GYDR (M)
- TSHE/ARNU3 (M)

[1]Current grouping as of November 1994.

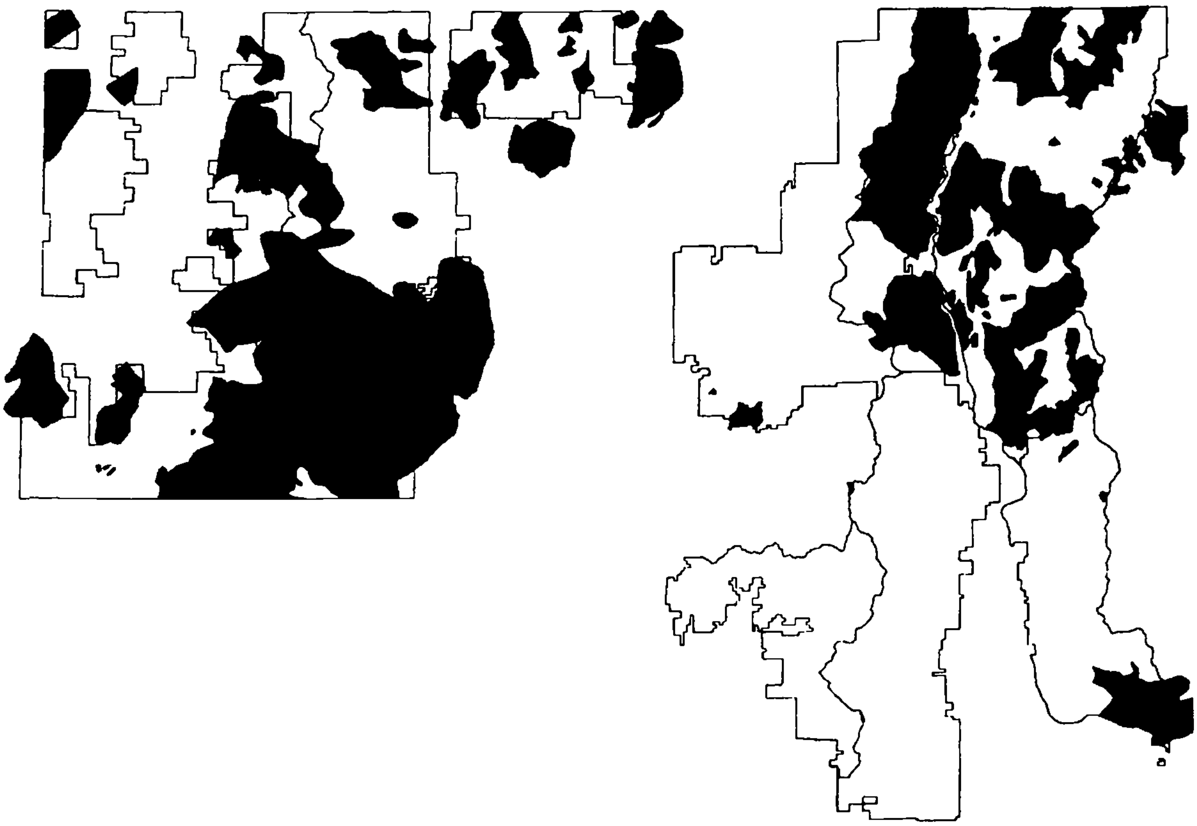


Figure 5. Locations of major fires (perimeters) between 1909-1994 on the Colville National Forest.

mature forests (stands 150 years or older) make up a small proportion of the present landscape.

Older forest stands were likely to have been a more common landscape element prior to Anglo-American settlement, but still would have occupied a relatively small percent of the area because of the integral role fire has in the ecology of northeast Washington's forests. Gruell (1983), using old photographs, suggests such a conclusion for the northern Rocky Mountains. The pattern of several large, catastrophic fires early in this century appear within the cycle of natural fire patterns that were part of the landscape ecology of the area for the past 2,000 years or more. Large fires took place at irregular intervals depending upon variations in weather. Native Americans also used fire to manipulate vegetation (Agee 1993, Arno 1980, Bakeless 1964, Butzer 1990).

Moist, highly productive (in biomass) forests are more common east of the Kettle and Columbia Rivers. Such forests accumulate considerable organic matter in short time periods and rapidly develop complex vertical structures. The moist environment reduces the flammability of the forests but the dense complex structures and high fuel loading predisposes the stands to crown fires when fires do occur. The more xeric forests characteristic of the area between the Kettle Mountains and the Okanogan River had a higher fire frequency but the relatively xeric conditions favored more open forest with much lower fuel loadings. Consequently most fires were relatively low intensity "ground fires". Intense stand replacing fires also occurred depending on local fuels and weather patterns.

Fire suppression has had the largest effect on the character of forest stands on sites with a natural history of repeated underburns. This is especially true of drier habitats within the Douglas-fir and Grand Fir Series. Dry habitats typically support a grass, low shrub or forb dominated undergrowth with low fuel loadings and light, flashy fuels. Periodic, low-intensity underburns with a 5-40 year interval between fires were typical. Relatively frequent, low intensity fires maintained open forests characterized by widely spaced large (and old) individuals of fire resistant species such as ponderosa pine, western larch and Douglas-fir. Fire sensitive species such as grand fir, subalpine fir and Engelmann spruce were normally minor stand components except, perhaps, in riparian zones. Crown fires often led to dominance for the first 100 years or so by lodgepole pine or western larch if a seed source was available.

Under fire suppression, fire sensitive but more competitive and shade-tolerant grand fir, subalpine fir and Engelmann spruce have increased in proportion to shade-intolerant seral species. Douglas-fir has also increased on the Douglas-fir Series. Consequently, stand structures have changed from relatively open single or two storied stands dominated by large individuals of seral, fire resistant species to denser, smaller-stemmed, multi-layered stands with a higher proportion of fire sensitive, late seral or climax species.

Periodic underburns on these drier sites also kept logs and other woody materials on the forest floor at relatively low levels. As the large, open grown, fire tolerant species die they become large snags or logs. Western larch, western white pine and ponderosa pine are unable to replace themselves in competition with more tolerant species so the large snag and log component will decline. With fire suppression, log and snag densities increase but snags and logs are usually much smaller in average size. Different tree species which become snags and logs have unique structures, decay attributes and chemical compositions, so snag and log dependent biota may also change. After several decades of fire control, sites with a natural history of underburns develop stand structures and conditions similar to those with a natural history of less frequent but more intense crown fires. Selective harvest of commercially valuable large, old seral trees (*e.g.* ponderosa pine, western larch) has accelerated these changes in composition and structure (Hungerford *et al.* 1991).

Such changes approximate late seral vegetation (primarily species composition) on habitats that normally supported early to mid-seral vegetation, and these late seral conditions now favor different biota than early seral conditions once did. Some insect populations are especially favored by extensive areas of late seral vegetation, as are various root diseases. Prior to fire suppression, late seral stands were a smaller proportion of the landscape and rarely occupied extensive contiguous areas. Fire suppression and other management activities have contributed to the development of extensive contiguous areas of late seral forest conditions that have no precedent in pre-settlement landscapes. This has also led to an increase in structural and species diversity.

Underburns were much less important in stand development on moist or cold habitats within the Subalpine Fir, Western Hemlock and Western Redcedar Series. The typical fire pattern was one of occasional intense fires on a 150 to 300+ year return interval, though these stands also exhibited patchy low-intensity underburning on occasion. Current stand development under fire control on moist sites does not appear markedly different than that prior to Anglo-American settlement because the time since fire suppression is well within the variation between major fires (150 - 300 years). Barrett *et al.* (1991) describe a similar pattern of fire occurrence in western larch-lodgepole pine forests in Montana. The fire regimes they discuss generally agree with our observations. For more information on their findings refer to the Fire Ecology discussion for the Subalpine Fir Series.

Ponderosa pine climax stands are uncommon on Colville National Forest lands, but are more prevalent on lands of other ownerships at lower elevations below the Forest boundary. These stands also had a history of frequent underburning. Fire suppression has not changed species compositions as much because the dry environments do not allow for more shade tolerant but moisture-requiring conifers such as Douglas-fir or grand fir to thrive. Other factors such as dead wood and shrub and herb composition have been altered with the change in fire regime.

It is obvious that fire and vegetation have interacted together over long periods of time in the Pacific Northwest. This is evident from the many fire-adaptations which various species exhibit such as thick corky bark, serotinous cones or seeds (which require fire to germinate), and vigorous re-sprouting of some shrubs and herbs after fire (Agee 1993). As reported by Christensen (1988), flammable features of plants can influence fire regimes and subsequent successional trajectories. Thus, fire (or the lack of) plays an important ecological role in the evolution of natural ecosytems in eastern Oregon and Washington (Agee 1993, Gast *et al.* 1991). The long-term implications of recent changes in fire regimes are not clear but important ecosystem processes such as nutrient cycling, pathogens and accumulation of organic materials may be altered (Cochran and Hopkins 1991). It is not probable (or perhaps possible) that the natural role of fire can be reapplied successfully to historical levels and intensities across the landscape (Agee 1993). However, the use of fire still represents an important and promising tool for managing for long-term productivity of forests in eastern Oregon and Washington (Gast *et al.* 1991).

*Insects and Disease***

The interrelationships between natural fire, insects and disease is receiving much attention because of large-scale insect population increases (Arno *et al.* 1991). Tree ring analysis in the southern Rocky Mountains suggests that periodic attacks by defoliating insects have been common for centuries but that the intensity and extent of recent outbreaks may be greater because of human-caused changes in forests (Swetnan and Lynch 1989). An assessment (preliminary draft) of forest health of the Colville National Forest was recently completed by a pathologist and entomologist (Hessburg and Flanagan 1991). Part of the their summary of current conditions is reproduced below.

** *(Portions of this and other discussions concerning insects and disease were contributed by Paul Flanagan and Jim Hadfield, entomologist and pathologist, respectively, U.S.D.A. Forest Service, Forestry Sciences Laboratory, Wenatchee, WA.)*

- Forest diseases are responsible for significant resource damage on the Colville N.F. We believe that there has been an increase in damage since the turn of the century when fire prevention programs were initiated. Damage continued to escalate with selection logging and aggressive fire suppression to the present day. Resource impacts today are directly related to the susceptibility of existing vegetation on the Forest.

- Historic conditions were low to moderate hazard and damage, depending upon the plant association and time since stand replacement fire. Current conditions range from moderate to very high hazard and damage. The areas most severely damaged have been logged several times and are successionally advanced. The areas least damaged are those that were most recently fire-regenerated and have not been entered due to their small timber size and/or high density.

- Over many areas of the Forest that have been entered, stocking levels are excessive in the understory, a direct result of effective fire suppression and past selective harvesting. The composition of these understories represents an increase in susceptibility to damage by forest diseases. The soil of harvested areas is more compacted and disrupted. Both of these effects create conditions which are conducive to greater damage by root diseases and bark beetles and perhaps other forest pests.

- In the historic context, forest pathogens and the diseases they caused were neither good nor bad. Most of the effects of forest pathogens were beneficial under natural disturbance regimes. Fire regulated the extent of those effects to typically low or moderate levels. Root diseases predisposed trees to windthrow providing down woody material for small mammal habitat, soil moisture retention, and refugia for essential soil microorganisms. Dwarf mistletoes provided roosting and nesting habitat for a variety of birds as well as the green fuel ladder for stand replacement fires that would regenerate the seral plant community. Stem decay pathogens in the seral species were prevalent on the Forest, providing essential habitat for cavity nesting birds and mammals and the impetus for small gap formation.

- Damage associated with the western spruce budworm and bark beetles is dramatic and visible and captures the attention of people who typically consider or observe the forest from a distance. Root diseases and dwarf mistletoes though, produce change on the landscape at a slow steady rate, seldom capturing the attention of the public or forest managers. Their effect on growth and survival of vegetation in the long term is much greater than that of all other forest insects (Hessburg and Flanagan 1991).

Insects and disease are essential components of the biology of the Colville N. F. They have essential roles in nutrient and organic matter cycling, providing habitat diversity and other vital ecosystem functions (Harvey *et al.* 1987, Hessburg and Flanagan 1991). However, introduced pathogens and insects may greatly reduce or even eliminate native species that have little or no natural resistance. In such instances a "balance" between hosts and "pests" does not exist. Man's activities can also alter the balance between pathogens and host species (McDonald *et al.* 1987a), with the case of fire suppression and introduced pathogens serving as examples. Table 5 lists some of the common fungal pathogens of conifers found on the Colville National Forest, as well each tree species' susceptability.

Table 5. Damaging agent-host susceptibility matrix for the conifer species found on the Colville National Forest. (table and information has been adapted from Harvey and Hessburg 1992).

AGENT	PSME	ABLA2	ABGR	TSHE	THPL	LAOC	PIPO	PICO	PIMO	PIEN	HARD-WOODS
Laminated root rot (*Phellinus weirii*)	H[a]	I	H	I	R	T	T	T	T	I	i
Armillaria root rot (*Armillaria ostoyae*)	H	I	H	I	I	T	I	I	I	I	R
Annosus root rot (*Heterobasidian annosum*)	T	H	H	I	R	R	I[b]	I	T	I	R
Tomentosus root rot (*Inonotus tomentosus*)	T	I	T	I	R	T	I	H	T	H	R
Brown cubical butt rot (*Phaeolus schweinitzii*)	H	T	T	T	R	H	H	H	I	H	R
Rust-red stringy rot (*Echinodontium tinctorium*)	R	H	H	H	R	i	i	i	i	R	i
Red ring rot (*Phellinus pini*)	H	I	H	H	R	I	H	I	H	H	R
Brown trunk rot (*Fomitopsis officinalis*)	H	R	R	R	i	H	H	H	I	T	i
Redcedar pencil rot (*Oligoporus sericeomollis*)	R	I	T	R	H	R	R	R	R	R	i

[a] Susceptibility: H=High, I=Intermediate, T=Tolerant, R=Resistant,i=Immune.

[b] PIPO is susceptible on dry climax PIPO sites.

Western white pine was once a major forest species in the inland Pacific Northwest; particularly on eastern portions of the Colville N.F. It was a major seral tree under the natural fire regime of periodic large stand-replacing fires. Following the introduction of white pine blister rust early in this century, western white pine mortality (accompanied by timber harvest) has been so great in natural stands that the species now plays a minor role in natural succession in areas where it formerly was an important component. This same pattern is now also occurring in whitebark pine (*Pinus albicaulis*) stands across much of the Pacific Northwest (Keane and Arno 1993), including the Colville N.F.

CLASSIFICATION CONCEPTS AND DEFINITIONS

Plant community classification consists of grouping a potentially infinite number of stands into a relatively few classes, groups, or types that can be more easily comprehended. Individual members of types should be more similar to each other than they are to members of other classes. The definition of types gives a "pigeon hole" into which information applicable to all members of a type can be placed. Therefore the classification in this guide should be viewed as an information storage and retrieval system where the units characterize conditions important for vegetation development. The development of classes or types involves an abstraction from reality. The sampled stands are real entities but grouping them into a class or type places them into an abstract, conceptual framework. Since classes are abstractions, a variety of different types of classification are possible. As the purposes of classification change, so may the classification.

Plant communities present after a relatively long period of time (approximately 300 years in our experience) under relatively consistent climatic conditions while free of disturbance and with stable composition have manifested their ability to exist under competition over time. These communities are termed plant associations and represent the potential climatic climax (Tansley 1935) plant community. The plant association (climax plant community) is an abstraction but it is useful as a reference point for plant succession and as a indicator of environmental diversity. Whether or not the "climax" community will ever develop on a site given the periodicity of disturbances is of minor consequence. What is important is that the association provides a conceptual end-point to plant succession and gives an indication of the direction of succession.

The concept of a climax dominant tree series is used in the same sense as Daubenmire (1968) where all associations capable of supporting a given climax tree species form a series. The series is named for the most shade tolerant and environmentally demanding tree species capable of reproducing itself. The series concept is useful even though it may be difficult to apply in some instances. It is meaningful to discuss the Western Hemlock Series as distinct from the Douglas-fir Series because of important differences in environments and plant communities encompassed by each. Single species names for tree series are used in this classification, but it is recognized that single species dominance may be an exception rather than a rule. Current stand dominants are often of minor value in determining the series.

Daubenmire (1968) used association as the climax plant community and habitat type as the land area that supports or may support a particular plant association. This very useful concept of habitat type has been used in many parts of the west (see Clausnitzer and Zamora 1987, Cooper *et al.* 1991, Hoffman and Alexander 1976, Pfister *et al.* 1977 and Steele *et al.* 1981). Unfortunately, the term "habitat type" or more often "habitat types" is often applied by biologists to mean "types of habitat" used by wildlife. Therefore, the term "plant association" is used to represent the climax or assumed climax plant community and the land area it may occupy as the "habitat" or" site" to avoid the confusion around the term "habitat type". Habitat type is used in this guide in the same sense of Daubenmire (1968).

The term "community type" is used for plant communities where climax status is not known or reasonably inferred. In this context, five important upland forest tree series, 33 plant associations and four community types are defined in this guide. Whether plant associations occur as discrete entities or not has been a subject of considerable debate (Cottam and McIntosh 1966, Daubenmire 1966). However, regardless of philosophy, even if a vegetation continuum exists it must still be subdivided into discrete units to make it comprehensible. Very often, the differences between various classifications reflect "where" and "how" the individual researchers decided to split these environment gradients.

METHODS

Field

As part of a larger vegetation classification effort on National Forest lands in eastern Washington State, reconnaissance sampling of the Colville National Forest took place in 1980 and intensive sampling in 1982 and 1983 . A total of 282 reconnaissance and 229 intensive plots form the data base for this report. Approximately 1,090,000 acres are administered by the Colville National Forest. This equates to a sampling intensity of approximately one plot for every 2,100 acres whereas the Daubenmires' (1968) sampling intensity as reported by Cooper *et al.* (1991) is about one plot for every 128,000 acres. Because of the size of the area it was first sampled with a reconnaissance technique. This sampling developed familiarity with vegetation patterns and variability and was used to develop preliminary plant community groups as a stratification to plan intensive sampling. Reconnaissance sampling methods were adapted from Franklin *et al.* (1970), Pfister *et al.* (1977) and Williams (1978). Plot size was from Pfister *et al.* (1977) and was a 375-square-meter circular plot.

Plots were selected "subjectively without preconceived bias" (Mueller-Dombois and Ellenberg 1974). Plots were located within homogeneous stands with uniform undergrowth, and apparent lack of recent disturbance. Random or systematic sampling techniques were rejected as too time consuming and inefficient. Most plots were located near roads to reduce travel time and were marked with aluminum tags to aid relocation. Reconnaissance data included information on slope, aspect, elevation, slope position, slope shape, and geographic location. A species list was made within the circular plot and foliar cover estimated for herbs, shrubs, tree understory and tree overstory by species. Foliar cover was estimated to the nearest 1% for values under 10% and to the nearest 5% for values above 10%. Tree cover was subdivided into mature and decadent categories in the tree overstory, and pole and young trees in the understory.

Reconnaissance plots representative of the variation within each association and throughout its geographic range were selected for revisiting. This was not to necessarily revisit a specific plot but to more efficiently sample the range of characteristics, locations and conditions of a given association. If the old reconnaissance plot was not quickly located, another suitable stand in the locale was substituted. If stands suitable for sampling were encountered, the crew was flexible to install plots as judgment and experience indicated.

Intensive plot data included everything taken on reconnaissance plots as well as measurements of tree height, diameter at breast height, basal areas, sapwood thickness, and growth rates for five individuals (if possible) of each tree species in the stand. There were a total 1,861 trees sampled on the Colville N.F. Additional data were added to some associations from plots located on the adjacent Okanogan N.F. Stand basal areas were measured and herbage production determined. A complete soil profile description was made near the plot center. Data on snags and logs were recorded, and observations on fire scars, wildlife and general stand conditions were also made.

Floristic, snag and log data were taken using the same size plot (375 sq. meters) as the reconnaissance plot, but tree data were taken with dimensionless plot techniques (*e.g.* use of prisms). Sampled trees may have been outside the floristic plot, but all had to be within the plant community the sample was designed to characterize. All plots were marked with aluminum tags and a cedar stake was put at plot center. In addition to the intensive and reconnaissance classification plots, approximately 2,200 Potential Natural Vegetation (PNV) plots were sampled on the Colville N.F. during 1993. These data, collected for vegetation modelling, are used in this guide to augment information about plant association distribution and environmental relationships for plant associations.

Office

Data were entered on a computer at the end of each field season and analyzed. Computer programs used in data analysis included synthesis tables, similarity index, cluster analysis, discriminant analysis (Volland and Connelly 1978), two way indicator species analysis (TWINSPAN) (Hill 1979b) and detrended correspondence analysis (DECORANA) (Hill 1979a). Synthesis tables and DECORANA were used most often in the analysis.

Initial groupings were based upon climax tree series. Plot data unassignable to a tree series were analyzed separately as community types. Secondary subdivisions were made within each tree series by identifying shrubs and herbs, that by their presence or dominance, suggested meaningful vegetation patterns. These floristic units were then examined for consistency in environmental characteristics and productivity estimates. If the floristic pattern appeared related to consistent environmental and productivity characteristics, then the type (association or community type) was described.

The following indices were determined from intensive plot data: Site Index (SI) to estimate height growth, Growth Basal Area (GBA) (Hall 1983) to estimate stockability, and Stand Density Index (SDI) (Reineke 1933) to estimate stand densities. Cubic feet per year productivity estimates were calculated using a combination of Site Index and Growth Basal Area (Hall, personal communication). Clipped herbage was air-dried and weighed to estimate herbage production in pounds per acre. All of these techniques have limitations, but because they were applied consistently to each plot they provide a reasonable means of comparing plots or associations. They are not directly comparable to estimates based on other methods or indices.

Site index tables and other equations used in our summary tables are included in appendix 2. Many, if not all, site index tables appear to poorly fit our stands. We recognize others may prefer different tables and equations than the ones we employed so our intensive plot data from all 229 intensive plots are available as a computer file. The file is available from the Area II Ecology Program ecologist.

Species Identification and Naming Conventions

The separation between individuals clearly recognizable as "tall" or shiny Oregon grape (*Berberis aquifolium*) and those clearly identifiable as "creeping" Oregon grape (*B. repens*) is not clear in much of the material, so they have been lumped into just Oregon grape. Most plants appeared to fit *B. aquifolium* best, though there is considerable variation from plant to plant. Cascade Oregon grape (*B. nervosa*) was in a few plots and was recorded as such.

Big huckleberry (*Vaccinium membranaceum*) and globe huckleberry (*V. globulare*) are morphologically similar species that occur in the study area and are easily confused (Steele *et al.* 1981). Globe huckleberry is more common in the Rocky Mountains and big huckleberry in the Cascade Range. Most of our material seems to better fit big huckleberry so we arbitrarily refer to all plants of this group as big huckleberry. Low huckleberry (*V. myrtillus*) appears at times to intergrade with both big and grouse huckleberry (*V. scoparium*). However, the difference in indicator value of the species is most significant when grouse huckleberry is the only or greatly predominant species. Species identification is normally readily apparent under these conditions.

Pfister *et al.* (1977) indicate most of the spruces in their area are a hybrid complex of Engelmann and white spruce. The same pattern may be true in our area but we did not collect any cone scale data to prove or disprove possible hybridization. Our material keys easily to Engelmann spruce so we refer to all spruces in our data by that name.

Common names are used in the text for plant species. Plant associations and community types are referred to in the text and tables by capital letter codes. This code is also used for species in some tables because of space limitations. The code is formed by taking the first two letters of each scientific name of a species. For example, the code for *Pseudotsuga menziesii* is PSME. The code occupies less space, is better adapted to computer use and helps distinguish between species and associations in the text. All codes follow Garrison *et al.* (1976). All codes, common and scientific names are presented in appendix 1. Scientific names follow Hitchcock and Cronquist (1973). Common names follow either Garrison *et al.* (1976) or Hitchcock and Cronquist (1973).

In plant association and community type names a slash (/) separates different life forms (trees, shrubs, herbs) *e.g.* PSME/CARU, and a dash (-) indicates members of the same life form *e.g.* PIPO-PSME/AGSP. Most association or community type names are restricted to the major climax tree species and the most indicative shrub or herb for brevity. Some longer names (three species) have been used as needed to avoid confusion.

Association Descriptions and Summary Tables

A map showing plot distribution is provided for each of the plant associations. These distribution maps show locations of ecology classification plots and Potential Natural Vegetation (PNV) mapping plots. The PNV plots were collected for the purpose of modelling vegetation patterns on the Forest, one product of which is the map of Vegetation Zones shown in Figure 4. The PNV plot data was also used in the histogram charts and tables describing environmental characteristics of each plant association. The number of visible plots on distribution maps may not always equal the total number of plots described (n) due to constraints in mapping and digitizing techniques.

Constancy is the percentage occurrence of a species in the plots used to describe a particular association. This is abbreviated as "CON" in many tables. The term "mean" indicates the arithmetic average of foliar cover of a species. We consistently use it as "relative mean cover" instead of "absolute mean cover". Relative or "characteristic" cover is the arithmetic average of cover values relative to the number of plots that species occurs in. For example, if a species was found in only five of the ten plots representative of an association the cover value would be that for the five plots it was found in rather than averaged across all ten plots. In this example the constancy would be 50%. A constancy of 100% indicates a species occurred in every plot representative of the association. Cover by species in vegetation layer (tree overstory, tree understory, shrubs, and herbs) was estimated independently. Cover for all species in a particular layer rarely approached 100% because areas without living vegetation were not part of the estimate. Cover was not taken as a proportion of all vegetation. Cover and constancy values calculated for each plant association (including appendix 1) were generated using only ecology classification plot data.

Productivity Information

Summary productivity estimates are given in appendix 2. Productivity estimates for each plant association are relative estimates of site potential. A majority of the plots are from mixed species stands and most site productivity estimation techniques are not well suited to multiple species stands. Further, we tried to visit the oldest stands we could find and these types of stands are not well adapted to providing growth estimates. Many, if not all, site index tables poorly fit our stands. Others may prefer different tables and equations than the ones we employed so our data from all intensive plots are available as a computer file. This file includes individual tree measurements for each live tree measured, and snags, and logs by species. The file is available from the Area II Ecology Program ecologist. A personal computer program (MS-DOS compatible) is also available that summarizes site index, GBA, and radial increment by species; and SDI, total basal area, snags and downed woody material per acre. These data are also available in a relational data base format.

The summary tables by type were generated using individual plot output from the above computer program as summarized and averaged in a relational data base. Because of different methods of calculating averages (*e.g.* normal means versus weighted means) some figures vary depending upon which computer program was used to summarize the data. The general patterns remain the same between types and species within a type. The data are most useful as relative indices and the absolute values less meaningful.

Management Interpretations

Management interpretations in association descriptions are based on field experience, literature, and interpretation of data. They are subject to modification as data and experience accumulate. This guide will be revised in the future, and user input will be a valuable addition. Management activities often make site identification more complex. Site potential may be altered indefinitely or more commonly, interpretation of site potential is more difficult. Use care and judgement in applying interpretations suggested in this or other guides. Events that alter the soil usually have profound and long-lasting effects. Soil erosion, mixing, or displacement can degrade and change site potential. Development of frost prone areas through harvest practices is also an important consideration (Figure 6). Timber harvest or fire will often make a site temporarily drier and warmer because of increased insolation. Absence of these disturbances can have the opposite effect.

Tree species common in late seral or climax stands may be poor selections for planting in the harvested stand or after wildfire. Conversely, moist sites can become swamps because removal of the tree "pumps" can raise the water table. Each series, plant association or community type description contains specific information on site characteristics and vegetation. Much of this

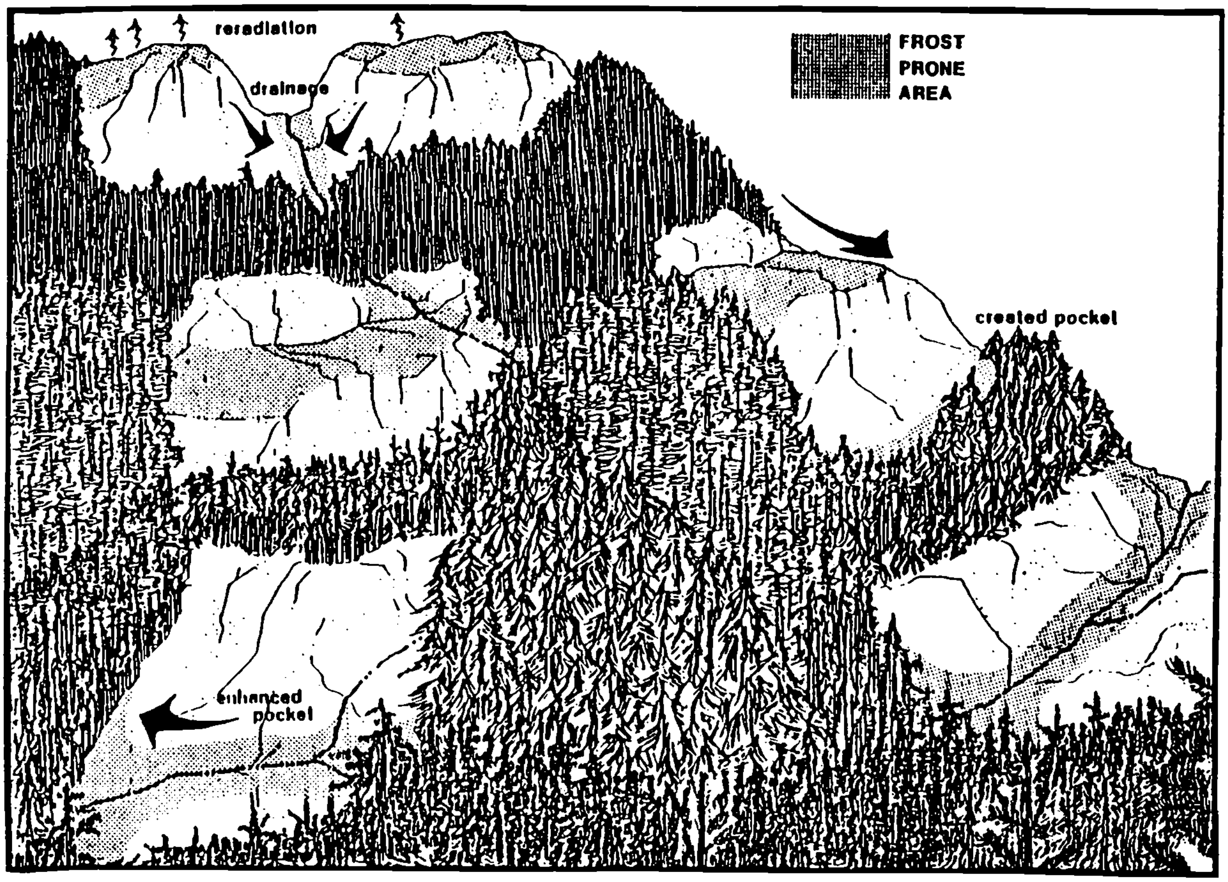


Figure 6. Development of frost prone areas in various topographic positions after clearcutting (Hemstrom *et al.* 1982).

information can be inferred from tables and appendices. Accumulated field experience on sites and vegetation responses to treatments can be related to other locations and users by using the classification as a method of indexing information.

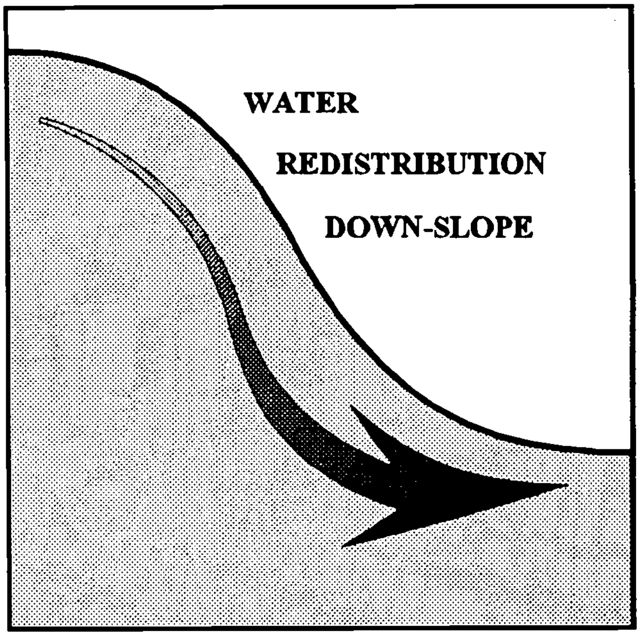


Figure 7. Water moves down-slope under the effect of gravity (Henderson *et al.* 1992).

Topographic Moisture

Topographic moisture is a concept used to describe and analyze the movement or redistribution of water by gravity through the soil and bedrock (Henderson *et al.* 1992). For any mountain slope, precipitation falls more or less evenly as snow or rain. Any unevenness of precipitation is due mostly to wind and the orographic effect of mountains. However, this effect is small relative to the redistribution of water once it is intercepted by the ecosystem. As precipitation is absorbed by litter or soil, it is immediately affected by the downward pull of gravity. The water in the soil that is free to move is therefore redistributed downward from ridgetops, steep slopes and convex surfaces to lower slopes, toeslopes and valley bottoms (Figure 7). The result of the redistribution of soil water by

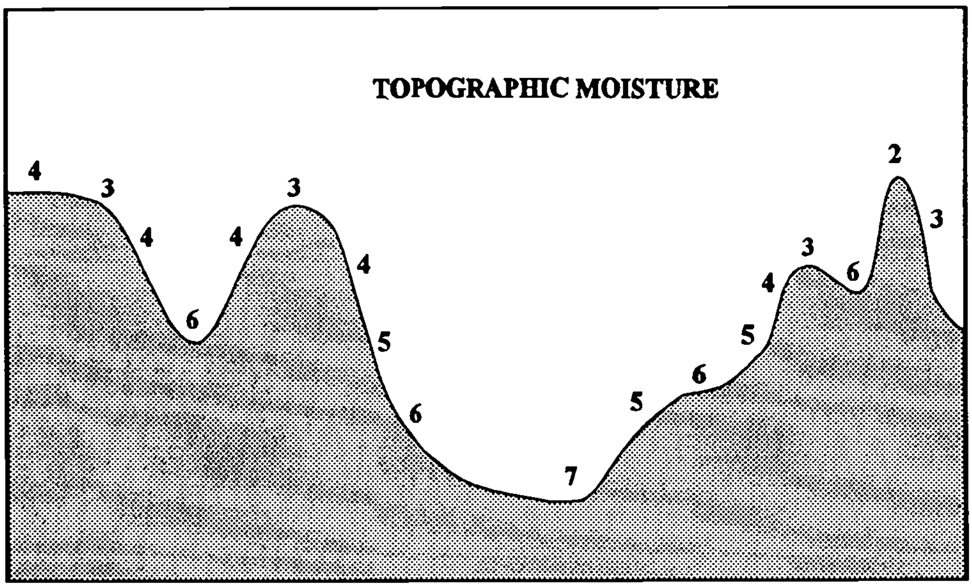


Figure 8. The topographic moisture scale relative to a schematic landscape (Henderson *et al.* 1992).

gravity is called "topographic moisture". We use a scale from one to nine to quantify the relative effects of this redistribution of soil water, where a "1" represents a very dry site where water immediately begins moving downhill. At the other extreme is code "9" which represents a body of open water. Code "5" represents a modal site where the effect of topography results in neither an accumulation nor deficit of soil water. Codes "3" and "4" are dry forest sites while codes "6" and "7" represent moist forest sites. This coding system is illustrated in Figure 8. Use of the topographic moisture concept allows one to quantify yet another of the important variables (*e.g.*, aspect, slope, elevation) which influence vegetation distribution across a landscape. The relationships of the different tree series with elevation and topographic moisture is shown in Figure 9. The graph shown in Figure 9 was generated using only PNV plot data. No reconnaissance or intensive plots were coded for this variable.

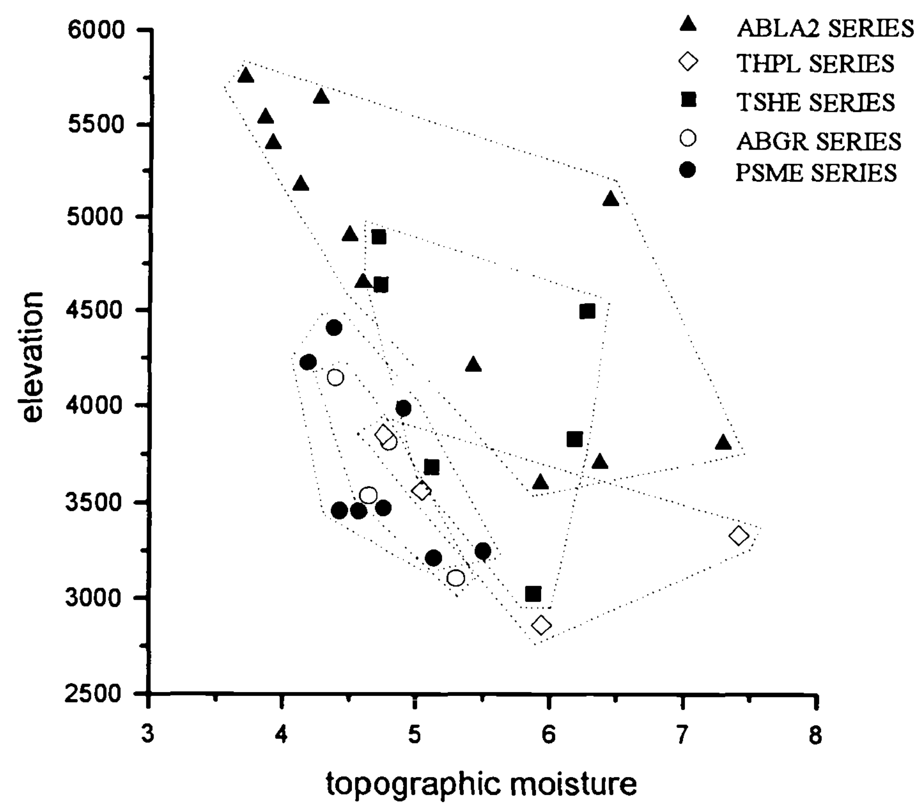
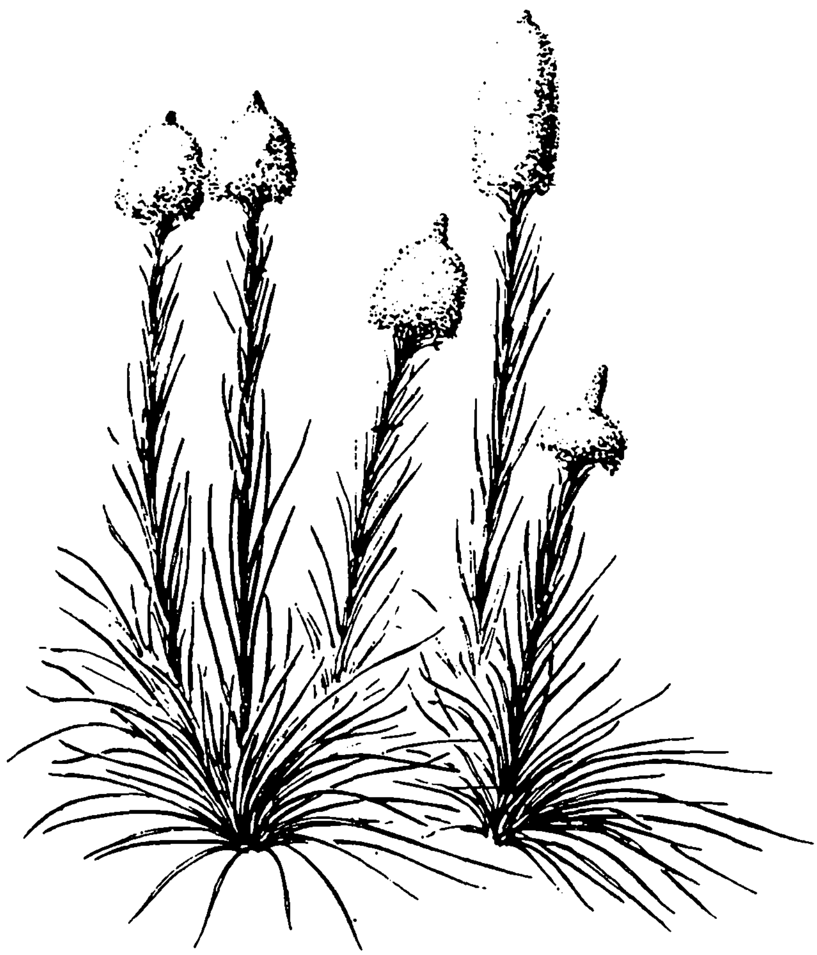


Figure 9. Ordination of plant associations on the Colville N. F. plotted by average elevation and topographic moisture value (based on Potential Natural Vegetation (PNV) plot data).

Key To Climax
Tree Series



Using the Keys

The keys presented here are the beginning of the development of uniform keys and plant association descriptions for the forests in eastern Washington (Wenatchee, Okanogan and Colville National Forests). Ultimately, all classifications and vegetation keys for these forests will be combined into one uniform classification that will be consistent across various administrative boundaries.

The keys in this guide were developed using stands with as little disturbance and in as late a successional stage as could be found. As a result, the vegetation keys work best with undisturbed, late successional stands. In disturbed stands, or those under about 150 years in age, it may be necessary to utilize the alternate strategies for stand identification presented for disturbed, early seral or very dense or closed stands. The alternate strategies follow the primary keys.

Remember, the vegetation key is not the classification. It is simply a tool to assist in the identification of the plant community. Not all sites will necessarily key to a type. Some sites may not fit the classification because of data limitations, and complex biological systems are not easily reduced to a few simple classes. Use your best judgement.

Always use the steps below for any keys in this guide. It is important to follow them carefully. *Incorrect identification can lead to improper management interpretations.*

1. **Select a vegetatively uniform area** representative of the community in question to record data on the field form. Plot size for vegetation data should be either 375 square meters or 1/10 acre. The radius of a 375 square meter plot is approximately 11 meters or 36 feet; a 1/10 acre plot has a radius of approximately 11.3 meters, or 37 feet.

2. **Complete the field form** (Appendix 4) before trying to key the stand. Identify and list tree, shrub, and indicator herb species and estimate the cover of each. Cover is estimated to the nearest one percent up to 10 %, and to the nearest 5 % thereafter.

3. **Enter the keys**, and work through the keys step by step, making sure not to skip important choices. Follow the steps below:

   A. Use the Series Key to identify climax tree series from the data on the field form. When using the keys, read each lead as a question. For example, in the Series Key the statement "forests with $\geq$ 10% canopy cover of subalpine fir" should be interpreted as, "Is the subalpine fir canopy cover greater or equal to 10% ?". If so, then read to the right, *i.e.*, to "SUBALPINE FIR SERIES". If not, read to the next lead immediately below. When the climax tree series has been identified, go to the Association Key for that series.

   B. Identify the plant association from the data on the field form. For example, the first entry in the key for subalpine fir plant associations reads "horsetail species $\geq$ 5% cover". If this statement is true, then read to the right, *i.e.*, to the PIEN/EQUIS Association. If it is false, go down to the next lead, *i.e.*, to "Cascades azalea and/or rusty menziesia $\geq$ 5%

cover; either singly or in combination".

C. Once a plant association has been identified, carefully read it's description to verify that the type, as identified, fits the narrative. If the type selected does not fit the narrative, review the key to determine if an error was made in the keying process. Further, review the coverage estimates from the field form and determine if, based on any coverage changes, a different association is possible. Often in using classification keys, other types would have been selected had coverage values of species been slightly different. Review those types and compare them with the original selection to determine the best fit. To help correctly identify the stand, make sure to review the cover and constancy values of plant species in Appendix 1.

4. **Resolve unanswered questions** about site identification. If the specific key you are using does not seem to fit:

A. Re-evaluate your choice of climax tree series. Remember, the ≥ 10% cover value for tree series is based on stands over 150 years in age. In the majority of stands of this age, the climax tree species will have at least 10% canopy cover. In younger stands, it may be necessary to project the coverage of the potential climax tree species into the future to see if it then would meet the ≥ 10% cover criterion. The general intent of the Series Key is to determine the most shade tolerant and/or competitive tree with the capability to have at least 10% cover in the stand.

B. For disturbed, early seral or dense stands, use the methodologies outlined below to identify the stand.

DETERMINING PLANT ASSOCIATIONS FOR EARLY SERAL, DISTURBED OR OVERSTOCKED STANDS

1. **Series Identification**- Many forested stands in eastern Washington originated following large stand-replacement fires in the last 100 years. If the stands have well-developed overstories and understories (roughly 30-100 years), there are often enough climax indicator trees to determine the potential tree series. However, it may be necessary to substitute "present and reproducing successfully" for "≥ 10% canopy cover" in the Series Key. This closely parallels previous conventions currently being used in keys for existing Area II vegetation classifications.

"Reproducing successfully" is defined as a species apparent ability to reproduce itself successfully under current conditions. It applies mainly to closed canopy conditions. The following conditions should be considered in the evaluation of reproduction success:

A. Trees per acre (an arbitrary starting point is 10 trees per acre- 20 or 30 is even better).

B. Tree health and vigor (*e.g.*, frost or drought intolerance or extreme age relative to size in some species).

C. Tree distribution (*e.g.*, species are not restricted to non-typical micro-sites and belong to more than one size or age-class in the understory).

Sometimes it is possible to use understory shrub and herb species to help determine the climax tree series. For example, the Douglas-fir Series is usually too dry to support either wild sarsaparilla (*Aralia nudicaulis*) or wild ginger (*Asarum caudatum*), so if a stand which is dominated by Douglas-fir also contains more than a trace of these species, the site should be keyed to one of the more moist tree series.

2. **Association Identification-** Recent disturbance, such as stand-replacement fire, timber harvest or extreme grazing pressure may make it impossible to identify a climax series or plant association using indicator plants. Likewise, early successional (generally less than 30 years old) and overstocked stands can be difficult. Indicator species are often absent in these stands and other approaches must be used:

   A. In overstocked stands with a depauperate understory:

      1. Lower cover values in the key by one class (*e.g.*, 10% becomes 5%, 5% becomes 2%).

      or

      2. Use relative rather than absolute canopy covers in the keys (*i.e.*, compare the amount of each species cover to the total cover in the sample plot).

   B. Project the stand development forward in time, using knowledge of plant succession for the area; use the projected values in the series and association keys.

   C. Look at similar sites in nearby areas that may be more open and/or less disturbed; determine their plant association and compare it to the stand in question.

KEY TO CLIMAX SERIES

Forests with ≥ 10% canopy cover of western hemlock .... WESTERN HEMLOCK SERIES p. 189

Forests with ≥ 10% canopy cover of western redcedar .... WESTERN REDCEDAR SERIES p. 231

Forests with ≥ 10% canopy cover of grand fir .... GRAND FIR SERIES p. 87

Forests with ≥ 10% canopy cover of subalpine fir .... SUBALPINE FIR SERIES p. 115

Forests with ≥ 10% canopy cover of Douglas-fir .... DOUGLAS-FIR SERIES p. 34

Forests dominated by lodgepole pine, western larch, quaking aspen or western birch or whitebark pine with meager evidence of climax tree species .... OTHER VEGETATION TYPES p. 262

OPTIONAL KEY TO CLIMAX SERIES
(disturbed or overstocked early seral stands)

Western hemlock present and reproducing successfully .... WESTERN HEMLOCK SERIES p. 189

Western redcedar present and reproducing successfully .... WESTERN REDCEDAR SERIES p. 231

Grand fir present and reproducing successfully .... GRAND FIR SERIES p. 87

Subalpine fir or Engelmann spruce present and reproducing successfully .... SUBALPINE FIR SERIES p. 115

Douglas-fir or ponderosa pine present and reproducing successfully .... DOUGLAS-FIR SERIES p. 34

Not as above; whitebark pine, lodgepole pine, quaking aspen or western birch dominant .... OTHER VEGETATION TYPES p. 262

DOUGLAS-FIR SERIES

DOUGLAS-FIR SERIES

Pseudostuga menziesii

PSME

DISTRIBUTION AND ENVIRONMENT

The Douglas-fir Series is found across the entire Colville N. F. (Figure 10), and occupies a wide range of elevations and aspects (Figure 11). Douglas-fir is the climax tree on habitats either too dry for or beyond the geographic ranges of western hemlock, western redcedar, grand fir, and subalpine fir. However, a distinct distribution pattern exists as one proceeds from west to east across the forest. West of the Kettle Mountains, the Douglas-fir Series is the most widespread tree series, and is found from below the Subalpine Fir Series to lower treeline on all aspects (Figure 12). East of the Kettle Mountain Crest, the Douglas-fir Series becomes increasingly restricted to relatively dry habitats on east to west aspects (Figure 12). This is due to the dominance of the grand fir, western hemlock or western redcedar series on the more moist northern aspects.

At low elevations, the Douglas-fir Series grades into non-forest communities or xeric ponderosa pine climax forests. Ponderosa pine stands lacking Douglas-fir in any form are uncommon on Colville N. F. lands, but are more prevalent at lower elevations along the Columbia River. Most ponderosa pine stands will key to the PIPO-PSME/AGSP Association. Clausnitzer and Zamora (1987) and Daubenmire and Daubenmire (1968) describe climax ponderosa pine forests in more detail. The

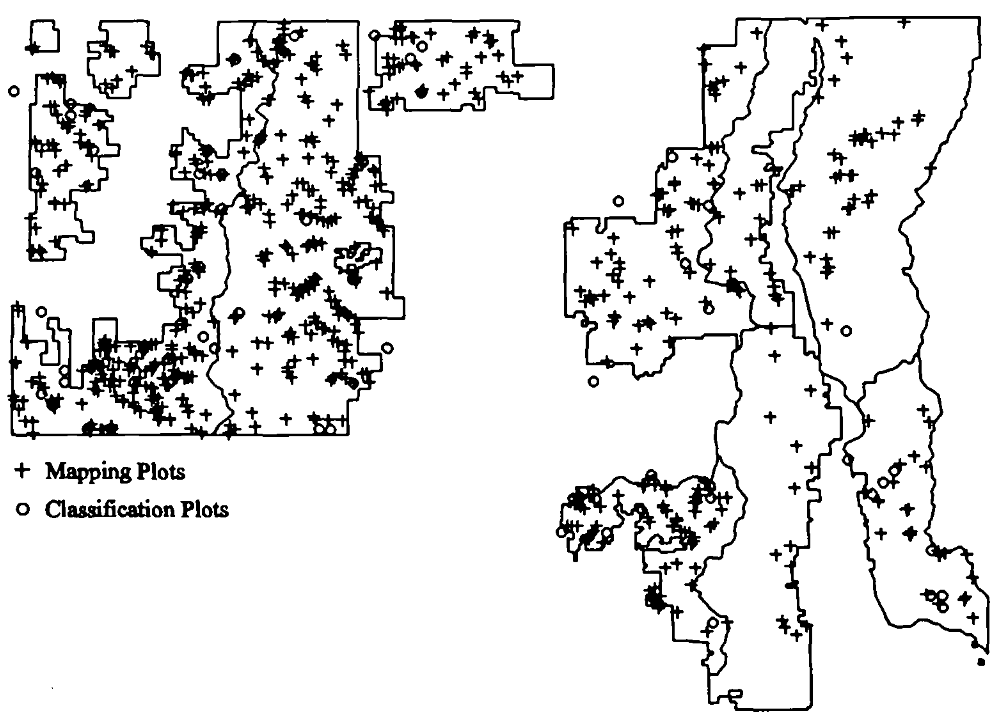


Figure 10. Plot locations for the Douglas-fir Series on the Colville N. F. (n=850).

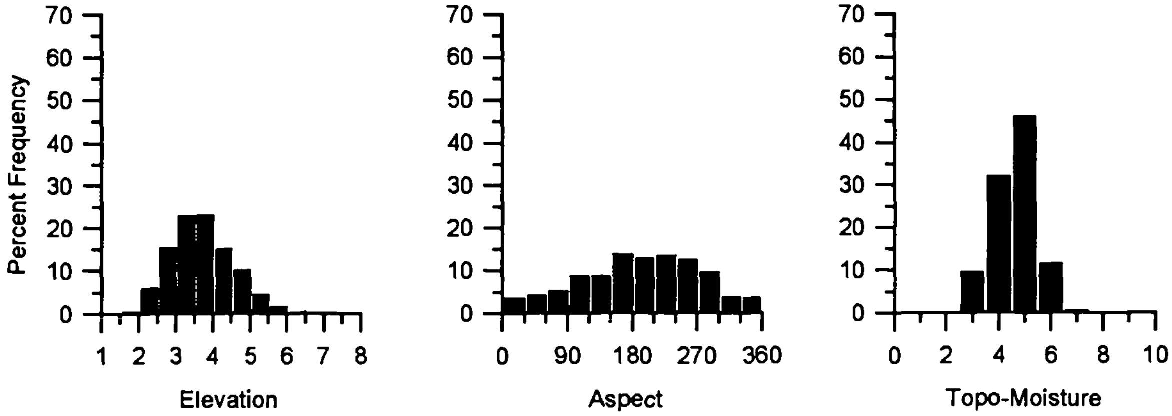


Figure 11. Frequency of Douglas-fir Series plots by elevation (1000 ft.), aspect, and topographic moisture.

Subalpine Fir Series typically forms the upper elevation bound west of the Kettle Mountain Crest. The Grand Fir Series is the common upper elevation bound east of the Kettle Mountains crest.

Seven associations and one community type are described for the Douglas-fir Series. These include: the PSME/PHMA-LIBOL, PSME/PHMA, PSME/VACA, PSME/SYAL, PSME/SYOR, PSME/CARU, and PIPO-PSME/AGSP Associations and the PSME/VAME Community Type. Some Colville N.F. plots included in the PSME/VAME Community Type may better fit the ABLA2/VAME Association. Some relatively stable early seral stages in the ABLA2/VAME Association are dominated by Douglas-fir and big huckleberry, and early seral stands key with difficulty to the ABLA2/VAME Association. Additional field observations also indicate that the PSME/ARUV Association of Williams and Lillybridge (1983) for the Okanogan N.F. can be found on the Colville N.F., but is an incidental type with a very limited distribution. A description is included for this association under "Other Vegetation Types".

Douglas-fir may occur as a seral species on all but the coldest and wettest forest habitats throughout the Colville N. F. Douglas-fir is often a dominant or co-dominant species in stands of the Western Hemlock, Grand Fir, or Western Redcedar Series. Douglas-fir occurs within all other series described for the Forest.

VEGETATION

Mature forests of the Douglas-fir Series vary from dry, open woodlands to productive, closed forest stands. Ponderosa pine, western larch, and lodgepole pine occur as seral species. Douglas-fir Series' habitats are generally the most xeric found on the Forest, and appear to have greater moisture losses at 12 and 20 in. (30 and 50 cm) depths than habitats in other series. Because the Douglas-fir Series

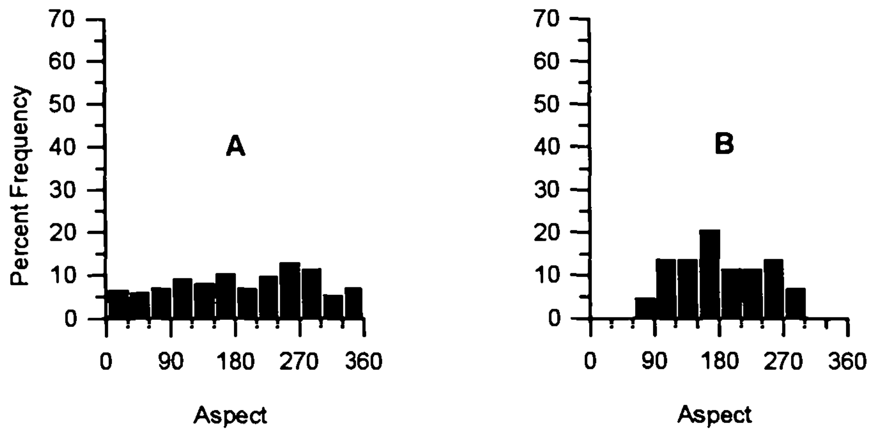


Figure 12. Frequency of Douglas-fir plots by aspect from Republic (A) and Sullivan Lake (B) Ranger Districts.

is the most xeric series found on the Colville N.F., it is easily distinguished from the more moist series by the absence of mesic site indicators (Table 6). Mesic site indicators, if present, are restricted to moist microsites. The presence of more than trace or accidental amounts of these species indicates environments more moist than that normally encompassed by the Douglas-fir Series. Douglas-fir is the only regenerating tree species widely found in mature stands within the Series. Ponderosa pine regeneration commonly occurs only at the warm end of the Series in the PIPO-PSME/AGSP Association.

The undergrowth of mature stands in this Series is largely shrub dominated with the exception of PSME/CARU or early successional sites. The undergrowth of the driest habitats is dominated by pinegrass swards or bluebunch wheatgrass. Any shrubs in these habitats tend to be prostrate and well hidden by grass. Serviceberry, common snowberry, yarrow, heartleaf arnica, strawberry spp., and pinegrass are the only species present in more than half of the stands. Ninebark, common snowberry, mountain snowberry, oceanspray, and big huckleberry are medium to tall shrubs that can be locally abundant. Pinegrass and the ubiquitous strawberry spp. are the only widespread herbs. Pinegrass is present in at least trace amounts in nearly every stand.

Total species richness and estimated richness are the highest of any single tree series on the Forest (Table 7). However, average species heterogeneity, or N_2, is the lowest of all the tree series. This indicates that as a whole, the Douglas-fir Series encompasses a wide array of environments but that most sites are dominated by only a few species. In addition, average richness per plot ranks second only to the Subalpine Fir Series as the lowest on the Forest. These statistics reinforce the interpretation of a wide variety of habitat conditions within the Series, but with strong dominance by only a few species in any one stand. This strong expression of dominance is due, in part, to the segment of the total forested environment of the Colville N.F. that is covered by the Douglas-fir Series. This environment is too dry by definition for many of the other conifer species that the more

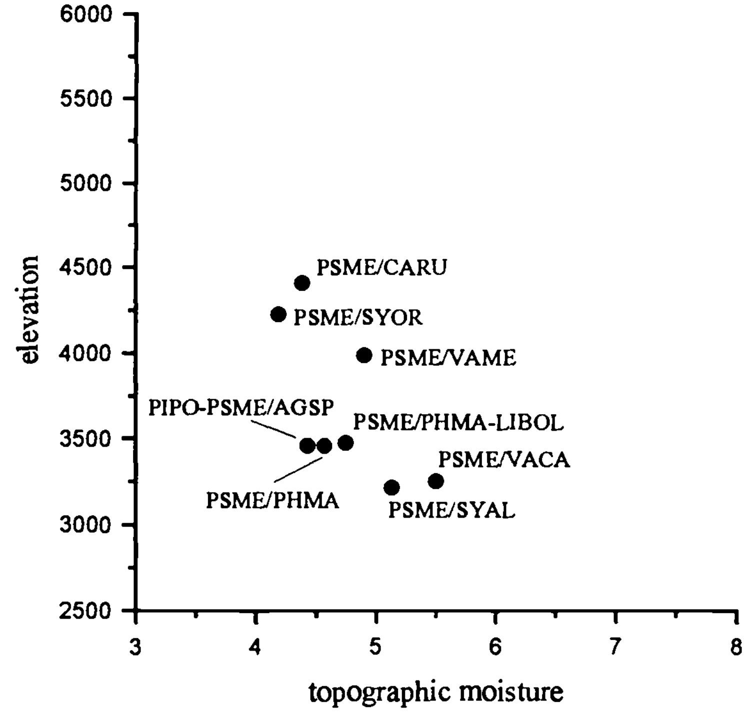


Figure 13. Ordination of Douglas-fir plant associations by elevation and topographic moisture.

mesic series can support. This leads to strong dominance in the overstory, at least, by relatively few tree species.

Four hundred and eighty-nine (489) Douglas-fir trees were sampled on the Colville N.F. (Table 8). Only two trees were over 300 years old (at breast height) when sampled. One was from a PSME/PHMA Association and the other from an unclassified paper birch (*Betula papyrifera*) stand. Only one tree had an age between 250 and 300 years while 20 were between the ages of 200 and 250 years. Trees over 200 years old were found over a wide range of climax tree series and plant associations.

Western larch is often associated with Douglas-fir but always functions in a early seral role on whatever site it occupies. Three hundred and eighty-five (385) western larch were sampled (Table 8). One was 570 years old, another tree on a different site was 460 years old, with three more trees between 300 and 400 years. Five larch were between 250 and 300 years of age with 31 between 200 and 250 years. Western larch over 200 years old were distributed over a range of tree series and plant associations. Individual tree ages from the same stand may vary by 100 or more years apparently due to repeated fire events.

Western larch is so intolerant of shade as a seedling and sapling that it can successfully regenerate

Table 6. Codes and common names of moist site indicators. More than trace or accidental amounts of any of these species indicates a series other than the Douglas-fir Series.

Code	Common Name	Code	Common Name
TREES			
ABGR	grand fir	PIEN	Engelmann spruce
ABLA2	subalpine fir	THPL	western redcedar
BEPA	paper birch	TSHE	western hemlock
SHRUBS			
COCA	bunchberry dogwood	RUPE	five-leaved bramble
COST	red-osier dogwood	TABR	Pacific yew
MEFE	rusty menziesia	XETE	beargrass
RHAL	Cascades azalea		
HERBS			
ACRU	baneberry	EQUIS	horsetail spp.
ARNU3	wild sarsaparilla	GYDR	oak-fern
ASCA3	wild ginger	LUHI	smooth woodrush
CACA	bluejoint reedgrass	SETR	arrowleaf groundsel
CIAL	circea	TIUN	coolwort foamflower
CLUN	queencup beadlily	TRCA3	false bugbane
DIHO	Hooker fairybells	VASI	Sitka valerian

only after a disturbance such as fire that removes much or all of the forest canopy. Extensive areas of western larch dominated stands of approximately the same age almost invariably have a few scattered older and larger individuals that were the parents of the remainder of the stand. This pattern of a few larch surviving even intense fires can be observed on the White Mountain Fire of 1988. With the heavy seeding of domestic grasses over much of that fire area it is too soon to tell how well western larch will establish and compete.

FIRE ECOLOGY

The predominance of young Douglas-fir trees and stands on the Colville N.F. indicates that fire has been a common event. Reported fire-return intervals for the Douglas-fir Series range from 10 (Hall 1976), 7-11 (Wischnofske and Anderson 1983), and 10-24 years (Finch 1984). Though mature Douglas-fir are relatively fire-resistant, saplings are very susceptible to ground fire due to thin bark, thin bud scales and resin blisters (Smith and Fischer 1995). Arno (1988) reports that it takes approximately 40 years for fire-resistant bark to develop on Douglas-fir trees, with 6" DBH trees

Table 7. Diversity components of the Douglas-fir Series.

Richness[1]	259	
Number of associations	7	
	Mean	**S.E.[2]**
Expected richness[3]	319.6	11.5
Expected N2[4]	10.3	0.6
Average richness per plot	23.9	0.6
Average N2 per plot	6.6	0.2

[1] Total number of vascular plant species in the Douglas-fir Series data.
[2] Standard error of the estimate.
[3] Jackknife estimate of richness given a sample size of 163 plots.

having moderate fire-resistance. Mature Douglas-fir trees exhibit high fire-resistance to low- and moderate-severity fires due to a thick layer of insulative, corky bark. However, the presence of flammable resin streaks on the lower bole of many trees often negates this protection. The probability of fire injury increases with the accumulation of heavy fuels at the base of Douglas-fir trees, including debris from dwarf-mistletoe brooms (Smith and Fischer 1995). Douglas-fir are more susceptible to crown scorch from summer fires than from late-season fires because buds are more vulnerable during summer. Western larch is better able to survive fire of a given intensity because of its thick insulating bark, open non-flammable crown, and deciduous habit. Western larch ages from the Colville N.F. confirm its greater fire resistance.

Low intensity ground fires (underburns) have significantly influenced the development of many stands. Fire-scarred trees were common in classification plots, especially on ponderosa pine and western larch, and frequent underburns favor these two species. Without underburning they are replaced by the more shade tolerant but less fire resistant Douglas-fir, and potentially some grand fir on wet microsites. Fire effects in the drier Douglas-fir associations with understory dominants like snowberry, pinegrass, and bluebunch wheatgrass have evolved with frequent low-intensity fires which kept these forests open and park-like, with ponderosa pine as a seral dominant (Agee 1994). This is especially characteristic of the PIPO-PSME/AGSP, PSME/CARU, and PSME/SYOR Associations.

Occasional longer fire-free periods seem to be associated with an increase of Douglas-fir on these sites (Keane *et al.* 1990). With fire-return intervals of less than 20 years, computer simulations (Keane *et al.* 1990) suggest that the Douglas-fir component was essentially eliminated or kept to a minimum in stands due to it's low fire-tolerance when young, but that Douglas-fir becomes a co-dominant with ponderosa pine and western larch with longer fire-return intervals. Thus, many stands today likely have a much higher component of Douglas-fir than historical (prior to modern fire suppression) stands.

Table 8. Distribution of sampled Douglas-fir and western larch trees among forest types.

Forest Type	Tree Species	
	Douglas-fir	Western larch
Douglas-fir Series	212	64
Grand Fir Series	50	28
Subalpine Fir Series	80	133
Western Hemlock Series	57	91
Western Redcedar Series	85	54
Paper Birch stand	5	--
Lodgepole Pine stands	--	15
Total Trees Sampled	489	385

Douglas-fir associations that contain dense shrub layers typically exhibit a moderate-intensity fire regime, resulting from a mix of low-intensity and high-intensity fires (Agee 1994). Douglas-fir associations such as PSME/PHMA, PSME/PHMA-LIBOL, PSME/VAME, and PSME/SYAL all may have dense shrub layers which provide ladder fuels for fires to reach tree crowns. Most Douglas-fir stands in reality probably show a mix of different fire-return intervals and intensities. Although stand-replacement fires were significant ecological factors of the past, the potential for catastrophic fire has increased because of increased ground and ladder fuels as dense Douglas-fir stands develop in the absence of underburns. Understory fuels tend to increase both horizontally and vertically in many Douglas-fir stands when low-intensity fire has been excluded. Thus, by altering natural fire regimes and subsequently, plant community composition and/or structure, there now exists a higher potential for stand-replacement fires in much of the Douglas-fir Series than existed historically (prior to modern fire suppression). Diversity in stand structure and composition has also increased.

INSECTS AND DISEASE

Associations located on the drier aspects, particularly on the convex south to southwest aspects at low elevations, were historically dominated by seral ponderosa pine. Fire suppression has allowed Douglas-fir to expand on these drier sites, which pose the greatest risk for insect and disease problems (Flanagan and Hadfield 1995). Douglas-fir dwarf mistletoe arguably has more impact in eastern Washington forests than any other insect or disease (Flanagan and Hadfield 1995). Douglas-fir is killed more readily by dwarf mistletoe than any other conifer. This disease has the greatest impact on dry sites in the Douglas-fir series, because the upward spread of dwarf-mistletoe exceeds the growth rate of the host. As previously mentioned, fuel ladders become more significant as Douglas-fir dwarf mistletoe cascades downward in the crown. Reducing incidence of dwarf mistletoe is an effective method of reducing other disease risks. If a low-level of dwarf mistletoe is acceptable or desirable, distribution of this disease should be restricted to islands of infestation rather than a uniform distribution.

Dry Douglas-fir plant associations are also most at risk of western spruce budworm outbreaks, meaning an outbreak is most likely to begin on those sites (Flanagan and Hadfield 1995). These sites historically (before modern fire suppression) were dominated by seral ponderosa pine. However, the most impact from these outbreaks is usually incurred on more mesic sites within both the Douglas-fir and Grand Fir Series. The Republic Ranger District was probably far less susceptible to budworm outbreaks before fire suppression and selective harvest of seral species such as ponderosa pine. Other areas on the Colville N.F. are becoming more susceptible to budworm, such as the southern Colville Ranger District east of Chewelah.

Douglas-fir tussock moth outbreaks historically began on the driest Douglas-fir sites (Williams *et al.* 1980). Outbreaks quickly spread through host types, including subalpine fir. Mortality is higher in a tussock moth outbreak than a budworm outbreak due to more extensive defoliation of crowns. Some entomologists feel that outbreaks occur in rather predictable cycles; others feel that stand conditions, climate, and the presence of a naturally occurring lethal virus determine outbreak frequency. When they occur, Douglas-fir beetle outbreaks are usually small, local events associated with fire injury, defoliation, drought, root disease, dwarf mistletoe and windthrow.

Douglas-fir is host to a variety of fungal pathogens. Laminated root rot is the most damaging root disease of Douglas-fir, and incidence is highest in both the Douglas-fir and Grand Fir Series (Flanagan and Hadfield 1995). Laminated root rot spreads almost exclusively via root to root contact, so todays disease centers are also the historic centers. The increase in the abundance of susceptible hosts this century allows the disease to spread more readily. Douglas-fir is also very susceptible to and is severely damaged by armillaria root disease. However, incidence is perhaps highest in the Grand Fir Series. Infection rates by armillaria root rot are relatively high in undisturbed Douglas-fir stands and is much higher than in undisturbed stands of the Western Hemlock, Western Redcedar, or Grand Fir Series. Host susceptibility is reduced on more productive habitats. Relatively low productivity sites have much higher overall mortality but lower overall incidence of the pathogen (McDonald *et al.* 1987a). *Schweinitzii* root and butt rot is common in remnant Douglas-fir, and incidence is probably highest in the wetter grand fir sites (Flanagan and Hadfield 1995). Douglas-fir beetle outbreaks are usually small, local events associated with fire injury, defoliation, drought, root disease, and dwarf mistletoe.

MANAGEMENT IMPLICATIONS

Summer soil drought is severe on many Douglas-fir sites. Western hemlock, western redcedar, subalpine fir, and grand fir are unable to successfully occupy habitats within the Douglas-fir Series due mainly to this drought stress. Many herbs and shrubs within the Series are rhizomatous and respond quickly to disturbance. This vegetative reproduction strategy gives species such as pinegrass, northwestern sedge, common snowberry, big huckleberry, and shiny-leaf spirea a competitive advantage over species that rely entirely on seed.

The most widespread types in the series are the PSME/PHMA and PSME/PHMA-LIBOL Associations. These are divisions of a more broadly defined PSME/PHMA Habitat Type of Daubenmire and Daubenmire (1968). The PSME/PHMA type (in the broad sense) is important for the numerous studies done concerning reforestation problems. Recent work by Harvey *et al.* (1987) is especially significant for the insight provided on the essential role of soil wood and soil organic matter in the distribution of tree roots. They report tree roots are almost entirely concentrated in soil wood and other types of organic matter. Mineral soil contained only 4% of the roots while soil wood and organic matter contained 96% of the roots. Soil wood and organic materials made up only 18% of the total available soil. Their results on root distributions and the essential role of organic matter seem equally applicable to the PSME/PHMA-LIBOL and PSME/PHMA types. Clearly, activities that reduce soil organic matter and soil wood reduce site capacity to support trees. Clearcutting combined with burning or scarification often results in extensive and persistent shrubfields that resist reforestation efforts for years. Apparently, the accumulation of sufficient organic matter and soil wood is essential for tree establishment, growth and survival. Shrubfields may be an essential part of the sere, functioning to restore organic matter and nutrients before forest restoration.

Regeneration of Douglas-fir on burned sites is generally best where it grows as a seral species, and is comparably poorer on climax Douglas-fir sites (Smith and Fischer 1995). Organic seedbeds less than 2" thick and mineral soil are most favorable for seedling establishment. On dry south- and west-facing slopes, tree regeneration is improved by shading. Nitrogen is the only nutrient in the Pacific Northwest which has been shown to be limiting to growth of Douglas-fir (Burns and Honkala 1990). Douglas-fir saplings respond satisfactorily to release from competing brush or overstory trees if they have not been suppressed too severely or too long. Trees that have developed in a closed stand, however, are poorly adapted to radical release, such as that occasioned by very heavy thinning (Burns and Honkala 1990). Also, sudden and drastic release of young Douglas-fir may cause a sharp temporary reduction in height growth (Staebler 1956). Douglas-fir represents an important species which is grown for christmas trees.

COMPARISONS

The Douglas-fir Series has been well described by ecologists in the Pacific Northwest, including eastern Washington and northern Idaho (Daubenmire and Daubenmire 1968), northern Idaho (Cooper *et al.* 1991), Montana (Pfister *et al.* 1977), central Idaho (Steele *et al.* 1981), and northeast Oregon (Johnson and Clausnitzer 1992, Johnson and Simon 1987). In addition, Clausnitzer and Zamora (1987) describe Douglas-fir types on the nearby Colville Indian Reservation. Zamora (1983) also described three Douglas-fir habitat types on the Spokane Indian Reservation. Douglas-fir forms a major forest zone along the entire east slope of the Cascade Range in Washington, and has been well documented by Lillybridge *et al.* (1995). All of the above classifications describe one or more Douglas-fir plant associations which are very similar to the types described for the Colville N.F. Seven "subzones" of Douglas-fir have been described for the southern interior of British Columbia immediately north of the Colville N.F. (Meidinger and Pojar 1991). Coastal populations of Douglas-fir are usually seral components of some of the drier western hemlock and redcedar plant communities from Vancouver Island, B.C., south to northern California. Some small areas of climax Douglas-fir have been described for western Washington by Henderson *et al.* (1989). These sites appear to be limited to relatively dry areas which are under the influence of a rainshadow-effect caused by the Olympic Mountains.

KEY TO PLANT ASSOCIATIONS IN THE DOUGLAS-FIR SERIES

Before using the key, the field form in Appendix 4 should be completed. Refer to the "USING THE KEYS" section in the introduction for more specific information on using the key, particularly if the stand in question does not key properly.

Ninebark and/or oceanspray ≥ 5%

Twinflower and/or western larch ≥ 1% . . . . . . PSME/PHMA-LIBOL Association p. 61

Twinflower and/or western larch < 1% . . . . PSME/PHMA Association p. 55

Dwarf huckleberry ≥ 5% . . . . PSME/VACA Association p. 76

Big huckleberry and/or low huckleberry ≥ 5% . . . . PSME/VAME Community Type p. 82

Common snowberry ≥ 5% . . . . PSME/SYAL Association p. 66

Mountain snowberry ≥ 5% . . . . PSME/SYOR Association p. 71

Pinegrass or heartleaf arnica ≥ 5% . . . . PSME/CARU Association p. 49

Bluebunch wheatgrass ≥ 5% . . . . PIPO-PSME/AGSP Association p. 44

PIPO-PSME/AGSP ASSOCIATION CDG3 11

Pinus ponderosa-Pseudotsuga menziesii/Agropyron spicatum
ponderosa pine-Douglas-fir/bluebunch wheatgrass

DISTRIBUTION AND ENVIRONMENT

The PIPO-PSME/AGSP Association is a minor type on the Colville N.F. (Figure 14) and is the hottest and driest plant association described. It is more common and forms more contiguous stands at elevations below that typically found on the Forest. On the forest proper, it generally occurs as smaller, non-contiguous islands of vegetation on well-drained, coarse-textured soils on steep southeast to west aspects (Figure 15) with convex microrelief. Elevations range from 2,160 to 5,860 ft., though most sites are below 4,000 ft. (Figure 15). The type as described here and in the Okanogan N.F. Guide (Williams and Lillybridge 1983) is based on a limited number of plots and is broadly defined. Current data are too limited for further subdivision although considerable variation is recognized. Okanogan N.F. plots are used to augment the data.

The regolith is glacial till or outwash and is often comprised of water sorted, sandy deposits. Soil textures are usually sandy loam to sand. Gravel is common. The type grades into non-forest grasslands and undescribed ponderosa pine climax forests on drier habitats. The type grades into the PSME/SYORU and PSME/CARU Associations on more moist habitats.

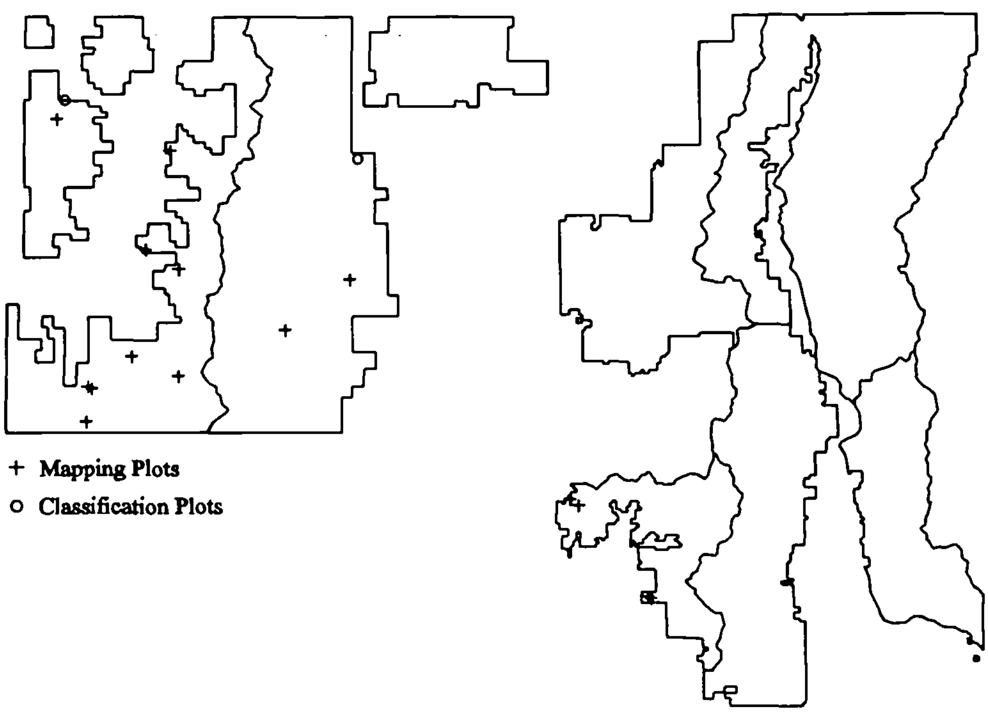


Figure 14. Plot locations for the PIPO-PSME/AGSP Association (n=19).

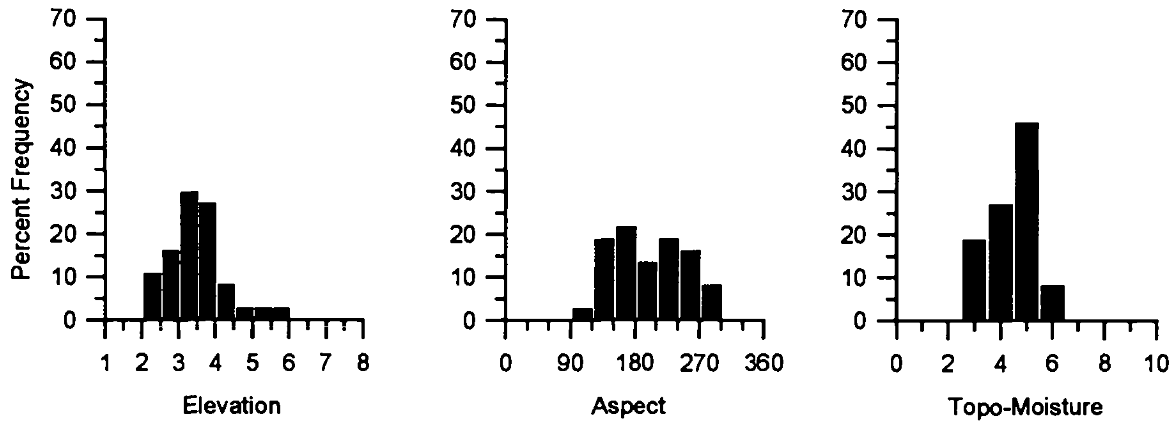


Figure 15. Frequency of PIPO-PSME/AGSP plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

These sites are characterized by open woodlands with a bunchgrass-dominated undergrowth. Ponderosa pine or Douglas-fir are the only tree species that occur. Therefore, seral and climax stands have essentially the same tree species composition because strictly seral tree species are lacking. These stands are open and rarely have a closed canopy. Ponderosa pine can reproduce successfully because the open canopy does not produce sufficient shade to exclude it. Most stands have been logged because of land ownership, ease of access and high value on large ponderosa pine.

Bunchgrasses dominate the undergrowth. Shrubs are generally absent or inconspicuous. Bearberry and the semi-shrubby Wyeth buckwheat may be present but usually with sparse cover. Ninebark indicates sites that best fit the PSME/PHMA Association. Bitterbrush is absent

Table 9. Common plants of the PIPO-PSME/AGSP Association (n=5).

		CON	COVER
TREE OVERSTORY LAYER			
PIPO	ponderosa pine	100	29
PSME	Douglas-fir	80	8
TREE UNDERSTORY LAYER			
PIPO	ponderosa pine	80	4
PSME	Douglas-fir	80	2
HERBS			
ACMI	yarrow	100	3
AGSP	bluebunch wheatgrass	80	33
LUSE	silky lupine	80	13
BASA	arrowleaf balsamroot	80	12
FEID	Idaho fescue	80	7
KOCR	Junegrass	80	2
CARU	pinegrass	60	7
ANRO	rosy pussytoes	60	3
ANLU	woodrush pussytoes	60	3
BRTE	cheatgrass	60	2
CARO	Ross sedge	60	1
AGIN	awnless b.b. wheatgrass	20	35

Table 10. Environmental and structural characteristics of the PIPO-PSME/AGSP Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3457	772	2160	5860
Aspect[2]	165	46	--	--
Slope	41	16	6	82
Topographic Moisture	4.43	0.90	3.0	6.0
Soil Surface[3]				
Exposed soil	18	16	3	35
Gravel	20	26	1	38
Rock	4	5	0	10
Bedrock	0	0	0	0
Moss	1	2	0	3
Lichen	1	2	0	3
Litter	40	--	40	40
Diversity[4]				
Richness	20.8	3.7	14	29
N2	6.1	1.5	4	8

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=37).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

from most of the Forest but may have been planted in some areas.

Bluebunch wheatgrass (both awned and awnless subspecies), Idaho fescue, prairie Junegrass, Ross sedge and arrowleaf balsamroot are the most characteristic herbs. Pinegrass indicates somewhat cooler and more moist conditions. Heartleaf arnica and northwestern sedge in combination with pinegrass indicate sites that better fit the PSME/CARU Association. Both average richness and average heterogeneity (N_2) are below the Series average and are second only to the PSME/CARU Association as the lowest in the Series on the Colville N.F. (Table 10). These low values reflect the relatively harsh conditions characteristic of these habitats.

MANAGEMENT IMPLICATIONS

Wildlife/Range- These are important winter range sites for many species of wildlife, including deer and elk. These sites remain relatively warm and snow-free most of the winter. Browse production is generally low, but warm exposures encourage frequent use. Many non-migratory avian species

Figure 16. Photo of the PIPO-PSME/AGSP Association.

make extensive use of these stands in winter as well. The type is valuable for livestock forage. High cheatgrass cover and an abundance of other annuals combined with reduced bunchgrass cover indicates past overgrazing. Silky lupine and arrowleaf balsamroot may increase under grazing pressure. Management of livestock should be keyed mainly to the sensitivity of bluebunch wheatgrass. This is true even with significant amounts of Idaho fescue because; 1) Idaho fescue is not as sensitive to abusive grazing as bluebunch wheatgrass, and 2) Idaho fescue is often grazed by cattle before they start on bluebunch wheatgrass. The high quality of Idaho fescue as forage should be considered in management. Both bluebunch wheatgrass and Idaho fescue are most sensitive to heavy defoliation at approximately the same growth stage: from flowering to seed ripening (Mueggler and Stewart 1980). The calendar dates of the sensitive growth stages of these two important forage grasses coincide reasonably well, which simplifies management (Mueggler and Stewart 1980).

Grazing also decreases fine fuels and increases tree regeneration (Arno and Gruell 1986). Gruell *et al.* (1986) recommend restriction of grazing for at least one year after burrning in order to develop sufficient fire fuel to carry a fire. According to Heidman (1988), successful regeneration requires the elimination of all grazing for several years after planting. Heavy grazing may aid tree establishment by reducing grass competition if not accompanied by an increase in knapweed. Coarse soils are easily displaced on steep slopes. Heavy grazing reduces cover of bluebunch wheatgrass and Idaho fescue.

Arrowleaf balsamroot, yarrow, silky lupine and cheatgrass either increase or become more conspicuous under grazing and diffuse knapweed may increase markedly.

Silviculture- Timber productivity is low due to open stands and slow growth rates. Poor regeneration success is a further problem. Reforestation is difficult to assure within 10 years because of drought and heat stress. Natural regeneration may take as long as 20-40 years (Pfister *et al.* 1977). Stocking should be open to favor more rapid tree growth and reduce the possibility of stagnation. These habitats are sufficiently harsh to prevent closed canopies except on local microsites. Site preparation by broadcast burning recycles nutrients and helps to control the severe competition for moisture typical of these sites (Ryker and Losensky 1983). Because soils tend to be thin and rocky, disturbance should be minimized to reduce the risks of erosion. Preventing the introduction or spread of noxious weeds such as diffuse knapweed are a management concern on disturbed sites.

Mature trees often have fire scars. Fire scar patterns suggest a natural fire interval of 5-30 years. Fire helps maintain the large, open grown, ponderosa pine characteristic of the association. Prescribed fire may be used to enhance forage, maintain healthy, open stands, reduce fuels and encourage regeneration (Smith and Fischer 1995). These conditions discourage the spread of dwarf mistletoe and enhances ponderosa pine growth, which in turn discourages mountain pine beetle infestation. Periodic underburning or some method of stocking level control is needed to grow large trees on these sites. Underburning can also be used to encourage ponderosa pine regeneration and remove Douglas-fir. After saplings are over 12' tall, some can withstand fire. Regular underburning then can be used for thinning, to remove further reproduction, and to reduce accumulated woody fuel and duff (Smith and Fischer 1995). Opportunities for prescribed burning occur before greenup and in late spring.

COMPARISONS

Lillybridge *et al.* (1995) describe several dry PIPO and PSME associations for the Wenatchee N.F. which would collectively belong in this type. The PSME/AGSP Association described for the Wenatchee N.F. seems most similar to the Colville type. The PIPO-PSME/AGSP Association is very similar to the PIPO-PSME/AGIN Association described for the Okanogan N.F. (Williams and Lillybridge 1983). The subspecies of bluebunch wheatgrass changes in dominance from west to east. The awnless subspecies (var. *inerme*) is more common in Okanogan County and adjacent Ferry County than is the awned subspecies (var. *spicatum*). Braumandl and Curran (1992), Brayshaw (1965), Lloyd *et al.* (1990) and McLean (1970) all describe several xeric PIPO and PSME associations for southern British Columbia. However, the majority of these associations have tree, shrub or herb layers which differ from those described for the Colville N.F. PIPO-PSME/AGSP Association. Steele *et al.* (1981) describe a PSME/AGSP Association for central Idaho that resembles some of our stands as does the PSME/AGSP Association of Cooper *et al.* (1991) in northern Idaho. Clausnitzer and Zamora (1987) have a PSME/FEID Association that is similar but their type contains more Idaho fescue than the PIPO-PSME/AGSP type. Many researchers describe one or more associations where ponderosa pine is climax and Douglas-fir absent or uncommon. Though some of these stands may resemble Colville N.F. stands in appearance, they differ greatly in composition.

PSME/CARU ASSOCIATION CDG1 31

Pseudotsuga menziesii/Calamagrostis rubescens
Douglas-fir/pinegrass

DISTRIBUTION AND ENVIRONMENT

The PSME/CARU Association is a widespread type on the western-half of the Forest on the Kettle Falls and Republic Ranger Districts (Figure 17). It is also common on the southern-half of the Colville Ranger District. It is uncommon elsewhere on the Forest. It represents relatively cool and dry environments on lower to upper slope positions. It is found on a variety of elevations and aspects. East to west aspects at upper elevations are most common (Figure 18). Elevations range from 1,920 to 6,300 ft., and average 4,406 ft. (Table 12). Though somewhat geographically limited on the Colville N.F., this type has an environmentally broad distribution where it is found. The PSME/CARU Association often represents the upper-elevational limits of the Douglas-fir Series on southern aspects.

The regolith is glacial till or outwash generally comprised of granitic parent material. Soil textures are silt to gravelly loams and sands. Coarse fragments usually comprise less than 50% of the profile. The PSME/CARU Association often grades into the PSME/PHMA or PSME/PHMA-LIBOL Associations on warmer sites and into the ABLA2/CARU Association on colder sites. The

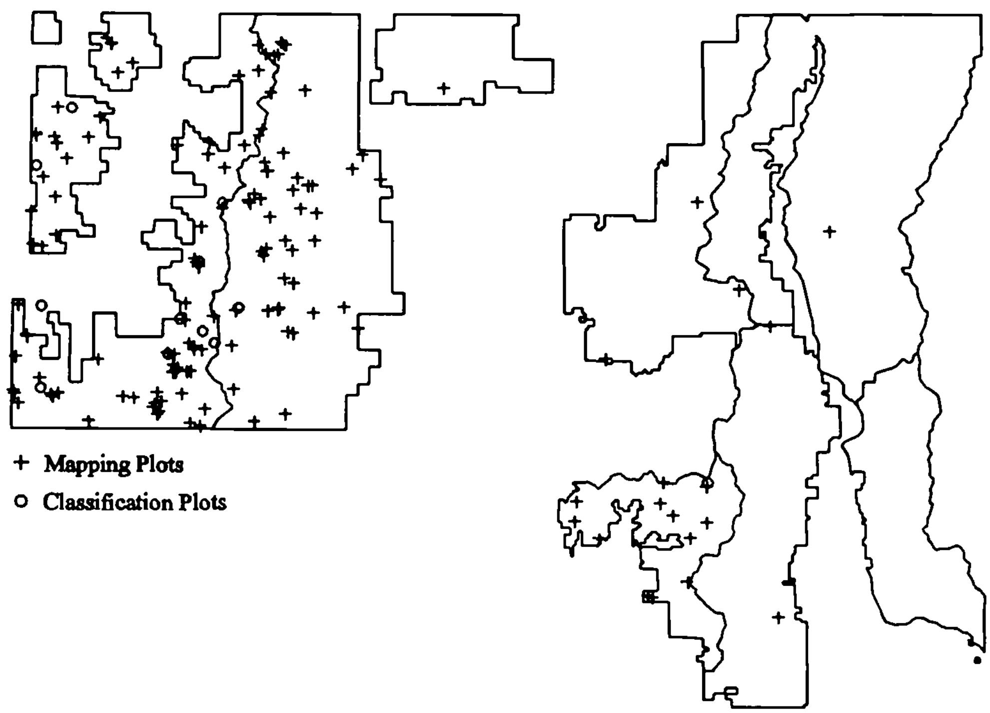


Figure 17. Plot locations for the PSME/CARU Association (n=161).

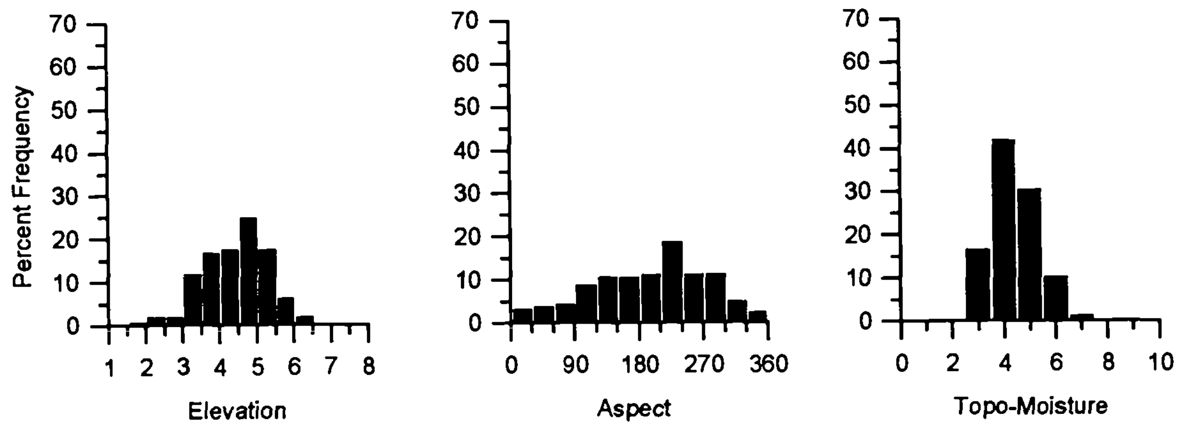


Figure 18. Frequency of PSME/CARU plots by elevation (1000 ft.), aspect, and topographic moisture.

PSME/SYOR Association occasionally adjoins it on more wind prone locations. Frosty, more moist habitats are usually occupied by the PSME/VACA Association.

VEGETATION

Douglas-fir and pinegrass typically dominate these habitats. Stands with vegetative commposition reflective of late seral conditions are more common in the PSME/CARU type than any other type. Even relatively young stands may develop species compositions similar to climax or late seral conditions. Stands with only Douglas-fir in the tree layer are not unusual. The apt description of Daubenmire and Daubenmire (1968) "A brilliant green sward, the uniformity of which is enhanced by the notable lack of inflorescences and the uniform spacing of grass tillers..." under a canopy of Douglas-fir captures the characteristic appearance of mature stands.

Table 11. Common plants of the PSME/CARU Association (n=42).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	98	29
LAOC	western larch	62	17
PIPO	ponderosa pine	52	18
TREE UNDERSTORY LAYER			
PSME	Douglas-fir	95	8
SHRUBS AND SUBSHRUBS			
PAMY	pachistima	52	3
ARUV	bearberry	52	3
HERBS			
CARU	pinegrass	100	46
FRAGA	strawberry spp.	74	3
ARCO	heartleaf arnica	62	4
ACMI	yarrow	60	2

Ponderosa pine is an important seral species in the lower, warmer stands under 4,000 ft. (1220 m) elevation and may dominate these sites, but is much less common at higher elevations. Western larch and/or lodgepole

Table 12. Environmental and structural characteristics of the PSME/CARU Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4406	852	1920	6300
Aspect[2]	209	70	--	---
Slope	33	15	1	66
Topographic Moisture	4.38	0.92	3.0	7.0
Soil Surface[3]				
Exposed soil	16	18	1	50
Gravel	16	16	1	38
Rock	6	10	0	38
Bedrock	0	1	0	5
Moss	1	1	0	2
Lichen	1	1	0	2
Litter	34	27	0	80
Diversity[4]				
Richness	18.6	6.4	8	35
N2	4.5	1.6	1	11

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=162).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

pine may dominate stands originating from stand-replacement fire. Lodgepole pine may be an early and long-lasting seral species on the cooler, high elevation sites on gentle terrain. Very old individuals of fire-resistant ponderosa pine and western larch are common in this type.

Pinegrass is the major herb species and characteristically forms a dense sward in the understory. Shrubs are minor stand components except in early seral stages. Snowbrush ceanothus may be abundant for the first few decades after fires. Pachistima, spiraea or snowberry may be locally common in some stands. Bearberry suggests rockier sites than normal and some sites with high bearberry cover and little pinegrass may better fit the harsh PSME/ARUV Association described for the Okanogan N.F. (Williams and Lillybridge 1983).

The average richness and average heterogeneity (N_2) are among the lowest of all associations for the Colville N.F. (Table 12). The low heterogeneity index indicates strong dominance by relatively few species. This agrees with visual impressions of mature stands where only Douglas-fir and pinegrass appear to be present. These low values reflect the relatively harsh conditions indicated by the type. The PSME/ARUV type (Williams and Lillybridge 1983) has lower values still, so the cautionary notes

Figure 19. Photo of the PSME/CARU Association.

about bearberry mentioned above need to be kept in mind.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Big game and domestic cattle may make heavy seasonal use of these sites. Mature stands provide moderate forage for wild and domestic ungulates. Early seral stages may have a tall shrub component (ceanothus, Scouler willow) useful as browse and cover. Seral stands that contain Ceanothus, Scouler willow, and aspen are very important to deer and elk. In some areas, these sites are important for elk calving. Old-growth stands are important nesting sites for Stellars jay, western tanager, and pine ciskin. Pileated woodpecker activity is also commonly observed in older stands.

Livestock often make use of these sites. Herbage production can be relatively high but tends to decrease as soil coarse fragments or tree overstory increases. Pinegrass is grazed well by cattle, and is not avoided in our stands to the extent it is in the Blue Mountains of Oregon. It often shows appreciable use even in areas with palatable seeded species. Pinegrass is relatively resistant to trampling damage.

Silviculture- Timber productivity is relatively low compared to other associations in the Douglas-fir Series (appendix 2). Considerations for management include competition from rhizomatous species, pocket gophers, wildlife and cattle damage to seedlings, and soil drought. Rummel (1951) points out that forage production and tree regeneration are incompatible goals on these sites. The best growth potential is usually seen with ponderosa pine located in the drier extremes of this type. Erosion control is rarely needed because of the characteristically abundant pinegrass. Coarse soils may be displaced by heavy equipment on steep slopes.

Herbaceous competition with young trees can be severe, especially on clearcuts. Prompt regeneration after harvest is essential to decrease pinegrass competition. With overstory removal, pinegrass may develop a thick sod which may require a special treatment to establish conifers. Moderate scarification combined with burning can also stimulate pinegrass. Regeneration is usually better in shelterwood cuts of 10-30 trees/acre than in clearcuts (Steele and Geier-Hayes 1993). Shelterwoods provide shade essential for successful reforestation. Shelter is particularly important on south and west aspects. Clearcutting and shelterwood systems will favor the seral species, while partial cutting will lead to eventual dominance by Douglas-fir (Pfister *et al.* 1977). Douglas-fir regeneration is enhanced if large woody debris remains on the site or if shrub cover develops to shelter the seedlings. Scarification can decrease early shrub and grass competition, but may increase erosion potential and pocket gopher activity (Smith and Fischer 1995).

Vegetation in this association recovers quickly from fire, especially species such as ponderosa pine, pinegrass, ceanothus and Scouler willow. Underburning can help maintain an open forest with a productive sward of pinegrass. Slash from thinning operations can be burned without "excessive damage" to reserved trees (Weaver 1968) but Grier (1989) cautions that spring fires may cause higher mortality than fall fires because they cause greater damage to the fine roots of the trees. Site preparation by burning has mixed-effects on tree regeneration but appears to enhance subsequent growth substantially. Several studies report that site preparation by fire enhances sapling growth and development and sites tend to have fewer pocket gophers than scarified sites. Broadcast burning enhances natural regeneration of ponderosa pine (Weaver 1968) if a seed source is available within 100 ft. and if 80-90% of mineral soil is exposed (Steele and Geier-Hayes 1993). Burning may set back competing grass species for 1-2 years, providing a short window for seedling establishment. However, severe fire behavior can lead to profuse germination of ceanothus, which could retard tree regeneration. If ceanothus seeds are in the soil, it is possible that fires may create a dominant ceanothus shrub layer for decades (Smith and Fischer 1995). Very hot fires designed to reduce pinegrass vigor may also cause long-term soil damage by reducing soil organic matter and nutrients.

COMPARISONS

The PSME/CARU Association is widespread throughout the Columbia River Basin. Variants described for northern Idaho (Cooper *et al.* 1991, Daubenmire and Daubenmire 1968), central Idaho (Steele *et al.* 1981), Montana (Pfister *et al.* 1977), southern British Columbia (Braumandl and Curran 1992, Lloyd *et al.* 1990, Mclean 1970), northeastern Washington (Clausnitzer and Zamora 1987, Daubenmire and Daubenmire 1968, Williams and Lillybridge 1983, Zamora 1983) and northeastern Oregon (Johnson and Clausnitzer 1992, Johnson and Simon 1987) are some of those available.

Lillybridge *et al.* (1995) also describe similar types for the eastern Cascade Mountains in central Washington.

The Bearberry Phase of the PSME/CARU Habitat Type of Daubenmire and Daubenmire (1968) is more comparable to our PSME/VACA Association and not PSME/CARU. Sites with bearberry but lacking dwarf huckleberry are considered as a warm dry extension of the PSME/VACA Habitat Type by some authors (Steele and Geier-Hayes 1987). We are uncertain if the same interpretation is always true in our area. Bearberry may occupy very rocky sites dissimilar to PSME/VACA habitats; such rocky sites better fit the PSME/ARUV Association described for the adjacent Okanogan N.F. (Williams and Lillybridge 1983) than the currently described PSME/CARU Association. Some sites similar to the PSME/ARUV Association may be found west of the Columbia River in Ferry and Okanogan Counties (*see* Other Vegetation Types).

Calamagrostis rubescens
pinegrass

PSME/PHMA ASSOCIATION CDS7 15

Pseudotsuga menziesii/Physocarpus malvaceus
Douglas-fir/ninebark

DISTRIBUTION AND ENVIRONMENT

The PSME/PHMA Association is the most widely occurring plant association in the Douglas-fir Series, and is found across the entire forest (Figure 20). It occupies warm, xeric habitats on lower to upper slope positions, primarily on east to west aspects (Figure 21). West of the Columbia River it can be found on northern aspects. However, east of the river it becomes increasingly restricted to steep, rocky, east- to west-facing slopes, particularly near the eastern forest boundary. Elevations range from 1,400 to 5,200 ft. (Table 14).

The regolith is gravelly and rocky colluvium. Soil textures are gravelly to cobbly silts and loams. Ash dominated profiles are uncommon. Discernable ash layers often indicate areas transitional to other associations such as the ABGR/PHMA type. Field notes describe many soils as "loose, non-coherent". These soils are well-to excessively-well drained. Summer soil temperatures at 20 in. (50 cm) normally range between 50 and 54 °F (10 to 12 °C). Soil Ph data are limited but range between 6.5 and 7.5. Rock outcrops and ledges are common. Near lower treeline the type may occur on relatively gentle slopes and north aspects.

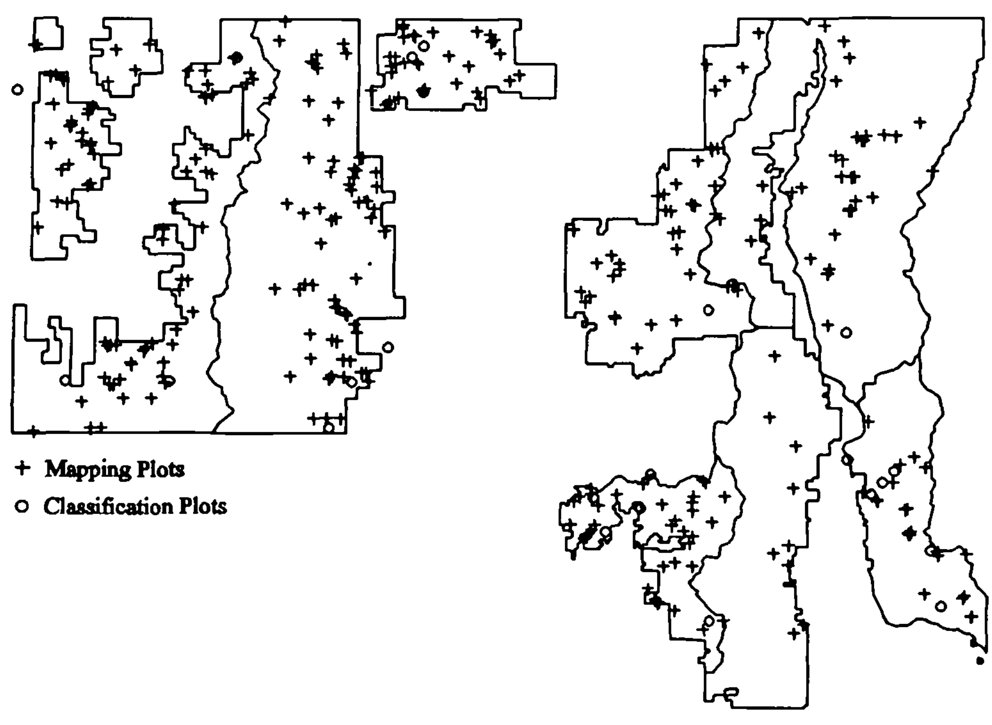


Figure 20. Plot locations for the PSME/PHMA Association (n=353).

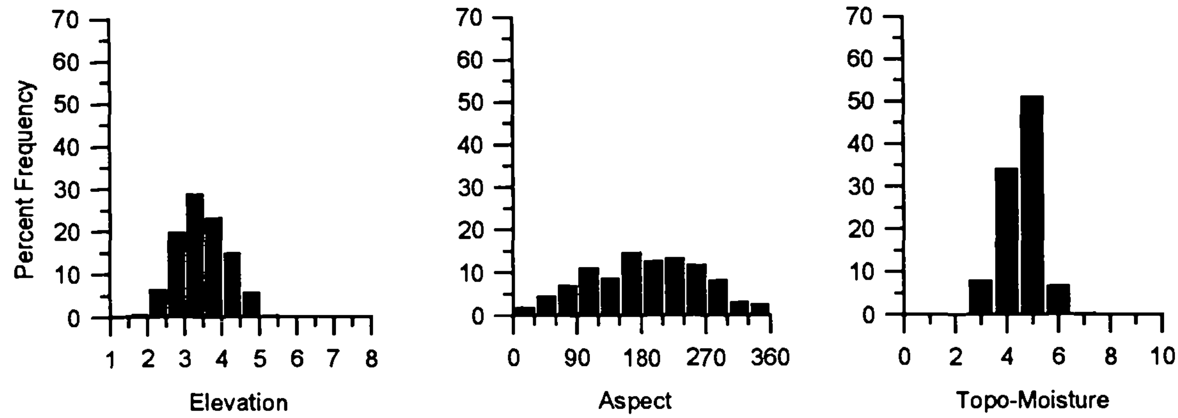


Figure 21. Frequency of PSME/PHMA plots by elevation (1000 ft.), aspect, and topographic moisture.

The PSME/PHMA Association grades into the PSME/PHMA-LIBOL Association on slightly more moist habitats. The latter type often occurs in more sheltered portions of the same slope or on areas of concave micro-relief while the PSME/PHMA Association is on convex or more exposed portions of the site. The PSME/PHMA type grades into either the PIPO-PSME/AGSP Association or a ninebark shrubland on drier habitats. It grades into the PSME/VACA or PSME/CARU Associations on cooler habitats. It is often found in a mosaic with PSME/CARU types, where CARU is growing on finer textured and/or deeper soils and PHMA on coarser, more well-drained soils.

Table 13. Common plants of the PSME/PHMA Association (n=33).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	97	47
PIPO	ponderosa pine	58	11
TREE UNDERSTORY LAYER			
PSME	Douglas-fir	79	4
SHRUBS AND SUBSHRUBS			
PHMA	ninebark	91	29
SPBEL	shiny-leaf spirea	91	6
AMAL	serviceberry	85	7
BEAQ	Oregon grape	79	5
SYAL	common snowberry	76	8
HODI	oceanspray	70	6
ROGY	baldhip rose	70	5
PAMY	pachistima	55	2
HERBS			
CARU	pinegrass	88	11
FRAGA	strawberry spp.	76	4
ARCO	heartleaf arnica	73	9
DITR	wartberry fairybells	73	3
SMRA	feather solomonplume	73	3

VEGETATION

Douglas-fir is the most common tree species in these stands. Ponderosa pine is the major seral species in this association, though only rarely is it the stand dominant. Individual large ponderosa pine trees may occur above the main canopy of Douglas-fir

Table 14. Environmental and structural characteristics of the PSME/PHMA Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3455	655	1400	5200
Aspect[2]	190	66	--	--
Slope	37	19	1	96
Topographic moisture	4.57	0.74	3.0	7.0
Soil Surface[3]				
Exposed soil	22	17	0	70
Gravel	34	20	1	62
Rock	23	26	0	88
Bedrock	0	0	0	0
Moss	2	1	0	3
Lichen	1	2	0	4
Litter	61	18	25	80
Diversity[4]				
Richness	24.6	3.2	10	35
N2	6.5	2.3	3.0	11.5

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=354).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

in some stands as they are more resistant to fire-related mortality and can survive one or more fires. Lodgepole pine is abundant only on habitats transitional to the PSME/VACA Association.

Abundant medium to tall shrubs dominate the undergrowth. Ninebark is characteristically the major shrub but oceanspray is an alternative indicator of the type. Ninebark is a Rocky Mountain species that nears its western distribution (except for disjunct populations) not far from the western boundary of the Colville N.F. Oceanspray extends into the Cascade Range and south into California. Douglas maple, serviceberry, Oregon grape, pachistima, mockorange, shiny-leaf spirea and common and mountain snowberries may be abundant and conspicuous shrubs in individual stands depending on local seed source, stand age, and disturbance history. Herbs are normally much less conspicuous than shrubs but pinegrass can be abundant. Average species richness and heterogeneity (N_2) are close to the average for the Series (Table 14).

There several extensive stands near Scatter Creek and Swan Lake on the Republic Ranger District that occur on steep, boulder covered slopes which may key here. These stands range from open woodland to closed forest conditions but are characterized by a unique undergrowth including

Figure 22. Photo of the PSME/PHMA Association.

mountain snowberry, ocean-spray, common snowberry, ninebark, serviceberry, shrubby penstemon, and bluebunch wheatgrass. Pod-fern (*Aspidotis densa*), a common serpentine indicator, may also be present. These stands typically occur below 3,000 ft. (910 m), though existing ecology plot data are insufficient to describe these stands.

MANAGEMENT IMPLICATIONS

Wildlife/Range- These stands provide important forage and cover for a wide variety of wildlife species. PSME/PHMA sites remain snow-free later in the fall and become snow-free earlier in the spring than many other forested plant communities on the Forest. In mature stands, wildlife use of this type is primarily for cover, since forage production is low. However, early seral stages of this association can be very productive for both food and cover requirements of big game. Bighorn sheep may use these areas for forage and cover areas, and grouse like to use these sites also. Severe fires every 30-60 years will maintain shrub cover on these sites, which elk and deer use as winter forage. Wild turkeys may forage and roost in large remnant ponderosa pine while flying squirrels are also known to use old, hollow pines. The type can also be important habitat for pileated woodpeckers, mountain chickadee's and nuthatches. Several common shrubs such as serviceberry, Douglas maple, redstem ceanothus and baldhip rose are considered good deer browse. The tall shrub layer also provides excellent hiding cover.

Livestock grazing is not important, except perhaps in very early successional stages with a high abundance of grasses. However, significant damage from livestock grazing can occur from excessive use as shaded rest areas adjacent to sites having greater herbage production. Strawberry spp. are disturbance-indicating species that flourish under heavy grazing on these sites.

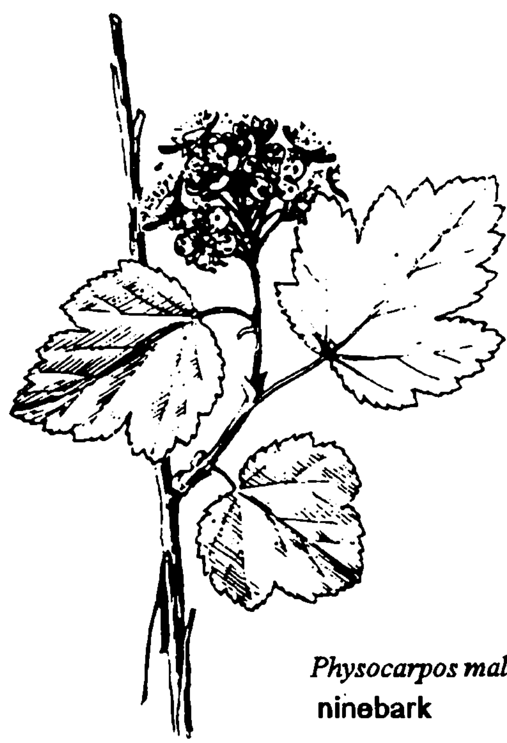
Silviculture- PSME/PHMA stands have major reforestation difficulties following traditional logging and reforestation practices (e.g. clearcutting, burning, scarification). These reforestation problems are primarily due to drought and heat stress, steep slopes, and shrub and grass competition. Plant species are fire-resistant and post-fire recovery of the understory occurs relatively quickly in most situations. Many plants in this association are rhizomatous and competition is intense. Sites with heavy coverage of pinegrass indicate potential regeneration problems due to competition. Natural regeneration (mainly Douglas-fir) in PSME/PHMA stands in Montana often required more than 20 years following logging practices common in the 1960's and early 1970's (Arno *et al.* 1985). Artificial regeneration in the same time frame was successful about half the time and then mainly after scarification or terracing. Similar studies from central Idaho agree with these findings (Steele and Geier-Hayes 1989). Timely regeneration following clearcutting is very difficult to assure regardless of the techniques employed. Clearcuts may resist reforestation efforts for decades, especially if followed by a broadcast burn. Only ponderosa pine and Douglas-fir are suggested for management. The presence of Douglas maple, smooth brome or sweetroot in a stand may indicate better than average tree productivity.

Soil wood and organic matter have a crucial role in nutrient cycling in a broadly defined PSME/PHMA type (Harvey *et al.* 1987). They report that tree roots are almost entirely concentrated in soil wood and other organic matter. Activities that reduce soil organic matter and soil wood also reduce capacity to support trees (refer to the Douglas-fir Series description for more information). Burning is commonly practiced on PSME/PHMA sites ostensibly with one goal: to reduce shrub competition with young trees. However, long-term studies of shrub dynamics on such sites indicate that burning encourages more shrub cover and slows reforestation compared to unburned sites. This is especially true of fall burning (Irwin and Peek 1979, Morgan and Neuenschwander 1988). Wildfire or broadcast burning often results in complete site occupancy by shrubs for extended periods of time. Appendix 1 provides some information on expected response of selected species to fire.

In view of the above considerations, natural regeneration under a shelterwood with little or no site preparation or fuels treatment appears to be the most cost effective reforestation method. The shelterwood should remain until the stand is adequately reforested before removal. This may require decades before trees are re-established. The alternative is a high rate of reforestation failures. No known techniques will assure reforestation in five years. Loose soils and steep slopes indicate that erosion can be a serious problem. Natural soil movement rates are high and heavy equipment on steep slopes and vegetation destruction may lead to accelerated erosion. On sites which are on the dry extreme for this type where ponderosa pine may dominate, underburning can be used in combination with partial or group selection cutting to maintain productivity and species composition as well as an open stand structure. A natural fire regime, consisting of frequent, non-lethal fires, perpetuates dominance by seral species. A combination of selection cutting with underburning can help perpetuate the pre-settlement stand structure. However, seral species may be difficult to replace or maintain after stand-replacing fire or clearcutting has removed seed sources. Dwarf mistletoe is commonly observed on larch and Douglas-fir trees in this association. Infections seem to be more pronounced on the drier sites within the type.

COMPARISONS

Plant associations with Douglas-fir as the major tree species and ninebark as the primary shrub have been widely reported for the Rocky Mountains. Similar associations have been described for northern Idaho (Cooper *et al.* 1991, Daubenmire and Daubenmire 1968), eastern Washington (Clausnitzer and Zamora 1987, Daubenmire and Daubenmire 1968, Williams and Lillybridge 1983, Zamora 1983), northeastern Oregon (Hall 1973, Johnson and Clausnitzer 1992, Johnson and Simon 1987), Montana (Pfister *et al.* 1977), and central Idaho (Steele *et al.* 1981). Braumandl and Curran (1992) describe a Douglas-fir-Ponderosa Pine/Ninebark Site Association for the southern Kettle River Valley in British Columbia. However, the association is found at lower elevations on warmer and drier sites than those that support the PSME/PHMA Association described for the Colville N.F.



Physocarpos malvaceus
ninebark

PSME/PHMA-LIBOL ASSOCIATION CDS7 16

Pseudotsuga menziesii/Physocarpus malvaceus-Linnaea borealis var. *longiflora*
Douglas-fir/ninebark-twinflower

DISTRIBUTION AND ENVIRONMENT

The PSME/PHMA-LIBOL Association is one of the most common plant associations in the Douglas-fir Series. It is found across the entire forest but is best represented west of the Pend Orielle River (Figure 23). It occupies warm, xeric habitats primarily on lower and mid-slope positions on a variety of aspects (Figure 24). At elevations nearer the lower forest margin it may be on sheltered north slopes, draws and swales while at higher elevations it is usually found on southeast to west-facing aspects. Elevations range from 2,000 to 5,000 ft. (Table 16).

The regolith is largely colluvium mixed with glacial till. Volcanic ash may be mixed in the upper horizon in some soils but most profiles do not have the ash layer characteristic of many other associations on the Forest. Soil textures are almost always gravelly to very gravelly silts or loams. Soil parent materials are variable including granitic, basaltic and metamorphic rock types. Soil pH ranged between 6.5 and 7.5. Soil temperatures at 20 in. (50 cm) ranged between 48 and 52 °F (9 to 11 °C). Some soils had compacted or very hard horizons deeper in the profile but compaction was not a common characteristic in natural stands.

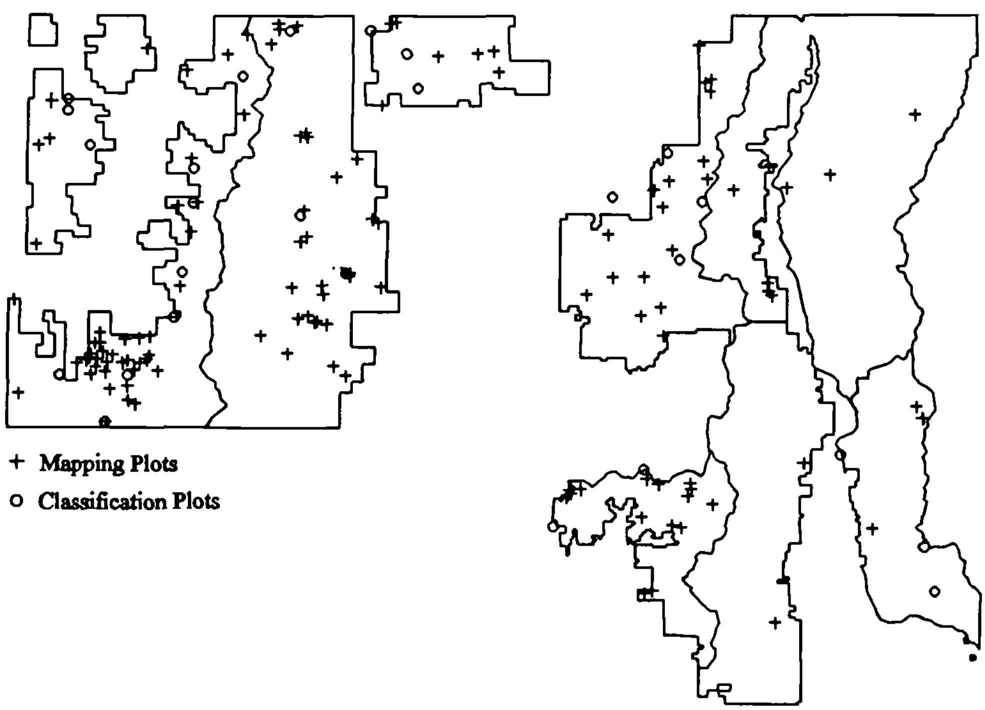


Figure 23. Plot locations for the PSME/PHMA-LIBOL Association (n=164).

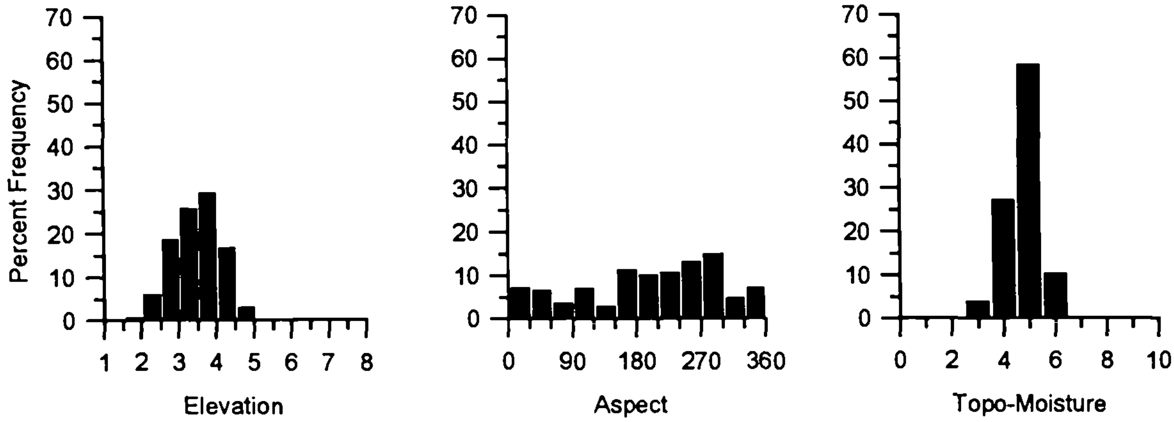


Figure 24. Frequency of PSME/PHMA-LIBOL plots by elevation (1000 ft.), aspect, and topographic moisture.

The PSME/PHMA-LIBOL type is very similar to the PSME/PHMA Association which occurs on what appear to be slightly more xeric habitats. The PSME/PHMA-LIBOL type is also closely related to the ABGR/PHMA Association and distinguishing between the types in early seral stands is often difficult. The PSME/PHMA-LIBOL Association grades into the PSME /VACA Association on colder, frostier sites. The presence of dwarf huckleberry and bearberry indicates habitats transitional between the two associations.

Table 15. Common plants of the PSME/PHMA-LIBOL Association (n=51).

		CON	COVER
<u>TREE OVERSTORY LAYER</u>			
PSME	Douglas-fir	100	43
LAOC	western larch	92	8
<u>TREE UNDERSTORY LAYER</u>			
PSME	Douglas-fir	82	7
<u>SHRUBS AND SUBSHRUBS</u>			
PHMA	ninebark	98	23
SPBEL	shiny-leaf spirea	88	9
AMAL	serviceberry	86	3
SYAL	common snowberry	75	5
BEAQ	Oregon grape	69	4
PAMY	pachistima	67	3
ROGY	baldhip rose	63	5
ARUV	bearberry	57	5
LIBOL	twinflower	51	5
<u>HERBS</u>			
CARU	pinegrass	98	22
FRAGA	strawberry spp.	92	4
ARCO	heartleaf arnica	75	6
SMRA	feather solomonplume	69	2
DITR	wartberry fairybells	57	3

VEGETATION

Very old stands are rare in these fire prone sites. Douglas-fir dominates late seral and mature stands. Western larch and ponderosa pine are common long-lived seral tree species. After a disturbance such as fire, the typical overstory is a mixture of Douglas-fir and western larch. Douglas-fir is normally dominant. Ponderosa pine is less common

Table 16. Environmental and structural characteristics of the PSME/PHMA-LIBOL Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3473	604	2000	5000
Aspect[2]	256	58	20	310
Slope	31	17	2	84
Topographic Moisture	4.75	0.69	3.0	6.0
Soil Surface[3]				
Exposed soil	41	23	0	70
Gravel	10	4	1	12
Rock	18	19	12	38
Bedrock	0	0	0	0
Moss	2	1	1	5
Lichen	0	0	0	0
Litter	69	21	35	85
Diversity[4]				
Richness	23.7	3.4	19	29
N2	6.1	1.7	4	10

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=167).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

in the sere as compared to the PSME/PHMA Association. Western larch and lodgepole pine are more important on the more moist sites within the type. Shrubs are common and ninebark is typically the most abundant species. Oceanspray may be locally abundant and is used as an alternate indicator species for these sites. Shiny-leaf spirea, pachistima, serviceberry, Douglas maple, Oregon grape, common snowberry and baldhip rose are other shrubs that may be abundant. South or west aspects in the Grand Fir, Western Redcedar and Western Hemlock Series may support shrub layers very similar to that of a PSME/PHMA-LIBOL type, particularly in early seral stages.

Pinegrass is the most common and abundant herb but other common species include wartberry fairybells, heartleaf arnica, strawberry and showy aster. Both average species richness and heterogeneity (N_2) values are close to the Series' averages (Table 16). Average species richness is the highest of any association in the Douglas-fir Series indicating the relatively mild environment characteristic of the type.

Figure 25. Photo of the PSME/PHMA-LIBOL Association.

MANAGEMENT IMPLICATIONS

Wildlife/Range- These stands provide important forage and cover for a wide variety of wildlife species. PSME/PHMA-LIBOL sites remain snow-free later in the fall and become snow-free earlier in the spring than many forested sites. In mature stands, wildlife use of this type is primarily for cover; forage production is low. However, early seral stages of this of the association can be very productive for both food and cover requirements of big game. Serviceberry, Douglas maple, redstem ceanothus and baldhip rose and other common shrubs are considered good deer browse. Bighorn sheep may use these areas for forage and cover areas, and ruffed grouse like to use these sites also. Severe fires every 30-60 years will maintain shrub cover on these sites, which elk and deer use as winter forage. When large, remnant ponderosa pine are present, wild turkeys may forage and roost, and flying squirrels are known to use the old, hollow pines. The type can also be important habitat for pileated woodpeckers, mountain chickadee's, and nuthatches.

Livestock grazing is not important, except perhaps in very early successional stages with a high abundance of grasses. However, significant damage from livestock grazing can occur from excessive use as shaded rest areas adjacent to sites having greater forage production. Strawberry spp. are disturbance-indicating species that flourish under heavy grazing.

Silviculture- The PSME/PHMA-LIBOL Association is easier (though still difficult) to regenerate than the PSME/PHMA type. Natural regeneration on similar stands in Montana required more than 10 years (Arno *et al.* 1985). This is about half the delay time for PSME/PHMA. Soil wood and organic matter have a crucial role in a broadly defined PSME/PHMA type (Harvey *et al.* 1987). Tree roots are almost entirely concentrated in soil wood and other types of organic matter. Activities that reduce soil organic matter and soil wood reduce site capacity to support trees (refer to the Douglas-fir Series description for more information). Additionally, steep slopes and rocky soils make planting difficult, and soils may be displaced by heavy equipment.

Shelterwood cuts with little or no site preparation are recommended to reduce reforestation difficulties. Clearcuts may resist reforestation efforts for decades, especially if broadcast burned. Burning is commonly practiced on PSME/PHMA-LIBOL sites ostensibly with one goal: the reduction of shrub competition with young trees. However, long-term studies of shrub dynamics on similar sites indicates broadcast burns encourage more shrub cover and retard reforestation when compared to unburned units. This is especially true of fall burns (Irwin and Peek 1979, Morgan and Neuenschwander 1988). Appendix 1 provides some information on expected response of selected species to fire. Abundant Douglas maple, smooth brome or sweetroot may indicate habitats with better than average productivity. Dwarf mistletoe is commonly observed on larch and Douglas-fir trees in this association.

COMPARISONS

The PSME/PHMA-LIBOL Association is separated from the PSME/PHMA Association based the presence of western larch and/or twinflower. These species indicate a more moist extreme of the PSME/PHMA Association, and have a different successional pathway (Arno *et al.* 1985). Plant associations with Douglas-fir as the major tree species and ninebark as the primary shrub have been widely reported for the Rocky Mountains. Similar associations have been described for northern Idaho (Cooper *et al.* 1991, Daubenmire and Daubenmire 1968), eastern Washington (Clausnitzer and Zamora 1987, Daubenmire and Daubenmire 1968, Williams and Lillybridge 1983, Zamora 1983), northeastern Oregon (Hall 1973, Johnson and Simon 1987), Montana (Pfister *et al.* 1977), and central Idaho (Steele *et al.* 1981).

The PSME/ACGL-PHMA Association of northeastern Oregon (Johnson and Simon 1987) is similar. However, Douglas maple (ACGL or ACGLD) is much less common in the Colville N.F. data. The PAMY Phase of the PSME/PHMA Habitat Type described for the adjacent Colville Indian Reservation (Clausnitzer and Zamora 1987) also appears to be very similar. The SMST Phase of PSME/PHMA Habitat Type described for northern Idaho (Cooper *et al.* 1991) can be considered an extension of the Colville N.F. PSME/PHMA-LIBOL type. The Colville data contain little starry solomonplume so twinflower and western larch are used as key species. Braumandl and Curran (1992) describe a Douglas-fir-Ponderosa Pine/Ninebark Site Association for the Kettle River Valley in southern British Columbia. However, this association contains no western larch or twinflower and is found on warmer and drier sites than those that support the PSME/PHMA-LIBOL Association.

PSME/SYAL ASSOCIATION CDS6 33

Pseudotsuga menziesii/Symphoricarpos albus
Douglas-fir/common snowberry

DISTRIBUTION AND ENVIRONMENT

The PSME/SYAL Association is most common west of the Pend Orielle River (Figure 26) though is even more common in lower elevations outside of National Forest lands. This type typifies warm, moist but well-drained lower slope, bench or terrace topographic positions that receive run-on or percolation water. Most PSME/SYAL stands are along drainages, in swales, or on lower slopes where subsurface moisture may accumulate. Slopes are variable and sites tend to be located on southeast to southwest aspects (Figure 27). Elevations range from 2,200 to 4,800 ft. (Table 18), but the type extends to lower elevations. These sites represent xero-riparian communities in many locations.

The regolith is alluvium or glacial till and outwash. Soil textures are sandy loams to sands. Coarse fragment content is variable. The upper soil horizons are relatively coarse-textured and xeric. However, subsurface horizons may be relatively moist and it is not uncommon to find seepage along nearby roadcuts. Wetter habitats are typically spruce (PIEN/SYAL), quaking aspen (POTR/SYAL)

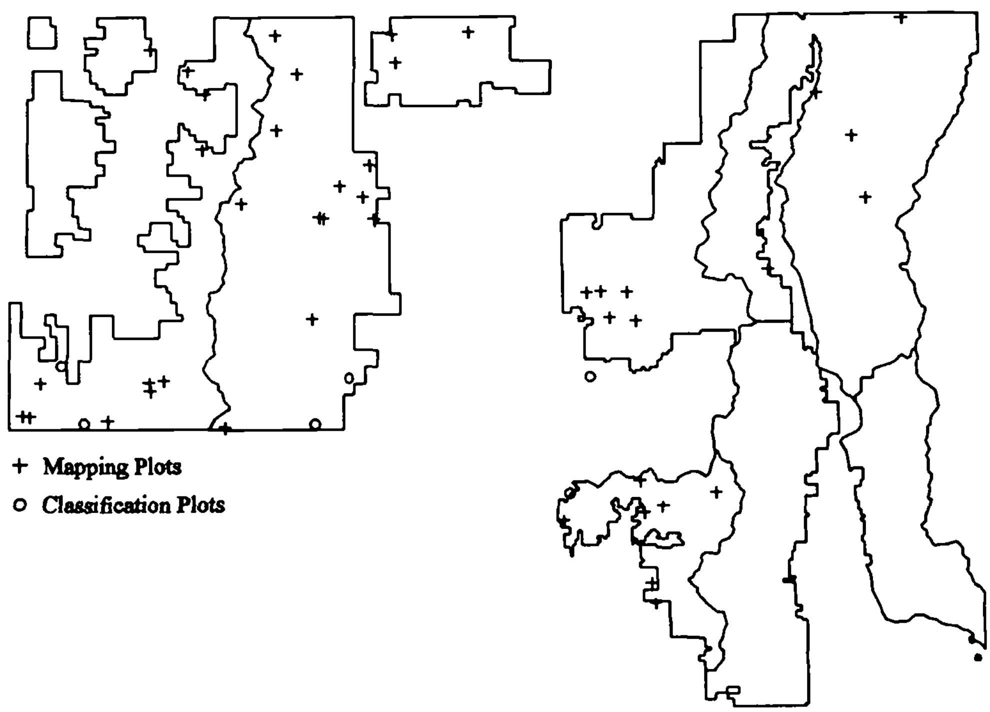


Figure 26. Plot locations for the PSME/SYAL Association (n=50).

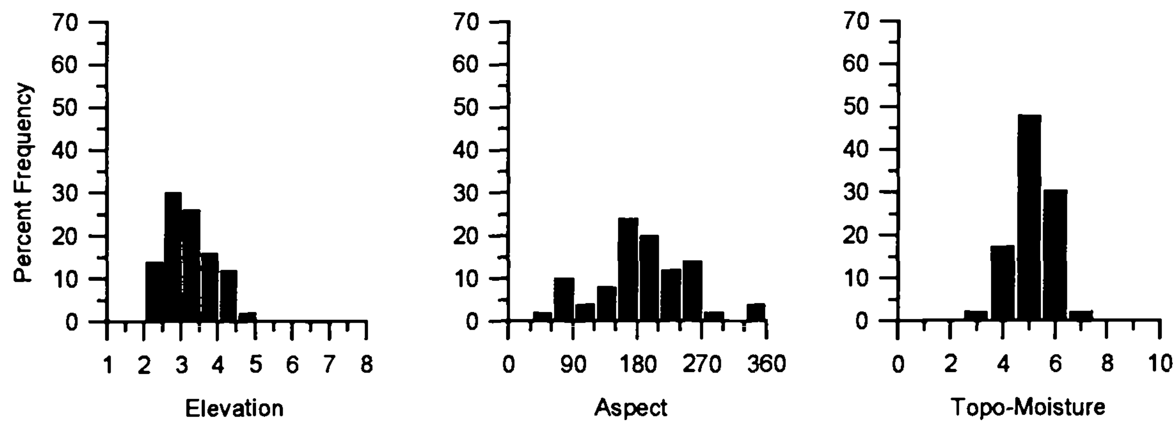


Figure 27. Frequency of PSME/SYAL plots by elevation (1000 ft.), aspect, and topographic moisture.

or black cottonwood (POTR2/SYAL) riparian communities. These riparian associations are described in greater detail by Kovalchik (1993). PSME/SYAL grades into the PSME/PHMA-LIBOL, PSME/PHMA or PSME/SYOR Associations on drier habitats.

VEGETATION

Douglas-fir, ponderosa pine, or a mixture of both species dominates the overstory of early to mid-seral stands. Western larch and lodgepole pine are occasional seral stand components. Quaking aspen may be a minor sub-canopy component in some stands. Douglas-fir is the most shade tolerant species present and is expected to dominate late seral or climax conditions. Currently, Douglas-fir dominates the tree reproduction layer due to changes in the fire regime. Ponderosa pine reproduction may dominate early succession, and would usually be found under an open, ponderosa-pine dominated canopy. Ponderosa pine typically dominates the warmer extensions of this type, and will seldom be totally excluded by Douglas-fir on these sites.

Table 17. Common plants of the PSME/SYAL Association (n=13).

		CON	COVER
TREE OVERSTORY LAYER			
PIPO	ponderosa pine	85	35
PSME	Douglas-fir	85	26
LAOC	western larch	8	40
TREE UNDERSTORY LAYER			
PSME	Douglas-fir	69	4
SHRUBS AND SUBSHRUBS			
SYAL	common snowberry	100	43
AMAL	serviceberry	69	4
BEAQ	Oregon grape	54	3
HERBS			
CARU	pinegrass	85	14
OSCH	sweetroot	62	2
FRAGA	strawberry spp.	62	2
ARCO	heartleaf arnica	54	5
ACMI	yarrow	54	2

Table 18. Environmental and structural characteristics of the PSME/SYAL Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3212	646	2200	4800
Aspect[2]	186	54	--	--
Slope	34	16	6	70
Topographic Moisture	5.13	0.81	3.0	7.0
Soil Surface[3]				
Exposed soil	23	13	10	50
Gravel	17	12	12	38
Rock	18	19	1	38
Bedrock	0	0	0	0
Moss	0	0	0	0
Lichen	0	0	0	0
Litter	--	--	--	--
Diversity[4]				
Richness	22.4	7.7	7	35
N2	6.6	2.9	4	13

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=50).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

A dense 2 ft. (0.6 m) high shrub layer in association with abundant grasses characterizes the undergrowth. Common snowberry is the dominant and characteristic shrub. Bristly nootka rose, wood's rose, Oregon grape, shiny-leaf spirea and serviceberry are locally abundant shrubs. Pinegrass is the most common grass and is often very abundant. Sweetroot, yarrow, heartleaf arnica and strawberry spp. are the only herbs present with a degree of constancy. Arrowleaf balsamroot indicates sites at the dry end of the type. Average species richness and heterogeneity (N_2) are close to the Series' averages (Table 18).

MANAGEMENT IMPLICATIONS

Wildlife/Range- Animal use can be high. Deer, elk, cattle, grouse, and passerines all utilize this habitat seasonally. These stands are important for forage, cover and proximity to water. Seral shrub species may provide important browse for elk and deer and provide good thermal and hiding cover when the shrub layer is dense. Ruffed grouse may use the drier types with ponderosa pine year-round. Turkeys may roost in large pines and feed on pine seeds. Livestock find low to moderate

Figure 28. Photo of the PSME/SYAL Association.

amounts of herbage in this type (appendix 2). However, sites may be heavily utilized as resting/shade areas due to gentle terrain and proximity to water. Cattle often congregate seeking shade and water, in which case damage from overuse may occur. Common snowberry is sensitive to trampling and soil compaction.

Silviculture- Site indexes are good for sites on gentle slopes (< 30%) but decline as slopes increase (appendix 2). Productivity data from Okanogan N. F. plots are used to characterize site productivity and all these plots are from slopes less than 30%. The modal sites tend to be very productive for the Douglas-fir Series, and timber productivity is moderate to high (appendix 2), though stocking control may be a problem. As with other Douglas-fir/tall shrub associations, competition from rhizomatous understory vegetation (common snowberry, shiny-leaf spirea, pinegrass, etc.) and animal use are important factors to consider in management (Johnson and Clausnitzer 1992). Natural reforestation potential is good but too much delay in tree establishment results in a dense shrub and grass stand highly competitive with young trees. Ponderosa pine regenerates well on the drier sites while Douglas-fir regenerates better on more moist sites within the type.

Pre-harvest species composition of shrub and herb layers, type and timing of treatment, combined with species responses in appendix 1 can be used to estimate vegetation responses to alternative treatments. Ponderosa pine, snowberry, and pinegrass will respond favorably to increased sunlight, though this may also allow pinegrass to form a dense sward which may retard conifer regeneration (Steele *et al.* 1981). These shrubs and herbs respond vigorously to overstory removal and may hinder regeneration in clearcuts. Most species are fire-resistant, and recurrent fire will promote ponderosa pine and pinegrass in this type. Underburning can be used to maintain open conditions, increase forage production and enhance the nutritional value of forage. Shrubs may take two years or more to regain dominance after underburning (Weaver 1968). Mechanical thinning could be used in conjunction with low-severity underburns to open up stands where fuel ladders are extensive or surface fuels are heavy (Smith and Fischer 1995). Elytroderma needle cast frequently infests ponderosa pine on PSME/SYAL sites on the neighboring Okanogan N.F. Slopes steeper than 30% or the presence of mountain snowberry indicates conditions where PSME/SYOR timber management interpretations are more applicable.

COMPARISONS

Similar types have been described for northern Idaho (Cooper *et al.* 1991, Daubenmire and Daubenmire 1968), eastern Washington (Clausnitzer and Zamora 1987, Lillybridge *et al.* 1995, Zamora 1983), Montana (Pfister *et al.* 1977), British Columbia (Brayshaw 1965), central Idaho (Steele *et al.* 1981) and northeastern Oregon (Johnson and Clausnitzer 1992, Johnson and Simon 1987). There are floristic differences between areas but all types are used to indicate similar environments. The PSME/SYAL/AGSP Association described by Lillybridge *et al.* (1995) is similar to some of the Colville N.F. stands. In Montana, the bluebunch wheatgrass phase of Pfister *et al.* (1977) seems to better fit the PSME/SYOR Association than the PSME/SYAL type described for the Colville N.F.

Symphoricarpos albus
common snowberry

PSME/SYOR ASSOCIATION CDS6 32

Pseudotsuga menziesii/Symphoricarpos oreophilus
Douglas-fir/mountain snowberry

DISTRIBUTION AND ENVIRONMENT

The PSME/SYOR Association is a minor type on the Colville N.F., and is primarily found west of the Kettle Mountain Crest on the Republic Ranger District (Figure 29). This association typically occurs on dry, windswept habitats with coarse textured soils. Sites are generally on upper-slope or ridgetop positions on southeast to southwest aspects (Figure 30). Elevations range from 2,550 to 5,280 ft. and average 4,224 ft. (Table 20). The PSME/SYOR Association represents one of the driest and harshest environments within the Douglas-fir Series.

The regolith is glacial till, outwash or colluvium. Soil textures are gravelly silts to loams. Coarse fragments often make up 50% or more of the soil profile. These are well- to excessively well-drained soils. Summer soil temperatures at 20 in. (50 cm) average 46 °F (8 °C) which are the coldest for the Douglas-fir Series on the Colville N.F. The PSME/SYOR Association often occurs next to shrublands with mountain snowberry or, less commonly, mountain big sagebrush. It grades into the PSME/CARU or ABLA2/CARU Associations on less xeric or somewhat cooler sites. Stands dominated by mountain snowberry are essentially wooded mountain shrublands. They frequently

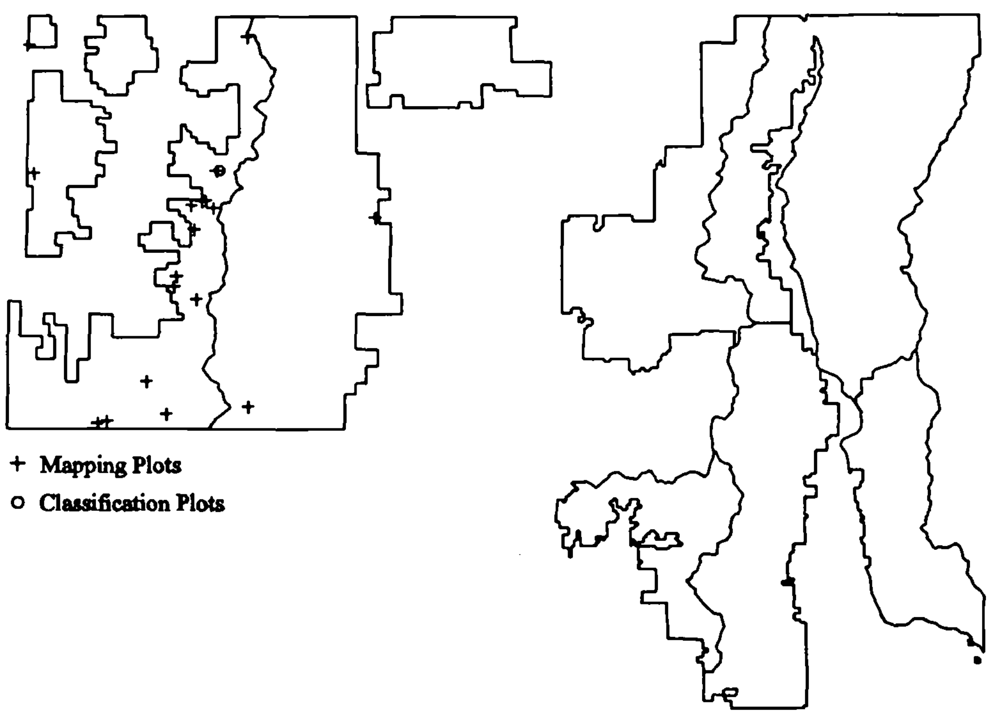


Figure 29. Plot locations for the PSME/SYOR Association (n=22).

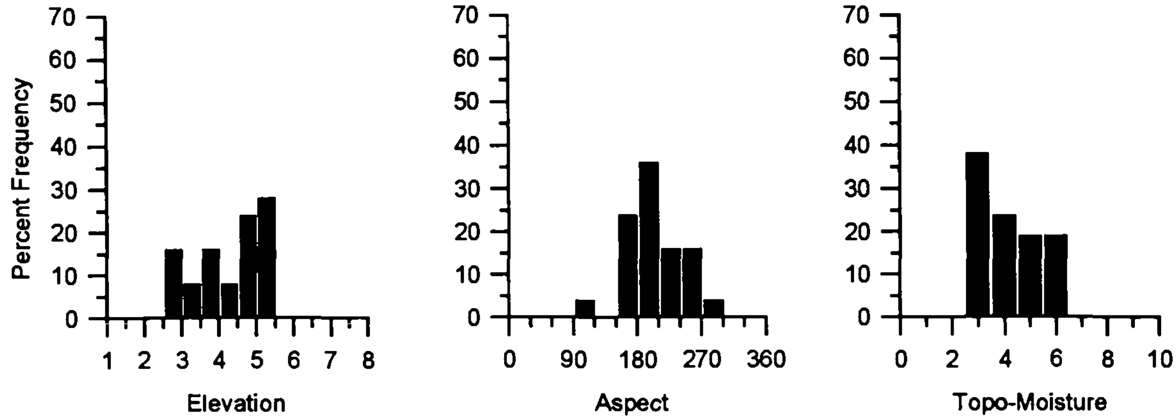


Figure 30. Frequency of PSME/SYOR plots by elevation (1000 ft.), aspect, and topographic moisture.

adjoin non-forested communities including grasslands and shrublands and represent a transition zone between forested and non-forested conditions within the Douglas-fir Series.

There are several extensive stands near Scatter Creek and Swan Lake on the Republic Ranger District that occur on steep, boulder covered slopes which may key here. These stands range from open woodland to closed forest conditions but are characterized by a unique undergrowth including mountain snowberry, ocean-spray, common snowberry, ninebark, serviceberry, shrubby penstemon, and bluebunch wheatgrass. Pod-fern (*Aspidotis densa*), a common serpentine indicator, may also be present. These stands typically occur below 3,000 ft. (910 m) which contrasts sharply with typical PSME/SYOR. Existing ecology plot data are insufficient to describe these stands.

Table 19. Common plants of the PSME/SYOR Association (n=9).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	100	36
PIPO	ponderosa pine	67	16
TREE UNDERSTORY LAYER			
PSME	Douglas-fir	89	3
SHRUBS AND SUBSHRUBS			
SYOR	mountain snowberry	100	11
AMAL	serviceberry	56	4
HERBS			
CARU	pinegrass	89	29
ACMI	yarrow	89	2
FRAGA	strawberry spp.	67	5
COPA	little flower collinsia	67	2
SMRA	feather solomonplume	67	1
LUSE	silky lupine	56	5
ANAN	tall pussytoes	56	3

VEGETATION

The PSME/SYOR Association represents semi-open forests of large trees with an open, grassy undergrowth and scattered shrub patches. They rarely form a closed forest situation. The physiognomy closely resembles the more open PSME/CARU

Table 20. Environmental and structural characteristics of the PSME/SYOR Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4224	916	2550	5280
Aspect[2]	205	33	--	--
Slope	42	16	10	63
Topographic Moisture	4.19	1.17	3.0	6.0
Soil Surface[3]				
Exposed soil	26	14	5	35
Gravel	12	--	12	12
Rock	9	16	0	38
Bedrock	0	0	0	0
Moss	2	1	1	5
Lichen	0	0	0	0
Litter	38	4	35	40
Diversity[4]				
Richness	25.1	9.0	13	36
N2	6.1	1.9	4	9

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=25).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

stands except for the shrub layer. Douglas-fir mixed with ponderosa pine dominates the open overstory canopy. Western larch is present in some stands. Douglas-fir dominates late seral and climax stands as both western larch and ponderosa pine are strictly seral. Douglas-fir is typically the only tree regeneration present.

Abundant pinegrass mixed with scattered mountain snowberry is the characteristic undergrowth. Mountain snowberry is a caespitose, non-rhizomatous species and rarely approaches the density characteristic of common snowberry in the PSME/SYAL Association. Rose spp. or shiny leaf spirea are the only other shrubs likely to occur. Pinegrass is the most common herbaceous species and may form a dense sward. Lupine spp., yarrow, strawberry spp. and tall pussytoes are some of the other common herbaceous species. A diverse mixture of other grass species is also present.

Average species richness is above the Series average while average heterogeneity (N_2) is slightly below the Series' average (Table 20). Transition vegetation types such as PSME/SYOR often have fairly diverse floras because of both the open canopies and adjacent vegetation. The open canopies provide a wide range of microclimatic conditions from near open conditions to closed-forest shade

Figure 31. Photo of the PSME/SYOR Association.

which tends to provide conditions suitable for a number of species. The transition areas receive propagules from both open, non-forested vegetation as well as adjacent closed-forest vegetation, which again tends to promote increased diversity. However, habitat conditions are relatively harsh, which limits the number of dominant species, hence the relatively lower heterogeneity index.

MANAGEMENT IMPLICATIONS

Wildlife/Range-These sites represent important transition areas between forest and non-forest communities, and enhance landscape and species diversity. Wildlife use is high, since these stands represent important forage and cover areas for a variety of wildlife species. Deer, elk, cattle, blue grouse, and passerines all utilize this habitat seasonally. Blue grouse especially favor the large Douglas-firs found on the windswept ridges. Shrub species may provide important browse for elk and deer, as well as provide good thermal and hiding cover when the shrub layer is dense. These habitats become snow-free early in the spring because of the warm, exposed slopes combined with snow removal by wind. As such, they provide important habitat for a variety of wildlife including winter range for large ungulates.

Grazing has been heavy on most sites and loss of perennial grass cover and a concomitant increase in weedy *arnica* spp., asters and annual forbs follow excessive grazing. Tree canopy reduction will increase herbage production, while heavy grazing tends to eliminate the more palatable herbs. Moderate to heavy livestock use is common because of the proximity of the type to grass or shrublands. These sites also represent good shade and rest areas, increasing domestic livestock use and impacts.

Silviculture- Douglas-fir and ponderosa pine site indices are moderate and stocking rates are moderately low (appendix 2). Natural regeneration is sparse and reforestation is difficult because of droughty soils and competition from herbs and shrubs. Succession to trees after deforestation is especially slow. Planting is usually needed to assure regeneration, but even then survival is often poor, and trees should be planted before the shrubs and herbs can respond to release. Shading may be required because of high insolation rates and shelterwoods appear to have the highest probability of reforestation success. Planting may not be required under a shelterwood, but tree establishment will be slow regardless of the techniques used.

Windthrow and winter desiccation are prevalent. Clearcuts next to natural shrublands and grasslands are very difficult to regenerate and have high potential for rodent damage. Clearcuts essentially extend the mountain shrublands and grasslands into formerly forested areas and tree establishment may require decades. Due to these factors, management activities need to be limited and planned very carefully. Uneven-aged silvicultural systems show promise on these habitats. Uneven-aged management combined with prescribed fire and extended rotations should be effective in helping to maintain or enhance open stand structures. Natural stocking in mature stands is often low enough that spread of disease and parasites such as mistletoe are slow. *Elytroderma* infections are common on ponderosa pine on the Okanogan N. F. Similar infection levels may occur on the Colville N. F., especially on the Republic Ranger District.

COMPARISONS

PSME/SYOR types have been described for western Wyoming (Reed 1969, 1976), Montana (Pfister *et al.* 1977), central Idaho (Steele *et al.* 1981), and northeastern Oregon (Johnson and Clausnitzer 1992, Johnson and Simon 1987). These communities often have less pinegrass and contain some species not present on the Colville N.F. The PSME/SYOR types described for central and northcentral washington (Lillybridge *et al.* 1995, Williams and Lillybridge 1983, respectively) are similar to the Colville N.F. type. Mountain snowberry is also used to identify phases of other associations in central Idaho which suggests that it's indicator role is different in that area (Steele *et al.* 1981). Most of the above studies describe PSME/SYOR as a minor type with a restricted distribution similar to the situation found on the Colville N.F.

PSME/VACA ASSOCIATION CDS8 13

Pseudotsuga menziesii/Vaccinium caespitosum

Douglas-fir/dwarf huckleberry

DISTRIBUTION AND ENVIRONMENT

The PSME/VACA Association is a minor type on the Colville N.F., best developed west of the Kettle Mountain Crest (Figure 32). It is similar to the ABGR/VACA Association, but occurs on drier sites which are generally outside the range of grand fir. It occupies gentle, moist, well-drained glacial outwash terraces, benches, and toeslopes on predominantly southeast to west aspects (Figure 33). Elevations range from 2,300 to 4,420 ft. (Table 22) and sites tend to accumulate cold air at night. This association represents warm day and cool- to frosty-night habitats within the Douglas-fir Series.

The regolith is glacial till, outwash (often of granitic origin), or colluvium with a thin surface layer of volcanic ash. Subsoils are often glacially compacted tills which may limit root penetration. Soil textures are sandy, gravelly to cobbly silts, sands and loams. Average soil temperature at 20 in. (50 cm) is 48 °F (9 °C) which ranks on the cool side for the Series. Soil Ph varied between 6.3 to 7.0. Subsoils are occasionally mottled. PSME/VACA is the most frost prone type in the Douglas-fir Series. It grades into either the ABGR/VACA or ABLA2/VACA Association on cooler, more moist habitats and into the PSME/PHMA, PSME/PHMA-LIBOL or PSME/CARU Associations on less

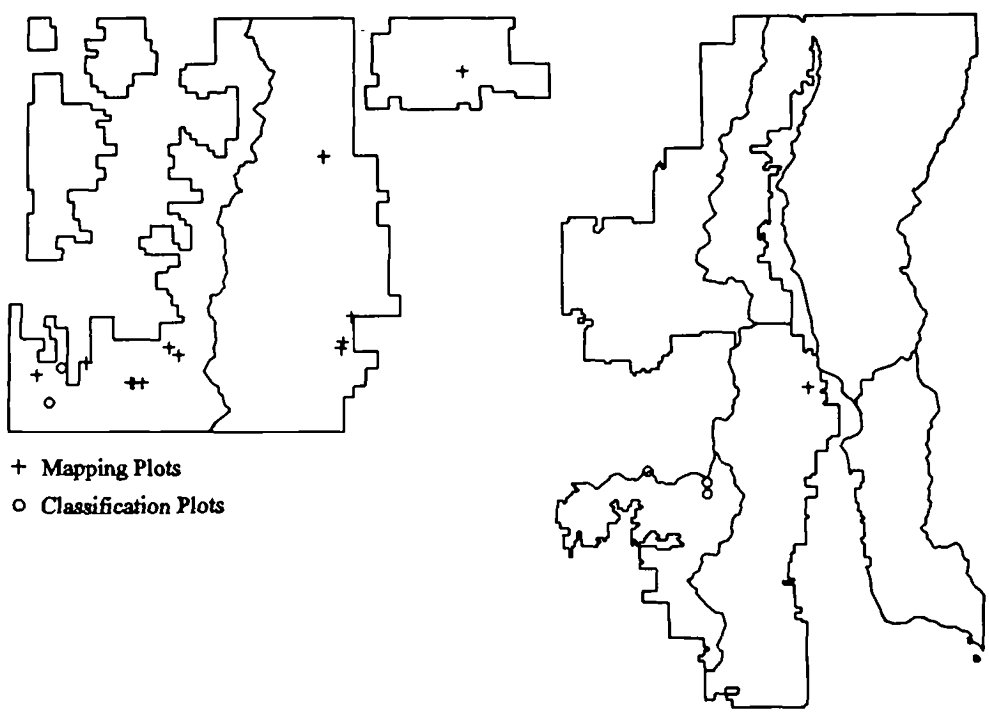


Figure 32. Plot locations for the PSME/VACA Association (n=22).

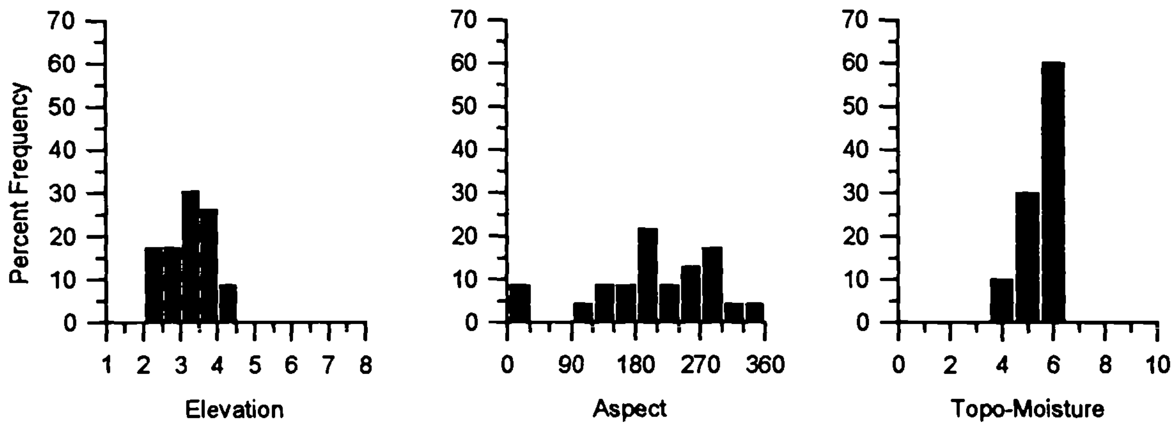


Figure 33. Frequency of PSME/VACA plots by elevation (1000 ft.), aspect, and topographic moisture.

frosty habitats. Gentle slopes and glacial outwash terraces and terrace sideslopes may key to PSME/ARUV but most seem best viewed as a warm-dry extension of the PSME/VACA Association.

VEGETATION

A diverse mixture of lodgepole pine, western larch, ponderosa pine, and Douglas-fir dominates early to mid-seral stands (Table 21). Large western larch are often survivors from previous stands and may be considerably older and larger than the current canopy trees. Douglas-fir is often absent or only a minor component of early seral stands. These stands are often dominated by lodgepole pine, especially if sites have experienced repeated moderate- and high-intensity fires in the past. Ponderosa pine is near its frost limits in this type. Small amounts of Engelmann spruce may be present on restricted, moist microsites. Douglas-fir dominates the regeneration. Lodgepole pine and even

Table 21. Common plants of the PSME/VACA Association (n=12).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	92	24
PICO	lodgepole pine	83	19
LAOC	western larch	75	12
TREE UNDERSTORY LAYER			
PSME	Douglas-fir	100	11
SHRUBS AND SUBSHRUBS			
ARUV	bearberry	100	7
VACA	dwarf huckleberry	100	5
SPBEL	shiny-leaf spirea	92	11
AMAL	serviceberry	92	2
LIBOL	twinflower	83	14
SYAL	common snowberry	75	5
PAMY	pachistima	75	2
SHCA	russet buffaloberry	67	9
LOUT2	Utah honeysuckle	67	5
CHUM	w. prince's pine	67	4
BEAQ	Oregon grape	67	1
HERBS			
CARU	pinegrass	100	27
FRAGA	strawberry spp.	92	4
VIAD	Hook violet	67	2
SMRA	feather solomonplume	58	3
ARCO	heartleaf arnica	50	6

Table 22. Environmental and structural characteristics of the PSME/VACA Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3249	556	2300	4420
Aspect[2]	227	56	--	--
Slope	19	19	1	58
Topographic Moisture	5.50	0.68	4.0	6.0
Soil Surface[3]				
Exposed soil	14	11	5	35
Gravel	21	13	12	38
Rock	1	--	0	2
Bedrock	0	0	0	0
Moss	2	--	2	2
Lichen	2	--	2	2
Litter	50	--	50	50
Diversity[4]				
Richness	24.8	5.5	17	35
N2	9.3	1.9	7	12

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=23).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

ponderosa pine regeneration may occur under open western larch or lodgepole pine canopies.

The undergrowth is a diverse mixture of low shrubs and sub-shrubs set in a pinegrass matrix. Abundant pinegrass cover is common in the PSME/VACA Association and may complicate identification by concealing diagnostic low or prostrate shrubs such as dwarf huckleberry and bearberry. The shrub layer is usually prostrate and hidden by the grasses. Mature stands often appear very open because of the lack of tall shrubs. Bearberry, twinflower, shiny-leaf spirea, dwarf or grouse huckleberry, serviceberry, and common snowberry are all common and abundant shrubs or sub-shrubs. Dwarf huckleberry indicates frost pockets with warm days and cold nights (cold air drainage). Russet buffaloberry may be abundant early in the sere. Bearberry and dwarf huckleberry consistently indicate coarse textured glacial outwash terraces and slopes. Bearberry and, to a lesser extent dwarf huckleberry, also suggest compacted or very stony subsoils that limit root penetration.

Pinegrass is the dominant and characteristic herb. The undergrowth can be dominated by pinegrass in earlier successional stages. Few other herbaceous species are common except strawberry spp., yarrow, and Hook violet. Average species richness is only slightly higher that the Series' average

Figure 34. Photo of the PSME/VACA Association.

(Table 22). However, average heterogeneity (N_2) is well above the Series' average which reflects the often diverse overstory and the large number of abundant low shrubs and subshrubs typically present. Many of these sites were homesteaded and these old homesteads are commonly dominated by lodgepole pine or a variety of weedy grasses and forbs including many introduced species. Highly disturbed stands on glacial outwash in the Little Pend Oreille Wildlife Recreation Area key to the PSME/VACA Association but are at much lower elevations than normal for the association.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Baldhip rose, Oregon grape, bearberry, and snowberry provide fruit used by bear, grouse, non-game birds, and small mammals, as well as browse for wild ungulates. Dense pole-size stands dominated by lodgepole pine may be valuable for wildlife cover. Good herbaceous production, proximity to water and gentle slopes make this association attractive to livestock. Heavy grazing was noted in several stands. Bearberry and twinflower increase (or at least become more evident) as grazing pressure increases. Strawberry increases with disturbance such as grazing while dwarf huckleberry can be eliminated by excessive grazing. Areas used for shade and rest areas by cattle have little herbaceous cover, and may suffer from overuse.

in part, the PSME/VACA Association. Much of this type though represents warmer upland sites than that described for the PSME/VACA type.

Vaccinium caespitosum

dwarf huckleberry

PSME/VAME COMMUNITY TYPE CDS8 14

Pseudotsuga menziesii/Vaccinium membranaceum
Douglas-fir/big huckleberry

DISTRIBUTION AND ENVIRONMENT

The PSME/VAME Community Type can be found on all districts, but is best represented west of the Columbia River in the Kettle Mountains (Figure 35). The type typically occupies moderate to steep slopes on a variety of aspects between 3,500 and 5,000 ft. (Figure 36). It is most often found on mid- to upper-slope positions on fairly well-drained sites.

The regolith is granitic glacial till. Soil textures are gravelly to cobbly silts and loams. Cobble and gravel often make up nearly half of the soil profile. Roots often extend throughout the soil pit profile. These are well- to excessively well-drained soils. Compacted subsoils may occur on habitats transitional to the PSME/VACA Association as indicated by the presence of bearberry. Further analysis indicates that some PSME/VAME stands may be successional to the ABLA2/VAME Community Type, particularly along the Kettle Crest. Early to mid-seral stands of the ABLA2/VAME Community Type may key to PSME/VAME because subalpine fir and Engelmann spruce have been excluded from the area by past disturbance (primarily stand-replacing fires). The presence of moist site indicators (Table 6; p. 38) indicates that the stand is not Douglas-fir climax.

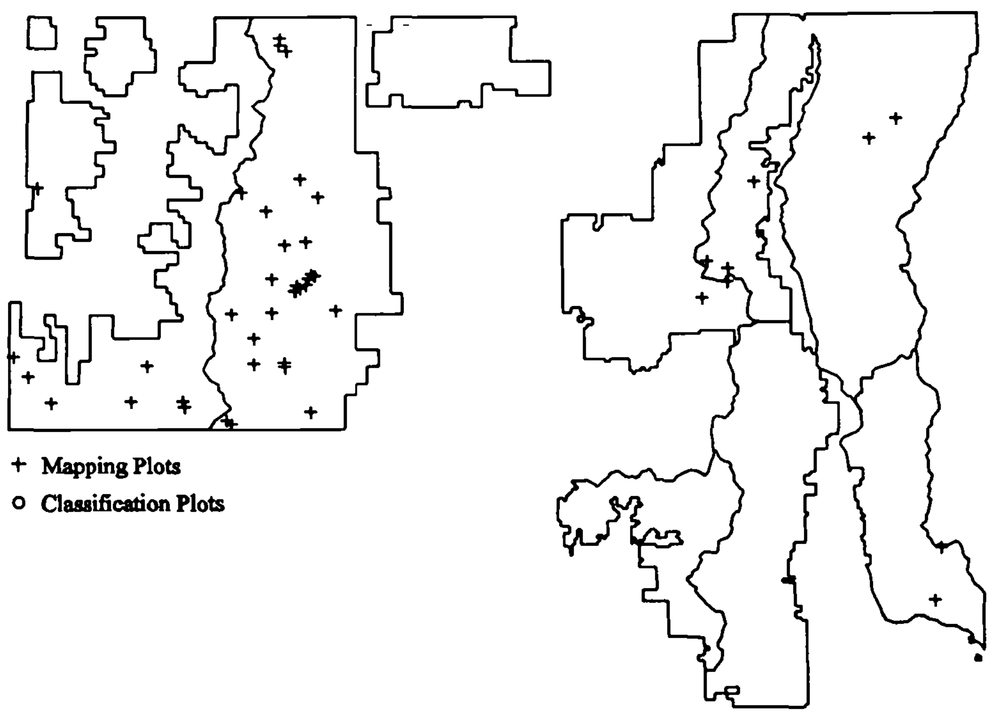


Figure 35. Plot locations for the PSME/VAME Community Type (n=46).

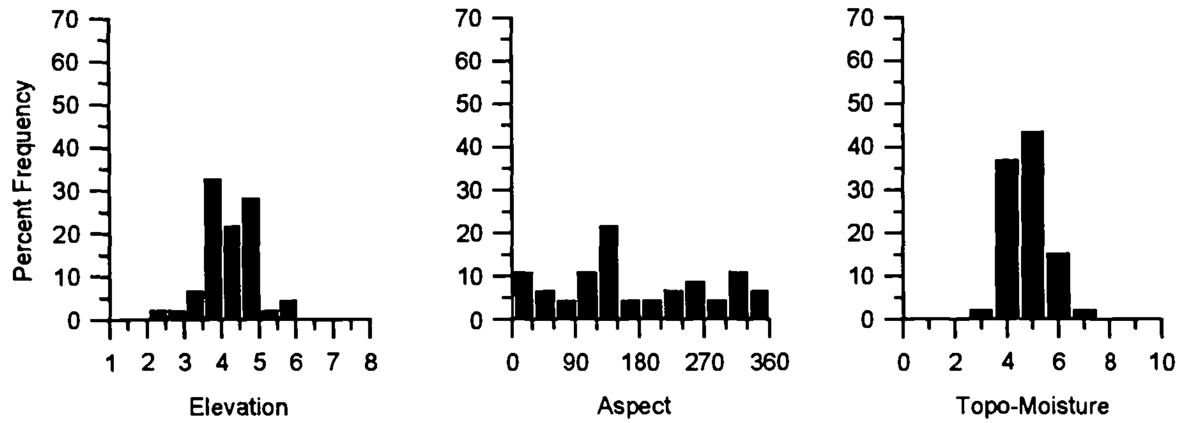


Figure 36. Frequency of PSME/VAME plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

Douglas-fir combined with western larch, lodgepole pine or ponderosa pine dominate the overstory of these stands. Tree regeneration is sporadic, with Douglas-fir the most tolerant tree species present, although small amounts of Engelmann spruce or subalpine fir may also occur on moist microsites.

Abundant big huckleberry mixed with pinegrass is the characteristic undergrowth. The growth form of big huckleberry is relatively low, unlike big huckleberry communities found in the Cascades, where it is much more robust. Pachistima is present in all plots but is normally much less abundant than big huckleberry or pinegrass. Stand-replacement fires appear to be the typical fire event based on stand ages and structures. Repeated underburns may lead to a reduction of shrub cover such that the stands will resemble those of the PSME/CARU Association.

Table 23. Common plants of the PSME/VAME Community Type (n=11).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	100	23
LAOC	western larch	100	16
PICO	lodgepole pine	91	22
TREE UNDERSTORY LAYER			
PSME	Douglas-fir	82	7
SHRUBS AND SUBSHRUBS			
PAMY	pachistima	91	14
SPBEL	shiny-leaf spirea	82	6
LIBOL	twinflower	73	15
AMAL	serviceberry	73	3
ROGY	baldhip rose	64	6
VAME	big huckleberry	55	18
SASC	Scouler willow	55	6
ARUV	bearberry	55	5
BEAQ	Oregon grape	55	5
VAMY	low huckleberry	36	18
HERBS			
CARU	pinegrass	100	21
FRAGA	strawberry spp.	73	2
HIAL	white hawkweed	73	2
CACO	Northwestern sedge	55	2

Table 24. Environmental and structural characteristics of the PSME/VAME Community Type.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4201	665	2500	5880
Aspect[2]	18	34	--	--
Slope	28	16	1	85
Topographic Moisture	4.78	0.81	3.0	7.0
Soil Surface[3]				
Exposed soil	33	11	25	40
Gravel	--	--	--	--
Rock	2	1	1	3
Bedrock	0	0	0	0
Moss	0	0	0	0
Lichen	0	0	0	0
Litter	--	--	--	--
Diversity[4]				
Richness	15.0	4.2	12	18
N2	5.1	0.4	4.8	5.3

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=46).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Berry-producing shrubs are important to a variety of wildlife. Species such as big and low huckleberry, serviceberry, bearberry, Utah honeysuckle and baldhip rose all produce valuable fruits. Berries may be used by bear, grouse, birds and humans. Sites provide good thermal and hiding cover for a variety of wildlife species. Domestic livestock grazing is extensive in some Okanogan N.F. stands. Abundant pinegrass and generally open undergrowth tend to produce moderate forage.

Silviculture- Expect severe reforestation problems with clearcuts. Natural regeneration after mechanical site scarification required approximately 10 years on similar sites in the PSME/VAGL Association in western Montana while broadcast burned sites required more than 15 years (Pfister *et al.* 1977). Artificial regeneration has a low success rate (with 1960's and 1970's techniques) with only 14 of 100 clearcuts rated as successful (Fiedler 1982). Silvicultural techniques that provide partial shade have the best chance of reforestation success. Frost may be a problem on gentle slopes transitional to the ABLA2/VACA or PSME/VACA Associations. Grouse huckleberry indicates

Figure 37. Photo of the PSME/VAME Community Type.

colder than normal conditions.

Shrubs and herbs respond vigorously to overstory removal and may hinder regeneration in clearcuts. Pinegrass may be abundant and pose a reforestation problem. Preharvest species composition of shrub and herb layers, type and timing of treatment, combined with species responses in Appendix 1 can be used to estimate vegetation responses to alternative treatments.

Dwarf mistletoe is common in both Douglas-fir and western larch. As plant succession proceeds, stands tend to develop multiple canopies of Douglas-fir. Such structures provide favorable habitat for defoliating insects such as spruce budworm.

These sites also provide considerable opportunity for berry picking. Big huckleberry stems and rhizomes are brittle so they do not tolerate mechanical disturbance or trampling. The sites are not good locations for recreation developments such as campgrounds if the huckleberries are to be retained. Pinegrass is relatively resistant to trampling damage so is able to maintain soil protection even if moderately disturbed.

COMPARISONS

Big huckleberry (VAME) is closely related to globe huckleberry (VAGL) and the two appear to intergrade in northeastern Washington (see Species Identification and Naming Conventions; p. 24). We use big huckleberry in a broad sense to include any intergrade with globe huckleberry and assume that pure globe huckleberry is absent. Vegetation classifications for Montana (Pfister *et al.* 1977), northern Idaho (Cooper *et al.* 1991) and central Idaho (Steele *et al.* 1981) adopt the opposite position by including all intergrade under a broadly defined globe huckleberry and assume that big huckleberry is absent.

The above mentioned classifications all describe a PSME/VAGL Habitat Type which is similar in many respects to the PSME/VAME type. Montana variants of a broadly defined PSME/VAME or /VAGL type have more ponderosa pine and less western larch as compared to northeastern Washington. Cooper *et al.* (1991) and Steele *et al.* (1981) do not provide data useful for comparison. Similar types have also been described for northeastern Oregon (Johnson and Clausnitzer 1992, Johnson and Simon 1987). The Oregon types differ in having more ponderosa pine as compared to the northeastern Washington type. The PSME/VAMY Association described by Lillybridge *et al.* (1995) for the Wenatchee N.F. is similar to the PSME/VAME type. It differs primarily by having more low huckleberry and ponderosa pine and less big huckleberry.

Vaccinium membranaceum
big huckleberry

GRAND FIR SERIES

GRAND FIR SERIES

Abies grandis

ABGR

DISTRIBUTION AND ENVIRONMENT

Grand fir is ranked lower in shade tolerance than western hemlock, western redcedar, and subalpine fir among the major conifers growing on the Colville N.F. (Minore 1979). Climax grand fir occurs only on sites too dry and/or warm to support subalpine fir, western hemlock or western redcedar. The distribution of grand fir is closely correlated with the inland maritime climate that is best developed east of the Kettle Mountain Crest (Figure 38). Grand fir is extremely scarce west of this area, though isolated stands do occur on the Republic Ranger District. The Grand Fir Series is best developed on the southern portions of the Colville and Newport Ranger Districts (Figure 38). Farther north and east in areas of higher precipitation, the Grand Fir Zone becomes much more restricted, generally located on dry edaphic or topo-edaphic sites due to exclusion by western hemlock and western redcedar. This pattern also occurs in the adjacent panhandle area of Idaho (Cooper *et al.* 1991). South and east of the Colville N.F. (beyond the range of western hemlock and redcedar) grand fir forms a major forest zone on the Clearwater and Nez Perce National Forests. Major grand fir zones also exist in the Blue Mountains of Oregon and Washington (Johnson and Clausnitzer 1992), and on the east slope of the Cascades south of the Entiat River (Lillybridge *et al.* 1995).

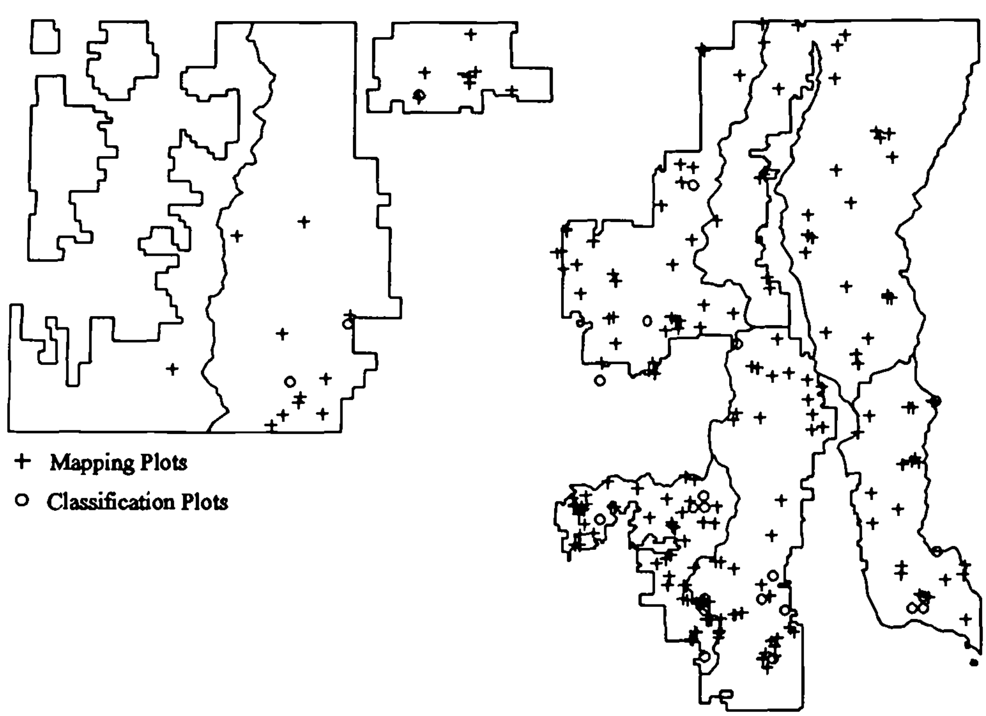


Figure 38. Plot locations for the grand fir series on the Colville National Forest (n=233).

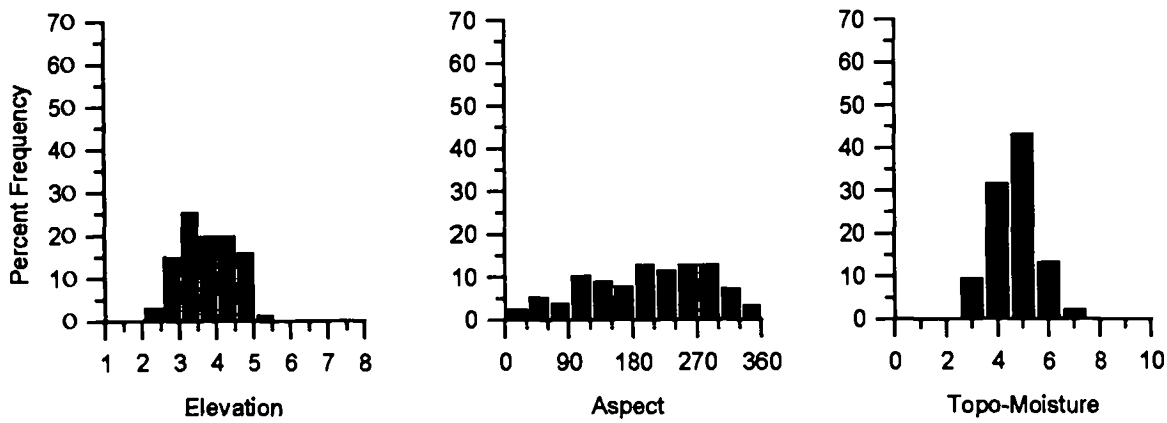


Figure 39. Frequency of Grand Fir Series plots by elevation (1000 ft.), aspect, and topographic moisture.

The Grand Fir Series is found primarily on east to west aspects on mid-to upper-slope positions between 2,500 to 5,000 ft. (Figure 39). It is generally excluded from northern aspects by subalpine fir, western hemlock, or western redcedar, except in the driest portions of it's range where it occupies some northern aspects. Most regoliths are glacial deposits with thick ash caps. Average rooting depth for the Series is the shallowest for the major forest tree series. The Grand Fir Series is largely restricted to relatively warm aspects and excessively drained substrates. The Subalpine Fir Series occurs on colder habitats, while the Western Hemlock and/or Western Redcedar Series occur on more moist habitats. The Douglas-fir Series occurs on drier and warmer habitats.

Grand fir ranks among the most productive tree species on the Colville N.F. It grows rapidly enough to compete with other seral species on moist sites in the Western Hemlock and Redcedar Series and represents a major seral species in these two series on the Colville N.F. Grand fir is occasionally found on moist microsites within the Douglas-fir Series. Douglas-fir is the major seral tree species on nearly all grand fir plant associations, and usually remains a dominant or co-dominant in the stand. Grand fir can form hybrids with both white fir (*Abies concolor*) (Steinhoff 1978) and reportedly also subalpine fir (Daubenmire and Daubenmire 1968), though these hybrids have not been observed on the Colville N.F.

Four plant associations are described for the Series: ABGR/ACGLD/CLUN, ABGR/PHMA, ABGR/VACA, and ABGR/VAME/CLUN. The ABGR/VACA, ABGR/ACGLD/CLUN and ABGR/VAME/CLUN Associations are subdivisions of the more broadly defined ABGR/PAMY Association described for eastern Washington and northern Idaho (Daubenmire and Daubenmire 1968) and the ABGR/CLUN Association for northern Idaho (Cooper *et al.* 1991). The ABGR/PHMA Association is closely related to the PSME/PHMA-LIBOL Association. The ABGR/VACA Association occurs on relatively frosty toe-slopes and bottoms and is generally the lowest elevation and wettest type in the Series (Figure 40). The ABGR/ACGLD/CLUN and ABGR/VAME/CLUN Associations occur

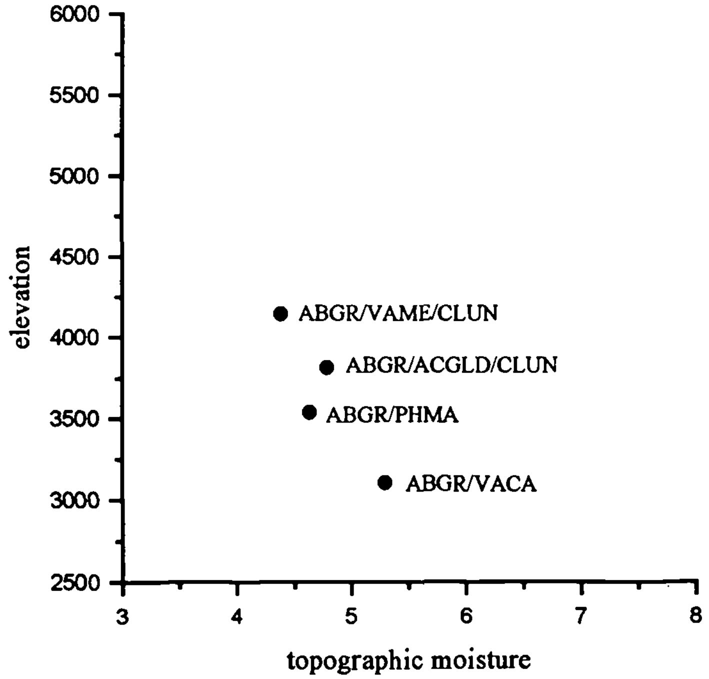


Figure 40. Ordination of grand fir plant associations by elevation and topographic moisture.

on less frosty sites and can be considered the "modal" types for the Series. They are a subdivision of the broad ABGR/CLUN described in the field version of the guide (Williams *et al.* 1990). The ABGR/VAME/CLUN Association occurs on slightly cooler habitats compared to the ABGR/ ACGLD/CLUN Association, and is the highest, driest type in the Series (Figure 3). The ABGR/ PHMA Association generally occurs on habitats with greater percentages of soil coarse fragments and generally drier conditions than in the ABGR/ACGLD/CLUN, ABGR/VAME/CLUN or ABGR/ VACA types. Figure 40 is an ordination of the different grand fir associations comparing elevation and topographic moisture.

VEGETATION

As with most forest stands, seral pathways in the ABGR Series are largely determined by interaction between initial composition, seed source, type and degree of disturbance and time since stand initiation. Widespread fire and other disturbances of the last century left few relict or old growth stands in this Series. Most of the plots used in this study were from stands averaging 100 years old (breast height) or less. Douglas-fir, western larch, lodgepole pine or ponderosa pine dominate most of these seral stands. Grand fir dominance is relatively uncommon and grand fir seldom grows in pure stands except in the Clearwater River drainage of north-central Idaho. Grand fir dominates the tree reproduction layers and is expected to be the overstory dominant in late seral or climax conditions.

Table 25. Diversity components of the Grand Fir Series.

Richness[1]	144	
Number of associations	5	
	Mean	S.E.[2]
Expected richness[3]	185.7	7.3
Expected N2[4]	23.4	2.1
Average richness per plot	32.1	1.1
Average N2 per plot	10.2	0.7

[1] Total number of vascular plant species in the Grand Fir Series data.
[2] Standard error of the estimate.
[3] Jackknife estimate of richness given a sample size of 33 plots.
[4] Jackknife estimate of N2 given a sample size of 33 plots.

Douglas-fir reproduction is also common in these younger stands, which may indicate that this species will be subclimax. All-aged grand fir (with relict Douglas-fir) is the theoretical climax forest for this Series. However, stand replacement fires have kept most stands in early to mid-seral conditions.

As in the Western Hemlock and Western Redcedar Series, the undergrowth is comprised largely of species assigned by Daubenmire and Daubenmire (1968) to the "Pachistima union". Queencup beadlily has been used by Cooper *et al.* (1991) and Pfister *et al.* (1977) as the most useful indicator of the "Pachistima union". Shiny-leaf spirea, common snowberry, big huckleberry, and pachistima are shrubs commonly found across the Series. Queencup beadlily, strawberry spp., white hawkweed, and sweetroot are the few ubiquitous forbs. Queencup beadlily is widespread over much of the Forest, especially east of the Kettle Mountains. Queencup beadlily is of greater indicator value in the Grand Fir Series than in either the Western Hemlock or Western Redcedar Series because the Grand Fir Series tends to define the limits of the strong inland maritime climatic pattern characteristic of northeastern Washington, northern Idaho, northwestern Montana, and portions of southeastern British Columbia.

Average plot richness and average plot heterogeneity (Table 25) are the highest of all series on the Colville N.F. and well above the overall averages. This is in part due to the moderate environment which the Grand Fir Zone represents. Total richness ranks fourth of the five major forest series. Unfortunately these numbers need to be interpreted with caution as the sample size for the Grand Fir Series is relatively small compared to that for the other forest series. In addition, species richness and heterogeneity are often highest for a particular forest type in the early to mid-seral stages. Since most of the stands used to describe the Series are early to mid-seral, richness and heterogeneity estimates can be uniformly high.

Age, diameter and height were recorded for 108 grand fir trees. Of these, 55 were in the Western

Hemlock Series, 33 in the Western Redcedar Series, 15 in the Grand Fir Series and 5 in the Subalpine Fir Series. As with most potential climax tree species, grand fir attains its best growth and development on habitats where it is not the indicated climax dominant. Therefore, it grows best within the Western Hemlock and Western Redcedar Series. Grand fir establishes less readily and grows more slowly on habitats where it is the climax dominant because the environment is drier compared to that of the Western Hemlock and Western Redcedar Series. No sampled grand fir were older than 200 years. Only 23 trees were over 100 years of age and only two were over 150 years old. Therefore, it appears that fire, disease or other disturbances kill most grand fir before their 200th year.

FIRE ECOLOGY

Grand fir has moderately thick bark which may allow it to survive low-to moderate-severity fires (Crane 1991). Grand fir has a higher fire resistance than subalpine fir, western hemlock or Engelmann spruce (Burns and Honkala 1990). Fire resistance of most conifer species is influenced by habitat. Individuals growing on dry uplands are more resistant to fire than trees in moist bottoms due to a deeper root system and thicker bark (Burns and Honkala 1990). However, grand fir has an overall low fire survival rating due to it's low and dense branching habit, shallow rooting system, foliage high in flammable terpenes, and dense stand habit (Smith and Fischer 1995). In addition, individuals surviving fire are highly susceptible to Indian paint fungus which enters through fire scars, causing mortality due to bole rot. Young seedlings and saplings are easily killed by fire and germination rates are very low following fire events (Smith and Fischer 1995).

As with all plant species, the effects of fire on individuals of grand fir and it's associated plant communities depends upon a complex relationship involving current stand composition and structure, type of potential community (environmental conditions) which exists at a particular site, neighboring communities, fire intensity or severity and time of year of the fire. Most of the grand fir communities on the Colville N.F. are ecologically similar to Douglas-fir communities and are generally surrounded by Douglas-fir communities, particularly on the dry extremes. Thus, much of what is known about Douglas-fir fire regimes can be extrapolated to the Grand Fir Series.

Fire regimes for the Grand Fir Series, like most other tree series, differs depending upon the plant association (or PAG) in question. Most grand fir communities are composed of mixed-species stands, similar to many Douglas-fir communities. These stands are usually composed of a mixture of Douglas-fir, ponderosa pine, western larch, lodgepole pine and grand fir. Agee (1994) reports that these kinds of mixed stands show the most frequent fire activity of all eastern Washington forest types. Due to increased levels of fine fuels, these sites show more fire activity than even that of the drier Ponderosa Pine Series. High elevation grand fir communities near the Subalpine Fir Zone, such as ABGR/VAME, are characterized by infrequent, high-intensity fires. This is in contrast with the lower, drier grand fir communities which exhibit more frequent, low-intensity fire activity. Stand-replacement fires with return intervals of 100-200 years have been reported for the cooler, moister grand fir associations, while fire-return intervals of 16-47 years for low-intensity fires have been reported for the drier associations (Agee 1994, Clausnitzer 1994, Johnson and Clausnitzer 1992). The estimated mean fire return interval for the Grand Fir Series in north-central Idaho is reported to be 70 to 120 years (Arno 1980). However, as with the Ponderosa Pine and Douglas-fir Series, human activity through logging and fire suppression has changed the structure and composition of many grand fir stands, favoring the more shade-tolerant species. In consequence, we now see an altered Grand Fir Series with a moderate-to high-intensity, stand-replacement fire regime.

Grand fir was kept subordinate to ponderosa pine and Douglas-fir in the understory of most associations due the historical fire regime. However, modern fire suppression efforts have resulted in more dense, multi-layered stands with a suppressed understory. These structural and compositional changes have led to the present moderate-to-high intensity fire regime due to increases in surface and ladder fuels, allowing fires to move into the canopy. As with both the Ponderosa Pine and Douglas-fir Series, small, low-intensity fires have been effectively controlled by fire suppression. As Agee states (1994), " the only fires realistically capable of affecting the landscape today are those burning under severe weather where fire-suppression efforts have failed". Thus, we've shifted from a low-to-moderate fire intensity regime which favored regeneration-thinned stands with large residuals where shade-tolerant species were nearly eliminated to one of high fire-intensity due to expansion of shade-tolerant species in the understory.

INSECTS AND DISEASE

Historic frequent low-intensity fires not only limit future fire intensity and extent, but also favor conifer species and stand structures which are much more resistant to insects and diseases. Selective harvesting of seral species such as ponderosa pine and western larch, combined with fire suppression, accelerate succession to Douglas-fir and grand fir. Western larch and ponderosa pine are relatively resistant to insects, diseases, and fire. Douglas-fir and grand fir are less resistant, thus making current stands more susceptible to insects, disease, and stand-replacing fires.

Indian paint fungus is very common in old grand fir. Filip *et al.* (1983) found the incidence highest on northerly aspects where grand fir was the primary overstory species and where old trees had a high incidence of wounding. Grand fir stands in late successional stages on moist sites may have decay rates exceeding 80% of total fir volume (Schmitt 1994). Grand fir is also highly susceptible to armillaria root disease, annosus root disease, and laminated root rot. Incidence of armillaria is highest in crowded, mid-successional stands on moist, disturbed sites with a high proportion of grand fir.

Annosus root disease is also common, particularly in managed stands of grand fir where freshly cut stumps and wounds are infected by airborne spores. Selective cutting of seral species such as western larch and ponderosa pine has accelerated the spread of annosus root disease both as a result in the increase in grand fir and through the infection of cut stumps. Centers of this disease are generally small, with a higher incidence on sites with a historical grand fir component. Grand fir stands in mid-to late-successional stages have the highest probability of infection by laminated root rot. In general, fire suppression has caused more continuous root-to-root contact between susceptible hosts, which has allowed the expansion of root diseases from historic (prior to modern fire suppression) sites.

Fir engravers are the main bark beetle causing mortality in grand fir. Research in California, Oregon, and Idaho show a strong correlation between fir engraver attacks and root disease infection. Thus, fire suppression may increase rates of root disease, which in turn may elevate bark beetle risks and increase fuel loads. Drought also predisposes grand fir to bark beetle attacks.

Grand fir on the Colville N.F. is at relatively low risk for western spruce budworm (Flanagan and Hadfield 1995). However, as grand fir expands its dominance within the Series due to fire suppression, the risk may increase. Increased vertical and horizontal layering of Douglas-fir and grand fir can increase the risk of western spruce budworm. Outbreaks that begin in the Douglas-fir Series spread to higher elevations through the Grand Fir Series to the Subalpine Fir Series. Outbreaks this century in other parts of the northwest have increased in extent, severity and duration as shade tolerant hosts increase in dominance following fire suppression efforts (Flanagan and Hadfield 1995). Douglas-fir tussock moth is another potential defoliator of grand fir, although outbreaks typically begin on Douglas-fir trees within the Douglas-fir Series. The best alternative for moderating effects of insects and disease is to restore or maintain a mix of seral species.

In addition, frost cracks and lightning scars appear more frequently on grand fir than other conifers in the Inland Northwest (Burns and Honkala 1990). These cracks can contribute to the spread of infection by decay fungi. In addition, western larch may be heavily impacted by larch dwarf mistletoe in the Grand Fir Series (Flanagan and Hadfield 1995).

MANAGEMENT IMPLICATIONS

Though the Grand Fir Series is somewhat limited in extent on the Colville N.F., it offers diverse silvicultural opportunities due to the productivity of the sites and moderate environments. Mature stands do not normally produce sufficient palatable forage for domestic livestock, though early seral stages may provide moderate forage. The high shrub cover characteristic of some associations provides both forage and cover for wildlife. These relatively warm sites are also important for fawning or calving and spring forage areas. Dense shrubfields are the common early successional stage after logging, fire and other disturbance. Disturbance type, timing, intensity and prior species composition are important determinants of secondary succession. Fall broadcast burns favor redstem ceanothus, Douglas maple and Scouler willow (Irwin and Peek 1979). Fall burns meet the scarification and cold-wet stratification needs of redstem ceanothus while spring burns normally do not provide these requirements. Redstem ceanothus will resprout vigorously if already present before the fire. Its seeds remain viable in the soil for many years and seedlings may be abundant following a wildfire or broadcast burn. Spring burning favors species that resprout from root crowns. Ninebark often forms extensive shrubfields within several associations of the Grand Fir Series, particularly if ninebark was present either in the stand or nearby before the disturbance. Conifer establishment and growth in these dense shrubfields is often slow because of intense competition for light, moisture, and nutrients.

COMPARISONS

The Grand Fir Series has been described throughout the Rocky Mountain region. Daubenmire and Daubenmire (1968) included the Grand Fir/Pachistima Habitat Type in the Western Hemlock Series.

Pfister *et al.* (1977) described the eastern limits of the Series in Montana. Steele *et al.* (1981) described the southern limits of the Series in central Idaho and Clausnitzer and Zamora (1987) describe its southern limits in east-central Washington just south of the Colville N.F. Cooper *et al.* (1991) described the northern and central distribution of the Series in northern Idaho. Interior populations of grand fir reach their northern limits of distribution in British Columbia just north of the border with Idaho but grand fir is not recognized as forming distinctive plant associations there (Meidinger and Pojar 1991). Coastal populations of grand fir are minor components of some of the drier western hemlock and western redcedar plant communities (Henderson *et al.* 1989, 1992), and are found from Vancouver Island, B.C. south to northern California. Grand fir is a major forest component on the east slope of the Cascade Range from the Entiat River (Lillybridge *et al.* 1995) south into central Oregon were the genome intergrades with white fir (*Abies concolor*).

KEY TO PLANT ASSOCIATIONS IN THE GRAND FIR SERIES

Before using the key, the field form in Appendix 4 should be completed. Refer to the "USING THE KEYS" section in the introduction for more specific information on using the key, particularly if the stand in question does not key properly.

Dwarf huckleberry and/or bearberry ≥ 5% .... ABGR/VACA Association p. 105

Big huckleberry ≥ 5% .... ABGR/VAME/CLUN Association p. 110

Douglas maple ≥ 5% .... ABGR/ACGLD/CLUN Association p. 95

Ninebark and/or oceanspray ≥ 5% .... ABGR/PHMA Association p. 100

ABGR/ACGLD/CLUN ASSOCIATION CWS4 22
Abies grandis/Acer glabrum/Clintonia uniflora
grand fir/Douglas maple/queencup beadlily

DISTRIBUTION AND ENVIRONMENT

The ABGR/ACGLD/CLUN Association is primarily found east of the Kettle Mountain Crest (Figure 41). The ABGR/ACGLD/CLUN Association tends to occupy warm and moist, lower- to upper-slope positions on a variety of different aspects (Figure 42). This association represents mesic sites within the Grand Fir Series, though sites are still relatively dry compared to the Western Hemlock and Redcedar Series. Elevations range from 2,400 to 5,100 ft, with an average of 3,813 ft. (Table 27). This association is a subdivision of the ABGR/CLUN Association described in the Colville Field Guide (Williams *et al.* 1990).

The regolith is depositional material (usually glacial drift) of mixed origin. Ash caps of 4 to 20 in. (10 to 50 cm) are common. Soil textures range from silts to sands with considerable coarse fragment content. Surface ash layers are not as deep as those in the THPL/CLUN Association. The ABGR/ACGLD/CLUN type grades into either the ABGR/VAME/CLUN on cooler sites or PSME/PHMA-LIBOL, PSME/PHMA and ABGR/PHMA Associations on drier sites. It grades into the THPL or TSHE Series on more moist sites.

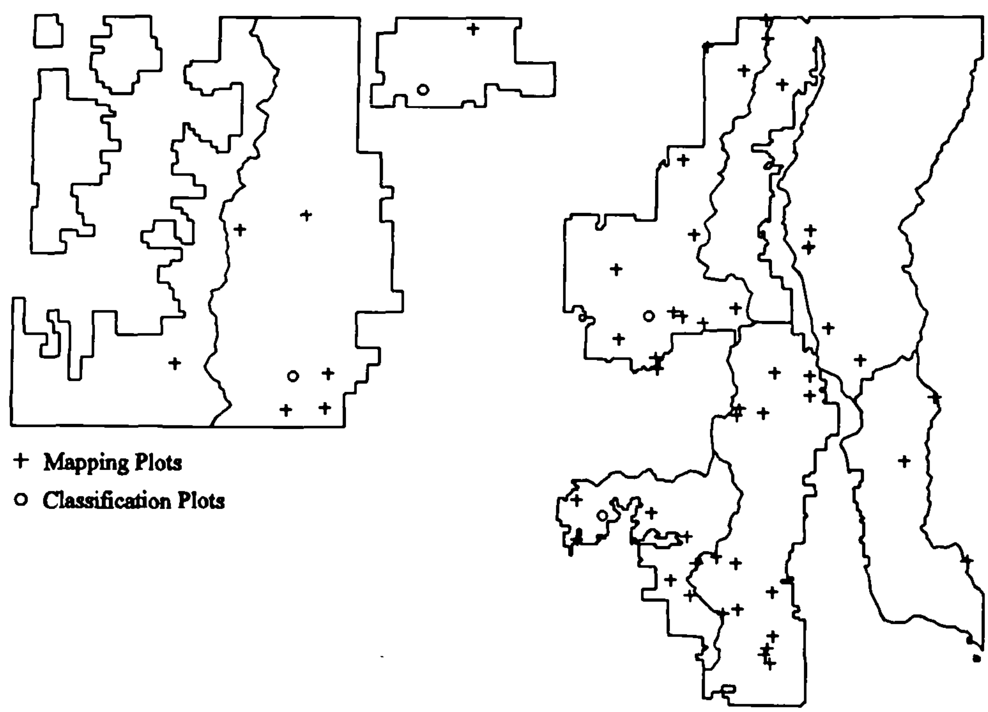


Figure 41. Plot locations for the ABGR/ACGLD/CLUN Association (n=57).

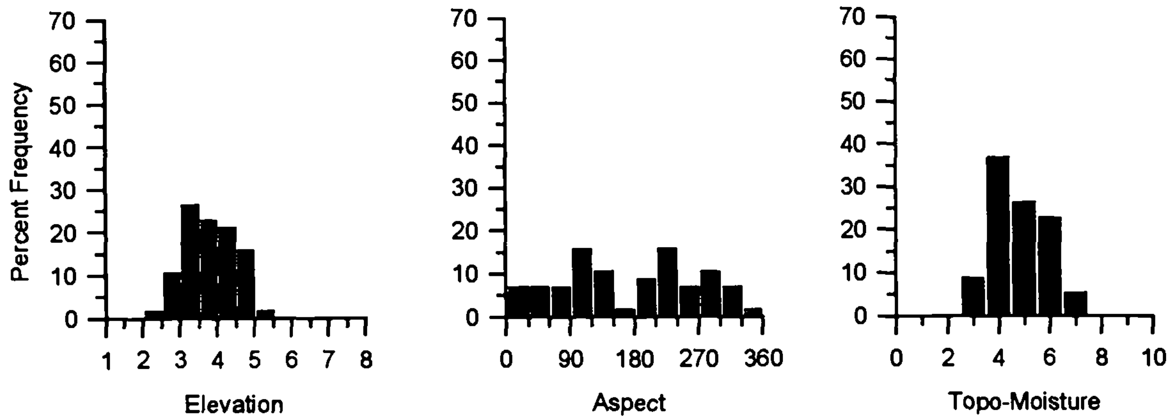


Figure 42. Frequency of ABGR/ACGLD/CLUN plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

The sample size is small and plots are from stands less than 110 years old. Therefore, successional patterns are not clear. Grand fir will theoretically dominate both the overstory and understory in mature stands. Grand fir dominates the reproduction layer in most stands. Douglas-fir or western larch normally dominate the overstory of young stands but grand fir can be dominant. Aspen, lodgepole pine, and ponderosa pine also occur as seral species in some stands.

Some stands that key to the ABGR/ ACGLD/CLUN Association may actually belong to the THPL or TSHE Series. Site degradation and loss of redcedar seed source due to severe fire may have altered succession patterns. Further succession to western redcedar or hemlock on these altered habitats requires both organic matter and nutrient accumulation and may require decades following a disturbance.

Table 26. Common plants of the ABGR/ACGLD /CLUN Association (n=4).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	100	24
LAOC	western larch	75	17
ABGR	grand fir	75	24
TREE UNDERSTORY LAYER			
ABGR	grand fir	82	4
SHRUBS AND SUBSHRUBS			
BEAQ	Oregon grape	100	5
CHUM	western prince's pine	75	4
AMAL	serviceberry	100	2
ACGLD	Douglas maple	100	11
SYAL	common snowberry	100	4
LIBOL	twinflower	100	20
PAMY	pachistima	75	3
HERBS			
ADBI	pathfinder	75	2
OSCH	sweetroot	88	2
FRAGA	strawberry spp.	75	1
SMST	starry solomonplume	100	3
HIAL	white hawkweed	75	2

Table 27. Environmental and structural characteristics of the ABGR/ACGLD/CLUN Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3813	724	2420	5100
Aspect[2]	175	56	5	350
Slope	29	17	1	58
Topographic moisture	4.79	1.06	3.0	7.0
Soil Surface[3]				
Exposed soil	--	--	--	--
Gravel	--	--	--	--
Rock	1	1	0	3
Bedrock	0	0	0	0
Moss	1	1	1	2
Lichen	1	1	0	2
Litter	59	25	30	90
Diversity[4]				
Richness	31.8	6.3	24	39
N2	8.8	4.1	3.4	13.2

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=57).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

An abundant and diverse tall shrub layer characterizes the undergrowth. Douglas-maple, Oregon grape, common snowberry, and serviceberry are common. Twinflower, pachistima and prince's pine are abundant low shrubs and subshrubs. Few herb species are abundant although several are common. Starry solomonplume, sweetroot, pathfinder, white hawkweed, round-leafed violet or queencup beadlily are common. Average plot richness is close to the Series average as is heterogeneity (N_2, Table 27). This is expected for these near modal habitats.

MANAGEMENT IMPLICATIONS

Wildlife/Range- ABGR/ACGL/CLUN sites provide valuable thermal cover for wildlife because of the mix of shrub species. Bear, grouse, non-game birds and small mammals use the fruits of big huckleberry, snowberry, and baldhip rose. These shrubs also provide browse for wild ungulates. Dense pole-size stands may also provide valuable wildlife cover. Early successional stands may be more useful to wildlife due to higher shrub cover. Mature stands provide little forage for livestock compared to early seral stages. Use by domestic livestock was not evident in sample stands.

Figure 43. Photo of the ABGR/ACGLD/CLUN Association.

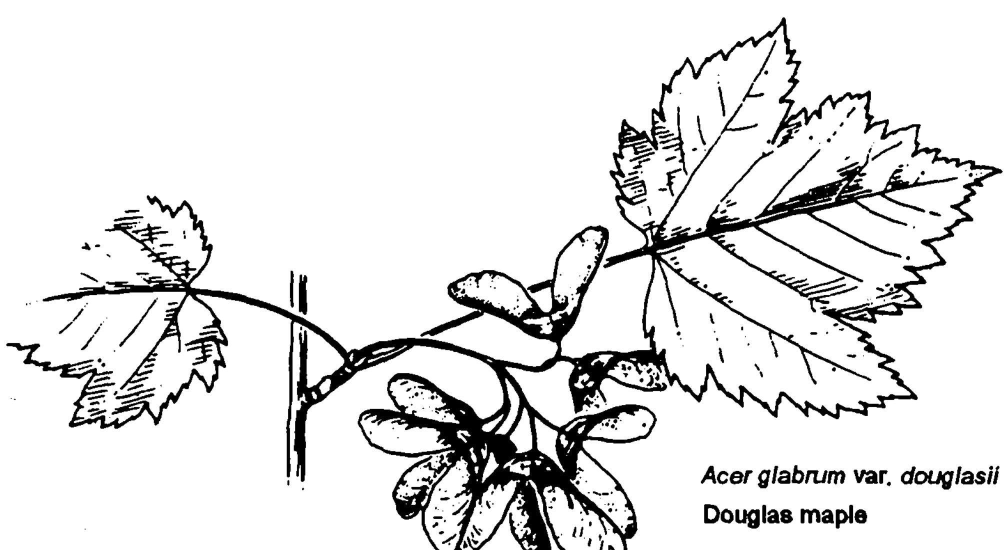
Silviculture- The moderate climate of these sites is favorable for western larch, Douglas-fir, and to a lesser extent, ponderosa pine. These sites appear to be the most productive within the Grand Fir Series, and rank among the highest in growth basal area of all types outside of the Western Hemlock and Western Redcedar Series (appendix 2).

Ninebark and oceanspray are present in some stands and can seed in and dominate south or west aspects after tree canopy removal. These shrubfields may hinder reforestation efforts and attempts to plant shade-intolerant western larch and ponderosa pine. However, shrub canopy shade may benefit regeneration of shade-tolerant grand fir compared to attempting to establish it in the open. Prescribed burning usually increases shrub cover, especially ceanothus. Redstem ceanothus becomes most abundant after fall burns while Douglas maple, common snowberry and ninebark (species that vigorously resprout from root crowns) are favored more by spring burns. Burned units are slower to reforest because of increased shrub competition while unburned units succeed more quickly to a mixture of conifers (Wittinger *et al.* 1977). This study also concluded that grand fir becomes established more quickly on unburned sites. Most shrubs are stimulated by slashing and other treatments that cause root crowns to resprout. In general, reforestation with a mix of species and low stand density is a long-term investment in healthy forests.

COMPARISONS

The ABGR/ACGLD/CLUN Association is a subdivision of the ABGR/CLUN Association described in the field version of this guide (Williams *et al.* 1990). The ABGR/CLUN type as described in the field guide contained considerable variation and warranted division into the warmer ABGR/ACGLD/CLUN and cooler ABGR/VAME/CLUN types based on consistent differences in floristics and environmental characteristics.

The ABGR/ACGLD/CLUN Association is part of the broadly defined ABGR/PAMY Association of Daubenmire and Daubenmire (1968). Subsequent workers in the northern Rocky Mountains have used queencup beadlily as the indicator of the Pachistima Union of Daubenmire and Daubenmire (1968). For examples see Cooper *et al.* (1991), Pfister *et al.* (1977) and Steele *et al.* (1981). All of these studies recognize an ABGR/CLUN Association that they subdivide into phases. The ABGR/ACGLD/CLUN Association generally equates to the CLUN phase of the ABGR/CLUN Association (Cooper *et al.* 1991). Johnson and Clausnitzer (1992) and Johnson and Simon (1987) describe an ABGR/CLUN Association in northeastern Oregon. That type is similar but contains more Engelmann spruce and grand fir. Johnson and Simon (1987) had a much larger sample of older stands which may account for some of the differences. Steele *et al.* (1981) also describe an ABGR/ACGL Association which is similar, but contains more subalpine fir and less western larch and lodgepole pine than the Colville N.F. type. Clausnitzer and Zamora (1987) have a broadly defined ABGR/LIBO2 (grand fir/twinflower) type from the adjacent Colville Indian Reservation that is very similar. However, that type includes species such as Pacific yew that are absent from the Colville N.F. stands.



Acer glabrum var. *douglasii*
Douglas maple

ABGR/PHMA ASSOCIATION CWS4 21
Abies grandis/Physocarpus malvaceus
grand fir/ninebark

DISTRIBUTION AND ENVIRONMENT

The ABGR/PHMA Association was sampled east of the Kettle Mountain Crest (Figure 44). It is the most common grand fir association on the Colville N.F. This association occupies warm and dry, lower-to upper-slope positions on east to west aspects (Figure 45). Seventy percent of the plots were on aspects between 90-300 degrees, and averaged 215 degrees (Table 29). Elevations range from 2,100 to 5,000 ft. The majority of the plots (80%) were located between 2,500 and 4,500 ft. (Figure 45). The ABGR/PHMA Association typifies the driest environment capable of consistently supporting grand fir on the Forest.

Soil in the single intensive sample is derived from mixed glacial material with 2.8 in. (7 cm) of ash on the surface. Reconnaissance plots indicate glacial material or colluvium as the predominant regolith. Coarse fragments range from 25 to 50% (estimate using reconnaissance data). It grades into the Douglas-fir Series (especially the PSME/PHMA and PSME/PHMA-LIBOL Associations) on drier habitats. It grades into the ABGR/CLUN or the THPL/CLUN or THPL/ARNU3 Associations on more moist habitats. The earliest drafts of this guide referred to the type as the ABGR/HODI

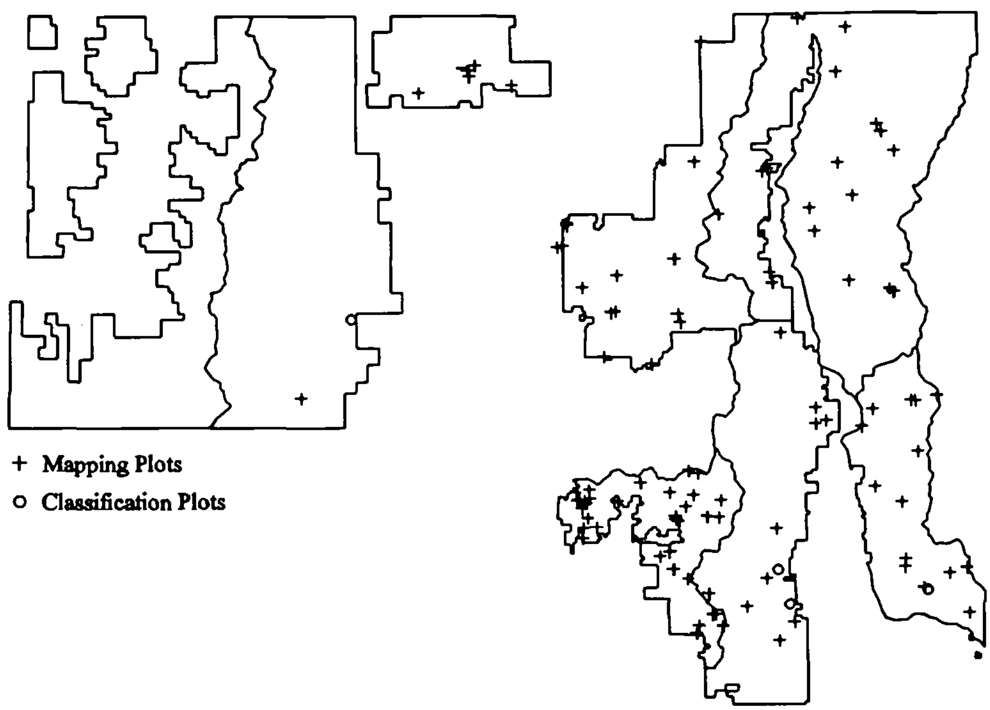


Figure 44. Plot locations for the ABGR/PHMA Association (n=110).

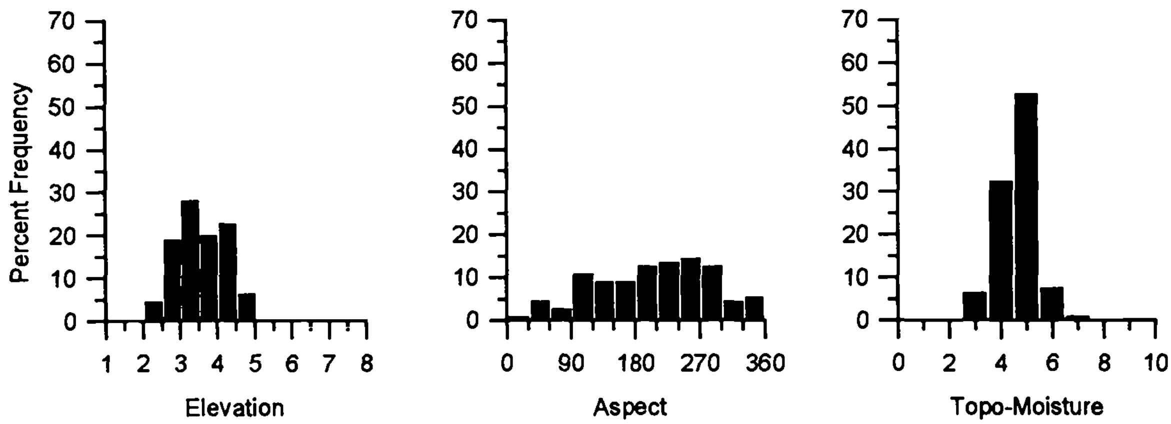


Figure 45. Frequency of ABGR/PHMA plots by elevation (1000 ft.), aspect, and topographic moisture.

Association.

VEGETATION

Grand fir is expected to dominate mature stands and is normally a minor component of seral stands. However, even in older stands, grand fir may not be well represented because these sites are near its environmental limits. Grand fir usually dominates the tree regeneration layer. Stands where grand fir seed sources have been removed by past fire are often nearly indistinguishable from the PSME/PHMA or PSME/PHMA-LIBOL Associations. These stands have a past history of frequent underburning, which further reduces grand fir composition. Douglas-fir and ponderosa pine dominate the overstory of early and mid-seral stands and are long-persisting seral species. Neither lodgepole pine nor western white pine do well on these warmer sites.

Table 28. Common plants of the ABGR/PHMA Association (n=7).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	100	37
LAOC	western larch	71	5
PIPO	ponderosa pine	57	22
TREE UNDERSTORY LAYER			
ABGR	grand fir	71	2
SHRUBS AND SUBSHRUBS			
HODI	oceanspray	100	9
SPBEL	shiny-leaf spirea	100	7
ROGY	baldhip rose	100	6
AMAL	serviceberry	100	2
PHMA	ninebark	86	13
PAMY	pachistima	86	3
ACGLD	Douglas maple	86	2
VAME	big huckleberry	71	2
HERBS			
HIAL	white hawkweed	100	2
SMST	starry solomonplume	86	5
OSCH	sweetroot	86	2
ADBI	pathfinder	71	8
CARU	pinegrass	71	6
CLUN	queencup beadlily	57	2
CARO	Ross sedge	57	2
FEOC	western fescue	57	1

Table 29. Environmental and structural characteristics of the ABGR/PHMA Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3537	648	2100	5000
Aspect[2]	215	46	4	356
Slope	34	17	2	72
Topographic moisture	4.64	0.75	3.0	7.0
Soil Surface[3]				
Exposed soil	33	12	15	50
Gravel	25	14	12	38
Rock	0	--	0	0
Bedrock	0	0	0	0
Moss	1	--	1	1
Lichen	0	--	0	0
Litter	35	--	35	35
Diversity[4]				
Richness	29.9	4.8	23	35
N2	10.4	1.9	8.0	13.0

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=111).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

Ninebark, Oregon grape, baldhip rose,common snowberry, shiny-leaf spirea, serviceberry and ocean-spray dominate the diverse tall shrub layer. Douglas maple, big huckleberry, pachistima, and prince's pine are other common shrubs and subshrubs.

Pinegrass, sweetroot, starry solomonplume, strawberry spp., and white hawkweed are the most common herbs. Herbaceous cover is typically low, although pinegrass may constitute a dominant herb layer in young or open stands. However, high shrub cover in later seral stages will reduce the graminoid component. Shrub and herb layers resemble early seral stages of the THPL/CLUN or even the TSHE/CLUN Associations when these latter types are on dry southeast to west aspects. Richness and heterogeneity are slightly lower than Series' averages (Table 29). Although this is the driest of associations within the Series, diversity is not significantly different from the Series' average.

MANAGEMENT IMPLICATIONS

Wildlife/Range- These sites, particularly ones in early seral stages, constitute important thermal and hiding cover for big game. This benefit is often year-long, with both winter and summer use. Sites

Figure 46. Photo of the ABGR/PHMA Association.

also provide important forage areas in the winter, especially in the earlier seral stages. Big huckleberry, snowberry and baldhip rose provide fruit for bear, grouse, non-game birds and small mammals. They also provide browse for wild ungulates. Dense pole-size stands may be valuable for wildlife cover. Early successional stands may be more useful to wildlife, especially if shrub cover is high. Livestock use is virtually non-existent except in early seral stages with higher grass components. Heavy grazing in early seral stands can reduce the productivity of grassy species and increase Douglas-fir and grand fir regeneration.

Silviculture- Site indices range from moderate to very high in northern Idaho for all seral and climax species. Douglas-fir and ponderosa pine should be favored for reforestation (Cooper *et al.* 1991). Overstory removal often leads to a persistent shrub layer that hinders subsequent tree reproduction. Silvicultural techniques for this and similar plant associations usually include group selection, shelterwood, or seed-tree prescriptions (Fiedler 1982, Ryker and Losensky 1983). Shelterwoods are suggested for relatively dry southerly slopes just as in the PSME/PHMA and PSME/PHMA-LIBOL Associations. Grand fir will be favored by shelterwoods. However, the alternative of severe reforestation difficulties is less desirable than increasing grand fir dominance within a stand.

Stand structure, composition, and productivity can be maintained in stands dominated by seral

Douglas-fir, western larch or ponderosa pine through a combination of underburning and partial or group cutting (Fiedler 1982). Dominance by these seral species can also be perpetuated by frequent, low-intensity fires which will help to maintain the pre-settlement stand structure (Smith and Fischer 1995). In addition, shrub cover, which represents important thermal and hiding cover as well as forage in winter for big game, can be maintained by fires every 30-60 years (Barrett and Arno 1991).

In addition, prescribed underburning can be used to prepare sites for western larch and ponderosa pine regeneration as well as decrease slash and/or natural fuel loads. Success rates for ponderosa pine and western larch germination increase on burned seedbeds under partial cuts. Dry fall burns produce twice as many seedlings as moist spring burns (Simmerman *et al.* 1991). Infection by mistletoe and root diseases, spruce budworm infestation, and severe fire behavior all increase in stands where dense Douglas-fir and grand fir dominate (Anderson *et al.* 1987, Byler *et al.* 1990). Prescribed fire and/or mechanical methods can be used to reduce or remove large quantities of woody fuels. The use of two-to-three prescribed fires when fuel moistures are high is recommended in such situations by Mutch *et al.* (1993). Steele *et al.* (1986) and Zimmerman (1979) suggest managing dense Douglas-fir regeneration through the use of fire, or fire combined with some harvesting method.

Seedling establishment on cleared sites can be improved by broadcast burning and by reducing competition from shrubs and herbs for up to one year (Steele and Geier-Hayes 1989). However, decaying wood reservoirs in the soil are critical rooting zones and must be protected by avoiding the use of severe fire (Harvey 1982). Competition from other plants, including bracken fern (*Pteridium aquilinum*), can be reduced by scarification, though this may increase pocket gopher activity and soil displacement. Arno *et al.* (1985) report decreases in pinegrass and increases in *Ribes* spp. (alternate host for white pine blister rust) following scarification.

COMPARISONS

This association combines characteristics of both the ABGR/CLUN Habitat Type-PHMA Phase and the ABGR/PHMA Habitat Type of northern Idaho (Cooper *et al.* 1991). The limited sample from the Colville N.F. is not sufficient to distinguish between the two types. The ABGR/ACGL Habitat Type-PHMA Phase of central Idaho (Steele *et al.* 1981) also appears to have some similarities to the ABGR/PHMA Association on the Colville N.F., as does the ABGR/HODI type described for central Washington (Lillybridge *et al.* 1995).

ABGR/VACA ASSOCIATION CWS8 21
Abies grandis/Vaccinium caespitosum
grand fir/dwarf huckleberry

DISTRIBUTION AND ENVIRONMENT

The ABGR/VACA Association is a minor type found on the four ranger districts east of the Kettle Mountain Crest (Figure 47). It is the least common type within the Grand Fir Series. This type typically occurs in lower elevation frost-pocket areas on frosty and relatively dry gentle lower slope or bench positions. Elevations range from 2,270 to 4,250 ft. (Table 31). The majority of sites are below 3,500 ft. (Figure 48). Microrelief is almost uniformly flat or concave.

The regolith is coarse glacial deposits with ash caps of 1.6 to 18 in. (4 to 46 cm). Soil textures are silt loams or sandy loams. Coarse fragments range from 4 to 68% and surface rock is scarce to absent. Average rooting depth is slightly above the Series average. Soils are sometimes compacted. The ABGR/VACA Association represents a warm day-frosty night temperature regime on well drained glacial outwash deposits. These very well-drained sites are dry, though adjacent sites with finer textured soils may support the ABGR/ACGL/CLUN Association or types within the THPL and TSHE Series. Some stands that key to the ABGR/VACA type may actually belong to the THPL/CLUN or TSHE/CLUN Associations. Repeated wildfire, homestead activities, tree harvest or

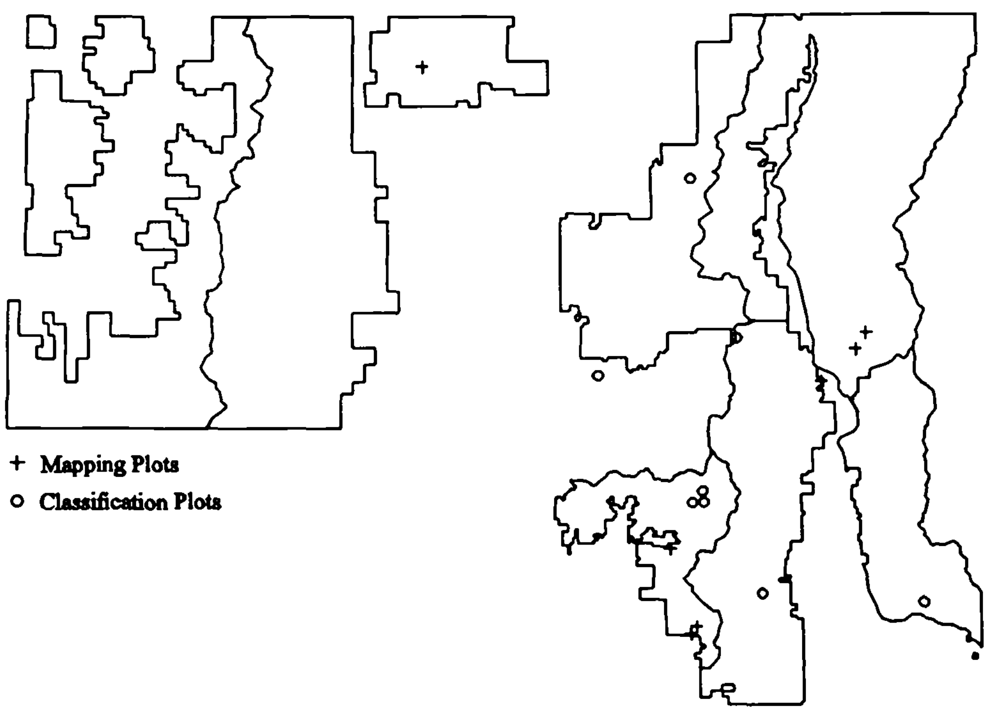


Figure 47. Plot locations for the ABGR/VACA Association (n=16).

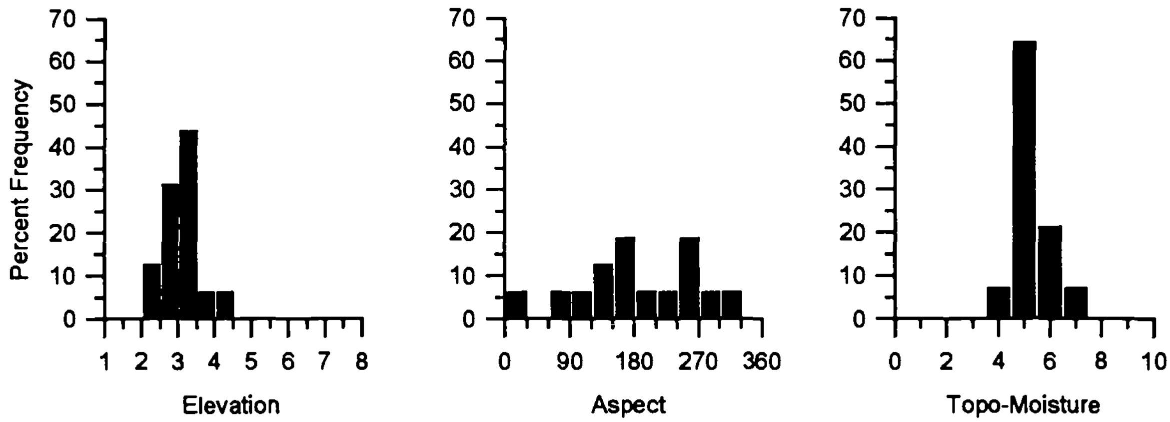


Figure 48. Frequency of ABGR/VACA plots by elevation (1000 ft.), aspect, and topographic moisture.

intense prescribed fires may have degraded site potential on these habitats. Organic matter and available nutrients may first need to accumulate to levels that western redcedar and western hemlock need to survive.

VEGETATION

The conifers in these stands are less than 100 years old and stands are in relatively early successional stages. Most stands are a mix of early seral species. Lodgepole pine, Douglas-fir and (less commonly) western larch dominate the overstory of these young stands. Overstories dominated by ponderosa pine or grand fir are uncommon. All-aged grand fir is the theoretical climax forest as it appears to be the most shade tolerant and competitive tree capable of reproducing on these habitats. Western hemlock, western redcedar, subalpine fir and Engelmann spruce may be present but are confined to moist microsites and do not appear capable of eventually

Table 30. Common plants of the ABGR/VACA Association (n=9).

		CON	COVER
TREE OVERSTORY LAYER			
PICO	lodgepole pine	100	19
PSME	Douglas-fir	100	10
LAOC	western larch	89	20
TREE UNDERSTORY LAYER			
PSME	Douglas-fir	100	4
ABGR	grand fir	100	4
SHRUBS AND SUBSHRUBS			
ROGY	baldhip rose	100	5
BEAQ	Oregon grape	100	4
PAMY	pachistima	100	3
LIBOL	twinflower	89	10
ARUV	bearberry	89	8
SPBEL	shiny-leaf spirea	89	7
LOCI	trumpet honeysuckle	89	3
SYAL	common snowberry	78	7
VACA	dwarf huckleberry	67	3
COCA	bunchberry dogwood	56	9
SHCA	russet buffaloberry	56	9
HERBS			
CARU	pinegrass	100	17
SMST	starry solomonplume	67	7
CLUN	queencup beadlily	56	3
FEOC	western fescue	56	2

Table 31. Environmental and structural characteristics of the ABGR/VACA Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3105	476	2270	4250
Aspect[2]	162	65	1	330
Slope	12	13	1	41
Topographic moisture	5.3	0.73	4.0	7.0
Soil Surface[3]				
Exposed soil	22	23	1	60
Gravel	8	6	1	12
Rock	7	15	0	38
Bedrock	0	0	0	0
Moss	3	1	2	5
Lichen	1	1	0	2
Litter	26	7	15	35
Diversity[4]				
Richness	37.8	6.0	29	47
N2	13.9	4.7	6.3	21.7

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=16).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

occupying these habitats under current climatic conditions. Ponderosa pine occurrence and abundance is erratic on these frost prone sites.

The undergrowth is comprised of a diverse and abundant mixture or low growing shrubs and subshrubs. Bearberry, Oregon grape, western prince's pine, twinflower and either dwarf huckleberry or low huckleberry are the most abundant shrubs and subshrubs. Other common shrubs include pachistima, shiny-leaf spirea, snowberry, serviceberry and baldhip rose. Russet buffaloberry is usually present and often dominates in areas burned by hot fire. Such stands resemble the PICO/SHCA Community Type unless grand fir is present in the reproduction layer.

The undergrowth can be dominated by pinegrass in early successional stages. Pinegrass is common and generally abundant except where heavily grazed. Dwarf huckleberry may be difficult to detect because of pinegrass swards and because it is generally mixed with other huckleberry species. Dwarf huckleberry and bunchberry dogwood indicates frost pockets with warm days and cold nights. Bearberry and dwarf huckleberry consistently indicate coarse textured glacial outwash terraces and slopes. Bearberry and, to a lesser extent dwarf huckleberry, also suggest compacted or very stony subsoils that limit root penetration. Average plot richness and heterogeneity are the highest of any

Figure 49. Photo of the ABGR/VACA Association.

association within the Series (Table 31). The diverse overstory canopy, in combination with a warm day-frosty night microclimate, appears to create a large set of niches or microhabitats for different species within a stand. Abundant grouse huckleberry indicates colder than normal habitats.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Baldhip rose, Oregon grape, bearberry, and snowberry fruits are used by bear, grouse, non-game birds and small mammals. They are also used as browse by wild ungulates. Dense pole-size stands may be valuable for wildlife cover. Strawberry, bearberry and twinflower increase (or at least become more evident) as grazing pressure increases. Good herbaceous production, proximity to water and moderate slopes make this association attractive to livestock. Heavy grazing was noted in several stands. Seeding for erosion control may not be necessary because rhizomatous and stoloniferous species are common.

Silviculture- Frost potential on these sites is high. Therefore slope position, topography and air drainage patterns must be considered in management activities. However, these sites are apparently less frosty than the similar ABLA2/VACA Association. Lodgepole pine is the most tolerant species to frost and compacted soils. Ashy soils are easily compacted when moist and/or displaced by heavy equipment. Western larch also thrives on these habitats and natural regeneration may be prolific if soils are not compacted and severe frost pockets are avoided. Many of these terraces were homesteaded and these old homesteads are commonly dominated by lodgepole pine and a variety of weedy grasses and forbs including many introduced species.

Fire suppression will favor grand fir. Severe fire and/or scarification of the site should lead to increases in pinegrass. Pinegrass may hinder regeneration if preharvest cover is high. Ninebark may become abundant if seed sources are available. Clearcuts tend to favor lodgepole pine, though full stocking may require more than 20 years. In addition, some clearcutting patterns may increase the pooling of cold air which allows lodgepole pine to dominate where other species may have been previously established. Gentle slopes or benches with pinegrass make good locations for campgrounds and similar uses. However, dwarf huckleberry is easily eliminated by mechanical equipment or trampling. Bearberry and pinegrass are relatively resistant to mechanical damage.

COMPARISONS

An ABGR/VACA Habitat Type is described in central Idaho (Steele *et al.* 1981). In that region dwarf huckleberry is interpreted as being a less important site indicator than queencup beadlily (*i.e.* all stands with queencup beadlily are identified as ABGR/CLUN). In northeastern Washington the situation is reversed, and dwarf huckleberry is considered to have a more restricted environmental amplitude. It is therefore used in the key before queencup beadlily and queencup beadlily is present in some stands. The ABGR/VACA Association is similar to the ABGR/LIBOL Association reported on the Colville Indian Reservation (Clausnitzer and Zamora 1987) and in northeast Oregon (Johnson and Clausnitzer 1992). The ABGR/LIBO Habitat Type-LIBO Phase described for northern Idaho (Cooper *et al.* 1991) is also similar, though lodgepole pine was uncommon in the type. Pfister *et al.* (1977) describe an ABGR/ARNU3 Habitat Type in Montana in which some sites appear to be similar to the ABGR/VACA Association described for the Colville N.F.

ABGR/VAME/CLUN-COL ASSOCIATION CWS2 14

Abies grandis/Vaccinium membranaceum/Clintonia uniflora
grand fir/big huckleberry/queencup beadlily

DISTRIBUTION AND ENVIRONMENT

The ABGR/VAME/CLUN Association was sampled east of the Kettle Mountain Crest (Figure 50). It is most common on the southern portions of the Colville and Newport Ranger Districts. It tends to occupy cool, dry mid-to upper-slope positions on south to west aspects (Figure 51). Average elevation was 4,143 ft., and ranged from 2,570 to 5,150 ft. (Table 33). The ABGR/VAME/CLUN Association generally occurs on colder and slightly drier sites than those supporting the ABGR/ACGLD/CLUN Association. This association is a subdivision of the ABGR/CLUN Association described in the Colville Field Guide (Williams *et al.* 1990).

The regolith is variable and includes glacial drift, saprolitic shales and granodiorite. Ash caps of 4 to 12 in. (10 to 30 cm) are typical. Soil textures range from silts to sands and contain considerable coarse fragments. Effective rooting depths are the deepest of the Series. Summer soil temperatures at 20 in. (50 cm) average 8.0 °C, which is the coolest of any soil in the Series. The ABGR/VAME/CLUN type grades into the ABGR/PHMA or PSME/PHMA-LIBOL Associations on drier sites and into the THPL/CLUN or THPL/ARNU3 Associations on more moist sites.

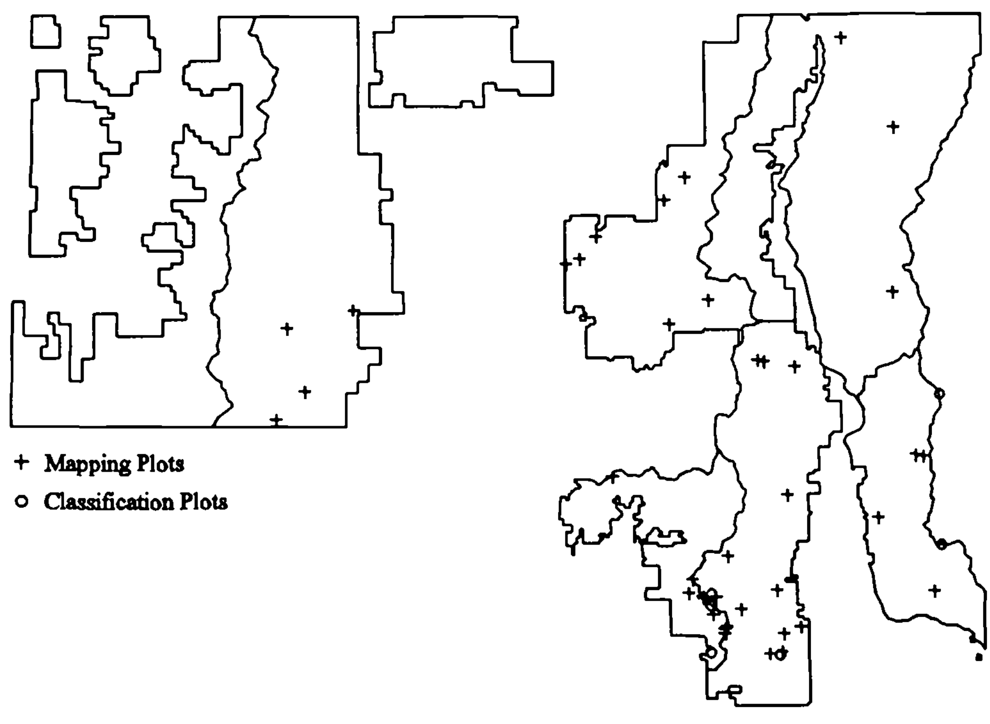


Figure 50. Plot locations for the ABGR/VAME/CLUN Association (n=49).

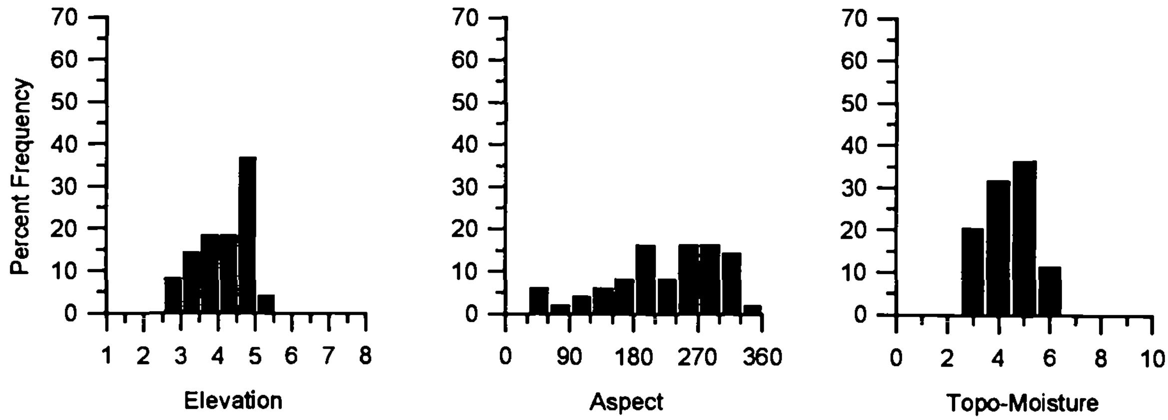


Figure 51. Frequency of ABGR/VAME/CLUN plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

All-aged grand fir is expected to dominate mature stands of ABGR/VAME/CLUN. Douglas-fir and western larch dominate the overstory of most seral stands. However, grand fir is occasionally an overstory component in relatively young stands. Stands occasionally contain lodgepole pine and western white pine but they do not seem to dominate. Grand fir is the most successfully reproducing tree species. Trace amounts of subalpine fir reproduction occur in a few stands.

A diverse mixture of medium and low shrubs combined with mesophytic herbs characterizes the undergrowth. Abundant big huckleberry and baldhip rose are the most prominent shrubs. Ninebark may be abundant in a few stands. Other common shrubs include serviceberry, shiny-leaf spirea, Utah honeysuckle, and mountain ash.

Starry solomonplume, western meadowrue,

Table 32. Common plants of the ABGR/VAME /CLUN Association (n=8).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	100	38
LAOC	western larch	100	12
ABGR	grand fir	75	23
TREE UNDERSTORY LAYER			
ABGR	grand fir	75	3
SHRUBS AND SUBSHRUBS			
SPBEL	shiny-leaf spirea	100	6
PAMY	pachistima	75	3
ROGY	baldhip rose	88	10
AMAL	serviceberry	100	3
LOUT2	Utah honeysuckle	100	4
SOSC2	mountain ash	88	2
VAME	big huckleberry	100	23
HERBS			
THOC	western meadowrue	100	4
ADBI	pathfinder	75	9
BRVU	Columbia brome	88	2
SMST	starry solomonplume	100	5
OSCH	sweetroot	100	3
CLUN	queencup beadlily	100	3
VIOR2	round-leaved violet	100	3

Table 33. Environmental and structural characteristics of the ABGR/VAME/CLUN Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4143	689	2570	5150
Aspect[2]	241	33	40	360
Slope	31	17	1	73
Topographic moisture	4.39	0.95	3.0	6.0
Soil Surface[3]				
Exposed soil	24	25	1	70
Gravel	25	18	12	38
Rock	17	20	0	38
Bedrock	0	0	0	0
Moss	2	1	0	3
Lichen	0	1	0	1
Litter	38	28	0	65
Diversity[4]				
Richness	28.3	3.5	24	34
N2	7.0	1.8	4.6	21.7

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=49).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

round-leafed violet, queencup beadlily, and sweetroot are the most common and abundant herbs. Pathfinder may be prominent in some stands. Other common herbs include sweetscented bedstraw, common brome, northwestern sedge, feather solomonplume, and white hawkweed. Average plot richness and heterogeneity are the lowest for any association in the Series (Table 33). The low heterogeneity indicates strong dominance by relatively few species (typically shrubs) in this association. While richness is low compared to other ABGR associations, it is still relatively high when compared to most other forest associations.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Wildlife values for thermal cover are high because of the mix of shrub species and the relatively warm aspects that become snow-free early. Big huckleberry provides food and cover for a variety of big game, small mammal and avian species. Dense pole-size stands may be valuable for wildlife cover. Early successional stands may be especially useful to wildlife if shrub cover is high. Mature stands provide little forage for livestock. Early seral stages may provide moderate forage. Use by domestic livestock was seldom evident in sample stands.

Figure 52. Photo of the ABGR/VAME/CLUN Association.

Silviculture- Successional responses to logging are related to the type of activity (broadcast burning, machine scarification, etc.) and to the season of disturbance. Shrubfields which develop after clearcutting may hinder reforestation. Burning generally increases the shrub cover on most sites. Most shrubs are stimulated by slashing and other treatments that cause root crowns to resprout. Ninebark establishment and dominance after tree canopy removal can be expected if a seed source is near. Redstem ceanothus (if present) becomes most abundant after fall burns while Douglas maple, common snowberry, ninebark and similar species that vigorously resprout from root crowns are favored by spring burns. Burned units are slower to reforest because of increased shrub competition while unburned units succeed more quickly to a mixture of conifers (Wittinger *et al.* 1977). Efforts to plant shade-intolerant western larch and ponderosa pine in established shrubfields may fail unless competition from overtopping shrubs is reduced. However, shade from shrubs may benefit grand fir regeneration. Seed tree cuts produce the highest rates of natural ponderosa pine and western larch regeneration on these sites, especially in lightly scarified stands (Steele *et al.* 1981).

Big huckleberry is sensitive to both high-intensity fires as well as mechanical scarification of the top six inches of the soil and duff due to its' shallow rhizomes. Also, unseasonably cold temperatures in winter in the absence of a deep, insulating snowpack can cause significant topkill in big huckleberry (Clausnitzer 1994). Thus, on sites exposed to intense sun and wind, any form of canopy removal decreases VAME apparently because snowpack does not remain on the site to protect stems from lethal winter temperatures (Arno *et al.* 1985). The recreational use of big huckleberry shrubfields for berry-picking attracts many visitors in late summer.

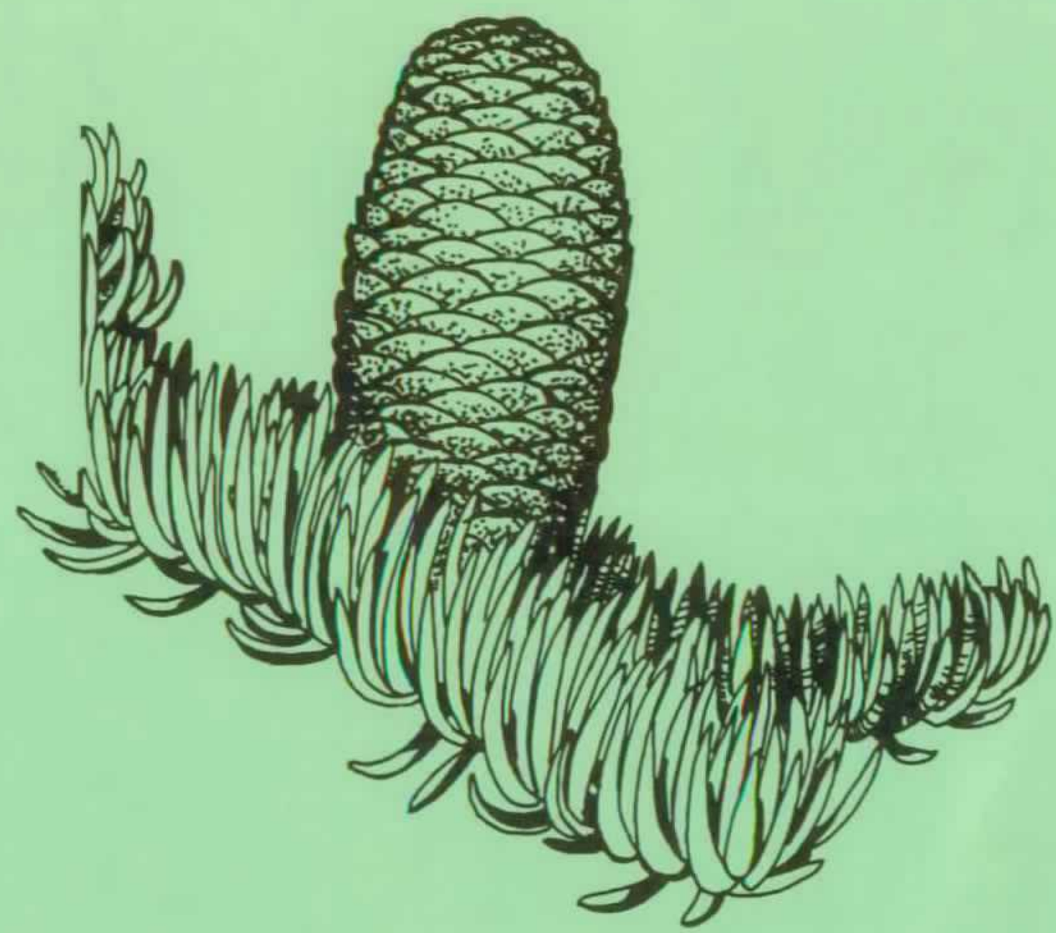
COMPARISONS

The ABGR/VAME/CLUN Association is a subdivision of the ABGR/CLUN Association described in the field version of this guide (Williams *et al.* 1990). The ABGR/CLUN type as described in the field guide contained considerable variation and warranted division into the warm ABGR/ACGLD/CLUN and cool ABGR/VAME/CLUN types based on consistent differences in floristics and environmental characteristics.

The ABGR/VAME/CLUN Association is part of the broadly defined ABGR/PAMY Association of Daubenmire and Daubenmire (1968). Subsequent workers in the northern Rocky Mountains have used queencup beadlily as the indicator of the Pachistima Union of Daubenmire and Daubenmire (1968). For examples see Cooper *et al.* (1991), Pfister *et al.* (1977) and Steele *et al.* (1981). All of these studies recognize an ABGR/CLUN Association that is subdivided into phases. The ABGR/VAME/CLUN Association described for the Colville N.F. generally equates to part of the CLUN Phase described in the above studies. Johnson and Clausnitzer (1992) and Johnson and Simon (1987) describe an ABGR/CLUN Association in northeastern Oregon. That type is similar but contains more Engelmann spruce and grand fir than do most Colville N.F. stands. Clausnitzer and Zamora (1987) have a broadly defined ABGR/LIBO2 (grand fir/twinflower) type that is somewhat related to the ABGR/VAME/CLUN Association.

Vaccinium membranaceum
big huckleberry

SUBALPINE FIR SERIES



SUBALPINE FIR SERIES

Abies Lasiocarpa

ABLA2

DISTRIBUTION AND ENVIRONMENT

Subalpine fir is the smallest of the true firs in eastern Washington and is widely distributed in western North America. It's core area of distribution is located in British Columbia, the Yukon, and portions of west-central Alberta. Although widely distributed, subalpine fir grows within a narrow range of mean temperatures (Burns and Honkala 1990). Cool summers, cold winters, and deep winter snowpacks are important factors in differentiating where subalpine fir grows in relation to other species. Subalpine fir has high rates of evapo-transpiration, which is why it is found primarily on cold, moist sites. Forests in which subalpine fir is climax generally occupy some of the highest water-yield areas in much of the west (Burns and Honkala 1990).

The Subalpine Fir Series, as defined here, includes all upland forest stands potentially dominated at climax by subalpine fir and/or Engelmann spruce. This series is distributed across the entire forest, but is best represented west of the Columbia River in the Kettle Mountains (Figure 53), where a strong continental-like climate exists in combination with high elevations. As a whole, the Subalpine Fir Series occupies a variety of aspects and elevations (Figure 54). However, the Series is primarily

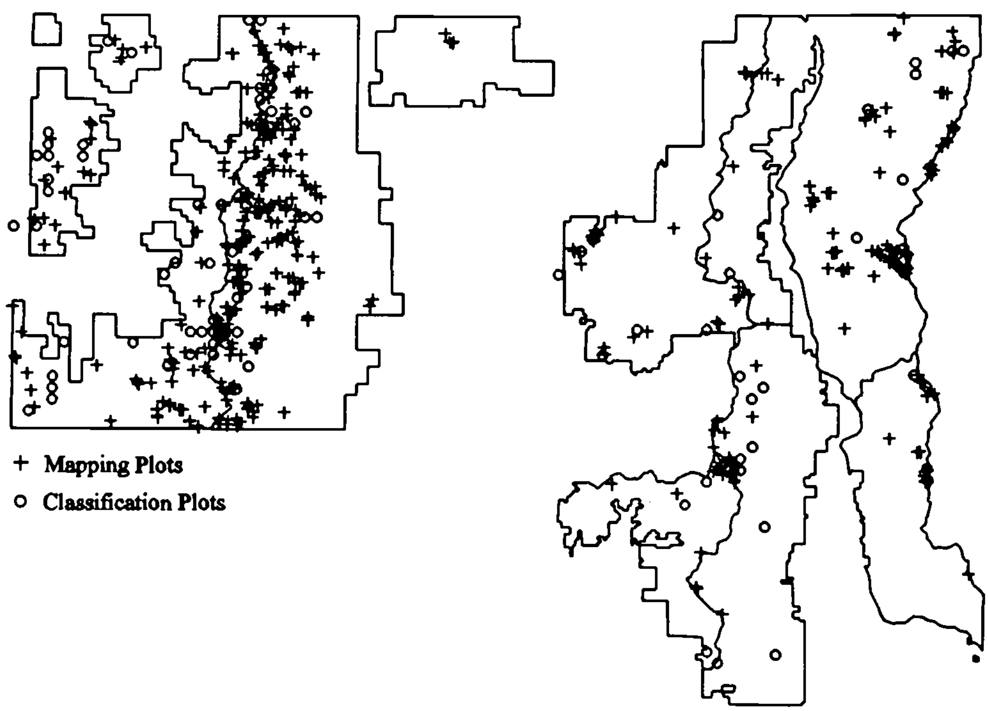


Figure 53. Plot locations for the Subalpine Fir Series on the Colville N. F. (n=585).

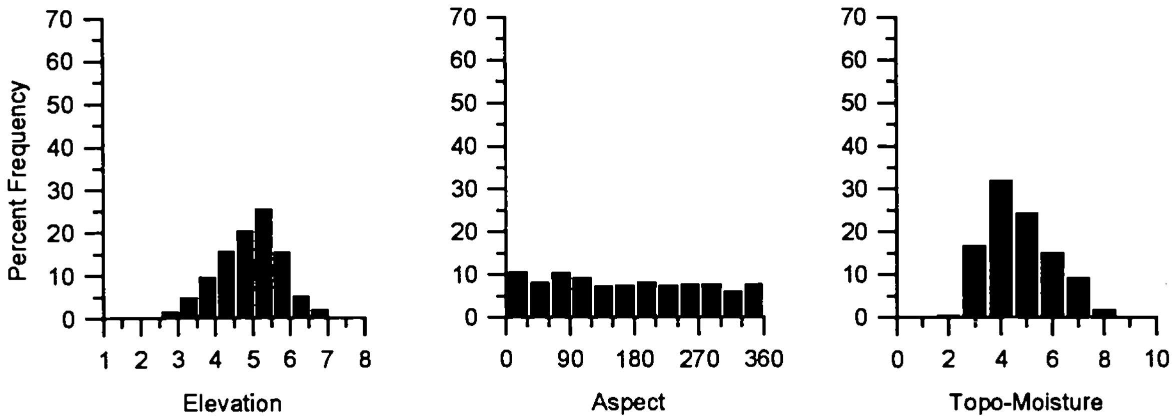


Figure 54. Frequency of Subalpine Fir Series plots by elevation (1000 ft.), aspect, and topographic moisture.

limited to north aspects and moist cold-air bottoms on the western extreme of the Forest in the "Okanogan Highlands". As one proceeds eastward towards Idaho, the Subalpine Fir Series becomes increasingly restricted to higher elevations on southerly aspects due to the expansion of the Western Hemlock and Western Redcedar Series. Differences in aspect and elevation of the Subalpine Fir Series on the Republic and Sullivan Lake Ranger Districts are illustrated in Figure 55.

The Subalpine Fir Series extends from mid-elevations to upper timberline. Consequently, temperatures are lower than in other climax tree series on the Colville N.F. West of the Kettle and Columbia Rivers, the Subalpine Fir Series often extends from climax Douglas-fir forests to upper timberline. East of these rivers subalpine fir and Douglas-fir climax forests are often separated by other climax tree series such as grand fir, western redcedar or western hemlock. The Whitebark Pine Series forms a small zone above subalpine fir only on the highest peaks (approximately 6,500 ft.). When the Subalpine Fir Series is found at elevations below other series, it indicates cold air drainage and frost pockets. Due to these cold-air and moisture effects, stands of subalpine fir and Engelmann spruce are commonly found as "stringers" in many lower elevation stream bottoms. It is not uncommon to find subalpine fir growing at 2,500 ft. and Engelmann spruce as low as 1,800 ft. in many of these cold-air bottoms. However, the majority of these low-elevation sites east of the Kettle Mountain Crest usually are either Western Redcedar or Western Hemlock Series sites.

Single species climax is often difficult to project for the Colville N.F. because most forest stands are relatively young. Subalpine fir is more shade tolerant than Engelmann spruce but the latter is more disease resistant and longer-lived (Minore 1979). Subalpine fir is better able to establish in litter than is Engelmann spruce (Knapp and Smith 1982). Engelmann spruce may also limit reproduction and growth of associated conifers from bark and litter leachates (Taylor and Shaw 1982). Cycles of insect populations and subsequent host mortality have been shown to alter species dominance in Colorado spruce-fir stands through time (Schmid and Hinds 1974). Therefore, some mature overstories are

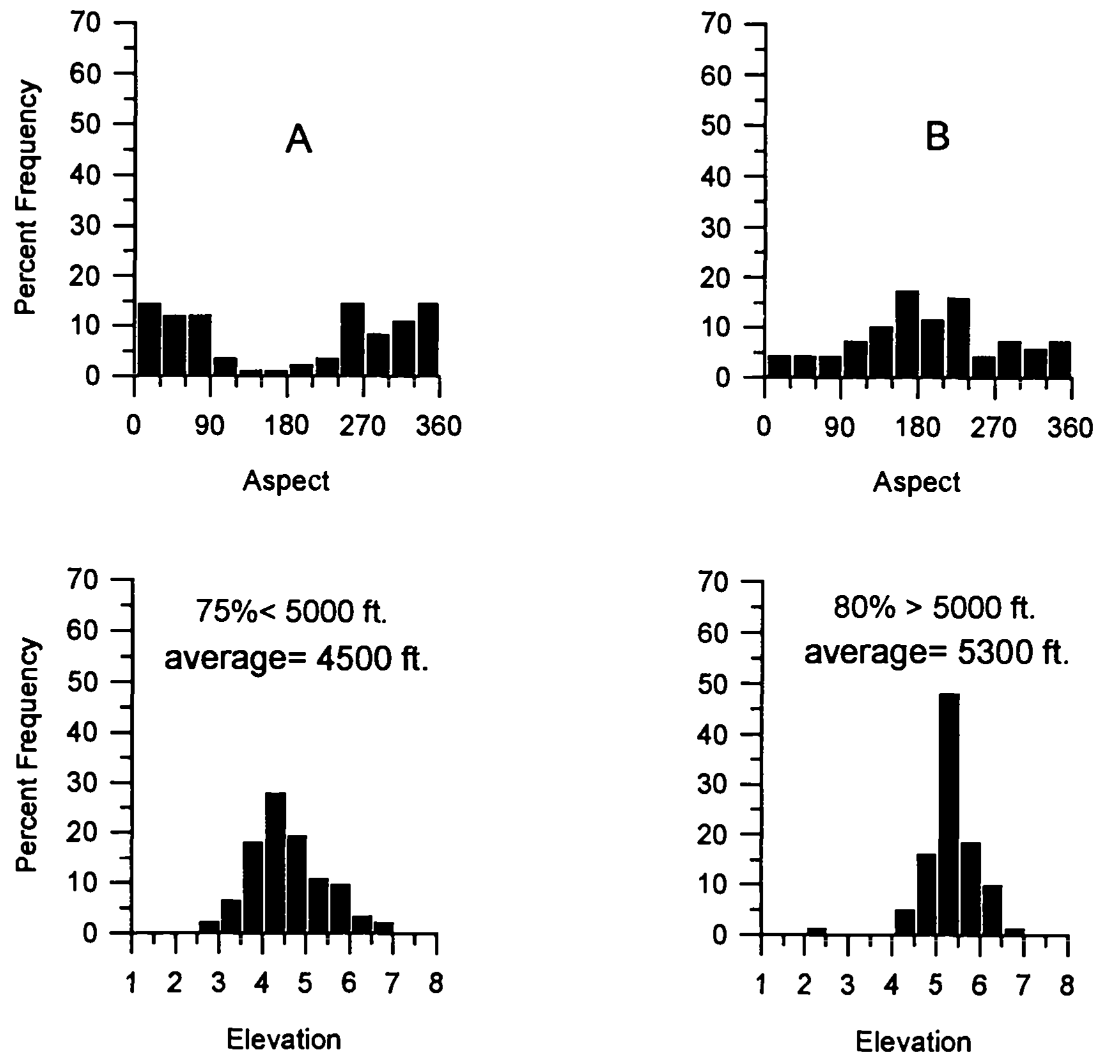


Figure 55. Comparison of subalpine fir plots from Republic (A) and Sullivan Lake (B) Ranger Districts by aspect and elevation.

dominated by Engelmann spruce.

It is difficult to prove that subalpine fir will completely replace Engelmann spruce over time given their autecological characteristics because few ancient stands exist on the Colville N.F. Ecologists have not reached consensus on the ecological roles of Engelmann spruce and subalpine fir in mixed stands. Daubenmire and Daubenmire (1968) and Pfister *et al.* (1977) consider Engelmann spruce to be a persistent seral species or minor co-climax in their Subalpine Fir Series in northern Idaho and western Montana, respectively. Succession studies in similar forests from northern Utah (Schimpf *et al.* 1980) and Colorado (Veblen 1986) conclude that subalpine fir will not replace Engelmann spruce as the climax dominant. Engelmann spruce populations are maintained or enhanced by the species' longevity and lower adult mortality as compared to subalpine fir (Veblen 1986).

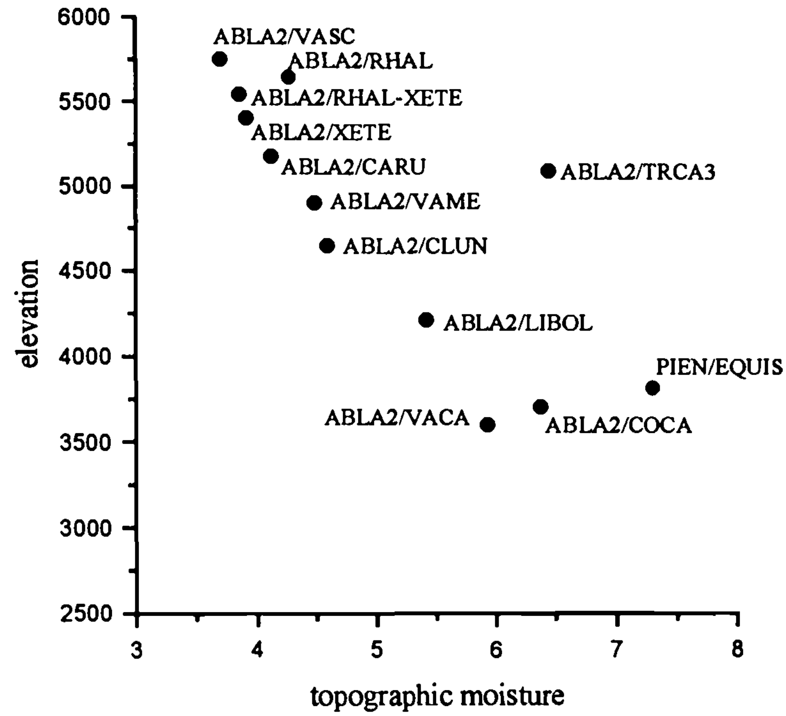


Figure 56. Ordination of subalpine fir plant associations by elevation and topographic moisture.

Aplet *et al.* (1988) using data from Colorado proposed that mixed stands evolve through several recognizable phases including: 1) an initial colonization phase for both species, 2) a spruce exclusion phase where spruce recruitment is inhibited which may last 100 years, 3) a spruce re-initiation phase where spruce recruitment again occurs, and 4) a second generation spruce-fir forest which develops as the second generation spruce cohort reaches the canopy. Data for forest stands on the Colville N.F. are inconclusive. Subalpine fir is the inferred climax dominant but Engelmann spruce is given equal value as an indicator of the Subalpine Fir Series for upland sites.

Engelmann spruce can tolerate both wetter and drier conditions than subalpine fir. Engelmann spruce is the indicated climax dominant in the PIEN/EQUIS Association. Further work is suggesting the separation of wet to moist habitats as better described by an Engelmann Spruce Series (Kovalchik 1993). In addition, further field observations also suggests a separate Engelmann Spruce Series for uplands which support good Englemann spruce regeneration but are too dry for subalpine fir. Stands like these exist on northern portions of the Republic Ranger District and the north-east portion of the Tonasket Ranger District on the Okanogan N.F. This corresponds well to the "Montane Spruce Zone" described for areas of southern British Columbia (Meidinger and Pojar 1991). With the above reservations, we currently consider subalpine fir a climax species on all forest sites where it occurs if the more shade tolerant western redcedar or western hemlock are absent or unable to reproduce successfully. Subalpine fir is the climax dominant on habitats too cold for more shade tolerant species to reproduce.

Eleven plant associations and one community type are defined for the Subalpine Fir Series. These are the ABLA2/RHAL-XETE, ABLA2/RHAL, ABLA2/COCA, ABLA2/TRCA3, ABLA2/XETE, ABLA2/CLUN, ABLA2/VACA, ABLA2/LIBOL, ABLA2/VASC, ABLA2/CARU, and PIEN/EQUIS Associations and the ABLA2/VAME Community Type. In addition, there may be representatives of associations described for northern Idaho (Cooper *et al.* 1991) that were not otherwise sampled or described for the Colville N.F. This will be especially true for the ranger districts east of the Columbia River. Stands in those areas that fit this classification poorly should also be keyed using the guide for northern Idaho (Cooper *et al.* 1991).

VEGETATION

These are open or closed forests characteristic of the upper montane and subalpine zones of the Colville N.F. Most stands may be classed as closed forest (total canopy closures greater than 60%). Stands at or near upper timberline or those stands adjacent to montane shrublands are often open forest (total canopy closure between 30% and 60%). The spire-shaped crowns of subalpine fir and Engelmann spruce characterize late seral stands. Either one or both of these species is expected to dominate climax stands. A variety of other tree species can be present as seral components. Douglas-fir and western larch are important seral species throughout much of the Series except for the coldest or wettest habitats.

Lodgepole pine is an important dominant of most early to mid-seral stands and is particularly common on stony, nutrient-poor soils derived from granitic tills and outwash. Succession to subalpine fir or Engelmann spruce is slow and most stands reburn before the lodgepole pine is replaced. Most other species are generally restricted in their distribution within the Series. Western hemlock, western redcedar, or grand fir occur as minor stand components restricted to favorable microsites at the warmer end of the Series. Western redcedar and western hemlock may be present on favorable microsites in stands with Cascade azalea, rusty menziesia or beargrass. Ponderosa pine is uncommon in the Subalpine Fir Series and is not well adapted to potential climax subalpine fir sites (Cooper *et al.* 1991).

Engelmann spruce is best developed on the more moist associations in the Series. It is often dominant in the ABLA2/LIBOL, ABLA2/COCA, PIEN/EQUIS and ABLA2/TRCA3 types. Dense stands of Engelmann spruce are often termed "spruce bottoms" because of the sheltered, lower slope positions typical of these associations. Engelmann spruce litter and compounds leached from the foliage and bark are allelopathic to associated tree species (Taylor and Shaw 1982). Lodgepole pine is one of the most susceptible tree species while subalpine fir is less affected. Allelopathy may significantly influence plant succession on habitats that escape fire for many years.

Mature stands of subalpine fir (greater than 12 in. [4.7 cm] dbh) in the Kettle Range were totally consumed during the White Mountain Fire of 1988. This acknowledges that subalpine fir may be removed from extensive areas by severe wildfire on the Colville N.F. Lodgepole pine, western larch or Douglas-fir can dominate severely burned areas with little evidence of either Engelmann spruce

Table 34. Diversity components of the Subalpine Fir Series.

Richness[1]	201	
Number of associations	12	
	Mean	S.E.[2]
Expected richness[3]	242.2	7.2
Expected N2[4]	17.3	1.0
Average richness per plot	23.5	0.7
Average N2 per plot	7.6	0.3

[1] Total number of vascular plant species in the Subalpine Fir Series data.
[2] Standard error of the estimate.
[3] Jackknife estimate of richness given a sample size of 149 plots.
[4] Jackknife estimate of N2 given a sample size of 149 plots.

or subalpine fir regeneration. Consequently, these stands may not be readily assignable to the Subalpine Fir Series for many decades. For example, some stands that key to the PSME/VAME Community Type or the PICO/SHCA Community Type may actually be part of the Subalpine Fir Series. Subalpine fir, and to a lesser extent Engelmann spruce, dominate the reproduction in most mid-seral stands. Douglas-fir and western larch are also common reproduction components. No other tree species show any consistent patterns.

The undergrowth can vary from dense shrub thickets to open, species-rich, forb dominated glades to near monospecific low shrub patches. Few undergrowth species are widely distributed across the Series. Utah honeysuckle, pachistima, sidebells pyrola, and pinegrass are the only undergrowth species occurring on more than half the plots in the Series. Actual species richness and expected richness for the Series as a whole are the second highest of all major forest series (Table 34). However, the average number of species per plot is the lowest of the forest series. The large number of species found within the Series and the low average richness per plot reflects the wide range of habitats and the relatively harsh environments typical of the Series. Species of the Pachistima union (Daubenmire and Daubenmire 1968) dominate the undergrowth of the ABLA2/CLUN, ABLA2/COCA, ABLA2/LIBOL, and ABLA2/TRCA3 Associations and portions of the ABLA2/VAME Type.

Age, height and dbh were collected on 179 subalpine fir trees. Sixteen were from stands assigned to the Western Hemlock Series, the rest were from the Subalpine Fir Series. The oldest subalpine fir tree sampled was 300 years old at breast height. Trees this old are typically unusual. Most subalpine firs die before reaching 200 years of age, primarily from heartrot. Two more trees were over 250 years old. All three of these older trees are in stands assigned to the ABLA2/RHAL-XETE Association. Five trees were between 200 and 249 years old and another 33 between 150 and 199 years of age. Sixty-two trees were between 100 and 149 years old. The remaining trees (76) are less than 100 years old.

Age, height and dbh were collected on 166 Engelmann spruce. Of these, 36 trees were from Western Hemlock Series stands, 13 from Western Redcedar Series stands and the remaining 117 from Subalpine Fir Series stands. The oldest Engelmann spruce tree sampled was 370 years old at breast height. Ten more trees were over 300 years and five were between 250 and 299 years of age. Eleven were between 200 and 249 years. The remaining 142 trees were less than 150 years old. Six of the 10 oldest trees were from stands assigned to the ABLA2/RHAL-XETE Association while the other 4 were from stands assigned to related associations such as the TSHE/XETE, TSHE/MEFE or ABLA2/RHAL Associations.

FIRE ECOLOGY

Vulnerability of subalpine fir to fire is high due to high stand densities and numerous dead and dry lower limbs (often draped with lichens). The thin, resinous bark and low-growing limbs of subalpine fir contribute to it's fire sensitivity (Smith and Fischer 1995). Subalpine firs' shallow root system is easily injured by fires that burn through the duff. Windthrow and/or attacks from wood-rots usually claim the rare subalpine fir trees that may have survived a fire. The cambium is easily killed by low-severity fires, which can quickly turn into crown fires via the low, ground-hugging branches. Generally, the only survivors of fire in these stands are remnant individuals of Douglas-fir or western larch.

Compared to the other tree series, fire intensities tend to increase and fire-return intervals lengthen to well over 100 years in the Subalpine Fir Series (Agee 1994). Large, stand-replacing fires were very common early in the century (Gannett 1902, Gorman 1899). In reality, fire regimes are quite diverse in this Series due to the wide variation in environments represented on subalpine fir sites. Subalpine fir plant associations whose distributions are correlated with the Inland Maritime weather pattern (ABLA2/RHAL, ABLA2/RHAL-XETE, and ABLA2/CLUN) exhibit the longest fire-return intervals. In contrast, drier high-elevation sites where subalpine fir is transitional to whitebark pine have the shortest fire-return intervals of east-side subalpine forests (Arno 1986, Arno and Habeck 1972, Morgan and Bunting 1990).

Subalpine fir forests also show considerable variation in fire intensities and patterns from drainage to drainage (Agee 1994). This pattern is less commonly observed in the lower elevation tree series. Information concerning the average size of these fires is somewhat scarce. Fahnestock (1976) found most fires in the Pasayten Wilderness were small. Eight-five percent of the fires were less than 33 acres in size. However, 60% of the total area burned was in two large fires which each burned areas greater than 22,000 acres. This suggests that a few large fires with many smaller fires may be the typical pattern in these forests. However, it is important to realize that this pattern will not be reflected by age-class distribution data since the few large fires will represent the dominant patch age in any given river basin (Agee 1994).

Barrett *et al.* (1991) studied the fire regimes of a western larch-lodgepole pine forest in Glacier National Park in Montana. They developed master fire chronologies from 1650 to the present. Two types of fire regimes prior to European settlement were identified: 1) "A mixed severity regime ranging from nonlethal underburns to stand-replacing fires at mean interval of 25-75 years." This pattern was for the part of their study area with a relatively dry climate and gentle topography; 2) "A regime of infrequent stand-replacing fires at mean intervals of 140-340 years." Our observations on the Colville N. F. generally agree with their findings. They concluded that fire suppression since the 1930's has altered Regime 1 but not that of Regime 2.

Lodgepole pine, followed by subalpine fir and Engelmann spruce, often dominates early succession after fires. It is common in stands which have had severe fire in the last 100 years. These stands are common over much of the landscape on the Colville N.F. The development of dense lodgepole pine stands is strongly favored by severe fires which occur at less than 150 year intervals. This is especially common on sites which support the ABLA2/VAME, ABLA2/VACA, and ABLA2/VASC Associations. Replacement of lodgepole pine by subalpine fir and Engelmann spruce is very slow, and may take centuries. However, another fire often occurs before the replacement sequence is complete, which favors lodgepole pine again. Lodgepole pine was shown to be the primary dominant in stands 50 years after stand-replacing fires in the Pasayten Wilderness (Fahnestock 1976). Subalpine fir and Engelmann spruce started 100-200 years after the fire. Fahnestock (1976) reported that lodgepole pine can persist for up to 400 years on some of these sites.

Burned sites may be dominated by shrubs such as big huckleberry, Cascades azalea or beargrass for 30-40 years after a fire if lodgepole pine does not regenerate immediately (Agee 1994). Western larch may be an important seral component on sites with big huckleberry, though trees regenerate on these sites very slowly. As the canopy develops, big huckleberry will decrease. Eventually a mixed-stand of long-lived western larch with younger and smaller subalpine fir and Engelmann spruce will develop (Agee 1994). Lodgepole pine is usually the post-fire dominant if well represented in the overstory at the time of the fire. Large burns tend to have poor subalpine fir regeneration in the centers of the burns due to poor seed dispersal from mature subalpine fir on the perimeters. Depending upon the size and intensity of the fire, availability of seed sources and post-fire weather patterns, large burns may remain treeless for decades. However, if such sites had lodgepole pine present, re-establishment of tree cover is usually quite rapid.

INSECTS AND DISEASE

Subalpine fir is attacked by various insects, most notably the fir-engraver and western balsam bark beetle. The silver fir beetle, western spruce budworm and balsam woolly adelgid may also be destructive. Where the Douglas-fir Series directly transitions into the Subalpine Fir Series, the risk of western spruce budworm is higher than where these two series are separated by the Grand Fir, Western Hemlock or Western Redcedar Series. Drier subalpine fir sites are more susceptible than wet sites. Kemp *et al.* (1985) describes all of the Colville N.F. as low outbreak frequency for western spruce budworm.

Fir broom rust and wood-rotting fungi are responsible for most disease losses. Important root and butt rots include annosus, armillaria, and laminated root rot. Annosus is particularly common in managed stands where freshly cut stumps or wounds are infected by spores. Armillaria is common and pathogenicity may increase following logging. Subalpine fir is only moderately susceptible to laminated root rot. These wood rots and broom rusts further predispose subalpine fir to windthrow by weakening them. Because the species suffers severely from wood rots, many trees either die or are complete culls at an early age.

The most dramatic insect outbreaks occur in relatively pure stands of lodgepole pine. When lodgepole pine stands approach 100 years of age or 8" DBH, stand susceptibility to mountain pine beetle increases. Outbreaks kill most trees which are greater than 6" DBH in a stand. Most stems fall over within 15 years, creating a high fuel load. Subsequent fires then initiate another relatively pure stand of lodgepole pine. Whether or not a beetle-infested stand of unmanaged lodgepole is unhealthy is debatable. It certainly is not a departure from the historic condition. Human-caused changes in the fire regime of this Series are less and more subtle than those in lower elevation series. Perhaps the overall greatest threats to the subalpine fir forests are from fires, insects and disease spreading from lower elevation forests that have elevated insect, disease and fire risks.

MANAGEMENT IMPLICATIONS

Many stands in the Subalpine Fir Series are relatively productive sites. The ABLA2/COCA, ABLA2/TRCA3 and ABLA2/CLUN Associations are the most productive types. A cold temperature regime is the main limiting factor to tree growth and frost is a common problem on all sites within the Series. Slope position and topography are important considerations for frost pocket development. Grouse huckleberry is the most cold hardy huckleberry species on the Forest and indicates cold sites. Dwarf huckleberry occurs on sites with warm days but frosty nights. Subalpine fir is often reduced to a prostrate shrub (vegetatively reproducing by layering) in harsh upper-elevation sites at timberline. In closed forest situations, it generally attains diameters of 12-24 inches and heights of 45-100 ft. Trees larger than 30 inches DBH and taller than 130 ft. are exceptional. Growth is not rapid, and trees 10-20" in diameter may be 150-200 years old.

Both even and uneven-aged silvicultural systems can be used in subalpine fir stands. When using seed-tree techniques, subalpine fir generally cannot be left as seed-trees because of the high susceptibility of subalpine fir to windthrow. The kind and intensity of cutting and exposure to wind will influence the likelihood of trees being windthrown. Clearcutting and shelterwood cutting are the favored even-aged cutting systems. Individual tree and group selection are appropriate uneven-aged cutting systems. In mixed spruce-fir stands, shelterwood and individual-tree selection methods generally favor subalpine fir over Englemann spruce, lodgepole pine, and Douglas-fir.

Dense pinegrass swards may develop following disturbance in the ABLA2/CARU, ABLA2/VACA and the ABLA2/VAME types. Dense Sitka alder thickets can develop following disturbance in all subalpine fir associations, but are especially common in the ABLA2/TRCA3 Association. The ABLA2/RHAL and ABLA2/RHAL-XETE Associations may also have high shrub cover, and regeneration difficulties may occur following disturbance. Dense shrubfields may develop after logging or fire on habitats where the undergrowth is largely comprised of the Pachistima union of Daubenmire and Daubenmire (1968).

Not only are there significant differences in vegetation development following disturbance by habitats as characterized by plant associations, but much variation is dependent on the timing, intensity and extent of perturbations. Shearer and Stickney (1991) followed natural revegetation on burned and unburned clearcuts. Timing of fire events in conjunction with other variables such as seed crops, duff consumption, soil moisture and repeated burns greatly affected vegetation development. Their study site seems most related to the ABLA2/XETE Association on south and west slopes and to the ABLA2/CLUN and ABLA2/RHAL-XETE Associations on more sheltered sites and aspects.

High water tables are common in several of the subalpine fir Associations, notably the PIEN/EQUIS and ABLA2/TRCA3 types, though other types may have high water tables depending upon slope position, time of year and winter snowpack levels. High water tables are particularly evident following deforestation and often hinder reforestation and road construction because of saturated soils.

COMPARISONS

The Subalpine Fir Series in the Pacific Northwest has been described in detail by numerous ecologists. The Series has been described in Montana (Pfister *et al.* 1977), northeast Oregon (Johnson and Clausnitzer 1992, Johnson and Simon 1987), central Idaho (Steele *et al.* 1981), northern Idaho (Cooper *et al.* 1991) and eastern Washington and northern Idaho (Daubenmire and Daubenmire 1968). Additional descriptions are provided for northeast and northcentral Washington by Clausnitzer and Zamora (1987), Lillybridge *et al.* (1995) and Williams and Lillybridge (1983). The classification by Lillybridge *et al.* (1995) for the eastern Cascade Mountains includes descriptions of some upper timberline and Krummholz subalpine fir communities. A similar "Engelmann Spruce-Subalpine Fir Zone" has been described for the adjacent Province of British Columbia by Braumandl and Curran (1992), Lloyd *et al.* (1990) and Meidinger and Pojar (1991). The majority of these classifications include some subalpine fir associations which are similar to types described for the Colville N.F. In addition, Kovalchik (1993) describes subalpine fir and Engelmann spruce riparian communities found in eastern Washington. West of the Cascade Crest, the Subalpine Fir Zone has a very limited distribution (Henderson *et al.* 1989, 1992).

KEY TO PLANT ASSOCIATIONS IN THE SUBALPINE FIR SERIES

Before using the key, the field form in Appendix 4 should be completed. Refer to the "USING THE KEYS" section in the introduction for more specific information on using the key, particularly if the stand in question does not key properly.

Horsetail species ≥ 5% .... PIEN/EQUIS Association p. 184

Cascades azalea and/or rusty menziesia ≥ 5%

- Beargrass ≥ 1% .... ABLA2/RHAL-XETE Association p. 152
- Beargrass < 1% .... ABLA2/RHAL Association p. 146

Bunchberry dogwood ≥ 5% .... ABLA2/COCA Association p. 136

False bugbane ≥ 5% .... ABLA2/TRCA3 Association p. 157

Beargrass ≥ 5% .... ABLA2/XETE Association p. 178

Queencup beadlily ≥ 5% .... ABLA2/CLUN Association p. 131

Dwarf huckleberry and/or bearberry ≥ 1% .... ABLA2/VACA Association p. 162

Big huckleberry and/or low huckleberry ≥ 5% ...... ABLA2/VAME Community Type p. 168

Twinflower ≥ 5% .... ABLA2/LIBOL Association p. 141

Grouse huckleberry ≥ 5% .... ABLA2/VASC Association p. 173

Pinegrass ≥ 5% .... ABLA2/CARU Association p. 126

ABLA2/CARU ASSOCIATION CEG3 11
Abies lasiocarpa/Calamagrostis rubescens
subalpine fir/pinegrass

DISTRIBUTION AND ENVIRONMENT

The ABLA2/CARU Association is found primarily west of the Columbia and Kettle Rivers in the Kettle Mountains (Figure 57). This association typically occupies relatively warm, dry and well-drained sites on mid- to upper-slope positions. Many sites have convex microrelief. It is usually found at mid- to upper-elevations on east to west aspects (Figure 58). Elevations range from 3,920 to 6,380 ft. and average 5,176 ft. The average aspect is 155 degrees (Table 36). The type characterizes a relatively warm and dry environment for the Subalpine Fir Series. High insolation rates and wide diurnal temperature ranges characterize these sites, and snow removal by wind is an additional characteristic.

The regolith is colluvium mixed with volcanic ash. Soil textures are gravelly silts and loams. Soils are well-drained and moderately deep. Boulders and rock outcrops are common in these stands. These stands are often transitional between Douglas-fir climax conditions and subalpine fir climax conditions. The PSME/CARU Association characterizes slightly warmer habitats at somewhat lower elevations. Some stands that key to PSME/CARU may actually belong to the ABLA2/CARU but

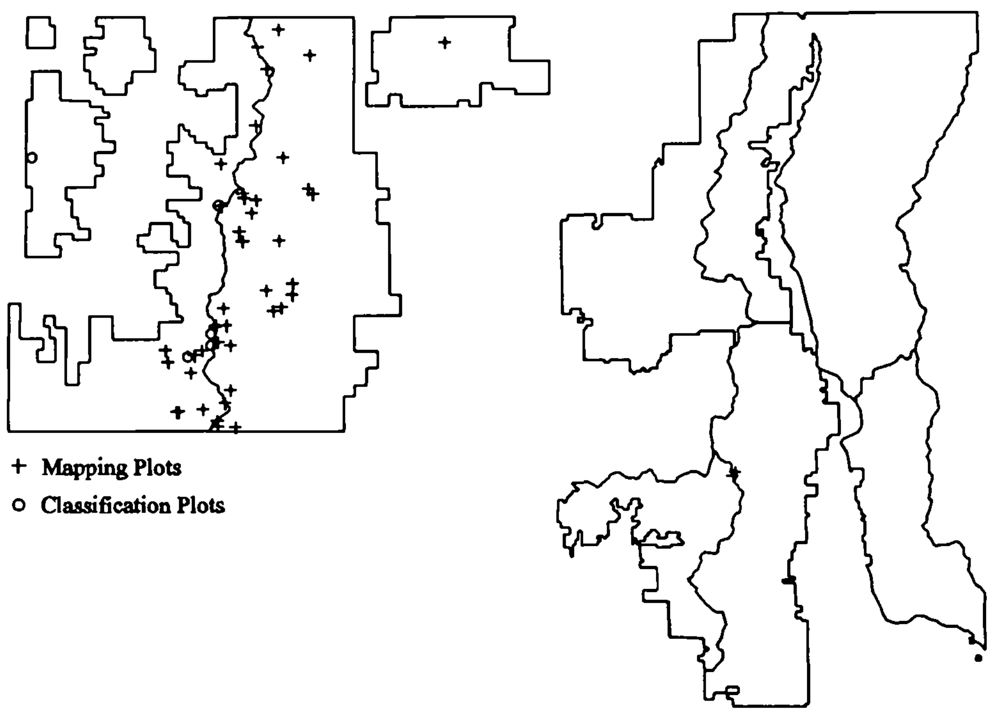


Figure 57. Plot locations for the ABLA2/CARU Association (n=51).

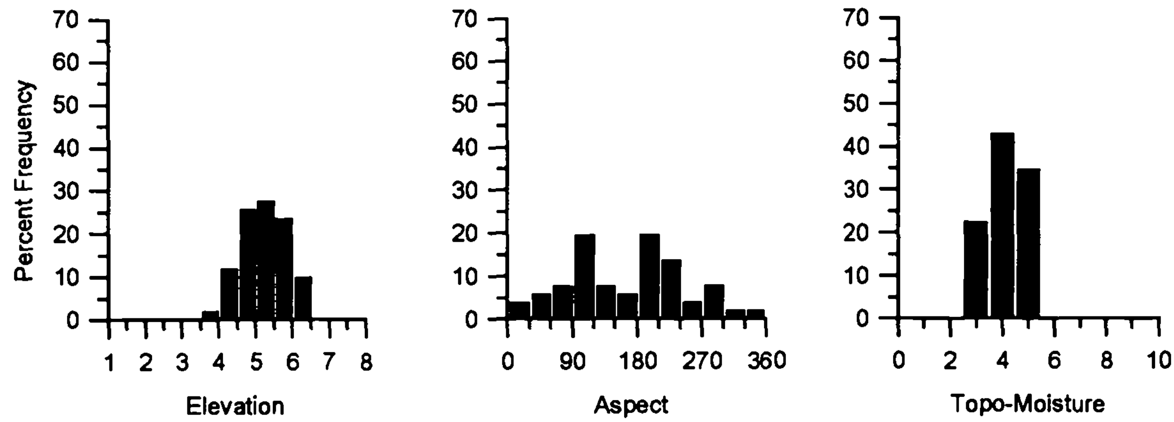


Figure 58. Frequency of ABLA2/CARU plots by elevation (1000 ft.), aspect, and topographic moisture.

fail to key properly because subalpine fir has been locally extirpated by fire and other disturbance.

Mountain shrublands dominated by mountain snowberry or mountain big sagebrush with an understory of Idaho or green fescue can often be found adjacent to these forest stands. Some ABLA2/CARU sites may adjoin whitebark pine stands, many of which are "ghost forests" (stands of whitebark pine snags), at the upper elevational limits of the type.

Table 35. Common plants of the ABLA2/CARU Association (n=7).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	100	36
LAOC	western larch	100	10
ABLA2	subalpine fir	71	6
TREE UNDERSTORY LAYER			
PSME	Douglas-fir	86	10
ABLA2	subalpine fir	71	2
SHRUBS AND SUBSHRUBS			
SPBEL	shiny-leaf spirea	71	4
PAMY	pachistima	71	3
HERBS			
CARU	pinegrass	100	56
ARCO	heartleaf arnica	100	9
ANRA	raceme pussytoes	86	4
FRAGA	strawberry spp.	86	3
THOC	western meadowrue	86	3
ASCO	showy aster	71	3
OSCH	sweetroot	57	3
HIAL	white hawkweed	57	2
ACMI	yarrow		

VEGETATION

None of the sample plots occurred in mature stands. However, subalpine fir is expected to be only a co-dominant with Douglas-fir in climax stands. Western larch is generally a minor overstory co-dominant. Engelmann spruce is virtually absent except on atypical, cool, north-facing slopes. Douglas-fir or, less frequently, western larch or lodgepole pine dominates the overstory of early to mid-seral stands. Some stands dominated by lodgepole pine

Table 36. Environmental and structural characteristics of the ABLA2/CARU Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	5176	602	3920	6380
Aspect[2]	155	48	--	--
Slope	32	12	4	65
Topographic Moisture	4.12	0.75	3.0	5.0
Soil Surface[3]				
Exposed soil	6.0	5.7	2	10
Gravel				
Rock	14.9	16.6	0	38
Bedrock	1.2	2.7	0	6
Moss	1.4	0.9	0	2
Lichen	1.0	0.7	0	2
Litter	27.0	17.2	10	50
Diversity[4]				
Richness	22.9	5.8	18	32
N2	5.5	2.0	3.8	6.7

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=51).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

have been observed.

Tree regeneration appears to be episodic and often limited to canopy gaps. These gaps are formed by the death of one or more canopy members due to disease, fire or windthrow. Douglas-fir and subalpine fir are generally the only regenerating tree species. Western larch and lodgepole pine usually only regenerate after the overstory has been removed by disturbance.

The undergrowth is typically a dense pinegrass sward and shrubs are inconspicuous. Shiny-leaf spirea and pachistima are the only common shrubs. Common herbs include lupine species, heartleaf arnica, raceme pussytoes, western meadowrue, white hawkweed, strawberry and sweetroot. Low or grouse huckleberry indicate slightly more moist and sheltered sites. The average number of species per plot is close to the overall average for the Series (Table 36). However, the heterogeneity index, N_2 - which measures the number of dominant species, is well below the Series average. This is consistent with the harsh environment of these stands; strong dominance by Douglas-fir and pinegrass with few other prominent species.

Figure 59. Photo of the ABLA2/CARU Association.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Southeast to west aspects, steep slopes and wind removal of snow makes these sites useful as wintering and forage areas for wildlife. Blue grouse favor the large, wolfy Douglas-firs typical of mature stands. Extensive pileated woodpecker activity has been observed in many of these stands. Pinegrass is relatively resistant to trampling and the grassy sward beneath the trees is attractive to livestock. The potential for forage production is especially good during early successional stages on these sites. Lupine spp., strawberry, pussytoes, heartleaf arnica, and asters increase with heavy grazing.

Silviculture- Environmental extremes make tree regeneration difficult on ABLA2/CARU sites. Problems include large seasonal and diurnal temperature ranges, strong pinegrass competition, droughty soil, and winter kill (desiccation). Young trees need shelter from high daytime soil temperatures and re-radiation frost at night. Pistol-butted trees are common which suggests snowcreep or soil movement. Stand basal area is moderate but site indices are not exceptional and most trees exhibit considerable stem taper. Damaged tree crowns from a combination of wind, snow and winter kill are common.

Douglas-fir is the most dependable species for timber management but expect severe regeneration problems on clearcuts. Prompt regeneration after harvest is essential to outpace pinegrass growth and competition. Natural regeneration is usually better in shelterwood cuts of 10-30 trees/acre than in clearcuts on somewhat similar PSME/CARU sites in central Idaho (Steel and Geier-Hayes 1993). Shelterwoods provide shade essential for successful reforestation, and shelter is particularly important on south and west aspects. Shelterwoods with little or no burning or scarification usually allows ample natural regeneration. Douglas-fir regeneration is enhanced if large woody debris remains on the site or if shrub cover develops to shelter the seedlings. Clearcutting and shelterwood systems will favor the seral species, while partial or selective cutting should help favor subalpine fir, though Douglas-fir will still regenerate quite well.

Some mechanical scarification may be necessary to obtain conifer regeneration following overstory removal due to potential increases and competition from pinegrass. Burning may set back competing grass species for 1-2 years, providing a short window for seedling establishment. However, very hot fires designed to reduce pinegrass vigor may cause long-term soil damage by reducing soil organic matter and nutrients. In addition, broadcast burning may cause mortality to planted trees because blackened soil surfaces may raise temperatures at the soil surface to lethal levels. Coarse soils may be displaced by heavy equipment on steep slopes. Erosion control is rarely needed because of the abundant pinegrass.

COMPARISONS

Many ecologists have described ABLA2/CARU communities in the Pacific Northwest. Types have been reported for Montana (Pfister *et al.* 1977), central Idaho (Steele *et al.*) and northeast Oregon (Johnson and Clausnitzer 1992, Johnson and Simon 1987). Additional types have been reported for Washington (Clausnitzer and Zamora 1987, Lillybridge *et al.* 1995, Williams and Lillybridge 1983) and the southern interior of British Columbia (Braumandl and Curran 1992). The ABLA2/CARU Association described for the Colville N. F. is very similar to the types described for the Wenatchee and Okanogan National Forests (Lillybridge *et al.* 1995, Williams and Lillybridge 1983, respectively). The ABLA2/CARU Association of Clausnitzer and Zamora (1987) better fits the ABLA2/VAME Association than the ABLA2/CARU Association as their type includes a number of plots with much more big huckleberry and pachistima than the Colville N.F. type. The ABLA2/CARU Association described for Montana is similar to this one, though that type contains elk sedge and common juniper which are nearly absent in these data. The type described for central Idaho appears more broadly defined than this one with more shrubs as well as less Douglas-fir and more subalpine fir. Those sites also have large amounts of elk sedge. The Lodgepole Pine-Engelmann Spruce/Pinegrass Site Association described for the southern interior of British Columbia (Braumandl and Curran 1992) is alsc very similar to the ABLA2/CARU Association. However, this type contains more grouse huckleberry than the type described for the Colville N. F.

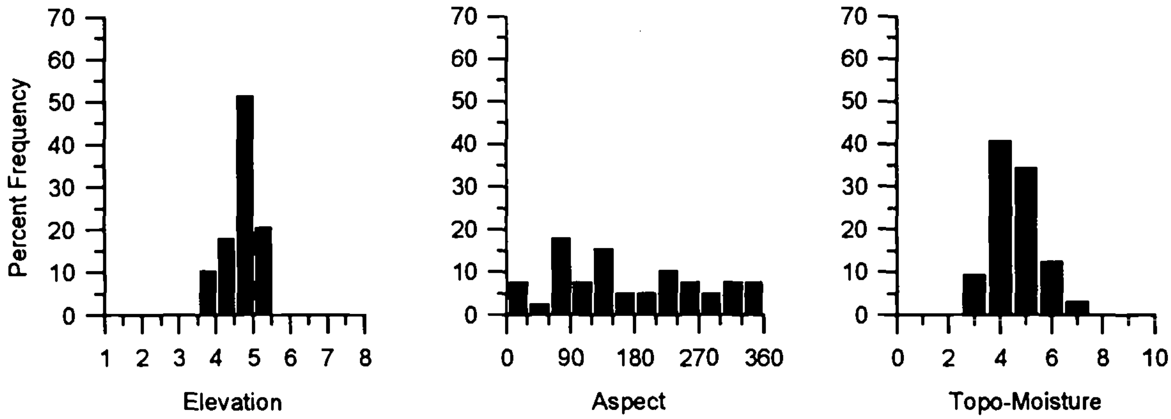


Figure 61. Frequency of ABLA2/CLUN plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

Subalpine fir and Engelmann spruce dominate mid and late seral stands. Engelmann spruce is more prominent on wetter habitats which approach the ABLA2/ LIBOL or ABLA2/TRCA3 Associations. Subalpine fir dominates the regeneration layers and is often the only reproducing tree species. Engelmann spruce reproduction is sporadic, but given it's autecological characteristics may still persist throughout the sere. Western larch is the most common and abundant seral tree species, although both lodgepole pine and Douglas-fir are usually present.

The undergrowth of mature stands is a heterogeneous mixture of shrubs and herbs. Shrubs are variable in amount and occurrence. Utah honeysuckle, pachistima, sidebells pyrola and twinflower are the most common shrubs. Thimbleberry, Sitka alder, big huckleberry and shiny-leaf spirea all may be important shrubs in early seral stands.

Table 37. Common plants of the ABLA2/CLUN Association (n=15).

		CON	COVER
TREE OVERSTORY LAYER			
ABLA2	subalpine fir	93	24
PIEN	Engelmann spruce	93	14
LAOC	western larch	80	13
PICO	lodgepole pine	60	11
PSME	Douglas-fir	53	10
TREE UNDERSTORY LAYER			
ABLA2	subalpine fir	93	11
PIEN	Engelmann spruce	53	3
SHRUBS AND SUBSHRUBS			
LOUT2	Utah honeysuckle	87	4
PAMY	pachistima	87	3
PYSE	sidebells pyrola	87	3
LIBOL	twinflower	73	8
CHUM	western prince's pine	73	3
RILA	prickly currant	60	1
VAMY	low huckleberry	53	10
HERBS			
CLUN	queencup beadlily	93	6
VIOR2	round-leaved violet	80	3
THOC	western meadowrue	73	2
SMST	starry solomonplume	67	4
BRVU	Columbia brome	67	3
OSCH	sweetroot	67	2
GOOB	western rattlesnake plantain	60	2

Table 38. Environmental and structural characteristics of the ABLA2/CLUN Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4647	441	3510	5360
Aspect[2]	99	64	--	--
Slope	27	12	2	55
Topographic Moisture	4.59	0.94	3.0	7.0
Soil Surface[3]				
Exposed soil	37	23	1	60
Gravel	12	--	12	12
Rock	6	14	0	38
Bedrock	0	0	0	0
Moss	1	1	1	3
Lichen	1	1	0	1
Litter	56	18	25	80
Diversity[4]				
Richness	26.9	6.5	13	35
N2	8.9	3.2	3.9	12.8

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=39).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

The shade tolerant and mesophytic herbs queencup beadlily and round-leaved violet are the most constant and indicative herbs. Other herbs include starry solomonplume, heartleaf arnica, pinegrass and Columbia brome. Queencup beadlily may be absent in a few stands. These stands can often be identified by using sweetscented bedstraw, round-leaved violet or coolwort foamflower as alternative indicators. Average species richness per plot is slightly higher than the Series average while the N_2 index of heterogeneity is well below average (Table 38).

MANAGEMENT IMPLICATIONS

Wildlife/Range- Herbaceous productivity is low in natural stands but the wide variety of herbs and shrubs offer some forage for wildlife. Seral stands may produce moderate browse for big game. Shrubs such as low huckleberry, Utah honeysuckle and prickly currant provide fruits for wildlife during late summer and fall. In addition, the high number of seral tree species found on these sites increases habitat diversity for wildlife. Sites are not well suited for livestock grazing due to low herbage availability .

Figure 62. Photo of the ABLA2/CLUN Association.

Silviculture- These sites may permit the greatest range of silvicultural options within the Subalpine Fir Series. Stand density and basal area are relatively high for subalpine fir (appendix 2). Opportunities for mixed-stand development and flexibility for timber management exist on these sites due to the presence of five seral species (western white pine, lodgepole pine, Engelmann spruce, Douglas-fir and western larch). Clearings with adequate sunlight should allow good lodgepole pine and western larch regeneration. Regeneration of subalpine fir and Engelmann spruce is favored by partial cutting, but this method will increase the risks of windthrow.

Clearcutting followed by broadcast burning may create persistent shrubfields which retard regeneration. However, natural regeneration can be good on these sites when competition from shrubs is not a concern. Reduced stocking success is correlated with understory coverage averaging greater than 15%. Utah honeysuckle, russet buffaloberry, thimbleberry, and huckleberry species are all stimulated by low-severity fire. Natural regeneration following clearcutting on these sites is good (70-80%), and even higher with site scarification than with burning (Fiedler 1980). Follow the guidelines of Harvey *et al.* (1987) to avoid soil nutrient and organic matter depletion.

Watershed values are important because of moderate snowpacks and precipitation. Naturally occurring shrubs and herbs are highly susceptible to trampling damage from hikers and campers and are slow to reestablish in closed canopy conditions.

COMPARISONS

The ABLA2/CLUN Association is similar to parts of the broadly defined ABLA2/PAMY Association of Daubenmire and Daubenmire (1968). Many other workers in the Pacific Northwest have described ABLA2/CLUN Associations. Pfister *et al.* (1977) in Montana, Steele *et al.* (1981) in central Idaho, Cooper *et al.* (1991) in northern Idaho all have a more broadly defined ABLA2/CLUN type that is subdivided into phases. The type described for the Colville N.F. correlates best with the CLUN Phase of the ABLA2/CLUN Association in each of the preceding classifications. Clausnitzer and Zamora (1987) have a broadly defined ABLA2/PAMY Association that includes this type. Johnson and Clausnitzer (1992) and Johnson and Simon (1987) describe ABLA2/CLUN Associations for northeast Oregon that are closely related to this type.

Clintonia uniflora
queencup beadlily

ABLA2/COCA ASSOCIATION CEF4 23
Abies lasiocarpa/Cornus canadensis
subalpine fir/bunchberry dogwood

DISTRIBUTION AND ENVIRONMENT

The ABLA2/COCA Association is most common west of the Columbia and Kettle Rivers on the Kettle Falls and Republic Ranger Districts (Figure 63). It is almost always found on cool, moist, xero-riparian sites on gentle terraces, benches and toeslopes along stream bottoms. The type is found at low to mid-elevations on a variety of aspects. West to northeast aspects are most common (Figure 64). Elevations range from 2,980 to 4,750 ft. (Table 40). Most sites are between 3,000 and 4,500 ft. These sites represent cool, moist, sheltered habitats subject to frosts and occasional flooding. Some plots from the Okanogan N.F. are used to augment the data.

The regolith is well-drained alluvium derived from a variety of rock types. Ash is common in the upper soil horizons or mixed with the alluvium. The ABLA2/COCA type grades into the ABLA2/TRCA3 or PIEN/EQUIS Associations on wetter habitats. It grades in to the ABLA2/CLUN, ABLA2/VAME or ABLA2/VACA types on drier habitats. Heavily shaded stands may key to the ABLA2/LIBOL Association, but if bunchberry dogwood is common (1%-5% cover), these sites should be retained in the ABLA2/COCA Association.

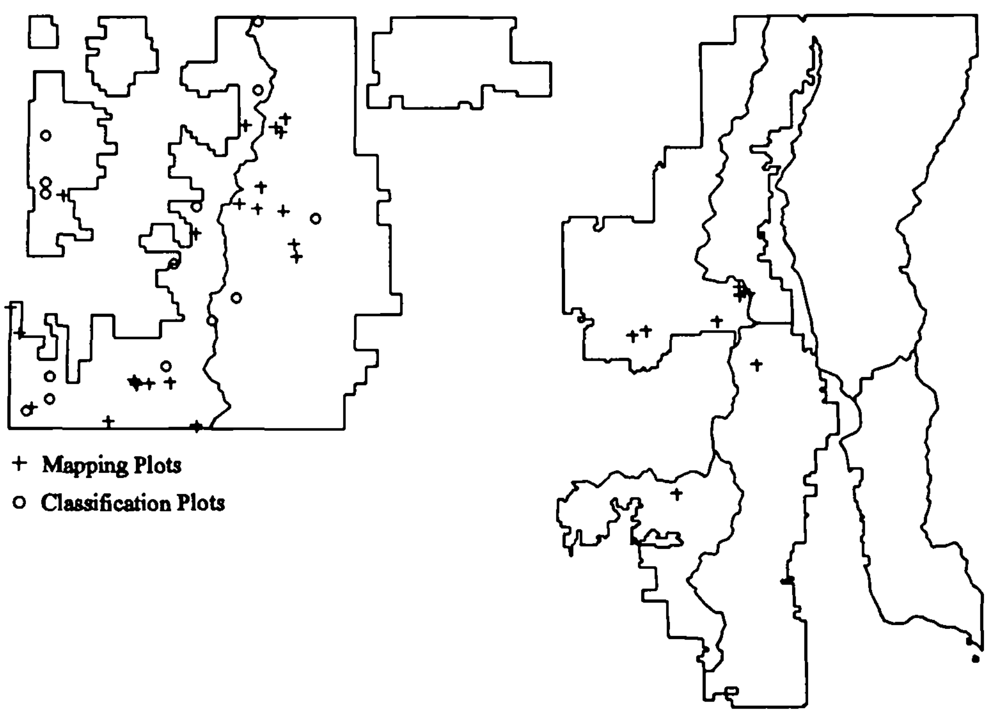


Figure 63. Plot locations for the ABLA2/COCA Association (n=49).

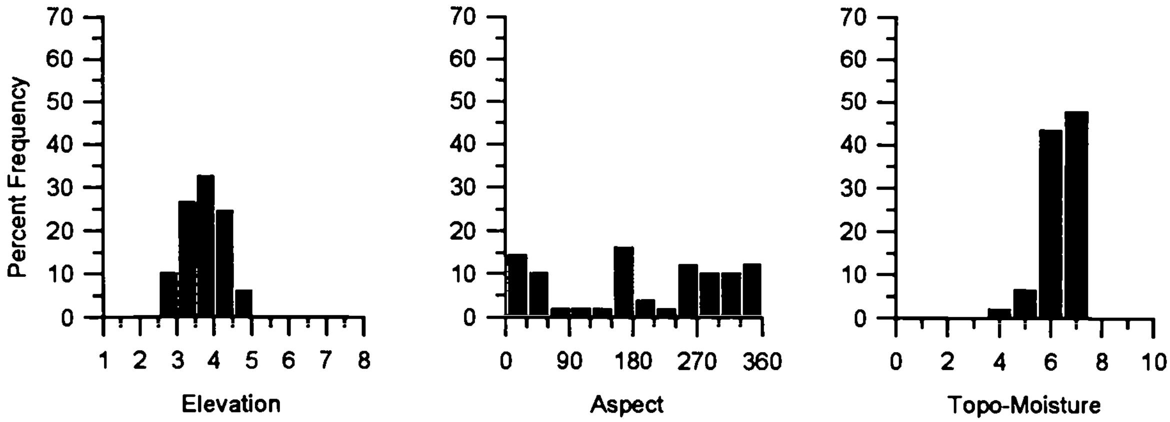


Figure 64. Frequency of ABLA2/COCA plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

Late seral and climax stands are composed of large Engelmann spruce mixed with subalpine fir. The Engelmann spruce is long-lived and often attains a much larger size compared to subalpine fir. Engelmann spruce is the most consistent understory species but subalpine fir regeneration is more abundant when present. Douglas-fir is the most common and often the most abundant seral species. Western larch and lodgepole pine may dominate some early seral stands. Minor amounts of Douglas-fir regeneration are present in most stands. Disturbance favors Douglas-fir, western larch, and lodgepole pine.

The undergrowth is a mixture of mesophytic herbs and subshrubs. The dwarf sub-shrub, bunchberry dogwood, normally averages over 10% cover and is characteristic of these sites. Other common shrubs include red-osier dogwood, twinflower, thimbleberry, Utah honeysuckle, pachistima,

Table 39. Common plants of the ABLA2/COCA Association (n=19).

		CON	COVER
TREE OVERSTORY LAYER			
PIEN	Engelmann spruce	100	26
PSME	Douglas-fir	95	23
LAOC	western larch	74	8
ABLA2	subalpine fir	68	13
TREE UNDERSTORY LAYER			
PIEN	Engelmann spruce	84	5
PSME	Douglas-fir	58	4
ABLA2	subalpine fir	53	7
SHRUBS AND SUBSHRUBS			
COCA	bunchberry dogwood	100	14
LIBOL	twinflower	95	13
LOUT2	Utah honeysuckle	84	4
RILA	prickly currant	79	3
PYSE	sidebells pyrola	79	3
RUPA	thimbleberry	74	3
COST	red-osier dogwood	68	5
ROGY	baldhip rose	68	4
SYAL	common snowberry	63	5
CHUM	western prince's pine	63	3
HERBS			
GOOB	western rattlesnake plantain	79	2
CARU	pinegrass	68	4
CLUN	queencup beadlily	68	3
SMST	starry solomonplume	63	3

Table 40. Environmental and structural characteristics of the ABLA2/COCA Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3703	479	2980	4750
Aspect[2]	324	74	--	--
Slope	14	13	1	60
Topographic Moisture	6.37	0.71	4.0	7.0
Soil Surface[3]				
Exposed soil	26	20	2	70
Gravel	12	--	12	12
Rock	2	3	0	12
Bedrock	0	0	0	0
Moss	7	14	0	40
Lichen	1	3	0	10
Litter	27	20	0	50
Diversity[4]				
Richness	32.4	6.1	19	42
N2	10.5	3.3	6	17

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=49).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

sidebells pyrola, prickly currant, baldhip rose and common snowberry. One or more huckleberry species may be present and abundant.

A variety of herbs is typical but covers are usually low and no herb is constant. The most consistent herbs are pinegrass, sweetscented bedstraw, Columbia brome, queencup beadlily, strawberry, western rattlesnake plantain, sweetroot, and starry solomonplume. The presence of oak-fern indicates habitats transitional to the PIEN/EQUIS Association. Average richness and heterogeneity (N_2) are the highest of any association in the Series (Table 40). Not only are there lots of species found within the type, but many may be abundant in any one stand. These high diversity values indicate that this environment is fairly moderate (though still subject to frosts) and represents a transition area between meso-riparian and upland habitats

MANAGEMENT IMPLICATIONS

Wildlife/Range- These stands represent important thermal and hiding cover for a variety of species. Dense spruce provide cool temperatures and good shade in the summer and also provide good winter

Figure 65. Photo of the ABLA2/COCA Association.

habitat. Some of these stands represent late seral or old-growth "stringers" in moist bottoms and have high value for old-growth dependent species due to stand structure. Silvicultural treatments should consider the high wildlife values, especially for late seral or old-growth stands. In addition, the fruits of some shrubs are utilized by wildlife species. Gentle slopes and close proximity to water can make stands susceptible to overuse as resting areas.

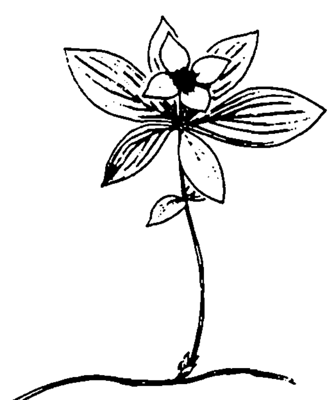
Silviculture- Management recommendations need to consider that these sites are usually located in riparian zones. Frost pocket potential is very high and attention needs to be paid to local topography and air drainage patterns to avoid concentrating cold air. Clearcutting may accentuate the cold air drainage and retard regeneration. Overstory removal may raise water tables from reduced evapo-transpiration, and this is especially a danger on sites transitional to wetter types such as the PIEN/EQUIS or ABLA2/TRCA3 Associations. In addition, soils are easily compacted by heavy equipment on these moist sites. Shrubs respond rapidly after burning and may create shrubfields, but conifers should regain dominance rather quickly, especially lodgepole pine and western larch. Shrubs increase in cover and density for 15 to 20 years and then begin to decline as succession to trees occurs. If burning or slashing are used as treatments to reduce shrub cover, the shrubs will often rejuvenate for another decade or more of site dominance. Natural regeneration potential is high, especially with western larch.

Windthrow of Engelmann spruce and subalpine fir is a serious concern. Engelmann spruce is the least wind-firm species in this area and the moderately high water tables common to some ABLA2/COCA Association sites limit deep root development. Mature stands of subalpine fir and Engelmann spruce also support various root and stem decays. However, no overriding insect or disease problems were apparent in the largely mid-seral sample plots.

Gentle slopes, nearby streams and relatively large trees in old stands has contributed to the relatively large number of campgrounds that are located within the type. However, the vegetation is sensitive to trampling. Thick litter and duff layers help reduce dust and help protect the sites from erosion. Snowberry and red-osier dogwood are fairly resistant to trampling damage and may help screen campsites from each other.

COMPARISONS

The ABLA2/COCA Association is a subdivision of the broadly defined ABLA2/LIBOL Association described on the Okanogan N.F. (Williams and Lillybridge 1983). The ABLA2/COCA Association described by Kovalchik (1993) for northeastern Washington is similar to the type described in this guide. No other workers have described an ABLA2/COCA Association in this area or in adjacent areas. These data do not fit well within the broadly defined ABLA2/PAMY Association of Daubenmire and Daubenmire (1968), since none of their plots contain bunchberry dogwood. One plot of the ABLA2/CLUN Habitat Type- CLUN Phase in northern Idaho (Cooper *et al.* 1991) appears to fit this type. A number of the plots in the ABLA2/CLUN Association of Pfister *et al.* (1977) in Montana contain sufficient bunchberry dogwood cover to key to this type. Their ARNU Phase has the highest constancy of bunchberry dogwood of the five phases they describe, but the type is not identical to the ABLA2/COCA Association of the Colville N.F. Some of the plots in the ABLA2/LIBO2 Association of Clausnitzer and Zamora (1987) also appear to fit this type. Braumandl and Curran (1992) describe Engelmann Spruce/Falsebox/Feathermoss and Engelmann Spruce/Gooseberry Site Associations for the southern interior of British Columbia. These site associations include environments (and plant species) similar to the ABLA2/COCA Association of the Colville N.F.



Cornus canadensis
bunchberry dogwood

ABLA2/LIBOL ASSOCIATION CEF 211
Abies lasiocarpa/Linnaea borealis var. *longiflora*
subalpine fir/twinflower

DISTRIBUTION AND ENVIRONMENT

The ABLA2/LIBOL Association is found primarily west of the Columbia and Kettle Rivers on the Kettle Falls and Republic Ranger Districts (Figure 66). This is primarily outside the range of the Inland Maritime climatic regime. It is usually located on moderately moist sites on gentle lower slopes, benches/terraces, and stream bottoms. It is occasionally found on moist mid-slope positions. This type is found on a variety of aspects at mid- to upper-elevations (Figure 67). Most sites are located between 3,500 and 5,000 ft. (Figure 67). Elevations range from 2,640 to 5,220 ft. (Table 42).

The regolith is either alluvium or glacial outwash. Ash is usually present, either mixed in the solum or forming an ash cap. Soil textures are silts to gravelly silts. Most soils are well drained but mottling occurs in some soils, suggesting high water tables for part of the year. Slope positions, soils and topography indicate these sites are areas of moisture accumulation. The ABLA2/LIBOL Association commonly grades into the PIEN/EQUIS or ABLA2/COCA Associations on wetter sites and into the ABLA2/VAME Association on drier sites.

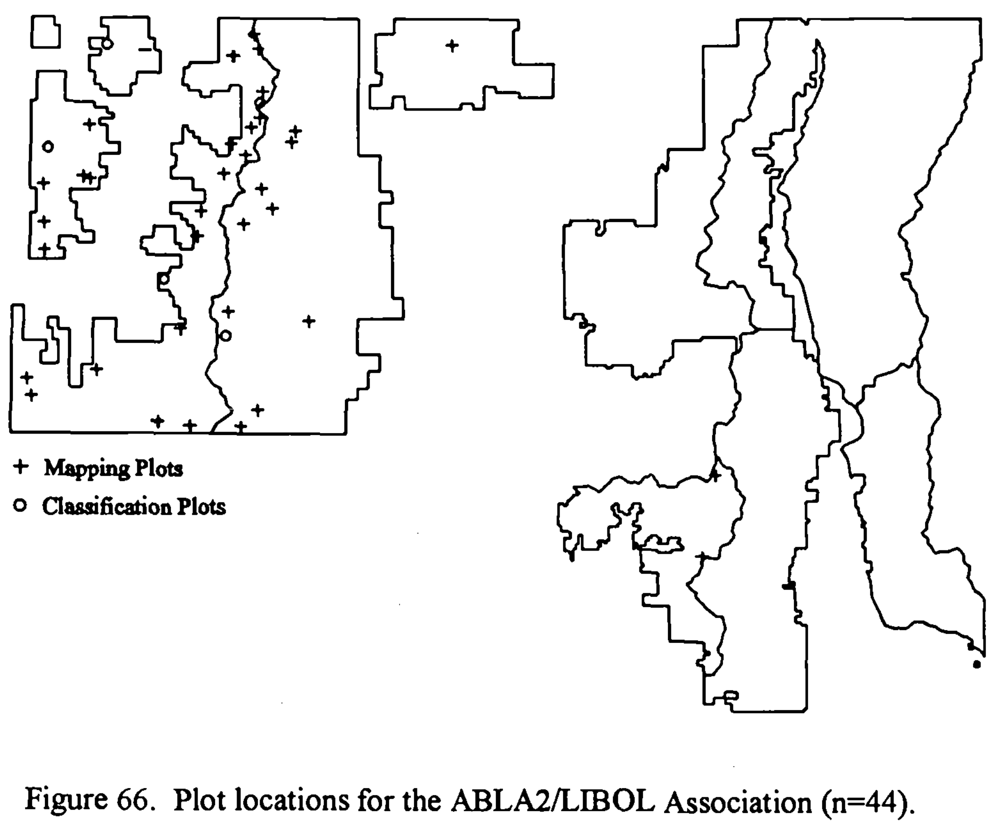


Figure 66. Plot locations for the ABLA2/LIBOL Association (n=44).

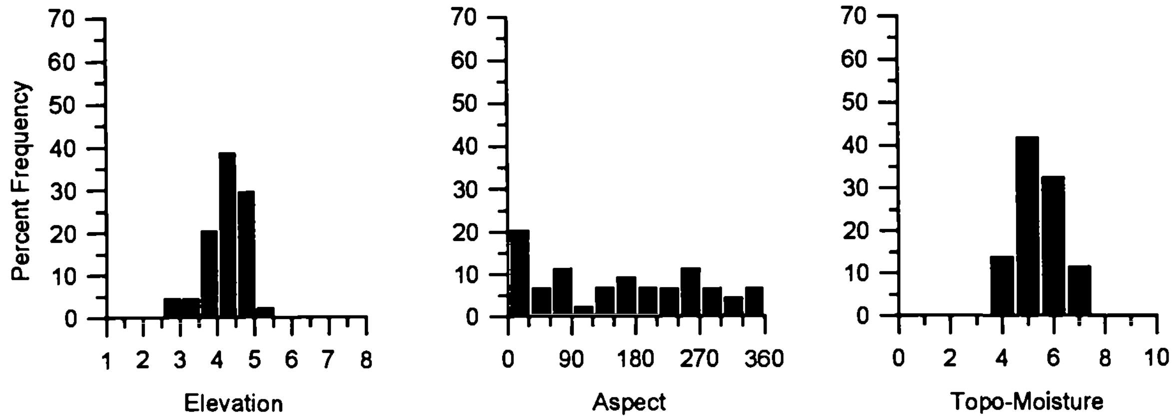


Figure 67. Frequency of ABLA2/LIBOL plots by elevation (1000 ft.), aspect, and topographic moisture.

Data from adjoining portions of the Okanogan N.F. are used to augment the sample in this guide. The ABLA2/LIBOL Association described for the Okanogan National Forest (Williams and Lillybridge 1983) was a very broad type. It has been divided into the ABLA2/LIBOL, ABLA2/COCA, ABLA2/CLUN and ABLA2/TRCA3 Associations in the prior field guide and this desk guide. As defined here, the ABLA2/LIBOL Association reflects stands with a paucity of other indicator species or where queencup beadlily is absent or scarce. Some of the poor shrub and herb layer development in some stands may be related to the inhibitory influences of Engelmann spruce litter and leachates.

Table 41. Common plants of the ABLA2/LIBOL Association (n=13).

		CON	COVER
TREE OVERSTORY LAYER			
PIEN	Engelmann spruce	85	26
LAOC	western larch	69	21
PSME	Douglas-fir	54	19
ABLA2	subalpine fir	54	16
TREE UNDERSTORY LAYER			
PIEN	Engelmann spruce	77	4
ABLA2	subalpine fir	54	9
PSME	Douglas-fir	54	7
SHRUBS AND SUBSHRUBS			
PYSE	sidebells pyrola	92	2
LIBOL	twinflower	77	10
RILA	prickly currant	69	3
SYAL	common snowberry	62	4
CHUM	western prince's pine	62	2
HERBS			
GOOB	western rattlesnake plantain	62	1
THOC	western meadowrue	54	2
GATR	sweetscented bedstraw	54	2

VEGETATION

Mature stands are lacking in the data. The oldest stands are characterized by Engelmann spruce dominating the overstory with a mixture of subalpine fir and Engelmann spruce in the understory. A variety of conifers can dominate early and mid-seral stands depending on age, disturbance history and seed sources. Western larch, subalpine fir, lodgepole pine,

Table 42. Environmental and structural characteristics of the ABLA2/LIBOL Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4207	569	2640	5220
Aspect[2]	20	49	--	--
Slope	21	15	1	53
Topographic Moisture	5.42	0.88	4.0	7.0
Soil Surface[3]				
Exposed soil	33	32	1	70
Gravel	12	0	12	12
Rock	3	6	0	15
Bedrock	0	0	0	1
Moss	6	6	0	15
Lichen	1	1	0	2
Litter	63	29	20	85
Diversity[4]				
Richness	20.5	11.2	6	45
N2	5.6	3.0	1.4	10.1

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=44).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

and Douglas-fir can all be important stands dominants.

Engelmann spruce is the most consistent understory species but subalpine fir is more abundant when present. Regeneration is often absent, apparently because of the dense shade characteristic of many stands. Allelopathy may an important limiting factor controlling species abundance and richness under an Engelmann spruce canopy (Taylor and Shaw 1982).

Many shrubs and herbs may be present depending on the type, timing and amount of past disturbance. Sweetscented bedstraw and starry solomonplume are present in most stands but rarely exceed 5% cover. Twinflower, sidebells pyrola, prickly current, Utah honeysuckle and thimbleberry are all relatively frequent shrubs and subshrubs. Average species richness and heterogeneity are slightly below the Series average (Table 42). However, the range in diversity values is the largest of the Series, reflecting the wide range of stand and site conditions that occur within the type.

Many workers abbreviate the code for twinflower somewhat differently depending on the reference they use or include the subspecies. The codes LIBO, LIBO2 and LIBOL all refer to the same species, twinflower (*Linnaea borealis* var. *longiflora*). Variety *longiflora* is the only variety found in the

Figure 68. Photo of the ABLA2/LIBOL Association.

Pacific Northwest (Hitchcock and Cronquist 1973) so we use the varietal name in the code to avoid the use of a numeric tie-breaker. The use of LIBO as a code for *Linnaea borealis* applies only to guides from areas other than Region Six.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Dense spruce provide cool temperatures and adequate shade, representing good summer thermal and hiding cover for a variety of wildlife species. Lower elevation sites in late-seral stages can also provide winter thermal cover due to the large spruce trees. Some of these stands are late-seral or old-growth "stringers" along stream bottoms, and are important to old-growth dependent species. These "stringers" may also represent travel corridors for many species of wildlife. Shrubs such as snowberry and currant produce fruits for wildlife. Gentle slopes and close proximity to water make many stands susceptible to overgrazing. Overuse as resting areas has been observed in several sites. Livestock use should be closely monitored.

Silviculture- Management plans need to consider that many locations are along stream bottoms. Frost pocket potential is high (though not as high as ABLA2/COCA sites), so careful attention needs to be paid to local topography and air drainage patterns to avoid concentrating cold air. Soils are easily compacted on these moist sites, and overstory removal may raise water tables from reduced evapo-transpiration, especially on sites transitional to the PIEN/EQUIS or ABLA2/TRCA3 Associations.

Western larch regenerates well under seed trees or when it is growing in adjacent stands and shrub and herb cover is low. Shrubs respond rapidly after burning and may create shrubfields for a time. Shrubs increase in cover and density for 15 to 20 years and then decline as succession to trees becomes evident. If the area is burned or slashed, shrubs will often rejuvenate for another decade or more. Gentle slopes, nearby streams and relatively large trees in old stands have contributed to the relatively large number of campgrounds that are located within the type. Unfortunately, most of the ground vegetation is sensitive to trampling damage. Thick litter and duff layers help protect the sites from erosion. Stands with a lot of subalpine fir or Engelmann spruce are at risk to windthrow. Engelmann spruce is the least wind-firm species in this area. Fortunately, most stands are in sheltered locations and are protected from intense winds. However, windthrow can still be a problem, and must be considered when planning any management activity.

COMPARISONS

The ABLA2/LIBOL Association in this guide is part of the broad ABLA2/LIBOL type described for the Okanogan N.F. (Williams and Lillybridge 1983). Some of these plots fit within the ABLA2/PAMY Association described by Daubenmire and Daubenmire (1968). Similar types have also been described in Montana (Pfister *et al.* 1977), central Idaho (Steele *et al.* 1981), northeast Oregon (Johnson and Clausnitzer 1992, Johnson and Simon 1987) and central Washington (Lillybridge *et al.* 1995). The Montana and Idaho types are similar, especially the twinflower phases. The Colville N.F. stands often have more western larch and less lodgepole pine, and less ponderosa pine than Montana stands. The types described for northeast Oregon have much more huckleberry cover and less Douglas-fir than the Colville N.F. plots. The ABLA2/LIBO2 Association described for the Colville Indian Reservation (Clausnitzer and Zamora 1987) is also a closely related type. It differs mainly by having grand fir as a seral species on some sites which does not seem to occur on the Colville N.F. The Engelmann Spruce/Falsebox/Feathermoss Site Association described for the southern interior of British Columbia (Braumandl and Curran 1992) contains sites similar to the ABLA2/LIBOL Association.

ABLA2/RHAL ASSOCIATION CES 2 11
Abies lasiocarpa/Rhododendron albiflorum
subalpine fir/Cascades azalea

DISTRIBUTION AND ENVIRONMENT

The ABLA2/RHAL Association is most common east of the Columbia River. Sites are also found at higher elevations along the Kettle Mountain Crest (Figure 69). This type occupies cold, wet, high-elevation sites with a deep, slow-melting snowpack. Aspects are almost exclusively northwest to northeast. The vast majority of sites are located above 5,000 ft. (Figure 70). Elevations range from 3,850 to 6,740 ft. Slopes are moderate to very steep.

The regolith is volcanic ash on top of or mixed with glacial or colluvial deposits. Soils textures are silts to gravelly loams. The proportion of coarse fragments increases with depth in the profile as the ash diminishes. These soils are usually well drained but are occasionally imperfectly drained near seeps or streams. Summer soil temperatures at 20 in. (50 cm) ranged between 41 and 45 °F (5 and 7 °C). This type commonly grades into the TSHE/MEFE Association on warmer sites east of the Columbia River and into the ABLA2/VASC, ABLA2/COCA, or ABLA2/VAME Associations west of the river. It may grade into the PIEN/EQUIS Association on wetter sites. Drier habitats are usually either the ABLA2/CLUN, ABLA2/LIBOL, ABLA2/VAME or ABLA2/VASC Associations.

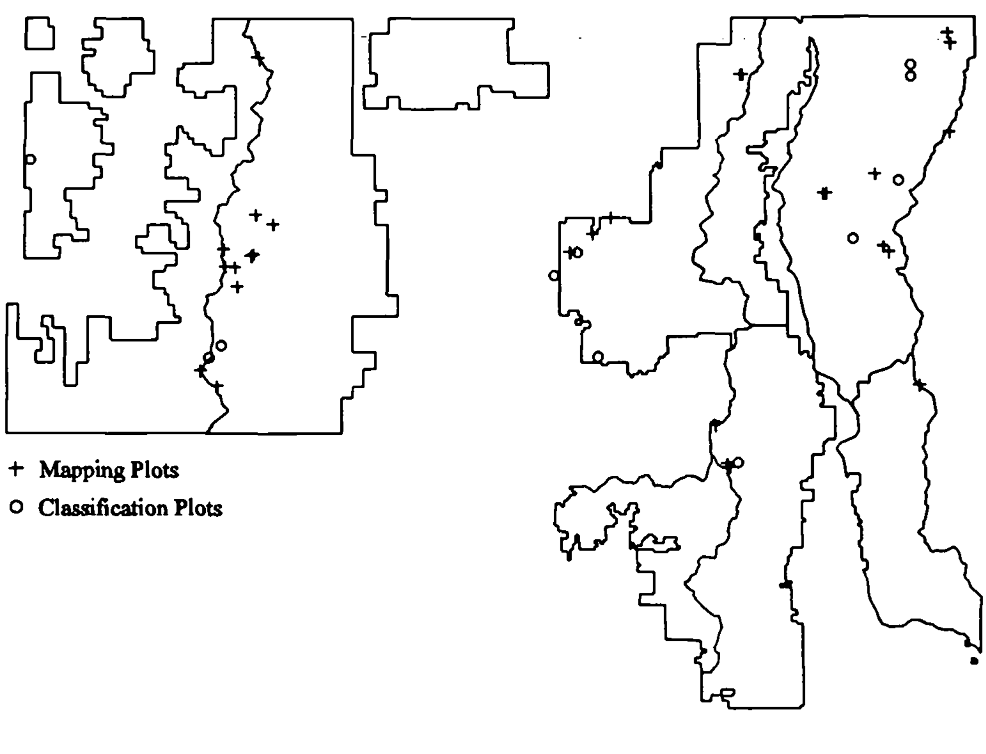


Figure 69. Plot locations for the ABLA2/RHAL Association (n=42).

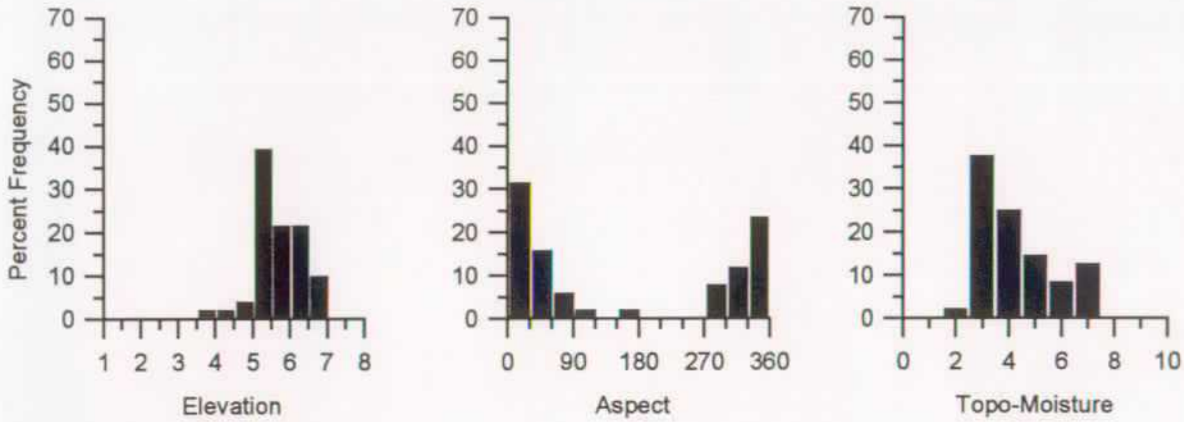


Figure 70. Frequency of ABLA2/RHAL plots by elevation (1000 ft.), aspect, and topographic moisture.

There are stands on the Colville N.F. that better fit the ABLA2/STAM (MEFE) Habitat Type (Cooper *et al.* 1991) but will key to the ABLA2/RHAL Association. These stands are distinguished by the abundance of rusty menziesia and the presence of claspleaf twisted-stalk, oak-fern and arrowleaf groundsel. Kovalchik (1991) provides a more detailed description of high-elevation xero- and meso-riparian plant communities found in eastern Washington.

VEGETATION

Late seral and climax stands are normally dominated by subalpine fir (in terms of individuals). Subalpine fir regeneration is abundant in mid-seral stands and often the sole regenerating tree species. Western hemlock or western redcedar regeneration, if present, are strictly accidental species limited to microsites. Engelmann spruce is a co-climax species and increases in prominence as stands age. Individual spruce have a larger average size than do associated subalpine fir, and may persist in these stands as massive old-growth trees.

Several other tree species such as western larch and lodgepole pine may be important

Table 43. Common plants of the ABLA2/RHAL Association (n=11).

		CON	COVER
TREE OVERSTORY LAYER			
ABLA2	subalpine fir	100	26
PICO	lodgepole pine	82	10
LAOC	western larch	73	11
TREE UNDERSTORY LAYER			
ABLA2	subalpine fir	100	14
SHRUBS AND SUBSHRUBS			
RHAL	Cascades azalea	100	22
LOUT2	Utah honeysuckle	73	4
VASC	grouse huckleberry	64	14
VAME	big huckleberry	55	15
VAMY	low huckleberry	55	12
PAMY	pachistima	55	5
PYSE	sidebells pyrola	55	3
CHUM	western prince's pine	55	2
MEFE	rusty menziesia	36	33

Table 44. Environmental and structural characteristics of the ABLA2/RHAL Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	5639	623	3850	6740
Aspect[2]	7	37	--	--
Slope	37	20	1	75
Topographic Moisture	4.27	1.42	2.0	7.0
Soil Surface[3]				
Exposed soil	21	25	0	60
Gravel	1	1	1	2
Rock	14	18	0	38
Bedrock	0	0	0	1
Moss	7	7	2	20
Lichen	2	2	0	5
Litter	48	23	20	85
Diversity[4]				
Richness	15.9	6.36	6	24
N2	4.8	1.5	3	7

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=51).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

seral components of younger stands but tend to diminish in importance as stand ages approach 200 years. In general, long fire-free intervals (>200 years) have prevented the establishment of pure lodgepole pine stands on most of these sites. Western larch grows poorly on poorly drained sites while Douglas-fir is common only on the driest and warmest sites within the type.

Dense thickets of both tall and low shrubs with few herbaceous species characterize the undergrowth. Cascades azalea is the most common and abundant shrub. Other tall shrubs include big huckleberry and rusty menziesia. Some stands along the Kettle Mountain Crest include a low shrub layer dominated by either low huckleberry or grouse huckleberry. These stands also include sidebells pyrola, pachistima and western princess pine. The herbaceous layer is depauperate without any species showing a strong constancy across many stands. Smooth woodrush may be found in the higher, extreme elevations of this type. Both richness and heterogeneity (N_2) are well below Series averages but are consistent with other subalpine habitats (Table 44).

Figure 71. Photo of the ABLA2/RHAL Association.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Deer and elk use these cool, shaded north-slopes for summer thermal and hiding cover and browse. Elk use some of the wetter sites for wallows. Wildlife values are high because of the abundance of shrubs, some of which produce fruits. In addition, stand structures of mature stands provide critical habitat for old-growth-dependent species. On the Sullivan Lake Ranger District, mature subalpine fir and Engelmann spruce stands serve as winter range for woodland caribou. The principal forage is epidendric lichens covering the older trees. While managing for caribou habitat, severe burns should be minimized to protect *Vaccinium* spp. roots and to avoid dense lodgepole regeneration (Smith and Fischer 1995). Old-growth stands are also important winter habitat for martin (Koehler and Hornocker 1977). Herbage production for livestock is low in most stands (appendix 2).

Silviculture- ABLA2/RHAL stands occur in the headwater areas of many streams. Any management actions should consider maintaining or enhancing watershed values (Pfister *et al.* 1977). Although site productivity is moderate to high (appendix 2), attempts at intensive management for timber production present major problems. Cold temperatures, heavy precipitation (mostly snow) and a short growing season limit growth rates. Toe slope and bench positions often have high water tables.

Overstory removal on such sites may raise the water table to the surface, creating boggy conditions. These boggy areas will reforest very slowly. Early seral species on these sites include claspleaf twisted-stalk, false hellebore, arrowleaf groundsel, licorice-root, drooping woodreed or blue-joint reedgrass. Intensive management should not occur on the harsher, upper-elevation sites where smooth woodrush (LUHI) is present (Cooper *et al.* 1991).

Selection or partial-cutting generally favors the regeneration of shade-tolerant subalpine fir and Engelmann spruce. Partial-cutting is not recommended because it predisposes these stands to heavy blowdown, especially on sites with high water tables. However, shelterwood techniques can be used on sites where soils are not saturated, though site preparation under shelterwoods must be limited where reserve trees are shallow rooted species. On the dry extreme where Douglas-fir may be present, Douglas-fir can be used for shelter trees and should allow the use of prescribed burning for site preparation. Clearcutting or group selection is suggested for regenerating lodgepole pine or spruce, but can lead to increased snowpacks. These increased deep snowpacks in clearcuts can then promote shrubfields dominated by false azalea, Cascades azalea or Sitka alder that often retard reforestation (Cooper *et al.* 1991). Fiedler (1982) found that natural regeneration can be retarded by up to 60% for up to 12 years when total shrub coverage exceeds 50%. Shrubby understories require site preparation for good regeneration. Scarification is reported as being the most successful method on gentler slopes. Prescribed burning is the only feasible method on steep slopes. However, due to moist fuels, successful burning can usually only be accomplished during a brief time period in most years. In addition, if abundant slash is present on the site, even cool fires can cause high residual tree mortality. Dominance by lodgepole pine can occur after severe broadcast burns if a seed source is present (Smith and Fischer 1995).

In general, natural stocking success is high on these sites, although stands may be moderately open. Regeneration success is highest following scarification rather than burning. Subalpine fir, Engelmann spruce, and lodgepole pine are adapted to most sites. Western larch will do well on all but the wettest sites provided that the canopy is open enough. Douglas-fir is poorly suited to the type and can only be considered on the warmest, best-drained sites. Engelmann spruce or lodgepole pine are suggested for wet or very frosty sites. The dense undergrowth and steep slopes of many sites limits most recreational opportunities. Moist conditions, heavy snowpacks and susceptibility of shrubs to mechanical damage makes these sites of limited value for recreational developments or trails.

These stands may require occasional fire protection during periods of severe fire conditions. However, disturbances to these moist forest soils that may accompany modern fire suppression efforts can produce more lasting damage than fire would cause (Bradley *et al.* 1992a).

COMPARISONS

Daubenmire and Daubenmire (1968) describe a broadly defined ABLA2/MEFE Association that occasionally contains Cascade azalea. These data would fit within their type. Pfister *et al.* (1977) in Montana describe a ABLA2/MEFE Association but their data do not contain Cascades azalea and is more related to the ABLA2/RHAL-XETE Association. The same is true for the ABLA2/MEFE Association of Steele *et al.* (1981) in central Idaho and Johnson and Clausnitzer (1992) and Johnson and Simon (1987) in northwest Oregon. Cooper *et al.* (1991) in northern Idaho describe a widespread ABLA2/MEFE Association that they subdivide into four phases. This type is most similar to their COOC Phase. Their LUHI Phase is similar to some of the upper elevational sites of the Colville N.F. type. The ABLA2/RHAL and ABLA2/RHAL/LUHI types described by Lillybridge *et al.* (1995) for the Wenatchee N.F. are very similar, and also represent the lower and upper elevational parts of the broad Colville N.F. type. Some of the ABLA2/RHAL sites described by Williams and Lillybridge (1983) for the adjacent Okanogan N.F. contain *Ledum glandulosum* (LEGL), indicating potentially wetter habitats (Kovalchik 1993). The ABLA2/RHAL described by Clausnitzer and Zamora (1987) for the Colville Indian Reservation is essentially identical to the type described for the Colville N.F. Braumandl and Curran (1992) describe several Subalpine Fir/White-Flowered Rhododendron Site Associations for the southern interior of British Columbia. Their ABLA2/RHAL/PAMY and ABLA2/RHAL/TIUN types appear most similar to the broader ABLA2/RHAL described for the Colville N.F.

Rhododendron albiflorum
Cascades azalea

ABLA2/RHAL-XETE ASSOCIATION CES2 10
Abies lasiocarpa/Rhododendron albiflorum-Xerophyllum tenax
subalpine fir/Cascades azalea-beargrass

DISTRIBUTION AND ENVIRONMENT

The ABLA2/RHAL-XETE Association is most common east of the Pend Orielle River on the Newport and Sullivan Lake Ranger Districts (Figure 72). This type occupies cold, wet, high-elevation sites with a deep, slow-melting snowpack. This community represents environments which are transitional between the ABLA2/RHAL and ABLA2/XETE Associations. It generally occupies upper slope or ridgetop positions on a variety of aspects (Figure 73). East and west aspects are most common. Snow deposition, carried on prevailing winds from nearby grassy slopes, is a common feature of these habitats. Sample plot elevations ranged from 4,850 to 6,520 ft. and averaged 5,536 ft. (Table 46).

The regolith is ash overlying glacial till or outwash. Ash depths vary from 1 to over 4 in. (2 to over 10 cm). Soils are well drained yet well-watered because of cool sites and deep, late-melting snowpacks. Soil textures are usually silts to gravelly loams. Coarse fragments normally increase with depth. Summer soil temperatures at 20 in. (50 cm) range from 40 °F (4.5 °C) to 46 °F (7.5 °C). This type grades into the TSHE/MEFE Association at lower elevations and into the ABLA2/XETE

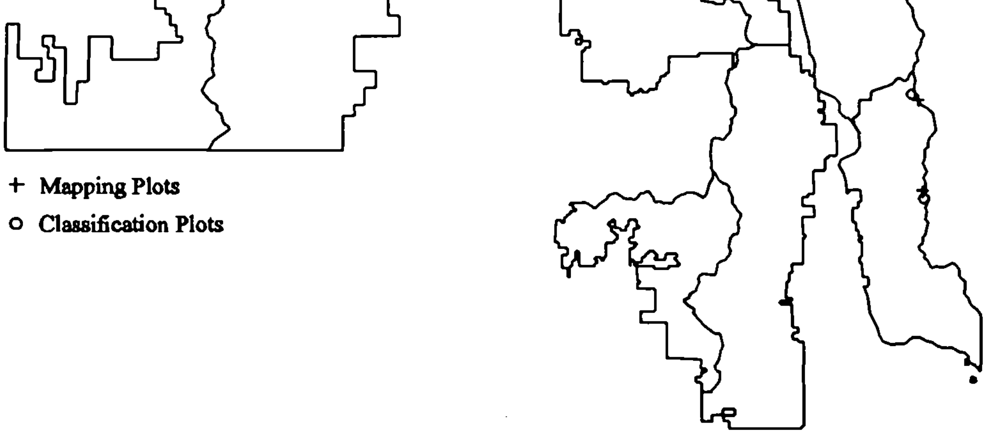


Figure 72. Plot locations for the ABLA2/RHAL-XETE Association (n=44).

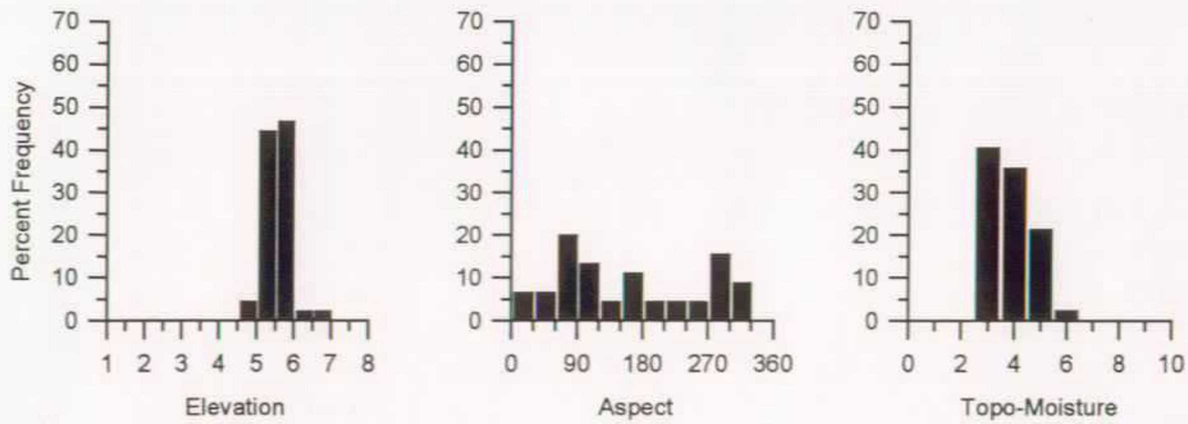


Figure 73. Frequency of ABLA2/RHAL-XETE plots by elevation (1000 ft.), aspect, and topographic moisture.

Association on drier habitats.

VEGETATION

Late seral and climax stands are characterized by subalpine fir and Engelmann spruce dominance in the tree overstory and subalpine fir dominating the understory. Subalpine fir is generally the most common tree although Engelmann spruce may occasionally be abundant. Engelmann spruce is typically much older than subalpine fir in most stands. Lodgepole pine is seldom abundant and western larch occurs only at lower elevations for the type. Stands near South Baldy Lookout on the Newport Ranger District have top damage to most of the western larch and lodgepole pine that is apparently due to snow or ice accumulation.

Table 45. Common plants of the ABLA2/RHAL-XETE Association (n=11).

		CON	COVER
TREE OVERSTORY LAYER			
ABLA2	subalpine fir	100	35
PIEN	Engelmann spruce	82	13
TREE UNDERSTORY LAYER			
ABLA2	subalpine fir	100	10
PIEN	Engelmann spruce	73	3
SHRUBS AND SUBSHRUBS			
RHAL	Cascades azalea	100	36
VAME	big huckleberry	100	18
XETE	beargrass	100	15
SOSC2	mountain ash	100	3
LOUT2	Utah honeysuckle	82	4
PAMY	pachistima	82	4
PYSE	sidebells pyrola	73	3
MEFE	rusty menziesia	64	17
HERBS			
TIUN	coolwort foamflower	64	3

A thick mixture of tall and low shrubs characterizes the undergrowth. Cascade azalea is the most dominant species in the tall shrub layer. Abundant beargrass and big huckleberry comprises the low shrub layer. The combination of Cascade azalea, big huckleberry and beargrass are definitive for the type. Other shrubs that may be common include Utah honeysuckle, mountain ash, pachistima and

Table 46. Environmental and structural characteristics of the ABLA2/RHAL-XETE Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	5536	372	4850	6520
Aspect[2]	90	71	--	--
Slope	37	15	2	70
Topographic Moisture	3.85	0.84	3.0	6.0
Soil Surface[3]				
Exposed soil	20	5	15	25
Gravel	12	0	12	12
Rock	6	13	0	38
Bedrock	0	0	0	0
Moss	25	22	0	65
Lichen	1	2	0	5
Litter	31	17	10	60
Diversity[4]				
Richness	15.3	5.5	7	28
N2	5.6	1.5	4	9

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=45).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4]Richness and heterogeneity, N_2, are expressed as average number of species per plot.

rusty menziesia. Beargrass is included as an important component in the ABLA2/RHAL-XETE type because of its persistence in the oldest stands, relatively limited geographic range (in this study area) and successional importance. Stands lacking beargrass will key to the ABLA2/RHAL Association.

Herbs are normally inconspicuous and are low in cover and constancy. Smooth woodrush occurs in some stands and indicates lingering snowpacks. Both richness and heterogeneity (N_2) are well below Series averages (Table 46), but are consistent with other truly subalpine habitats. The low values indicate an environment with some severe limitations. Heterogeneity is slightly higher than that for ABLA2/RHAL, reflecting the importance of beargrass, while average richness for the two types is about equal.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Bear, grouse, and many avian species use the berries of shrub species such as big huckleberry, serviceberry, and mountain ash. Beargrass is a desirable forage species for deer. The

Figure 74. Photo of the ABLA2/RHAL-XETE Association.

beargrass flowering heads are often cropped-off by the ungulates. The seeds are a favorite food of chipmunks and other rodents. Elk and deer use these sites for summer forage and cover. This is especially true for sites in early and mid-seral stages (Simpson 1990). Early seral species such as *Carex* spp. and pinegrass can be important spring forage for bears. These stands may also represent important thermal areas for deer and elk. Some of these stands are in late seral or old-growth stages and provide valuable habitat for old-growth dependent species. Mature stands on the Sullivan Lake Ranger District are important winter range for woodland caribou. The principal forage is epidendric lichens often draping the older trees. While managing for caribou habitat, severe burns should be minimized to protect *Vaccinium* spp. roots and to avoid dense lodgepole regeneration (Smith and Fischer 1995). These old-growth stands are important winter habitat for martin (Koehler and Hornocker 1977). Herbage production for livestock is very low in most stands. Little use is made of ABLA2/RHAL-XETE stands by livestock.

Silviculture- Cold temperatures and heavy snow accumulations limit growth rates on these sites. Subalpine fir and Engelmann spruce are adapted to all sites and would be appropriate species for natural or artificial regeneration. Lodgepole pine is adapted to most sites and may be useful where other species fail. Western larch and Douglas-fir are suited only to the warmest habitats in the type and not recommended for wide scale regeneration. Engelmann spruce seedlings are suggested for wet or very frosty sites.

Water tables may be close to the soil surface on toe slopes or benches, and overstory removal on these sites may raise water tables to the surface, creating boggy conditions that are difficult to reforest. In addition, ashy soils can be compacted when wet. Selective harvest favors subalpine fir, but predisposes stands to blowdown. Clearcutting is suggested, except for high water table sites, even though this may increase snowpacks. Reforestation is less reliable than in the ABLA2/RHAL Association because of the additional competition from beargrass. These sites are good choices for natural regeneration and there is a high probability of success on most sites (Cooper *et al.* 1991). They may require 10 or more years for full stocking following mechanical scarification or broadcast burning. Artificial regeneration (with 1960's and 1970's techniques) was often successful, but was often redundant because of ample natural regeneration (Fiedler 1982).

Cascade azalea and rusty menziesia decrease in abundance in response to scarification and/or burning. Cool fire will stimulate beargrass, mountain ash and Utah honeysuckle. Very hot or repeated burns favor beargrass over the other species. Mechanical scarification is detrimental to huckleberries and beargrass. Beargrass is highly resistant to trampling damage and will exhibit little evidence of damage while most other shrubs suffer extensive damage under the same level of use.

Silvicultural treatments should consider the high wildlife values, especially for late seral or old-growth stands. There is relatively little old-growth on the Colville N.F. due to the extensive fire history of the area. Remaining late seral or old-growth stands likely represent very important habitat to species requiring late seral stand structures. Management plans need to address these important considerations. Managers also need to address the relative importance of these stands in watershed management, due to the high levels of precipitation (and subsequent runoff) which these sites receive.

COMPARISONS

Daubenmire and Daubenmire (1968) describe a broadly defined ABLA2/MEFE Association that occasionally contains Cascade azalea. These data would fit within their type. Pfister *et al.* (1977) in Montana describe a ABLA2/MEFE Association but their data does not contain Cascades azalea. They also describe rusty menziesia phases of other associations in the Subalpine Fir Series, so apparently view rusty menziesia's indicator value differently. Steele *et al.* (1981) also describe a ABLA2/MEFE Association for central Idaho as do Johnson and Clausnitzer (1992) and Johnson and Simon (1987) for northeast Oregon. Their types also do not contain Cascades azalea and have little or no beargrass. Cooper *et al.* (1991) describe a widespread ABLA2/MEFE Association that they divide into four phases. The ABLA2/RHAL-XETE Association appears to best fit their XETE Phase. This phase often has Cascade azalea and part of the range of their phase adjoins northeast Washington. Braumandl and Curran (1992) describe several Subalpine Fir/White-Flowered Rhododendron Site Associations for the southern interior of British Columbia, though none contain beargrass. The authors note that in the extreme southern portions of the Selkirk Mountains there are sites similar to the ABLA2/RHAL-XETE where substantial amounts of beargrass grow but have yet to be described.

ABLA2/TRCA3 ASSOCIATION CEF4 22

Abies lasiocarpa/Trautvetteria caroliniensis

subalpine fir/false bugbane

DISTRIBUTION AND ENVIRONMENT

The Subalpine Fir/False Bugbane Association is a minor but distinctive high-elevation meso-riparian plant community. It can be found on all ranger districts, but is most common along the Kettle Mountain Crest and the southern portions of the Colville and Newport Ranger Districts (Figure 75). It generally occupies cold, moist-to-wet, upper-elevation sites near streams or on sub-irrigated slopes. Aspects are usually west to east (Figure 76). Plot elevations are located between 4,450 and 5,600 ft. (Table 48).

The regolith is volcanic ash mixed with glacial till, colluvium or glacial outwash, with the glacial till often comprised of metamorphic or basaltic rocks. Soils are poorly drained. Mottling and rust pockets was found in many soil pits, indicating high water tables for at least part of the year. Compacted layers in some soil profiles may indicate perched water tables. The ABLA2/COCA Association often adjoins this type on stream terraces. The ABLA2/CLUN or ABLA2/VAME Associations may occur on nearby sideslopes. The ABLA2/RHAL Association may adjoin this type on higher elevational sites. The ABLA2/TRCA3 Association may be confused with the PIEN/EQUIS.

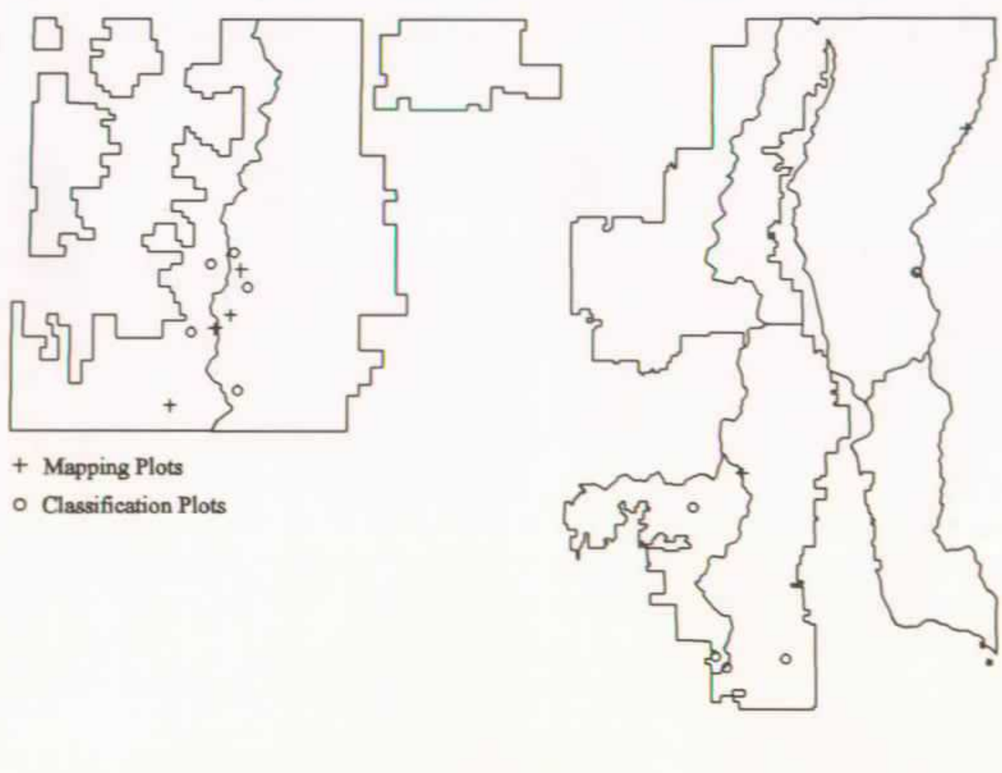


Figure 75. Plot locations for the ABLA2/TRCA3 Association (n=19).

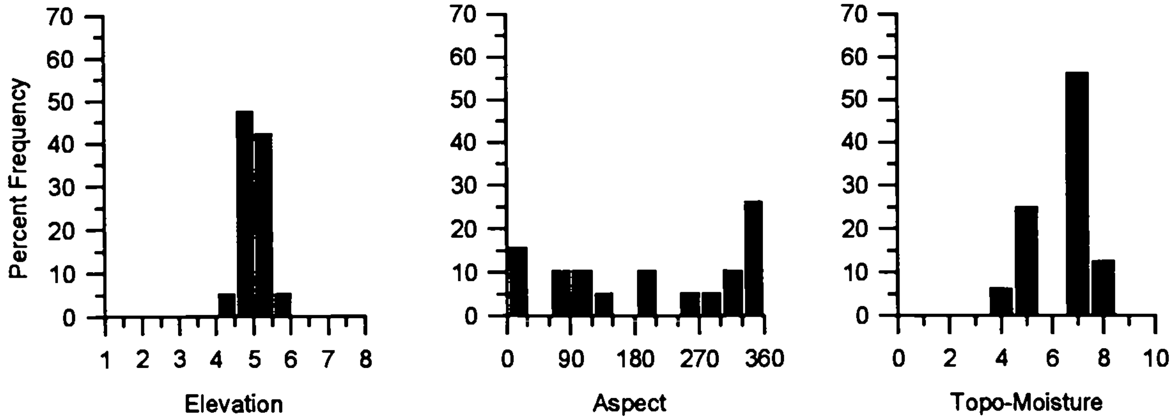


Figure 76. Frequency of ABLA2/TRCA3 plots by elevation (1000 ft.), aspect, and topographic moisture.

However, it tends to occur at higher elevations and on higher slope positions than the PIEN/EQUIS Association.

VEGETATION

Subalpine fir and Engelmann spruce will dominate late seral and climax stands. Grand fir may persist in small numbers in some stands. However, all stands sampled for this type are less than 100 years old so exact overstory composition in late seral stages is unknown. Engelmann spruce is common but is less abundant in these data than expected for such a moist and cool environment. Subalpine fir dominates the regeneration tree layer, especially in the oldest stands within the data. Engelmann spruce regeneration is typically present along with scattered grand fir.

Subalpine fir, grand fir, Douglas-fir, western larch or lodgepole pine dominate early seral stands depending on stand age, history and

Table 47. Common plants of the ABLA2/TRCA3 Association (n=8).

		CON	COVER
TREE OVERSTORY LAYER			
ABLA2	subalpine fir	88	23
PIEN	Engelmann spruce	88	15
PSME	Douglas-fir	88	7
LAOC	western larch	75	21
PICO	lodgepole pine	50	16
ABGR	grand fir	50	14
TREE UNDERSTORY LAYER			
ABLA2	subalpine fir	88	3
PIEN	Engelmann spruce	63	1
SHRUBS AND SUBSHRUBS			
PYSE	sidebells pyrola	100	2
LOUT2	Utah honeysuckle	75	3
VAME	big huckleberry	63	19
RILA	prickly currant	63	4
PAMY	pachistima	63	2
SPBEL	shiny-leaf spirea	50	2
HERBS			
TRCA3	false bugbane	100	15
VIOR2	round-leaved violet	88	4
CLUN	queencup beadlily	75	7
THOC	western meadowrue	75	4

Table 48. Environmental and structural characteristics of the ABLA2/TRCA3 Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	5031	355	4450	5600
Aspect[2]	355	48	--	--
Slope	24	13	1	56
Topographic Moisture	6.43	1.21	4.0	8.0
Soil Surface[3]				
Exposed soil	45	19	25	70
Gravel	12	0	12	12
Rock	13	20	0	38
Bedrock	0	0	0	0
Moss	6	9	0	20
Lichen	0	1	0	1
Litter	55	30	15	80
Diversity[4]				
Richness	25.3	5.6	21	31
N2	9.7	2.6	4	11

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=19).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

pattern of disturbance. Repeated fires favor pine when the interval between major conflagrations is less than 200 years. Less intense fires or longer intervals are more favorable to western larch or, to a lesser extent, Douglas-fir.

Shrub and herb layers are floristically rich and variable in both the numbers and amount of species. Big huckleberry and swamp current are the most common and abundant shrubs. A wide variety of other shrubs may be abundant as well. Sitka alder is a minor component of closed canopy stands but forms dense thickets if stands are burned or logged. False bugbane is characteristic and diagnostic and dominates the herb layer. Coolwort foamflower, round-leaved violet, lady-fern, queencup beadlily, and western meadowrue are common. Both richness and heterogeneity (N_2) are higher than the Series average (Table 48), and any single stand in this type is likely to have close to 25 vascular plant species. The relatively high species richness and heterogeneity is a common characteristic of the cool and moist, but not cold, habitats within the Series.

Figure 77. Photo of the ABLA2/TRCA3 Association.

MANAGEMENT IMPLICATIONS

Wildlife/Range- The type provides valuable riparian habitat for wildlife. Deer and elk use the type for cover and forage. Forage may be moderate to high depending upon seral stage and amount of shrub coverage. Wet spots make good elk wallows. Gentle slopes and close proximity to water make many of these sites susceptible to overgrazing. Livestock are attracted to these sites due to abundant herbs and water which usually remains throughout summer, though false bugbane may be toxic to livestock. Soils are very susceptible to disturbance from cattle. Continued overgrazing may churn soils and destroy herb and tree regeneration layers (Cooper *et al.* 1991). Livestock use should be monitored closely.

Silviculture- Management opportunities are limited due to high water tables and the close proximity to water courses. Tree productivity is the highest within the Series but stands are generally limited in acreage and are seldom large enough to be managed independently. Most stands are in small, moist stringers or pockets within larger management units. Removal of trees may raise the already high water table, creating sites with standing water. Soils are also subject to compaction and flooding. The dense Sitka alder thickets and saturated soils that develop following wildfire or timber harvest may inhibit conifer regeneration. Cold air accumulation causes additional concern for management. Frost pocket potential is high so careful attention should be paid to local topography and air drainage patterns to avoid concentrating cold air.

Partial-cutting can lead to high amounts of windthrow on these sites, which can be negated to a certain extent by clearcutting. However, shrub-dominated communities, especially those dominated by Sitka alder, often develop after clearcutting due to rising water tables. Conifer regeneration can be inhibited for long periods of time. Where this association occurs on uplands, sub-surface irrigation will also limit timber management alternatives and road building activities. Any use of heavy equipment should be delayed until late summer or fall when the soils are less saturated and less prone to damage from compaction (Cooper *et al.* 1991). Site development such as roads or trails should be avoided. Potential for natural regeneration with western larch is good especially when understory development of shrubs and herbs is sparse and water tables are not so high as to make the sites boggy. The moist nature of these sites limit the number of days when prescribed natural fires can burn and when management ignited fires can be conducted effectively and safely. Also, when the opportunity arises for effective prescribed burns on these sites, other fire suppression needs may be claiming forest resources in other locations (Smith and Fischer 1995).

Trails in these wet sites have been shown to be in poorer condition than surrounding drier upland sites such as ABLA2/VAME, ABLA2/VASC or ABLA2/RHAL. The lush vegetation development makes these sites interesting and attractive to those interested in wildflowers and taxonomy. However, the wet nature of the sites makes them very poor choices for recreation developments. Most of these forbs are sensitive to trampling and are easily damaged by foot traffic.

COMPARISONS

The ABLA2/TRCA3 Association is a subdivision of the broadly defined ABLA2/LIBOL Association of Williams and Lillybridge (1983). Johnson and Clausnitzer (1992) and Kovalchik (1993) describe nearly identical ABLA2/TRCA3 plant associations for northeast Oregon and northeast Washington, respectively. These data would fit within the broadly defined ABLA2/PAMY Association of Daubenmire and Daubenmire (1968). One plot from that classification would key to this type. The ABLA2/STAM Habitat Type- LICA (*Ligusticum canbyi*) Phase of Cooper *et al.* (1991) and of Steele *et al.* (1981) in Idaho includes data that appear to fit this type. Most of the plots in the ABLA2/GYDR Association of Clausnitzer and Zamora (1987) also appear to fit this type. Colville N.F. data have much less oak-fern, but these sites appear to be similar except for some floristic differences. Both types appear to indicate a similar habitat.

ABLA2/VACA ASSOCIATION CES4 22

Abies lasiocarpa/Vaccinium caespitosum
subalpine fir/dwarf huckleberry

DISTRIBUTION AND ENVIRONMENT

The ABLA2/VACA Association is most common west of the Columbia and Kettle Rivers on the Kettle Falls and Republic Ranger Districts (Figure 78). It is also locally abundant near the Little Pend Oreille Lakes on the Colville Ranger District. This type represents xero-riparian sites located on gentle, well-drained glacial outwash terraces and benches along lower slopes and in large stream bottoms. Sites generally have seasonally high water tables due to compacted subsoils and experience warm-day, frosty-night temperature regimes. This type is usually found at moderate elevations between 3,000 and 4,000 ft. on east to west aspects (Figure 79). Many stands in the type have been affected by grazing, homesteading, recreation developments or roads because of the favorable topography.

The regolith is volcanic ash deposited over glacial outwash or till. Nearly all sampled stands have compacted or very stony subsoils that limit root penetration. Upper soil horizons are typically mixed with ash and are well drained. Soil textures are silts to gravelly silt loams. Summer soil temperatures at 20 in. (50 cm) varied between 45 and 50 °F (7 and 10 °C). The ABLA2/VACA Association is

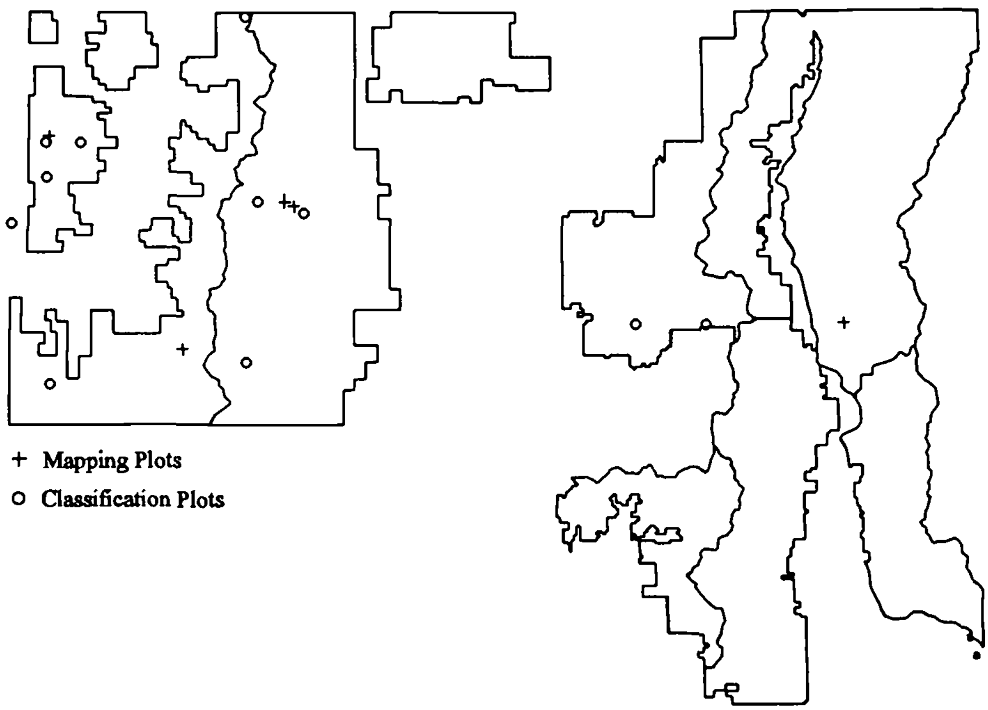


Figure 78. Plot locations for the ABLA2/VACA Association (n=20).

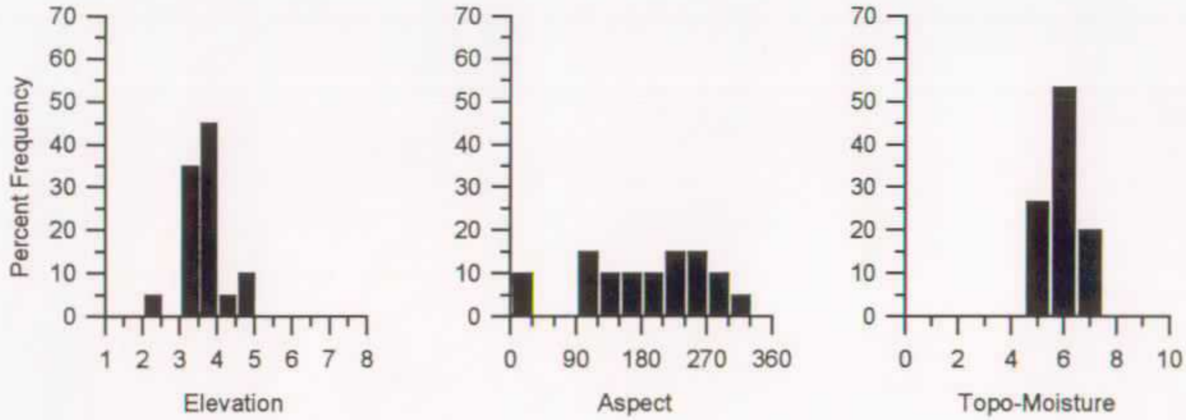


Figure 79. Frequency of ABLA2/VACA plots by elevation (1000 ft.), aspect, and topographic moisture.

closely related to the slightly less frosty ABGR/VACA Association. The PSME/VACA Association occurs on still warmer sites. Stands that key to the ABGR/VACA or PSME/VACA Associations may actually belong to the ABLA2/VACA Association but lack, through disturbance, subalpine fir or Engelmann spruce. Careful examination of elevation range or geographic distribution may help make a proper assignment. Many stands in the PICO/SHCA Community Type probably belong to this type, but lack of definitive indicators prevent their present assignment to a plant association.

VEGETATION

Late seral or climax stands are absent from the data and successional patterns in this part of the sere are not fully understood. Theoretically, late seral or climax stands will be dominated by subalpine fir with some Engelmann spruce and a minor component of Douglas-fir.

Table 49. Common plants of the ABLA2/VACA Association (n=15).

		CON	COVER
TREE OVERSTORY LAYER			
LAOC	western larch	93	18
PSME	Douglas-fir	73	23
PICO	lodgepole pine	73	20
TREE UNDERSTORY LAYER			
PSME	Douglas-fir	93	6
PIEN	Engelmann spruce	67	3
ABLA2	subalpine fir	60	6
SHRUBS AND SUBSHRUBS			
LIBOL	twinflower	93	19
PAMY	pachistima	93	5
ARUV	bearberry	87	9
AMAL	serviceberry	80	2
CHUM	western prince's pine	73	4
BEAQ	Oregon grape	73	2
VACA	dwarf huckleberry	67	6
LOUT2	Utah honeysuckle	67	3
SPBEL	shiny-leaf spirea	60	5
HERBS			
CARU	pinegrass	100	27
HIAL	white hawkweed	80	2
FRAGA	strawberry spp.	73	5
CACO	northwestern sedge	53	3

Table 50. Environmental and structural characteristics of the ABLA2/VACA Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3599	526	2480	4580
Aspect[2]	196	69	--	--
Slope	18	12	1	38
Topographic Moisture	5.93	0.70	5.0	7.0
Soil Surface[3]				
Exposed soil	21	16	1	60
Gravel	17	13	1	38
Rock	8	19	0	62
Bedrock	0	0	0	0
Moss	1	1	0	4
Lichen	0	0	0	1
Litter	31	18	5	45
Diversity[4]				
Richness	28.0	6.2	17	38
N2	9.7	2.9	4.3	16.0

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=20).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

Douglas-fir, western larch or lodgepole pine may dominate seral stands depending on stand age and history. A common stand structure is an open upper canopy of older, fire-resistant western larch or Douglas-fir over a subcanopy of younger Engelmann spruce, subalpine fir and/or lodgepole pine. The subcanopy cohort belong to a much younger age class that became established after a ground fire. Considerable differences in individual tree ages may exist within a stand due to the natural fire regime of this type.

Douglas-fir is the most common and often the most abundant tree species in the understory. Very open stands may also have western larch reproduction, but these are not expected to survive long enough to reach the upper canopy unless a disturbance removes most of the dominants. The abundant Douglas-fir (relative to subalpine fir and Engelmann spruce) indicates that long, disturbance free periods will be needed for Engelmann spruce and subalpine fir to become dominant (relatively rare in this type).

The undergrowth consists of a diverse mixture of low shrubs and subshrubs set in a pinegrass matrix. Few tall shrubs are present and those that are have a low abundance. Serviceberry and Utah honeysuckle are the only tall shrubs widely distributed in the type. The subshrubs and low shrubs are

Figure 80. Photo of the ABLA2/VACA Association.

often inconspicuous because of their stature and the abundant pinegrass. Twinflower, bearberry, Oregon grape, western prince's pine, pachistima, and a variety of huckleberry species are likely to be present in undisturbed stands. Dwarf huckleberry is the most common huckleberry. Grouse huckleberry, low huckleberry or big huckleberry are locally common. Pinegrass is present in every stand and usually abundant. Northwestern sedge may also be common.

Average species richness per plot in the ABLA2/VACA type is well above the average for the Series as a whole while the heterogeneity indices are about equal (Table 50). The high richness probably reflects the relative open canopy characteristic of the type which increases the range of microsite habitats available. The average heterogeneity values, despite the relatively rich flora available, probably reflect an environmental limitation associated with the unique environment of warm days-frosty nights. High grouse huckleberry cover indicates frostier than normal sites with a shorter growing season. Dwarf huckleberry indicates frost pockets with warm days and cold nights. Bearberry, and to a lesser extent, dwarf huckleberry suggest compacted or very stony subsoils that limit root penetration. Bearberry is also common on sandy soils or rocky outcrops. Most of these shrubs and herbs can resprout after fire.

Dwarf huckleberry is retained as the type name even though it is not present in every stand because:

a) studies in the northern Rocky Mountains on similar sites use dwarf huckleberry as the type indicator, and b) dwarf huckleberry combined with bearberry consistently indicates coarse textured glacial outwash terraces and slopes. Dwarf huckleberry is highly susceptible to mechanical injury while bearberry is much more resistant, making the latter a more consistent key species on disturbed sites.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Deer and elk make moderate use of this type during the summer. *Vaccinium* spp. fruits are utilized by blue grouse and other wildlife species. Livestock grazing is common within the type. Twinflower and bearberry increase (or at least become more apparent) as pinegrass cover is reduced by grazing. Pinegrass provides moderately palatable forage for cattle. These sites are used for resting and shading areas by livestock as well.

Silviculture- This type has the lowest stand density index and lowest average basal area of any association within the Subalpine Fir Series (appendix 2). Since these stands are close to the lower elevation boundary for the Series, these low production indices point to some limiting site characteristics. Growth is slow on these sites due to frequent summer frosts combined with relatively warm daily maximum temperatures. Frost potential is high and slope position, topography and air drainage pattern must be considered in management planning. Frost is generally a result of cold air concentrations rather than radiation cooling. Both western larch and lodgepole pine are well adapted to these conditions and natural regeneration can be prolific if soils are not compacted and severe frost pockets are avoided. An ash horizon at the soil surface is usually present and especially subject to compaction. Lodgepole pine is the most tolerant tree species to frost and compacted soils. Pinegrass may hinder reforestation if pre-harvest cover is high.

Low-severity understory fires for thinning the overstory and preparing a patchy seedbed for regeneration can be used on these sites (Smith and Fischer 1995). In addition, prescribed fire can be used in conjunction with tree harvesting for site preparation and hazard reduction. On sites which may have seasonally high levels of soil moisture, management activities should be restricted to periods when soils are less vulnerable to compaction. Open stands of western larch and Douglas-fir over swards of pinegrass and gentle topography makes these sites desirable for campgrounds and similar types of uses. Dwarf huckleberry is easily eliminated by trampling but bearberry and pinegrass are relatively resistant to such activities. However, campers may prefer to locate themselves in areas that receive less frost than these sites.

COMPARISONS

The ABLA2/VACA Association is a part of the more broadly defined ABLA2/VACCI Association described for the Okanogan N.F. (Williams and Lillybridge 1983) and earlier drafts of the Colville N.F. guide. Similar ABLA2/VACA sites have been described in Montana (Pfister *et al.* 1977), central Idaho (Steele *et al.* 1981) and northern Idaho (Cooper *et al.* 1991). The Colville N.F. stands typically contain more Douglas-fir, Engelmann spruce, subalpine fir and western larch and generally less lodgepole pine than the stands described by Pfister *et al.* (1977). This may be due to the more severe continental climate (east of the Continental Divide) where the majority of their plots were sampled.

Vaccinium caespitosum
dwarf huckleberry

ABLA2/VAME COMMUNITY TYPE CES3 13

Abies lasiocarpa/Vaccinium membranaceum
subalpine fir/big huckleberry

DISTRIBUTION AND ENVIRONMENT

The ABLA2/VAME Community Type is the most common subalpine fir plant community on the Colville N.F. It is found on all ranger districts, but is clearly most abundant west of the Columbia and Kettle Rivers in the Kettle Mountain Range (Figure 81). It occupies mid- to upper-slope positions on relatively cool and dry habitats at mid- to upper-elevations, and is located on a variety of aspects (Figure 82). Approximately 90% of the plots are above 4,000 ft. (Figure 82), with elevations ranging from 2,570 to 6,700 ft. (Table 52).

The regolith is volcanic ash mixed with glacial till or outwash. The tills are often of metamorphic or granitic origin (particularly along the Kettle Mountain Crest). Cobbles are common in the soils and most soils are well-drained to excessively well-drained. Most soil textures are gravelly silts to silts depending on the amount of volcanic ash mixed into the solum. The ABLA2/VAME type normally grades into the ABLA2/XETE, ABLA2/CARU or PSME/VAME Associations on drier habitats and into the ABLA2/COCA, ABLA2/LIBOL or the ABLA2/RHAL Associations on more moist habitats.

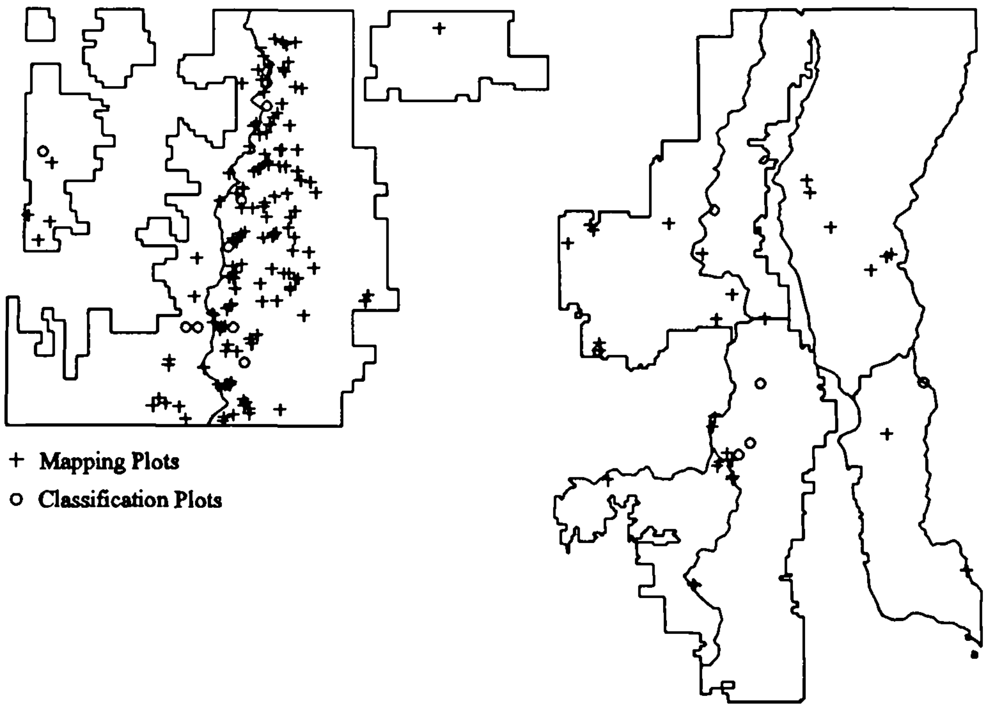


Figure 81. Plot locations for the ABLA2/VAME Community Type (n=191).

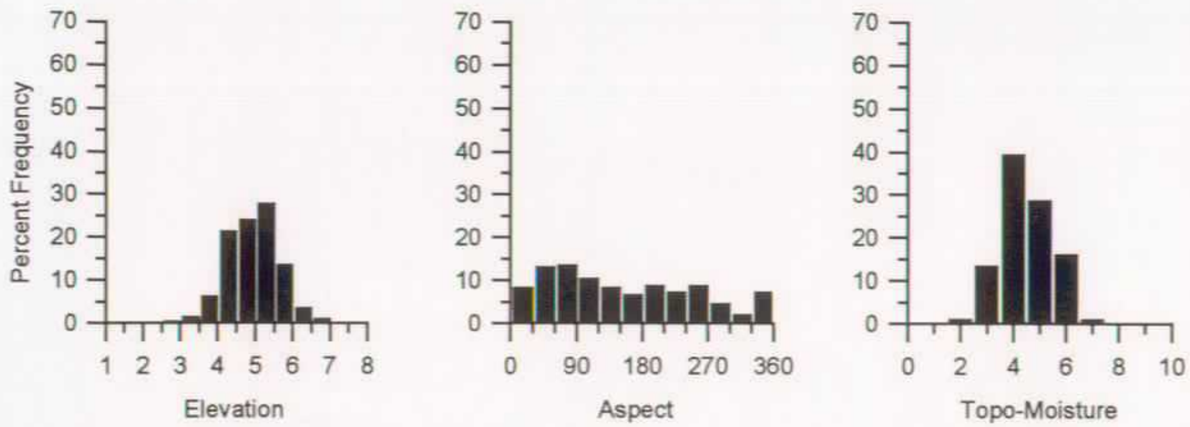


Figure 82. Frequency of ABLA2/VAME plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

Mature stands are poorly represented in the data but apparently subalpine fir will dominate in the overstory and understory. Subalpine fir increases in prominence as stand ages exceed 100 years but this pattern is variable depending on amount and type of past disturbance. Subalpine fir dominates the regeneration layer, though Engelmann spruce is often present as reproduction but seldom very abundant. Scattered Douglas-fir reproduction may occur under open canopies but is also seldom abundant.

Western larch and Douglas-fir often occur as large seral remnants over a dense subcanopy of subalpine fir in early to mid-seral stands. Western larch or lodgepole pine commonly dominate early seral stands (<100 years old). Engelmann spruce is more common on northerly aspects while Douglas-fir is more common on southerly aspects.

Table 51. Common plants of the ABLA2/VAME Community Type (n=24).

		CON	COVER
TREE OVERSTORY LAYER			
LAOC	western larch	96	19
PICO	lodgepole pine	79	22
ABLA2	subalpine fir	71	15
PSME	Douglas-fir	67	18
TREE UNDERSTORY LAYER			
ABLA2	subalpine fir	79	11
SHRUBS AND SUBSHRUBS			
PAMY	pachistima	92	6
CHUM	western prince's pine	75	3
SPBEL	shiny-leaf spirea	63	6
LOUT2	Utah honeysuckle	63	3
VAMY	low huckleberry	58	10
VAME	big huckleberry	54	18
PYSE	sidebells pyrola	50	3
SHCA	russet buffaloberry	4	25
HERBS			
CARU	pinegrass	79	25
VIOR2	round-leaved violet	79	3
HIAL	white hawkweed	75	2

Table 52. Environmental and structural characteristics of the ABLA2/VAME Community Type.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4899	670	2570	6700
Aspect[2]	94	72	--	--
Slope	28	15	1	66
Topographic Moisture	4.49	0.99	2.0	7.0
Soil Surface[3]				
Exposed soil	32	31	0	85
Gravel	20	25	1	38
Rock	17	19	0	38
Bedrock	0	0	0	0
Moss	5	8	0	30
Lichen	1	1	0	4
Litter	42	26	0	80
Diversity[4]				
Richness	23.5	5.9	13	32
N2	7.1	1.8	4	10

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=191)
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

The undergrowth is a diverse mixture of shrubs and herbs. Either big huckleberry and/or low huckleberry being the most abundant shrubs. Low huckleberry indicates somewhat cooler sites than does big huckleberry and grouse huckleberry indicates still yet cooler conditions. Grouse huckleberry is present on the coldest sites with the association. Other common shrubs and subshrubs include Pachistima, Utah honeysuckle, western princes's pine and shiny-leaf spirea. Herbs are variable in occurrence and abundance. Pinegrass is often abundant. Other common herbs include round-leaved violet, sweetroot and white hawkweed. Both species richness and heterogeneity are close to the Series average (Table 52).

Some sites in the Kettle Range that were severely burned in the 1929 Fire often closely resemble the ABLA2/VASC Association. However, these stands have low huckleberry instead of grouse huckleberry, have deeper soils and are at elevations lower than those typical of the ABLA2/VASC Association. However, due to problems identifying low and grouse huckleberry in the field, some high elevation ABLA2/VAME sites (based on presence of low huckleberry) may actually be ABLA2/VASC sites. We also suspect that many stands in the Kettle Mountains that key out to the PSME/VAME Community Type are actually ABLA2/VAME sites with little-to-none subalpine fir regeneration due to the extensive fire history in the area.

Figure 83. Photo of the ABLA2/VAME Community Type.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Berry-producing shrubs such as big and low huckleberry, serviceberry, bearberry, Utah honeysuckle and baldhip rose all produce fruits which are important to a variety of wildlife. Berries are used by bear, grouse, non-game birds and humans. These sites provide good thermal and hiding cover for wildlife species. Herbage for livestock is moderately low and overgrazing further reduces pinegrass cover. Huckleberry species are easily damaged by trampling.

Silviculture- Stand density index is relatively high for the Subalpine Fir Series (appendix 2). Both western larch and Douglas-fir have good site index values and appear well adapted to these sites. Natural regeneration should be acceptable with properly applied seed tree harvests. Seed tree and shelterwood cuts are more favorable for regeneration than clearcuts. Douglas-fir and subalpine fir will regenerate better in small clearings that receive partial shade. Lodgepole pine is better suited for the colder sites, perhaps indicated by low amounts of grouse huckleberry or gentle terrain. It regenerates better in clearings that receive full sunlight. Douglas-fir regenerates well using shelterwood techniques.

Mechanical scarification may be used to reduce shrub competition and enhance Engelmann spruce regeneration, but substantial woody debris should be left to shelter seedlings. Natural regeneration after mechanical scarification required approximately 10 years while after broadcast burning required 15 years (Fiedler 1982). However, big huckleberry is easily damaged by scarification or heavy equipment. Big huckleberry and pinegrass should increase with canopy removal and may compete with regeneration seedlings, especially on the more moist sites. Management to enhance berry production may be an important consideration. Huckleberries will decrease with ground scarification and it's shallow rhizomes are very sensitive to trampling damage.

High pinegrass cover before harvest may indicate potential reforestation difficulties. These pinegrass-dominated habitats also tend to be on southerly or westerly aspects, increasing reforestation difficulty. Natural regeneration may decrease on sites after burning or piling woody debris, since woody debris is an important source of soil wood, acidifying the soil and nurturing ectomycorhizzal fungi (Harvey 1982). Wood also shelters tree seedlings (Smith and Fischer 1995). Very hot burns may severely damage the roots of big huckleberry, reducing the cover of this species for many years (Smith and Fischer 1995). However, low-severity burns can stimulate the growth of big huckleberry. In general, broadcast burning heavily favors lodgepole pine when present on sites, and favors shrubs over herbs, which may discourage pocket gopher expansion (Smith and Fischer 1995). Burning has been used beneficially to remove mistletoe-infested lodgepole pine (Chonka 1986) and inhibit spruce beetles by removing their food supply of cull logs or windthrows (Wright and Bailey 1982).

COMPARISONS

The ABLA2/VAME Community Type is part of the broadly defined ABLA2/VACCI Association (Williams and Lillybridge 1983). It is very similar to the ABLA2/VACCI Association reported for the Colville Indian Reservation (Clausnitzer and Zamora 1987). It is also similar to the ABLA2/VAME Association described for central Washington by Lillybridge *et al.* (1995), though that type contains very little low huckleberry. Big huckleberry was the dominant *Vaccinium* spp. in the preceding classifications. Similar types have also been described in central Idaho (Steele *et al.* 1981), Montana (Pfister *et al.* 1977) and northeast Oregon (Johnson and Clausnitzer 1992). These types tend to have more grouse huckleberry and less lodgepole pine than the ABLA2/VAME type described for the Colville N.F. The ABLA2/VAME Association of Johnson and Simon (1987) for the Wallowa-Snake Province is similar to this type, and they also describe a stable successional stage dominated by lodgepole pine as a PICO/VAME Community Type. Braumandl and Curran (1992) describe Subalpine Fir/Grouseberry/Cladonia and Subalpine Fir/Falsebox/Grouseberry Site Associations. Portions of both of these types contain comparable environments and species compositions to the ABLA2/VAME Community Type.

ABLA2/VASC ASSOCIATION CES4 12

Abies lasiocarpa/Vaccinium scoparium

subalpine fir/grouse huckleberry

DISTRIBUTION AND ENVIRONMENT

The ABLA2/VASC Association is a minor type on the Colville N. F. It is more common to the west on the Okanogan N. F. Plot locations include upper elevation sites along the Kettle Mountain Crest and on prominent peaks such as Calispell Peak (Figure 84). The association typifies cold, high elevation sites on gentle or rolling benches and ridgetops. Locations are usually above 5,500 ft. (Figure 85), though elevations range from 3,680 to 6,720 ft. (Table 54). The type can extend well below the average elevation on sites with cold air accumulation. Aspects are variable. Severe frost is common on many of these sites.

Soils are cold, acid, shallow, droughty, well-drained and poorly developed. The regolith is comprised of metamorphic material such as gneiss and often mixed with volcanic ash. Soil textures are gravelly silts to very gravelly silts. The ABLA2/VASC Association grades into the ABLA2/RHAL Association on somewhat more moist habitats, particularly on steep northeast exposures. Drier, more exposed sites are often in whitebark pine associations. Warmer sites with abundant pinegrass are either the ABLA2/VAME or ABLA2/CARU types. Heavily burned stands in the ABLA2/

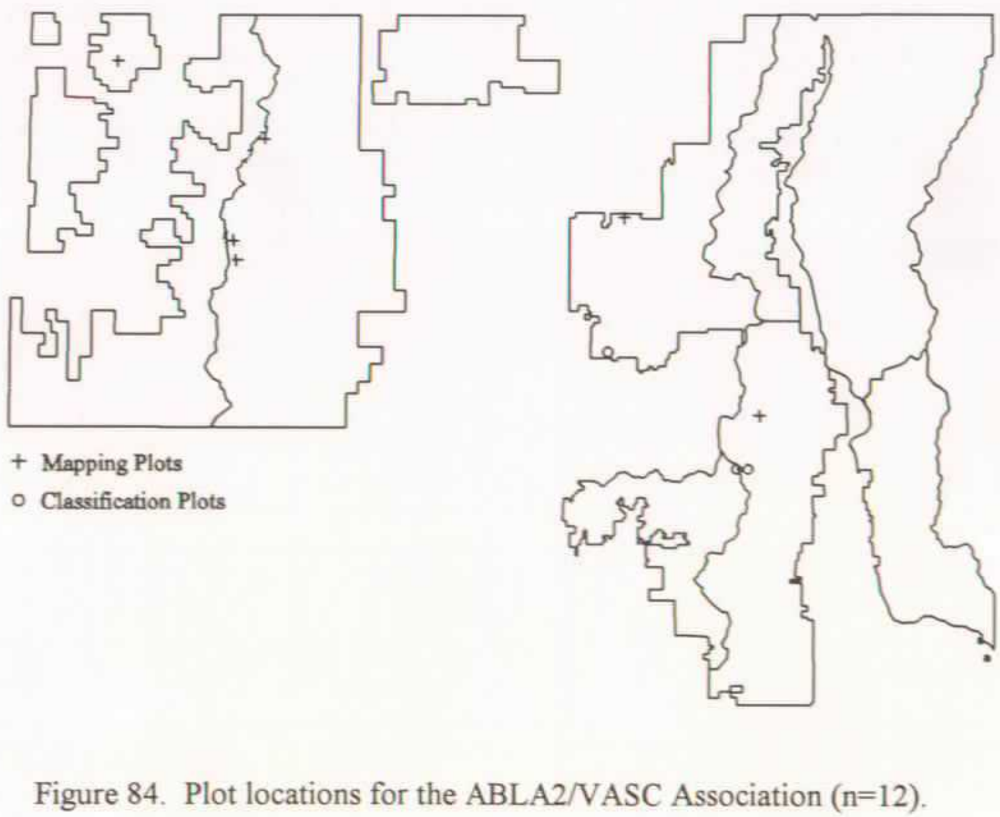


Figure 84. Plot locations for the ABLA2/VASC Association (n=12).

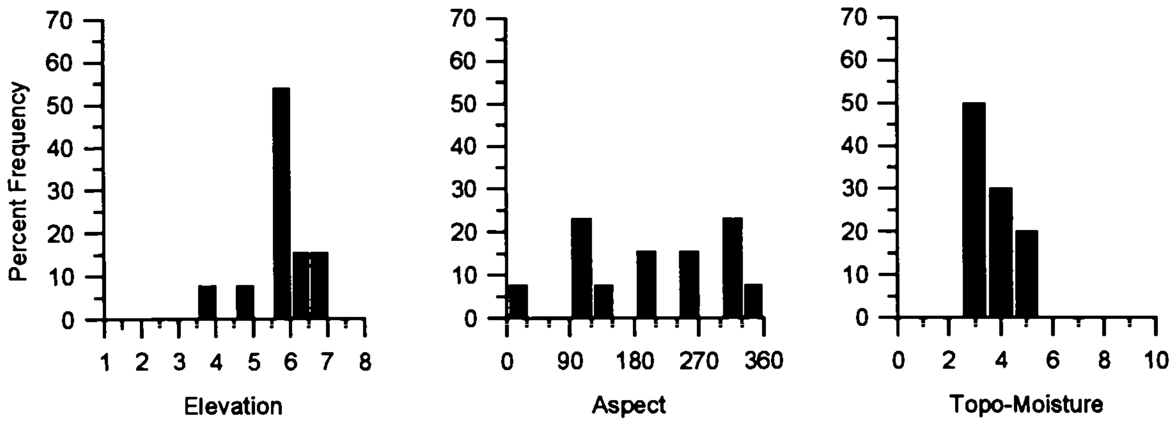


Figure 85. Frequency of ABLA2/VASC plots by elevation (1000 ft.), aspect, and topographic moisture.

VAME Community Type in the Kettle Mountains often closely resemble the ABLA2/VASC Association, apparently because of organic matter and nutrient depletion. Burned over ABLA2/VAME sites typically have only low huckleberry present and are at lower elevations and on generally deeper soils than those characteristic of the ABLA2/VASC Association.

VEGETATION

The data is limited in size and geographic extent. Late seral or climax stands are rare. Species composition and successional characteristics indicate that subalpine fir increases in importance as stands age. Engelmann spruce did not occur in the Colville N.F. data but has been sampled in the same type both in northern Idaho (Cooper *et al.* 1991) and on the Okanogan N.F. (Williams and Lillybridge 1983). Subalpine fir dominates the regeneration layer. Lodgepole pine is the most common tree species and dominates early to mid-seral stands. Sites are too harsh for Douglas-fir and western larch to do well although rare individuals may survive on favorable microsites. Whitebark pine may be found in the upper-elevational limits of

Table 53. Common plants of the ABLA2/VASC Association (n=6).

		CON	COVER
TREE OVERSTORY LAYER			
ABLA2	subalpine fir	100	31
PICO	lodgepole pine	100	26
TREE UNDERSTORY LAYER			
ABLA2	subalpine fir	100	14
SHRUBS AND SUBSHRUBS			
VASC	grouse huckleberry	67	25
PAMY	pachistima	67	6
CHUM	western prince's pine	67	2
VAMY	low huckleberry	50	10
SOSC2	mountain ash	50	2
HERBS			
VASI	Sitka valerian	83	3
LUPIN	lupine spp.	67	3
SENEC	groundsel spp.	67	2
HYMO	pinesap	50	2

Table 54. Environmental and structural characteristics of the ABLA2/VASC Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	5750	793	3680	6720
Aspect[2]	322	65	--	--
Slope	25	15	1	45
Topographic Moisture	3.7	0.82	3.0	5.0
Soil Surface[3]				
Exposed soil	19	20	1	40
Gravel	20	25	2	38
Rock	17	19	0	38
Bedrock	0	0	0	0
Moss	8	3	5	10
Lichen	1	1	0	2
Litter	70	18	55	90
Diversity[4]				
Richness	11.0	3.0	9	17
N2	3.9	1.7	2.5	7.1

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=13).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

these sites.

The depauperate undergrowth is dominated by a prostrate layer of grouse huckleberry. The leaf size of the huckleberry may occasionally exceed the limits described for grouse huckleberry and therefore is called low huckleberry. See the section on taxonomic problems in the introduction. Pachistima, western princess pine, Sitka valerian, and various lupine species are typically present but seldom abundant. Undergrowth is apparently naturally depauperate due to the harsh nature of the sites. The average species richness and heterogeneity (N_2) indices are the lowest for the Series reinforcing the interpretation that these are the harshest sites described for the Subalpine Fir Series (Table 54).

MANAGEMENT IMPLICATIONS

Wildlife/Range- Grouse huckleberry fruits are edible, and provide important food for wildlife, especially species of grouse and bear. Dense lodgepole pine stands in this type are important components of Canadian lynx habitat because of the relative abundance of snowshoe hares. These stands are also considered important habitat for marten. These sites are reportedly good nesting

Figure 86. Photo of the ABLA2/VASC Association.

habitat for red crossbill, dark-eyed junco, mountain chickadee, and red-breasted nuthatch species (Steele *et al.* 1981). Forage potential for domestic livestock grazing is generally very low. Early successional stages may produce some grass and shrub forage. Use by livestock is generally low except for cover and bedding on these sites.

Silviculture- Cold temperatures, snowpack and potential late-summer drought are all concerns for timber management. Trees grow slowly in these harsh conditions. Site index tends to decrease with increasing elevation, especially above 6,500 ft. Frost may occur at any time of the year, either from re-radiation cooling or cold air ponding. Frost pockets often develop after overstory removal. Lodgepole pine is the most reliable species under an even-aged management scenario and will regenerate quite well in unshaded clearings. Clearcutting and burning is not an ecological substitute for the crown fires typical of the association. For example, post-fire snags give protection to seedlings from sun and frost. In consequence, burned areas often have excessive regeneration while some harvest units may have little or none. Harvested areas may have little or no regeneration if prescribed fire is used after harvest to treat slash. Fire in these situations destroys the seed stored in serotinous cones left on site. Any prescribed burning or site preparation by mechanical means must be completed within a short time after logging to avoid loss of stored seed. Most roots are concentrated in the upper 8 in. (20 cm) or less of soil suggesting low nutrient availability.

Disturbance or removal of the upper soil horizons will greatly reduce productivity. In addition, soil scarification may increase frost heaving. The shallow soils can be easily displaced by heavy equipment.

Stocking level control is needed to maintain reasonable growth rates for lodgepole pine regeneration. Unmanaged lodgepole pine stands often quickly stagnate so thinning before stagnation is necessary to insure good response. Grouse huckleberry is sensitive to mechanical or trampling damage so the type is a poor choice for campgrounds if the natural vegetation is to be maintained. Annual snowpacks on these sites may produce high quantities of water in certain watersheds.

COMPARISONS

Associations nearly identical to the ABLA2/VASC Association have been reported by many workers in the Pacific Northwest. Only the most applicable studies are cited. The association has been described in Montana (Pfister *et al.* 1977), northern Idaho (Cooper *et al.* 1991), central Idaho (Steele *et al.* 1981), central Washington (lillybridge *et al.* 1995) and eastern Washington and northern Idaho (Daubenmire and Daubenmire 1968). Most of these preceding classifications use LUHI as an additional indicator to identify the upper elevational environment for this type. Additional types have been reported in northcentral Washington (Clausnitzer and Zamora 1987, Williams and Lillybridge 1983), northeastern Oregon (Johnson and Clausnitzer 1992, Johnson and Simon 1987) and British Columbia (McLean 1970). Braumandl and Curran (1992) describe Lodgepole Pine-Engelmann Spruce/Pinegrass and Subalpine Fir/Grouseberry/Cladonia Site Associations for the southern interior of British Columbia. Both of these broader Site Associations include environments and species compositions which are similar to the ABLA2/VASC Association.

Vaccinium scoparium
grouse huckleberry

ABLA2/XETE ASSOCIATION CEF1 11

Abies lasiocarpa/Xerophyllum tenax
subalpine fir/beargrass

DISTRIBUTION/ENVIRONMENT

The ABLA2/XETE Association is most common east of the Pend Oreille River on the Newport and Sullivan Lake Ranger Districts (Figure 87). The distribution of beargrass is closely correlated with the Inland Maritime weather pattern, and thus, is limited to the eastern-half of the Forest. It typically occupies upper-slope or ridgetop positions above 5,000 ft. on southeast to west aspects (Figure 88). Elevations range from 4,500 to 6,680 ft. and average aspect is 208 degrees (Table 56). Non-forest openings are found next to ABLA2/XETE stands. The type grades into the TSHE/XETE Association on warmer habitats and into the ABLA2/RHAL-XETE Association on cooler aspects or moister soils.

The regolith is volcanic ash deposited over glacial till or residual material. Granite or quartzite are the parent rock type for most tills. Soils are well drained. Soil textures are silts and gravelly silt loams. Soil pH measurements are as low as 4.3 in the upper horizons which indicates acidic, nutrient poor soils. Most soils are relatively cold with summer temperatures at 20 in. (50 cm) of 6 °C.

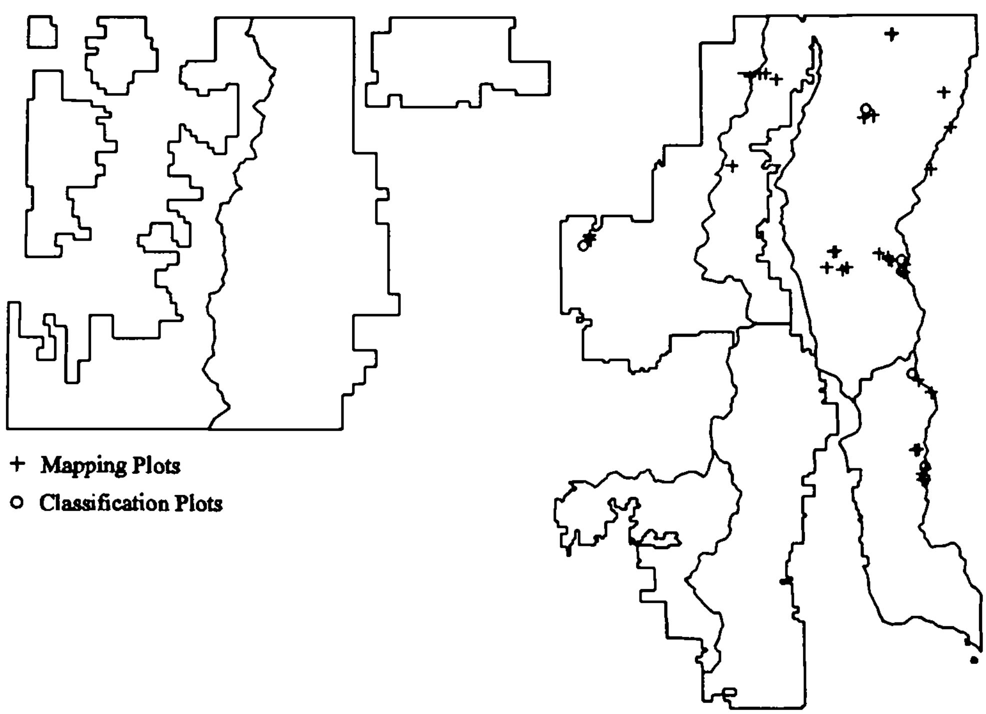


Figure 87. Plot locations for the ABLA2/XETE Association (n=47).

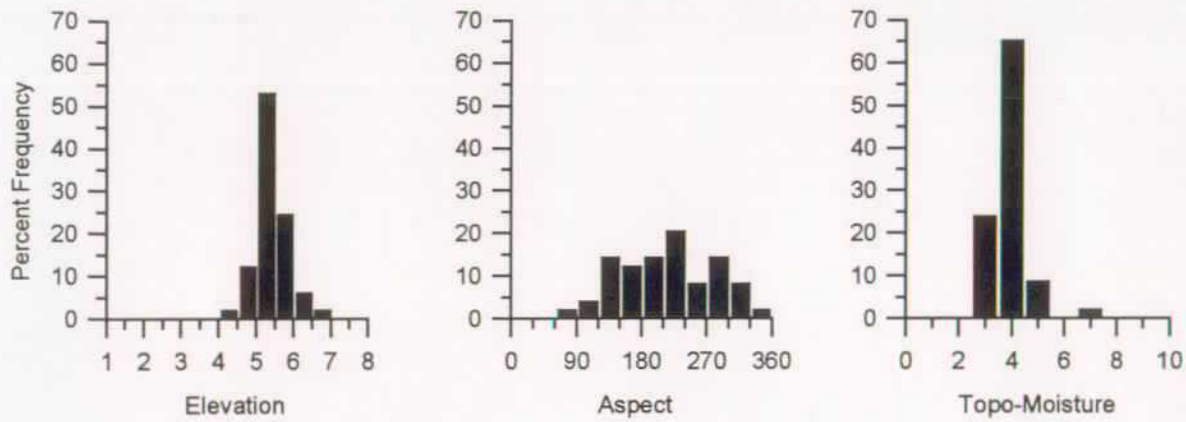


Figure 88. Frequency of ABLA2/XETE plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

Mature stands are characterized by an open or patchy canopy of subalpine fir over a dense, low shrub layer composed mainly of beargrass and big huckleberry. Engelmann spruce is found in most stands but has relatively low cover. Abundant subalpine fir dominates the reproduction layer, and small numbers of Engelmann spruce regeneration are also usually present. Western hemlock and western redcedar often form a minor part of the tree sere, apparently reflecting transitional conditions to the TSHE/XETE Association. Other trees present in early to mid-seral stands are western larch, lodgepole pine and Douglas-fir. Lodgepole pine tends to increase in seral dominance on harsher, upper-elevation sites. Western white pine may be part of the sere on more moderate sites. Whitebark pine may be found occasionally in the extreme upper elevations of this type.

Table 55. Common plants of the ABLA2/XETE Association (n=10).

		CON	COVER
TREE OVERSTORY LAYER			
ABLA2	subalpine fir	100	35
PIEN	Engelmann spruce	70	11
PICO	lodgepole pine	50	6
PSME	Douglas-fir	50	6
TREE UNDERSTORY LAYER			
ABLA2	subalpine fir	100	20
PIEN	Engelmann spruce	70	3
SHRUBS AND SUBSHRUBS			
XETE	beargrass	100	31
SOSC2	mountain ash	100	4
VAME	big huckleberry	90	24
LOUT2	Utah honeysuckle	70	3
VAMY	low huckleberry	50	10
RHAL	Cascades azalea	50	3
HERBS			
LUHI	smooth woodrush	60	3
HIAL	white hawkweed	60	2

The undergrowth generally consists of abundant beargrass and big huckleberry.

Table 56. Environmental and structural characteristics of the ABLA2/XETE Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	5400	443	4500	6680
Aspect[2]	208	58	--	--
Slope	32	15	1	68
Topographic Moisture	3.91	0.73	3.0	7.0
Soil Surface[3]				
Exposed soil	9	10	2	20
Gravel	38	--	38	38
Rock	9	16	0	38
Bedrock	0	0	0	1
Moss	12	15	3	20
Lichen	1	1	0	2
Litter	38	19	25	60
Diversity[4]				
Richness	15.0	5.6	7	24
N2	4.7	1.8	3.1	7.3

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=49).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

Mountain ash, Utah honeysuckle or Cascades azalea are usually present in low amounts. A variety of other shrubs may be present, but Cascades azalea is absent or with very low cover. Herbs are inconspicuous. Smooth woodrush is the most common herbaceous species, indicating deep snowpacks.

Average richness and heterogeneity (N_2) are relatively low and comparable to the ABLA2/RHAL and ABLA2/RHAL-XETE Associations (Table 56). These values seem to reflect the relatively harsh subalpine environment characteristic of these sites.

MANAGEMENT IMPLICATIONS

Wildlife/Range- ABLA2/XETE sites may produce abundant wildlife forage in early and mid-seral stages (Simpson 1990). Deer, elk and other wildlife use the berries of shrubs such as big huckleberry, mountain ash, elderberry, and serviceberry in late summer and fall. The flowering heads of beargrass are heavily used as forage by ungulates, and rodents prefer the seeds. Some of these stands may be in late seral or old-growth stages and provide valuable habitat for species dependant upon these stand

Table 56. Environmental and structural characteristics of the ABLA2/XETE Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	5400	443	4500	6680
Aspect[2]	208	58	--	--
Slope	32	15	1	68
Topographic Moisture	3.91	0.73	3.0	7.0
Soil Surface[3]				
Exposed soil	9	10	2	20
Gravel	38	--	38	38
Rock	9	16	0	38
Bedrock	0	0	0	1
Moss	12	15	3	20
Lichen	1	1	0	2
Litter	38	19	25	60
Diversity[4]				
Richness	15.0	5.6	7	24
N2	4.7	1.8	3.1	7.3

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=49).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3]Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

Mountain ash, Utah honeysuckle or Cascades azalea are usually present in low amounts. A variety of other shrubs may be present, but Cascades azalea is absent or with very low cover. Herbs are inconspicuous. Smooth woodrush is the most common herbaceous species, indicating deep snowpacks.

Average richness and heterogeneity (N_2) are relatively low and comparable to the ABLA2/RHAL and ABLA2/RHAL-XETE Associations (Table 56). These values seem to reflect the relatively harsh subalpine environment characteristic of these sites.

MANAGEMENT IMPLICATIONS

Wildlife/Range- ABLA2/XETE sites may produce abundant wildlife forage in early and mid-seral stages (Simpson 1990). Deer, elk and other wildlife use the berries of shrubs such as big huckleberry, mountain ash, elderberry, and serviceberry in late summer and fall. The flowering heads of beargrass are heavily used as forage by ungulates, and rodents prefer the seeds. Some of these stands may be in late seral or old-growth stages and provide valuable habitat for species dependant upon these stand

Figure 89. Photo of the ABLA2/XETE Association.

structures. Mature stands on the Sullivan Lake Ranger District may represent important winter range for woodland caribou. The principal forage is epidendric lichens often draping the larger trees. While managing for caribou habitat, severe burns should be minimized to protect *Vaccinium* spp. roots and to avoid dense lodgepole regeneration (Smith and Fischer 1995). There is little herbage for domestic livestock on ABLA2/XETE sites.

Silviculture- Tree growth is slow and reforestation often difficult due to relatively harsh sites and shrub competition. Extremes in environmental conditions include south and west slopes with desiccating winds, large diurnal temperature ranges, droughty soils and snow removal by wind. Selective-cutting techniques expose Engelmann spruce and subalpine fir to windthrow. Clearcutting can lead to the development of open shrubfields which can also retard reforestation efforts. Clearcuts can also increase snow deposition and retard reforestation on these sites. Partial-cutting has been recommended for severe steep and dry sites where regeneration tends to be slow and difficult (DeByle 1981, Fiedler 1982).

Research results concerning site preparation for conifer regeneration has been somewhat mixed. Broadcast-burning following clearcutting has been reported to be both beneficial (Shearer and Stickney 1991) and non-beneficial (Arno *et al.* 1985, Simpson 1990) for enhancing tree regeneration on these sites. Natural regeneration may decrease on sites after burning or piling woody debris. Woody debris is an important source of soil wood, acidifying the soil and nurturing ectomycorhizzal fungi (Harvey 1982). Wood debris also shelters tree seedlings (Smith and Fischer 1995). Very hot burns will favor beargrass but may severely damage the roots of big huckleberry, depleting this species for many years (Smith and Fischer 1995). Low-severity burns can stimulate both beargrass and big huckleberry. In general, broadcast burning heavily favors lodgepole pine, and favors shrubs over herbs, which may discourage pocket gopher expansion (Smith and Fischer 1995). Burning has been used beneficially to remove mistletoe-infested lodgepole pine (Chonka 1986) and inhibit spruce beetles by removing their food supply of cull logs or windthrows (Wright and Bailey 1982).

Generally, natural regeneration is usually adequate to restock these sites. Planting does not seem to improve regeneration in ABLA2/XETE communities (Fiedler 1982). Fiedler (1982) also reported that regeneration in clearcuts in northwestern Montana was improved by scarification compared to burning, and that the "no treatment" option was the least successful method. Natural regeneration after mechanical scarification required approximately 10 years while after broadcast burning required 15 years. Mechanical scarification may be used to reduce shrub competition and enhance Engelmann spruce regeneration. However, both beargrass and big huckleberry are easily damaged by scarification or heavy equipment, so care must be used not eliminate or deplete these species. Regardless of techniques, substantial woody debris must be left on sites to shelter seedlings.

Guidelines for species selection on ABLA2/XETE sites have been given by Simpson (1990). Lodgepole pine appears suited to most ABLA2/XETE sites, and perhaps is the best species for timber management. Douglas-fir may be suited for regeneration on sites where ceanothus or sticky currant are present. In general, Douglas-fir and western larch appear best suited to the warmer, more moderate sites. Utah honeysuckle and swamp currant are useful indicators of potential Engelmann spruce sites. Engelmann spruce or lodgepole pine should do well on harsher, upper-elevation sites containing smooth woodrush.

Watershed management should recognize the moderately high precipitation coupled with high evapotranspiration and run-off rates on southerly exposures. Snowpack on these sites may melt periodically during mild winter weather and disappear in the spring several weeks earlier than in adjacent types. Beargrass is important to protect watersheds in these exposed sites which are subject to rapid snowmelt. Many of these sites are used by recreationalists in summer. Big huckleberry stems are very sensitive to trampling damage and its shallow rhizomes are also easily damaged by foot traffic or equipment.

COMPARISONS

Similar types are described in northern Idaho (Cooper *et al.* 1991, Daubenmire and Daubenmire 1968), central Idaho (Steele *et al.* 1981) and Montana (Pfister *et al.* 1977). Workers other than Daubenmire and Daubenmire (1968) have generally subdivided the association into phases based on species such as smooth woodrush (LUHI) and globe huckleberry (VAGL). Most of the Colville N.F. plots would best fit the ABLA2/XETE-VAGL Phase due to the low average cover of LUHI on most plots. However, some sampled stands do fit the LUHI Phase of Cooper *et al.* (1991) for northern

Idaho. Braumandl and Curran (1992) do not describe any similar types for the southern interior of British Columbia. However, the authors note that in the extreme southern portions of the Selkirk Mountains there are communities similar to the ABLA2/XETE (with substantial amounts of beargrass) that have yet to be described.

Xerophyllum tenax

beargrass

PIEN/EQUIS ASSOCIATION CE-M2-11
Picea engelmannii/Equisetum
Engelmann spruce/horsetail

DISTRIBUTION AND ENVIRONMENT

The PIEN/EQUIS Association is a minor type on the Colville N.F., and is best developed west of the Columbia River on the Kettle Falls and Republic Ranger Districts (Figure 90). It occurs on moist to wet river bottoms, flats and benches. The association represents meso-riparian conditions where running or standing water is usually evident. It is found on a variety of aspects generally between 3,000 and 4,500 ft. (Figure 91). It occasionally occurs within the geographic range of western redcedar and western hemlock, but is restricted to habitats too cold to support the THPL/OPHO Association.

The regolith is alluvium or glacial till. We have observed on the Colville N.F., but not sampled, PIEN/EQUIS stands on steep slopes (> 60%) where compacted glacial tills have created a perched water table. Some soils are too wet for a soil pit. Okanogan N.F. data are included to augment the sample for the type.

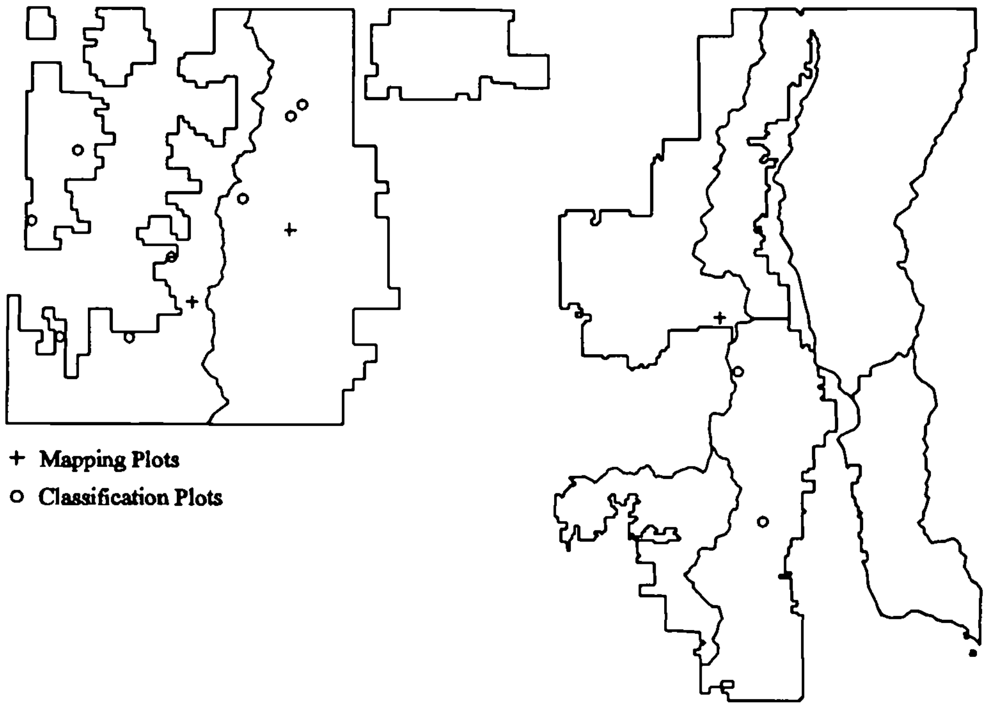


Figure 90. Plot locations for the PIEN/EQUIS Association (n=14).

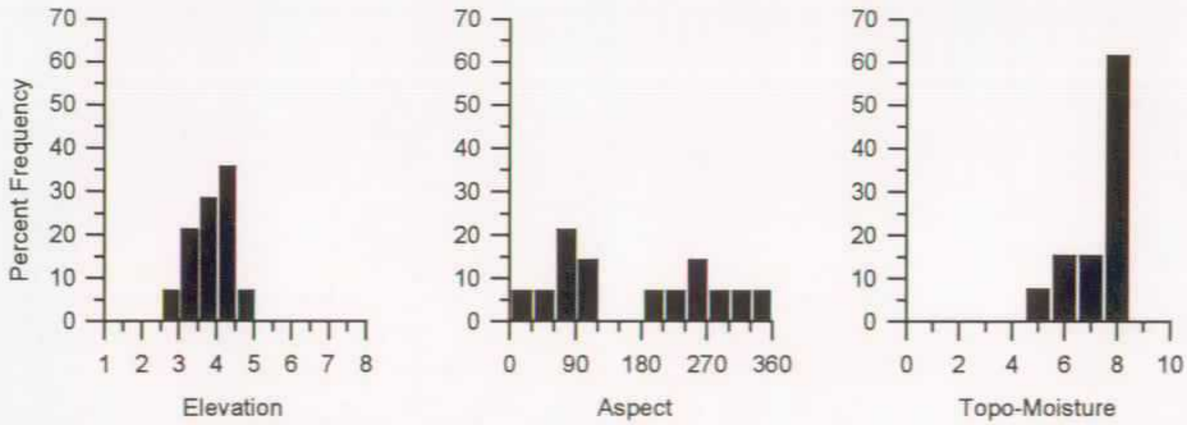


Figure 91. Frequency of PIEN/EQUIS plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

Engelmann spruce often dominates the overstory and understory of mature stands. Subalpine fir is often present in these stands but is usually not abundant. Lodgepole pine is reported as a prominent seral species from this type in western Montana (Pfister *et al.* 1977) and central Oregon (Kovalchik 1987). It is generally found on slightly drier hummocks. Western larch or Douglas-fir are also found on hummocks when present. Black cottonwood is common on a few plots from the Okanogan area but is lacking on the Colville N.F. plots.

Undergrowth composition and abundance is variable as a result of variation in water table depth. Common horsetail and moisture-loving herbs and shrubs are prominent in wet, low areas. The most common shrubs are red-osier dogwood, prickly currant and bunchberry dogwood. They occur on relatively dry root-crown hummocks. Common horsetail, lady-fern,

Table 57. Common plants of the PIEN/EQUIS Association (n=5).

		CON	COVER
TREE OVERSTORY LAYER			
PIEN	Engelmann spruce	100	44
ABLA2	subalpine fir	80	13
TREE UNDERSTORY LAYER			
PIEN	Engelmann spruce	100	2
ABLA2	subalpine fir	80	5
SHRUBS AND SUBSHRUBS			
COCA	bunchberry dogwood	100	8
COST	red-osier dogwood	100	5
RILA	prickly currant	100	4
ALSI	Sitka alder	80	9
LIBOL	twinflower	80	4
RUPE	five-leaved bramble	60	3
VAMY	low huckleberry	60	3
HERBS			
CACA	bluejoint reedgrass	100	5
EQAR	horsetail	80	36
GYDR	oak-fern	80	19
STAM	claspleaf twisted-stalk	80	4
ATFI	lady-fern	80	3
TRCA3	false bugbane	80	2
TIUN	coolwort foamflower	60	5
OSCH	sweetroot	60	2
SETR	arrowleaf groundsel	60	2

Table 58. Environmental and structural characteristics of the PIEN/EQUIS Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3810	472	3000	4630
Aspect[2]	47	68	--	--
Slope	9	19	1	72
Topographic Moisture	7.3	1.03	5.0	8.0
Soil Surface[3]				
Exposed soil	12	3	10	15
Gravel	12	--	12	12
Rock	0	1	0	1
Bedrock	0	0	0	0
Moss	8	9	0	20
Lichen	1	1	0	2
Litter	38	19	25	60
Diversity[4]				
Richness	27.3	5.0	20	35
N2	7.1	1.0	6.2	8.9

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=14).
[2]The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3]Soil surface characteristics in percent cover.
[4]Richness and heterogeneity, N_2, are expressed as average number of species per plot.

oak-fern, bluejoint reedgrass and claspleaf twisted-stalk are the most common and abundant herbs. Readers should refer to Kovalchik (1993) for a more detailed description of these and other riparian plant associations found on the Colville N.F. Average species richness is slightly above the Series average while heterogeneity (N_2) is about equal (Table 58). Higher values might be expected in such moist habitats, but the PIEN/EQUIS Association represents a wet and frosty environment that verges on the extreme cold and wet. Overstory and understory species composition is noticeably poor, and many stands are almost monotypic to spruce.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Wet forests have high value for a variety of wildlife because of abundant lush vegetation that remains succulent throughout the growing season as well as for water and cover. Big game may seek out the lush forbs and use these sites for wallows. In addition, due to the large size many of the Engelmann spruce attain in this type, these sites likely represent important habitat for species dependent upon old-growth-like stand structures. The humid conditions may also attract a large variety of insects, which in turn attract avian species. Herbage for domestic livestock is limited

Figure 92. Photo of the PIEN/EQUIS Association.

but cattle may congregate seeking water and shade. As with many types of meso-riparian plant communities, concentrated cattle use can destroy the plant cover of these sites. Sites should be monitored very closely.

Silviculture- Timber productivity is relatively high for the Subalpine Fir Series, but saturated soils make management difficult. Engelmann spruce is the conifer best suited to these wet habitats. Tree removal often raises the water table by reducing evapo-transpiration. Engelmann spruce and subalpine fir are highly susceptible to windthrow on these wet sites. Saturated soils also greatly inhibit tree regeneration and creates extreme problems for road construction and maintenance. Roads are subject to repeated movement and mass wasting, especially on steeper slopes. Adequate drainage is difficult to establish because of subirrigated soils.

Advanced natural regeneration often occurs only on drier root-crown hummocks under the trees. Tree harvest may create boggy conditions nearly impossible to reforest. Observations of old clearcuts indicate that three decades or more pass before even minimal stocking is attained. Frost is also a serious concern for conifer regeneration. Wet soils, heavy snowpacks and susceptibility of shrubs to mechanical damage makes these sites poor for recreation developments or trails.

COMPARISONS

Many researchers in the northwest have described plant associations similar to the PIEN/EQUIS Association of the Colville N.F. Pfister *et al.* (1977) describe a PICEA/EQAR Association (spruce/common horsetail) in Montana that appears nearly identical to the PIEN/EQUIS Association. However, the spruce in their stands exhibited considerable introgression with white spruce (*Picea glauca*). Steele *et al.* (1981) and Kovalchik (1987, 1993) describe essentially identical types for central Idaho (PIEN/EQAR), central Oregon (PIEN/EQAR-STAM) and northeast Washington (PIEN/EQAR), respectively. A PIEN/EQAR Association is also described for the Blue Mountains in northeast Oregon by Crowe and Clausnitzer (1995). Braumandl and Curran (1992) describe a Subalpine Fir/Common Horsetail/Leafymoss Site Association for the interior of British Columbia which is very similar to the PIEN/EQUIS Association of the Colville N.F. The authors describe several other closely related Subalpine Fir/Common Horsetail Site Associations for the Okanogan Highlands. However, these latter types all contain Labrador tea (*Ledum glandulosum)*, a species rarely found on the Colville N.F. Ogilvie (1962) described a PICEA/EQUISETUM Habitat Type for the Rocky Mountains of Alberta.

Equisetum arvense
common horsetail

WESTERN HEMLOCK SERIES

WESTERN HEMLOCK SERIES

WESTERN HEMLOCK SERIES

Tsuga heterophylla

TSHE

DISTRIBUTION AND ENVIRONMENT

Western hemlock has a distribution in Washington which is nearly identical to that of western redcedar, with disjunct coastal and interior populations. The interior distribution, which includes portions of the Colville N. F., is closely correlated with the Inland Maritime climatic regime. Western hemlock is the most shade tolerant and environmentally restricted conifer on the Colville N. F. The Series is limited to the eastern-half of the Forest (Figure 93), and is found primarily east of a line formed by the Columbia and Kettle Rivers. It occurs only sporadically in isolated stands west of this line and is apparently absent (or extremely rare) on the Colville Indian Reservation (Clausnitzer and Zamora 1987). Most stands are found between 2,500 and 5,000 ft. (Figure 94), though the Series can occur as high as 5,800 ft. on warm southerly slopes in areas of high precipitation. Aspects can be variable, though the Series becomes more environmentally restricted to northern aspects towards the southern and central portions of the Forest (Figure 95). Soils tend to be deep and include a significant amount of ash.

With one exception, the presence of western hemlock indicates that the stand belongs in the Western Hemlock Series. These are swampy habitats co-dominated by western redcedar. Very wet habitats

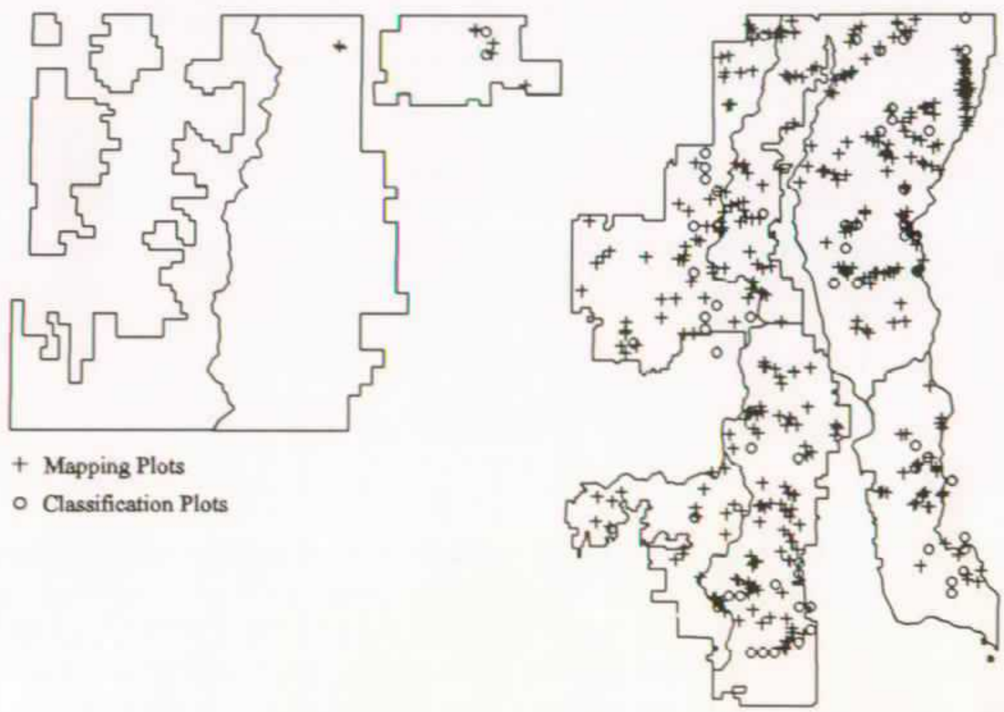


Figure 93. Plot locations for the Western Hemlock Series on the Colville N. F. (n=504).

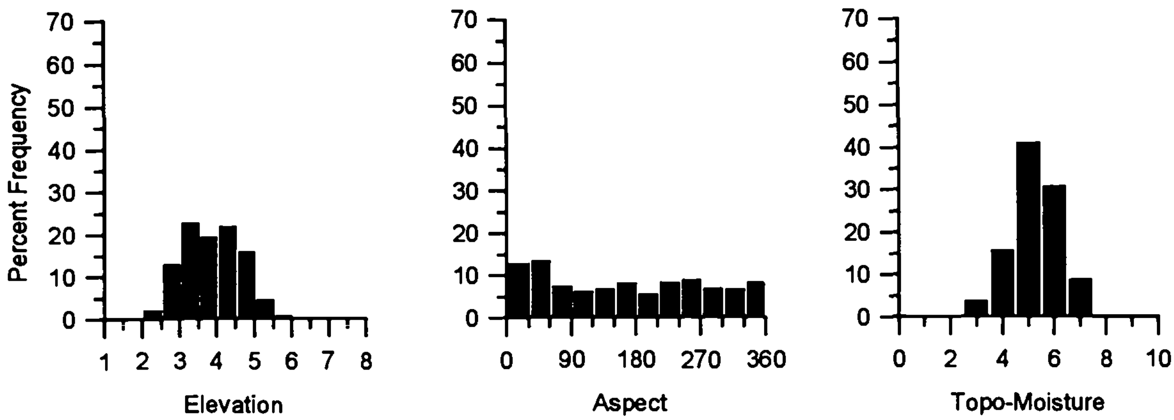


Figure 94. Frequency of Western Hemlock Series plots by elevation (1000 ft.), aspect, and topographic moisture.

where western redcedar and western hemlock co-dominate are assigned to the Western Redcedar Series following the precedent established by Daubenmire and Daubenmire (1968) and Pfister *et al.* (1977). Western redcedar tolerates warmer temperatures, and both wetter and drier conditions better than does western hemlock (Minore 1979). A few individual western hemlock trees are occasionally found in stands that best fit the Western Redcedar Series, though western hemlock is typically located on moist microsites in such conditions. The Subalpine Fir Series occupies colder habitats, while the Western Redcedar or Grand Fir Series occur on warmer, slightly drier habitats.

Six associations are described for the Western Hemlock Series. These include the TSHE/ARNU3, TSHE/CLUN, TSHE/GYDR, TSHE/MEFE, TSHE/RUPE and TSHE/XETE Associations. These associations can be divided into two broad groups based on elevation and, presumably, temperature. The lower elevation (warmer) group includes TSHE/GYDR, TSHE/ARNU3, and TSHE/CLUN arranged from moist to relatively dry. The upper elevation (cooler) group includes the TSHE/RUPE, TSHE/MEFE, and TSHE/XETE associations, again arranged from moist to relatively dry. These relationships are illustrated in figure 96.

VEGETATION

In general, very old stands are rare on the Forest because of widespread disturbance including widespread wildfire, logging and homestead clearing. The oldest western hemlock sampled (550 years old at breast height) was in a swampy site assigned to the THPL/OPHO Association. The next oldest western hemlock (just under 400 years at breast height) was in a stand assigned to the TSHE/RUPE Association. These are the only sampled western hemlock trees over 300 years of age. The oldest tree aged in the Series was a 570-year-old western larch in a stand assigned to the TSHE/XETE Association.

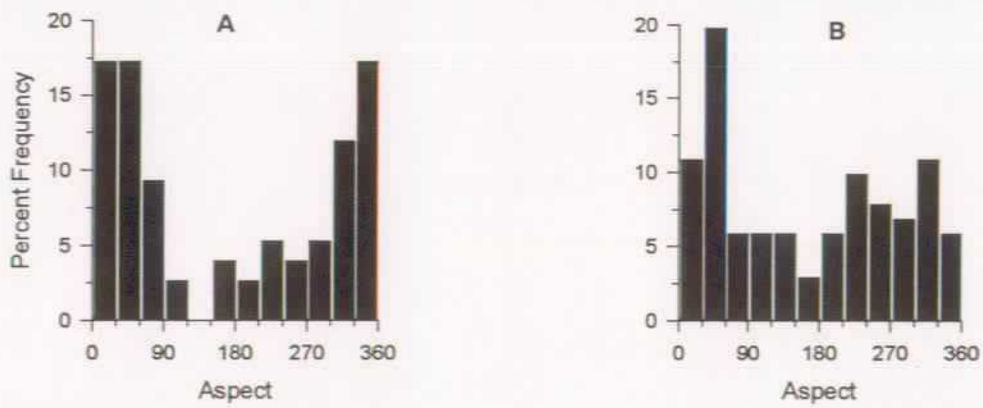


Figure 95. Frequency of western hemlock plots by aspect from Colville (south-half) (A) and Sullivan Lake (B) Ranger Districts.

Mid- (100-200 years) to late-seral (200+ years) stands are normally dominated by western hemlock and western redcedar, although a variety of other tree species may be present dependant on association, type and extent of disturbance and time since disturbance. Grand fir is a common mid- to late-seral component on the TSHE/GYDR, TSHE/ARNU3, and TSHE/CLUN Associations. Subalpine fir and Engelmann spruce are more common late-seral associates in the TSHE/MEFE, TSHE/XETE, and TSHE/RUPE Associations. Tree regeneration layer composition follows a pattern similar to the overstory. Western hemlock and western redcedar typically dominate the understory of mid-seral to mature stands. Grand fir, Engelmann spruce or subalpine fir are present in lesser amounts. Western hemlock reproduces best in closed canopy forests on rotten logs and stumps (Daubenmire and Daubenmire 1968). It is more successful under such conditions than any of its associates. Engelmann spruce regeneration occurs in low amounts in nearly every stand. As organic matter accumulates with time, western hemlock's competitive advantage is increased. However, western hemlock also reproduces on bare mineral soil, especially on moist habitats.

Undergrowth composition varies from dense, tall shrubs to open glades characterized by a mixture of low shrubs and herbs. Many prominent undergrowth species in this series are closely tied to Inland Maritime environments. Many widespread undergrowth species belong to the "Pachistima union" of Daubenmire and Daubenmire (1968). Queencup beadlily is identified as the most useful indicator of the Pachistima union for northern Idaho and western Montana (Cooper *et al.* 1991, Pfister *et al.* 1977). However, on the Colville National Forest, queencup beadlily is nearly ubiquitous over much of the Western Hemlock Series and is therefore less useful as an indicator. Species such as oak-fern, rusty menziesia, beargrass, five-leaved bramble, and wild sarsaparilla have more restricted environments and are more effective environmental indicators. However, dense stands with depauperate shrub and herb layers are frequent and have few or no shrubs and herbs. A thick litter layer is often the most prominent forest floor feature in these stands and the paucity of shrubs and herbs is transitory and more related to tree canopy density and litter accumulation than to intrinsic

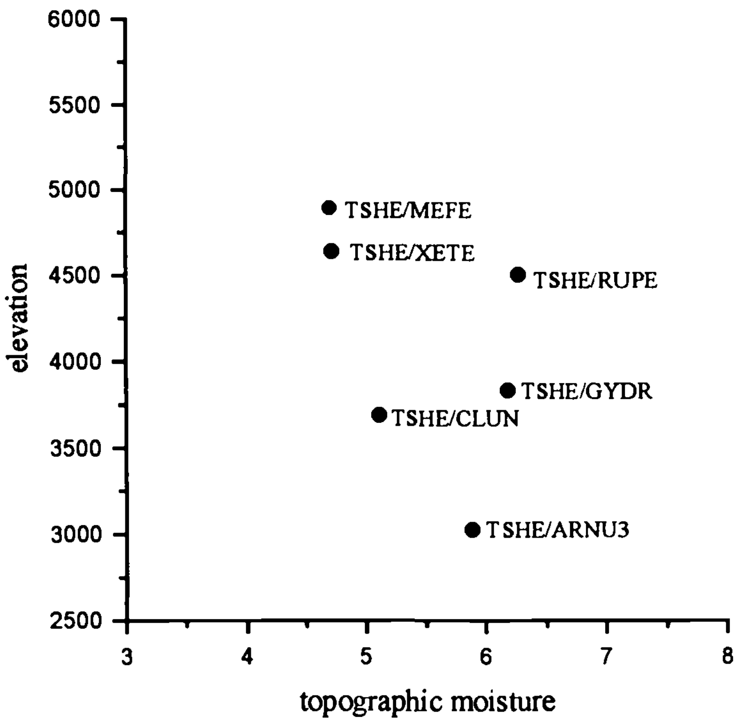


Figure 96. Ordination of western hemlock plant associations by elevation and topographic moisture.

site factors. Most of these stands presently key to the TSHE/CLUN Association with the lack of better indicator species.

The Western Hemlock Series is one of the least diverse series on the Forest (Table 59). Both richness and N2 index are among the lowest for any series on the Forest. A total of 134 different vascular plant species were found on the 118 plots used to described the Series and associations. Close to 157 species would be expected if all mid-seral to climax stands could be inventoried. The per-plot diversity index averages are very close to the overall averages for the entire ecology plot data set for the Forest. These diversity data imply that individual stands belonging to the Series are about average in vascular plant species diversity, but that the Series, as defined, encompasses relatively little habitat variation. Hence, the overall plant species diversity of the Series is low.

Disturbance type, timing, intensity, prior species composition and other biological legacies are important modifiers of secondary succession within the Series. Many possible successional paths exist within this moist Series. Despite this complexity, some general patterns exist and have been discussed in the literature. Nearly any tree species on the Forest may be important during early-seral stages within warmer portions of this series. Ponderosa pine is typically found only on the warmest sites in the TSHE/CLUN and TSHE/ARNU3 Associations. Here it is predisposed to needle diseases

Table 59. Diversity components of the Western Hemlock Series.

Richness[1]	134	
Number of associations	6	
	Mean	S.E.[2]
Expected richness[3]	156.8	5.5
Expected N2[4]	13.1	1.0
Average richness per plot	25.1	0.7
Average N2 per plot	7.3	0.3

[1] Total number of vascular plant species in the Western Hemlock Series data.
[2] Standard error of the estimate.
[3] Jackknife estimate of richness given a sample size of 118 plots.
[4] Jackknife estimate of N2 given a sample size of 118 plots.

because of the relatively moist environment characteristic of the Series. Quaking aspen, paper birch and black cottonwood may form extensive stands early in the sere of several associations after the humus layer has been removed by fire. Grand fir, Douglas-fir, western larch, and western redcedar are markedly less frequent in the cooler TSHE/RUPE, TSHE/MEFE, and TSHE/XETE Associations. Subalpine fir may never be completely excluded from the high elevation TSHE/MEFE and TSHE/XETE types because even mature stands often have relatively open canopies. Mid-seral stands (100-200 years old) in the TSHE/GYDR, TSHE/ARNU3 and TSHE/CLUN Associations often have abundant, vigorous grand fir under a canopy of long-lived seral species such as western larch, Douglas-fir or western white pine. Grand fir may be nearly the same age as the western larch, Douglas-fir and western white pine but slow early growth keeps it in smaller size classes until its superior shade tolerance and vigorous later growth allow it to grow into the upper canopy. After approximately 200 years the proportion of grand fir diminishes, perhaps because of pathogens and/or increased competition from the more shade-tolerant western hemlock and redcedar.

Dense shrubfields often dominate early successional stages following logging, wildfire and other disturbances. Although shrubfield development may initially appear deleterious to conifer establishment and early growth, the ecologic role of the shrub-dominant stage of succession is not well understood. Shrubs provide shade for conifers, add organic matter to the soil and may help retain nutrient capital on site. Species such as ceanothus, alders and russet buffaloberry fix nitrogen. Further, many shrubs provide important forage and cover for insectivorous wildlife which also influence stand health and vigor. Further research is needed on the ecological roles shrubfields have both within stands and in larger landscape heterogeneity. Douglas maple, Scouler willow, big huckleberry, serviceberry, Sitka alder and snowbrush ceanothus are common shrubfield species. Ninebark is generally a minor shrubfield component only on sites within the TSHE/CLUN

Association.

Pacific yew is relatively uncommon shrub on the Colville N. F. Of the 20 ecology plots containing yew, 14 are assigned to the Western Hemlock Series. Three other plots also containing yew are assigned to the THPL/OPHO Association. Yew was most often found in the THPL/OPHO and TSHE/GYDR Associations where it occurred on about half the plots. This indicates that Pacific yew occurrence is strongly related to moist sites where the maritime climatic pattern is strongest. Pacific yew is much less frequent and less abundant on drier habitats. It was found in stands ranging in age from less than 100 years old to over 500 years old. It may enter the sere at an relatively early stage and persist for centuries. All yew on the Colville N.F. had a shrub growth form.

Shrubs such as russet buffaloberry, thimbleberry, elderberry, sticky currant and the two ceanothus species eventually disappear as vegetation physiognomy changes from shrub-field to conifer forest. However, seeds of these species remain viable in the soil long after all other evidence of the plants disappear. Seeds of some species are believed to be viable for decades or perhaps even centuries. These seeds germinate following a disturbance such as fire or logging, leading to rapid shrubfield formation. Other species such as Scouler willow, Douglas-maple, alders, serviceberry, pachistima, baldhip rose and common snowberry often linger as scattered individuals for decades after closed conifer canopies have developed. Seeds of these species are viable for a few years or less in the forest floor. However, individuals which persist vegetatively for many years often respond rapidly after a disturbance from buried roots or root crowns. Nearby populations may also provide seed to the site.

FIRE ECOLOGY

Fire return intervals are not well documented for the Western Hemlock Series, though most sites show some evidence of past fire such as buried charcoal and fire-scarred trees. Fire has certainly been a major influence within the Series on the Forest. Most of the stand data are comprised of stands less than 200 years and often near 100 years old. In north Idaho, a typical fire-return interval for low- to moderate-severity fires is 50-100 years; a stand-replacement interval is 150-500 years (Arno and Davis 1980). In general, it appears that most upland cedar/hemlock stands on the Colville N.F. are characterized by fairly frequent fire activity. However, fire regimes and intensities can be quite variable in this Series. The resulting pattern on the landscape is often a complex mixture of "... 1) complete stand replacement, 2) partially killed overstory (resistant species surviving), 3) underburning with little overstory mortality and 4) unburned forest" (Arno and Davis 1980). Variation in fire intensity and frequency may be expected both within similar plant associations (*i.e.* TSHE/CLUN sites on dry compared to wet areas of the forest) as well as between different associations (TSHE/CLUN compared to TSHE/GYDR sites). This is due to the mosaic of different environments which exist across the Colville N.F. landscape. These are major factors in affecting fire regimes of any particular tree series or stand.

The drier western hemlock associations found on uplands are more at risk of burning than the wetter types located in stream bottoms, seeps, and benches. These mid-slope stands are generally warmer, drier, and more wind-exposed, and may form a "thermal belt" which burns more intensely than lower slope positions (Arno and Davis 1980). Most hemlock stands on these slope positions on the Colville

N.F. are TSHE/CLUN sites. None of the sampled stands in the relatively warm TSHE/CLUN or TSHE/ARNU3 Associations had western hemlock trees over 200 years of age. These warmer habitats appear to burn more frequently and perhaps more intensely than cooler and more moist associations. In comparison, the very moist western hemlock associations tend to burn less frequently than the drier types. In many instances, riparian "stringers" of western hemlock/redcedar can form natural firebreaks on the landscape (Fisher and Bradley 1987) and develop into late seral or old-growth stands. Age data for 101 western hemlock trees were recorded. Only 21 western hemlock trees aged on the Colville N. F. were over 200 years old. These trees were all from stands in either the TSHE/GYDR, TSHE/RUPE, TSHE/XETE, TSHE/MEFE or THPL/OPHO Associations. All of these associations are relatively cool and moist and often occur in sheltered locations near streams.

In addition, hemlock stands have an increased risk of burning when surrounded by drier (and more fire prone) grand fir or Douglas-fir communities on adjacent aspects or slope positions. Many of the western hemlock stands on the Colville N.F. are not continuous in nature, but are instead limited to northern exposures or moist stream bottoms on southern exposures. Douglas-fir communities generally dominate most of the southern aspects. Many fires may originate in these drier Douglas-fir stands on south aspects and then spread (depending upon fire conditions) into the western hemlock stands. Even the very moist hemlock sites can burn, particularly under severe drought conditions when crown fires spread from these drier neighboring stands. Thus, when these narrow cedar/hemlock "stringers" are located in the midst of large stands of drier plant associations such as PSME/PHMA or ABGR/PHMA, the risk of burning is even greater. Many moist cedar/hemlock stands on the Colville N.F. reflect this situation. In comparison, on the wetter portions of the Forest near the Sullivan Lake area, western hemlock and redcedar stands tend to be more widespread and continuous across the landscape. Due to the increased amounts of precipitation and moist forest types, longer fire-return intervals would be expected, allowing the development of older forests.

When fire occurs in these stands, the patch size can be very large. Some very large and intense fires have burned in the cedar/hemlock forests of northeast Washington, north Idaho, and northwestern Montana and include the 20,000 hectare Sundance Fire in north Idaho in 1967 (Anderson 1968). Cooper *et al.* (1991) note other extensive fires in the area in 1889, 1919, 1926, and 1934. Barrows (1952) states that 400,000 hectares burned in north Idaho in 1910 alone. The Colville N.F. was no exception, with a similar history of intense fires in the cedar and hemlock forests. These past fires account for many of the young and dense cedar/hemlock "doghair" stands found on the Forest.

Subalpine fir, Engelmann spruce, lodgepole pine, grand fir, and western hemlock all have naturally low resistance to fire, and are easily killed by moderate severity fires. Western hemlock has a shallow root system which is very susceptible to fire. Species such as Douglas-fir, western larch, ponderosa pine, and western redcedar often survive as residuals due to their higher tolerance to fire. After stand-replacing fires, western redcedar usually enters most sites early in succession due to its prolific seed production (Smith and Fischer 1995). Western hemlock usually regenerates in a stand early in succession in the wetter associations, though may first require the development of an overstory of redcedar to regenerate on the drier sites. Generally, the faster growing seral species (ABGR and PSME) usually overtop the western redcedar and hemlock seedlings and saplings (Smith and Fischer 1995). Western hemlock usually dominates the mid- to late-successional stages on most sites.

INSECTS AND DISEASE

No major foliar diseases are known to cause serious problems for western hemlock. However, wounds on western hemlock are readily infected by several decay fungi. Stem decay caused by the fungus that causes annosus root rot is most common. Indian paint fungus is common in old western hemlock trees, wherever the host occurs. The major butt and root rot pathogens of western hemlock include armillaria, *Schweinitzii*, brown pocket and laminated root rots (Burns and Honkala 1990). Armillaria root rot is present in virtually all stands of the Western Hemlock Series in the northern Rocky Mountains (McDonald *et al.* 1987b). However, the infection rate is low in undisturbed stands. Apparently, the total environmental and biological stress on productive sites does not exceed the tree's tolerance. Infection rates increase threefold after man-caused disturbance (*i.e.* logging or road building). Less productive sites such as those in the Douglas-fir or Subalpine Fir Series have much higher infection rates but as whole these series have a lower overall incidence of the pathogen (McDonald *et al.* 1987a). In addition, western hemlock is very susceptible to windthrow due to its shallow root system.

MANAGEMENT IMPLICATIONS

Some western hemlock forests are among the most productive forests in the world, more so than equatorial rainforests, with very high amounts of net primary productivity. As an example, a western hemlock stand measured on the H.J. Andrews Experimental Forest near Blue River, Oregon, was recorded as having over 600 tons/acre of standing biomass, one of the highest biomasses ever measured. Though not as productive as stands in or west of the Cascade Range, the Western Hemlock Series is the most productive Series found on the Colville N. F. Average basal and average SDI are the highest among all series. However, on an individual basis, most of the seral tree species are more productive than western hemlock.

Both mineral and organic seedbeds are favorable for western hemlock regeneration (Burns and Honkala 1990). Rotten wood and decaying logs are perhaps the most favorable seedbeds, a substrate which provides moisture and nutrients for adequate growth and survival of seedlings. Due to the diversity of seedbeds which western hemlock seedlings can thrive on, successful natural regeneration can be obtained with cutting methods ranging from single-tree selection to clearcutting. However, western hemlock is a shallow-rooted species which does not develop a large taproot. The majority of roots are most abundant near the surface, and are easily damaged by fire and/or harvesting equipment. This shallow root system also makes western hemlock quite susceptible to windthrow as well.

Knowledge of shrub and herb composition can be used to tailor treatments to achieve desired post-treatment condition. Knowledge of seral characteristics or adaptive strategies of shrubs, forbs and graminoids is useful in predicting vegetation response to management or disturbances. Adaptive strategies, species composition, site characteristics, type, intensity and timing of perturbations all affect shrub composition and density. For example, species that resprout from root crowns such as Sitka alder and Scouler willow increase in stem densities after slashing. Appendix 1 lists seral characteristics of the most common shrub, forb and grass species.

As another example, Morgan and Neuenschwander (1988) studied post-clearcut shrub response to high and low intensity burns on Western Redcedar Series sites in north Idaho. Their findings appear applicable to most of the Western Hemlock Series because the Pachistima union of Daubenmire and Daubenmire (1968) was present on most, if not all, study sites. They concluded that burn intensity after clearcutting greatly affects resulting undergrowth species composition and abundance. Low intensity fire favors species with rhizomatous sprouts or buried root crowns while high intensity fire favors shrub establishment from seed. Multiple entries before a clearcut and burn modify the response by opening the canopy and providing disturbed soils that allow establishment of shade-intolerant shrubs. These shrubs then resprout vigorously after the clearcut and burn. In addition, prescribed burning can be used as an effective means of eliminating western hemlock advanced regeneration if necessary due to it's susceptibility to fire.

Shrub height growth and twig production on logged over sites are generally related to time since logging and residual tree cover (Irwin and Peek 1979). Shrub size and twig production peak between 10 and 14 years after logging. Seedtree and shelterwood treatments have significantly less shrub development than clearcuts. Late summer and fall broadcast burning in clearcuts leads to the greatest shrub development due to increased snowbrush ceanothus cover. Optimum germination of ceanothus seed requires both seed coat scarification and cold-wet seed stratification. Fall and late summer burns best meet these requirements. Spring burns usually do not provide the necessary cold-wet stratification resulting in reduced ceanothus germination. However, spring burning does favor species that sprout from root crowns or buried roots (see appendix 1).

Ashy soils are easily compacted or displaced by heavy equipment thereby reducing site productivity and hindering tree regeneration. Harvesting practices that minimize soil compaction and organic matter loss have been suggested by Page-Dumroese (1993). Preserving the rich but somewhat fragile soils on found on many western hemlock sites must be considered during any harvesting or site preparation planning (Smith and Fischer 1995). Soil organic matter content and porosity are both very important soil properties to consider during planning. Soil water-holding capacity is increased by organic matter from duff, roots and plant debris (Smith and Fischer 1995). Harvey (1982) reports that soil wood is an excellent seedbed for regeneration because 1) it retains moisture, 2) reduces non-conifer competition and decay fungi and 3) hosts more mycorrhizae than humus. Soil wood and soil organic matter can be increased from logging debris (Page-Dumroese *et al.* 1994). Slash decays rapidly on the moist sites. Decay of slash can be accelerated and the potential threat of wildfire can be minimized on sites by lopping and scattering slash (Smith and Fischer 1995). Piling fuels with heavy equipment may cause soil compaction and the intense heat generated by burning large slash piles drastically alters soil structure and removes essential nutrients and organic matter. Cool broadcast burns should provide adequate fuel reduction.

Suitable livestock herbage is provided only by early seral stages of succession for most associations. Once tree canopy closure occurs, the herbaceous undergrowth composition changes to include mostly herbs of low palatability. Mature forested stands with shade and available water may receive heavy livestock use as resting areas. Black bear are known to girdle pole-sized hemlock trees and larger saplings. Elk and deer will browse western hemlock and snowshoe hares will eat small hemlock leaders (Burns and Honkala 1990).

COMPARISONS

The interior variant of the Western Hemlock Series or an equivalent syntaxon has been well described by many authors (Bell 1965; Cooper *et al.* 1991, Daubenmire and Daubenmire 1968; Pfister *et al.* 1977). In addition, the coastal variant, which extends from coastal Alaska south into California, has been described by numerous ecologists, including Franklin *et al.* (1988), Henderson *et al.* (1989, 1992) and Topik *et al.* (1986). Meidinger and Pojar (1991) describe the coastal and interior variants of the Series in British Columbia.

KEY TO PLANT ASSOCIATIONS OF THE WESTERN HEMLOCK SERIES

Before using the key, the field form in Appendix 4 should be completed. Refer to the "USING THE KEYS" section in the introduction for more specific information on using the key, particularly if the stand in question does not key properly.

Devils club ≥ 5% . . . . THPL/OPHO Association p. 251

Oak-fern ≥ 5% and five-leaved bramble <1% . . . . TSHE/GYDR Association p. 209

Rusty menziesia and/or Cascades azalea ≥ 5% . . . . TSHE/MEFE Association p. 215

Beargrass ≥ 5% . . . . TSHE/XETE Association p. 226

Five-leaved bramble ≥ 1% . . . . TSHE/RUPE Association p. 221

Wild sarsaparilla ≥ 1% . . . . TSHE/ARNU3 Association p. 199

Queencup beadlily ≥ 1 % . . . . TSHE/CLUN Association p. 204

TSHE/ARNU3 ASSOCIATION CHF3 12

Tsuga heterophylla/Aralia nudicaulis
western hemlock/wild sarsaparilla

DISTRIBUTION AND ENVIRONMENT

The Western Hemlock/Wild Sarsaparilla Association is found east of the line formed by the Kettle and Columbia Rivers (Figure 97). It typically occupies gentle to moderate lower slope, bench and bottom positions in the xero-riparian zone. Aspects are variable and most sites occur between 2,000 and 3,500 ft. (Figure 98) and average 3,027 ft. (Table 61). The TSHE/ARNU3 Association represents sites which are lower elevation, warmer, and slightly drier than TSHE/GYDR or TSHE/RUPE sites.

Soils are formed in volcanic ash over glacial-fluvial deposits. Compacted subsoils are common at 12 to 24 in. (30 to 60 cm) deep in the profile. Soils are well-drained and have textures that vary from silt to cobbly silt-loam. Average soil temperature at 20 in. (50 cm) was 8 °C. Surface rock is usually absent. Humus and duff ranged from 3 to 5 in. (8-13 cm) in depth. Organic matter turnover is rapid on these relatively warm and humid sites. The TSHE/ARNU3 association is possibly the warmest environment in the Western Hemlock Series. It grades into the similar THPL/ARNU3 Association which occurs on yet warmer sites. The TSHE/GYDR association is found on what are apparently cooler, higher-elevation habitats.

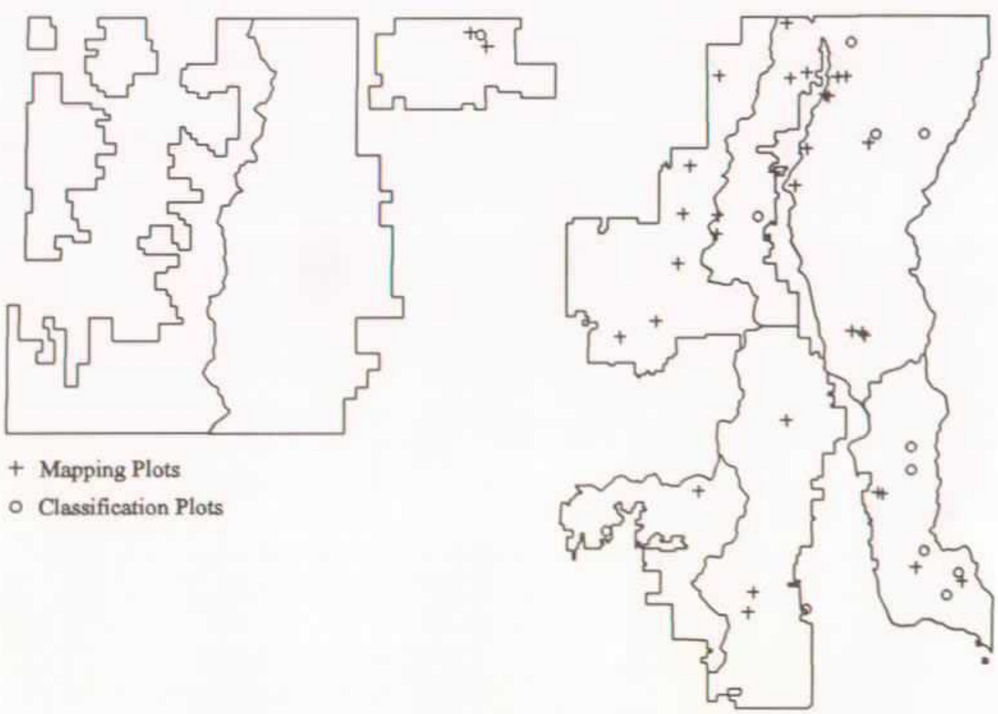


Figure 97. Plot locations for the TSHE/ARNU3 Association (n=48).

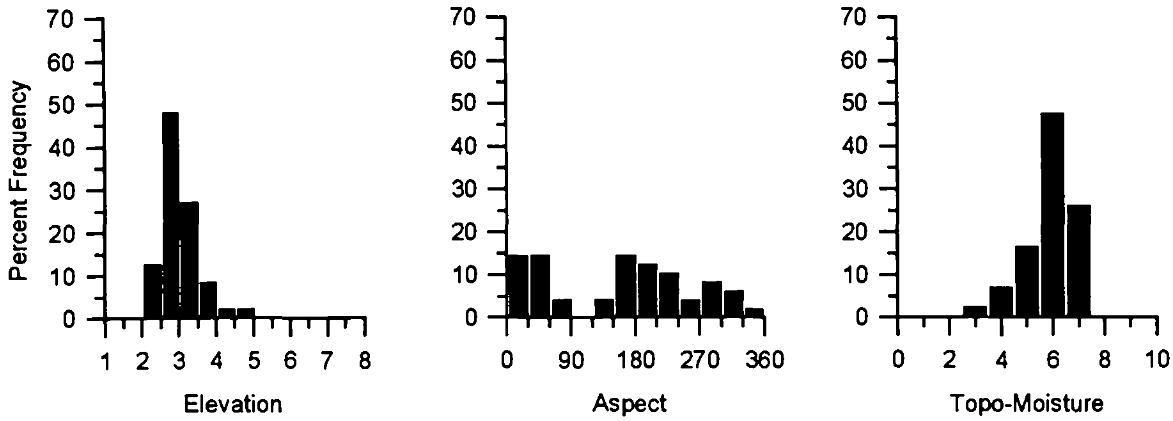


Figure 98. Frequency of TSHE/ARNU3 plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

All conifer species occurring on the Forest (except subalpine fir and whitebark pine) can be found on the TSHE/ARNU3 Association. It is not uncommon to find six or more conifer species present on any single plot. This is the only association in the Western Hemlock Series where ponderosa pine is more than a minor part of the tree sere. Paper birch and/or quaking aspen are especially important following fires that remove most of the humus.

A dense, multi-layered canopy dominated by western hemlock is characteristic of late-seral and climax stands. Western redcedar is a very important stand component and may never be completely replaced by western hemlock. Both western hemlock and western redcedar are common understory species. Seral grand fir, Douglas-fir, western larch and western white pine are present only as snags or scattered canopy emergents in the oldest

Table 60. Common plants of the TSHE/ARNU3 Association (n=11).

		CON	COVER
TREE OVERSTORY LAYER			
ABGR	grand fir	91	25
TSHE	western hemlock	91	17
THPL	western redcedar	91	11
PSME	Douglas-fir	82	12
LAOC	western larch	64	14
PIMO	western white pine	64	10
TREE UNDERSTORY LAYER			
THPL	western redcedar	91	6
TSHE	western hemlock	82	7
ABGR	grand fir	73	3
SHRUBS AND SUBSHRUBS			
LIBOL	twinflower	100	11
CHUM	western prince's pine	100	3
ROGY	baldhip rose	82	3
BEAQ	Oregon grape	82	3
RUPA	thimbleberry	73	4
VAME	big huckleberry	64	4
ACGLD	Douglas maple	55	3
HERBS			
ARNU3	wild sarsaparilla	91	18
VIOR2	round-leaved violet	91	2
SMST	starry solomonplume	82	5
CLUN	queencup beadlily	82	5

Table 61. Environmental and structural characteristics of the TSHE/ARNU3 Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3027	481	2130	4600
Aspect[2]	327	67	--	--
Slope	15	16	1	68
Topographic Moisture	5.88	0.97	3.0	7.0
Soil Surface[3]				
Exposed soil	43	31	5	80
Gravel	16	10	12	38
Rock	0	0	0	0
Bedrock	0	0	0	0
Moss	2	2	1	5
Lichen	0	1	0	1
Litter	56	28	25	85
Diversity[4]				
Richness	30.7	6.5	20	41
N2	8.5	4.8	4	20

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=48).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

stands (Figure 99).

A variety of shrubs are present. All but twinflower have low cover. Utah honeysuckle, baldhip rose, and shiny-leaf spirea are common and regenerate from buried roots, rootcrowns or rhizomes after a disturbance. Russet buffaloberry occurs only in stands with lodgepole pine that are less than 100 years old. The herb layer is floristically rich, but only wild sarsaparilla, queencup beadlily and starry solomonplume normally have more than 5% cover. Bracken fern and other early seral opportunists may dominate the herb layer in early seral communities that have not yet developed a full tree canopy. Abandoned homesteads and fields (which are common) are typically dominated by lodgepole pine and/or a wide variety of weedy herbs and grasses, including many introduced species.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Sheltered, relatively warm sites, proximity to streams and rich shrub and herb layers

Figure 99. Photo of the TSHE/ARNU3 Association.

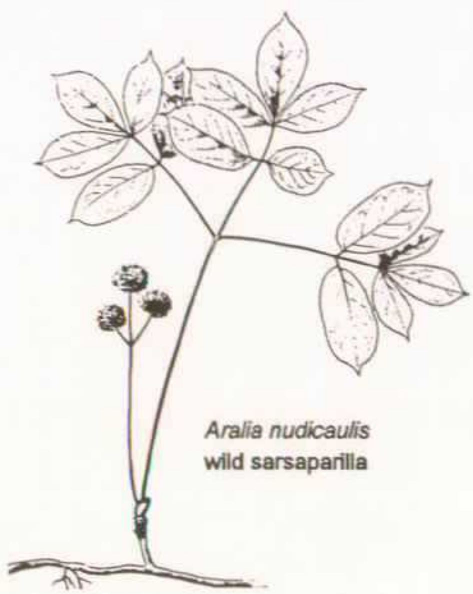
make the association highly valuable for wildlife and domestic livestock. Forage production for elk and deer may be high. Herbage production may be moderate for livestock during early-successional stages. Shrubs such as Oregon grape, bald-hip rose, thimbleberry, and big huckleberry are common in this type and all provide fruits for wildlife species. In addition, stands with high coverage of shrubs such as big huckleberry may provide important winter range areas for big game species. Stands with multiple tree canopies provide good habitat for arboreal mammals and birds. Fire may enhance deer and elk habitat, particularly if ceanothus seeds are present. Pacific yew provides good winter browse for moose.

Silviculture- These are very productive sites that support a wide variety of conifer species and offer a variety of options for timber management. Preserving the rich but somewhat fragile soils on these sites must be considered during any harvesting or site preparation planning (Smith and Fischer 1995). Organic matter, soil nitrogen and other nutrients can be easily lost on these sites (Harvey *et al.* 1987). Organic matter and nutrient loss from similar soils and slope positions appear at least partially responsible for the development of persistent, depauperate, lodgepole pine-dominated communities such as the PICO/SHCA Community Type. Follow the guidelines of Harvey *et al.* (1987) to protect site quality. This is especially a concern in the spring or fall when soils may be wet. Intense heat generated by burning large slash piles drastically alters soil structure and removes essential nutrients and organic matter. The needs for soil protection, fuel reduction, and mineral soil exposure for regeneration all need to be balanced during the planning stages of slash disposal and site preparation methods. Cool broadcast burns should provide adequate fuel reduction.

Most natural or artificial regeneration treatments should be successful. Shelterwood or selection treatments will most likely favor regeneration of grand fir, western redcedar and western hemlock. Seed-tree techniques may be used to favor regeneration of western larch, Douglas-fir and to a lesser extent, western white pine. Complete overstory removal will also generally promote regeneration of these seral species. Subalpine fir and Engelmann spruce are poorly represented in the data and appear to be poor choices for reforestation. Inherently high productivity of these sites can lead to heavy shrub competition following tree harvest, particularly if shrub establishment is allowed to precede tree regeneration by one to two years. Seral shrubs and herbs may especially hinder reforestation following fall broadcast burns. Pre-treatment species composition and seral characteristics (Appendix 1) are important in determining vegetation responses after treatment.

COMPARISONS

Kovalchik (1993) describes a very similar riparian TSHE/ARNU3 Association for eastern Washington. The broadly defined TSHE/ASCA Habitat Type of Cooper *et al.* (1991) for north Idaho has an ARNU3 Phase that is nearly identical to the TSHE/ARNU3 Association. Pfister *et al.* (1977) describe a TSHE/CLUN Habitat Type-ARNU3 Phase in Montana that resembles some TSHE/ARNU3 stands on the Colville N.F. However, this former type also encompasses stands that better fit the TSHE/GYDR and TSHE/RUPE Associations. The TSHE/ASCA3 Association described by Lillybridge *et al.* (1995) for central Washington also characterizes somewhat similar environments and landform positions. Braumandle and Curran (1992) describe a Western Redcedar-Douglas-fir/Falsebox Site Association: Mesic-Subhygric Phase which includes environments very similar to the TSHE/ARNU3 Association. Bell's (1965) Slope Aralia Oakfern Association - alluvial aralia oakfern forest type, also in southern British Columbia, appears similar to the TSHE/ARNU3 association.



TSHE/CLUN ASSOCIATION CHF3 11

Tsuga heterophylla/Clintonia uniflora
western hemlock/queencup beadlily

DISTRIBUTION AND ENVIRONMENT

The TSHE/CLUN Association is the most common western hemlock association found on the Colville N. F., and occurs over a broad range of habitats. It is generally restricted to the eastern-half of the Forest with the exception of the northern portion of the Kettle Falls Ranger District (Figure 100). Aspects are variable and most sites (90 %) are found between 2,500 and 4,500 ft. (Figure 101). Through most of its range, the TSHE/CLUN Association occurs mainly on upland habitats while the TSHE/GYDR, TSHE/ARNU3 or the TSHE/RUPE Associations primarily occupy sub-irrigated upland, stream bottom or toe-slope positions. However, the TSHE/CLUN Association can be found near streams or along stream terraces near the drier southern and eastern geographic range limits of western hemlock.

Soils are formed in ash overlying glacial till. Ash depths range from 2 to 20 in. (5 to 50 cm). Surface horizon soil textures are silt loams changing to sandy loam subsoils (a few profiles had clayey subsoils). Coarse fragments are common but surface rock is usually absent or has low cover. Humus and duff depths ranged from 3 to 9 in. (8-23 cm). Organic matter decays rapidly on these

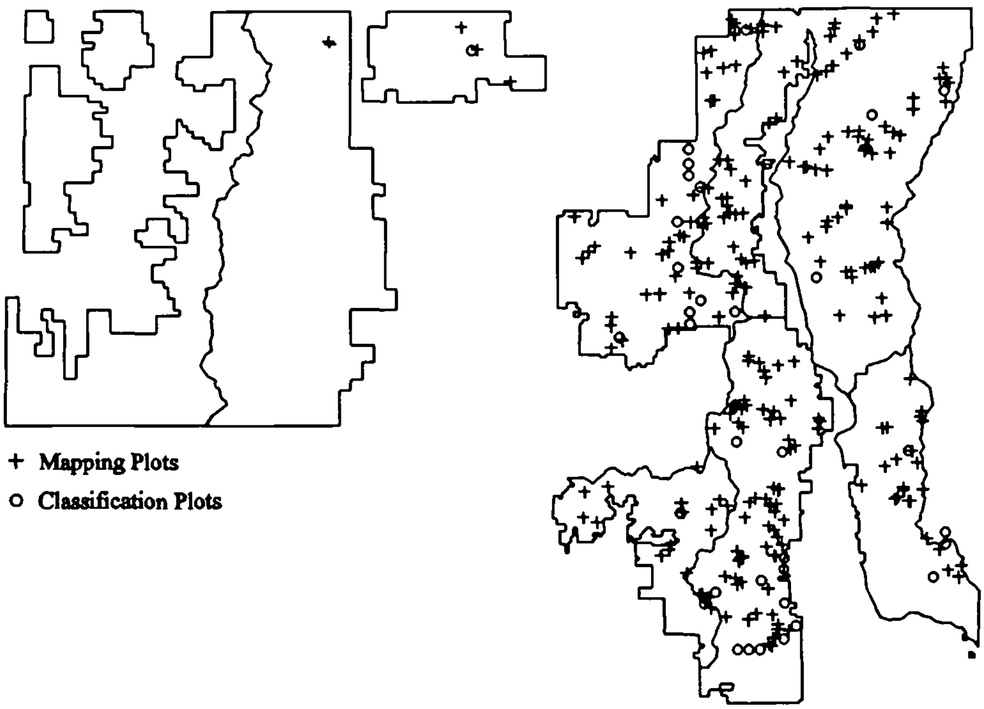


Figure 100. Plot locations for the TSHE/CLUN Association (n=309).

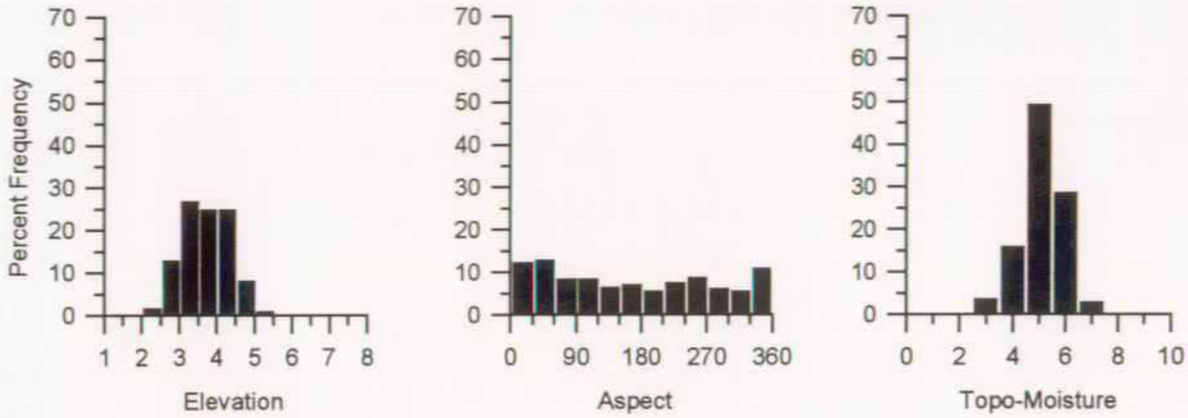


Figure 101. Frequency of TSHE/CLUN plots by elevation (1000 ft.), aspect, and topographic moisture.

warm and mesic habitats.

VEGETATION

A variety of seral tree species may dominate early seral stands (<100 years old). Exact composition depends on seed source, and the type, intensity, and time since disturbance. Most mid-seral stands (100-200 years old) have abundant, vigorous grand fir or western redcedar under a canopy of early seral species such as western larch, Douglas-fir, or western white pine (Figure 102). Multiple canopy layers often develop in less than 100 years. Grand fir and cedar may be nearly the same age as the larch and pine but slow early growth keeps them subordinate until their superior shade tolerance and vigorous later growth allow them to reach upper canopy positions. Paper birch and quaking aspen are also common in stands which have originated from past fires.

Grand fir tends to decline in abundance and cover as stands exceed 200 years of age.

Table 62. Common plants of the TSHE/CLUN Association (n=58).

		CON	COVER
TREE OVERSTORY LAYER			
THPL	western redcedar	95	25
PSME	Douglas-fir	79	16
LAOC	western larch	79	15
TSHE	western hemlock	74	19
ABGR	grand fir	66	15
PIMO	western white pine	53	5
TREE UNDERSTORY LAYER			
THPL	western redcedar	95	10
TSHE	western hemlock	83	4
ABGR	grand fir	52	5
SHRUBS AND SUBSHRUBS			
LIBOL	twinflower	81	8
PAMY	pachistima	78	5
CHUM	western prince's pine	74	4
PYSE	sidebells pyrola	74	2
ROGY	baldhip rose	69	3
LOUT2	Utah honeysuckle	67	2
VAME	big huckleberry	55	3
HERBS			
CLUN	queencup beadlily	93	3
VIOR2	round-leaved violet	88	3
GOOB	western rattlesnake plantain	71	2
SMST	starry solomonplume	59	3

Table 63. Environmental and structural characteristics of the TSHE/CLUN Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3688	616	2290	5150
Aspect[2]	28	75	--	--
Slope	28	17	1	86
Topographic Moisture	5.11	0.83	3.0	7.0
Soil Surface[3]				
Exposed soil	48	36	0	98
Gravel	15	11	12	38
Rock	14	18	0	38
Bedrock	0	0	0	0
Moss	3	3	0	10
Lichen	1	1	0	3
Litter	69	30	0	98
Diversity[4]				
Richness	25.2	8.9	9	43
N2	7.2	3.9	2	17

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=49).
[2] Thc mcan and standard deviation valucs for aspcct arc calculatcd using statistical formulac for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

Perhaps this is due to a combination of disease, insects and competition from more shade tolerant western hemlock and western redcedar. Western redcedar is especially persistent and may never be fully replaced by western hemlock between naturally occurring disturbances. Succession to western hemlock is slower on this type than in the other associations in the Western Hemlock Series. It is difficult to distinguish between the TSHE/CLUN and THPL/CLUN Associations on sites burned within the last 100 years . Late seral and climax stands are rare in our data. Successional dynamics suggest that late seral conditions would be characterized by dense shady stands composed primarily of western hemlock and western redcedar with low cover of shrubs and herbs in the understory

A rich variety of herbs and shrubs are present depending on stand history, age and density. Very dense "doghair" stands have very little shrub and herb cover. Common shrubs include twinflower, pachistima, Utah honeysuckle, baldhip rose and big huckleberry. Ninebark, baldhip rose and Douglas maple are especially common on warmer slopes (see series description for more information on shrub succession). Queencup beadlily, round-leaved violet, plantain, starry-solomonplume and trillium are the common herbs. Shrub and herb succession is greatly influenced by previous stand conditions

Figure 102. Photo of the TSHE/CLUN Association.

since many resprout from root crowns or rhizomes (see appendix 1). Bracken fern may increase dramatically after disturbance if present.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Stands with multiple tree canopies provide excellent habitat for arboreal mammals and birds. Multiple tree and shrub canopies common in mid-seral (100-200 year) stands provide considerable forage and shelter for a wide variety of wildlife species. A large variety of bird and mammal species utilize these stands for either thermal and hiding cover or forage due also in part to their extensive distribution across the landscape. Palatable livestock forage is lacking in natural stands but early seral stages may provide considerable herbage. On most sites plant succession is quite rapid towards a temporary dominance by seral shrubs.

Silviculture- These sites support a wide variety of conifer species and offer an array of different options for timber management. Tree productivity is also quite good on these sites. Shrub and herb competition and soil compaction are the main limitations to intensive timber management. Avoid soil compaction and nutrient and organic matter depletion by following the guidelines of Harvey *et al.*

(1987). Soil organic matter content and porosity are both very important soil properties to consider during planning. Soil water-holding capacity is increased by organic matter, which is generated by duff, roots, and plant debris (Smith and Fischer 1995). Either severe fire or slash treatment can destroy soil organic matter. Destruction of soil organic matter can contribute to the development of dense shrubfields (Harvey *et al.* 1987). Fall broadcast burns will likely encourage dense shrubfield formation (see the Western Hemlock Series description for more information). Stands with soils compacted during whole-tree harvest may resemble the depauperate and unproductive PICO/SHCA Community Type.

Selection and shelterwood cuts favor western hemlock, western redcedar and grand fir while seedtree treatments favor adequate natural regeneration of western larch, Douglas-fir and western white pine. Burning harvest units increases shrub competition with conifer seedlings (see series description). Cooper *et al.* (1991) suggest good stands of western larch and Douglas-fir will develop following seedtree or open shelterwood cuts on southeast to west aspects. Dense shelterwood and selection treatments favor grand fir, western redcedar, Engelmann spruce, subalpine fir and western hemlock. Ponderosa pine should grow well on warm aspects with good air drainage on clearcuts or seedtree cuts. Poor air drainage areas are frost prone and have higher humidity leading to needle infections such as elytroderma needle cast on ponderosa pine. Many of these stands which originated from stand-replacing fires support moderate amounts of paper birch and quaking aspen. These fairly short-lived species (generally less than 100 years) play an important role in nutrient cycling and organic matter build-up following intense fires. These hardwood species also increase the vegetative diversity of these stands.

COMPARISONS

The TSHE/CLUN Association is part of the broad TSHE/PAMY Association described by Daubenmire and Daubenmire (1968) for eastern Washington and Northern Idaho. They identified the TSHE/PAMY type as the only upland western hemlock association. Types which show more similarity to the TSHE/CLUN Association on the Colville N.F. have been described for northern Idaho (Cooper *et al.* 1991), northwest Montana (Pfister *et al.* 1977) and southern British Columbia (Bell 1965, Braumandl and Curran 1992). It corresponds most closely to the TSHE/CLUN Habitat Type-CLUN Phase described by Cooper *et al.* (1991). However, Cooper *et al.* (1991) generally equate coolwort foamflower with queencup beadlily as diagnostic of their TSHE/CLUN Association in northern Idaho. Coolwort foamflower has relatively low constancy in these data and is less useful as an indicator. Pfister *et al.* (1977) consider all Western Hemlock Series stands to be part of the TSHE/CLUN association in Montana. Lillybridge *et al.* (1995) describe an TSHE/LIBOL/CLUN Association for central Washington which characterizes similar environments. Braumandl and Curran (1992) describe several Site Associations in southern British Columbia which reflect similar environments. The Western Redcedar-Douglas-Fir/Falsebox Site Association appears to be most similar to the TSHE/CLUN Association. Bell (1965) describes a Moss association within which he describes five distinct forest types. Of these, the Slope Normal Moss, Slope Dry Moss and Slope Bunchberry Moss Forest Types appear most similar to the TSHE/CLUN association.

TSHE/GYDR ASSOCIATION CHF4 22

Tsuga heterophylla/Gymnocarpium dryopteris
western hemlock/oak-fern

DISTRIBUTION AND ENVIRONMENT

The TSHE/GYDR Association is found on the three ranger districts east of the Columbia River (Figure 103), and indicates sites with conditions of moisture accumulation and low insolation. It is generally restricted to sheltered slopes, benches and bottoms, and often forms part of the meso-riparian zone, and is perhaps the wettest of the western hemlock associations described. Aspects tend to be variable due to the sheltered locations and sites tend to be at low to mid-elevations between 3,000 and 4,500 ft. (Figure 104).

Soils are formed in volcanic ash overlying mixed alluvium or colluvium. Ash depths range from 3.5 to 30 in. (9 to 75 cm). Silt to silt loam textures are typical of surface horizons. Lower horizons are clayey, sandy or very cobbly and gravelly at the level of old streambeds. Drainage was impeded on two sites and water tables are often close to the surface. Coarse fragments range from 17 to 62% and surface rock is usually absent. Rooting depth ranges from 13 to 32 in. (34 to 81 cm). Average soil temperature at 20 in. (50 cm) was 8 °C (range: 7 to 10 °C). These soils are easily compacted because of the ash in the upper horizons and are moist year-around. Organic matter in the soils is

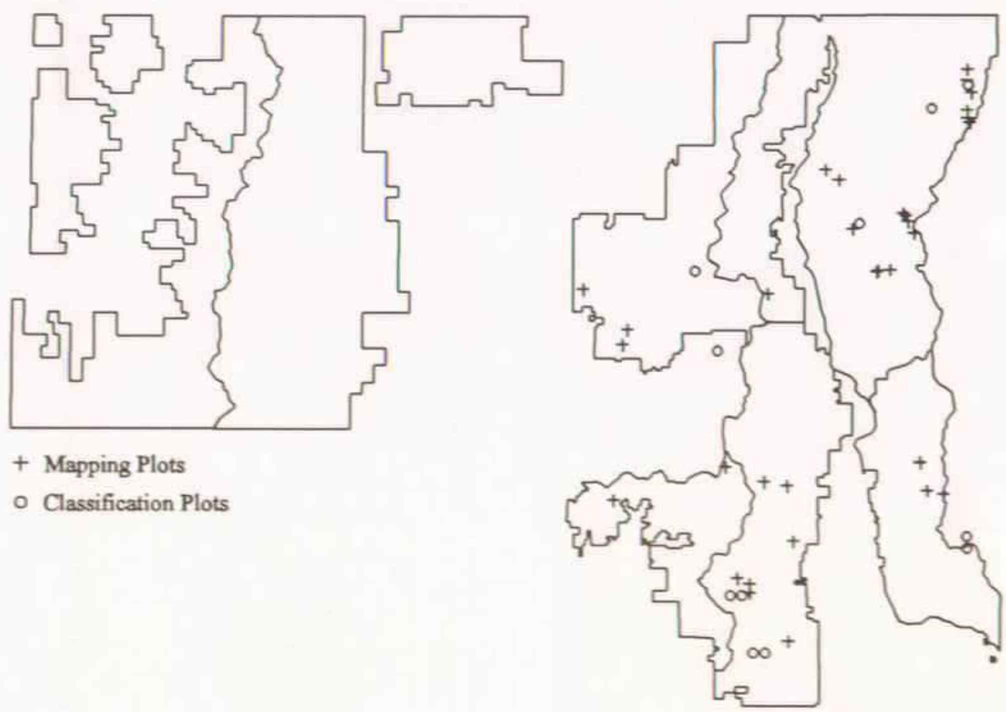


Figure 103. Plot locations for the TSHE/GYDR Association (n=52).

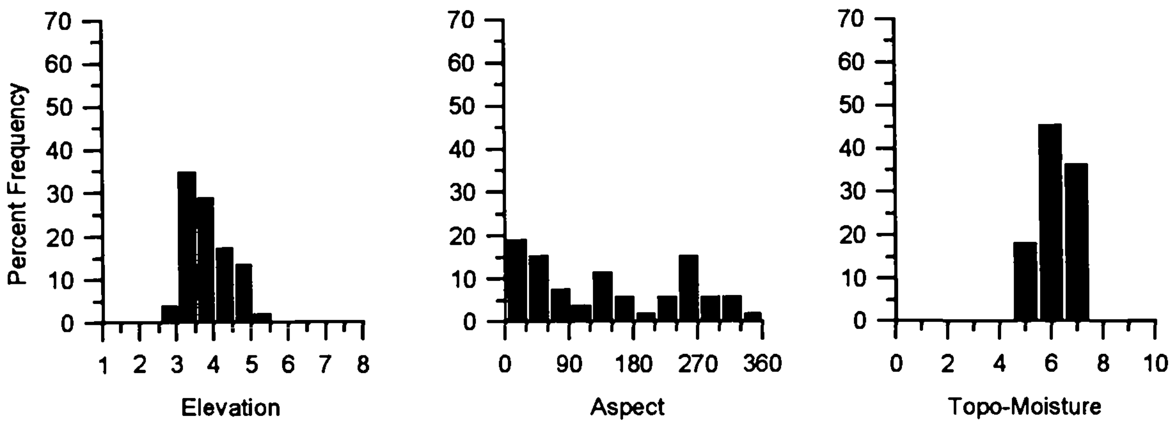


Figure 104. Frequency of TSHE/GYDR plots by elevation (1000 ft.), aspect, and topographic moisture.

high and humus layers ranged from 3 to 5 in. (8-13 cm) in depth. Cycling of litter and humus is fairly rapid in these moist, cool environments.

The TSHE/GYDR Association occupies areas of intermediate moisture between the saturated soils of the THPL/OPHO Association and the less sheltered and apparently better drained soils of the TSHE/ARNU3 Association. On warmer and somewhat drier habitats TSHE/GYDR grades into the TSHE/ARNU3 Association and on higher and cooler sites into the TSHE/RUPE Association.

VEGETATION

Western hemlock dominates the tree regeneration layer in late seral and climax stands and is co-dominant with western redcedar in the overstory (Figure 105). Red cedar was co-dominant with western hemlock in the oldest stands sampled with no sign of hemlock replacing the cedar.

Table 64. Common plants of the TSHE/GYDR Association (n=15).

		CON	COVER
TREE OVERSTORY LAYER			
THPL	western redcedar	100	37
TSHE	western hemlock	100	28
ABGR	grand fir	73	13
TREE UNDERSTORY LAYER			
TSHE	western hemlock	100	4
THPL	western redcedar	87	6
ABGR	grand fir	53	2
SHRUBS AND SUBSHRUBS			
LIBOL	twinflower	87	7
VAME	big huckleberry	73	3
LOUT2	Utah honeysuckle	60	2
PAMY	pachistima	53	2
HERBS			
GYDR	oak-fern	100	15
CLUN	queencup beadlily	100	6
SMST	starry solomonplume	100	5
TIUN	coolwort foamflower	93	7
VIOR2	round-leaved violet	87	3
ATFI	lady-fern	87	2
DIHO	Hooker fairybells	80	3
ADBI	pathfinder	73	3
GOOB	western rattlesnake plantain	73	2
GATR	sweetscented bedstraw	73	2

Table 65. Environmental and structural characteristics of the TSHE/GYDR Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3832	562	2900	5350
Aspect[2]	38	58	--	--
Slope	19	15	1	52
Topographic Moisture	6.18	0.72	5.0	7.0
Soil Surface[3]				
Exposed soil	41	23	0	70
Gravel	10	4	1	12
Rock	18	19	12	38
Bedrock	0	0	0	0
Moss	2	1	1	5
Lichen	0	0	0	0
Litter	69	21	35	85
Diversity[4]				
Richness	23.7	3.4	19	29
N2	6.1	1.7	4	10

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=52).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

Western redcedar individuals were almost always the oldest trees sampled on these sites, apparently because they had survived one or more fires. The largest cedars were often 100 or more years older than the other associated tree species. Relict Douglas-fir, western larch and western white pine may linger for hundreds of years in the canopy but are rarely able to survive as reproduction. They must await a stand opening disturbance such as fire or perhaps windthrow to establish on sites in the TSHE/GYDR Association.

Western larch dominates many early seral stands. Western larch and western white pine are favored by periodic, severe wildfires that occur at 200 year or longer intervals. Grand fir and western redcedar are often prominent in 100-200 year old stands. In the absence of stand-opening disturbances, the more shade tolerant and competitive western hemlock and western redcedar will increase in prominence as stands age. Grand fir declines in abundance once stands exceed 200 years in age, providing soil wood and logs for hemlock regeneration in the older stands. Small amounts of grand fir remain in the oldest stands sampled but it is not nearly as abundant as western hemlock or western redcedar. Douglas-fir is an important component of the tree overstory in some stands

Figure 105. Photo of the TSHE/GYDR Association.

but is poorly represented in the ecology plot data. Subalpine fir and/or Engelmann spruce may be important seral species on cooler sites and the spruce may live for more than 300 years. Some mid- and late-seral stands have two or more tree canopies with rapidly growing species such as western white pine or western larch over a denser canopy of shade tolerant western redcedar, western hemlock, or grand fir.

Lodgepole pine is absent from the plot data and also the data of Cooper *et al.* (1991) in north Idaho for their similar TSHE/GYDR Habitat Type. The lack of lodgepole pine may be related to the relatively nutrient-rich and high organic matter of the soils. The relationship is not well understood and is not simply a matter of stand age. These data span stand ages of less than 60 years to stands with some trees older than 400 years. Establishment of western or paper birch, quaking aspen or black cottonwood is favored by fires that remove the duff layer.

The species rich shrub and herb layers reflect the moderate temperatures and abundant moisture on these sites. Oak-fern, queencup beadlily, Hooker fairybells, pathfinder, wild ginger, starry solomon plume, round-leaved violet, and coolwort foamflower are common herbs. These mesophytic herbs often survive fire or logging but are reduced in abundance until a tree canopy is re-established when they once again become the characteristic undergrowth species. Very dense conifer stands with heavy shade often have low total shrub and herb cover, although oak-fern tolerates shade reasonably well. Twinflower, Utah honeysuckle, pachistima, and big huckleberry are typical shrubs. Utah honeysuckle and pachistima tend to decrease in cover as stands age but big huckleberry, twinflower and yew are better able to maintain higher cover values in older stands. Pacific yew is more common in this type than any other association on the Forest except the THPL/OPHO Association. Pacific yew is seldom abundant, perhaps because of native ungulate browsing. The presence of lady-fern and devil's club indicate especially moist sites which are transitional to the THPL/OPHO Association.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Stands with more than one tree canopy layer provide more and higher quality habitat for arboreal mammals and birds than do those with a single canopy layer. Complex canopy structures are common with two or more tree layers in the canopy. Due to the large size many of the cedar and hemlock may attain in this type, some sites represent important habitat for species dependent upon old-growth stand structures. Such sites may serve as important refugia for old-growth-dependent species. The humid conditions also attract a large variety of insects, which in turn attract avian species. The TSHE/GYDR Association has little utility for domestic livestock except for shade or water. Good forage production for wild ungulates occurs during early seral stages and is fair in mature stands (Cooper *et al.* 1991).

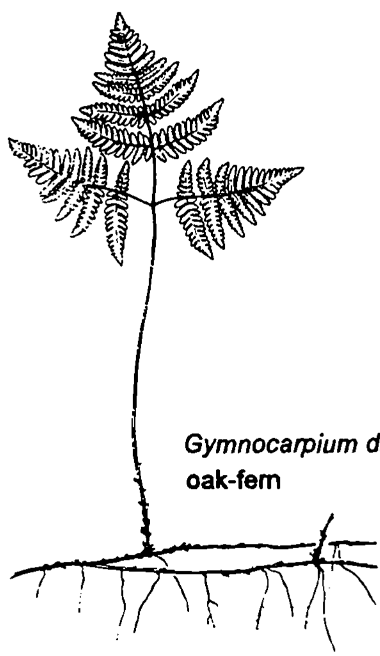
Silviculture- The TSHE/GYDR is one of the most productive associations on the Forest, as indicated by average SDI and BA values (appendix 2). Average site index for western larch, western hemlock, and western redcedar are all in the top 25% range. Both even- and uneven-aged management techniques can be used on these sites due to the moderate environment and variety of seral species which are present. A short rotation, even-aged management regime with seral species such as western larch, Engelmann spruce or western white pine (blister rust resistant stock) has been recommended for a comparable habitat type in northern Idaho (Cooper *et al.* 1991). When western larch is the dominant seral species, Barrett (1982) recommends even-aged management with broadcast burning. However, Harvey *et al.* (1987) caution that organic matter, soil nitrogen and other important nutrients could be lost, leading to reduced long-term site productivity. In addition, complete overstory removal may raise water tables on these sites, creating boggy conditions which may be hard to regenerate.

Regeneration on drier aspects is enhanced by shelter from residual overstory trees (Ferguson *et al.* 1986). Seral species such as ponderosa pine, western larch, or Douglas-fir may be enhanced by underburning in combination with shelterwood or selection cutting techniques (Arno and Davis 1980). Moeur (1992, 1993) reports that selective cutting could be used to alter the structure of late-seral or old-growth stands by opening the canopy and encouraging reproduction by the shade-tolerant species. Adequate stocking is not usually difficult to obtain on these sites, but site preparation and planting are often needed to obtain a high proportion of seral species (Zack and Morgan 1994). The needs for soil protection, fuel reduction, and mineral soil exposure for regeneration all need to be balanced during the planning stages of slash disposal and site preparation methods. Avoid or restrict activities that compact the soil such as unrestricted tractor logging, whole tree harvest, slash piling or scarification. Managers need to consider wildlife habitat values and proximity to streams when planning management activities in or near this type.

Mature stands are cool and shady, have large trees, gentle topography and are near streams; thus seeming to be attractive campsites and possible campground locations. However, the natural vegetation is highly sensitive to trampling from vehicles and foot traffic. Additionally, the soils are moist or wet much of the spring and summer. Therefore TSHE/GYDR stands are not suitable for campgrounds.

COMPARISONS

Cooper *et al.* (1991) describe a TSHE/GYDR Habitat Type from north Idaho nearly identical to this one. However, some Colville stands would key to their THPL/ATFI Habitat Type because lady-fern, claspleaf twisted-stalk or false bugbane are present. However, no TSHE/GYDR stands on the Colville N.F. are fully representative of the preceding authors' THPL/ATFI Habitat Type. The TSHE/GYDR Association described for eastern Washington by Kovalchik (1993) is also nearly identical to the type described here. Some TSHE/GYDR stands fit the TSHE/CLUN Habitat Type-ARNU3 Phase described for Montana (Pfister *et al.* 1977). Daubenmire and Daubenmire (1968) did not recognize a TSHE/GYDR type, but many of their TSHE/PAMY plots fit within this TSHE/GYDR Association. Only two of their plots are from Washington, the rest are in north Idaho. The TSHE/GYDR Association falls within the Aralia Oak-fern Association of Bell (1965). Of the seven "Forest Types" recognized by Bell, the Slope Aralia Oak-fern Southern Variant appears the most similar to this TSHE/GYDR Association. The Western Redcedar-Hemlock/Oak-fern-Foamflower Site Association described for the southern interior of British Columbia (Braumandl and Curran 1992) is also very similar to the TSHE/GYDR Association. However, some of those sites contain more five-leaved bramble and would key out to the TSHE/RUPE Association.


Gymnocarpium dryopteris
oak-fern

TSHE/MEFE ASSOCIATION CHS7 11
Tsuga heterophylla/Menziesia ferruginea
western hemlock/rusty menziesia

DISTRIBUTION AND ENVIRONMENT

The TSHE/MEFE Association is found east of the Columbia River and is most common on the Sullivan Lake Ranger District (Figure 106). It occurs on all aspects, though is primarily found on northwest to northeast aspects (Figure 107). It is generally restricted to wet topographic positions when found on southern exposures. Most sites are between 4,500 and 5,500 ft. (Figure 107), and average 4,900 ft. (Table 67). This type indicates relatively high-elevation, heavy snowpack and high precipitation sites within the Western Hemlock Series.

The regolith is ash overlying colluvium which, in turn, often overlies glacial till. The colluvium and till are derived from a variety of rock types. Ash depths range from 7 to 11 in. (17 to 29 cm). Surface horizon soil textures are silt loams with sandy or cobbly loam subsoils. Coarse fragments range from 19 to 60% and surface rock is usually absent. Soils are apparently deep, with coarse fragments increasing with depth. Humus and duff ranged between 2 and 6 in. (5-15 cm). Cool temperatures and lingering snowpacks slow the rate of organic matter turnover relative to warmer associations with the Western Hemlock Series. The TSHE/MEFE Association grades into the

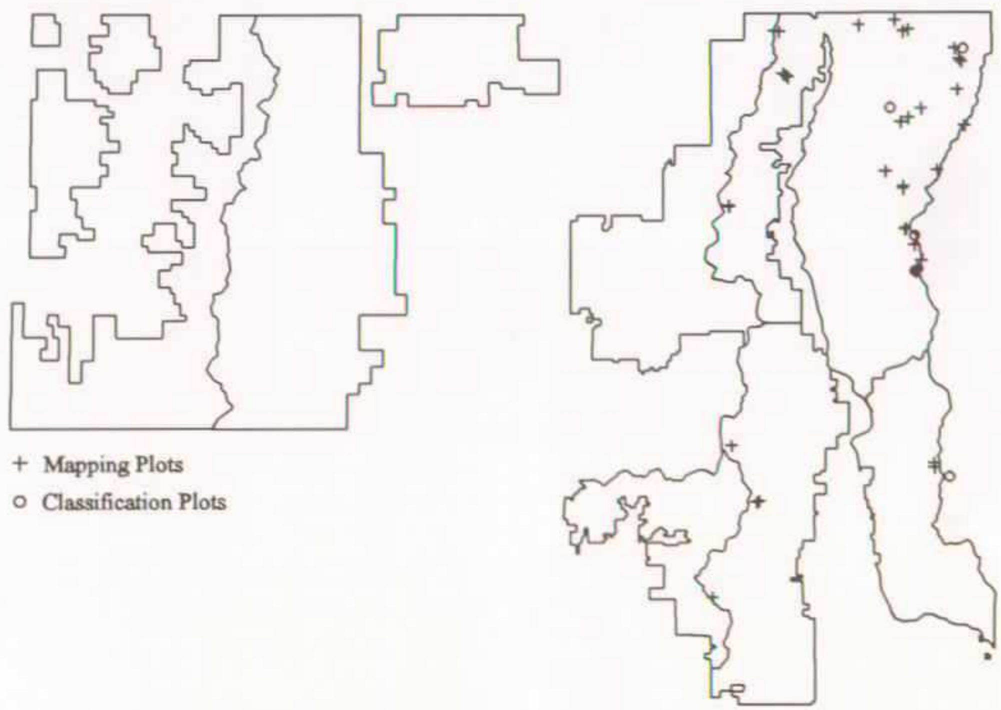


Figure 106. Plot locations for the TSHE/MEFE Association (n=48).

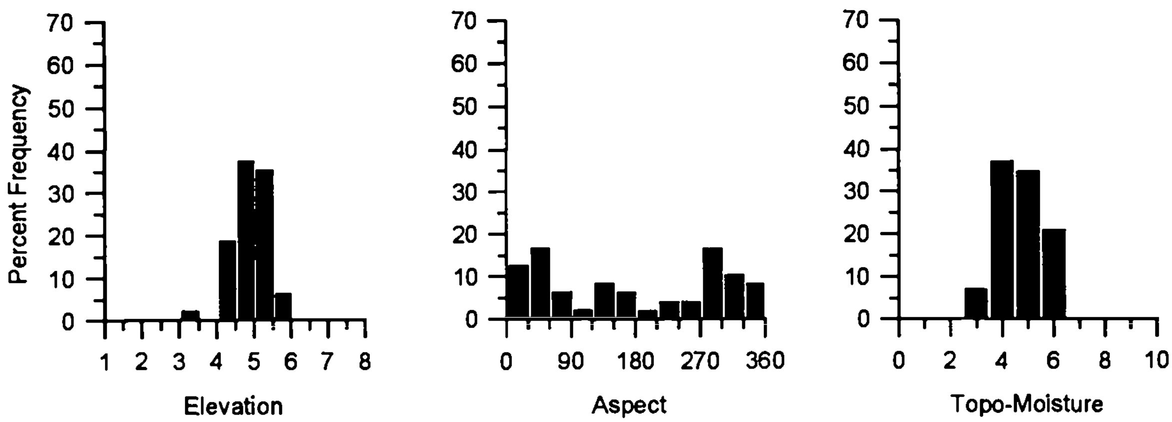


Figure 107. Frequency of TSHE/MEFE plots by elevation (1000 ft.), aspect, and topographic moisture.

TSHE/CLUN or TSHE/GYDR Associations on warmer habitats and the ABLA2/RHAL-XETE or ABLA2/RHAL Associations on cooler habitats. The TSHE/XETE Association occurs on similar slopes and elevations but apparently where soil moisture and/or snowpack accumulations are insufficient for rusty menziesia or Cascades azalea to thrive.

VEGETATION

Western hemlock dominates both the understory and overstory of late seral and climax stands (Figure 108). The oldest stands often have a somewhat discontinuous tree canopy over a well developed shrub and subshrub layer. The oldest stand in the data is 300 years old based on the age of the oldest tree measured. This stand is almost wholly dominated by western hemlock in both the overstory and tree regeneration layers. Snags of western larch are present but no live trees remain.

Table 66. Common plants of the TSHE/MEFE Association (n=11).

		CON	COVER
TREE OVERSTORY LAYER			
PIEN	Engelmann spruce	91	18
ABLA2	subalpine fir	91	11
TSHE	western hemlock	73	36
LAOC	western larch	9	40
TREE UNDERSTORY LAYER			
TSHE	western hemlock	91	6
ABLA2	subalpine fir	91	5
SHRUBS AND SUBSHRUBS			
VAME	big huckleberry	100	12
MEFE	rusty menziesia	100	8
PAMY	pachistima	100	4
XETE	beargrass	91	14
RHAL	Cascades azalea	91	10
LOUT2	Utah honeysuckle	91	6
SOSC2	mountain ash	91	2
PYSE	sidebells pyrola	73	3
HERBS			
TIUN	coolwort foamflower	73	7
CLUN	queencup beadlily	55	9

Table 67. Environmental and structural characteristics of the TSHE/MEFE Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4892	477	3150	5830
Aspect[2]	2	72	--	--
Slope	33	14	7	74
Topographic Moisture	4.70	0.89	3.0	6.0
Soil Surface[3]				
Exposed soil	19	16	1	40
Gravel	20	17	12	38
Rock	10	19	0	38
Bedrock	0	0	0	0
Moss	7	4	1	10
Lichen	0	1	0	1
Litter	34	15	10	50
Diversity[4]				
Richness	22.1	8.8	11	34
N2	8.3	3.7	2	13

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=48).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

Subalpine fir and Engelmann spruce are important seral trees in early to mid-successional stands (<200 years). Subalpine fir is present in nearly all plots and may be the most abundant species in the tree regeneration layer in mid-seral stands. However, subalpine fir is much less disease resistant and shorter lived than western hemlock and does not regenerate as well in heavy shade. Both species can persist into late seral and climax stand conditions. Western larch and lodgepole pine are abundant early in the sere in some stands, apparently because of differences in disturbance patterns and stand history. Douglas-fir rarely dominates and is most abundant as a seral species on the warmest extremes of the type. Western redcedar is often only a minor stand component. This is in marked contrast to its relative abundance in warmer types within the Western Hemlock Series.

Most stands have two or more shrub layers with rusty menziesia, Cascades azalea and mountain ash as the tall shrub layer. Big huckleberry and Utah honeysuckle often form the intermediate shrub layer, while beargrass and sidebells pyrola are common species in the low or subshrub layer. Cascades

Figure 108. Photo of the TSHE/MEFE Association.

azalea is more abundant at higher elevations and indicates conditions transitional to the Subalpine Fir Series. The herb layer is normally inconspicuous under the thick tall shrub layer. Only coolwort foamflower, round-leaved violet and queencup beadlily are in more than 50 percent of the plots.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Wildlife use these cool, shaded north-slope areas in summer for thermal and hiding cover. These stands represent important thermal and browse areas for deer and elk. Elk use some of the wetter sites for wallows. Wildlife values are high because of the abundance of shrubs, some of which produce fruits. In addition, some of these stands are in late-seral or old-growth stages, representing high value to other old-growth dependent species. Mature stands serve as critical winter range for woodland caribou, their principal forage being epidendric lichens covering many of the older trees. While managing for caribou habitat, severe burns should be minimized to protect *Vaccinium* spp. roots and to avoid the potential for dense lodgepole regeneration (Smith and Fischer 1995). This will also help retain large trees and their associated lichens. Old-growth stands may be important winter habitat for martin (Koehler and Hornocker 1977). Forage for livestock is poor in natural stands and livestock grazing has little potential except for shade and water.

Silviculture- Although timber productivity is moderate to high, particularly for western larch and Douglas-fir (appendix 2), attempts at intensive management for timber production presents some major problems. Cold temperatures, heavy precipitation (mostly snow) and short growing seasons limit growth rates and management activities. These stands usually occur in areas of deep snow accumulation at the headwater areas of streams. Management actions need to consider maintaining or improving water yields (Pfister *et al.* 1977). In addition, toe slope and bench positions often have high water tables, and overstory removal on these sites may raise water tables, creating boggy conditions. These boggy areas may reforest slowly, and early seral species on these sites may include false hellebore, arrowleaf groundsel, licorice-root, drooping woodreed, or blue-joint reedgrass.

Selection or partial-cutting generally favors the regeneration of the shade-tolerant western hemlock, subalpine fir and Engelmann spruce, though partial-cutting predisposes these species to blowdown. Clearcutting or group selection is suggested except for sites near seeps or streams with high water-tables, though this can lead to increased snowpacks. Deep snowpacks in clearcuts can then promote shrubfields dominated by Cascades azalea, rusty menziesia or Sitka alder which can retard reforestation (Cooper *et al.* 1991). Fiedler (1982) found that natural regeneration can be retarded by up to 60% of a sites potential stocking for up to 12 years when total understory shrub coverages exceed 50%. Shrubby understories require site preparation for good regeneration, with scarification reported as being the most successful method on gentler slopes. Prescribed burning is the only feasible method on steep slopes, but due to moist fuels, successful burning can usually only be accomplished during a brief time period in certain years. In addition, if abundant slash is present on the site, low-severity fires can cause high tree mortality. Dominance by lodgepole pine can occur after severe broadcast burns if a seed source is present (Smith and Fischer 1995).

Under natural conditions, subalpine fir and western hemlock dominate conifer regeneration. Western hemlock, subalpine fir and Engelmann spruce are adapted to most sites. Engelmann spruce is recommended for reforestation on most sites, and should do especially well on sites that accumulate moisture or are frost prone such as benches or toe slopes. Douglas-fir and western larch are suitable on the drier and warmer habitats within the type which have good soil and air drainage such as midslopes. Few plots contained lodgepole pine but this species should be suited to the type since it is common in the drier parts of the ABLA2/RHAL Association and Cooper *et al.* (1991) have lodgepole pine in several of their plots in both the TSHE/CLUN-MEFE Phase habitat type and their TSHE/MEFE habitat type. Other tree species are questionable for timber management.

These stands may require occasional fire protection during periods of severe fire conditions. However, disturbances to these moist forest soils that may accompany modern fire suppression can produce more lasting damage than fire would cause (Bradley *et al.* 1992). The dense undergrowth and steep slopes of many sites limits most recreational opportunities. Moist conditions, heavy snowpacks and susceptibility of shrubs to mechanical damage makes these sites of limited value for recreational developments or trails.

COMPARISONS

Cooper *et al.* (1991) describe a similar TSHE/MEFE Habitat Type from northern Idaho. They also describe a TSHE/CLUN Habitat Type-MEFE Phase that resembles the TSHE/MEFE Association, but it appears to have a different seral tree species pattern and is found at generally lower elevations. Lillybridge *et al.* (1995) describe a TSHE/MEFE Association for the Cascade Range in central Washington which is also similar. Braumandl and Curran (1992) describe a Subalpine Fir-Western Hemlock/Rhododendron-Azalea Site Association for the southern interior of British Columbia. This type resembles the TSHE/MEFE Association, though contains more subalpine fir and Engelmann spruce and less western redcedar than the TSHE/MEFE Association. Bell (1965) recognized a Degraded Aralia Oakfern Northern Variant within his Aralia Oakfern Association that appears similar to the TSHE/MEFE Association.

Menziesia ferruginea
rusty menziesia

TSHE/RUPE ASSOCIATION CHS4 11
Tsuga heterophylla/Rubus pedatus
western hemlock/five-leaved bramble

DISTRIBUTION AND ENVIRONMENT

The TSHE/RUPE Association is a very minor meso-riparian type on the Colville N. F. and is primarily restricted to the Sullivan Lake Ranger District (Figure 109). It typically occurs in riparian zones near streams at upper elevations on gentle lower slopes and benches with flat or concave microrelief. Aspects are variable. Over 90% of sites are located between 4,000 and 5,000 ft. (Figure 110). The type characterizes a cool, moist and sheltered environment with relatively acid soils and deep humus accumulations. These sites are very similar (though slightly drier) to TSHE/GYDR sites except for perhaps differences in soil acidity indicated by the presence of *Rubus pedatus*, and higher average elevations.

Soils are formed in glacial or alluvial material mixed with volcanic ash. Five-leaved bramble indicates thick, acid humus (Bell 1964) as well as cold environments. Duff, litter and humus layers are thick. Humus and duff ranged in depth for 3 to 13 in. (8-33 cm) in depth. The oldest stands had thicker duff and humus layers. Gravelly silt loams in the upper parts of the profile shift to cobbly silt loams deeper in the profile. Coarse fragments composed 16% to 56% of the soil profile and surface rock

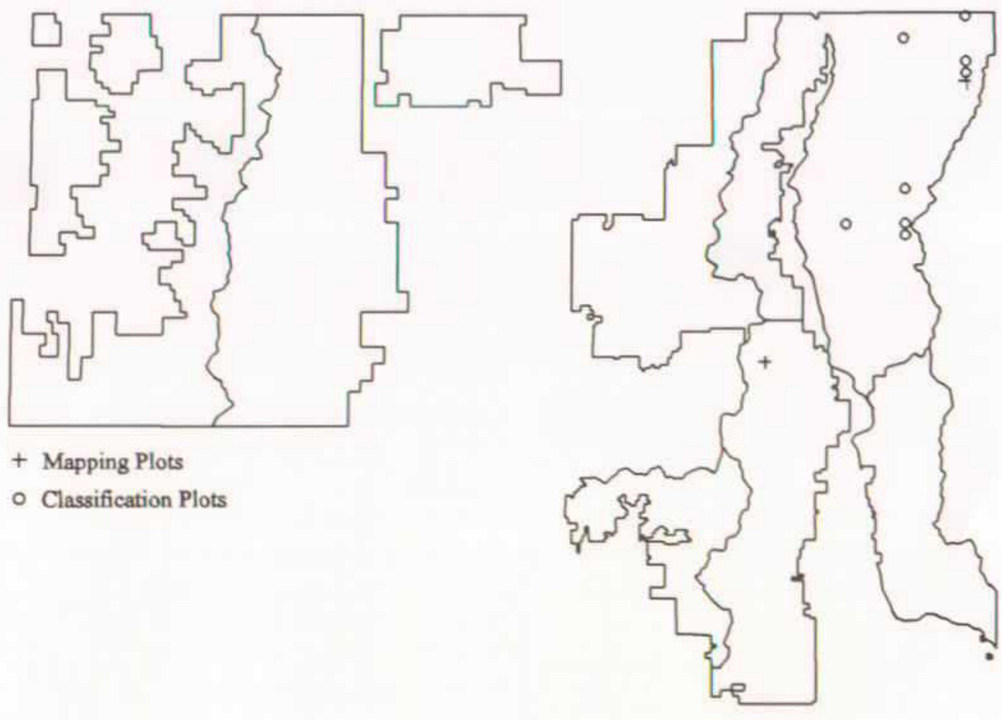


Figure 109. Plot locations for the TSHE/RUPE Association (n=18).

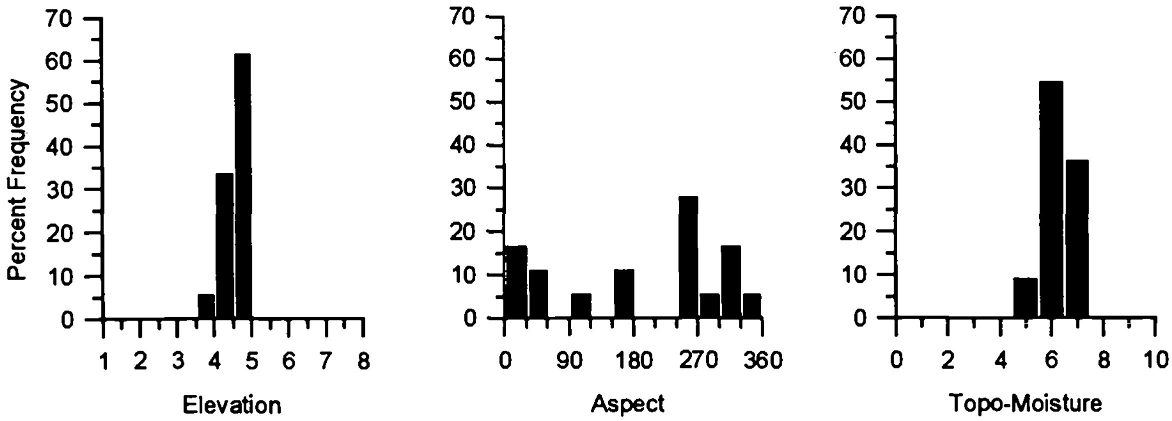


Figure 110. Frequency of TSHE/RUPE plots by elevation (1000 ft.), aspect, and topographic moisture.

is usually present. Pistol-butted trees and frequent tip-ups suggest unstable soils or difficulty of deep root establishment.

VEGETATION

A dense overstory of western redcedar and western hemlock characterizes late seral and climax stands. Multiple canopies are common in mature stands. Seral species which are occasionally present include subalpine fir and lodgepole pine. Some of the oldest trees sampled on the Colville N.F. were in the TSHE/RUPE Association. One western redcedar was nearly 550 years old. Several plots had trees over 300 years old.

Western hemlock tends to dominate the tree regeneration layer in the oldest stands (Figure 111). However, western redcedar is extremely long-lived and simple abundance of trees in the regeneration size classes may not adequately reflect the long-term successional dynamics of a stand.

Table 68. Common plants of the TSHE/RUPE Association (n=15).

		CON	COVER
TREE OVERSTORY LAYER			
TSHE	western hemlock	100	36
THPL	western redcedar	93	29
ABLA2	subalpine fir	53	6
PICO	lodgepole pine	7	30
TREE UNDERSTORY LAYER			
TSHE	western hemlock	100	5
THPL	western redcedar	93	5
SHRUBS AND SUBSHRUBS			
RUPE	five-leaved bramble	100	9
VAME	big huckleberry	93	7
PYSE	sidebells pyrola	87	3
PAMY	pachistima	80	3
LOUT2	Utah honeysuckle	73	3
MEFE	rusty menziesia	73	2
HERBS			
GYDR	oak-fern	100	12
CLUN	queencup beadlily	100	7
VIOR2	round-leaved violet	100	4
TIUN	coolwort foamflower	93	8
STAM	claspleaf twisted-stalk	93	2
TROV	trillium	93	2
GOOB	western rattlesnake plantain	73	2
OSCH	sweetroot	60	2

Table 69. Environmental and structural characteristics of the TSHE/RUPE Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4500	293	3750	4920
Aspect[2]	348	55	--	--
Slope	20	9	3	35
Topographic Moisture	6.27	0.65	5.0	7.0
Soil Surface[3]				
Exposed soil	33	27	3	90
Gravel	16	11	12	38
Rock	2	2	0	5
Bedrock	0	0	0	0
Moss	10	10	3	30
Lichen	1	1	0	2
Litter	55	19	35	85
Diversity[4]				
Richness	23.9	4.7	19	34
N2	7.4	2.6	4	12

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=18).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

Early seral (<100 years old) stands are dominated by western larch, lodgepole pine or Engelmann spruce. Western white pine and Douglas-fir are part of the sere only if most of the raw humus layer is lost (Bell 1964). This may be the reason that Douglas-fir is so poorly represented in these data.

The shrub and herb layers are often sparse in old, heavily shaded stands. Dwarf bramble characterizes these moist, cold sites. Other shrubs are low in stature and relatively inconspicuous, especially in late seral stands. Shrubs such as beargrass and big huckleberry increase after disturbance and may be abundant in early seral stands. Oak-fern, coolwort foamflower, trillium, claspleaf twisted-stalk, round-leaved violet and queencup beadlily are the most common herbs. Moist site indicators such as rusty menziesia, devil's club, lady-fern and claspleaf twisted-stalk may be present in stands close to streams or seepage areas. Mosses and lichens typically cover much of the forest floor and the many old and large logs.

Figure 111. Photo of the TSHE/RUPE Association.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Complex canopy structures are common with two or more tree layers in the canopy. Stands with more than one tree canopy layer provide more and higher quality habitat for arboreal mammals and birds than do those with a single canopy layer. Deer and elk use these cool, shaded areas in summer for browse and thermal and hiding cover. Elk use some of the wetter sites for wallows. Most of the stands sampled are in late seral or old-growth stages, representing high value to old-growth dependent species due to their stand structures. Mature stands may represent winter range for woodland caribou, their principal forage being epidendric lichens covering many of the older trees. Old-growth stands are important winter habitat for martin (Koehler and Hornocker 1977). Herbage for livestock is low in natural stands and livestock grazing has little potential except for shade and water.

Silviculture- High basal area and stand density index values (appendix 2) reflect moist, sheltered growing conditions as well as the relative old ages of the sample stands. Site index interpretations are weak because most trees were rotten and too old for the tables or equations. Streamside habitats make erosion potential an important consideration. Frost pockets from cold air drainage may also cause reforestation difficulties.

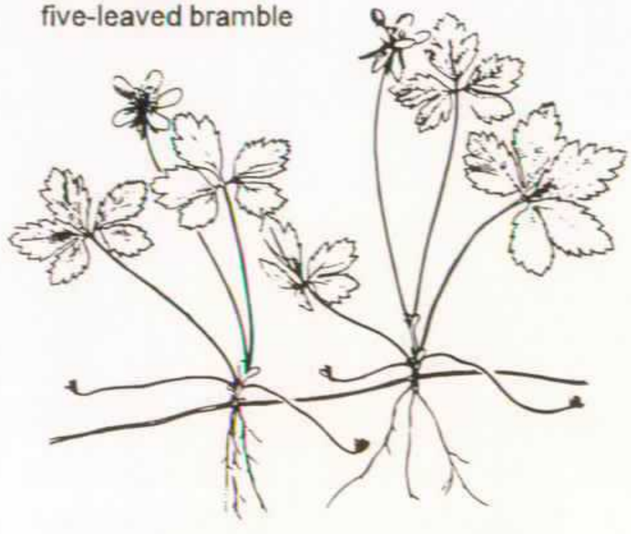
Lodgepole pine, Engelmann spruce and western larch are the best adapted species for reforestation. Shrub and herb competition is low. Natural regeneration should be easily achieved with the proper species and treatment. Western larch should respond well to shelterwoods, though this technique may lead to windthrow problems. Individual and group selection cutting works well on these sites for promoting western hemlock, western redcedar, subalpine fir and Engelmann spruce. Douglas-fir is apparently not well adapted to the cool, frosty conditions characteristic of the association. Efforts to plant Douglas-fir on TSHE/RUPE sites should be viewed as experimental rather than meeting reforestation targets.

Mature stands are cool and shady, often with large trees, gentle topography and near streams. However, stands in the TSHE/RUPE Association are poor choices for campgrounds because the natural vegetation does not tolerate trampling and heavy use. Additionally, the soils are quite moist much of the spring and early summer. Old trees in dense, shady stands over a layer of mosses, lichens, delicate ferns, subshrubs and herbs are visually attractive and make good trail and nature walk areas. Visitors should be restricted to paths. Big huckleberry provides recreational berrying in more open stands. Huckleberries are easily eliminated if their shallow rhizomes are damaged by excessive foot traffic or heavy equipment.

COMPARISONS

Braumandl and Curran (1992) describe a Western Redcedar-Western Hemlock/Oak Fern-Foamflower Site Association for the southern interior of British Columbia. Many of those sites would key to the TSHE/RUPE Association, though they contain less subalpine fir. Bell's (1965) Slope Aralia Oakfern Association - Degraded Aralia Oakfern Forest Type, also in southern British Columbia, is very similar to the TSHE/RUPE Association. Other authors in the northern Rocky Mountains have not described a TSHE/RUPE Association. Some Colville N.F. stands will key out to the TSHE/GYDR Habitat Type of Cooper *et al.* (1991) from northern Idaho or the TSHE/CLUN Habitat Type-ARNU3 Phase of Pfister *et al.* (1977) from Montana.

Rubus pedatus
five-leaved bramble



TSHE/XETE ASSOCIATION CHF5 21
Tsuga heterophylla/Xerophyllum tenax
western hemlock/beargrass

DISTRIBUTION AND ENVIRONMENT

The TSHE/XETE Association is a minor type primarily limited to the Sullivan Lake Ranger District in the northeast corner of the Forest (Figure 112). It typically occupies mid- to upper-slope positions on southeast to southwest aspects, but can occur on other aspects (Figure 113). Approximately 90% of the plots are located between 4,000 and 5,000 ft. (Figure 113) and average 4,639 ft. (Table 71).

Soils are formed in volcanic ash deposited over colluvium, glacial till or outwash. Bedrock geology tends to be granitic. Coarse fragments increase with depth and compacted layers were found in some soil profiles. Hummocks, slumps, rootwads and windthrown trees suggest unstable soils even on gentle to moderate slopes (< 40%). Humus and duff layers ranged between 1 and 6 in. (2.5 -16 cm.). The TSHE/XETE Association generally grades into the TSHE/MEFE Association on more northerly aspects or concave sites as effective soil moisture increases. It grades into the TSHE/CLUN Association on warmer habitats within the Hemlock Series. The ABLA2/XETE Association is found at higher elevations (above 5,000 ft.) on colder and somewhat drier sites. Some overlap between the ABLA2/XETE and TSHE/XETE Associations occurs and differentiation between the two types is

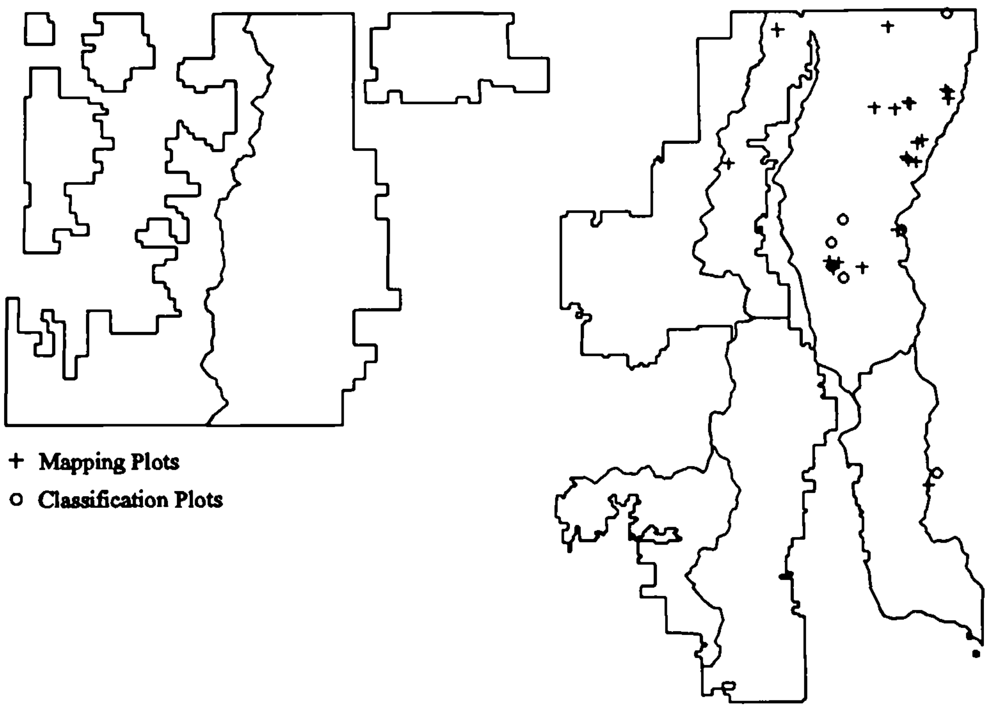


Figure 112. Plot locations of the TSHE/XETE Association (n=29).

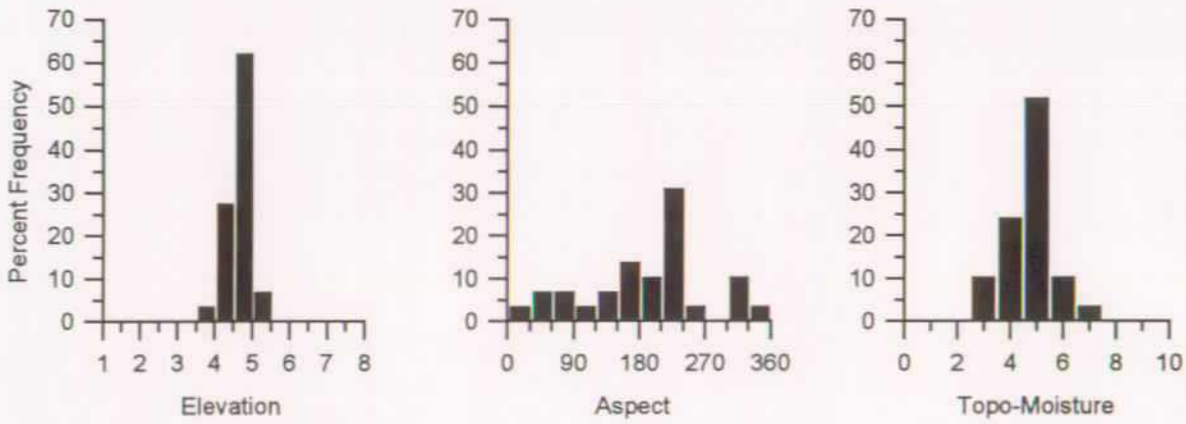


Figure 113. Frequency of TSHE/XETE plots by elevation (1000 ft.), aspect, and topographic moisture.

based on the reproductive success of western hemlock.

VEGETATION

Late seral and climax stands are characterized by western hemlock dominance in all tree layers and an open, park-like undergrowth (Figure 114). The TSHE/XETE Association contains some of the oldest trees sampled. One western larch was 570 years old at breast height. Douglas-fir and western white pine are minor seral species occurring only on warmer portions of the type. Western larch or western white pine may form a sparse, emergent layer over a shorter main canopy comprised of western hemlock, Engelmann spruce, subalpine fir and/or western redcedar. Grand fir and ponderosa pine were absent from the data. Early seral stands (<100 years old) may closely resemble the THPL/VAME Community Type. Lodgepole pine or western larch often dominate these early-seral stands.

Table 70. Common plants of the TSHE/XETE Association (n=8).

		CON	COVER
TREE OVERSTORY LAYER			
TSHE	western hemlock	88	46
THPL	western redcedar	88	16
PIEN	Engelmann spruce	75	6
ABLA2	subalpine fir	63	5
PICO	lodgepole pine	13	60
TREE UNDERSTORY LAYER			
TSHE	western hemlock	100	10
THPL	western redcedar	75	8
ABLA2	subalpine fir	63	2
SHRUBS AND SUBSHRUBS			
XETE	beargrass	100	9
PAMY	pachistima	100	5
LOUT2	Utah honeysuckle	100	3
VAME	big huckleberry	88	8
PYSE	sidebells pyrola	88	3
LIBOL	twinflower	75	9
CHUM	western prince's pine	75	5
MEFE	rusty menziesia	50	3
HERBS			
CLUN	queencup beadlily	100	6
TIUN	coolwort foamflower	88	5
VIOR2	round-leaved violet	88	3
GOOB	western rattlesnake plantain	75	2

Table 71. Environmental and structural characteristics of the TSHE/XETE Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4639	294	4000	5280
Aspect[2]	347	79	--	--
Slope	33	16	2	69
Topographic Moisture	4.72	0.92	3.0	7.0
Soil Surface[3]				
Exposed soil	20	20	1	40
Gravel	62	0	62	62
Rock	10	14	0	38
Bedrock	0	0	0	0
Moss	8	5	2	15
Lichen	1	1	0	2
Litter	70	14	50	80
Diversity[4]				
Richness	26.3	5.5	21	35
N2	7.1	3.7	2	12

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=29).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

A wide variety of shrubs are typical of the association. Only Utah honeysuckle, pachistima, twinflower, sidebells pyrola, big huckleberry and beargrass have more than 75% constancy. Russet buffaloberry may be abundant in relatively young stands dominated by lodgepole pine but is absent from sampled stands over 100 years old. Rusty menziesia, Cascades azalea and alpine pyrola are often present in small amounts. Herb cover is normally low but a variety of species may be present. Queencup beadlily occurred on all the plots and coolwort foamflower, trillium, western rattlesnake plantain and round-leaved violet are common associates. Mosses cover much of the ground in mature stands.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Moderate sites may produce abundant wildlife forage in early and mid-seral stages. Utah honeysuckle, pachistima, big huckleberry and russet buffaloberry provide wildlife forage. Big huckleberry is frequently browsed and the flowering heads of beargrass are used by ungulates and

Figure 114. Photo of the TSHE/XETE Association.

small mammals such as chipmunks and squirrels. Some of these stands are in late seral or old-growth stages and are important to old-growth-dependent species due to their stand structures. Mature, open stands may serve as winter range for woodland caribou, their principal forage being epidendric lichens covering many of the older trees. Old-growth stands may be important winter habitat for martin (Koehler and Hornocker 1977). Stands with more than one tree canopy layer provide habitat for arboreal mammals and birds. The TSHE/XETE Association provides little herbage for domestic livestock because of low herb production and unpalatable species.

Silviculture- Timber productivity is generally good on these sites. Shrub and herb competition and soil compaction are the main limitations to intensive timber management. Competition from beargrass and other shrubs may hinder tree regeneration. In addition, tree seedling stress caused by strong diurnal fluctuations in temperature is common in the upper slope positions characteristic of the type. Tree top damage, presumably from ice or snow, is common. Stands on west aspects are especially subject to rapid snowmelt and to ice damage to conifer crowns. The unstable soils merit special attention to avoid slumps and slides. Protection of soil organic matter and nutrients is essential to maintain site productivity.

Selection and shelterwood cuts favor shade-tolerant species such as western redcedar, western hemlock and subalpine fir. More open cutting techniques may predispose these species to blowdown. Group selection cutting may be the best alternative to prevent blowdown and avoid the problems associated with larger clearcuts (snow accumulation, temperature changes, etc.). Clearcuts followed by broadcast burns may be difficult to reforest because of greater temperature ranges and insolation rates. Blackened soil surfaces may raise temperatures at the soil-air interface enough to kill seedlings.

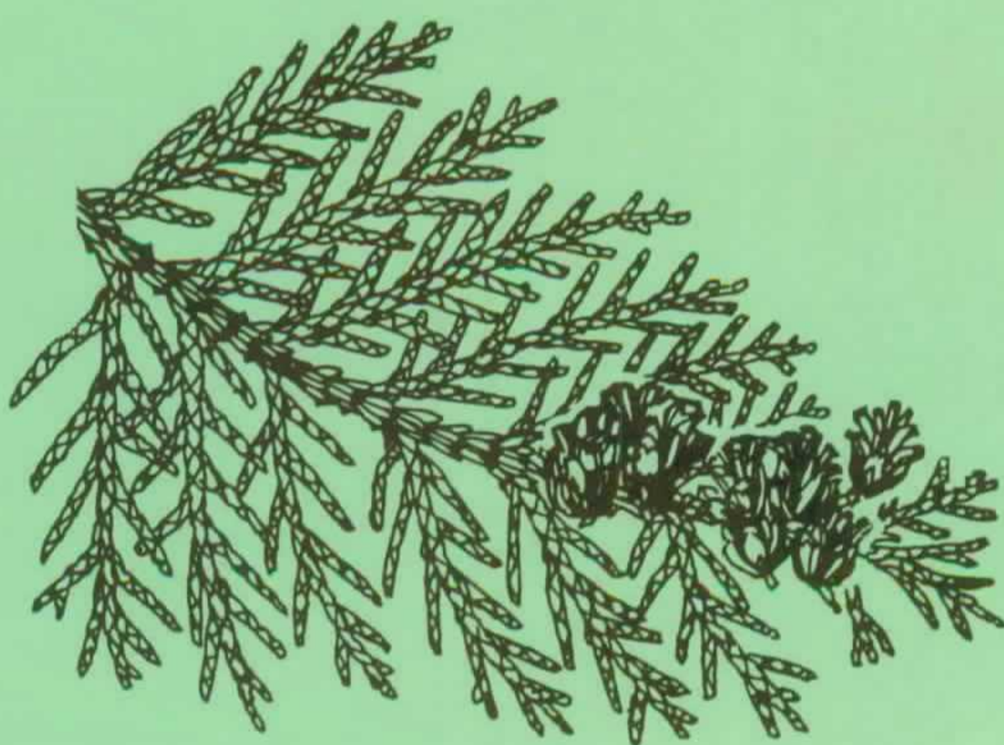
Broadcast burning also stimulates beargrass development and increases shrub competition. Moderate natural regeneration of seral western larch and Douglas-fir should result from seedtree and shelterwood treatments if adequate seed sources are present. Cool fires appear to stimulate both beargrass and big huckleberry growth while hot fires reduce huckleberry growth more than beargrass growth. Mechanical scarification decreases growth of both species. Lodgepole pine may be the most suitable species for timber management (when good seed sources are present) because the species is adapted well to the harsh growing conditions existing on some TSHE/XETE sites. In general, shelter in the form of standing trees or by logs left on site is essential for successful reforestation.

Bench habitats in the association are often good choices for campgrounds because beargrass is quite resistant to foot traffic. TSHE/XETE sites also make good locations for trails. Big or low huckleberries are easily damaged but these stands remain well vegetated longer than most other associations because of beargrass' resistance to trampling. Extensive areas of beargrass in flower are visually attractive. Huckleberry picking may also attract forest visitors to these sites. Good air and soil drainage are also typical of these stands.

COMPARISONS

Cooper *et al.* (1991) describe a beargrass phase of their TSHE/CLUN Habitat Type that resembles the TSHE/XETE Association. However, their environmental conditions and successional patterns differ. Other workers in the Rocky Mountains have not recognized a TSHE/XETE Association.

WESTERN REDCEDAR SERIES



WESTERN REDCEDAR SERIES

Thuja plicata

THPL

DISTRIBUTION AND ENVIRONMENT

Western redcedar is a long-lived conifer which can reach ages as old as 800 to 1,000 years. The species has two separate coastal and interior distributions. The interior distribution is correlated with the Inland Maritime climatic regime which includes northeast Washington, northern Idaho, northwest Montana and southeast British Columbia. Western redcedar ranks second only to western hemlock as the most shade tolerant and environmentally restricted conifer on the Colville N. F. Compared to western hemlock, western redcedar is more tolerant of high soil moisture, summer drought and temperature extremes (Minore 1979). The Western Redcedar Series (where redcedar is the indicated climax dominant) occurs only on that part of the species' range beyond the environmental or geographic range of western hemlock, and western redcedar regeneration without hemlock indicates the Western Redcedar Series. Only minor amounts of western hemlock (confined to moist microsites) are acceptable in the Western Redcedar Series. The one exception is where western hemlock can be a significant stand component in the wet THPL/OPHO Association.

The Western Redcedar Series is widespread over the eastern two-thirds of the Colville N.F. (Figure 115). Other than the Lone Ranch Creek drainage in the north, with only small and isolated stands

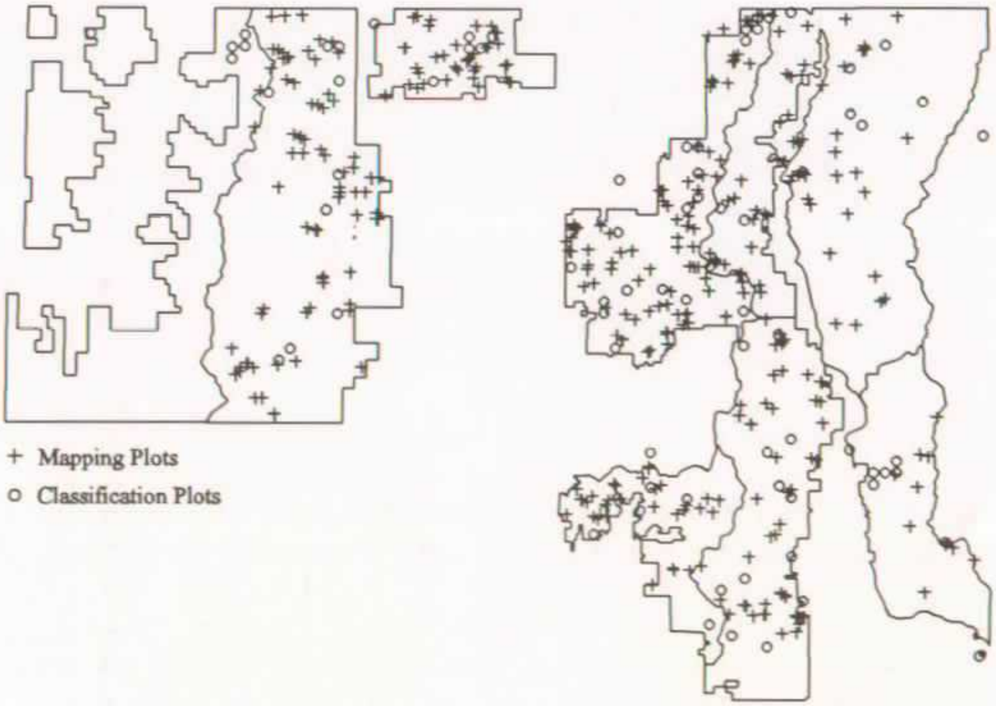


Figure 115. Plot locations for the Western Redcedar Series on the Colville N. F. (n=463).

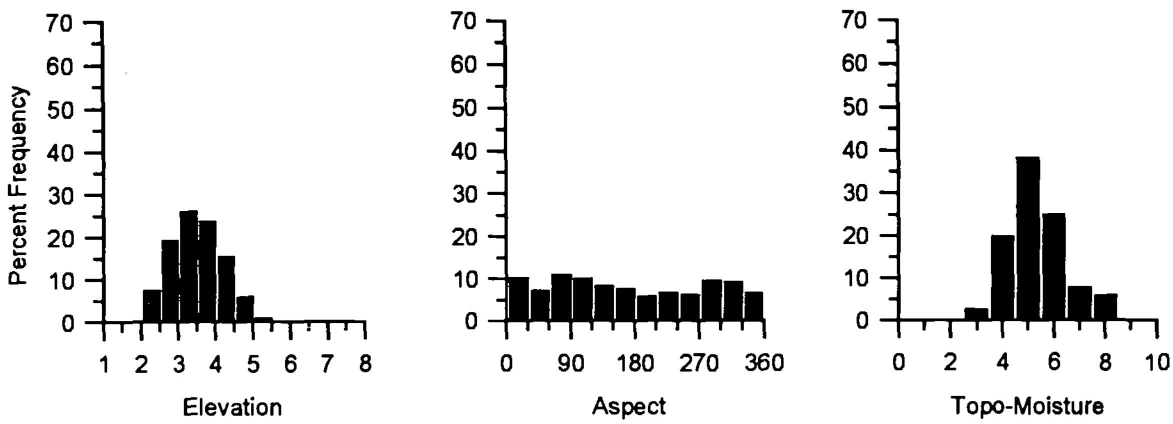


Figure 116. Frequency of Western Redcedar Series plots by elevation (1000 ft.), aspect, and topographic moisture.

occur west of the Kettle Mountain Crest. The Western Redcedar Series occupies a variety of aspects and elevations (Figure 116). Most stands occur between 2,500 and 4,500 ft. elevation. However, the Western Redcedar Series can extend down to lower elevations in moist stream bottoms with cold air drainage. It is not uncommon to find western redcedar as low as 1,700 or 1,800 ft. in certain localities. In addition, local distribution patterns of western recedar differ depending upon aspect, geology and precipitation levels. Western redcedar is generally restricted to moist stream bottoms and northern aspects in the southwest area of it's distribution on the Colville N.F. and gradually expands to a wider range of slope positions and landforms as one progresses to the northeast. Differences in aspect of the Western Redcedar Series on the Colville and Sullivan Lake Ranger Districts is illustrated in Figure 117. Low temperatures also limit western redcedar distribution within it's range, since it is not resistant to frost.

The Series has a bimodal moisture distribution. At one end it characterizes sites too dry to support the Western Hemlock Series but somewhat more moist than the Grand Fir Series. Root penetration of western redcedar is better than that of western hemlock, perhaps allowing it to survive in somewhat drier locations (Burns and Honkala 1990). The Western Redcedar Series also occurs on very wet sites where western hemlock is usually, but not always, a climax co-dominant. We follow Daubenmire and Daubenmire (1968) and Pfister *et al.* (1977) in assigning these wet habitats to the THPL/OPHO Association which is part of the Western Redcedar Series. However, a pure floristic separation from the Western Hemlock Series based on tree reproductive success is questionable.

Three associations and one community type are described for the Series. These include the THPL/OPHO, THPL/ARNU3, THPL/CLUN Associations and the THPL/VAME Community Type. Swampy sites resembling the THPL/ATFI Association of Daubenmire and Daubenmire (1968) were seen, but were either too small or too poorly developed to sample. Additionally, these fragments were found within the range of western hemlock which contradicts the observations of Daubenmire

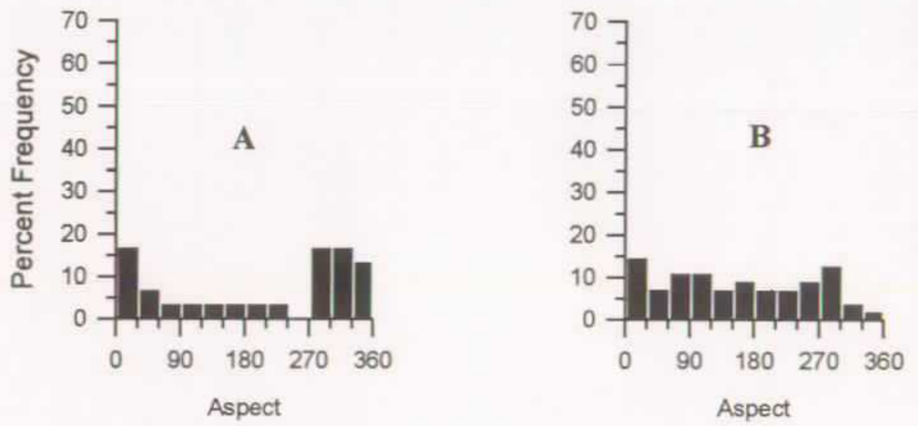


Figure 117. Frequency of western redcedar plots by aspect from the south-half of Colville (**A**) and Sullivan Lake (**B**) Ranger Districts.

---

and Daubenmire (1968). Riparian plant associations in the Western Redcedar Series (such as THPL/ATFI) are described in riparian classifications for eastern Washington (Kovalchik 1993).

VEGETATION

All tree species occurring on the Colville N.F. (except whitebark pine) may be found within the Western Redcedar Series depending on association and stand history. Western larch, Douglas-fir, lodgepole pine and grand fir are the most important seral trees. Western white pine was a major seral species prior to the introduction and spread of white pine blister rust. Subalpine fir and Engelmann spruce are locally abundant as seral species within some of the cooler stands, particularly in stream bottoms with cold air drainage. However, both of these species are more common in the Western Hemlock Series. Ponderosa pine is a minor seral species except on very warm, well-drained habitats. Western hemlock, as described above, may co-dominate on wet THPL/OPHO sites. Western hemlock is an accidental species located on favorable microsites in the remaining three western redcedar plant associations

Western redcedar influences soil development and undergrowth composition much differently than western hemlock. Mineral soil next to redcedar trees in mixed-species stands has higher extractable calcium, base saturation, ph and nitrification potential compared to soils under neighboring hemlocks (Turner and Franz 1986). Also, undergrowth under western redcedar has more species and larger individuals compared to undergrowth under western hemlock (Turner and Franz 1986). The tree regeneration layers follow a pattern similar to the overstory. Western redcedar is usually present, along with lesser amounts of grand fir. Douglas-fir may be a significant regeneration component under certain seral conditions, such as beneath decadent lodgepole pine, but disappears as the secondary canopy of Douglas-fir, grand fir and western redcedar assumes dominance. Small amounts

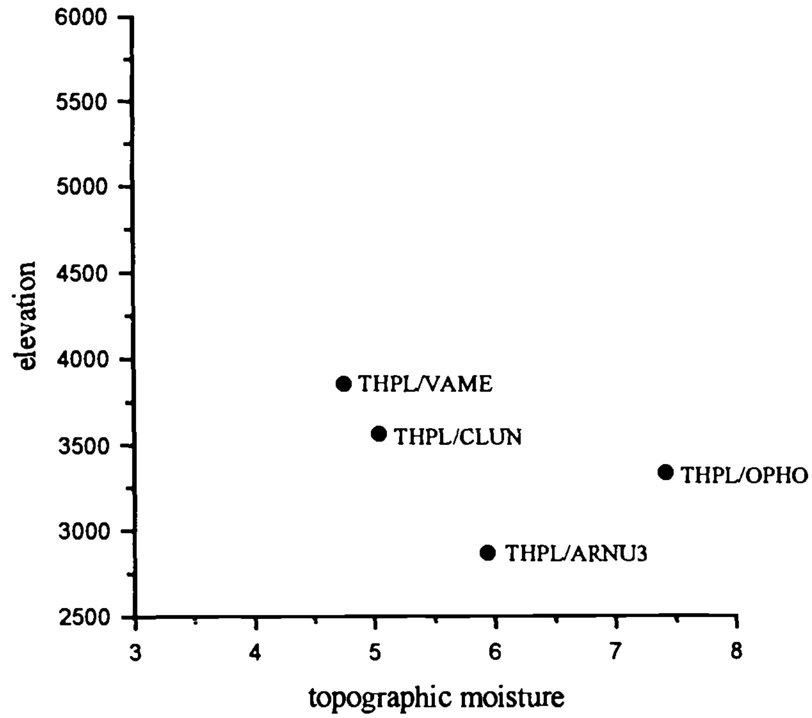


Figure 118. Ordination of western redcedar plant associations by elevation and topographic moisture.

---

of subalpine fir and/or Engelmann spruce regeneration may also be found in cooler stands. Successful western hemlock regeneration is found only in the THPL/OPHO Association.

Stands with "depauperate" shrub and herb layers are often encountered in dense stands of western redcedar with a thick layer of litter. Such stands have few or no shrubs and herbs or very low cover for the species present. Presently we key many of these sites to the THPL/CLUN Association; viewing the paucity of shrubs and herbs as transitory and more related to tree canopy densities and litter accumulations than to intrinsic site factors. The undergrowth of mature stands varies from lush devil's club and ferns to carpets of pachistima and twinflower to virtually nothing under very dense overstory conditions. Tall shrubs over 3.5 ft. (1 m) rarely seem to dominate except for devil's club or in early seral conditions. Likewise, herbaceous species seldom dominate. The typical upland undergrowth is characterized by an abundance of species from the "*Pachistima myrsinites* union" of Daubenmire and Daubenmire (1968). Common species often include pachistima, queencup beadlily, twinflower, pyrola spp. and common brome.

Of the five major conifer series found on the Forest, the Western Redcedar Series ranks in the middle regarding diversity components. A total of 154 vascular plant species were found on the 74 plots (as of August 1991) used to describe the Series and associations (Table 72). However, a graph of richness against sample size (not shown) shows a rising curve without any plateau. This suggests that

Table 72. Diversity components of the Western Redcedar Series.

	Mean	S.E.[2]
Richness[1]	154	
Number of associations	3	
Expected richness[3]	186.6	7.6
Expected N2[4]	18.4	1.9
Average richness per plot	27.5	0.9
Average N2 per plot	8.7	0.5

[1] Total number of vascular plant species in the Western Redcedar Series data.
[2] Standard error of the estimate.
[3] Jackknife estimate of richness given a sample size of 74 plots.
[4] Jackknife estimate of N2 given a sample size of 74 plots.

richness, at least, has been poorly characterized by existing data and that the jackknife estimate of richness is unreliable. However, the other species diversity components are reliable even with small sample sizes and they also rank in the middle. The only exception to this middle ranking of diversity is the number of associations which ties for lowest among the major conifer series. This low number of associations occurs despite the bimodal moisture distribution of the series. This indicates that the series encompasses little habitat variation except for the contrast between the two extremes (wet and dry).

Age data are available for 116 western redcedar trees. Fifty are from stands in the Western Redcedar Series and 66 from the Western Hemlock Series. These 116 trees are grouped into the following age classes: 32 were less than 100 years old, 39 were between 100 and 200 years, 22 between 200 and 300 years, 18 between 300 and 400 years, 4 between 400 and 500 years, and 1 was over 500 years old. All ages are at breast height at time of sampling (1982 or 1983). All trees over 400 years old were from stands in the TSHE/RUPE or TSHE/GYDR Associations. The oldest western redcedar in the Western Redcedar Series was 345 years old and was found on a THPL/OPHO site that also contained a 550 year old western hemlock. In the Western Redcedar Series, only three western redcedars over 200 years old are from types other than the THPL/OPHO Association. The paucity of old trees is attributable to a combination of recent fire history and that old stands were often the first entered by loggers.

Dense shrub fields are characteristic of early seral stages after logging or wildfire. Redstem ceanothus, pachistima, sticky currant, thimbleberry, snowberry, Douglas maple, shiny-leaf spirea and Scouler willow are important shrubfield components. Ninebark is not normally as prolific in the Western Redcedar Series as in the Grand Fir or Douglas-fir Series and normally occurs only on drier and warmer sites within either the THPL/CLUN or THPL/ARNU3 Associations. Appendix 1 lists the reproductive strategies of selected species. Species that regenerate from seed after intense fire include both redstem and snowbrush ceanothus, thimbleberry, pachistima and sticky currant. Seeds of these species remain viable in the forest soil or duff layer for many years. Douglas maple, Scouler willow, common snowberry and shiny-leaf spirea generally regenerate from buried roots, root crowns, rhizomes or by seeds from outside the burned area. Seeds of these latter species remain viable in the soil for relatively short periods of time.

FIRE ECOLOGY

Fire return intervals are not well documented for the Western Redcedar Series, though most sites show some evidence of past fire such as buried charcoal and fire-scarred trees. Fire has certainly been a major influence within the Series on the Forest. Most of the stand data (except THPL/OPHO stands) are comprised of stands less than 200 years and often near 100 years old. In north Idaho, a typical fire-return interval for low- to moderate-severity fires is 50-100 years; a stand-replacement interval is 150-500 years. However, fire regimes and intensjties can be quite variable in this Series. The drier western redcedar associations found on uplands are more at risk of burning than the wetter types located in stream bottoms, seeps, and benches. Redcedar communities south of Interstate 90 in Montana are typically riparian in nature, and burn much less frequently than the drier adjacent uplands (Agee 1994). This results in a pattern of late successional cedar forests surrounded by younger forests on the drier uplands. This pattern is commonly observed on many areas of the Colville N.F., particularly in the drier areas on southern exposures. Thus, in many instances, these riparian "stringers" of western recedar can form natural firebreaks on the landscape (Fisher and Bradley 1987). However, even these very moist redcedar sites can burn, particularly under severe drought conditions when crown fires spread from the drier neighboring stands. Thus, when these narrow cedar "stringers" are located in the midst of large stands of drier plant associations such as PSME/PHMA or ABGR/PHMA, the risk of burning is greater. Many riparian cedar stands on the Colville N.F. reflect this situation.

On the wetter portions of the forest, such as the Sullivan Lake area, redcedar and hemlock stands tend to be more widespread and continuous and have longer fire-return intervals, allowing the development of older forests. However, fire has also been a major type of disturbance in these areas, particularly in stands on steep mid-slopes. These mid-slope stands are generally warmer, drier, and more wind-exposed, and may form a "thermal belt" which burns more intensely than lower slope positions (Arno and Davis 1980). Most of these stands are either THPL/CLUN or THPL/VAME types. When fire occurs in these stands, the patch size can be very large. Some very large and intense fires have burned in the cedar/hemlock forests of northeast Washington, north Idaho, and northwestern Montana and include the 20,000 hectare Sundance Fire in north Idaho in 1967 (Anderson 1968). Cooper *et al.* (1991) note other extensive fires in the area in 1889, 1919, 1926, and 1934. Barrows (1952) states that 400,000 hectares burned in north Idaho in 1910 alone. The Colville N.F. was no exception, with a similar history of intense fires in the cedar and hemlock forests. These past fires account for many of the young and dense cedar-hemlock "doghair" stands found on the Forest.

Subalpine fir, Engelmann spruce, lodgepole pine, grand fir, and western hemlock all have naturally low resistance to fire, and are easily killed by moderate severity fires. Species such as Douglas-fir, western larch, ponderosa pine, and western redcedar often survive as residuals due to their higher tolerance to fire. Quite often, western redcedar will survive fires if any portion of the bole and cambium survived and also due to its large size (Smith and Fischer 1995). Fire-scarred redcedar are common on the Colville N.F. After stand-replacing fires, western redcedar usually enters most sites early in succession due to its prolific seed production. Burned, exposed mineral soil provides good germination for redcedar, though the faster growing seral species (grand fir and Douglas-fir) usually overtop the seedlings and saplings (Smith and Fischer 1995). Western redcedar usually dominates the mid-to late-successional stages on most sites and continues this trend to climax.

INSECTS AND DISEASE

Generally, western redcedar is free of major problems associated with insects and diseases. Redcedar seems to suffer little damage from most insects. Western redcedar is less susceptible than it's associates to most damaging agents, but damaged trees are common due to its longevity. Redcedar are often windthrown in wet environments and are not resistant to windthrow on the moist sites where growth and yield are highest. More than 200 species of fungi are found on redcedar, and hollow old trees are common. The most common root and butt rots include *Phellinus weiri*, *Armillaria mellea* and *Poria asiatica*. These rots are most evident in old stands, where much of the standing volume is often defective and unmerchantable. In addition, redcedar pencil rot may be of concern for managers on developed sites.

Armillaria root rot is present in virtually all stands of the Western Redcedar Series in the northern Rocky Mountains (McDonald *et al.* 1987b). However, the infection rate is low in undisturbed stands. In addition, more productive sites have lower infection rates compared to less productive stands. Apparently, the total environmental and biological stress on productive sites does not exceed the tree's tolerance. Infection rates increase threefold after man-caused disturbance (*i.e.* logging or road building). Less productive sites, such as those in the Douglas-fir or Subalpine Fir Series, have much higher infection rates but as whole these series have a lower overall incidence of the pathogen (McDonald *et al.* 1987a).

MANAGEMENT IMPLICATIONS

The Western Redcedar Series is second only to the Western Hemlock Series in productivity. High water tables and shrub competition are the greatest timber management hazards in most stands. Most western redcedar have been harvested traditionally by clearcutting the mixed-species stands in which they grow. Because of the often steep terrain, wood decay, and breakage, redcedar harvesting costs are usually high and lumber recovery is usually low (Burns and Honkala 1990). Western redcedars should not be left as scattered seed trees; even those individuals along clearcut margins may be lost to windthrow or exposure.

Knowledge of shrub and herb composition can be used to tailor treatments to achieve desired post-treatment condition. As an example, Morgan and Neuenschwander (1988) studied post-clearcut shrub response to high and low intensity burns on Western Redcedar Series sites in north Idaho. Extracts from their results follow. Burn intensity after clearcutting greatly affects resulting undergrowth species composition and abundance. Low intensity fire favors species with rhizomatous sprouts or buried root crowns while high intensity fire favors shrub establishment from seed. Multiple entries before a clearcut and burn modify the response as well. Multiple entries open the canopy and provide disturbed soils allowing establishment of shade-intolerant shrubs, and these shrubs then resprout vigorously after the clearcut and burn. Clearcutting followed by broadcast burning especially favors redstem ceanothus (Irwin and Peek 1979) if an adequate seed source is present. Shrub production usually peaks between 10 and 14 years after treatment although tall shrubs (*i.e.* Scouler willow and Douglas maple) may continue to increase in cover over a longer time period (Irwin and Peek 1979).

Ashy soils are easily compacted or displaced by heavy equipment thereby reducing site productivity and hindering tree regeneration. Harvesting practices that minimize soil compaction and organic matter loss have been suggested by Page-Dumroese (1993). Preserving the rich but somewhat fragile soils on found on many western redcedar sites must be considered during any harvesting or site preparation planning (Smith and Fischer 1995). Soil organic matter content and porosity are both very important soil properties to consider during planning. Soil water-holding capacity is increased by organic matter from duff, roots and plant debris (Smith and Fischer 1995). Harvey (1982) reports that soil wood is an excellent seedbed for regeneration because 1) it retains moisture, 2) reduces non-conifer competition and decay fungi and 3) hosts more mycorrhizae than humus. Soil wood and soil organic matter can be increased from logging debris (Page-Dumroese *et al.* 1994). Slash decays rapidly on these moist sites. Decay of slash can be accelerated and the potential threat of wildfire can be minimized on sites by lopping and scattering slash (Smith and Fischer 1995). Piling fuels with heavy equipment may cause soil compaction and the intense heat generated by burning large slash piles drastically alters soil structure and removes essential nutrients and organic matter. Cool broadcast burns should provide adequate fuel reduction.

Mature stands in most associations provide little forage for domestic livestock or wild ungulates. Early seral stages produce more forage and have higher cover values in most canopy layers (except the tree canopy). Wildlife, including elk, deer, and snowshoe hares (as well as livestock) consume much of the cedar reproduction in closed stands (Cooper *et al.* 1991). Redcedar seedlings and saplings are often severely browsed by deer, elk or rodents and browse damage may be an important stand-establishment problem. Production of shingles and shakes constitute perhaps the most important special use of redcedar wood.

COMPARISONS

The Western Redcedar Series (or analogs to it) has been well described for the northern Rocky Mountains. Daubenmire and Daubenmire (1968) incorporated climax western redcedar associations into the Western Hemlock Series and did not explicitly recognize a Western Redcedar Series. Otherwise, the Western Redcedar Series has been described for western Montana (Pfister *et al.* 1977), northern Idaho (Cooper *et al.* 1991) and the adjacent southern interior of British Columbia (Braumandl and Curran 1992). Western redcedar stands occurring along the west and east slopes of the Cascade Range are typically included within the Western Hemlock Series (Henderson *et al.* 1992, Lillybridge *et al.* 1995, respectively). The only possible exception is in the southern Oregon

Cascades and coast ranges where western hemlock has a restricted distribution. Preliminary classifications recognize a Western Redcedar Series in these areas (Atzet and McCrimmon 1990, Atzet and Wheeler 1984).

KEY TO PLANT ASSOCIATIONS IN THE WESTERN REDCEDAR SERIES

Before using the key, the field form in Appendix 4 should be completed. Refer to the "USING THE KEYS" section in the introduction for more specific information on using the key, particularly if the stand in question does not key properly.

Devils club ≥ 5% . . . . THPL/OPHO Association p. 251

Wild sarsaparilla, baneberry, wild ginger, and/or bunchberry dogwood ≥ 5% . . . . . .
. . . . THPL/ARNU3 Association p. 240

Big huckleberry ≥ 5% . . . . THPL/VAME Community Type p. 256

Queencup beadlily and/or round-leaved violet ≥ 1% . . . . . . THPL/CLUN Association p. 246

THPL/ARNU3 ASSOCIATION CCF2 22

Thuja plicata/Aralia nudicaulis
western redcedar/wild sarsaparilla

DISTRIBUTION AND ENVIRONMENT

The THPL/ARNU3 Association is found on all ranger districts on the Colville N.F., though is primarily limited to sites east of the Kettle Mountain Crest (Figure 119). It is very limited on the Republic Ranger District, with the only sites sampled located in the Lone Ranch Creek drainage. This association typically occupies moist, gentle to moderate lower-slopes, benches or bottoms. These sites represent warm, moist xero-riparian conditions when next to streams or on stream terraces, though sites are occasionally found on subirrigated mid-slopes. Most sites are below 3,500 ft. (Figure 120). Aspects are variable due to the sheltered topographic positions of most stands.

The regolith is volcanic ash deposited over coarse textured alluvium or glacial outwash. Only soils from the Lone Ranch Creek drainage are without significant ash. Litter covers much of the soil surface and humus layers are well developed. Nutrient cycling from breakdown of litter appears relatively rapid on these moist, warm sites. The THPL/ARNU3 type is typically replaced by the TSHE/ARNU3 Association on similar but cooler sites and by the THPL/CLUN or ABGR/CLUN Associations on more exposed slopes. Adjacent upland sites are often in the Douglas-Fir or Grand

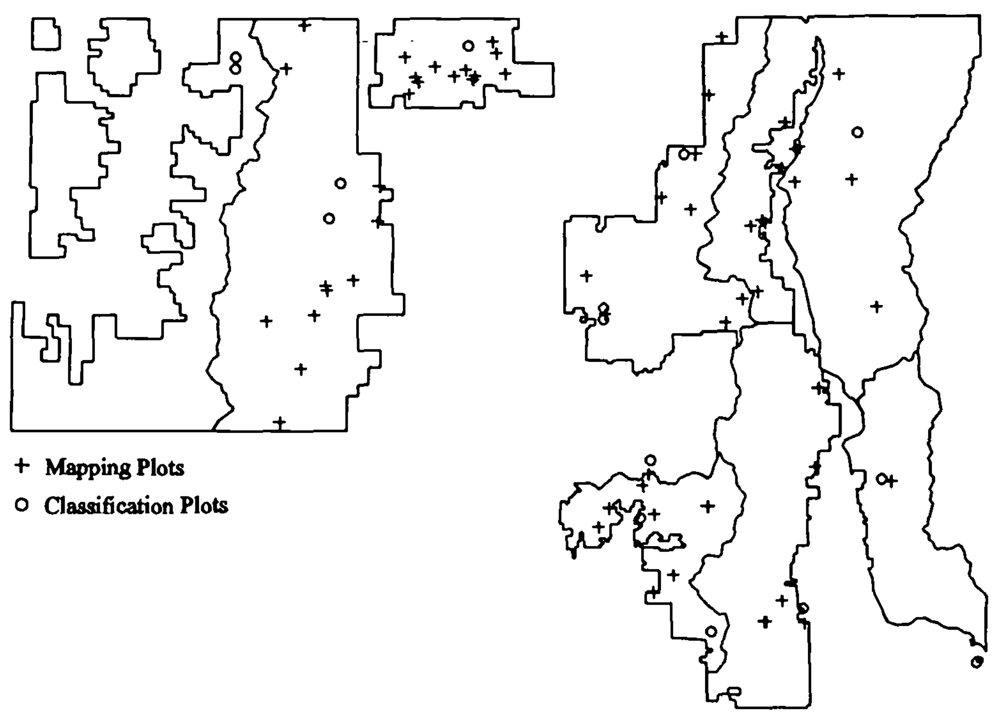


Figure 119. Plot locations for the THPL/ARNU3 Association (n=84).

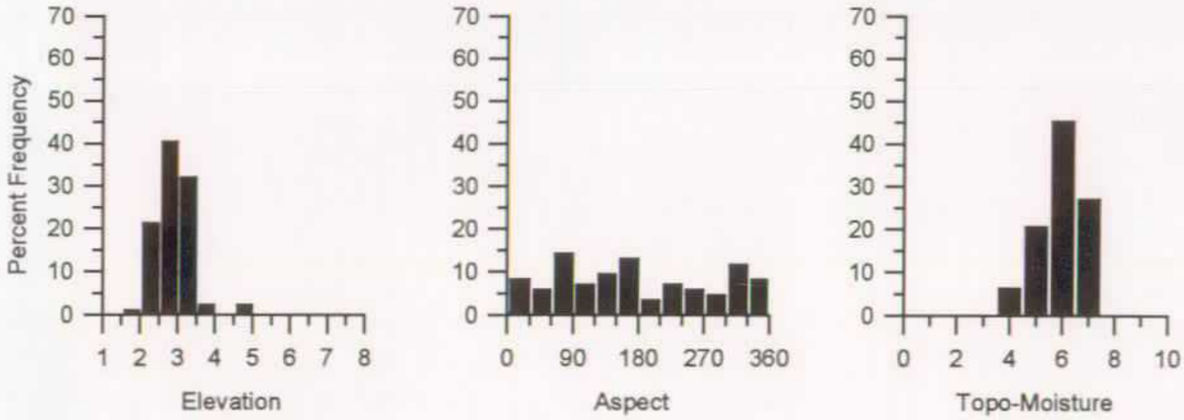


Figure 120. Frequency of THPL/ARNU3 plots by elevation (1000 ft.), aspect, and topographic moisture.

Fir Series. West of the Kettle Mountain Crest the type appears to be replaced the ABLA2/COCA Association which is found on apparently frostier sites or where the climate is less maritime in character.

Some stands in the PICO/SHCA Community Type appear to be on sites similar to those supporting the THPL/ ARNU3 Association. We speculate that such areas may have burned intensely one or more times with subsequent reductions of nutrient pools and organic matter levels such that the sites have not yet fully recovered. Similar vegetation patterns exist on sites that were cleared and used as fields. Gentle slopes, low elevations and relatively deep soils make areas supporting the THPL/ ARNU3 Association attractive for homesteads or other kinds of intensive land use. Abandoned homesteads and fields are usually dominated by lodgepole pine and a wide variety of weedy forbs and grasses, including many introduced species. Several decades to a century or more may be required before species composition on

Table 73. Common plants of the THPL/ARNU3 Association (n=16).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	100	18
THPL	western redcedar	94	24
ABGR	grand fir	75	13
LAOC	western larch	75	8
PIEN	Engelmann spruce	56	14
BEPA	paper birch	50	6
TREE UNDERSTORY LAYER			
THPL	western redcedar	94	4
ABGR	grand fir	56	5
SHRUBS AND SUBSHRUBS			
LIBOL	twinflower	94	6
ACGLD	Douglas maple	94	4
ROGY	baldhip rose	88	4
BEAQ	Oregon grape	75	3
RUPA	thimbleberry	69	5
COCA	bunchberry dogwood	63	6
HERBS			
ARNU3	wild sarsaparilla	81	12
CLUN	queencup beadlily	81	4
SMST	starry solomonplume	75	5
GATR	sweetscented bedstraw	69	3
OSCH	sweetroot	63	3

Table 74. Environmental and structural characteristics of the THPL/ARNU3 Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	2864	490	2000	4860
Aspect[2]	82	70	--	--
Slope	15	19	1	87
Topographic Moisture	5.94	0.86	4.0	7.0
Soil Surface[3]				
Exposed soil	42	43	1	95
Gravel	14	10	1	38
Rock	9	16	0	38
Bedrock	0	0	0	0
Moss	3	5	0	15
Lichen	0	1	0	3
Litter	68	25	30	95
Diversity[4]				
Richness	29.3	5.4	19	37
N2	8.2	3.4	4	15

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=49).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

profoundly disturbed sites approximates that of the THPL/ARNU3 Association.

VEGETATION

Late seral conditions are difficult to find and have to be inferred from composition of the tree regeneration layers. Mature stands are likely comprised of large western redcedar and scattered remnants of seral species such as Engelmann spruce, grand fir and Douglas-fir. Most conifer species except western hemlock, subalpine fir and whitebark pine can occur as seral species on THPL/ARNU3 sites. Composition of mid-seral stands depends on the type, intensity, and frequency of disturbance, and on prior stand composition. Douglas-fir, western larch, grand fir, and western redcedar typically dominate the overstory of mid-seral stands. Engelmann spruce may be an important overstory component, especially where cold air ponds during stand establishment periods. Lodgepole pine can dominate early-seral stages. Ponderosa pine is unusual but may occur on warm, well-drained, mid-slope habitats where repeated underburns are common.

Western white pine is poorly represented in the data, but was undoubtedly more common in this type

Figure 121. Photo of the THPL/ARNU3 association

before the spread of white pine blister rust. Paper birch and/or quaking aspen are especially important seral species on sites where fire removed much of the humus. These rapid growing, short lived, intolerant species may be very important in nutrient cycling on sites that have been intensely burned. Black cottonwood is a minor seral species on alluvial terraces close to water. Western redcedar and grand fir dominate the regeneration layers of mid-seral stands, and Engelmann spruce regeneration may also be found in colder stands.

The undergrowth is comprised of scattered tall shrubs and a relatively rich ground layer of mesophytic subshrubs and herbs. Douglas maple and baldhip rose are the most common tall shrubs. Thimbleberry and common snowberry may be abundant, especially where Engelmann spruce also occurs. Oregon grape and serviceberry are also common. These shrubs all decline in cover with the formation of dense canopies of western redcedar or grand fir.

Typical herbs include Twinflower, bunchberry dogwood, wild sarsaparilla, queencup beadlily and starry solomonplume. Coolwort foamflower, wartberry fairybells, baneberry, round-leaved violet and Columbia brome are other common species. Wild ginger can be locally abundant and represents an alternate indicator species for this type. Wild ginger also indicates habitats transitional to the THPL/ASCA3 Habitat Type described for northern Idaho (Cooper *et al.* 1991). THPL/ARNU3 has the highest average species richness of the three associations in the Series (Table 74), second only to the THPL/VAME Community Type. Average dominance is equal with the THPL/OPHO as the highest of the associations in the Series. Average dominance of just the undergrowth species is the highest overall. Not only is average richness above both Forest and Series averages, these figures also indicate that more species have relatively higher proportional abundances than average.

MANAGEMENT IMPLICATIONS

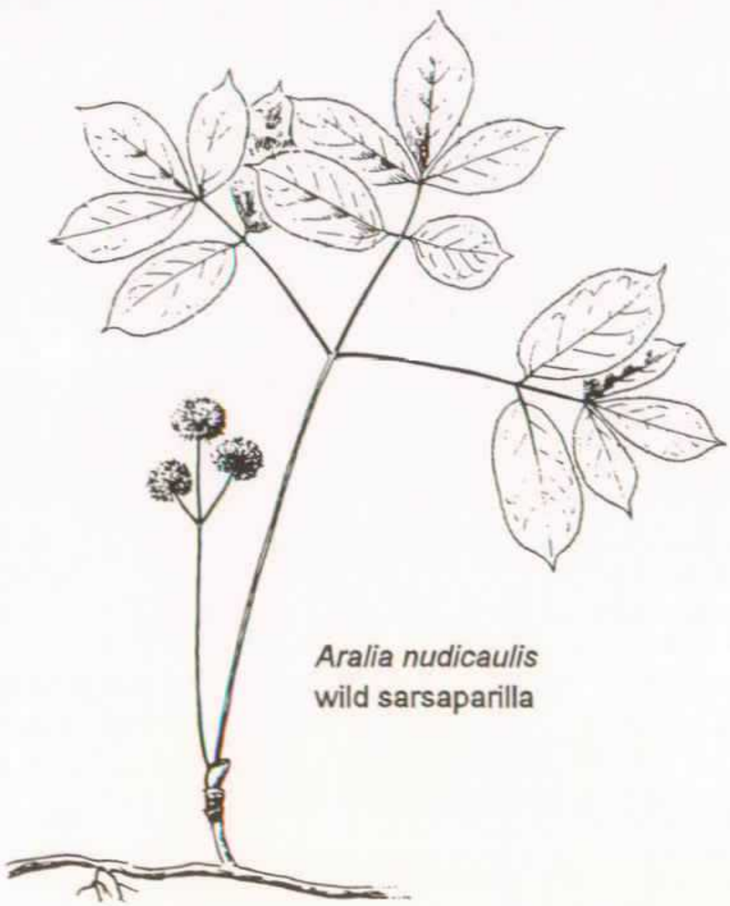
Wildlife/Range- Sheltered, relatively warm sites, proximity to streams and rich shrub and herb layers make the association highly valuable for wildlife and domestic livestock. Stands with multiple tree canopies provide good habitat for arboreal mammals and birds. Early successional stages may contain important browse species such as redstem ceanothus. Fire may enhance deer and elk habitat, particularly if ceanothus seeds are present. Pacific yew, if present, provides good winter browse for moose. Herbage for livestock is only moderate and continued overgrazing, combined with overstory removal, can result in large increases in weedy species on these sites.

Silviculture- These are highly productive timber sites. Many conifers are suitable for management and species selection for reforestation is more dependent on management objectives than on site characteristics. Seral shrubs and herbs may hinder reforestation, especially after fall broadcast burns. Pre-treatment species composition and seral characteristics (appendix 1) are important in determining vegetation responses after treatment. However, organic matter, soil nitrogen and other nutrients are easily lost (Harvey *et al.* 1987). Follow the guidelines of Harvey *et al.* (1987) to protect site quality. Ashy soils are easily compacted or displaced by heavy equipment, thereby reducing site productivity and hindering tree regeneration. The needs for soil protection, fuel reduction, and mineral soil exposure for regeneration all need to be balanced during the planning stages of proposed management activities.

Both even- and uneven-aged management techniques can be applied on these sites due to the moderate environment and seral species which are often present. Barrett (1982) recommends even-aged management with broadcast burning when western larch is the dominant seral species on north-facing slopes. Regeneration on drier aspects is enhanced by shelter from residual overstory trees (Ferguson *et al.* 1986). Seral species such as ponderosa pine, western larch or Douglas-fir may be enhanced by underburning in combination with shelterwood or selection cutting techniques (Arno and Davis 1980). In general, burning seems to enhance regeneration of seral species, particularly on clearcuts (Smith and Fischer 1995). Burning may also increase the potential for natural regeneration on these sites by reducing seed-destroying insects for 1-2 years after fire (Fellin and Kennedy 1972). Moeur (1992, 1994) reports that selective cutting could be used to alter the structure of late seral or old-growth stands by opening the canopy and encouraging reproduction by the shade-tolerant species. Ninebark and other warm-site shrubs such as thimbleberry, Oregon grape, and Douglas maple may become abundant after a fire either from stored seed or from buried roots, rootcrowns or rhizomes. Periodic disturbance favors species such as ninebark.

COMPARISONS

Several researchers have described plant associations in the Pacific Northwest which are similar to the THPL/ARNU3 Association. Variations have been reported for Montana (Pfister *et al.* 1977), eastern Washington and northern Idaho (Daubenmire and Daubenmire 1968), northern Idaho (Cooper *et al.* 1991), northcentral Washington (Clausnitzer and Zamora 1987), and southern British Columbia (Braumandle and Curran 1992). Kovalchik (1993) describes a nearly identical riparian THPL/ARNU3 Association for eastern Washington. The THPL/ARNU3 Association is a part of the THPL/PAMY Habitat Type of Daubenmire and Daubenmire (1968). Pfister *et al.* (1977) describe a THPL/CLUN Habitat Type-ARNU3 Phase that closely resembles the THPL/ARNU3 Association. Cooper *et al.* (1991) have a broadly defined THPL/ASCA3 Habitat Type. Part of the THPL/ASCA3 Habitat Type-ASCA3 Phase is similar to the THPL/ARNU3 Association. Clausnitzer and Zamora (1987) describe a THPL/ARNU3 Habitat Type on the Colville Indian Reservation that appears to be the same as the THPL/ARNU3 Association. The Hybrid White Spruce-Douglas-Fir/Gooseberry/Wild Sarsaparilla Site Association described for the southern interior of British Columbia (Braumandle and Curran 1992) is also a similar type. However, this type contains more spruce and subalpine fir than the THPL/ARNU3 Association described for the Colville N.F.



Aralia nudicaulis
wild sarsaparilla

THPL/CLUN ASSOCIATION CCF2 21
Thuja plicata/Clintonia uniflora
western redcedar/queencup beadlily

DISTRIBUTION AND ENVIRONMENT

The THPL/CLUN Association is the most common and widely distributed western redcedar association on the Colville N.F. It occurs on all districts (Figure 122) and encompasses a broad range of habitat conditions within its geographic range. It is especially common on the Kettle Falls and Colville Ranger Districts. Aspects are variable and most sites are between 2,500 and 4,500 ft. (Figure 123). Elevations of plots range as high as 5,280 ft. (Table 76). This association indicates some of the driest sites normally capable of supporting western redcedar as a climax dominant. When within the geographic range of western hemlock, this community is restricted to relatively warm and dry sites.

The regolith is volcanic ash deposits overlying glacial till or outwash. The glacial deposits are comprised of a variety of bedrock types including both calcium rich and granitic rock types. Humus depths range between 2 and 10 in. (5-25 cm) in depth. Many of these stands are in early stages of succession because of the stand-replacement fires which burned much of the Forest earlier this century. This factor, combined with the relatively dry nature of these sites, makes further

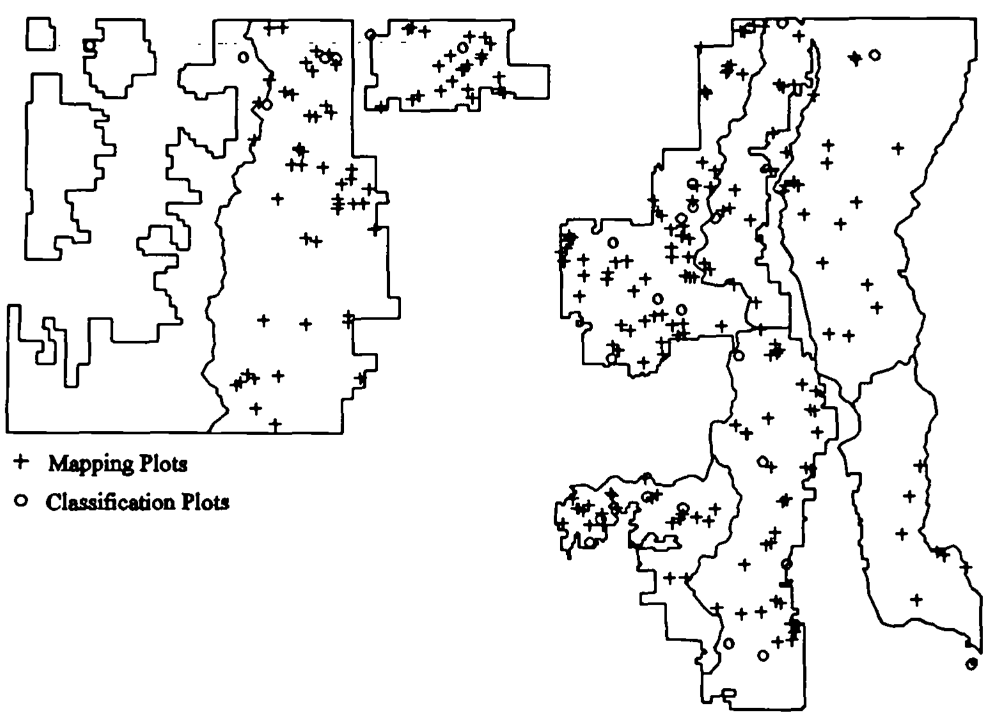


Figure 122. Plot locations for the THPL/CLUN Association (n=270).

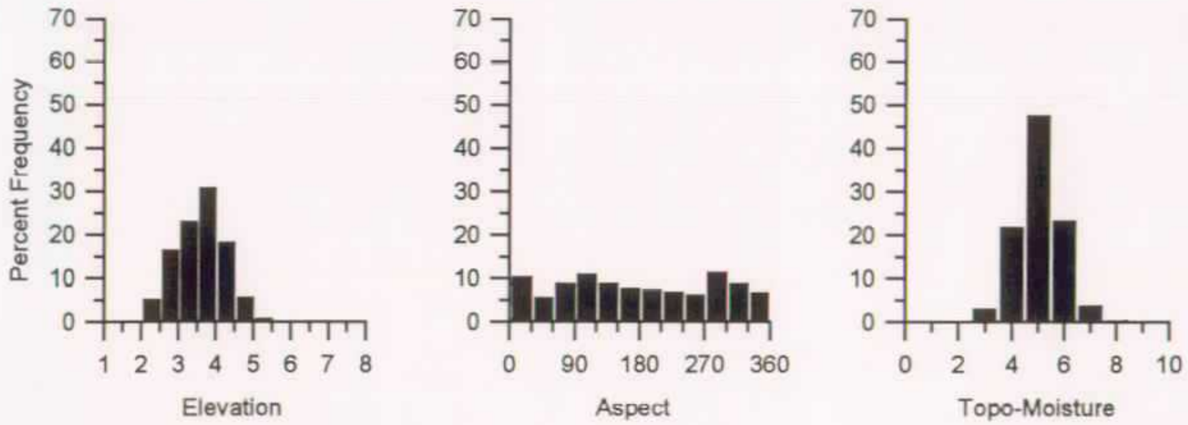


Figure 123. Frequency of THPL/CLUN plots by elevation (1000 ft.), aspect, and topographic moisture.

successional or classification interpretations of these sites difficult. The THPL/CLUN type grades into the TSHE/CLUN or THPL/ARNU3 Association with increasing site moisture and into Douglas-fir or Grand Fir Series associations with decreasing site moisture.

VEGETATION

Douglas-fir, western larch and (occasionally) ponderosa pine dominate the overstory of most early to mid-seral stands. Lodgepole pine may dominate young stands (< 100 yrs). Grand fir and western redcedar comprise a subordinate sub-canopy in mid-seral stands that gradually increases in dominance as stands age. Grand fir often establishes in a stand at nearly the same time as Douglas-fir or western larch. However, slow early growth keeps it subordinate until superior shade tolerance and vigorous later growth give it more prominence. Grand fir often seems to peak in prominence near the 150 year mark in stand development. Western redcedar establishment will often be delayed several decades past stand initiation. Late seral and climax stands are

Table 75. Common plants of the THPL/CLUN Association (n=31).

		CON	COVER
TREE OVERSTORY LAYER			
LAOC	western larch	90	12
PSME	Douglas-fir	87	21
THPL	western redcedar	68	34
TREE UNDERSTORY LAYER			
THPL	western redcedar	90	6
ABGR	grand fir	71	4
SHRUBS AND SUBSHRUBS			
PAMY	pachistima	84	10
LIBOL	twinflower	81	12
CHUM	w. prince's pine	77	5
ROGY	baldhip rose	77	5
ACGLD	Douglas maple	71	4
BEAQ	Oregon grape	68	4
LOUT2	Utah honeysuckle	65	2
HERBS			
VIOR2	round-leaved violet	68	2
CLUN	queencup beadlily	65	4
GOOB	w. rattlesnake plantain	61	2
SMST	starry solomonplume	58	4

Table 76. Environmental and structural characteristics of the THPL/CLUN Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3565	630	2240	5280
Aspect[2]	29	71	1	360
Slope	26	16	1	85
Topographic Moisture	5.04	0.87	3.0	8.0
Soil Surface[3]				
Exposed soil	44	35	0	98
Gravel	14	10	1	38
Rock	5	9	0	38
Bedrock	0	0	0	0
Moss	3	2	1	10
Lichen	1	1	0	2
Litter	53	34	0	98
Diversity[4]				
Richness	25.2	10.0	7	50
N2	7.5	4.1	2	18

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=273).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

assumed to be dominated by western redcedar. Grand fir and Douglas-fir will persist late in the sere and grand fir may be co-climax on the driest sites within the type.

Western redcedar clearly dominates reproduction in older stands while grand fir exhibits a decline in reproductive success in stands over 100 years old. Abundant Douglas-fir regeneration occurs only in early seral stands where lodgepole pine and/or ponderosa pine are prominent in the overstory. Ponderosa pine may be common on warm, well-drained sites where there has been a pattern of repeated underburns. Such sites are often associated with ninebark and oceanspray. Western white pine is poorly represented in the data, though prior to the introduction of white pine blister rust, it was a major seral species well adapted to occasional intense fires.

Shrub cover and composition is highly variable. Twinflower, pachistima, baldhip rose, Douglas maple, Utah honeysuckle, and shiny-leaf spirea are all likely to occur. Snowbrush ceanothus, redstem ceanothus, serviceberry, thimbleberry, common snowberry and ninebark may be locally well represented depending on stand structure, age and disturbance history. The herb layer is also variable in composition and cover dependent on stand history, density and age. No herbs exceed 75% constancy and only "Pachistima union" indicators such as queencup beadlily, round-leaved violet and

Figure 124. Photo of the THPL/CLUN Association.

starry solomonplume are relatively common.

THPL/CLUN has the lowest average overall species diversity of all types in the Series (Table 76). This low average diversity is undoubtedly related to the number of depauperate stands in the data for the type. Both richness and dominance rank at the bottom, although these figures are close to average for the Forest as a whole. Stands with "depauperate" shrub and herb layers are often encountered. Such stands have few or no shrubs and herbs or very low cover for the species present. Presently we retain most such sites in the THPL/CLUN Association; viewing the paucity of shrubs and herbs as transitory and more related to tree canopy densities and litter accumulations than to intrinsic site factors.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Stands with multiple tree canopies provide excellent habitat for arboreal mammals and birds. Multiple tree and shrub canopies common in mid-seral (100-200 year) stands provide considerable forage and shelter for a wide variety of wildlife species. A large variety of bird and mammal species utilize these stands for either thermal and hiding cover or forage. This is due in part to their extensive distribution across the landscape. Palatable domestic livestock herbage is lacking in most stands but early seral stages may provide moderate herbage.

Silviculture- Tree productivity is good on these sites. Shrub and herb competition and soil compaction are the main limitations to intensive timber management. Avoid soil compaction and nutrient and organic matter depletion by following the guidelines of Harvey *et al.* (1987). Soil organic matter content and porosity are both very important soil properties to consider during planning.

Both even- and uneven-aged management techniques can be used on these sites due to the moderate environment and variety of seral species which are present. Individual and group selection techniques should favor western redcedar and grand fir. Adequate natural regeneration of western larch and Douglas-fir should result from seedtree or shelterwood treatments. Regeneration on drier aspects is enhanced by shelter from residual overstory trees (Ferguson *et al.* 1986). Seral species such as ponderosa pine, western larch, or Douglas-fir may be enhanced by underburning in combination with shelterwood or selection cutting techniques (Arno and Davis 1980). In general, prescribed burning seems to enhance regeneration of seral species, particularly on clearcuts (Smith and Fischer 1995). Burning may also increase the potential for natural regeneration on these sites by reducing seed-destroying insects for 1-2 years after fire (Fellin and Kennedy 1972). However, both burning and bulldozer activity resulted in significant increases in the bulk density of soil samples taken 10-12" below the surface.

COMPARISONS

The THPL/CLUN Association is part of the THPL/PAMY Association of Daubenmire and Daubenmire (1968). They identified the THPL/PAMY type as the only upland western redcedar association. The THPL/CLUN Habitat Type-CLUN Phase described for Montana (Pfister *et al.* 1977) and northern Idaho (Cooper *et al.* 1991) includes the THPL/CLUN Association as described for the Colville N.F. Clausnitzer and Zamora (1987) describe a THPL/LIBO2 Habitat Type on the Colville Indian Reservation which appears to have significant overlap in environment with the THPL/CLUN type. Several of those plots would have keyed to the THPL/CLUN Association. Likewise, Braumandl and Curran (1992) describe a Western Redcedar-Hybrid Spruce/Falsebox Site Association for the southern interior of British Columbia which contains environments representative of the THPL/CLUN Association. However, the type contains more subalpine fir and Engelmann spruce than the THPL/CLUN Association described for the Colville N.F.

THPL/OPHO ASSOCIATION CCS2 11

Thuja plicata/Oplopanax horridum
western redcedar/devil's club

DISTRIBUTION AND ENVIRONMENT

The THPL/OPHO Association is a minor but distinctive meso-riparian plant community on the Colville N.F. It is found on the four ranger districts east of the Kettle Mountain Crest (Figure 125), but is most common on the Newport and Sullivan Lake Ranger Districts. Aspects and elevations are variable. The majority of sites are at elevations between 2,500 and 4,500 ft. (Figure 126). The THPL/OPHO Association occurs on wet bottomlands, benches or seep areas on side slopes, usually as narrow and sometimes intermittent "stringers". These stands are often small and fragmented, making it difficult to find uniform areas large enough to sample. Hummocky ground next to or between stream channels or associated with old root-wads combined with large downed woody material are common characteristics of these sites.

The regolith is alluvium derived from a variety of rock types. Volcanic ash is often present in the upper profile and sometimes forms an "ash cap". Soils are dark in color, high in organic matter, and poorly drained. Litter cover is commonly high but humus layers were only 2 to 5 in. (5-13 cm) in depth. Apparently the relatively thin humus layers are due to rapid decay on these wet sites. High

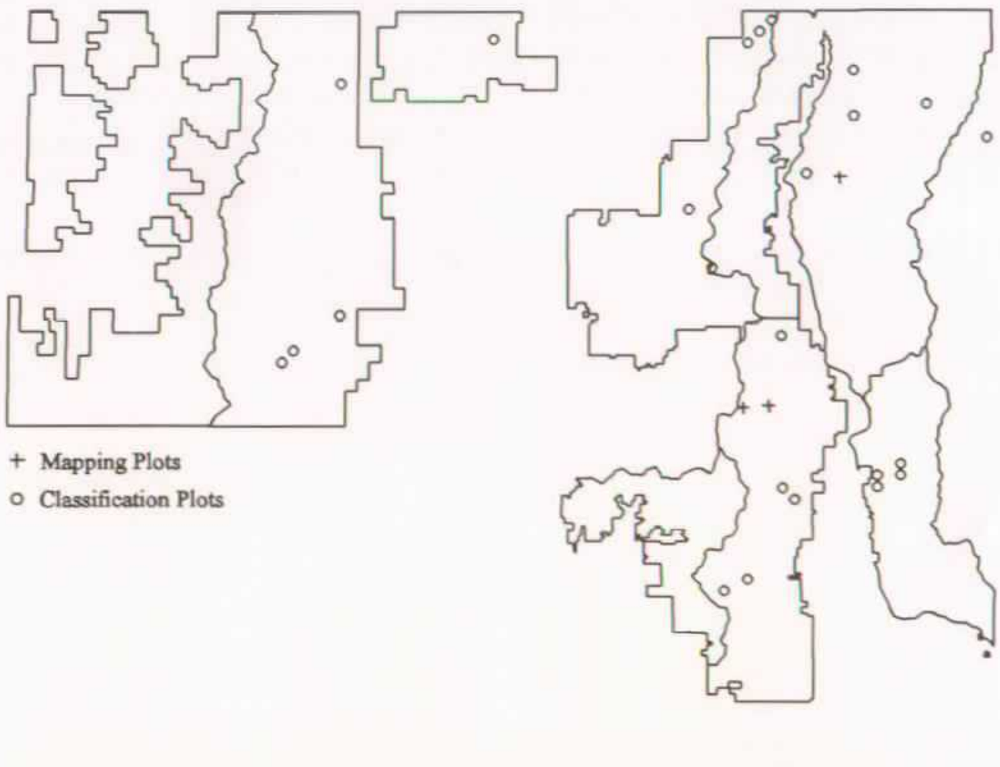


Figure 125. Plot locations for the THPL/OPHO Association (n=31).

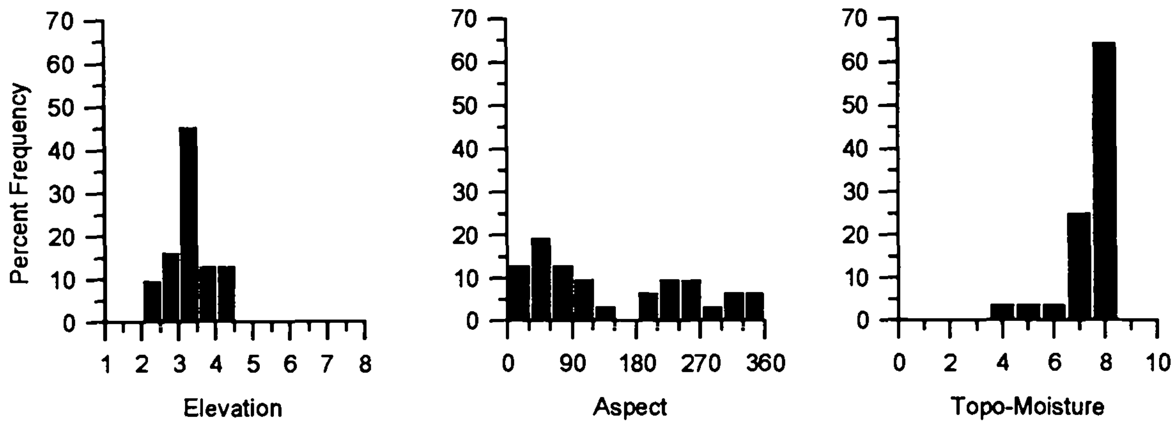


Figure 126. Frequency of THPL/OPHO plots by elevation (1000 ft.), aspect, and topographic moisture.

water tables with standing surface water in old stream channels and holes created by windthrown trees are characteristic features. Exposed rock or gravel at the soil surface is common, especially next to flowing water or in abandoned stream channels. Somewhat drier sites with better drained soils are typically in the TSHE/GYDR Association.

Table 77. Common plants of the THPL/OPHO Association (n=6).

		CON	COVER
TREE OVERSTORY LAYER			
THPL	western redcedar	100	35
TSHE	western hemlock	100	23
ABGR	grand fir	100	13
TREE UNDERSTORY LAYER			
TSHE	western hemlock	100	2
THPL	western redcedar	67	4
SHRUBS AND SUBSHRUBS			
OPHO	devil's club	100	9
ACGLD	Douglas maple	83	3
RILA	prickly currant	67	2
HERBS			
ATFI	lady-fern	100	29
GYDR	oak-fern	100	23
ASCA3	wild ginger	100	7
TIUN	coolwort foamflower	100	7
CLUN	queencup beadlily	100	4
ACRU	baneberry	100	4
CIAL	circaea	100	2
GATR	sweetscented bedstraw	100	2
SMST	starry solomonplume	83	9
STAM	claspleaf twisted-stalk	83	3
DIHO	Hooker fairybells	83	3
ADBI	pathfinder	83	2

VEGETATION

The THPL/OPHO Association characterizes one of the wettest sites that normally support conifers on the Forest. The overstory of mature stands typically contains two or more layers. Western redcedar usually forms a lower canopy while Douglas-fir, grand fir or western hemlock comprise the open, emergent layer. Western hemlock is commonly restricted to drier microsites such as old root-wads, stumps, short snags and logs. Engelmann spruce or white spruce did not occur in the sample plots, but either of these species

Table 78. Environmental and structural characteristics of the THPL/OPHO Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3332	559	2320	4400
Aspect[2]	38	67	--	--
Slope	11	12	2	67
Topographic Moisture	7.42	0.99	4.0	8.0
Soil Surface[3]				
Exposed soil	15	13	1	30
Gravel	9	5	3	12
Rock	10	19	0	38
Bedrock	0	0	0	0
Moss	5	0	1	5
Lichen	0	0	0	0
Litter	28	13	15	40
Diversity[4]				
Richness	26.5	1.6	24	29
N2	8.0	2.8	5	13

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=31).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

may be present as minor seral components. Analogs of this type described for Montana (Pfister *et al.* 1977) and northern Idaho (Cooper *et al.* 1991) both have one or the other of the above species in their plots. Western redcedar and/or western hemlock dominate the regeneration layers in late seral or climax stands.

Grand fir and Douglas-fir are common in early to mid-seral stands but are restricted to drier microsites. Microsite variation strongly affects vegetation composition. Species that grow best on mounds require better drainage than that available in the wet swales between hummocks.

The undergrowth is characterized by a rich variety of shrubs, herbs and ferns beneath a layer of devil's club. Devil's club is the most constant and abundant shrub and is diagnostic of the association (if well represented). Other common shrubs include Douglas maple, twinflower, prickly currant and Pacific yew. Lady-fern is usually abundant, and has higher cover than devil's club in most stands. Oak-fern forms a nearly continuous layer under the lady-fern and devil's club. Wild ginger, arrowleaf groundsel, claspleaf twisted-stalk, Hooker fairybells, pathfinder, coolwort foamflower, queencup beadlily, wild sarsaparilla, and baneberry are other common herbs that indicate wet to moist habitats.

Figure 127. Photo of the THPL/OPHO association.

This association ranks third of the four types in the Series in both richness and dominance (Table 78) and close to average for the Forest as a whole. Although very moist to wet habitats support lush vegetation, they seldom have the highest concentrations of species. Wet soils and competition by meso- or hydrophytic obligates exceeds the ability of many species to survive.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Despite limited acreage, the type is an important landscape element. Wet forests are important for species diversity, water, shelter and refugia during major fires. The association is valuable riparian habitat for many species of wildlife, offering water, cover and forage. Big game may seek out the lush forbs and use these sites for wallows, and elk relish the spiny leaves of devil's club. In addition, due to the large size many of the cedar or hemlock attain in this type, these sites may represent important habitat for species dependent upon old-growth stand structures. Sites in these "cedar-hemlock bottoms" may represent the only remaining old-growth in some areas of the forest where most of the surrounding uplands have burned. The humid conditions also attract a large variety of insects, which in turn attract avian species. Domestic livestock use in the type is low except as access to water and for shade. As with many types of riparian plant communities, concentrated cattle use can destroy the plant cover of these sites, so use should be monitored very closely.

Silviculture- Timber productivity as estimated by basal area and SDI is high (appendix 2), but good site index estimates are difficult to obtain because of the high proportion of defective and diseased trees present in most natural stands. High water tables and riparian conditions severely limit silvicultural options. The association is not well suited to intensive timber management. Managers should consider other values when managing these stands because of high wildlife and watershed values and the difficulty of assuring regeneration after harvest. Soils are subject to compaction and flooding, making harvesting and road building very difficult. Natural stands normally have a high percentage of "cull" trees from rot, multiple tops or dead tops. Opening the overstory canopy often results in windthrow. The type is poorly suited to recreation developments and trails because of the swampy conditions. The type is biologically rich but sensitive to disturbance.

COMPARISONS

The THPL/OPHO association has been previously described first for northern Idaho and eastern Washington (Daubenmire and Daubenmire 1968) and, subsequently, Montana (Pfister *et al.* 1977) and northern Idaho (Cooper *et al.* 1991). Kovalchik (1993) describes an identical THPL/OPHO Association for riparian sites in eastern Washington. Braumandl and Curran (1992) also describe a very similar Western Redcedar-Hemlock/Devils Club/Lady Fern Site Association for the southern interior of British Columbia. The type is also comparable to the Oplopanaceton (Devil's Club) Association described by Bell (1965) for central British Columbia.

Oplopanax horridum
devil's club

THPL/VAME COMMUNITY TYPE CCS3 11

Thuja plicata/Vaccinium membranaceum
western redcedar/big huckleberry

DISTRIBUTION AND ENVIRONMENT

The THPL/VAME Community Type is found on all districts east of the Kettle Mountain Crest (Figure 128). This type typically occupies mid- to upper-slope positions on west to east (northerly) aspects. Stands are usually between 3,000 and 5,000 ft. (Figure 129). This plant community is very heterogeneous as it occurs across a broad range of habitat conditions. This type generally occupies the highest elevations within the Western Redcedar Series (considering modal sites). Stand structures and presence of western redcedar and big huckleberry are presently the main unifying characteristics for this type.

The regolith is volcanic ash deposited over glacial outwash and till. Surface soil textures are usually sandy. Nearly half of the soil profiles used for this description have a compacted subsoil. Roots do not penetrate the compacted layers and become concentrated in the upper soil horizons. Humus and duff depths show considerable variation, ranging between 2 and 12 in. (5-30 cm). Only one of six soil profiles had humus and duff over 5 in. (13 cm). This site supported a dense stand of thimbleberry, perhaps indicating the site was more moist than normal.

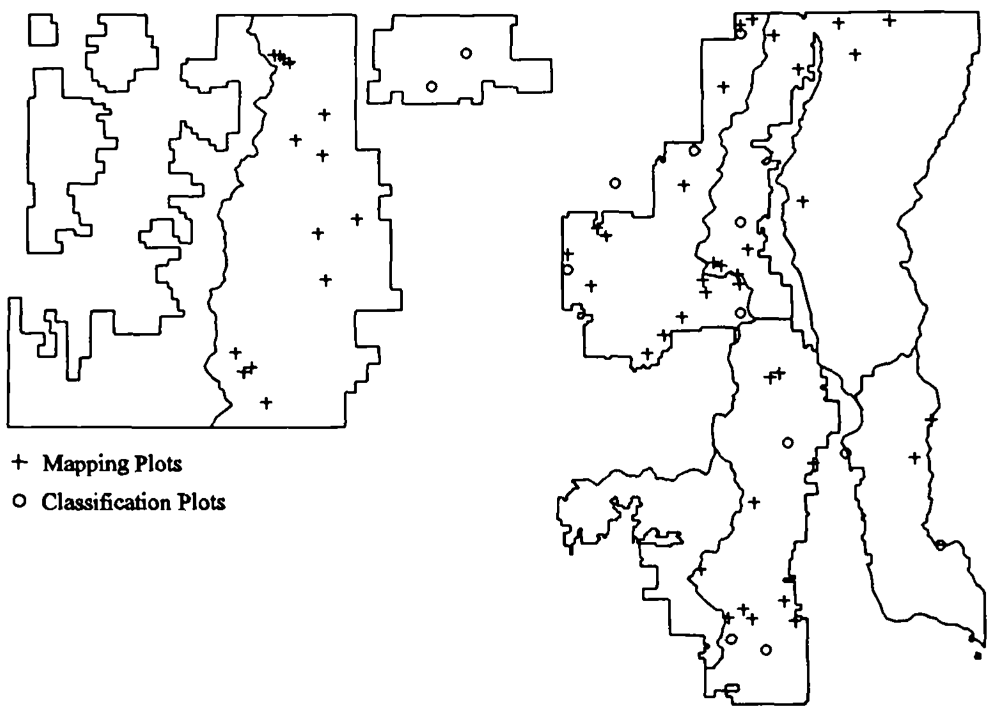


Figure 128. Plot locations for the THPL/VAME Community Type (n=72).

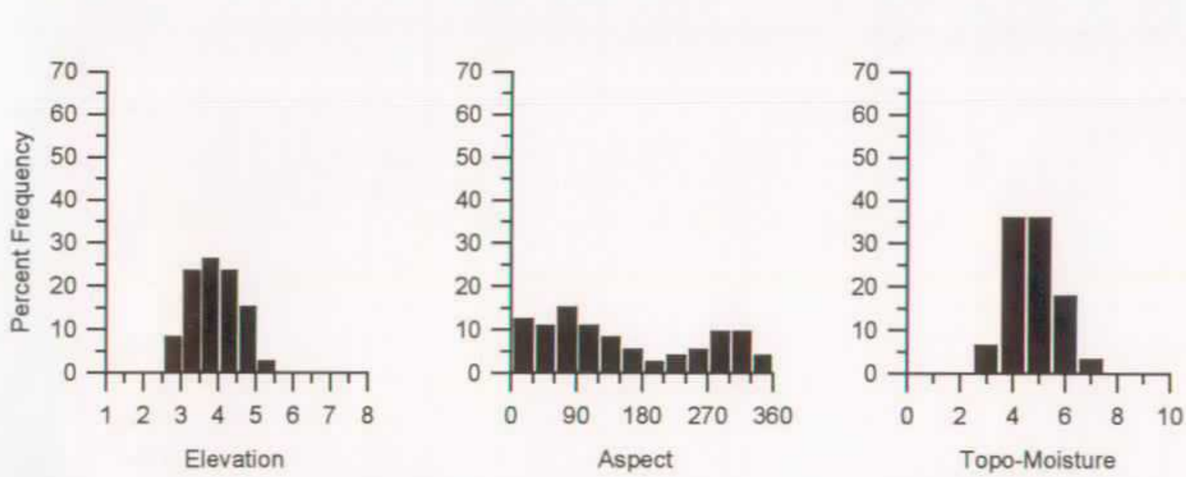


Figure 129. Frequency of THPL/VAME plots by elevation (1000 ft.), aspect, and topographic moisture.

Very hot, large fires appear to be the originating factors in at least some stands but repeated underburning may be important on other sites. Fire evidence in the form of snags, charred stumps, charcoal and scarred trees is common. We speculate that relatively recent intense fires or activities related to homesteading removed much of the soil organic materials and nutrients such that species compositions are not yet adjusted to the local climate and soil potential.

VEGETATION

Western larch, Douglas-fir, lodgepole pine or a mixture of these three species dominates the overstory of this community type. Grand fir and western redcedar occasionally form significant components of the overstory. Western redcedar and grand fir will increase in dominance as stands age. Succession is slow to the more shade tolerant and environmentally restricted

Table 79. Common plants of the THPL/VAME Community Type (n=20).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	95	19
LAOC	western larch	95	15
ABGR	grand fir	70	8
PICO	lodgepole pine	65	19
THPL	western redcedar	55	11
TREE UNDERSTORY LAYER			
THPL	western redcedar	100	4
PSME	Douglas-fir	80	4
ABGR	grand fir	65	4
SHRUBS AND SUBSHRUBS			
VAME	big huckleberry	95	14
PAMY	pachistima	95	7
ROGY	baldhip rose	95	4
LOUT2	Utah honeysuckle	80	4
BEAQ	Oregon grape	80	3
CHUM	w. prince's pine	75	5
LIBOL	twinflower	70	16
SPBEL	shiny-leaf spirea	70	5
ARUV	bearberry	55	4
HERBS			
VIOR2	round-leaved violet	90	4
CLUN	queencup beadlily	85	4
SMST	starry solomonplume	65	4

Table 80. Environmental and structural characteristics of the THPL/VAME Community Type.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3852	638	2640	5180
Aspect[2]	63	60	--	--
Slope	24	15	2	67
Topographic Moisture	4.75	0.94	3.0	7.0
Soil Surface[3]				
Exposed soil	25	13	10	50
Gravel	22	13	12	38
Rock	15	18	0	38
Bedrock	0	0	0	0
Moss	2	1	1	5
Lichen	0	1	0	2
Litter	37	18	20	70
Diversity[4]				
Richness	30.1	4.6	20	37
N2	11.3	3.5	6	18

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=72).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N_2, are expressed as average number of species per plot.

western redcedar.

Some sites may be successional to western hemlock. Many plots in the type are within the geographic range of western hemlock with suitably deep soils and maritime climate. It is possible that intense conflagrations preceding the current stands removed seed sources and destroyed essential organic seed beds. A century or more may be required to restore organic matter and nutrients after a severe disturbance to pre-disturbance levels (Harvey *et al.* 1987).

The shrub layer is floristically variable but high in total cover. The open nature of these stands may account for much of the shrub vigor. Big huckleberry, pachistima and baldhip rose are present on nearly all plots. Other common shrubs include bearberry, twinflower, Utah honeysuckle, mountain ash, shiny-leaf spirea and thimbleberry. Low huckleberry is abundant in some stands and may be the only huckleberry present on some sites.

Herbs are variable in occurrence and cover. Queencup beadlily is present in most plots but the presence of other herbs appears dependent on shrub density, microsite variation and disturbance history. Starry solomonplume and round-leaved violet are the only herbs other than queencup

Figure 130. Photo of the THPL/VAME Community Type.

beadlily with more than 50% constancy. False bugbane, pinegrass and western meadowrue may be well represented, but are present in only a few stands. THPL/VAME has highest average overall diversity in the Series, including both species richness and dominance (Table 80). This is to be expected from sample plots that include only early-seral stands where diversity is often high. As such stands mature, species richness will begin to decline. Structural diversity (not measured) will likely tend to increase as canopy structure becomes more complex.

Some stands in the THPL/VAME Community Type appear to be on sites similar to those supporting both the PICO/SHCA Community Type and the THPL/ARNU3 Association. We speculate that such areas may have burned intensely one or more times with subsequent reductions of nutrient pools and organic matter levels such that the sites have not yet fully recovered. Similar vegetation patterns exist on sites that were cleared and used as fields.

MANAGEMENT IMPLICATIONS

Wildlife/Range- These sites have obvious wildlife forage value due to the presence of big huckleberry in the stands. Big huckleberry provides food and cover for a variety of big game, small mammal, and avian species. Wildlife values for thermal cover are high because of the mix of shrub species and the relatively warm sites that become snow-free earlier than most sites in the Subalpine Fir or Western Hemlock Series. Dense pole-size stands may be valuable for wildlife cover. Early successional stands may be more useful to wildlife, especially if shrub cover is high. Mature stands provide low to moderate amounts of herbage for livestock but early seral stages may provide considerable herbage. There was little evidence of livestock use in the sample plots.

Silviculture- THPL/VAME sites have the lowest productivity in the Western Redcedar Series (appendix 2), though are still relatively productive. Past disturbance intensity, loss of nutrients and organic matter, and compacted soils may all contribute to lower productivity. Western larch and Douglas-fir have reasonably good site indexes. Grand fir was measured on only one plot but that stand had good growth rates. Basal areas in most stands are fairly low, so limitations to stocking apparently exist. Avoid further soil compaction, and nutrient and organic matter depletion by following the guidelines of Harvey *et al.* (1987). Soil organic matter content and porosity are both very important soil properties to consider during planning. Treatments such as whole tree harvest should be avoided so as to reduce nutrient and organic matter losses. Equipment should be restricted to the least amount of area as possible because of the danger of soil compaction.

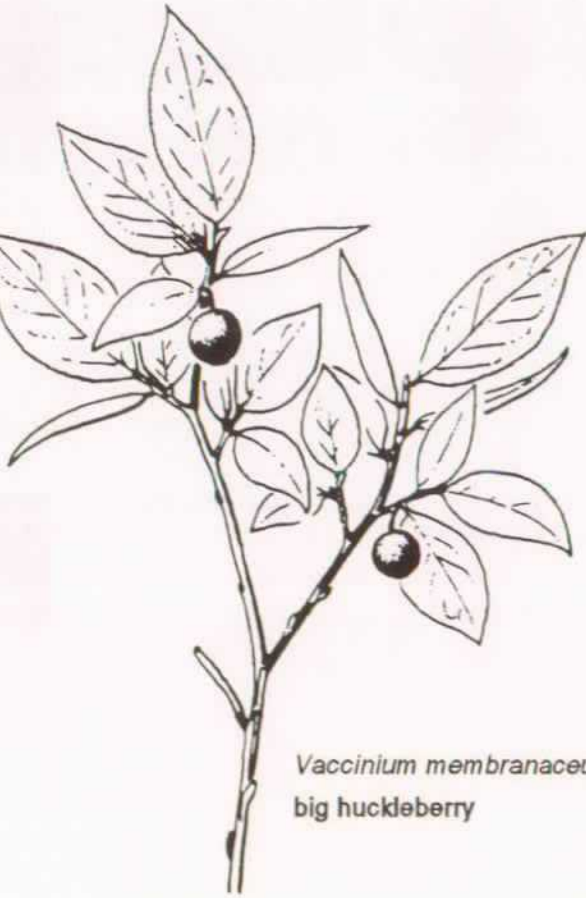
Both even- and uneven-aged management techniques can be used due to the moderate moisture and temperature regimes and seral species which are present. When western larch is the dominant seral species on north-facing slopes, Barrett (1982) recommends even-aged management with broadcast burning. However, both Larsen (1922) and Stickney (1982) report that clearcutting may create sites too harsh for adequate tree regeneration. Regeneration on drier southern aspects is enhanced by shelter from residual overstory trees (Ferguson *et al.* 1986).

Broadcast burning generally stimulates Douglas maple, russet buffaloberry, serviceberry and big huckleberry but will reduce soil nutrients and organic matter. Seral species such as ponderosa pine, western larch, or Douglas-fir may be enhanced by underburning in combination with shelterwood or selection cutting techniques (Arno and Davis 1980). In general, burning seems to enhance regeneration of seral species, particularly on clearcuts (Smith and Fischer 1995). Burning may also increase the potential for natural regeneration on these sites by reducing seed-destroying insects for 1-2 years after fire (Fellin and Kennedy 1972).

COMPARISONS

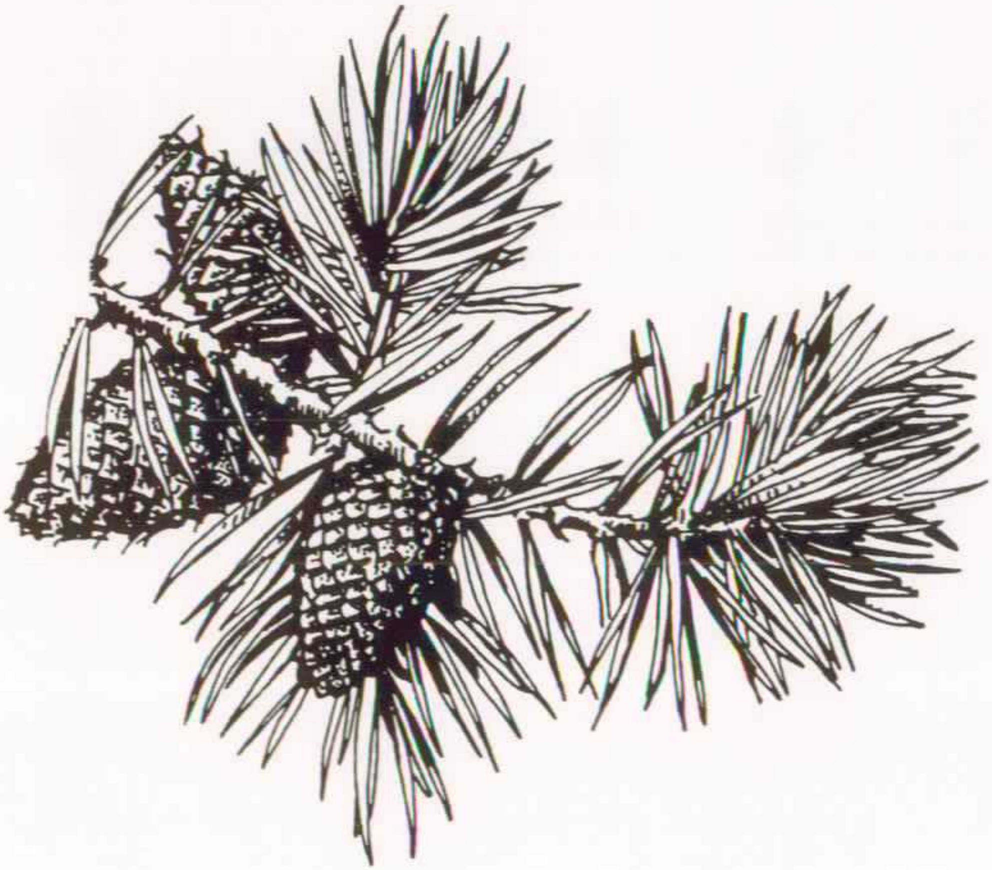
The THPL/VAME Community Type has not been described in the Pacific Northwest before. The THPL/CLUN Habitat Type-XETE Phase of Cooper *et al.* (1991) resembles some of our plots but beargrass is less common in northeast Washington compared to northern Idaho. Two stands sampled on the Colville N.F. have beargrass and would key to their type. The THPL/VAME Community Type is similar to the THPL/CLUN Habitat Type-VAGL Phase described in Montana (Pfister *et al.* 1977). It is also part of the THPL/PAMY Habitat Type described by Daubenmire and Daubenmire (1968) for eastern Washington and northern Idaho. Clausnitzer and Zamora (1987) describe a THPL/LIBO2 Habitat Type on the Colville Indian Reservation which appears to have significant overlap in environment with the THPL/VAME type. Several of those plots would have keyed to the

THPL/VAME Community Type. Likewise, Braumandl and Curran (1992) describe a Lodgepole Pine-Douglas-Fir/Sitka Alder/Pinegrass Site Association for the southern interior of British Columbia which contains environments and species similar to the THPL/VAME Community Type. However, the type contains more Sitka alder and pinegrass and less big huckleberry than the THPL/VAME Community Type.



Vaccinium membranaceum
big huckleberry

OTHER VEGETATION TYPES



PIAL ASSOCIATIONS CAG1 12

Pinus albicaulis
whitebark pine

DISTRIBUTION AND ENVIRONMENT

Whitebark pine stands are generally limited to the higher peaks along the Kettle Mountain Crest and in the Salmo-Priest Wilderness (Figure 131). Whitebark pine occur on dry, windswept, southerly to westerly slopes near upper timberline, generally above 6,000 ft. (Figure 132). Severe insolation, winter desiccation and snow removal by wind are characteristic of the sites. Whitebark pine stands are so limited in extent and ravaged by wildfires and blister rust during the last century that we have little data other than observations. This type was not sampled on the Colville N.F. but stands have been observed and skeleton forests from fire, blister rust and insects are present on some of the higher peaks. Data from Okanogan N.F. plots are used to describe the type. Whitebark pine associations occurring on the Colville N.F. will be described in greater detail in future publications after adequate sampling. Whitebark pine types may be bounded by mountain big sagebrush, mountain snowberry or graminoid dominated communities which include such species as Idaho fescue or green fescue.

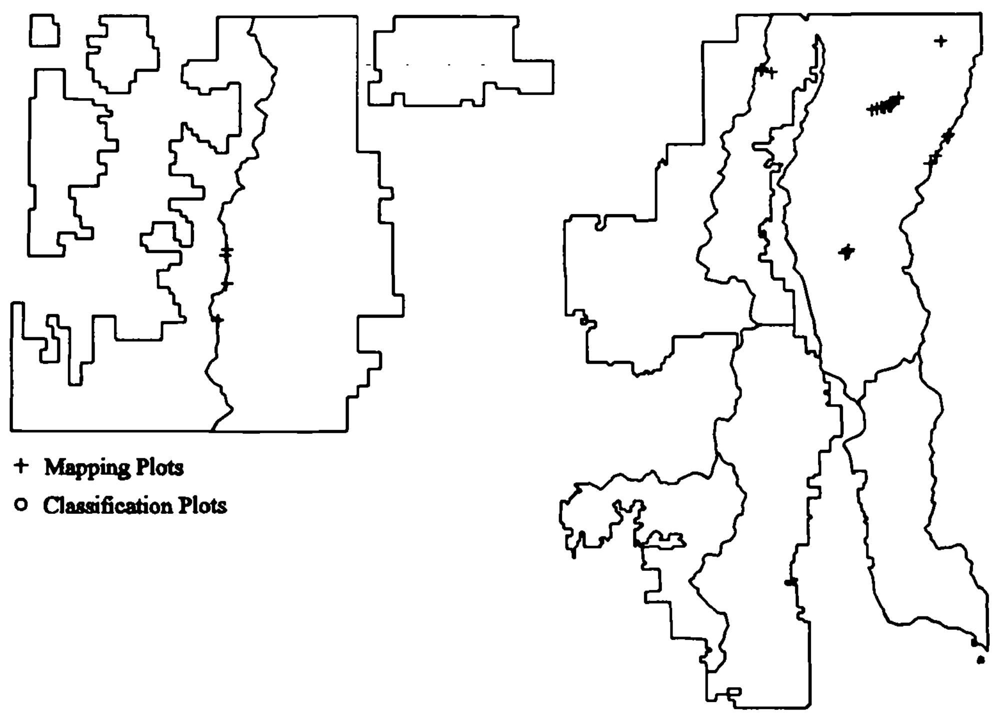


Figure 131. Plot locations for the Whitebark Pine Series on the Colville N. F. (n=28).

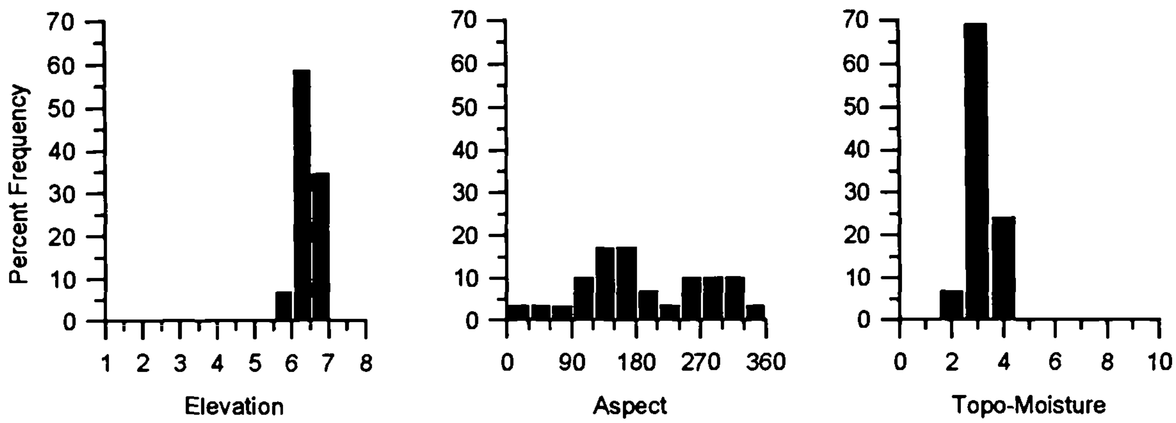


Figure 132. Frequency of PIAL Series plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

Sites dominated by whitebark pine are lumped into one type at present because of limited data. However, species composition and sites are sufficiently diverse that several associations could be described (*See* Lillybridge *et al.* 1995). Ongoing work in subalpine environments will add to our understanding of these complex systems. Late seral and climax stands on the Forest have not been seen because of widespread fires and infection by blister rust (*Cronartium ribicola*). Data from other areas and published descriptions of whitebark stands in Montana (Pfister *et al.* 1977, Williams and Lillybridge 1983) are used to help describe the type.

Stands rarely develop a closed canopy because of harsh environmental conditions. Multi-stemmed trees are common. Whitebark pine should dominate mature, natural stands. However, most Colville N.F. stands are now "ghost forests" of dead

Table 81. Common plants of the PIAL Series (n=6).

		CON	COVER
TREE OVERSTORY LAYER			
PIAL	whitebark pine	100	13
PSME	Douglas-fir	50	15
ABLA2	subalpine fir	50	7
TREE UNDERSTORY LAYER			
PIAL	whitebark pine	83	2
SHRUBS AND SUBSHRUBS			
PAMY	pachistima	67	2
VASC	grouse huckleberry	50	3
JUCO4	common juniper	17	30
HERBS			
CARU	pinegrass	100	10
ACMI	yarrow	100	5
ERIOG	buckwheat spp.	83	6
CARO	Ross sedge	67	6
CASTI	paintbrush spp.	67	2
FEID	Idaho fescue	50	6
ASTER	aster spp.	50	4
POA	bluegrass spp.	50	4
SENEC	groundsel spp.	50	3
HIERA	hawkweed	50	3
ANTEN	pussytoes spp.	50	3

Figure 133. Photo of the PIAL Series.

and down whitebark pine, composed of old burned or rust-killed skeletons on the tops of some of the higher peaks while living trees are scarce or absent. Although whitebark pine is the most common tree, subalpine fir, Engelmann spruce, Douglas-fir and lodgepole pine may be present depending on local conditions and elevations. Lodgepole pine and Douglas-fir are more common at lower elevations. Other tree species are usually limited to small, sheltered areas with more favorable microsites provided by the whitebark pine trees. Snow accumulations are greater and melting is delayed on the lee-side of existing whitebark trees, thereby creating more favorable microsites.

Extensive conflagration fires in the last 100 years killed most or all of the fire sensitive and highly flammable whitebark pines. These areas may remain virtually free of living trees for decades while old snags give mute evidence of former forested or wooded stands. Forest development on high elevation windswept slopes often requires hardy whitebark pines to form sheltered microsites for subalpine fir. High elevation habitats are often so severe that even climax stands of subalpine fir have fairly open canopies. At elevations where whitebark pine is a major stand component, individual subalpine firs are often stunted and distorted; reproducing mainly by layering. Shrubs have low coverages and most individuals are sheltered by rocks. Pinegrass is the most common and constant herb. Other herbs are variable in constancy and cover, though smooth woodrush and Drummond's rush (*Juncus drummondii*) have been observed to dominate some sites.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Whitebark pines have edible seeds, "pine nuts", which serve as important forage for a wide variety of wildlife including squirrels, grizzly bears and Clark's nutcrackers. Clark's nutcracker also plays an important ecological role in the seed dispersal of whitebark pine, with seed caches often germinating. In Wyoming, squirrels were the major seed predator of whitebark pine seeds (Hutchins 1994). These slopes are among the first to green up in the spring making them important forage areas for many wildlife species. Livestock often make heavy use of the grasses, sedges and herbs typical of the type. Sites are slow to recover from grazing because of shallow rocky soils, drought and short growing season.

Silviculture- Tree growth and stocking are low to very low. No techniques are known to assure reforestation. Overstory removal increases potential for severe frost heaving, winter desiccation and drought, and alters snow pack patterns and melting regimes. Whitebark pine wood is highly flammable even when green and the dry, windswept upper slope locations are predisposed to lighting strikes. Only the sparse, discontinuous cover typical of the habitat allows stands to reach maturity. Frost is possible any night of the year. Whitebark pine is host to mountain pinebeetle, and is often killed when the tree achieves a large size, particularly if there is an epidemic in progress in nearby lodgepole pine stands.

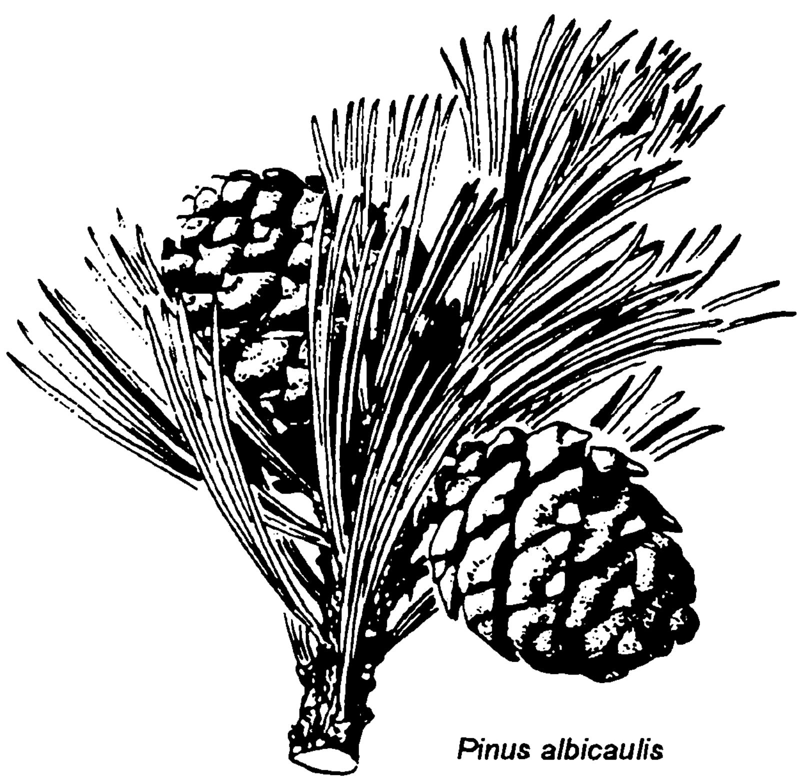
The continuing decline or loss of whitebark pine communities throughout the northwest has important ramifications regarding various community and landscape processes. The most obvious impacts are related to a decline in an important wildlife food source (seeds) and changes in plant community composition. These latter changes can result in the absence of reforestation after disturbances on these harsh sites, effectively lowering tree-line elevations. These changes in the landscape patterns of high-elevation communities may result in altered snow accumulations and subsequent changes in the hydrology of large areas (Kendall 1994).

Most of the whitebark pine stands on the Colville N.F. are naturally small, isolated populations. This fact combined with their slow growing nature (50 to 100 years for significant cone crops) makes management and conservation of this species very difficult (Kendall and Arno 1990). However, the combination of using rust-resistant stock and/or introducing a natural fire regime offer some promise for future enhancement and conservation of whitebark pine communities. Kendall's (1994) recommendations for management of whitebark pine communities on National Park Service lands are quite applicable to most national forest lands. An important priority for areas with small, isolated populations (as on the Colville N.F.) should be to preserve the unique genotypic and phenotypic varieties by way of seed bank collections.

COMPARISONS

Many ecologists have described whitebark pine communities in the Pacific Northwest, though community descriptions tend to be quite variable. Various types have been described for Montana (Pfister *et al.* 1977), northeast Oregon (Johnson and Clausnitzer 1992), northeast and northcentral

Washington (Clausnitzer and Zamora 1987, Lillybridge *et al.* 1995, Williams and Lillybridge 1983), north Idaho (Cooper *et al.* 1991) and central Idaho (Steele *et al.* 1981). Additional types are described for the southern interior of British Columbia by Lloyd *et al.* (1990).



Pinus albicaulis
whitebark pine

PICO/SHCA COMMUNITY TYPE CLS5 21

Pinus contorta/Shepherdia canadensis
lodgepole pine/russet buffaloberry

DISTRIBUTION AND ENVIRONMENT

The PICO/SHCA Community Type is most common east of the Kettle Mountain Crest (Figure 134). It is characteristic of gently sloping glacial outwash benches and terraces. The majority of sites are located on southern aspects (Figure 135). Most soil profiles have compacted subsoils and roots are concentrated in the surface ash horizons. Slopes are typically gentle and elevations moderate. Frost pockets are common. Some sites that are now dominated by lodgepole pine have been past homesteads and were used as fields. Historic soils were destroyed on many sites by burning and/or farming, the "A" horizon having been eliminated. Thus, the PICO/SHCA Association apparently reflectes many of these past disturbances.

VEGETATION

Lodgepole pine is the main overstory species except for a few stands that have a preponderance of western larch. Our oldest stand was about 150 years old and was dominated by western larch. Other plots were less than 50 years old and these are almost wholly dominated by lodgepole pine. Quaking

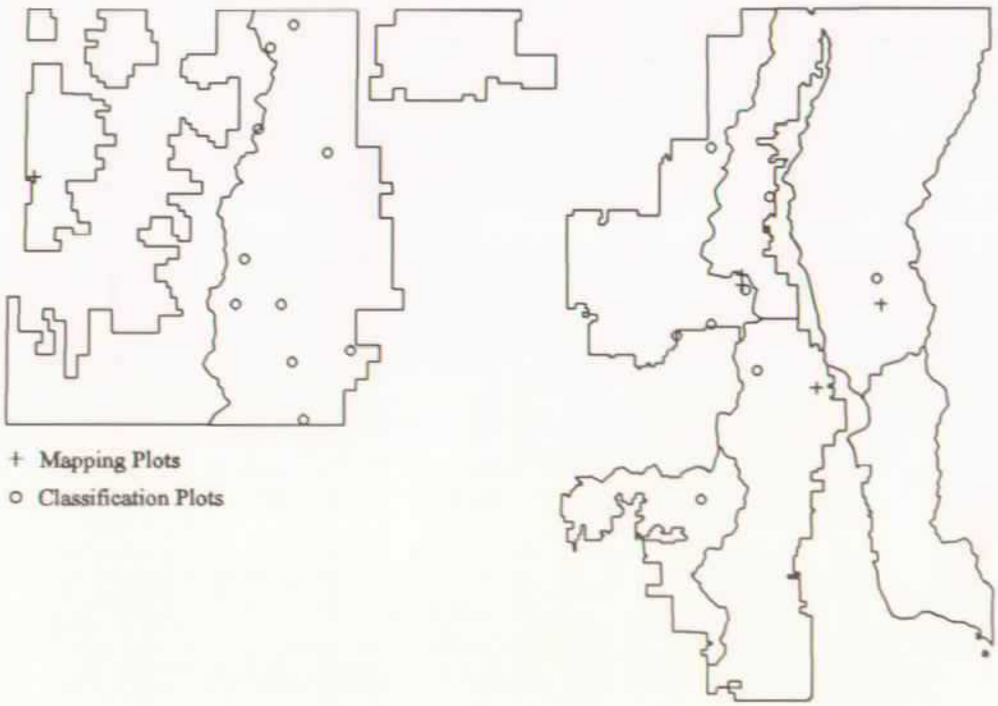


Figure 134. Plot locations for the PICO/SHCA Association (n=25).

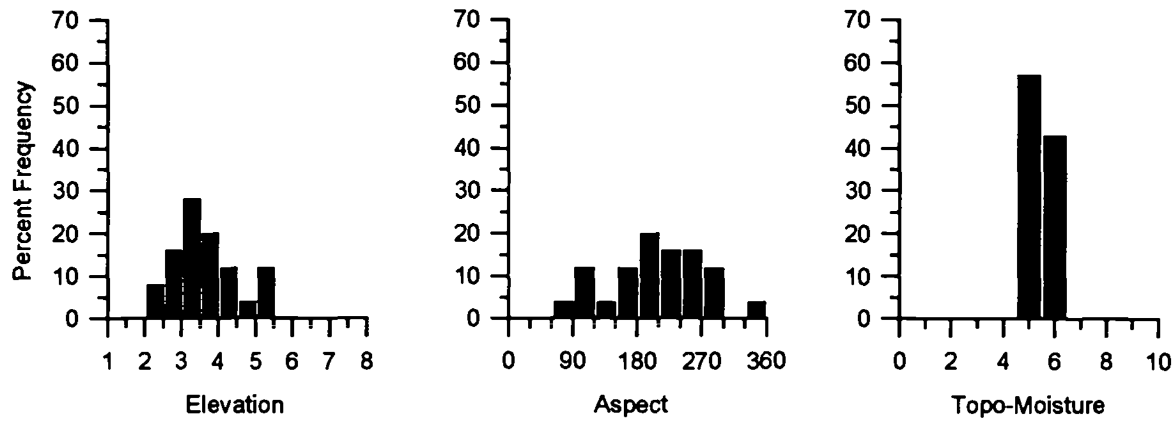


Figure 135. Frequency of PICO/SHCA plots by elevation (1000 ft.), aspect, and topographic moisture.

aspen and perhaps paper birch may form part of the sere in some areas along with lodgepole pine or western larch. Other conifers are usually minor stand components if present. Evidence of climax tree composition is meager but judging from geographic location and site characteristics it appears the PICO/SHCA Community Type describes a relatively stable seral condition that may occur on ABLA2/VACA, ABGR/VACA, THPL/CLUN, THPL/ARNU3, TSHE/CLUN and TSHE/ARNU3 Association sites.

Russet buffaloberry, a nitrogen-fixing, early successional shrub, typifies the shrub layer but a variety of other species may be present depending on stand history and intensity of past perturbations. Common shrubs include western prince's pine, twinflower, pachistima, baldhip rose and shiny-leaf spirea. One or more huckleberry species are present in nearly all stands examined. Grouse huckleberry suggests sites with somewhat cooler temperatures. Dwarf huckleberry indicates sites with warm days

Table 82. Common plants of the PICO/SHCA Association (n=20).

		CON	COVER
TREE OVERSTORY LAYER			
PICO	lodgepole pine	100	46
LAOC	western larch	60	13
PSME	Douglas-fir	50	5
TREE UNDERSTORY LAYER			
PSME	Douglas-fir	65	4
SHRUBS AND SUBSHRUBS			
SPBEL	shiny-leaf spirea	95	7
PAMY	pachistima	90	5
CHUM	western prince's pine	90	5
LIBOL	twinflower	75	23
ROGY	baldhip rose	75	4
SHCA	russet buffaloberry	70	7
BEAQ	Oregon grape	70	4
SYAL	common snowberry	65	3
SASC	Scouler willow	60	4
AMAL	serviceberry	60	4
VAME	big huckleberry	55	11
HERBS			
CARU	pinegrass	90	19
HIAL	white hawkweed	75	2
FRAGA	strawberry spp.	70	3
VIOR2	round-leaved violet	60	3

Figure 136. Photo of the PICO/SHCA Association.

and cool nights. Pinegrass is normally the most abundant herbaceous species and may form a dense sward. Other herbs are variable in constancy and cover.

Very hot conflagration fires or intensive land use such as farming appear to be the originating factors for the stands but repeated underburning may be important at least on some sites. Fire evidence in the form of snags, charred stumps, and charcoal and scarred trees is abundant. Some plots between Colville and Tiger have fire-scarred lodgepole pines with up to three scars on living trees. We speculate that relatively recent intense fires destroyed much of the soil organic materials and nutrients, as did farming. The frost-prone topography and relatively shallow soils further hinder plant succession such that potential climax tree species are slow to establish.

MANAGEMENT IMPLICATIONS

Frost from cold air concentrations is a major factor in reforestation. Ash soils are easily compacted and naturally compacted layers deeper in the profile are common. Most roots are concentrated in the ash influenced soil horizons and these should be protected from displacement and compaction. Organic matter and nutrient capitals should be protected by following the guidelines of Harvey *et al.*

(1987) with care. Harvest methods and/or intensive slash treatments that compact the soils, remove tree crowns or essential organic matter should be avoided.

Livestock favor the type because of gentle slopes and abundant grasses and herbs. Intense grazing leads to an increase in strawberries, dandelions and other weedy herbs. Recreation developments are common and the sites are relatively resistant to damage because only very hardy species remain on these sites. However, huckleberries are easily damaged by trampling in recreation areas.

COMPARISONS

The PICO/SHCA Community Type has not been previously described in the Pacific Northwest.

Shepherdia canadensis
russet buffaloberry

POTR ASSOCIATIONS

Populus tremuloides
quaking aspen

Quaking aspen is found on all districts of the Colville N.F. It is rarely a major landscape component, normally occurring in small clumps of a few acres or less in size; or as scattered trees in conifer dominated stands. In most cases, the majority of areas with quaking aspen have enough conifer regeneration to indicate eventual conifer dominance. These areas are treated as conifer forest. However, some sites contain little or no conifers and evidence of eventual conifer dominance is lacking. This is especially true with aspen communities in riparian areas such as wet, poorly-drained basins and around springs and seeps. At least some of these riparian sites appear to be successionally stable or climax quaking aspen stands. Riparian aspen community types and plant associations will be described in further detail in later studies. Preliminary descriptions are available from Kovalchik (1993). Two broad aspen communities are discussed in this classification; quaking aspen/pinegrass and quaking aspen/snowberry. There are no aspen plots established on the Colville N.F. and these descriptions are derived from Okanogan N.F. data (10 plots). Therefore, the descriptions are brief until further data is available for the Colville N.F.

POTR/SYAL ASSOCIATION HQS2 11

Populus tremuloides/Symphoricarpos albus
quaking aspen/common snowberry

DISTRIBUTION AND ENVIRONMENT

The POTR/SYAL Association is a minor type observed on the Colville N.F. The three plots representing the type are from the Okanogan N.F. It's distribution on the Colville N.F. is not well understood, but it is probably more common in areas supporting the Douglas-fir and Subalpine Fir Vegetation Zones. The limited data suggests the type occurs on sites ranging from the edge of marshes and wet meadows to drainage depressions to mesic mid- and lower-slopes. The three sample plots occurred on gentle (3-28%) slopes located on various aspects. Elevations ranged from 3800 to 4500 ft.

Soils have a deep humus layer derived from the dead aspen and snowberry leaves. Most of the root biomass is located in this rich organic "sponge" layer. The moist, fine-textured mineral soil is often high in organic matter. Available water holding capacity is high and soils may be seasonally saturated, particularly during spring.

VEGETATION

As presently defined, POTR/SYAL sites support a wide range of vegetation. Quaking aspen dominated all plots while a variety of conifers (PSME, PICO, LAOC, PIPO, ABLA2 and PIEN) were subordinant. One xero-riparian plot was dominated by common snowberry with a rich mix of moist-site herbs underneath. The single upland plot was dominated by both common snowberry and pinegrass. Douglas-fir appeared to be the indicated climax on most sites based on understory composition. The POTR/SYAL type will probably be refined into upland and riparian variants with further study and analysis.

Table 83. Common plants of the POTR/SYAL Association (n=3).

		CON	COVER
TREE OVERSTORY LAYER			
POTR	quaking aspen	100	77
PICO	lodgepole pine	82	10
LAOC	western larch	73	11
TREE UNDERSTORY LAYER			
POTR	quaking aspen	100	10
PSME	Douglas-fir	100	5
SHRUBS AND SUBSHRUBS			
SYAL	Common snowberry	100	34
AMAL	serviceberry	67	3
HERBS			
ACMI	yarrow	67	1
TAOF	dandelion	100	2
THOC	meadowrue	100	2

MANAGEMENT IMPLICATIONS

Wildlife/Range- Many POTR/SYAL stands are near perennial water sources and provide important habitat for beaver, various bird species and other wildlife (Kovalchik 1987, Thomas *et al.* 1979). Beaver activity in conjunction with browsing by ungulates can severely damage or eliminate aspen stands. Common flickers, black-capped chickadees, hairy woodpeckers, yellow-bellied sapsuckers and many other species of birds nest in aspen. Deer, and ocassionally elk and moose, are observed feeding and bedding in aspen stands. Deer frequently use aspen stands for fawning areas (Kovalchik 1987). Although small in area, aspen stands provide a critical source of diversity across the landscape and should be managed with emphasis on providing habitat for wildlife (Kovalchik 1987).

Although measured herbage production was low (21 lbs./acre), livestock can make considerable use of POTR/SYAL sites (Kovalchik 1987). The aspen suckers are readily eaten by livestock, which may prevent replacement of mature and dying trees. Snowberry is sensitive to trampling and its cover is drastically reduced in overgrazed allotments. Eventually, grazing may eliminate conifers as well as aspen and snowberry, converting such sites to herbaceous meadows.

Silviculture- Fire suppression has contributed to the conversion of aspen stands to conifers or meadows (Kovalchik 1987). Fire can be an important tool for stimulating aspen suckers and rejuvenating deteriorating stands. Protection from browsing may also be needed in order to enhance some decadent stands. Snowberry will resprout from stem bases following light to moderate-intensity fire.

Although many diseases affect aspen, relatively few kill or seriously injure living trees (Hinds 1985). Important fungal diseases of aspen leaves include black leaf spot, ink spot, shephards crook and other leaf rusts and powdery mildews. Many poorly understood viruses and systemic pathogens

Figure 137. Photo of the POTR/SYAL Association.

(mycoplasms, rickettsia, flagellates) also attack the leaves of aspen. Important decay fungi include tinder fungus, canker fungus and root and butt rots. The many bole cankers of aspen include sooty-bark canker, black canker and cytospora canker. Some defoliating insects include tent caterpillars, leaf miners and various leaf rollers.

COMPARISONS

Kovalchik (1987) describes a POTR/SYAL/ELGL Association in central Oregon that is similar to some of the wetter POTR/SYAL sites. It has been dewscribed on the Okanogan N.F. (Williams and Lillybridge 1983) and has been observed but not sampled on the Wenatchee N.F. in central Washington (Lillybridge *et al.* 1995).

POTR/CARU ASSOCIATION HQG1 11

Populus tremuloides/Calamagrostis rubescens
quaking aspen/pinegrass

DISTRIBUTION AND ENVIRONMENT

The POTR/CARU Association is a minor type on the Colville N.F. The seven plots representing the type are from the Okanogan N.F. The limited data suggests the type is found primarily on upland habitats. Stands were located on gentle slopes (11-31%) on south to west aspects. Elevations ranged from 4200 to 6200 ft.

Soils have a moderate humus layer derived from decaying aspen leaves and herbs. Many aspen and herb roots are concentrated in this layer. The moist mineral soil is often high in organic matter. Soil textures on the few soil pits ranged from silty clay to fine sandy loams over gravelly subsoils. Compacted subsoils often curtailed root growth as well as causing water retention near the soil surface.

VEGETATION

Plot data indicates a well-defined type with undergrowth vegetation similar to the PSME/CARU Association. Quaking aspen dominates the overstory and regeneration layers. Conifers are present in many stands and include (in order of importance) lodgepole pine, Douglas-fir and western larch. Some of these communities appear stable but others are apparently successional to the PSME/CARU or possibly ABLA2/CARU Associations. Shrubs are poorly represented except in early seral stages. Pinegrass dominates the herb layer. Other common herbs include California brome, blue wildrye, lupine spp. and western meadowrue.

Table 84. Common plants of the POTR/CARU Association (n=7).

		CON	COVER
TREE OVERSTORY LAYER			
POTR	quaking aspen	100	42
PICO	lodgepole pine	57	8
LAOC	western larch	73	11
TREE UNDERSTORY LAYER			
POTR	quaking aspen	86	13
SHRUBS AND SUBSHRUBS			
SHCA	russett buffaloberry	42	3
HERBS			
CARU	pinegrass	100	59
BRCA	California brome	57	2
LUPIN	lupine spp.	86	4
THOC	western meadowrue	86	15
ELGL	blue wildrye	42	9

MANAGEMENT IMPLICATIONS

Wildlife/Range- POTR/CARU stands provide important habitat for various birds and other wildlife species (Thomas *et al.* 1979). Common flickers, black-capped chickadees, hairy woodpeckers and yellow-bellied sapsuckers are a few of the bird species which nest in aspen stands. Deer and ocassionally, moose and elk, have been observed feeding and bedding in aspenstands. Deer frequently use aspen

Figure 138. Photo of the POTR/CARU Association.

stands for fawning areas (Kovalchik 1987). Although small in area, aspen provides a critical source of landscape diversity and should be managed with emphasis on providing habitat for wildlife (Kovalchik 1987).

Herbage production is considerably greater than virtually any other plant association described in this classification. Two plots averaged 1,212 lbs. of herbage per acre, and use by all classes of wild and domestic ungulates is high. Many stands have been heavily grazed, changing the understory dominance from pinegrass to species such as Kentucky bluegrass, blue wildrye and various native and introduced bromes and forbs. Overgrazing may eventually eliminate both aspens and conifers, converting sites to herbaceous meadows.

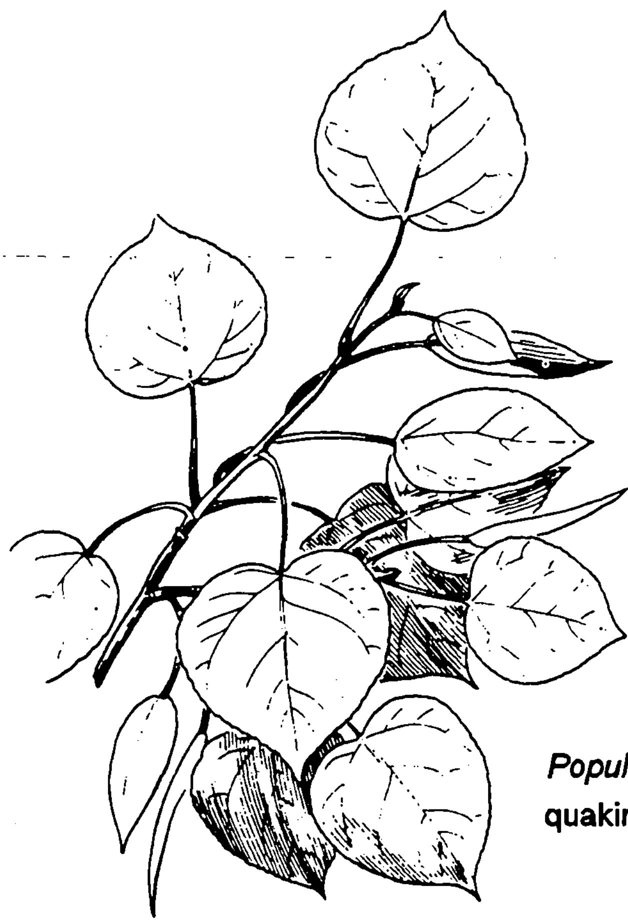
Silviculture- Growth rates and stocking appear moderate compared to POTR/SYAL. Two intensive plots had basal area averages of 130 sq. ft./acre, while site index values for western larch and lodgepole pine averaged 55 and 49 ft., respectively (50 year basis). Although conifers are present on many plots, succession to conifer climax appears to be very slow. Managers should consider the important ecological diversity provided by aspen groves when planning management activities for these stands. Clearcutting will favor aspen while partial cutting may favor conifer species (Kovalchik 1987). Cutting should not result in any significant increase in water tables on POTR/CARU sites.

The dense pinegrass sod will provide considerable competition with conifer regeneration, especially after clearcutting or in very open stands.

Fire suppression has contributed to the conversion of aspen stands to conifers or meadows (Kovalchik 1987). Fire can be an important tool for stimulating aspen suckers and rejuvenating deteriorating stands. Protection from browsing may also be needed for enhancement of aspen stands.

COMPARISONS

Similar POTR/CARU types have been described in the Intermountain Region (Mueggler 1988, Mueggler and Campbell 1982) and also for northcentral Washington (Williams and Lillybridge 1983). The POTR/CARU Association has been observed on the Wenatchee N.F. in central Washington and in parts of Montana.



Populus tremuloides
quaking aspen

PSME/ARUV ASSOCIATION CDG1 23

Pseudotsuga menziesii/Arctostaphylos uva-ursi

Douglas-fir/bearberry

DISTRIBUTION AND ENVIRONMENT

The PSME/ARUV Association is a minor type on the Colville N.F. and there are few plots representative of it. It was not described in the field version of this guide (Williams *et al.* 1990) but subsequent field observations and additional data analysis indicates that it deserves mentioning as an incidental type. The type is more common on the Okanogan N.F. than on the Colville N.F. It is most common on the Republic and Kettle Falls Ranger Districts, but may be found on the other ranger districts as well.

The PSME/ARUV Association characterizes west or south facing aspects on slopes steeper than 20%, usually with exposed rock or boulders. The type occurs on mid- to upper-slope positions or rocky ridgetops with moderate to steep slopes on warm aspects. Elevations usually range between 4,000 and 5,500 ft. Most sites have considerable surface rock exposed, and are generally convex in shape. Gentle slopes and glacial outwash terraces and terra•e sideslopes may key to the type but most of these sites seem best viewed as a warm-dry extension of the PSME/VACA Association.

Soils are formed in mixed glacial till and colluvium. Soils are effectively shallow usually with less than 20 in. (50 cm) of rooting depth with 30% or more gravels and cobbles in the profile. Some ash may be mixed in the upper horizons but the lower horizons are invariably high in rock content that limits root development.

VEGETATION

Typically these are open forest stands with a low growing undergrowth (Figure 139). Douglas-fir dominates mid to late seral and climax stands. Ponderosa pine, western larch and lodgepole pine are usually part of the tree sere and ponderosa pine and western larch may linger as relics for centuries. Lodgepole pine is shorter lived are rarely persists in the stands past 200 years. All of the mentioned tree species are capable of pioneering on these habitats, but only Douglas-fir is tolerant enough to persist in the absence of disturbances such as fire. Douglas-fir is the only significant regeneration species although any of the seral species may reproduce in openings.

The undergrowth is a mixture of prostrate shrubs, low-growing shrubs, grasses and forbs. Bearberry is the characteristic species and usually the dominant shrub component. Shiny-leaf spirea and pachistima are the other common shrubs. Pinegrass and northwestern sedge are the dominant herbaceous species. Grass and forb cover is often variable; apparently because of differences in soil depth, surface rock exposure and past grazing use. Other forbs may be abundant but seldom have any consistency between stands.

Figure 139. Photo of the PSME/ARUV Association.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Sites are often extensively grazed by domestic livestock and many areas are in old sheep driveways. We speculate that past abusive grazing may have altered sites that formerly supported the PSME/CARU or perhaps even the ABLA2/CARU Associations to PSME/ARUV conditions through soil erosion of fine-textured materials and consequent proportional increase in rock content of the remaining regolith. The type has value for wildlife because the exposed, upper elevation sites become snow-free early in the season and snow removal by wind reduces snow depths.

Silviculture- Growth rates tend to be slow and few trees attain diameters greater than 30 inches even after 200 or more years of growth. This may be due to landscape level fire patterns more than intrinsic environmental differences. Environmental extremes make tree regeneration difficult. Problems include large diurnal temperature range, strong pinegrass competition, droughty soil, rocky sites and winter kill by desiccation. In addition, many stands are near the upper elevation limits for the Douglas-fir Series and night time frost may be a problem. Young trees need shelter from excessive sun, high daytime soil temperatures and re-radiation frost at night. Expect severe regeneration problems on clearcuts. Broadcast burning may cause mortality to planted trees because blackened soil surfaces may raise temperatures at the soil surface to lethal levels. Sites are often so stony that planting of trees is very difficult or impossible. All of these factors made tree establishment difficult. Clearcuts may remain unforested for decades. Shelter is essential for regeneration, providing some type of protection from high insolation rates. As the forest canopy closes the sites become more suitable for Douglas-fir establishment. Dwarf mistletoe is common in Douglas-fir trees on these sites, as is western pine beetle on ponderosa pine. The presence of armillaria and laminated root rot is common, primarily infecting Douglas-fir.

Many mature trees greater than 10" DBH have charcoal on the bark and fire scars are common. Light underburns were probably common on this type under pre-settlement conditions. Upper slope sites are pre-disposed to lighting strikes and natural fire frequencies appear to have occurred on 5 to 20 year intervals. Most of the important undergrowth species are well adapted to frequent, light underburns. These adaptations usually include rapid resprouting combined with a rhizomatous growth habit. This combination allows a species to rapidly re-establish itself following fire. Snowbrush ceanothus is a common seral shrub after a fire or similar disturbance and may persist for decades even under a tree canopy because of the open nature of many stands. Russet buffaloberry is another nitrogen-fixing shrub that forms an important part of the sere after wildfire. Pinegrass is the major herb and responds vigorously to most disturbances and is especially well adapted to periodic underburning. Several of our plots also contain low huckleberry. These sites are all on south aspects and may reflect some environmental variation our data are inadequate to reflect.

COMPARISONS

Lillybridge *et al.* (1995) describe an PSME/ARUV/CARU Association which is nearly identical to the type described for the Colville N.F. Pfister *et al.* (1977) describe a PSME/ARUV Habitat Type for central Montana, but species composition and environmental conditions are different. Brayshaw (1965) in British Columbia describes a PSME-PIPO/ARUV association that appears comparable to ours. Most Canadian workers defined their associations more broadly than us so types are often not directly comparable. Daubenmire and Daubenmire (1968) in eastern Washington and northern Idaho, and Pfister *et al.* (1977) in Montana, Steele *et al.* (1981) in central Idaho, Cooper *et al.* (1991) in north Idaho and McLean (1970) in the southern interior of British Columbia all describe a PSME/CARU Habitat Type-Bearberry Phase following the pattern set by Daubenmire and Daubenmire (1968). However, some of these sites may better fit our PSME/VACA Association.

ACKNOWLEDGMENTS

Many people have contributed to this publication throughout the course of its development. Various Forest Supervisors and Forest Staff have supported this work from the beginning. At the present time they include E. Schultz and G. Buckingham. Additional acknowledgment is extended to R. Everett, Wenatchee Forestry Sciences Laboratory, for his professional support for publication. Especially significant for his professional contributions is Area I Ecologist J. Henderson. Many of his ideas and techniques have been incorporated into this publication. In addition, Area II Ecologist Bud Kovalchik deserves special acknowledgment for his professional and technical assistance in development of this publication. Many people have assisted the authors on field crews during the length of the project. They include T. Colvin, M. Fossum, D. Landolt, K. Larson, L. Martin, M. Mensor, S. Murphy, G. Olenik, J. Peterson, D. Shaw and M. Wendel. Special thanks to D. Larson, GIS Coordinator on the Colville National Forest, for his assistance with graphics development. P. Flanagan and J. Hadfield, Wenatchee Forestry Sciences Laboratory, assisted in the discussions concerning insects and disease. R. Lentz, Okanogan National Forest, assisted in the geology discussion. Special thanks is extended to J. Berube, F. Hall, M. Hemstrom, J. McGowan and J. Townsley for their review comments. Finally, special thanks to D. Thompson and K. Esterholdt, Pacific Northwest Research Station, for their assistance in design and publication details.

Line drawings of indicator species are reproduced with permission from Hitchcock, C.L.; Cronquist, A.; Ownbey, M.; and J.W. Thompson (1959-1969). Vascular Plants of the Pacific Northwest Vols. 1-5. University of Washington Press, Seattle, WA.

REFERENCES

Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Island Press. Washington, DC. 493 p.

Agee, J.K. 1994. Fire and weather disturbances in terrestrial ecosystems of the eastern Cascades. U.S.D.A. Forest Service, PNW-GTR-320. Pacific Northwest Research Station, Portland, OR. 52 p.

Alt, D.D.; and D.W. Hyndman. 1984. Roadside geology of Washington. Mountain Press Publishing Company. Missoula, MT. 282 p.

Amman, G.D. 1990. Bark beetle-fire associations in the greater Yellowstone area. *In*: Proceedings--Fire and the environment: ecological and cultural perspective. U.S.D.A. Forest Service, Gen. Tech. Rep. SE-69. Southeastern Forest Experiment Station, Asheville, NC: 313-320.

Anderson, H.E. 1968. Sundance Fire: an analysis of fire phenomenon. U.S.D.A. Forest Service, INT-56. Intermountain Forest and Range Experiment Station, Ogden, UT. 22 p.

Anderson, L.; Carlson, C.E.; and R.H. Wakimoto. 1987. Forest fire frequency and western spruce budworm outbreaks in western Montana. Forest Ecology and Management. 22: 251-260.

Aplet, G.; Laven, R.; and F. Smith. 1988. Patterns of community dynamics in Colorado Engelmann spruce-subalpine fir forests. Ecology. 69: 312-319.

Arno, S.F. 1980. Forest fire history in the northern Rockies. Journal of Forestry. 78 (8): 460-465.

Arno, S.F. 1986. Whitebark pine cone crops- a diminishing source of wildlife food. Western Journal of Applied Forestry. 1(3): 92-94.

Arno, S.F. 1988. Fire ecology and its management implications in ponderosa pine forests. *In*: Proceedings--Ponderosa pine: the species and its management. Washington State University Cooperative Extension, Pullman, WA: 133-139.

Arno, S.F.; Brown, J.; Carlson, C. [and others]1991. Maintaining forest health in the Blue Mountains: a strategy for fire's future role. Unpublished memo. U.S.D.A. Forest Service. December 6, 1991. 11 p.

Arno, S.F.; and D.H. Davis. 1980. Fire history of western redcedar/hemlock forests in northern Idaho. U.S.D.A. Forest Service, Gen. Tech. Rep. RM-81. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO: 21-26.

Arno, S.F.; and G.E. Gruell. 1986. Douglas-fir encroachment into mountain grasslands in southwestern Montana. Journal of Range Management. 39 (3): 272-275.

Arno, S.F.; and J.R. Habeck. 1972. Ecology of alpine larch in the Pacific Northwest. Ecological Monographs. 42: 417-450.

Arno, S.F.; Simmerman, D.G.; and R.E. Keane. 1985. Forest succession on four habitat types in western Montana. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-177. Intermountain Forest and Range Experiment Station, Ogden, UT. 74 p.

Atzet, T.; and L.A. McCrimmon. 1990. Preliminary plant associations of the southern Oregon Cascade Mountain Province [DRAFT]. U.S.D.A. Forest Service, Pacific Northwest Region, Siskiyou National Forest, Grants Pass, OR. 330 p.

Atzet, T.; and D. L. Wheeler. 1984. Preliminary plant associations of the Siskiyou Mountain Province [DRAFT]. U.S.D.A. Forest Service, Pacific Northwest Region, Siskiyou National Forest, Grants Pass, OR. 315 p.

Bakeless, J. (ed.). 1964. The Journals of Lewis and Clark. Mentor Book, New York. 384 p.

Barrett, J.W. 1978. Height growth and site index curves for managed, even-aged stands of ponderosa pine in the Pacific Northwest. U.S.D.A. Forest Service, Res. Pap. PNW-232. Pacific Northwest Forest and Range Experiment Station, Portland, OR.

Barrett, S.W. 1982. Fires influence on ecosystems of the Clearwater National Forest: Cook Mountain fire history inventory. U.S.D.A. Forest Service, Intermountain Region, Clearwater National Forest, Orofino, ID. 42 p.

Barrett, S.W.; and S.F. Arno. 1991. Classifying fire regimes and defining their topographic controls in the Selway-Bitterroot Wilderness. *In*: Proceedings--11th conference on fire and forest meteorology. Society of American Foresters, Bethesda, MD: 299-307.

Barrett, S.W.; Arno S.F.; and C.H. Key. 1991. Fire regimes of western larch-lodgepole pine forests in Glacier National Park, Montana. Canadian Journal of Forest Research. 21: 1711-1720.

Barrows, J.S. 1952. Forest fires in the northern Rocky Mountains. U.S.D.A. Forest Service, Paper 29. Northern Rocky Mountain Forest and Range Experiment Station, Missoula, MT. 251 p.

Batschlet, E. 1981. Circular statistics in biology. Academic Press. New York. 371 p.

Bell, M.A.M. 1964. Phytocoenoses in the dry subzone of the interior western hemlock zone of British Columbia. Ph.D. thesis, University of British Columbia. Vancouver, BC. 246 p.

Bell, M.A.M. 1965. The dry subzone of the interior western hemlock zone. In: Ecology of Western North America. V.J. Krajina (ed.). Vol. 1, University of British Columbia, Department of Botany. Vancouver, B.C: 42-64.

Bradley, A.F. 1984. Rhizome morphology, soil distribution, and the potential fire survival of eight woody understory species in western Montana. M.S. thesis. University of Montana Missoula, MT. 184 p.

Bradley, A.F.; Fischer, W.C.; and N.V. Noste. 1992. Fire ecology of the forest habitat types of eastern Idaho and western Wyoming. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-290. Intermountain Research Station, Ogden, UT. 92 p.

Brakke, M.B. 1991. Fire severity and early vegetation recovery in a *Pinus contorta/Abies lasiocarpa* community, Colville National Forest, Washington. M.S. thesis. Western Washington University, Bellingham, WA. 42 p.

Braumandl, T.F.; and M.P. Curran (eds.). 1992. A field guide for site identification and interpretation for the Nelson Forest Region. British Columbia Ministry of Forests, Nelson Forest Region, Nelson, BC. 311 p.

Brayshaw, T.C. 1965. The dry forest of southern British Columbia. *In*: Ecology of Western North America. V.J. Krajina (ed.). Vol. 1, University of British Columbia, Department of Botany. Vancouver, BC: 65-75.

Brickell, J.E. 1970. Equation and computer subroutines for estimating site quality of eight Rocky Mountain species. U.S.D.A. Forest Service, Res. Pap. INT-75. Intermountain Forest and Range Experiment Station, Ogden, UT. 35 p.

Burke, T.; and J. Nisbet. 1979. A checklist of birds of the Colville National Forest. Unpublished memo. On file with: U.S.D.A. Forest Service, Pacific Northwest Region, Colville National Forest, Colville, WA. 8 p.

Burns, R.M.; and B.H. Honkala. 1990. Silvics of North America, Vol. 1-Conifers. U.S.D.A. Forest Service, Agricultural Handbook 654. Washington, DC. 675 p.

Butzer, K.W. 1990. The Indian legacy in the American landscape. *In*: The making of the American landscape. Boston, MA: 27-50.

Byler, J.W.; Marsden, M.A.; and S.K. Hagle. 1990. The probability of root diseases on the Lolo National Forest, Montana. Canadian Journal of Forestry Research. 20: 987-994.

Cajander, A.K. 1926. The theory of forest types. Acta Forestalia Fennica 29: 1-108.

Chonka, J. 1986. Red Mountain mistletoe control: prescribed burn plan. Unpublished paper. U.S.D.A. Forest Service, Intermountain Region, Uncompahgre and Gunnison National Forests, Taylor River Ranger District.

Christensen, N.L. 1988. Succession and natural disturbance: paradigms, problems, and preservation of natural ecosystems. *In*: Ecosystem Management for Parks and Wilderness. University of Washington Press. Seattle, WA: 62-86.

Clausnitzer, R.R. 1994. The grand fir series in northeastern Oregon and southeastern Washington: successional stages and management guide. U.S.D.A. Forest Service, R6-ECOL-TP-050-93. Pacific Northwest Region, Portland, OR. 193 p.

Clausnitzer, R.R.; and B.A. Zamora. 1987. Forest habitat types of the Colville Indian Reservation. Agriculture Research Center, Publ. No. MISC0110. Washington State University, Pullman, WA. 110 p.

Clayton, J.; Kellog, G.; and N. Forrester. 1987. Soil disturbance-tree growth relations in central Idaho clearcuts. U.S.D.A. Forest Service, Res. Note INT-372. Intermountain Experiment Station, Ogden, UT. 6 p.

Cleary, B.D.; Greaves, R.D.; and R.K. Hermann. 1978. Regenerating Oregon's Forests. Oregon State University Extension Service. Corvallis, OR. 286 p.

Clendenen, C.W. 1977. Base-age conversion and site index equations for Engelmann spruce stands in the central and southern Rocky Mountains. U.S.D.A. Forest Service, Res. Note INT-223. Intermountain Forest and Range Experiment Station, Ogden, UT. 6 p.

Cochran, P.H. 1979. Gross yields for even-aged stands of Douglas-fir and white or grand fir east of the Cascades in Oregon and Washington. U.S.D.A. Forest Service, Res. Pap. PNW-263. Pacific Northwest Forest and Range Experiment Station, Portland, OR. 17 p.

Cochran, P.H.; and W.E. Hopkins. 1991. Does fire exclusion increase productivity of ponderosa pine? U.S.D.A. Forest Service, Gen. Tech. Rep. INT-280. Intermountain Research Station, Ogden, UT: 224-228.

Cooper, S.V., Neiman, K.E.; Steele, R.; and D.W. Roberts. 1991. Forest habitat types of northern Idaho--a second approximation. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-236. Intermountain Research Station, Ogden, UT. 143 p.

Cottam, G.; and R.P. McIntosh. 1966. (Reply to Daubenmire 1966) Science. 152: 546-547.

Crane, M.F. 1991. *Abies grandis*. *In*: The fire effects information system (data base). U.S.D.A. Forest Service. Intermountain Fire Sciences Laboratory, Missoula, MT.

Crane, M.F.; and W.C. Fisher. 1986. Fire ecology of the forest habitat types of central Idaho. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-218. Intermountain Research Station, Ogden, UT. 86 p.

Crane, M.F.; and J.R. Habeck. 1982. Vegetative responses after a severe wildfire on a Douglas-fir/ninebark habitat type. *In*: Proceedings--Site preparation and fuels management on steep terrain. Washington State University Cooperative Extension, Pullman, WA: 133-138.

Crane, M.F.; Habeck, J.R.; and W.C. Fischer. 1983. Early postfire revegetation in a western Montana Douglas-fir forest. U.S.D.A. Forest Service, Research Paper INT-319. Intermountain Forest and Range Experiment Station, Ogden, UT. 29 p.

Crowe, E.A.; and R.R. Clausnitzer. 1995. Mid-montane wetlands classification of the Malheur, Umatilla, and Wallowa-Whitman National Forests [DRAFT]. U.S.D.A. Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest, Baker, OR. 188 p.

Daubenmire, R. 1960. An experimental study of variation in the *Agropyron spicatum-A. inerme* complex. Botanical Gazette. 122: 104-108.

Daubenmire, R. 1961. Vegetative indicators of rate of height growth in ponderosa pine. Forest Science. 7: 24-34.

Daubenmire, R. 1966. Vegetation: identification of typal communities. Science. 151: 291-298.

Daubenmire, R. 1968. Plant Communities. Harper & Row, NY. 300 p.

Daubenmire, R. 1975. Floristic plant geography of eastern Washington and northern Idaho. Journal of Biogeography. 2: 1-18.

Daubenmire, R. 1976. The use of vegetation in assessing the productivity of forest lands. Botanical Review 42 (2): 115-143.

Daubenmire, R. 1978. Plant Geography with Special Reference to North America. Academic Press. 338 p.

Daubenmire, R. 1981. The scientific basis for a classification system in land-use allocation. *In*: Proceedings--Land-use allocation: processes, people, politics, professionals. Society of American Foresters, Spokane, WA: 159-162.

Daubenmire, R. 1989. The roots of a concept. *In*: Proceedings--Land classification based on vegetation: applications for resource management. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-257. Intermountain Research Station, Ogden, UT. 315 p.

Daubenmire, R.; and J. Daubenmire. 1968. Forest vegetation of eastern Washington and northern Idaho. Technical Bulletin 60, Washington Agricultural Experiment Station, Pullman, WA. 104 p.

DeByle, N.V. 1981. Clearcutting and fire in the larch/Douglas-fir forests of western Montana, a multi-faceted research summary. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-99. Intermountain Forest and Range Experiment Station, Ogden, UT. 73 p.

Driscoll, R.S.; Merkel, D.L.; Radloff, D.L.; Synder, D.E.; and J.S. Hagihara. 1984. An ecological land classification framework for the United States. U.S.D.A. Forest Service, Misc. Publ. 1439, Washington, DC.

Easterbrook, D.J.; and D.A. Rahm. 1970. Landforms of Washington. Union Printing Co., Bellingham, WA. 156 p.

Fahnestock, G.R. 1976. Fires, fuel, and flora as factors in wilderness management: the Pasayten case. Proceedings--15th annual Tall Timbers fire ecology conference: 33-70.

Fellin, D.G.; and P.C. Kennedy. 1972. Abundance of arthropods inhabiting duff and soil after prescribed burning on forest clearcuts in northern Idaho. U.S.D.A. Forest Service, Res. Note INT-162. Intermountain Forest and Range Experiment Station, Ogden, UT. 8 p.

Ferguson, D.E.; and R.J. Boyd. 1988. Bracken fern inhibition of conifer regeneration in northern Idaho. U.S.D.A. Forest Service, Res. Pap. INT-388. Intermountain Research Station, Ogden, UT. 11 p.

Ferguson, D.E.; Stage, A.R.; and R.J. Boyd. 1986. Predicting regeneration in the grand fir-cedar-hemlock ecosystem of the northern Rocky Mountains. Forest Science Monograph 26. Society of American Foresters, Washington, DC. 41 p.

Fiedler, C.E. 1980. Analysis of regeneration in the subalpine fir zone of western Montana. Manuscript on file. U.S.D.A. Forest Service, Forestry Sciences Laboratory, Bozeman, MT. 64 p.

Fiedler, C.E. 1982. Regeneration of clearcuts within four habitat types in western Montana. *In*: Proceedings--Site preparation and fuels management on steep terrain. Washington State University Cooperative Extension, Pullman, WA: 139-147.

Filip, G.M.; Aho, P.E.; and M.R. Wiitala. 1983. Indian paint fungus: a method of recognizing and reducing hazard in advanced grand fir and white fir regeneration in eastern Oregon and Washington. U.S.D.A. Forest Service, Pacific Northwest Region, Portland, OR. 24 p.

Finch, R.B. 1984. Fire history of selected sites on the Okanogan National Forest. U.S.D.A. Forest Service, Pacific Northwest Region, Okanogan National Forest, Okanogan, WA. 22 p.

Fisher, W.C.; and A.F. Bradley. 1987. Fire ecology of western Montana habitat types. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-223. Intermountain Research Station, Ogden, UT. 95 p.

Flanagan, P.; and J. Hadfield. 1995. Unpublished memo. On file with: U.S.D.A. Forest Service, Pacific Northwest Region, Colville National Forest, Colville, WA. 7 p.

Franklin, J.F.; and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. U.S.D.A. Forest Service, Gen. Tech. Rep. PNW-8. Pacific Northwest Range and Experiment Station., Portland, OR. 417 p.

Franklin, J.F.; Dyrness, C.T.; and W.H. Moir. 1970. A reconnaissance method of forest site classification. Shrinrin Richi. 12: 1-14.

Franklin, J.F.; Moir, W.H.; Hemstrom, M.A.; Greene, S.E.; and B.G. Smith. 1988. The Forest communities of Mount Rainier National Park. U.S. Dept. Interior, National Park Service, Monograph Series 19. Washington, DC. 194 p.

Gabriel, H.W.; and S.S. Talbot. 1984. Glossary of landcape and vegetation ecology for Alaska. U.S. Dept. Interior, Bureau of Land Management, BLM-Alaska Tech. Rep. 10. 132 p.

Gannett, H. 1902. The forests of Oregon. U.S. Dept. of Interior, Geological Survey, Prof. Pap. 4, Series H, Forestry, 1. Washington, DC. 42 p.

Garrison, G.A.; Skovlin, J.M.; Poulton, C.E.; and A.H. Winward. 1976. Northwest range plant names and symbols for ecosystem inventory and analysis. 4th ed. U.S.D.A. Forest Service, Gen. Tech. Rep. PNW-46. Pacific Northwest Forest and Range Experiment Station, Portland, OR. 263 p.

Gast, W.R.; Jr., Scott, D.W.; Schmitt, C. [and others}. 1991. Blue Mountains forest health report: new perspectives in forest health. U.S.D.A. Forest Service, Malheur, Umatilla, and Wallowa-Whitman National Forests, Pacific Northwest Region, Portland, OR.

Geier-Hayes, K. 1989. Vegetation response to helicopter logging and broadcast burning in Douglas-fir habitat types at Silver Creek, central Idaho. U.S.D.A. Forest Service, Res. Pap. INT-405. Intermountain Research Station, Ogden, UT. 24 p.

Gorman, M.W. 1899. Eastern part of the Washington forest reserve. U.S. Dept. of Interior, Geological Survey, 19th Annual Report, Pt. 5. Washington, DC: 315-350.

Grier, C.C. 1989. Effects of prescribed springtime underburning on production and nutrient status of a young ponderosa pine stand. *In*: Proceedings--Multiresource management of ponderosa pine forests. U.S.D.A. Forest Service, Gen. Tech. Rep. RM-185. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO: 71-76.

Gruell, G.E. 1983. Fire and vegetative trends in the northern Rockies: interpretations from 1871-1982 photographs. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-158. Intermountain Research Station, Ogden, UT.

Gruell, G.E.; Brown, J.K.; and C.L. Bushey. 1986. Prescribed fire opportunities in grasslands invaded by Douglas-fir: state-of-the-art guidelines. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-198. Intermountain Research Station, Ogden, UT. 19 p.

Hagel, S.K.; McDonald, G.I.; and E.A. Norby. 1989. White pine blister rust in northern Idaho and western Montana: alternatives for integrated management. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-261. Intermountain Research Station, Ogden, UT. 35 p.

Hall, F.C. 1967. Vegetation-soil relations as a basis for resource management on the Ochoco National Forest of central Oregon. Ph.D. thesis. Oregon State University, Corvallis, OR. 207 p.

Hall, F.C. 1973. Plant communities of the Blue Mountains in eastern Oregon and southeastern Washington. U.S.D.A. Forest Service, Area Guide 3-1, Pacific Northwest Region, Portland, OR. 62 p.

Hall, F.C. 1976. Fire and vegetation in the Blue Mountains- implications for land managers. In: Proceedings--15th annual Tall Timbers fire ecology conference: 155-170.

Hall, F.C. 1983. Personal communication.

Hall, F.C. 1983. Growth basal area: a field method for appraising forest site potential for stockability. Canadian Journal of Forest Research 13 (1): 70-77.

Hansen, H.P. 1947. Post-glacial forest succession, climate and chronology in the Pacific Northwest. Transactions of the American Philosophical Society 37: 1-130.

Harvey, A.E. 1982. The importance of residual organic debris in site preparation and amelioration for reforestation. *In*: Proceedings--Site preparation and fuels management on steep terrain. Washington State University Cooperative Extension, Pullman, WA: 75-85.

Harvey, A.E.; Jurgensen, M.F.; Larson, M.J.; and R.T. Graham. 1987. Decaying organic materials and soil quality in the inland northwest: a management opportunity. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-225. Intermountain Research Station, Ogden, UT. 15 p.

Harvey, Jr., R.D.; and P.F. Hessburg. 1992. Long-range planning for developed sites in the Pacific Northwest: the context of hazard tree management. U.S.D.A. Forest Service, FPM-TP039-92. Pacific Northwest Region, Portland, OR. 120 p.

Hegyi, F.; Jelinek, J.J.; Viszlai, J.; and D.B. Carpenter. 1979. Site index equation and curves for the major tree species in British Columbia. British Columbia Ministry of Forests, Forest Inventory Rept. No. 1. Victoria, BC.

Heidmann, L.J. 1988. Regeneration strategies for ponderosa pine. *In*: Proceedings--Ponderosa pine-the species and its management. Washington State University Cooperative Extension, Pullman, WA: 227-233.

Hemstrom, M.A.; Halverson, N.M.; Logan, S.E.; and C. Topik. 1982. Plant association and management guide for the Pacific silver fir zone, Mt. Hood and Willamette National Forests. U.S.D.A. Forest Service, R6-ECOL-1982a. Pacific Northwest Region, Portland, OR. 104 p.

Henderson, J.A., Lesher, R.D.; Peter, D.H.; and D.C. Shaw. 1992. Field guide to the forested plant associations of the Mt. Baker-Snoqualmie National Forest. U.S.D.A. Forest Service, R6-ECOL-TP-028-91. Pacific Northwest Region, Portland, OR. 196 p.

Henderson, J.A.; Peter, D.H.; Lesher, R.D.; and D.C. Shaw. 1989. Forested plant associations of the Olympic National Forest. U.S.D.A. Forest Service, R6-ECOL-TP-001-88. Pacific Northwest Region, Portland, OR. 502 p.

Hessburg, P.; and P. Flanagan. 1991. Forest health on the Colville National Forest--an analysis of the current management situation. Unpublished memo [DRAFT]. On file at: U.S.D.A. Forest Service, Pacific Northwest Region, Forestry Sciences Laboratory, Wenatchee, WA. 25 p.

Hill, M.O. 1979a. DECORANA-a FORTRAN program for detrended correspondence analysis and reciprocal averaging. Cornell University, Ithaca, NY.

Hill, M.O. 1979b. TWINSPAN-A FORTRAN Program for Arranging Multivariate Data in an Ordered Two-Way Table by Classification of the Individuals and Attributes. Cornell University, Ithaca, NY.

Hinds, T.E. 1985. Diseases. *In*: Aspen: ecology and management in the western United States (DeByle, N.V.; and R.P. Winokur, eds.). U.S.D.A. Forest Service, Gen. Tech. Rep. RM-119. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO: 87-114.

Hitchcock, C.L.; and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press. Seattle, WA. 730 p.

Hitchcock, C.L.; Cronquist, A.; Owenby, M.; and J.W. Thompson. 1955-69. Vascular plants of the Pacific Northwest, Parts 1-5. University of Washington Press, Seattle, WA.

Hoffman, G.R.; and R.R. Alexander. 1976. Forest vegetation of the Bighorn Mountains, Wyoming: a habitat type classification. U.S.D.A. Forest Service, Res. Pap. RM-170. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 38 p.

Hopkins, W.A. 1979a. Plant associations of the Fremont National Forest. U.S.D.A. Forest Service, R6-ECOL-79-004. Pacific Northwest Region, Portland, OR. 106 p.

Hopkins, W.A. 1979b. Plant associations of south Chiloquin and Klamath Ranger Districts, Winema National Forest. U.S.D.A. Forest Service, R6-ECOL-79-005. Pacific Northwest Region, Portland, OR. 96 p.

Hungerford, R.D.; Harrington, M.G.; Frandsen, W.H.; Ryan, K.C.; and G.J. Niehoff. 1991. Influence of fire on factors that affect site productivity. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-280. Intermountain Research Station, Ogden, UT: 32-50.

Hutchins, H.E. 1994. Roles of various animals in dispersal and establishment of whitebark pine in the Rocky Mountains, U.S.A. *In*: Proceedings--International workshop on subalpine stone pines and their environment: the status of our knowledge. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-GTR-309. Intermountain Research Station, Ogden, UT: 163-171.

Irwin, L.L.; and J.M. Peek. 1979. Shrub production and biomass trends following five logging treatments within the cedar-hemlock zone of northern Idaho. Forest Science 25 (3): 415-426.

Johnson, C.G.; and S. Simon. 1987. Plant associations of the Wallowa-Snake Province. U.S.D.A. Forest Service, R6-ECOL-TP-225a-86. Pacific Northwest Region, Portland, OR. 399 p.

Johnson, C.G.; and R.R. Clausnitzer. 1992. Plant associations of the Blue and Ochoco Mountains. U.S.D.A. Forest Service, R6-ERW-TP-036-92. Pacific Northwest Region, Portland, OR. 208 p.

Keane, R.E.; and S.F. Arno. 1993. Rapid decline of whitebark pine in western Montana: evidence from 20-year measurements. Western Journal of Applied Forestry 8 (2): 44-47.

Keane, R.E.; Arno S.F.; and J.K. Brown. 1990. Simulating cumulative fire effects in ponderosa pine/Douglas-fir forests. Ecology 71 (1): 189-203.

Kemp, W.P.; Everson, D.O.; and W.G. Wellington. 1985. Regional climatic patterns and western spruce budworm outbreaks. U.S.D.A. Forest Service, Tech. Bull. 1693. Washington, DC. 31 p.

Kendall, K.C. 1994. Whitebark pine conservation in North American national parks. *In*: Proceedings--International workshop on subalpine stone pines and their environment: the status of our knowledge. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-GTR-309. Intermountain Research Station, Ogden, UT: 302-307.

Kendall, K.C.; and S.F. Arno. 1990. Whitebark pine- an important but endangered wildlife resource. *In*: Symposium on whitebark pine ecosystems: ecology and management of a high-mountain resource. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-270. Intermountain Research Station, Ogden, UT: 264-274.

Kingery, J.; Graham, R.; and J. White. 1987. Damage to first-year conifers under three livestock grazing intensities in Idaho. U.S.D.A. Forest Service, Res. Pap. INT-376. Intermountain Research Station, Ogden, UT. 8 p.

Knapp, A.K.; and W.K. Smith. 1982 Factors influencing understory seedling establishment of Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) in southeast Wyoming. Canadian Journal of Botany. 60: 2753-2761.

Knapp, W.A. 1981. Using Reineke's stand density index to estimate growth capability. U.S.D.A. Forest Service, in-house paper on file. Pacific Northwest Region, Portland, OR. 6 p.

Koehler, G.M.; and M.G. Hornocker. 1977. Fire effects on martin habitat in the Selway-Bitterroot Wilderness. Journal of Wildlife Management 41: 500-505.

Kovalchik, B.L. 1987. Riparian zone associations, Deschutes, Ochoco, Fremont, and Winema National Forests. U.S.D.A. Forest Service, R6 ECOL-TP-279-87. Pacific Northwest Region, Portland, OR. 171 p.

Kovalchik, B.L. 1993. Riparian plant associations on the National Forests of eastern Washington [DRAFT]. U.S.D.A. Forest Service, Pacific Northwest Region, Colville National Forest, Colville, WA. 202 p.

Kramer, N.B. 1984. Mature forest seed banks on three habitat types in central Idaho. Unpublished Masters Thesis. University of Idaho, Moscow, ID. 107 p.

Kuchler, A.W. 1964. Manual to accompany the map of potential natural vegetation of the conterminous United States. American Geographical Society Special Publication 36, various paging.

Larsen, J.A. 1922. Effect of removal of the virgin whitepine stand upon the physical factors of the site. Ecology 3 (4): 302-305.

Layser, E.F. 1974. Vegetation classification: its application to forestry in the northern Rocky Mountains. Journal of Forestry 72: 354-357.

Lillybridge, T.R.; Kovalchik, B.L.; Williams, C.K.; and B.G. Smith. 1995. Forested plant associations of the Wenatchee National Forest [DRAFT]. U.S.D.A. Forest Service, Pacific Northwest Region, Wenatchee National Forest, Wenatchee, WA. 352 p.

Lincoln, R.J.; Boxshall, G.A.; and P.F. Clark. 1982. A dictionary of ecology, evolution and systematics. Cambridge University Press. Cambridge, England. 298 p.

Lloyd, D.; Angove, K.; Hope, G.; and C. Thompson. 1990. A guide to site identification and interpretation for the Kamloops Forest Region. British Columbia Ministry of Forests, Kamloops Forest Region, Kamloops, BC. 399 p.

Lotan, J. E.; Alexander, M.E.; Arno, S.F. [and others]. 1981. Effects of fire on flora: a state-of-knowledge review. U.S.D.A. Forest Service, Gen. Tech. Rep. WO-16. Washington, DC. 71 p.

Lyon, L.J. 1984. The Sleeping Child Burn- 21 years of postfire change. Gen. Tech. Rep. INT-330. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-330. Intermountain Research Station, Ogden, UT. 17 p.

Lyon, L.J.; and P.F. Stickney. 1976. Early vegetal succession following large northern Rocky Mountain wildfires. *In*: Proceedings of Montana Tall Timbers fire ecology conference and fire and land management symposium 14: 355-375.

Mack, R.N.; Rutter, N.W.; Bryant, V.M.; and S. Valastro. 1978a. Late quaternary pollen record from Big Meadow, Pend Oreille County, Washington. Ecology 59 (5): 956-966.

Mack, R.N.; Rutter, N.W.; and S. Valastro. 1978b. Late quaternary pollen record from the Sanpoil Valley, Washington. Canadian Journal of Botany 56: 1642-1650.

McDonald, G.; Martin, N.; and A. Harvey. 1987a. *Armillaria* in the northern Rockies: pathogenicity and host susceptibility on pristine and disturbed sites. U.S.D.A. Forest Service, Res. Note INT-371. Intermountain Research Station, Ogden, UT. 5 p.

McDonald, G.; Martin, N.; and A. Harvey. 1987b. Occurrence of *Armillaria* spp. in forests of the northern Rocky Mountains. U.S.D.A. Forest Service, Res. Note INT-381. Intermountain Research Station, Ogden, UT. 5 p.

McKee, B. 1972. Cascadia- The geologic evolution of the Pacific Northwest. McGraw-Hill Book Company. 394 p.

McLean, A. 1969. Fire resistance of forest species as influenced by root systems. Journal of Range Management. 22 (2): 120-122.

McLean, A. 1970. Plant communities of the Similkameen Valley, British Columbia and their relationships to soils. Ecological Monographs. 40 (4): 403-424.

Meidinger, D.; and J. Pojar (eds.). 1991. Ecosystems of British Columbia. B.C. Ministry of Forests, Vancouver, BC. 330 p.

Miller, M. 1977. Response of blue huckleberry to prescribed fires in a western Montana larch-fir forest. U.S.D.A. Forest Service, Research Paper INT-188. Intermountain Forest and Range Experiment Station, Ogden, UT. 33 p.

Minore, D. 1979. Comparative autecological characteristics of northwestern tree species: a literature review. U.S.D.A. Forest Service, Gen Tech. Rep. PNW-87. Pacific Northwest Forest and Range Experiment Station, Portland, OR. 72 p.

Moeur, M. 1992. Baseline demographics of late successional western hemlock/western redcedar stands in northern Idaho Research Natural Areas. U.S.D.A. Forest Service, Res. Pap. INT-456. Intermountain Research Station, Ogden, UT. 16 p.

Moeur, M. 1994. Spatial pattern development in old-growth cedar/hemlock forests. *In*: Proceedings--Interior cedar-hemlock-whitepine forests: ecology and management. Washington State University Cooperative Extension, Pullman, WA: 57-68.

Monserud, R.A. 1985. Comparison of Douglas-fir site index and height growth curves in the Pacific Northwest. Canadian Journal of Forest Research 15: 673-679.

Morgan, P.; and S.C. Bunting. 1990. Fire effects in whitebark pine forests. *In*: Symposium on whitebark pine ecosystems: ecology and management of a high-mountain resource. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-270. Intermountain Forest and Range Experiment Station, Ogden, UT: 166-170.

Morgan, P.; and L.F. Neuenschwander. 1988. Shrub response to high and low severity burns following clearcutting in northern Idaho. Western Journal of Applied Forestry 3 (1): 5-9.

Morris, W. (ed.) 1976. The American Heritage dictionary of the English language. Houghton Mifflin Co., Boston, MA. 1550 p.

Mueggler, W.F. 1965. Ecology of seral shrub communities in the cedar-hemlock zone of northern Idaho. Ecological Monographs 35: 165-185.

Mueggler, W.F. 1988. Aspen community types of the Intermountain Region. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-250. Intermountain Research Station, Ogden, UT. 135 p.

Mueggler, W.F.; and Campbell, R.B., Jr. 1982. Aspen community types on the Caribou and Targhee National Forests in southeastern Idaho. U.S.D.A. Forest Service, Research Paper INT-294. Intermountain Forest and Range Experiment Station, Ogden, UT. 32 p.

Mueggler, W.F.; and W.L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-66. Intermountain Forest and Range Experiment Station, Ogden, UT. 154 p.

Mueller-Dombois, D.; and H. Ellenburg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, NY. 547 p.

Mutch, R.W.; Arno, S.F.; Brown, J.K.; Carlson, C.E.; Ottmar, R.D.; and J.L. Peterson. 1993. Forest health in the Blue Mountains: a management strategy for fire-adapted ecosystems. U.S.D.A. Forest Service, Gen. Tech. Rep. PNW-GTR-310. Pacific Northwest Research Station, Portland, OR. 14 p.

Noste, N.V. 1985. Influence of fire severity on response of evergreen ceanothus. U.S.D.A. Forest Service, Res. Note INT-381. Intermountain Research Station, Ogden, UT: 91-96.

Noste, N.V.; and C.L. Bushey. 1987. Fire response of shrubs of dry forest habitat types in Montana and Idaho. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-239. Intermountain Research Station, Ogden, UT. 22 p.

Ogilvie, R.T. 1962. Ecology of spruce forests of the east slope of the Rocky Mountains in Alberta. Ph.D. dissertation. Washington State University, Pullman, WA. 189 p.

Page-Dumroese, D.S. 1993. Susceptibility of volcanic ash-influenced soil in northern Idaho to mechanical compaction. U.S.D.A. Forest Service, Res. Note INT-409. Intermountain Research Station, Ogden, UT. 5 p.

Page-Dumroese, D.S.; Jurgensen, M.; and A. Harvey. 1994. Relationships among woody residues, soil organic matter, and ectomycorrhizae in the cedar-hemlock ecosystem. *In*: Proceedings--Interior cedar-hemlock-whitepine forests: ecology and management. Washington State University Cooperative Extension, Pullman, WA: 85-90.

Pfister, R.D. 1989. Basic concepts of using vegetation to build a site classification system. *In*: Proceedings--Land classification based on vegetation: applications for resource management. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-257. Intermountain Research Station, Ogden, UT. 315 p.

Pfister, R.D.; Kovalchik, B.L.; Arno, S.F.; and R.C. Presby. 1977. Forest habitat types of Montana. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-34. Intermountain Forest and Range Experiment Station, Ogden, UT. 174 p.

Phillips, E.L.; and D.C. Durkee. 1972. Washington climate for the counties Ferry, Pend Oreille, and Stevens. Washington State University Cooperative Extension Service Bull. EM-3554, Pullman, WA. 63 p.

Pielou, E.C. 1991. After the Ice Age. The University of Chicago Press, Chicago and London. 366 p.

Public Land Law Review Commission. 1970. One third of the nation's land. U.S. Govt. Printing Office, Washington, DC. 342 p.

Pyke, D.A.; and B.A. Zamora. 1982. Relationships between overstory structure and understory production in the grand fir/myrtle boxwood habitat type of northcentral Idaho. Journal of Range Management 35 (6): 769-773.

Reed, R.M. 1969. A study of vegetation in the Wind River Mountains, Wyoming. Unpublished Ph.D. thesis. Washington State University, Pullman, WA. 77 p.

Reed, R.M. 1976. Coniferous forest habitat types of the Wind River Mountains, Wyoming. American Midland Naturalist 95 (1): 159-173.

Reineke, L.H. 1933. Perfecting a stand-density index for even-aged forests. Journal of Agricultural Research 16: 627-628.

Richmond, G.M.; Fryxell, R.; Neff, G.E.; and P.L. Weis. 1965. The Cordilleran ice sheet of the northern Rocky Mountains, and related Quaternary history of the Columbia Plateau. *In*: The Quaternary of the United States. H.E. Wright, Jr. and D.G. Frey (eds.). Princeton University Press, Princeton, NJ: 231-242.

Rowe, J.S. 1983. Concepts of fire effects on plant individuals and species. *In*: The Role of Fire in Circumpolar Regions. Scope 18 Series. John Wiley and Sons. 135-154.

Rummel, R.S. 1951. Some effects of livestock grazing on ponderosa pine forest and range in central Washington. Ecology 32 (4): 594-607.

Ryan, K.; and N.V. Noste. 1985. Evaluating prescribed fire. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-182. Intermountain Research Station, Ogden, UT: 230-238.

Ryker, R.; and J. Losensky. 1983. Ponderosa pine and Rocky Mountain Douglas-fir. *In*: Silvicultural sytems for the major forest types of the United States. U.S.D.A. Forest Service, Agricultural Handbook 445. Washington, DC: 53-55.

Schimpf, D.; Henderson J.; and J. MacMahon. 1980. Some aspects of succession in the spruce-fir forest zone of northern Utah. The Great Basin Naturalist 40: 1-26.

Schmid, J.M.; and T.E. Hinds. 1974. Development of spruce-fir stands following spruce beetle outbreaks. U.S.D.A. Forest Service, Res. Pap. RM-131. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 16 p.

Schmitt, C.L. 1994. Forest tree diseases. U.S.D.A. Forest Service, Unpublished manuscript. On file at: U.S.D.A. Forest Service, Blue Mountains Pest Management Zone. La Grande Forestry Sciences Laboratory, La Grande, OR.

Shearer, R.C.; and P.F. Stickney. 1991. Natural revegetation of burned and unburned clearcuts in western larch forests of northwest Montana. *In*: Proceedings--Fire and the environment: ecological and cultural perspectives. U.S.D.A. Forest Service, Gen. Tech. Rep. SE-69, Southeastern Forest Experiment Station, Ashville, NC: 66-74.

Simmerman, D.G.; Arno, S.F.; Harrington, M.G.; and R.T. Graham. 1991. A comparison of dry and moist fuel underburns in ponderosa pine shelterwood units in Idaho. *In*: Proceedings--11th Conference on fire and forest meteorology. Society of American Foresters, Bethesda, MD: 387-397.

Simpson, M.L. 1990. The subalpine fir/beargrass habitat type: succession and management. M.S. thesis. University of Idaho, Moscow, ID. 134 p.

Slater, J.R. 1963. Distribution of Washington reptiles. Occasional Paper 24. University of Puget Sound, Tacoma, WA: 212-233.

Slater, J.R. 1964. County records of amphibians for Washington. Occasional Paper 26. University of Puget Sound, Tacoma, WA: 237-242.

Smith, J.K.; and W.C. Fischer. 1995. Fire ecology of the forest habitat types of northern Idaho [REVIEW DRAFT]. U.S.D.A. Forest Service, Intermountain Research Station, Ogden, UT.

Staebler, G.R. 1956. Evidence of shock following thinning of young Douglas-fir. Journal of Forestry 54 (5): 339.

Steele, R., Arno, S.F.; and K. Geier-Hayes. 1986. Wildfire patterns change in central Idaho's ponderosa pine-Douglas-fir forest. Western Journal of Applied Forestry 1(1): 16-18.

Steele, R.; and K. Geier-Hayes. 1987. The Douglas-fir/blue huckleberry habitat type in central Idaho: succession and management. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-228. Intermountain Research Station, Ogden, UT. 66 p.

Steele, R.; and K. Geier-Hayes. 1989. The Douglas-fir/ninebark habitat type in central Idaho: succession and management. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-252. Intermountain Research Station, Ogden, UT. 65 p.

Steele, R.; and K. Geier-Hayes. 1993. The Douglas-fir/pinegrass habitat type in central Idaho: succession and management. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-298. Intermountain Research Station, Ogden, UT. 83 p.

Steele, R.; Pfister, R.D.; Ryker, R.A.; and J.A. Kittams. 1981. Forest habitat types of central Idaho. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-114. Intermountain Forest and Range Experiment Station, Ogden, UT. 138 p.

Steinhoff, R.J. 1978. Distribution, ecology, silvicultural characteristics, and genetics of the *Abies grandis-Abies concolor* complex. *In*: Proceedings of the IUFRO joint meeting of working parties, Vol 2. B.C. Ministry of Forests, Vancouver, BC: 123-132.

Stickney, P. 1980a. Data base for post-fire succession, first 6 to 9 years, in Montana larch-fir forests. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-62. Intermountain Research Station, Ogden, UT. 26 p.

Stickney, P. 1980b. Data base for early post-fire succession on the Sundance Burn, northern Idaho. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-189. Intermountain Research Station, Ogden, UT. 121 p.

Stickney, P.F. 1981. Vegetative recovery and development. *In*: Clearcutting and fire in the larch/Douglas-fir forests of western Montana--a multifaceted research summary. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-99. Intermountain Forest and Range Experiment Station, Ogden, UT: 33-40.

Stickney, P.F. 1982. Vegetation response to clearcutting and broadcast burning on north and south slopes at Newman Ridge. *In*: Proceedings--Site preparation and fuels management on steep terrain. Washington State University Cooperative Extension, Pullman, WA: 119-124.

Stickney, P. 1986. First decade plant succession following the Sundance forest fire, northern Idaho. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-197. Intermountain Research Station, Ogden, UT. 26 p.

Stoffel, K.L.; Joseph, N.L.; Waggoner, S.Z.; Gulick, C.W.; Korosec, M.A.; and B.B. Bunning. 1991. Geologic map of Washington, northeast quadrant. Washington Division of Geology and Earth Resources, Geologic Map GM-39. Washington State Department of Natural Resources, Olympia, WA.

Sukatchev, V.N. 1928. Principles of classification of the spruce communities of European Russia. Journal of Ecology 16: 1-18.

Swetnam, T.W.; and A.M. Lynch. 1989. A tree-ring reconstruction of western spruce budworm history in the southern Rocky Mountains. Forest Science 35: 962-986.

Tansley, A.G. 1935. The use and abuse of vegetational concepts and terms. Ecology. 16: 284-307.

Taylor, R.J.; and D.C. Shaw. 1982. Allelopathic effects of Engelmann spruce bark stilbenes and tannin-stilbene combination on seed germination and seedling growth of selected conifers. Canadian Journal of Botany 61: 279-289.

Tepley, J.; and J. Berger. 1971. Mean annual increment equations. Unpublished document. U.S.D.A. Forest Service, Pacific Northwest Region, Portland, OR.

Thomas, J.W.; Maser, C.; and J.E. Rodiek. Riparian Zones. *In*: Wildlife habitats in managed forests--the Blue Mountains of Oregon and Washington. U.S.D.A. Forest Service, Agricultural Handbook No. 553. Pacific Northwest Forest and Range Experiment Station, Portland, OR. 512 p.

Topik, C.; Halverson, N.M.; and D.G. Brockway. 1986. Plant association and management guide for the western hemlock zone, Gifford Pinchot National Forest. U.S.D.A. Forest Service, R6-ECOL-230A-1986. Pacific Northwest Region, Portland, OR. 132 p.

Turner, D.P.; and E.H. Franz. 1986. Influence of canopy dominants on understory vegetation patterns in and old-growth cedar-hemlock forest. American Midland Naturalist 116 (2): 387-393.

Veblen, T. 1986. Treefalls and the coexistence of conifers in subalpine forests of the central Rockies. Ecology 67: 644-649.

Volland, L.A. 1976. Plant communities of the central Oregon pumice zone. U.S.D.A. Forest Service, R6 Area Guide 4-2. Pacific Northwest Region, Portland, OR. 110 p.

Volland, L.A.; and M. Connelly. 1978. Computer analysis of ecological data: methods and programs. U.S.D.A. Forest Service, R6-ECOL-79-003. Pacific Northwest Region, Portland, OR.

Volland, L.A.; and J.D. Dell. 1981. Fire effects on Pacific Northwest forest and range vegetation. U.S.D.A. Forest Service, R-6-R-067. Pacific Northwest Region, Portland, OR. 23 p.

Weaver, H. 1968. Fire and it's relationship to ponderosa pine. *In*: Proceedings--7th annual Tall Timbers fire ecology conference. Hoberg, CA: 127-149.

Wellner, C.A. 1970. Fire history in the northern Rocky Mountains. *In*: Proceedings--The role of fire in the Intermountain West. Intermountain Fire Research Council, Missoula, MT: 42-64.

Wellner, C.A. 1989. Classification of habitat types in the western United States. *In*: Proceedings, Land classification based on vegetation: applications for resource management. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-257. Intermountain Research Station, Ogden, UT: 7-21.

Westveld, M. 1951. Vegetation mapping as a guide to better silviculture. Ecology 32: 508-517.

Wiley, K.N. 1978. Site index tables for western hemlock in the Pacific Northwest. Weyerhaeuser Forestry Paper 17. Centralia, WA.

Williams, C.K. 1978. Vegetation classification for the Badger Allotment, Mt. Hood National Forest. Ph.D. thesis. Oregon State University, Corvallis, OR. 141 p.

Williams, C.K.; and T.R. Lillybridge. 1983. Forested plant associations of the Okanogan National Forest. U.S.D.A. Forest Service, R6-ECOL-132b-1983. Pacific Northwest Region, Portland, OR. 140 p.

Williams, C.K.; and T.R. Lillybridge. 1987. Major indicator shrubs and herbs on National Forests of eastern Washington. U.S.D.A. Forest Service, R6-TM-TP-304-87. Pacific Northwest Region, Portland, OR. 224 p.

Williams, C.K.; Lillybridge, T.R.; and B.G. Smith. 1990. Field guide to the forested plant associations of the Colville National Forest. U.S.D.A. Forest Service, non-indexed document. Pacific Northwest Region, Portland, OR. 133 p.

Williams, C.K.; and B.G. Smith. 1991. Forested plant associations of the Wenatchee National Forest [DRAFT]. U.S.D.A. Forest Service, Pacific Northwest Region, Wenatchee National Forest, Wenatchee, WA. 226 p.

Williams, J.T.; Martin, R.E.; and S.G. Pickford. 1980. Silvicultural and fire management implications from a timber type evaluation of tussock moth outbreak areas. *In*: Proceedings of the 6th conference on fire and forest meteorology: 191-196.

Wischnofske, M.G.; and D.W. Anderson. 1983. The natural role of fire in Wenatchee Valley, Wenatchee, WA. Unpublished document. On file at: U.S.D.A. Forest Service, Pacific Northwest Region, Wenatchee National Forest, Wenatchee, WA. 24 p.

Wittinger, W.T.; Pengelly, W.L.; Irwin, L.L.; and J.M. Peek. 1977. A 20 year record of shrub succession in logged areas in the cedar-hemlock zone of northern Idaho. Northwest Science 51: 161-171.

Wright, H.A. 1972. Shrub response to fire. *In*: Wildland shrubs--their biology and utilization. U.S.D.A. Forest Service, Gen. Tech. Rep. INT-1. Intermountain Forest and Range Experiment Station, Ogden, UT: 204-217.

Wright, H.A. 1978. The effect of fire on vegetation in ponderosa pine forests: a state-of-the-art review. College of Agricultural Sciences Publication No. T-9-199, Texas Tech University, Lubbock, Texas. 21 p.

Wright, H.A.; and A.W. Bailey. 1982. Fire ecology. John Wiley and Sons, NY. 501 p.

Youngblood, A.P.; Padgett, W.G.; and A.H. Winward. 1985. Riparian community type classification of Eastern Idaho-western Wyoming. U.S.D.A. Forest Service, R4-ECOL-85-01. Intermountain Research Station, Ogden, UT. 78 P.

Zack, A.C.; and P. Morgan. 1994. Early succession on two hemlock habitat types in northern Idaho. *In*: Proceedings--Interior cedar-hemlock-whitepine forests: ecology and management. Washington State University Cooperative Extension, Pullman, WA: 71-84.

Zamora, B.A. 1983. Forest habitat types of the Spokane Indian Reservation. Research Bulletin XB-0936-1983. Agricultural Research Center, Washington State University, Pullman, WA. 141 p.

Zimmerman, G.T. 1979. Livestock grazing, fire, and their interactions within the Douglas-fir/ninebark habitat type. M.S. thesis. University of Idaho, Moscow, ID. 128 p.

APPENDICES

Appendices

APPENDIX 1

- Selected plant species adaptations to fire
- List of important trees, shrubs, subshrubs and herbs
- Mean cover and constancy of important plant species by plant association

Table 85. Summary of postfire survival strategy and fire response for some shrubs and herbaceous plants occurring in forests west of the Continental Divide in Montana.

SPECIES	POSTFIRE SURVIVAL STRATEGY	COMMENTS ON FIRE RESPONSE
SHRUBS		
Alnus sinuata Sitka alder	Sprouts from surviving root crown.	Usually increases on site following fire. Early seed production (after 5 years) aids in this increase.
Acer circinatum Vine maple	Sprouts from surviving root crown.	Shade tolerance allows it to persist between fires and then resprout and increase in density after a fire. Characteristic of strongly maritime environments.
Acer glabrum var. *douglasii* Douglas maple	Sprouts from surviving root crown.	Less shade tolerant than *A. circinatum* but responds in a similar fashion. Characteristic of relatively xeric to mesic sites. Usually increases following fire.
Amelanchier alnifolia Western serviceberry	Sprouts from surviving root crown, frequently producing multiple stems.	Pioneer species; usually survives even severe fires especially if soil is moist at time of fire. Coverage usually increases following fire.
Arctostaphylos nevadensis Pinemat manzanita	May sprout from a root crown; regeneration from stolons more common. May have somewhat fire-resistant seeds.	Susceptible to fire-kill. Will survive some low severity fires when duff is moist and therefore not consumed by fire. May invade burned area from unburned patches.
Arctostaphylow uva-ursi Bearberry (kinnikinnik)	Similar to *A. nevadensis*.	See *A. nevadensis*
Artemisia arbuscula Low sagebrush	Wind-dispersed seed.	Individual shrubs are susceptible to fire-kill. Reseeds from adjacent unburned areas. Does not respout.
Artemisia tridentata vaseyana Mountain big sagebrush	Wind-dispersed seed. Subspecies *vaseyana* stores seed in the soil that germinates as a result of fire-induced heating.	Individual shrubs are susceptible to fire-kill. Recovery is hastened when a good seed crop exists before burning.

Table 85. continued.

SPECIES	POSTFIRE SURVIVAL STRATEGY	COMMENTS ON FIRE RESPONSE
Artemisia tripartitia Three-tip sagebrush	Wind dispersed seed. Sprouts from a surviving root crown.	One of the few sagebrush species that resprouts after a fire. Hot fires under drought conditions may kill the plants. Fires when the soil is moist are more favorable for resprouting.
Berberis repens Creeping Oregon grape	Sprouts from surviving rhizomes that grow 0.5 to 2 inches (1-5 to 5 cm) below soil surface.	Moderately resistant to fire-kill. Usually survives all but severe fires that remove duff and cause extended heating of upper soil.
Ceanothus sanguineus Redstem ceanothus	Soil-stored seed germinates following heat treatment. It can also sprout from root crowns following a cool fire.	Usually increases following fire, often dramatically. Seeds may remain dormant in the soil for decades until fire or mechanical scarification breaks seed dormancy.
Ceanothus velutinus Snowbrush ceanothus	Similar to *C. sanguineus*.	See *C. samguineus*.
Cornus canadensis Bunchberry dogwood	Sprouts from surviving rhizomes growing 2 to 5 inches (5 to 13 cm) below soil surface.	Moderately resistant to fire-kill. Will survive all but severe fires that remove duff and cause extended heating of upper soil.
Cornus stolonifera Red-osier dogwood	Sprouts from surviving rhizomes or stolons (runners).	Susceptible to fire-kill. Will survive all but severe fires that remove duff and cause extended heating of upper soil.
Holodiscus discolor Oceanspray	Regenerates from soil-stored seed or sprouts from surviving root crown.	Moderately resistant to fire-kill. Is often enhanced by fire.
Juniperus communis Common juniper	Bird-dispersed seed.	Susceptible to fire-kill. Seed requires long germination period.
Juniperus horizontalis Creeping juniper	Similar to *J. communis.*	See *J. communis*
Ledum glandulosum Western ledum	Fire avoider, rhizomes.	Unknown, probably poor response.

Table 85. continued.

SPECIES	POSTFIRE SURVIVAL STRATEGY	COMMENTS ON FIRE RESPONSE
Linnaea borealis longiflora Twinflower	Sprouts from surviving root crown located just below soil surface. Fibrous roots and runners at soil surface.	Susceptible to fire-kill. May survive some cool fires where duff is moist and not consumed. Can invade burned area from unburned patches.
Lonicera utahensis Utah honeysuckle	Sprouts from surviving root crown.	Often has a reduction in cover and frequency following fire.
Menziesia ferruginea Rusty menziesia	Normally a fire avoider. Sprouts from surviving root crown if duff is not burned.	Susceptible to fire-kill. Moderate to severe fires reduce survival and slow redevelopment.
Oplopanax horridum Devil's club	May sprout from root crown.	Susceptible to fire-kill.
Pachistima myrsinites Pachistima	Sprouts from surviving root crown and from buds along taproot.	Moderately resistant to fire-kill. Usually survives low to moderate severity fires that do not consume the duff and heat soil excessively. Usually increases.
Philadelphus lewisii Lewis mockorange	Sprouts from root crown.	Fire resistant; a vigorous resprouter.
Physocarpus malvaceus Mountain ninebark	Sprouts from surviving root crown or horizontal rhizomes.	Fire resistant. Resprouts well although spreading may be somewhat delayed.
Potentilla fruticosa Shrubby cinquefoil	Sprouts from surviving root crown.	Susceptible to fire-kill, but may survive low to moderate fires.
Prunus emarginata Bittercherry	Sprouts from surviving root crown; perhaps from short rhizomes.	Oten increases in cover after a fire. Multiple sprouts often increase density of stems.
Prunus virginiana Chokecherry	Sprouts from surviving root crown; occasionally from rhizomes.	Usually increases coverage following fire.

Table 85. continued.

SPECIES	POSTFIRE SURVIVAL STRATEGY	COMMENTS ON FIRE RESPONSE
Purshia tridentata Bitterbrush	A weak sprouter. Animal-dispersed seed and seed caches present on area prior to fire.	Susceptible to fire-kill, especially in summer and fall. Rarely seen decumbent growth form sprouts vigorously, columnar form sprouts weakly if at all and sprouts rarely persist more than a season or two. Spring burns enhance sprouting, fall burns are best for regeneration by seed.
Rhododendron albiflorum Cascades azalea	A fire avoider. Weak sprouter from root crown.	Susceptiable to fire kill. Rarely resprouts except where duff was not consumed.
Ribes cereum Wax currant	Weak sprouter from root crown, soil stored seed.	Dry habitat makes individual shrubs susceptible to fire kill. Stored seed in soil may germinate after a fire. Rarely increases after a fire.
Ribes lacustre Prickly currant	Sprouts from surviving root crown that is located beneath soil surface.	Resistant to fire-kill. Usually increases even after severe fire. Seedlings may establish after low or moderate fires.
Ribes viscosissimum Sticky currant	A weak sprouter; soil-stored seed may require heat treatment. Seeds remain viable in the soil for years.	Relatively shade intolerant and is normally an early to mid-successional species on forested sites. Individual shrubs are susceptiable to fire kill; but density may increase dramatically after a fire from germination of soil-stored seed even if few or no plants were evident immediately prior to fire.
Rosa gymnocarpa Baldhip rose	Sprouts from surviving root stock.	Very hot fires that consume the duff kills most individuals.
Rosa nutkana hispida Bristly nootka rose	Sprouts from surviving root stock or short rhizomes. May store seed in soil for a year or two.	Very hot fires may reduce cover and resprouting.
Rosa woodsii ultramontana Wood's rose	Sprouts from surviving root stock or short rhizomes. May store seed in soil for 1-2 years.	Very hot fires may reduce cover and resprouting.

Table 85. continued.

SPECIES	POSTFIRE SURVIVAL STRATEGY	COMMENTS ON FIRE RESPONSE
Rubus lasiococcus Dwarf bramble	Sprouts from surviving root crown. Stolons freely rooting.	Susceptible to fire that removes the duff and humus. Root crowns are near soil surface. Can invade burned area from unburned patches.
Rubus parviflorus Thimbleberry	Sprouts from surviving rhizomes; seedlings from soil-stored and possible bird dispersed seed. Seed in soil may remain viable for years.	Spreads vigorously from rhizomes; rapid recovery after fire and may germinate from stored seed.
Rubus pedatus Five-leaved bramble	Sprouts from surviving root crowns. Stolons freely rooting.	Susceptible to fire that removes the duff and humus. Can invade from unburned patches.
Salix scouleriana Scouler willow	Sprouts from root crown/ caudex. Has numerous wind-borne seeds.	Resprouts vigorously after fire and seeds germinate readily on moist burned sites.
Shepherdia canadensis Russet buffaloberry	Sprouts from surviving root crown and from buds along taproot.	Moderately resistant to fire-kill. Will usually survive cool to moderately severe fires that fail to consume duff and heat soil extensively.
Sorbus scopulina Mountain ash	Sprouts from deep-seated rhizomes.	Resprouts vigorously after fire.
Spiraea betulifolia Shiny-leaf spirea	Sprouts from surviving root crown and from rhizomes that grow 2 to 5 inches (5 to 13 cm) below surface.	Resistant to fire-kill. Will usually survive even a severe fire. Generally increases coverage following fire.
Symphoricarpos albus Common snowberry	Sprouts vigorously from surviving rhizomes that are located between 2 and 5 inches (5 to 13 cm) below soil surface.	Resistant to fire-kill. Will usually survive even severe fires. Greatly enhanced by cool to moderately severe fires
Symphoricarpos mollis hesperius Creeping snowberry	Sprouts from root crown. Training branches may root freely.	Moderately resistant to fire-kill. Often quickly invades burned areas from unburned sites.
Symphoricarpos oreophilus utahensis Mountain snowberry	Sprouts from root crown. No rhizomes or trailing branches.	Usually survives most fires in its habitat. Often favored by relatively cool, fast-moving fires every 8-10 yr.

Table 85. continued.

SPECIES	POSTFIRE SURVIVAL STRATEGY	COMMENTS ON FIRE RESPONSE
Taxus brevifolia Pacific yew	Bird-dispersed seed.	Easily killed by fire because of thin bark
Vaccinium membranaceum Big huckleberry	Shallow and deep rhizomes.	Moderately resistant to fire-kill, Will usually survive cool to moderately severe fires. Repeated severe fires will reduce cover.
Vaccinium myrtillus Low huckleberry	Sprouts from surviving rhizomes in duff and upper few inches of soil.	Moderately resistant to fire-kill. Normally survives cool to moderately severe fires.
Vaccinium scoparium Grouse huckleberry	Sprouts from surviving rhizomes that grow in duff layer or at surface of soil.	Moderately resistant to fire-kill. Will usually survive cool to moderately severe fires that fail to consume the lower layer of duff.
FORBS:		
Adenocaulon bicolor Pathfinder	Sprouts from rhizomes near mineral soil surface.	Moderately susceptible to fire-kill. May survive moderately severe fires that fail to consume lower duff.
Apocynum androsaemifolium Spreading dogbane	Sprouts from surviving rhizomes.	Generally maintains pre-fire frequency following fire.
Aralia nudicaulis Wild sarsaparilla	Sprouts from surviving rhizomes.	Generally resistant to fire-kill.
Arnica cordifolia Heartleaf arnica	Sprouts from surviving rhizomes that creep laterally from 0.4 to 0.8 inches (1 to 2 cm) below soil surface. Wind-dispersed seed.	Susceptible to fire-kill. Shoots produce small crowns within the duff that are easily killed by all but cool fires that occur when duff is moist. May rapidly invade burned area via wind-borne seed.
Arnica latifolia Broadleaf arnica	Sprouts from surviving rhizomes that creep laterally in the soil.	Susceptible to fire-kill. Will usually survive cool to moderately severe fires. May exhibit rapid initial regrowth accompanied by heavy flowering and seedling establishment.

Table 85. continued.

SPECIES	POSTFIRE SURVIVAL STRATEGY	COMMENTS ON FIRE RESPONSE
Aster conspicuus Showy aster	Sprouts from surviving rhizomes that mostly grow from 0.5 to 2 inches (1.5 to 5 cm) below soil surface.	Moderately resistant to fire-kill. Will usually survive cool to moderately severe fires that do not result in excessive soil heating. May rapidly increase following fire.
Astragalus miser Timber milkvetch	Sprouts from buds along surviving taproot that may be 2 to 8 inches (5 to 20 cm) below root crown.	Resistant to fire-kill. Can regenerate from taproot even when entire plant crown is destroyed. Can send up shoots and set seed the first year. May increase dramatically following fire. Note: Milkvetch is poisonous to sheep and cattle.
Balsamorhiza sagittata Arrowleaf balsamroot	Regrowth from surviving thick caudex.	Resistant to fire-kill. Will survive even the most severe fire.
Chimaphila umbellata Prince's pine	Rhizomes in duff near mineral soil surface.	May survive moderate fires that do not thoroughly heat duff.
Clintonia uniflora Queencup beadlily	Sprouts from surviving rhizomes.	Usually decreases following fire. Postfire environment evidently not conducive to rapid recovery.
Disporum hookeri Hooker fairybells	Rhizomes 0.5 to 2 inches (1 to 5 cm) deep in the soil.	Initally decreased by fire but often recovers to preburn levels relatively rapidly. Recovery may depend on intensity of burn and survival of rhizomes
Disporum trachycarpum Wartberry fairybells	Similar to *D. hookeri*.	See *D. hookeri*.
Epilobium angustifolium Fireweed	Sprouts from rhizomes and germinates from wind-blown seed.	Needs mineral soil for best seedling establishment. An early seral species that can persist for years vegetatively and then flower the first summer after a fire with copious seed production. Rapid invader of burned sites and may be a community dominate for the first few years after a fire.

Table 85. continued.

SPECIES	POSTFIRE SURVIVAL STRATEGY	COMMENTS ON FIRE RESPONSE
Equisetum arvense Common horsetail	Spreading rhizomes and wind-dispersed minute propagules.	Frequency unchanged or increased after fire. Especially favored by moist mineral soil exposure.
Fragaria virginiana Virginia strawberry	Sprouts from surviving stolons (runners) at or just below soil surface.	Susceptible to fire-kill. Will often survive cool fires that do not consume duff because of high duff moisture content.
Galium triflorum Sweetscented bedstraw	Sprouts from surviving rhizomes; barbed, animal-borne seeds.	Susceptible to fire-kill. Usually a sharp decrease following severe fire. Can increase following spring and fall fires.
Iliamna longisepala Longsepal globemallow	Soil-stored seed.	Responds vigorously to severe burning, a pioneer species.
Iliamna rivularis Streambank globemallow	Same as *I. longisepala.*	See *I. longisepala.*
Osmorhiza chilensis Mountain sweetroot	Short shallow roots; barbed, animal-dispersed seeds.	Moderately fire resistant; temporary increase after fire.
Pyrola secunda Sidebells pyrola	Sprouts from surviving rhizomes that grow mostly in the duff or at soil surface.	Susceptible to fire-kill. Coverage frequently reduced following fire. May survive cool fires when duff moisture is high.
Smilacina racemosa Feather solomonplume	Sprouts from surviving stout creeping rhizomes.	Moderately resistant to fire-kill. May be killed by severe fires that remove duff and heat soil excessively. Usually maintains pre-fire frequency.
Smilacina stellata Starry solomonplume	Sprouts from surviving creeping rhizomes.	Moderately resistant to fire-kill. May be killed by severe fires that remove duff and heat soil excessively. Frequency often reduced following fire.
Streptopus amplexifolius Claspleaf twistedstalk	Fire avoider. Extensively rhizomatous.	Decreased by fire but moist habitats tend to protect rhizomes. May not flourish in post-fire environment.
Streptopus rosea Rosy twistedstalk	Fire avoider. Extensively rhizomatous.	Little is know but presumably responds similarily to *S. amplexifolius.*

Table 85. continued.

SPECIES	POSTFIRE SURVIVAL STRATEGY	COMMENTS ON FIRE RESPONSE
Thalictrum occidentals Western meadowrue	Sprouts from surviving rhizomes.	Susceptible to fire-kill. Frequency usually reduced following fire. May survive cool fires that do not consume duff.
Trautvetteria caroliniensis False bugbane	Fire avoider. Widely spreading rhizomes.	Slight decrease after a fire but moist to wet habitats allow most rhizomes to survive most fires.
Xerophyllum tenax Beargrass	Sprouts from surviving stout shallow rhizomes.	Individual plants are susceptible to fire-kill if the duff and soil are heated. Will survive cool fires that do not consume lower duff. Resprouts flower vigorously after a fire until new overstory canopy develops. Usually increases following a fire.
Zigadenus elegans Mountain death-camas	Survives from surviving onion-like (tunicated) bulb.	Resistant to fire-kill.
<u>GRASSES/GRASSLIKES:</u>		
Agropyron spicatum Bluebunch wheatgrass	Seed germination and some sprouts from root crowns or even surviving rhizomes.	Usually not seriously damaged by fire. Response depends on severity of fire and physiological state of plant. Damage will be greatest following dry year.
Bromus tectorum Cheatgrass	Annual plant that relies on seed reserves in soil; variable germination seasons; relatively high heat resistance of seed.	Individual plants susceptiable to heat-kill. Surviving seed germinate at various time during the year-fall, late winter, spring. Early summer burns before seed mature are more effective for controlling cheatgrass than midsummer and fall burns.
Calamagrostis canadensis Bluejoint reedgrass	Invader, wind-disseminated seed; aslso an enduring sprouter.	Increases on wet to moist postfire sites.

Table 85. continued.

SPECIES	POSTFIRE SURVIVALSTRATEGY	COMMENTS ON FIRE RESPONSE
Calamagrostis rubescens Pinegrass	Sprouts from surviving spreading rhizomes that grow within the top 2 inches (5 cm) of soil.	Moderately resistant to fire-kill. Will usually survive cool to moderately severe fires that do not heat the rhizomes. Burned areas are often successfully invaded by pinegrass. Often flowers abundantly after burning.
Carex concinnoides Northwestern sedge	Sprouts from short, shallow rhizomes.	Moderately resistant to fire and usually returns to pre-burn levels within a few years. Rarely increases aggressively.
Carex geyeri Elk sedge	Sprouts from surviving rhizomes.	Invades burned areas and forms dense stands. Often increases following most fires severe enough to heat but not completely consume duff.
Carex rossii Ross sedge	Seed stored in duff or soil that germinates when heat treated. Also sprouts from surviving root crown.	Increased coverage usually results following most fires severe enough to heat but not completely consume duff. Often increases after a fire.
Festuca idahoensis Idaho fescue	Seed germination and sprouts from residual root crown.	Susceptible to fire-kill. Response will vary with severity of fire and physiological state of plant. Can be seriously harmed by hot summer and fall fires. Only slightly damaged during spring or tall when soil moisture is high.
Festuca scabrella Rough fescue	Seed germination and residual plant survival (root crown).	Usually harmed by spring burning.
Koeleria cristata Junegrass	Seed germination and residual plant survival (root crown).	Susceptible to fire-kill. Response will vary according to fire severity and physiological state of plant.
Luzula hitchcockii Smooth woodrush	Sprouts from surviving rhizomes.	Often a slight increase following fire.

Sources: Bradley 1984; Crane *et al.* 1983; Daubenmire and Daubenmire 1968; Kramer 1984; Lotan *et al.* 1981; Lyon and Stickney 1976; McLean 1969; Miller 1977; Mueggler 1965; Noste 1985; Rowe 1983; Stickney 1981; Volland and Dell 1981; Wright 1978, 1972; Wright and Bailey 1982.

Table 86. List of important trees, shrubs, subshrubs, and herbs by code, scientific name and common name.

Code	Scientific name	Common name
TREES		
ABGR	*Abies grandis*	grand fir
ABLA2	*Abies lasiocarpa*	subalpine fir
BEOC	*Betula occidentalis*	western water birch
BEPA	*Betula papyrifera*	paper birch
LAOC	*Larix occidentalis*	western larch
PIEN	*Picea engelmannii*	Engelmann spruce
PIGL	*Picea glauca*	white spruce
PIAL	*Pinus albicaulis*	whitebark pine
PICO	*Pinus contorta*	lodgepole pine
PIMO	*Pinus monticola*	western white pine
PIPO	*Pinus ponderosa*	ponderosa pine
POTR	*Populus tremuloides*	quaking aspen
POTR2	*Populus trichocarpa*	black cottonwood
PSME	*Pseudotsuga menziesii*	Douglas-fir
TSHE	*Tsuga heterophylla*	western hemlock
THPL	*Thuja plicata*	western redcedar
SHRUBS AND SUBSHRUBS		
ACGLD	*Acer glabrum* var. *douglasii*	Douglas maple
ALSI	*Alnus sinuata*	Sitka alder
AMAL	*Amelanchier alnifolia*	serviceberry
ARNE	*Arctostaphylos nevadensis*	pinemat manzanita
ARUV	*Arctostaphylos uva-ursi*	bearberry
BEAQ	*Berberis aquifolium*	Oregon grape
CASSI	*Cassiope* species	moss-heather
CESA	*Ceanothus sanguineus*	redstem ceanothus
CEVE	*Ceanothus velutinus*	snowbrush ceanothus
CHME	*Chimaphila menziesii*	little prince's pine
CHUMO	*Chimaphila umbellata* var. *occidentalis*	western prince's pine
COCA	*Cornus canadensis*	bunchberry dogwood
COST	*Cornus stolonifera*	red-osier dogwood
HODI	*Holodiscus discolor*	ocean-spray
LEGL	*Ledum glandulosum*	Labrador tea
LIBOL	*Linnaea borealis* var. *longiflora*	twinflower

Table 86. continued.

Code	Scientific name	Common name
SHRUBS AND SUBSHRUBS, cont.		
LOCI	*Lonicera ciliosa*	trumpet honeysuckle
LOIN	*Lonicera involucrata*	bearberry honeysuckle
LOUT	*Lonicera utahensis*	Utah honeysuckle
MEFE	*Menziesia ferruginea*	rusty menziesia
OPHO	*Oplopanax horridum*	devil's club
PAMY	*Pachistima myrsinities*	pachistima
PEFR3	*Penstemon fruiticosus*	shrubby penstemon
PHLE2	*Philadelphus lewisii*	mockorange
PHEM	*Phyllodoce empetriformis*	red mountain heath
PHMA	*Physocarpus malvaceus*	ninebark
PUTR	*Purshia tridentata*	bitterbrush
PYAS	*Pyrola asarifolia*	alpine pyrola
PYCH	*Pyrola chlorantha*	green pyrola
PYSE	*Pyrola secunda*	sidebells pyrola
PYUN	*Pyrola uniflora*	woodnymph pyrola
RHAL	*Rhododendron albiflorum*	Cascade azalea
RICE	*Ribes cereum*	wax currant
RILA	*Ribes lacustre*	prickly currant
RIVI	*Ribes viscosissimum*	sticky currant
ROGY	*Rosa gymnocarpa*	baldhip rose
RONUH	*Rosa nutkana* var. *hispida*	bristly nootka rose
ROSA	*Rosa* spp.	rose species
ROWO	*Rosa woodsii*	Wood's rose
RUPE	*Rubus pedatus*	five-leaved bramble
RUPA	*Rubus parviflorus*	western thimbleberry
SACE	*Sambucus cerulea*	blue elderberry
SALIX	*Salix* spp.	willow species
SASC	*Salix scouleriana*	Scouler willow
SHCA	*Shepherdia canadensis*	russet buffaloberry
SOSC2	*Sorbus scopulina*	mountain ash
SPBEL	*Spirea betulifolia* var. *lucida*	shiny-leaf spirea
SYAL	*Symphoricarpos albus*	common snowberry
SYOR	*S. oreophilus* var. *utahensis*	mountain snowberry
TABR	*Taxus brevifolia*	Pacific yew
VACA	*Vaccinium caespitosum*	dwarf huckleberry
VACCI	*Vaccinium* spp.	huckleberry species
VAME	*Vaccinium membranaceum*	big huckleberry
VAMY	*Vaccinium myrtillus*	low huckleberry

Table 86. continued.

Code	Scientific name	Common name
SHRUBS AND SUBSHRUBS, cont.		
VASC	*Vaccinium scoparium*	grouse huckleberry
XETE	*Xerophyllum tenax*	beargrass
HERBS		
ACMI	*Achillea millefolium*	yarrow
ACRU	*Actaea rubra*	baneberry
ADBI	*Adenocaulon bicolor*	pathfinder
AGSP	*Agropyron spicatum*	bluebunch wheatgrass
AGIN	*Agropyron spicatum* var. *inerme*	beardless bluebunch wheatgrass
ANPI	*Anemone piperi*	Piper anemone
ANTEN	*Antennaria* species	pussytoes species
ANAN	*Antennaria anaphaloides*	tall pussytoes
ANMI	*Antennaria microphylla*	rose pussytoes
ANRA	*Antennaria racemosa*	raceme pussytoes
ANUM	*Antennaria umbrinella*	umber pussytoes
APAN	*Apocynum androsaemifolium*	spreading dogbane
AQUIL	*Aquilegia* species	columbine species
ARNU3	*Aralia nudicaulis*	wild sarsaparilla
ARNIC	*Arnica* species	arnica species
ARCO	*Arnica cordifolia*	heartleaf arnica
ARLA	*Arnica latifolia*	broadleaf arnica
ASCA3	*Asarum caudatum*	wild ginger
ASMI	*Astragalus miser*	starved milkvetch
ASCO	*Aster conspicuus*	showy aster
ASTER	*Aster* species	aster species
ATFI	*Athyrium filix-femina*	ladyfern
BASA	*Balsamorhiza sagittata*	arrowleaf balsamroot
BROMU	*Bromus* species	bromegrass species
BRTE	*Bromus tectorum*	cheatgrass
BRSU	*Bromus suksdorfii*	Suksdorf brome
BRVU	*Bromus vulgaris*	Columbia brome
CACO	*Carex concinnoides*	northwestern sedge
CAGE	*Carex geyeri*	elk sedge
CAREX	*Carex* species	sedge species
CARO	*Carex rossii*	Ross sedge
CACA	*Calamagrostis canadensis*	bluejoint reedgrass
CARU	*Calamagrostis rubescens*	pinegrass
CASTI	*Castilleja* species	paintbrush species

Table 86. continued.

Code	Scientific name	Common name
HERBS, cont.		
CEDI	*Centaurea diffusa*	diffuse knapweed
CIAL	*Circaea alpina*	circaea
CLCO	*Clematis columbiana*	rock clematis
CLUN	*Clintonia uniflora*	queencup beadlily
COGR	*Collinsia grandiflora*	bluetips collinsia
COPA	*Collinsia parviflora*	little flower collinsia
COGR2	*Collomia grandiflora*	large flowered collomia
CRAT	*Crepis atrabarba*	slender hawksbeard
DENU3	*Delphinium nuttallianum*	larkspur
DIHO	*Disporum hookeri*	Hooker fairybells
DITR	*Disporum trachycarpum*	wartberry fairybells
ELGL	*Elymus glaucus*	blue wildrye
EPAN	*Epilobium angustifolium*	fireweed
EQUIS	*Equisetum* species	horsetail species
EQAR	*Equisetum arvense*	common horsetail
EQSC	*Equisetum scirpoides*	sedgelike horsetail
ERHE	*Eriogonum heracleoides*	Wyeth buckwheat
FEID	*Festuca idahoensis*	Idaho fescue
FEOC	*Festuca occidentalis*	western fescue
FRAGA	*Fragaria* spp.	strawberry species
GATR	*Galium triflorum*	sweetscented bedstraw
GOOB	*Goodyera oblongifolia*	western rattlesnake plantain
GYDR	*Gymnocarpium dryopteris*	oak fern
HECY	*Heuchera cylindrica*	roundleaf alumroot
HIERA	*Hieracium* species	hawkweed species
HIAL	*Hieracium albiflorum*	white hawkweed
HICY	*Hieracium cynoglossoides*	houndstongue hawkweed
HYMO	*Hypopitys monotropa*	pinesap
KOCR	*Koeleria cristata*	prairie Junegrass
LICHE	Lichen species	lichen species
LIRU	*Lithospermum ruderale*	wayside gromwell
LODI	*Lomatium dissectum*	fern-leaved lomatium
LUHI	*Luzula hitchcockii*	smooth woodrush
LUPIN	*Lupinus* species	lupine species
LULA	*Lupinus latifolius*	broadleaf lupine
LUSE	*Lupinus sericeus*	silky lupine
LUWY	*Lupinus wyethii*	Wyeth lupine
MITEL	*Mitella* species	miterwort species
MOSS	Moss species	moss species

Table 86. continued.

Code	Scientific name	Common name
HERBS, cont.		
OSCH	*Osmorhiza chilensis*	sweetroot
PEBR	*Pedicularis bracteosa*	bracted pedicularis
PEPR2	*Penstemon pruinosus*	prickleaf penstemon
PERA	*Pedicularis racemosa*	sickletop pedicularis
PESA	*Petasites sagittatus*	arrowleaf butterbur
POA	*Poa* species	bluegrass species
PONE	*Poa nervosa*	Wheeler bluegrass
SEIN	*Senecio integerrimus*	western groundsel
SETR	*Senecio triangularis*	arrowleaf groundsel
SMRA	*Smilacina racemosa*	feather solomonplume
SMST	*Smilacina stellata*	starry solomonplume
STAM	*Streptopus amplexifolius*	claspleaf twisted stalk
TAOF	*Taraxacum officinale*	common dandelion
THOC	*Thalictrum occidentale*	western meadowrue
TRCA3	*Trautvetteria caroliniensis*	false bugbane
TIUN	*Tiarella unifoliata*	coolwort foamflower
VASI	*Valeriana sitchensis*	Sitka valerian
VIAD	*Viola adunca*	Hook violet
VIGL	*Viola glabrella*	pioneer violet
VIOR2	*Viola orbiculata*	round-leaved violet
ZIVE	*Zigadenus venenosus*	meadow death-camas

Table 87. Mean cover and constancy of important plant species in the Douglas-fir Series by plant association.

SPECIES	PIPO-PSME/AGSP 5 PLOTS		PSME/CARU 42 PLOTS		PSME/PHMA 33 PLOTS		PSME/PHMA-LIBOL 51 PLOTS	
TREE OVERSTORY LAYER	CON	COV	CON	COV	CON	COV	CON	COV
Abies grandis	.	.	.	.	9	2	2	1
Abies lasiocarpa	.	.	2	1	.	.	2	1
Betula papyrifera	.	.	.	.	.	.	2	1
Larix occidentalis	.	.	62	17	.	.	92	8
Pinus albicaulis	.	.	.	.	.	.	.	.
Pinus contorta	.	.	21	9	12	10	27	10
Picea engelmannii	.	.	.	.	.	.	6	1
Pinus monticola	.	.	.	.	.	.	.	.
Pinus ponderosa	100	29	52	18	58	11	37	8
Pseudotsuga menziesii	80	8	98	29	97	47	100	43
Thuja plicata	.	.	.	.	.	.	.	.
Tsuga heterophylla	.	.	.	.	.	.	.	.
TREE UNDERSTORY LAYER								
Abies grandis	.	.	.	.	9	2	4	1
Abies lasiocarpa	.	.	2	1	.	.	.	.
Pinus albicaulis	.	.	.	.	.	.	.	.
Picea engelmannii	.	.	.	.	.	.	6	4
Pinus ponderosa	80	4	14	2	.	.	.	.
Pseudostuga menziesii	80	2	95	8	79	4	82	7
Thuja plicata	.	.	.	.	.	.	.	.
Tsuga heterophylla	.	.	.	.	.	.	2	1
SHRUBS AND SUBSHRUBS								
Acer douglasii	.	.	7	1	33	4	29	5
Alnus sinuata	.	.	2	4	.	.	2	3
Amelanchier alnifolia	40	2	31	2	85	7	86	3
Arctostaphylos uva-ursi	40	3	52	3	12	2	57	5
Berberis aquifolium	20	8	14	3	79	5	69	4
Berberis nervosa	.	.	.	.	.	.	2	1
Chimaphila umbellata	.	.	12	2	15	2	29	3
Cornus canadensis	.	.	.	.	.	.	8	2
Cornus stolonifera	.	.	.	.	.	.	2	1
Holodiscus discolor	.	.	7	1	70	6	25	7
Juniperus communis	.	.	5	1	.	.	2	1
Linnaea borealis	.	.	10	5	.	.	51	5
Lonicera ciliosa	.	.	5	6	6	2	14	2
Lonicera utahensis	.	.	12	2	9	4	39	4

Table 87 (cont.). Mean cover and constancy of important plant species in the Douglas-fir Series by plant association.

SPECIES	PIPO-PSME/AGSP 5 PLOTS		PSME/CARU 42 PLOTS		PSME/PHMA 33 PLOTS		PSME/PHMA-LIBOL 51 PLOTS	
SHRUBS AND SUBSHRUBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Menziesia ferruginea	.	.	.	.	.	.	.	.
Oplopanax horridum	.	.	.	.	.	.	.	.
Pachistima myrsinites	.	.	52	3	55	2	67	3
Physocarpus malvaceus	.	.	10	3	91	29	98	23
Pyrola asarifolia	.	.	.	.	.	.	.	.
Pyrola secunda	.	.	10	1	9	1	10	1
Rhododendron albiflorum	.	.	.	.	.	.	.	.
Ribes lacustre	.	.	2	1	.	.	4	2
Rosa gymnocarpa	.	.	17	5	70	5	63	5
Rubus parviflorus	.	.	5	2	6	2	14	2
Rubus pedatus	.	.	.	.	.	.	.	.
Salix scouleriana	20	1	21	3	9	3	18	3
Shepherdia canadensis	.	.	12	1	6	2	25	4
Sorbus scopulina	.	.	2	3	9	1	10	2
Spiraea betulifolia	20	10	33	7	91	6	88	9
Symphoricarpos albus	20	2	38	2	76	8	75	5
Symphoricarpos oreophilus	.	.	17	3	12	5	2	1
Taxus brevifolia	.	.	.	.	.	.	.	.
Vaccinium caespitosum	.	.	.	.	9	2	14	5
Vaccinium membranaceum	.	.	10	3	3	1	12	3
Vaccinium myrtillus	.	.	2	5	.	.	.	.
Vaccinium scoparium	.	.	2	3	.	.	.	.
Xerophyllum tenax	.	.	.	.	.	.	.	.
HERBS								
Achillea millefolium	100	3	60	2	27	3	33	2
Actaea rubra	.	.	.	.	.	.	2	1
Adenocaulon bicolor	.	.	.	.	9	2	12	2
Agropyron inerme	20	35	.	.	.	.	.	.
Agropyron spicatum	80	33	2	20	15	10	8	8
Aralia nudicaulis	.	.	.	.	.	.	4	2
Arnica cordifolia	.	.	62	4	73	9	75	6
Asarum caudatum	.	.	.	.	.	.	.	.
Athyrium filix-femina	.	.	.	.	.	.	.	.
Balsamorhiza sagittata	80	12	.	.	6	2	.	.
Bromus tectorum	60	2	5	2	12	1	4	2
Bromus vulgaris	.	.	2	2	24	3	25	4
Calamagrostis canadensis	.	.	.	.	.	.	.	.

Table 87 (cont.). Mean cover and constancy of important plant species in the Douglas-fir Series by plant association.

SPECIES	PIPO-PSME/AGSP 5 PLOTS		PSME/CARU 42 PLOTS		PSME/PHMA 33 PLOTS		PSME/PHMA-LIBOL 51 PLOTS	
HERBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Calamagrostis rubescens	60	7	100	46	88	11	98	22
Carex concinnoides	.	.	43	4	12	2	37	2
Carex rossii	60	1	31	2	45	2	25	2
Circaea alpina	.	.	.	.	.	.	.	.
Clintonia uniflora	.	.	.	.	3	2	8	2
Disporum hookeri	.	.	.	.	3	5	.	.
Disporum trachycarpum	.	.	5	1	73	3	57	3
Equisetum arvense	.	.	.	.	.	.	.	.
Eriogonum heracleoides	80	2	.	.	.	.	.	.
Festuca idahoensis	80	7	12	4	6	4	8	1
Galium triflorum	.	.	2	1	18	1	16	2
Goodyera oblongifolia	.	.	12	1	39	1	43	2
Gymnocarpium dryopteris	.	.	.	.	.	.	.	.
Hieracium albiflorum	.	.	36	2	61	2	55	2
Hypopitys monotropa	.	.	.	.	.	.	.	.
Koeleria cristata	80	2	10	2	3	1	.	.
Lithospermum ruderale	60	1	10	1	6	1	.	.
Lupinus sericeus	80	13	38	5	18	5	18	8
Luzula hitchcockii	.	.	.	.	.	.	.	.
Osmorhiza chilensis	.	.	17	1	36	2	33	2
Pedicularis bracteosa	.	.	7	1	.	.	2	1
Pedicularis racemosa	.	.	2	2	.	.	.	.
Poa pratensis	20	3	2	1	3	3	.	.
Poa sandbergii	60	3	.	.	.	.	.	.
Senecio triangularis	.	.	.	.	.	.	.	.
Smilacina racemosa	.	.	24	1	73	3	69	2
Smilacina stellata	.	.	5	1	18	2	24	2
Streptopus amplexifolius	.	.	.	.	.	.	.	.
Thalictrum occidentale	.	.	21	3	18	2	33	3
Tiarella unifoliata	.	.	2	1	3	2	.	.
Trautvetteria caroliniensis	.	.	2	1	.	.	.	.
Trillium ovatum	.	.	2	1	3	1	.	.
Valeriana sitchensis	.	.	2	1	.	.	.	.
Viola adunca	.	.	10	1	9	1	14	2
Viola canadensis	.	.	.	.	.	.	.	.
Viola orbiculata	.	.	5	1	6	1	4	2

Table 87 (cont.). Mean cover and constancy of important plant species in the Douglas-fir Series by plant association.

SPECIES	PSME/SYAL 13 PLOTS		PSME/SYOR 9 PLOTS		PSME/VACA 12 PLOTS		PSME/VAME 11 PLOTS	
TREE OVERSTORY LAYER	CON	COV	CON	COV	CON	COV	CON	COV
Abies grandis	.	.	.	.	.	.	.	.
Abies lasiocarpa	.	.	.	.	.	.	.	.
Betula papyrifera	.	.	.	.	.	.	.	.
Larix occidentalis	8	40	44	17	75	12	100	16
Pinus albicaulis	.	.	.	.	.	.	.	.
Pinus contorta	8	10	.	.	83	19	91	22
Picea engelmannii	.	.	.	.	25	4	18	2
Pinus monticola	.	.	.	.	.	.	.	.
Pinus ponderosa	85	35	67	16	42	12	27	3
Pseudotsuga menziesii	85	26	100	36	92	24	100	23
Thuja plicata	.	.	.	.	.	.	.	.
Tsuga heterophylla	.	.	.	.	.	.	.	.
TREE UNDERSTORY LAYER								
Abies grandis	.	.	.	.	.	.	.	.
Abies lasiocarpa	.	.	.	.	8	3	27	2
Pinus albicaulis	.	.	.	.	.	.	.	.
Picea engelmannii	.	.	.	.	42	2	9	4
Pinus ponderosa	31	1	11	1	17	3	.	.
Pseudostuga menziesii	69	4	89	3	100	11	82	7
Thuja plicata	.	.	.	.	.	.	.	.
Tsuga heterophylla	.	.	.	.	.	.	9	1
SHRUBS AND SUBSHRUBS								
Acer douglasii	23	2	22	4	17	2	9	5
Alnus sinuata	.	.	.	.	.	.	45	8
Amelanchier alnifolia	69	4	56	4	92	2	73	3
Arctostaphylos uva-ursi	.	.	44	1	100	7	55	5
Berberis aquifolium	54	3	11	10	67	1	55	5
Berberis nervosa	.	.	.	.	.	.	.	.
Chimaphila umbellata	.	.	.	.	67	4	45	5
Cornus canadensis	.	.	.	.	33	7	.	.
Cornus stolonifera	.	.	.	.	8	2	.	.
Holodiscus discolor	23	2	11	1	.	.	18	2
Juniperus communis	.	.	.	.	.	.	.	.
Linnaea borealis	.	.	.	.	83	14	73	15
Lonicera ciliosa	.	.	.	.	8	1	9	4
Lonicera utahensis	.	.	.	.	67	5	36	4

Table 87 (cont.). Mean cover and constancy of important plant species in the Douglas-fir Series by plant association.

SPECIES	PSME/SYAL 13 PLOTS		PSME/SYOR 9 PLOTS		PSME/VACA 12 PLOTS		PSME/VAME 11 PLOTS	
SHRUBS AND SUBSHRUBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Menziesia ferruginea	.	.	.	.	.	.	.	.
Oplopanax horridum	.	.	.	.	.	.	.	.
Pachistima myrsinites	38	4	11	6	75	2	91	14
Physocarpus malvaceus	.	.	.	.	17	1	.	.
Pyrola asarifolia	.	.	.	.	.	.	.	.
Pyrola secunda	.	.	.	.	33	2	36	2
Rhododendron albiflorum	.	.	.	.	.	.	.	.
Ribes lacustre	.	.	.	.	8	2	9	1
Rosa gymnocarpa	31	6	11	3	33	3	64	6
Rubus parviflorus	.	.	.	.	25	2	27	2
Rubus pedatus	.	.	.	.	.	.	.	.
Salix scouleriana	31	2	.	.	8	2	55	6
Shepherdia canadensis	15	3	.	.	67	9	18	2
Sorbus scopulina	.	.	.	.	8	1	18	1
Spiraea betulifolia	46	5	33	3	92	11	82	6
Symphoricarpos albus	100	43	.	.	75	5	27	1
Symphoricarpos oreophilus	.	.	100	11	8	1	.	.
Taxus brevifolia	.	.	.	.	.	.	.	.
Vaccinium caespitosum	8	5	.	.	100	5	9	1
Vaccinium membranaceum	.	.	.	.	25	6	55	18
Vaccinium myrtillus	.	.	.	.	8	3	36	18
Vaccinium scoparium	.	.	.	.	8	5	45	13
Xerophyllum tenax	.	.	.	.	.	.	.	.
HERBS								
Achillea millefolium	54	2	89	2	42	3	9	1
Actaea rubra	.	.	.	.	.	.	.	.
Adenocaulon bicolor	.	.	.	.	.	.	18	3
Agropyron inerme	.	.	22	5	.	.	.	.
Agropyron spicatum	15	2	33	2	8	5	.	.
Aralia nudicaulis	.	.	.	.	.	.	.	.
Arnica cordifolia	54	5	44	4	50	6	27	5
Asarum caudatum	.	.	.	.	.	.	.	.
Athyrium filix-femina	.	.	.	.	.	.	.	.
Balsamorhiza sagittata	15	1	11	20	.	.	.	.
Bromus tectorum	15	2	22	2	.	.	.	.
Bromus vulgaris	8	1	22	3	25	1	9	2
Calamagrostis canadensis	.	.	.	.	.	.	.	.

Table 87 (cont.). Mean cover and constancy of important plant species in the Douglas-fir Series by plant association.

SPECIES	PSME/SYAL 13 PLOTS		PSME/SYOR 9 PLOTS		PSME/VACA 12 PLOTS		PSME/VAME 11 PLOTS	
HERBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Calamagrostis rubescens	85	14	89	29	100	27	100	21
Carex concinnoides	8	1	22	1	42	3	55	2
Carex rossii	8	1	44	2	8	1	9	2
Circaea alpina	.	.	.	.	.	.	.	.
Clintonia uniflora	.	.	.	.	.	.	18	4
Disporum hookeri	.	.	.	.	8	1	.	.
Disporum trachycarpum	.	.	22	2	42	2	.	.
Equisetum arvense	.	.	.	.	8	2	.	.
Eriogonum heracleoides	.	.	.	.	.	.	.	.
Festuca idahoensis	15	2	22	6	.	.	.	.
Galium triflorum	.	.	11	1	8	2	.	.
Goodyera oblongifolia	8	3	.	.	25	1	18	2
Gymnocarpium dryopteris	.	.	.	.	.	.	.	.
Hieracium albiflorum	31	2	11	2	33	2	73	2
Hypopitys monotropa	.	.	.	.	.	.	.	.
Koeleria cristata	.	.	22	4	.	.	.	.
Lithospermum ruderale	31	1	11	1	.	.	.	.
Lupinus sericeus	23	14	56	5	33	4	9	10
Luzula hitchcockii	.	.	.	.	.	.	.	.
Osmorhiza chilensis	62	2	.	.	25	1	36	2
Pedicularis bracteosa	.	.	.	.	.	.	27	2
Pedicularis racemosa	.	.	.	.	.	.	.	.
Poa pratensis	8	25	.	.	8	2	.	.
Poa sandbergii	.	.	11	2	.	.	.	.
Senecio triangularis	.	.	.	.	.	.	.	.
Smilacina racemosa	15	2	67	1	58	3	36	2
Smilacina stellata	.	.	.	.	25	2	36	1
Streptopus amplexifolius	.	.	.	.	.	.	.	.
Thalictrum occidentale	23	4	44	3	42	2	18	1
Tiarella unifoliata	.	.	.	.	.	.	.	.
Trautvetteria caroliniensis	.	.	.	.	8	1	.	.
Trillium ovatum	.	.	.	.	.	.	.	.
Valeriana sitchensis	.	.	.	.	.	.	.	.
Viola adunca	.	.	.	.	67	2	.	.
Viola canadensis	.	.	.	.	.	.	.	.
Viola orbiculata	.	.	.	.	8	2	36	3

Table 88. Mean cover and constancy of important plant species in the Grand Fir Series by plant association.

SPECIES	ABGR/ACGL/ CLUN 4 PLOTS		ABGR/PHMA 7 PLOTS		ABGR/VACA 9 PLOTS		ABGR/VAME/ CLUN 8 PLOTS	
TREE OVERSTORY LAYER	CON	COV	CON	COV	CON	COV	CON	COV
Abies grandis	75	24	43	15	44	9	75	23
Abies lasiocarpa	.	.	.	.	11	5	.	.
Betula papyrifera	50	3	.	.	11	5	.	.
Larix occidentalis	75	17	71	5	89	20	100	12
Pinus albicaulis	.	.	.	.	.	.	.	.
Pinus contorta	50	7	29	10	100	19	50	4
Picea engelmannii	25	8	.	.	33	3	.	.
Pinus monticola	.	.	29	3	11	5	13	5
Pinus ponderosa	50	5.5	57	22	44	12	13	1
Pseudotsuga menziesii	100	24	100	37	100	10	100	38
Thuja plicata	.	.	14	1	.	.	.	.
Tsuga heterophylla	.	.	.	.	.	.	.	.
TREE UNDERSTORY LAYER								
Abies grandis	100	3	71	2	100	4	75	3
Abies lasiocarpa	25	1	.	.	11	1	25	2
Pinus albicaulis	.	.	.	.	.	.	.	.
Picea engelmannii	25	2	.	.	44	2	.	.
Pinus ponderosa	.	.	.	.	11	1	.	.
Pseudostuga menziesii	50	1	43	1	100	4	50	1
Thuja plicata	.	.	.	.	11	1	.	.
Tsuga heterophylla	.	.	.	.	11	2	.	.
SHRUBS AND SUBSHRUBS								
Acer douglasii	100	11	86	2	11	1	63	1
Alnus sinuata	.	.	.	.	22	11	13	5
Amelanchier alnifolia	100	2	100	2	89	3	100	3
Arctostaphylos uva-ursi	25	1	.	.	89	8	.	.
Berberis aquifolium	100	5	71	7	100	4	13	2
Berberis nervosa	.	.	.	.	.	.	.	.
Chimaphila umbellata	75	4	71	3	78	4	25	2
Cornus canadensis	.	.	.	.	56	9	.	.
Cornus stolonifera	50	3	.	.	.	.	.	.
Holodiscus discolor	50	2	100	9	33	5	63	3
Juniperus communis	.	.	.	.	.	.	.	.
Linnaea borealis	100	20	29	2	89	10	.	.
Lonicera ciliosa	50	2	43	2	89	3	25	2
Lonicera utahensis	50	2	29	3	22	2	100	4

Table 88 (cont.). Mean cover and constancy of important plant species in the Grand Fir Series by plant association.

SPECIES	ABGR/ACGL/ CLUN 4 PLOTS		ABGR/PHMA 7 PLOTS		ABGR/VACA 9 PLOTS		ABGR/VAME /CLUN 8 PLOTS	
SHRUBS AND SUBSHRUBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Menziesia ferruginea	.	.	.	.	.	.	.	.
Oplopanax horridum	.	.	.	.	.	.	.	.
Pachistima myrsinites	75	3	86	3	100	3	75	3
Physocarpus malvaceus	50	2	86	13	33	2	38	23
Pyrola asarifolia	.	.	.	.	22	1	.	.
Pyrola secunda	50	3	14	1	.	.	38	1
Rhododendron albiflorum	.	.	.	.	.	.	.	.
Ribes lacustre	25	1	.	.	11	1	13	1
Rosa gymnocarpa	25	6	100	6	100	5	88	10
Rubus parviflorus	50	3	57	2	33	4	75	3
Rubus pedatus	.	.	.	.	.	.	.	.
Salix scouleriana	50	5	14	3	44	2	.	.
Shepherdia canadensis	.	.	.	.	56	9	.	.
Sorbus scopulina	50	1	29	1	22	2	88	2
Spiraea betulifolia	25	8	100	7	89	7	100	6
Symphoricarpos albus	100	4	71	4	78	7	38	3
Symphoricarpos oreophilus	.	.	.	.	.	.	.	.
Taxus brevifolia	.	.	14	1	.	.	13	1
Vaccinium caespitosum	.	.	.	.	67	3	.	.
Vaccinium membranaceum	.	.	71	5	67	3	100	23
Vaccinium myrtillus	.	.	.	.	44	12	.	.
Vaccinium scoparium	.	.	.	.	22	9	.	.
Xerophyllum tenax	.	.	.	.	.	.	.	.
HERBS								
Achillea millefolium	.	.	.	.	22	3	.	.
Actaea rubra	.	.	.	.	.	.	.	.
Adenocaulon bicolor	75	2	71	8	33	2	75	9
Agropyron inerme	.	.	.	.	.	.	.	.
Agropyron spicatum	.	.	.	.	.	.	.	.
Aralia nudicaulis	.	.	.	.	.	.	.	.
Arnica cordifolia	.	.	29	2	22	4	50	2
Asarum caudatum	.	.	14	1	.	.	13	1
Athyrium filix-femina	.	.	.	.	.	.	.	.
Balsamorhiza sagittata	.	.	.	.	.	.	.	.
Bromus tectorum	.	.	.	.	.	.	.	.
Bromus vulgaris	50	3	29	1	33	5	88	2
Calamagrostis canadensis	.	.	.	.	.	.	.	.

Table 88 (cont.). Mean cover and constancy of important plant species in the Grand Fir Series by plant association.

SPECIES	ABGR/ACGL/ CLUN 4 PLOTS		ABGR/PHMA 7 PLOTS		ABGR/VACA 9 PLOTS		ABGR/VAME /CLUN 8 PLOTS	
HERBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Calamagrostis rubescens	25	2	71	6	100	17	38	1
Carex concinnoides	50	3	71	2	33	2	75	1
Carex rossii	.	.	57	2	33	1	50	2
Circaea alpina	.	.	14	1	.	.	13	1
Clintonia uniflora	50	2	57	2	56	3	100	3
Disporum hookeri	.	.	14	1	.	.	13	1
Disporum trachycarpum	50	2	29	3	11	3	13	1
Equisetum arvense	.	.	.	.	.	.	13	1
Eriogonum heracleoides	.	.	.	.	.	.	.	.
Festuca idahoensis	25	1	.	.	.	.	50	2
Galium triflorum	50	2	71	3	44	2	75	3
Goodyera oblongifolia	.	.	43	2	11	2	63	2
Gymnocarpium dryopteris	.	.	.	.	.	.	.	.
Hieracium albiflorum	75	2	100	2	100	3	75	2
Hypopitys monotropa	.	.	.	.	.	.	.	.
Koeleria cristata	.	.	.	.	.	.	.	.
Lithospermum ruderale	.	.	.	.	.	.	.	.
Lupinus sericeus	25	1	.	.	22	4	13	1
Luzula hitchcockii	.	.	.	.	.	.	.	.
Osmorhiza chilensis	100	2	86	2	67	3	100	3
Pedicularis bracteosa	.	.	.	.	.	.	38	1
Pedicularis racemosa	.	.	.	.	.	.	.	.
Poa pratensis	50	1	.	.	11	3	.	.
Poa sandbergii	.	.	.	.	.	.	.	.
Senecio triangularis	.	.	.	.	.	.	.	.
Smilacina racemosa	25	2	29	3	22	2	75	2
Smilacina stellata	100	3	86	5	67	7	100	5
Streptopus amplexifolius	.	.	.	.	.	.	.	.
Thalictrum occidentale	50	2	43	3	22	3	100	4
Tiarella unifoliata	.	.	.	.	.	.	.	.
Trautvetteria caroliniensis	.	.	.	.	.	.	13	2
Trillium ovatum	.	.	14	1	11	1	13	1
Valeriana sitchensis	.	.	.	.	.	.	.	.
Viola adunca	.	.	14	1	44	2	.	.
Viola canadensis	.	.	.	.	.	.	.	.
Viola orbiculata	50	4	29	3	44	3	13	1

Table 89. Mean cover and constancy of important plant species in the Subalpine Fir Series by plant association.

SPECIES	ABLA2/CARU 7 PLOTS		ABLA2/CLUN 15 PLOTS		ABLA2/COCA 19 PLOTS		ABLA2/LIBOL 13 PLOTS	
TREE OVERSTORY LAYER	CON	COV	CON	COV	CON	COV	CON	COV
Abies grandis	.	.	.	.	.	.	.	.
Abies lasiocarpa	71	6	93	24	68	13	54	16
Betula papyrifera	.	.	.	.	11	6	.	.
Larix occidentalis	100	10	80	13	74	8	69	21
Pinus albicaulis	.	.	.	.	.	.	.	.
Pinus contorta	29	20	60	11	47	4	38	18
Picea engelmannii	29	2	93	14	100	26	85	26
Pinus monticola	.	.	13	1	.	.	.	.
Pinus ponderosa	.	.	.	.	11	1	.	.
Pseudotsuga menziesii	100	36	53	10	95	23	54	19
Thuja plicata	.	.	7	5	.	.	.	.
Tsuga heterophylla	.	.	33	4	.	.	.	.
TREE UNDERSTORY LAYER								
Abies grandis	.	.	20	1	.	.	.	.
Abies lasiocarpa	71	2	93	11	53	7	54	9
Pinus albicaulis	14	1	.	.	.	.	.	.
Picea engelmannii	14	2	53	3	84	5	77	4
Pinus ponderosa	.	.	.	.	.	.	.	.
Pseudostuga menziesii	86	10	20	3	58	4	54	7
Thuja plicata	.	.	13	2	.	.	.	.
Tsuga heterophylla	.	.	7	2	.	.	.	.
SHRUBS AND SUBSHRUBS								
Acer douglasii	.	.	13	7	26	10	15	2
Alnus sinuata	.	.	33	9	26	3	15	1
Amelanchier alnifolia	43	2	40	2	84	3	38	1
Arctostaphylos uva-ursi	29	2	7	6	11	7	8	5
Berberis aquifolium	.	.	27	3	53	3	23	3
Berberis nervosa	.	.	.	.	.	.	.	.
Chimaphila umbellata	.	.	73	3	63	3	62	2
Cornus canadensis	.	.	13	3	100	14	23	2
Cornus stolonifera	.	.	13	1	68	5	15	1
Holodiscus discolor	.	.	.	.	5	3	.	.
Juniperus communis	14	1	.	.	.	.	.	.
Linnaea borealis	29	3	73	8	95	13	77	10
Lonicera ciliosa	.	.	.	.	5	2	.	.
Lonicera utahensis	29	4	87	4	84	4	46	3

Table 89 (cont.). Mean cover and constancy of important plant species in the Subalpine Fir Series by plant association.

SPECIES	ABLA2/CARU 7 PLOTS		ABLA2/CLUN 15 PLOTS		ABLA2/COCA 19 PLOTS		ABLA2/LIBOL 13 PLOTS	
SHRUBS AND SUBSHRUBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Menziesia ferruginea	.	.	.	.	.	.	.	.
Oplopanax horridum	.	.	.	.	.	.	.	.
Pachistima myrsinites	71	3	87	3	63	3	38	2
Physocarpus malvaceus	.	.	.	.	16	1	23	2
Pyrola asarifolia	.	.	13	2	.	.	.	.
Pyrola secunda	43	1	87	3	79	3	92	2
Rhododendron albiflorum	.	.	.	.	.	.	.	.
Ribes lacustre	.	.	60	1	79	3	69	3
Rosa gymnocarpa	29	10	20	2	68	4	8	2
Rubus parviflorus	.	.	53	2	74	3	38	3
Rubus pedatus	.	.	.	.	5	3	8	1
Salix scouleriana	43	2	7	1	.	.	.	.
Shepherdia canadensis	.	.	7	15	11	3	8	1
Sorbus scopulina	.	.	40	1	11	2	.	.
Spiraea betulifolia	71	4	33	3	42	6	8	15
Symphoricarpos albus	14	2	20	2	63	5	62	4
Symphoricarpos oreophilus	14	1	.	.	.	.	.	.
Taxus brevifolia	.	.	.	.	.	.	.	.
Vaccinium caespitosum	29	2	.	.	11	3	.	.
Vaccinium membranaceum	14	2	27	3	42	7	.	.
Vaccinium myrtillus	43	2	53	10	16	6	15	2
Vaccinium scoparium	14	15	27	5	32	4	8	1
Xerophyllum tenax	.	.	.	.	.	.	.	.
HERBS								
Achillea millefolium	57	2	7	1	.	.	8	1
Actaea rubra	.	.	.	.	32	3	15	3
Adenocaulon bicolor	.	.	53	3	11	1	.	.
Agropyron inerme	.	.	.	.	.	.	.	.
Agropyron spicatum	.	.	.	.	.	.	.	.
Aralia nudicaulis	.	.	.	.	11	18	.	.
Arnica cordifolia	100	9	27	10	21	4	15	2
Asarum caudatum	.	.	.	.	.	.	.	.
Athyrium filix-femina	.	.	13	1	.	.	.	.
Balsamorhiza sagittata	.	.	.	.	.	.	.	.
Bromus tectorum	.	.	.	.	.	.	.	.
Bromus vulgaris	29	2	67	3	53	3	23	2
Calamagrostis canadensis	.	.	.	.	5	3	.	.
Calamagrostis rubescens	100	56	53	4	68	4	38	7

Table 89 (cont.). Mean cover and constancy of important plant species in the Subalpine Fir Series by plant association.

SPECIES	ABLA2/CARU 7 PLOTS		ABLA2/CLUN 15 PLOTS		ABLA2/COCA 19 PLOTS		ABLA2/LIBOL 13 PLOTS	
HERBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Carex concinnoides	43	3	27	2	26	3	31	3
Carex rossii	.	.	13	3	.	.	23	3
Circaea alpina	.	.	.	.	5	1	.	.
Clintonia uniflora	.	.	93	6	68	3	15	2
Disporum hookeri	.	.	.	.	5	4	8	3
Disporum trachycarpum	.	.	.	.	53	2	15	2
Equisetum arvense	.	.	7	2	21	2	.	.
Eriogonum heracleoides	.	..	.	.	.	.	.	.
Festuca idahoensis	.	.	.	.	.	.	.	.
Galium triflorum	.	.	60	1	84	3	54	2
Goodyera oblongifolia	14	2	60	2	79	2	62	1
Gymnocarpium dryopteris	.	.	.	.	26	18	.	.
Hieracium albiflorum	57	2	53	2	37	2	23	2
Hypopitys monotropa	.	.	.	.	.	.	.	.
Koeleria cristata	.	.	.	.	.	.	.	.
Lithospermum ruderale	.	.	.	.	.	.	.	.
Lupinus sericeus	29	2	.	.	5	1	.	.
Luzula hitchcockii	.	.	.	.	.	.	.	.
Osmorhiza chilensis	57	3	67	2	79	3	46	2
Pedicularis bracteosa	57	2	.	.	.	.	.	.
Pedicularis racemosa	.	.	40	2	11	1	.	.
Poa pratensis	.	.	.	.	.	.	.	.
Poa sandbergii	.	.	.	.	.	.	.	.
Senecio triangularis	.	.	.	.	.	.	.	.
Smilacina racemosa	43	3	13	1	32	2	8	1
Smilacina stellata	.	.	67	4	63	3	46	1
Streptopus amplexifolius	.	.	7	2	26	3	15	1
Thalictrum occidentale	86	3	73	2	26	3	54	2
Tiarella unifoliata	.	.	47	2	16	1	23	2
Trautvetteria caroliniensis	29	2	7	2	26	7	15	3
Trillium ovatum	.	.	7	1	.	.	.	.
Valeriana sitchensis	.	.	13	2	.	.	.	.
Viola adunca	14	1	.	.	5	4	8	1
Viola canadensis	.	.	.	.	5	10	.	.
Viola orbiculata	.	.	80	3	16	1	23	1

Table 89 (cont.). Mean cover and constancy of important plant species in the Subalpine Fir Series by plant association.

SPECIES	ABLA2/RHAL 11 PLOTS		ABLA2/RHAL-XETE 11 PLOTS		ABLA2/TRCA3 8 PLOTS		ABLA2/VACA 15 PLOTS	
TREE OVERSTORY LAYER	CON	COV	CON	COV	CON	COV	CON	COV
Abies grandis	.	.	.	.	50	14	.	.
Abies lasiocarpa	100	26	100	35	88	23	20	5
Betula papyrifera	.	.	.	.	.	.	.	.
Larix occidentalis	73	11	27	7	75	21	93	18
Pinus albicaulis	.	.	9	2	.	.	.	.
Pinus contorta	82	10	36	5	50	16	73	20
Picea engelmannii	45	18	82	13	88	15	47	7
Pinus monticola	18	8	9	3	.	.	.	.
Pinus ponderosa	.	.	.	.	.	.	7	1
Pseudotsuga menziesii	27	5	18	3	88	7	73	23
Thuja plicata	.	.	9	2	13	1	.	.
Tsuga heterophylla	.	.	18	3	.	.	.	.
TREE UNDERSTORY LAYER								
Abies grandis	9	1	.	.	38	1	13	3
Abies lasiocarpa	100	14	100	10	88	3	60	6
Pinus albicaulis	.	.	.	.	.	.	.	.
Picea engelmannii	36	3	73	3	63	1	67	3
Pinus ponderosa	.	.	.	.	.	.	.	.
Pseudostuga menziesii	9	2	.	.	.	.	93	6
Thuja plicata	9	2	9	8	13	2	7	1
Tsuga heterophylla	18	1	27	2	.	.	.	.
SHRUBS AND SUBSHRUBS								
Acer douglasii	.	.	9	1	.	.	7	2
Alnus sinuata	18	1	9	5	25	2	13	4
Amelanchier alnifolia	.	.	9	4	13	2	80	2
Arctostaphylos uva-ursi	9	2	.	.	.	.	87	9
Berberis aquifolium	9	1	.	.	.	.	73	2
Berberis nervosa	.	.	.	.	.	.	.	.
Chimaphila umbellata	55	2	.	.	13	2	73	4
Cornus canadensis	.	.	.	.	.	.	33	6
Cornus stolonifera	.	.	.	.	13	3	.	.
Holodiscus discolor	.	.	.	.	.	.	7	1
Juniperus communis	.	.	.	.	.	.	7	1
Linnaea borealis	18	3	.	.	13	3	93	19
Lonicera ciliosa	.	.	.	.	.	.	20	2
Lonicera utahensis	73	4	82	4	75	3	67	3

Table 89 (cont.). Mean cover and constancy of important plant species in the Subalpine Fir Series by plant association.

SPECIES	ABLA2/RHAL 11 PLOTS		ABLA2/RHAL-XETE 11 PLOTS		ABLA2/TRCA3 8 PLOTS		ABLA2/VACA 15 PLOTS	
SHRUBS AND SUBSHRUBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Menziesia ferruginea	36	33	64	17	.	.	.	.
Oplopanax horridum	.	.	.	.	.	.	.	.
Pachistima myrsinites	55	5	82	4	63	2	93	5
Physocarpus malvaceus	.	.	.	.	.	.	.	.
Pyrola asarifolia	9	1	18	3	50	4	.	.
Pyrola secunda	55	3	73	3	100	2	60	2
Rhododendron albiflorum	100	22	100	36	13	1	.	.
Ribes lacustre	36	2	18	1	63	4	13	3
Rosa gymnocarpa	.	.	.	.	13	2	53	3
Rubus parviflorus	.	.	.	.	25	3	27	3
Rubus pedatus	18	15	.	.	25	10	.	.
Salix scouleriana	9	3	.	.	13	2	33	4
Shepherdia canadensis	.	.	.	.	.	.	47	6
Sorbus scopulina	9	1	100	3	25	2	7	1
Spiraea betulifolia	9	1	.	.	50	2	60	5
Symphoricarpos albus	.	.	.	.	13	1	20	2
Symphoricarpos oreophilus	.	.	.	.	.	.	.	.
Taxus brevifolia	.	.	.	.	.	.	.	.
Vaccinium caespitosum	.	.	.	.	.	.	67	6
Vaccinium membranaceum	55	15	100	18	63	19	33	5
Vaccinium myrtillus	55	12	9	5	13	4	27	10
Vaccinium scoparium	64	14	9	2	38	3	40	5
Xerophyllum tenax	.	.	100	15	.	.	.	.
HERBS								
Achillea millefolium	.	.	.	.	.	.	27	2
Actaea rubra	.	.	.	.	13	1	.	.
Adenocaulon bicolor	.	.	.	.	.	.	.	.
Agropyron inerme	.	.	.	.	.	.	.	.
Agropyron spicatum	.	.	.	.	.	.	.	.
Aralia nudicaulis	.	.	.	.	.	.	.	.
Arnica cordifolia	27	1	9	2	25	6	33	3
Asarum caudatum	.	.	.	.	.	.	.	.
Athyrium filix-femina	18	9	.	.	13	6	.	.
Balsamorhiza sagittata	.	.	.	.	.	.	.	.
Bromus tectorum	.	.	.	.	.	.	.	.
Bromus vulgaris	9	2	.	.	13	2	20	2
Calamagrostis canadensis	.	.	.	.	13	2	.	.
Calamagrostis rubescens	18	2	.	.	13	3	100	27

Table 89 (cont.). Mean cover and constancy of important plant species in the Subalpine Fir Series by plant association.

SPECIES	ABLA2/RHAL 11 PLOTS		ABLA2/RHAL-XETE 11 PLOTS		ABLA2/TRCA3 8 PLOTS		ABLA2/VACA 15 PLOTS	
HERBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Carex concinnoides	18	2	.	.	13	3	53	3
Carex rossii	9	1	.	.	.	.	20	1
Circaea alpina	.	.	.	.	.	.	.	.
Clintonia uniflora	18	10	9	3	75	7	27	3
Disporum hookeri	.	.	9	1	13	1	.	.
Disporum trachycarpum	.	.	.	.	.	.	13	4
Equisetum arvense	.	.	.	.	.	.	.	.
Eriogonum heracleoides	.	.	.	.	.	.	.	.
Festuca idahoensis	.	.	.	.	.	.	.	.
Galium triflorum	18	5	.	.	50	3	7	2
Goodyera oblongifolia	45	2	36	2	75	1	47	2
Gymnocarpium dryopteris	18	13	.	.	13	3	.	.
Hieracium albiflorum	36	2	9	1	13	1	80	2
Hypopitys monotropa	9	1	18	2	.	.	.	.
Koeleria cristata	.	.	.	.	.	.	.	.
Lithospermum ruderale	.	.	.	.	.	.	.	.
Lupinus sericeus	.	.	.	.	.	.	33	6
Luzula hitchcockii	27	1	45	4	.	.	.	.
Osmorhiza chilensis	27	3	9	2	63	2	40	1
Pedicularis bracteosa	.	.	18	1	63	2	13	1
Pedicularis racemosa	27	1	18	1	25	2	7	2
Poa pratensis	.	.	.	.	.	.	.	.
Poa sandbergii	.	.	.	.	.	.	.	.
Senecio triangularis	18	9	.	.	.	.	.	.
Smilacina racemosa	.	.	.	.	38	2	47	2
Smilacina stellata	9	5	9	1	38	5	33	3
Streptopus amplexifolius	18	3	.	.	25	3	.	.
Thalictrum occidentale	18	2	.	.	75	4	20	2
Tiarella unifoliata	18	13	64	3	25	12	.	.
Trautvetteria caroliniensis	18	3	.	.	100	15	.	.
Trillium ovatum	.	.	.	.	50	1	.	.
Valeriana sitchensis	18	1	18	1	25	2	.	.
Viola adunca	.	.	.	.	.	.	20	2
Viola canadensis	18	9	.	.	.	.	.	.
Viola orbiculata	36	2	45	2	88	4	20	2

Table 89 (cont.). Mean cover and constancy of important plant species in the Subalpine Fir Series by plant association.

SPECIES	ABLA2/VAME 24 PLOTS		ABLA2/VASC 6 PLOTS		ABLA2/XETE 15 PLOTS		PIEN/EQUIS 5 PLOTS	
TREE OVERSTORY LAYER	CON	COV	CON	COV	CON	COV	CON	COV
Abies grandis	21	6	.	.	.	.	.	.
Abies lasiocarpa	71	15	100	31	100	35	80	13
Betula papyrifera	.	.	.	.	.	.	.	.
Larix occidentalis	96	19	17	2	40	10	20	2
Pinus albicaulis	.	.	.	.	.	.	.	.
Pinus contorta	79	22	100	26	50	6	.	.
Picea engelmannii	38	13	.	.	70	11	100	44
Pinus monticola	4	1	.	.	.	.	.	.
Pinus ponderosa	8	3	.	.	.	.	.	.
Pseudotsuga menziesii	67	18	17	3	50	6	40	3
Thuja plicata	.	.	.	.	10	2	.	.
Tsuga heterophylla	.	.	.	.	10	5	.	.
TREE UNDERSTORY LAYER								
Abies grandis	25	2	.	.	.	.	.	.
Abies lasiocarpa	79	11	100	14	100	20	80	5
Pinus albicaulis	.	.	.	.	10	1	.	.
Picea engelmannii	42	6	.	.	70	3	100	2
Pinus ponderosa	.	.	.	.	.	.	.	.
Pseudostuga menziesii	42	5	.	.	10	6	20	1
Thuja plicata	8	2	.	.	40	2	.	.
Tsuga heterophylla	.	.	.	.	30	1	.	.
SHRUBS AND SUBSHRUBS								
Acer douglasii	13	1	.	.	10	1	.	.
Alnus sinuata	25	3	.	.	.	.	80	9
Amelanchier alnifolia	42	2	.	.	10	5	20	1
Arctostaphylos uva-ursi	13	4	.	.	.	.	.	.
Berberis aquifolium	13	3	.	.	.	.	.	.
Berberis nervosa	.	.	.	.	.	.	.	.
Chimaphila umbellata	75	3	67	2	20	3	60	1
Cornus canadensis	.	.	.	.	.	.	100	8
Cornus stolonifera	4	1	.	.	.	.	100	5
Holodiscus discolor	4	1	.	.	.	.	.	.
Juniperus communis	.	.	.	.	.	.	.	.
Linnaea borealis	38	9	.	.	.	.	80	4
Lonicera ciliosa	.	.	.	.	.	.	.	.
Lonicera utahensis	62	3	33	2	70	3	20	2

Table 89 (cont.). Mean cover and constancy of important plant species in the Subalpine Fir Series by plant association.

SPECIES	ABLA2/VAME 24 PLOTS		ABLA2/VASC 6 PLOTS		ABLA2/XETE 15 PLOTS		PIEN/EQUIS 5 PLOTS	
SHRUBS AND SUBSHRUBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Menziesia ferruginea	.	.	.	.	30	1	.	.
Oplopanax horridum	.	.	.	.	.	.	.	.
Pachistima myrsinites	92	6	67	6	40	3	.	.
Physocarpus malvaceus	.	.	.	.	.	.	.	.
Pyrola asarifolia	4	2	.	.	10	1	60	5
Pyrola secunda	50	3	33	8	40	2	80	2
Rhododendron albiflorum	8	2	.	.	50	3	.	.
Ribes lacustre	17	2	.	.	.	.	100	4
Rosa gymnocarpa	38	3	.	.	.	.	20	3
Rubus parviflorus	21	2	.	.	.	.	60	1
Rubus pedatus	.	.	.	.	.	.	60	3
Salix scouleriana	13	5	.	.	10	1	.	.
Shepherdia canadensis	4	25	.	.	.	.	.	.
Sorbus scopulina	38	2	50	2	100	4	.	.
Spiraea betulifolia	62	6	.	.	20	3	.	.
Symphoricarpos albus	13	1	.	.	.	.	40	3
Symphoricarpos oreophilus	.	.	.	.	.	.	.	.
Taxus brevifolia	4	1	.	.	.	.	.	.
Vaccinium caespitosum	4	1	.	.	20	5	.	.
Vaccinium membranaceum	54	18	17	2	90	24	.	.
Vaccinium myrtillus	58	10	50	10	50	10	60	3
Vaccinium scoparium	25	15	67	25	30	16	.	.
Xerophyllum tenax	4	2	.	.	100	31	.	.
HERBS								
Achillea millefolium	13	2	33	1	10	2	.	.
Actaea rubra	.	.	.	.	.	.	40	2
Adenocaulon bicolor	17	2	.	.	.	.	.	.
Agropyron inerme	.	.	.	.	.	.	.	.
Agropyron spicatum	.	.	.	.	.	.	.	.
Aralia nudicaulis	.	.	.	.	.	.	.	.
Arnica cordifolia	38	3	17	8	.	.	40	1
Asarum caudatum	.	.	.	.	.	.	.	.
Athyrium filix-femina	.	.	.	.	.	.	80	3
Balsamorhiza sagittata	.	.	.	.	.	.	.	.
Bromus tectorum	.	.	.	.	.	.	.	.
Bromus vulgaris	33	2	.	.	10	2	.	.
Calamagrostis canadensis	.	.	.	.	.	.	100	5
Calamagrostis rubescens	79	25	17	8	10	10	.	.

Table 89 (cont.). Mean cover and constancy of important plant species in the Subalpine Fir Series by plant association.

SPECIES	ABLA2/VAME 24 PLOTS		ABLA2/VASC 6 PLOTS		ABLA2/XETE 15 PLOTS		PIEN/EQUIS 5 PLOTS	
HERBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Carex concinnoides	33	2	33	2	10	3	.	.
Carex rossii	8	3	33	2	10	2	.	.
Circaea alpina	.	.	.	.	.	.	20	1
Clintonia uniflora	33	2	.	.	10	2	40	3
Disporum hookeri	.	.	.	.	.	.	.	.
Disporum trachycarpum	.	.	.	.	.	.	.	.
Equisetum arvense	.	.	.	.	.	.	80	36
Eriogonum heracleoides	.	.	.	.	.	.	.	.
Festuca idahoensis	.	.	.	.	.	.	.	.
Galium triflorum	13	1	.	.	.	.	40	2
Goodyera oblongifolia	42	2	.	.	30	2	20	1
Gymnocarpium dryopteris	.	.	.	.	.	.	80	19
Hieracium albiflorum	75	2	17	2	60	2	.	.
Hypopitys monotropa	8	3	50	2	.	.	.	.
Koeleria cristata	.	.	.	.	.	.	.	.
Lithospermum ruderale	.	.	.	.	.	.	.	.
Lupinus sericeus	4	10	.	.	.	.	.	.
Luzula hitchcockii	.	.	.	.	60	3	.	.
Osmorhiza chilensis	54	2	.	.	10	2	60	2
Pedicularis bracteosa	17	2	.	.	.	.	.	.
Pedicularis racemosa	13	1	.	.	10	1	.	.
Poa pratensis	.	.	.	.	.	.	.	.
Poa sandbergii	.	.	.	.	.	.	.	.
Senecio triangularis	.	.	.	.	.	.	60	2
Smilacina racemosa	13	2	.	.	.	.	.	.
Smilacina stellata	29	1	.	.	10	1	40	2
Streptopus amplexifolius	4	2	.	.	.	.	80	4
Thalictrum occidentale	33	4	.	.	10	2	.	.
Tiarella unifoliata	8	1	.	.	.	.	60	5
Trautvetteria caroliniensis	4	1	.	.	.	.	80	2
Trillium ovatum	.	.	.	.	.	.	.	.
Valeriana sitchensis	13	1	83	3	10	1	.	.
Viola adunca	.	.	.	.	.	.	.	.
Viola canadensis	.	.	.	.	.	.	.	.
Viola orbiculata	79	3	17	2	20	2	.	.

Table 90. Mean cover and constancy of important plant species in the Western Hemlock Series by plant association.

SPECIES	TSHE/ARNU3 11 PLOTS		TSHE/CLUN 58 PLOTS		TSHE/GYDR 15 PLOTS		TSHE/MEFE 11 PLOTS	
TREE OVERSTORY LAYER	CON	COV	CON	COV	CON	COV	CON	COV
Abies grandis	91	25	66	15	73	13	.	.
Abies lasiocarpa	.	.	12	4	7	1	91	11
Betula papyrifera	27	2	17	5	.	.	.	.
Larix occidentalis	64	14	79	15	33	11	9	40
Pinus albicaulis	.	.	.	.	.	.	.	.
Pinus contorta	36	6	33	11	.	.	9	15
Picea engelmannii	9	7	22	7	13	6	91	18
Pinus monticola	64	10	53	5	33	3	9	1
Pinus ponderosa	18	3	7	6	.	.	.	.
Pseudotsuga menziesii	82	12	79	16	20	11	36	8
Thuja plicata	91	11	95	25	100	37	27	2
Tsuga heterophylla	91	17	74	19	100	28	73	36
TREE UNDERSTORY LAYER								
Abies grandis	73	3	52	5	53	2	9	1
Abies lasiocarpa	.	.	24	2	.	.	91	5
Pinus albicaulis	.	.	.	.	.	.	.	.
Picea engelmannii	18	1	7	1	7	1	27	1
Pinus ponderosa	.	.	.	.	.	.	.	.
Pseudostuga menziesii	27	3	24	4	.	.	18	1
Thuja plicata	91	6	95	10	87	6	27	2
Tsuga heterophylla	82	7	83	4	100	4	91	6
SHRUBS AND SUBSHRUBS								
Acer douglasii	55	3	34	5	33	2	9	1
Alnus sinuata	.	.	22	3	.	.	.	.
Amelanchier alnifolia	64	1	43	2	7	2	9	1
Arctostaphylos uva-ursi	9	2	7	2	.	.	.	.
Berberis aquifolium	82	3	41	3	.	.	.	.
Berberis nervosa	.	.	.	.	.	.	.	.
Chimaphila umbellata	100	3	74	4	.	.	36	2
Cornus canadensis	45	2	9	3	7	20	.	.
Cornus stolonifera	.	.	.	.	.	.	.	.
Holodiscus discolor	36	1	16	3	.	.	.	.
Juniperus communis	.	.	.	.	.	.	.	.
Linnaea borealis	100	11	81	8	87	7	9	3
Lonicera ciliosa	36	3	17	2	.	.	.	.
Lonicera utahensis	64	2	67	2	60	2	91	6

Table 90 (cont.). Mean cover and constancy of important plant species in the Western Hemlock Series by plant association.

SPECIES	TSHE/ARNU3 11 PLOTS		TSHE/CLUN 58 PLOTS		TSHE/GYDR 15 PLOTS		TSHE/MEFE 11 PLOTS	
SHRUBS AND SUBSHRUBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Menziesia ferruginea	.	.	2	3	7	2	100	8
Oplopanax horridum	.	.	2	1	33	1	.	.
Pachistima myrsinites	45	2	78	5	53	2	100	4
Physocarpus malvaceus	9	1	16	10	.	.	.	.
Pyrola asarifolia	18	1	24	2	33	2	9	2
Pyrola secunda	45	2	74	2	47	2	73	3
Rhododendron albiflorum	.	.	.	.	.	.	91	10
Ribes lacustre	.	.	9	1	.	.	45	3
Rosa gymnocarpa	82	3	69	3	27	3	.	.
Rubus parviflorus	73	4	43	2	33	1	45	7
Rubus pedatus	.	.	5	3	.	.	45	19
Salix scouleriana	.	.	3	4	.	.	.	.
Shepherdia canadensis	18	4	19	3	.	.	.	.
Sorbus scopulina	9	3	21	2	7	1	91	2
Spiraea betulifolia	73	3	31	3	.	.	9	1
Symphoricarpos albus	55	2	21	3	13	2	.	.
Symphoricarpos oreophilus	.	.	.	.	.	.	.	.
Taxus brevifolia	.	.	10	3	47	4	.	.
Vaccinium caespitosum	.	.	.	.	.	.	.	.
Vaccinium membranaceum	64	4	55	3	73	3	100	12
Vaccinium myrtillus	27	1	26	7	.	.	9	1
Vaccinium scoparium	9	1	9	2	.	.	.	.
Xerophyllum tenax	.	.	7	1	.	.	91	14
HERBS								
Achillea millefolium	.	.	.	.	.	.	.	.
Actaea rubra	9	1	9	1	33	2	18	2
Adenocaulon bicolor	45	2	26	4	73	3	9	2
Agropyron inerme	.	.	.	.	.	.	.	.
Agropyron spicatum	.	.	.	.	.	.	.	.
Aralia nudicaulis	91	18	.	.	7	5	.	.
Arnica cordifolia	9	1	5	6	.	.	.	.
Asarum caudatum	18	1	9	3	53	4	9	2
Athyrium filix-femina	27	2	3	1	87	2	27	4
Balsamorhiza sagittata	.	.	.	.	.	.	.	.
Bromus tectorum	.	.	.	.	.	.	.	.
Bromus vulgaris	55	2	29	3	27	2	45	2
Calamagrostis canadensis	.	.	.	.	.	.	.	.
Calamagrostis rubescens	18	1	16	6	.	.	.	.

Table 90 (cont.). Mean cover and constancy of important plant species in the Western Hemlock Series by plant association.

SPECIES	TSHE/ARNU3 11 PLOTS		TSHE/CLUN 58 PLOTS		TSHE/GYDR 15 PLOTS		TSHE/MEFE 11 PLOTS	
HERBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Carex concinnoides	9	1	12	1	.	.	.	.
Carex rossii	27	1	5	1	.	.	9	2
Circaea alpina	.	.	2	1	.	.	.	.
Clintonia uniflora	82	5	93	3	100	6	55	9
Disporum hookeri	18	3	9	2	80	3	18	9
Disporum trachycarpum	64	1	16	2	7	5	.	.
Equisetum arvense	.	.	.	.	7	1	.	.
Eriogonum heracleoides	.	.	.	.	.	.	.	.
Festuca idahoensis	.	.	.	.	.	.	.	.
Galium triflorum	73	2	22	2	73	2	45	3
Goodyera oblongifolia	36	2	71	2	73	2	45	2
Gymnocarpium dryopteris	.	.	5	2	100	15	45	13
Hieracium albiflorum	36	1	41	2	.	.	36	2
Hypopitys monotropa	.	.	3	1	.	.	.	.
Koeleria cristata	.	.	.	.	.	.	.	.
Lithospermum ruderale	.	.	.	.	.	.	.	.
Lupinus sericeus	.	.	.	.	.	.	.	.
Luzula hitchcockii	.	.	.	.	.	.	.	.
Osmorhiza chilensis	55	2	33	2	67	2	36	2
Pedicularis bracteosa	.	.	.	.	7	2	27	2
Pedicularis racemosa	18	2	9	1	.	.	.	.
Poa pratensis	.	.	.	.	.	.	.	.
Poa sandbergii	.	.	.	.	.	.	.	.
Senecio triangularis	.	.	.	.	.	.	.	.
Smilacina racemosa	9	2	22	1	.	.	18	2
Smilacina stellata	82	5	59	3	100	5	36	7
Streptopus amplexifolius	.	.	.	.	27	2	18	2
Thalictrum occidentale	9	1	16	3	13	2	45	3
Tiarella unifoliata	45	2	41	2	93	7	73	7
Trautvetteria caroliniensis	9	1	2	8	27	4	.	.
Trillium ovatum	64	1	59	1	73	2	27	2
Valeriana sitchensis	.	.	.	.	.	.	.	.
Viola adunca	.	.	.	.	.	.	.	.
Viola canadensis	.	.	2	1	13	2	18	4
Viola orbiculata	91	2	88	3	87	3	55	5

Table 90 (cont.). Mean cover and constancy of important plant species in the Western Hemlock Series by plant association.

SPECIES	TSHE/RUPE 15 PLOTS		TSHE/XETE 8 PLOTS	
TREE OVERSTORY LAYER	CON	COV	CON	COV
Abies grandis	.	.	.	.
Abies lasiocarpa	53	6	63	5
Betula papyrifera	7	1	.	.
Larix occidentalis	27	8	38	6
Pinus albicaulis	.	.	.	.
Pinus contorta	7	30	13	60
Picea engelmannii	47	7	75	6
Pinus monticola	33	9	38	4
Pinus ponderosa	.	.	.	.
Pseudotsuga menziesii	27	1	13	1
Thuja plicata	93	29	88	16
Tsuga heterophylla	100	36	88	46
TREE UNDERSTORY LAYER				
Abies grandis	7	2	.	.
Abies lasiocarpa	47	2	63	2
Pinus albicaulis	.	.	.	.
Picea engelmannii	13	2	13	2
Pinus ponderosa	.	.	.	.
Pseudostuga menziesii	.	.	.	.
Thuja plicata	93	5	75	8
Tsuga heterophylla	100	5	100	10
SHRUBS AND SUBSHRUBS				
Acer douglasii	13	3	13	2
Alnus sinuata	.	.	13	7
Amelanchier alnifolia	.	.	13	3
Arctostaphylos uva-ursi	.	.	.	.
Berberis aquifolium	.	.	13	2
Berberis nervosa	.	.	.	.
Chimaphila umbellata	13	1	75	5
Cornus canadensis	.	.	.	.
Cornus stolonifera	.	.	.	.
Holodiscus discolor	.	.	.	.
Juniperus communis	.	.	.	.
Linnaea borealis	47	9	75	9
Lonicera ciliosa	.	.	.	.
Lonicera utahensis	73	3	100	3

Table 90 (cont.). Mean cover and constancy of important plant species in the Western Hemlock Series by plant association.

SPECIES	TSHE/RUPE 15 PLOTS		TSHE/XETE 8 PLOTS	
SHRUBS AND SUBSHRUBS, cont.	CON	COV	CON	COV
Menziesia ferruginea	73	2	50	3
Oplopanax horridum	13	1	.	.
Pachistima myrsinites	80	3	100	5
Physocarpus malvaceus	.	.	.	.
Pyrola asarifolia	13	3	63	3
Pyrola secunda	87	3	88	3
Rhododendron albiflorum	27	2	38	2
Ribes lacustre	33	1	38	1
Rosa gymnocarpa	.	.	13	7
Rubus parviflorus	47	2	25	3
Rubus pedatus	100	9	25	4
Salix scouleriana	.	.	13	3
Shepherdia canadensis	.	.	13	15
Sorbus scopulina	7	1	13	1
Spiraea betulifolia	7	1	13	8
Symphoricarpos albus	.	.	.	.
Symphoricarpos oreophilus	.	.	.	.
Taxus brevifolia	7	6	.	.
Vaccinium caespitosum	.	.	.	.
Vaccinium membranaceum	93	7	88	8
Vaccinium myrtillus	7	2	38	8
Vaccinium scoparium	7	1	.	.
Xerophyllum tenax	20	2	100	9
HERBS				
Achillea millefolium	.	.	.	.
Actaea rubra	7	2	.	.
Adenocaulon bicolor	13	3	63	2
Agropyron inerme	.	.	.	.
Agropyron spicatum	.	.	.	.
Aralia nudicaulis	.	.	.	.
Arnica cordifolia	13	1	13	3
Asarum caudatum	.	.	.	.
Athyrium filix-femina	53	3	25	1
Balsamorhiza sagittata	.	.	.	.
Bromus tectorum	.	.	.	.
Bromus vulgaris	20	4	25	2
Calamagrostis canadensis	.	.	.	.
Calamagrostis rubescens	.	.	13	3

Table 90 (cont.). Mean cover and constancy of important plant species in the Western Hemlock Series by plant association.

SPECIES	TSHE/RUPE 15 PLOTS		TSHE/XETE 8 PLOTS	
HERBS, cont.	CON	COV	CON	COV
Carex concinnoides	.	.	.	.
Carex rossii	.	.	.	.
Circaea alpina	.	.	.	.
Clintonia uniflora	100	7	100	6
Disporum hookeri	47	3	50	2
Disporum trachycarpum	.	.	.	.
Equisetum arvense	.	.	.	.
Eriogonum heracleoides	.	.	.	.
Festuca idahoensis	.	.	.	.
Galium triflorum	40	3	.	.
Goodyera oblongifolia	73	2	75	2
Gymnocarpium dryopteris	100	12	25	2
Hieracium albiflorum	7	1	38	2
Hypopitys monotropa	.	.	13	1
Koeleria cristata	.	.	.	.
Lithospermum ruderale	.	.	.	.
Lupinus sericeus	.	.	.	.
Luzula hitchcockii	.	.	13	1
Osmorhiza chilensis	60	2	50	1
Pedicularis bracteosa	.	.	25	1
Pedicularis racemosa	7	1	50	2
Poa pratensis	.	.	.	.
Poa sandbergii	.	.	.	.
Senecio triangularis	7	1	.	.
Smilacina racemosa	13	2	13	1
Smilacina stellata	40	2	25	3
Streptopus amplexifolius	93	2	13	1
Thalictrum occidentale	53	2	25	2
Tiarella unifoliata	93	8	88	5
Trautvetteria caroliniensis	27	1	.	.
Trillium ovatum	93	2	75	2
Valeriana sitchensis	.	.	13	1
Viola adunca	.	.	.	.
Viola canadensis	7	2	25	2
Viola orbiculata	100	4	88	3

Table 91. Mean cover and constancy of important plant species in the Western Redcedar Series by plant association.

SPECIES	THPL/ARNU3 16 PLOTS		THPL/CLUN 31 PLOTS		THPL/OPHO 6 PLOTS		THPL/VAME 20 PLOTS	
TREE OVERSTORY LAYER	CON	COV	CON	COV	CON	COV	CON	COV
Abies grandis	75	13	48	22	100	13	70	8
Abies lasiocarpa	.	.	.	.	.	.	40	5
Betula papyrifera	50	6	29	4	.	.	5	5
Larix occidentalis	75	8	90	12	.	.	95	15
Pinus albicaulis	.	.	.	.	.	.	.	.
Pinus contorta	31	4	32	14	.	.	65	19
Picea engelmannii	56	14	26	7	.	.	15	3
Pinus monticola	19	2	16	4	.	.	5	5
Pinus ponderosa	13	33	26	9	.	.	.	.
Pseudotsuga menziesii	100	18	87	21	33	8	95	19
Thuja plicata	94	24	68	34	100	35	55	11
Tsuga heterophylla	13	2	6	1	100	23	.	.
TREE UNDERSTORY LAYER								
Abies grandis	56	5	71	4	17	1	65	4
Abies lasiocarpa	.	.	13	3	.	.	40	3
Pinus albicaulis	.	.	.	.	.	.	.	.
Picea engelmannii	44	4	10	1	.	.	10	1
Pinus ponderosa	.	.	.	.	.	.	.	.
Pseudostuga menziesii	38	2	39	5	.	.	80	4
Thuja plicata	94	4	90	6	67	4	100	4
Tsuga heterophylla	.	.	3	1	100	2	10	1
SHRUBS AND SUBSHRUBS								
Acer douglasii	94	4	71	4	83	3	40	5
Alnus sinuata	13	3	6	2	.	.	45	5
Amelanchier alnifolia	63	2	48	2	.	.	70	3
Arctostaphylos uva-ursi	.	.	16	4	.	.	55	4
Berberis aquifolium	75	3	68	4	.	.	80	3
Berberis nervosa	.	.	3	2	.	.	.	.
Chimaphila umbellata	31	2	77	5	.	.	75	5
Cornus canadensis	63	6	.	.	.	.	.	.
Cornus stolonifera	19	1	3	1	33	2	5	1
Holodiscus discolor	19	2	29	11	.	.	30	3
Juniperus communis	.	.	.	.	.	.	.	.
Linnaea borealis	94	6	81	12	67	3	70	16
Lonicera ciliosa	13	4	35	3	.	.	25	2
Lonicera utahensis	38	2	65	2	.	.	80	4

Table 91 (cont.). Mean cover and constancy of important plant species in the Western Redcedar Series by plant association.

SPECIES	THPL/ARNU3 16 PLOTS		THPL/CLUN 31 PLOTS		THPL/OPHO 6 PLOTS		THPL/VAME 20 PLOTS	
SHRUBS AND SUBSHRUBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Menziesia ferruginea	.	.	.	.	.	.	.	.
Oplopanax horridum	.	.	.	.	100	9	.	.
Pachistima myrsinites	56	1	84	10	.	.	95	7
Physocarpus malvaceus	44	2	42	3	.	.	30	3
Pyrola asarifolia	.	.	3	2	50	2	20	3
Pyrola secunda	56	2	61	1	17	1	25	2
Rhododendron albiflorum	.	.	.	.	.	.	.	.
Ribes lacustre	31	3	6	3	67	2	10	2
Rosa gymnocarpa	88	4	77	5	.	.	95	4
Rubus parviflorus	69	5	48	5	.	.	50	12
Rubus pedatus	.	.	.	.	33	1	.	.
Salix scouleriana	.	.	26	2	.	.	30	4
Shepherdia canadensis	6	2	16	4	.	.	45	4
Sorbus scopulina	.	.	10	1	.	.	65	2
Spiraea betulifolia	19	2	55	6	.	.	70	5
Symphoricarpos albus	56	4	45	3	33	3	10	4
Symphoricarpos oreophilus	.	.	.	.	.	.	.	.
Taxus brevifolia	.	.	3	1	50	3	.	.
Vaccinium caespitosum	.	.	6	3	.	.	5	2
Vaccinium membranaceum	6	1	13	2	33	2	95	14
Vaccinium myrtillus	.	.	23	1	.	.	30	12
Vaccinium scoparium	.	.	.	.	.	.	.	.
Xerophyllum tenax	.	.	.	.	.	.	15	8
HERBS								
Achillea millefolium	6	1	3	1	.	.	.	.
Actaea rubra	50	2	.	.	100	4	.	.
Adenocaulon bicolor	44	2	45	4	83	2	40	3
Agropyron inerme	.	.	.	.	.	.	.	.
Agropyron spicatum	.	.	.	.	.	.	.	.
Aralia nudicaulis	81	12	.	.	.	.	5	1
Arnica cordifolia	.	.	13	4	.	.	15	2
Asarum caudatum	31	6	3	1	100	7	.	.
Athyrium filix-femina	19	4	6	2	100	29	5	1
Balsamorhiza sagittata	.	.	.	.	.	.	.	.
Bromus tectorum	.	.	.	.	.	.	.	.
Bromus vulgaris	63	3	32	2	33	1	50	3
Calamagrostis canadensis	.	.	.	.	17	1	.	.
Calamagrostis rubescens	19	2	26	7	.	.	40	9

Table 91 (cont.). Mean cover and constancy of important plant species in the Western Redcedar Series by plant association.

SPECIES	THPL/ARNU3 16 PLOTS		THPL/CLUN 31 PLOTS		THPL/OPHO 6 PLOTS		THPL/VAME 20 PLOTS	
HERBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Carex concinnoides	.	.	23	1	.	.	50	2
Carex rossii	13	1	6	1	.	.	10	1
Circaea alpina	19	6	.	.	100	2	10	5
Clintonia uniflora	81	4	65	4	100	4	85	4
Disporum hookeri	19	4	10	8	83	3	20	3
Disporum trachycarpum	56	2	29	2	.	.	25	2
Equisetum arvense	25	1	3	2	.	.	.	.
Eriogonum heracleoides	.	.	.	.	.	.	.	.
Festuca idahoensis	.	.	.	.	.	.	.	.
Galium triflorum	69	3	19	2	100	2	35	3
Goodyera oblongifolia	31	1	61	2	67	2	60	2
Gymnocarpium dryopteris	6	1	3	15	100	23	.	.
Hieracium albiflorum	44	1	58	2	.	.	60	3
Hypopitys monotropa	6	1	3	1	.	.	.	.
Koeleria cristata	.	.	.	.	.	.	.	.
Lithospermum ruderale	.	.	.	.	.	.	.	.
Lupinus sericeus	.	.	.	.	.	.	.	.
Luzula hitchcockii	.	.	.	.	.	.	.	.
Osmorhiza chilensis	63	3	42	2	67	2	40	3
Pedicularis bracteosa	.	.	.	.	.	.	25	2
Pedicularis racemosa	.	.	3	1	.	.	5	2
Poa pratensis	6	3	.	.	.	.	.	.
Poa sandbergii	.	.	.	.	.	.	.	.
Senecio triangularis	.	.	.	.	50	2	.	.
Smilacina racemosa	25	1	35	1	.	.	55	2
Smilacina stellata	75	5	58	4	83	9	65	4
Streptopus amplexifolius	19	1	3	4	83	3	.	.
Thalictrum occidentale	13	5	29	3	.	.	35	4
Tiarella unifoliata	50	5	6	6	100	7	15	6
Trautvetteria caroliniensis	6	1	3	8	33	4	10	40
Trillium ovatum	44	3	23	2	50	2	15	2
Valeriana sitchensis	.	.	.	.	.	.	5	4
Viola adunca	6	2	3	1	.	.	.	.
Viola canadensis	19	2	.	.	50	3	.	.
Viola orbiculata	50	2	68	2	50	3	90	4

Table 92. Mean cover and constancy of important plant species for the Incidental Vegetation Types by community type.

SPECIES	PIAL 6 PLOTS		PICO/SHCA 20 PLOTS		POTR/CARU 7 PLOTS		POTR/SYAL 3 PLOTS	
TREE OVERSTORY LAYER	CON	COV	CON	COV	CON	COV	CON	COV
Abies grandis	.	.	.	.	.	.	.	.
Abies lasiocarpa	50	7	5	5	.	.	.	.
Betula papyrifera	.	.	5	20	.	.	.	.
Larix occidentalis	.	.	60	13	.	.	73	11
Pinus albicaulis	100	13	.	.	.	.	.	.
Pinus contorta	17	8	100	46	57	8	82	10
Picea engelmannii	17	5	15	2	.	.	.	.
Pinus monticola	.	.	.	.	.	.	.	.
Pinus ponderosa	.	.	10	3	.	.	.	.
Populus tremuloides	.	.	.	.	100	42	100	77
Pseudotsuga menziesii	50	15	50	5	14	5	33	2
Thuja plicata	.	.	5	1	.	.	.	.
Tsuga heterophylla	.	.	.	.	.	.	.	.
TREE UNDERSTORY LAYER								
Abies grandis	.	.	20	3	.	.	.	.
Abies lasiocarpa	17	1	45	2	.	.	33	10
Pinus albicaulis	83	2	.	.	.	.	.	.
Picea engelmannii	17	2	30	8	.	.	33	15
Pinus ponderosa	.	.	.	.	.	.	100	2
Populus tremuloides					86	14	100	10
Pseudostuga menziesii	.	.	65	4	14	2	100	5
Thuja plicata	.	.	35	1	.	.	.	.
Tsuga heterophylla	.	.	10	2	.	.	.	.
SHRUBS AND SUBSHRUBS								
Acer douglasii	.	.	45	2	.	.	.	.
Alnus sinuata	.	.	35	5	.	.	.	.
Amelanchier alnifolia	.	.	60	4	.	.	67	3
Arctostaphylos uva-ursi	.	.	35	11	.	.	.	.
Berberis aquifolium	.	.	70	4	.	.	.	.
Berberis nervosa	.	.	.	.	.	.	.	.
Chimaphila umbellata	.	.	90	5	.	.	.	.
Cornus canadensis	.	.	20	12	.	.	.	.
Cornus stolonifera	.	.	15	2	.	.	.	.
Holodiscus discolor	.	.	30	4	.	.	.	.
Juniperus communis	17	30	5	2	14	1	.	.
Linnaea borealis	.	.	75	23	14	1	.	.
Lonicera ciliosa	.	.	10	3	.	.	.	.
Lonicera utahensis	.	.	40	2	.	.	.	.

Table 92 (cont.). Mean cover and constancy of important plant species for the Incidental Vegetation Types by community type.

SPECIES	PIAL 6 PLOTS		PICO/SHCA 20 PLOTS		POTR/CARU 7 PLOTS		POTR/SYAL 3 PLOTS	
SHRUBS AND SUBSHRUBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Menziesia ferruginea	.	.	5	3	.	.	.	.
Oplopanax horridum	.	.	.	.	.	.	.	.
Pachistima myrsinites	67	2	90	5	29	3	.	.
Physocarpus malvaceus	.	.	25	2	.	.	.	.
Pyrola asarifolia	.	.	5	1	.	.	.	.
Pyrola secunda	.	.	45	2	.	.	.	.
Rhododendron albiflorum	.	.	.	.	.	.	.	.
Ribes lacustre	.	.	5	1	.	.	33	5
Rosa gymnocarpa	.	.	75	4	.	.	33	2
Rubus parviflorus	.	.	40	3	.	.	.	.
Rubus pedatus	.	.	.	.	.	.	.	.
Salix scouleriana	.	.	60	4	.	.	.	.
Shepherdia canadensis	.	.	70	7	42	3	33	1
Sorbus scopulina	.	.	25	1	.	.	.	.
Spiraea betulifolia	.	.	95	7	.	.	.	.
Symphoricarpos albus	.	.	65	3	14	2	100	34
Symphoricarpos oreophilus	.	.	.	.	14	2	.	.
Taxus brevifolia	.	.	.	.	.	.	.	.
Vaccinium caespitosum	.	.	25	5	.	.	.	.
Vaccinium membranaceum	17	3	55	11	.	.	.	.
Vaccinium myrtillus	.	.	45	9	.	.	.	.
Vaccinium scoparium	50	3	30	17	.	.	.	.
Xerophyllum tenax	.	.	5	1	.	.	.	.
HERBS								
Achillea millefolium	100	5	30	2	57	2	66	1
Actaea rubra	.	.	.	.	.	.	33	1
Adenocaulon bicolor	.	.	20	3	.	.	.	.
Agropyron inerme	.	.	.	.	.	.	.	.
Agropyron spicatum	.	.	.	.	14	1	33	4
Aralia nudicaulis	.	.	.	.	.	.	.	.
Arnica cordifolia	33	2	35	3	.	.	.	.
Asarum caudatum	.	.	.	.	.	.	.	.
Athyrium filix-femina	.	.	.	.	.	.	33	1
Balsamorhiza sagittata	.	.	.	.	29	1	.	.
Bromus tectorum	.	.	.	.	.	.	.	.
Bromus vulgaris	.	.	20	3	.	.	.	.
Calamagrostis canadensis	.	.	.	.	.	.	.	.
Calamagrostis rubescens	100	10	90	19	100	59	33	30

Table 92 (cont.). Mean cover and constancy of important plant species for the Incidental Vegetation Types by community type.

SPECIES	PIAL 6 PLOTS		PICO/SHCA 20 PLOTS		POTR/CARU 7 PLOTS		POTR/SYAL 3 PLOTS	
HERBS, cont.	CON	COV	CON	COV	CON	COV	CON	COV
Carex concinnoides	17	3	20	2	.	.	.	.
Carex rossii	67	6	15	1	.	.	.	.
Circaea alpina	.	.	.	.	.	.	.	.
Clintonia uniflora	.	.	35	5	.	.	.	.
Disporum hookeri	.	.	5	2	.	.	.	.
Disporum trachycarpum	.	.	20	2	.	.	33	1
Equisetum arvense	.	.	.	.	.	.	.	.
Eriogonum heracleoides	.	.	.	.	.	.	.	.
Festuca idahoensis	50	6	.	.	.	.	.	.
Galium triflorum	.	.	20	2	.	.	.	.
Goodyera oblongifolia	.	.	20	2	.	.	.	.
Gymnocarpium dryopteris	.	.	.	.	.	.	.	.
Hieracium albiflorum	.	.	75	2	14	1	.	.
Hypopitys monotropa	.	.	.	.	.	.	.	.
Koeleria cristata	33	3	.	.	.	.	.	.
Lithospermum ruderale	.	.	.	.	.	.	33	1
Lupinus sericeus	17	5	15	3	.	.	.	.
Luzula hitchcockii	17	5	.	.	.	.	.	.
Osmorhiza chilensis	.	.	35	3	29	2	66	4
Pedicularis bracteosa	.	.	5	1	.	.	.	.
Pedicularis racemosa	.	.	.	.	.	.	.	.
Poa pratensis	.	.	.	.	14	3	.	.
Poa sandbergii	.	.	.	.	.	.	.	.
Senecio triangularis	.	.	.	.	.	.	.	.
Smilacina racemosa	.	.	20	2	.	.	.	.
Smilacina stellata	.	.	40	1	14	3	66	2
Streptopus amplexifolius	.	.	.	.	.	.	.	.
Thalictrum occidentale	.	.	10	2	86	15	100	2
Tiarella unifoliata	.	.	.	.	.	.	.	.
Trautvetteria caroliniensis	.	.	.	.	.	.	33	5
Trillium ovatum	.	.	.	.	.	.	.	.
Valeriana sitchensis	.	.	.	.	.	.	.	.
Viola adunca	.	.	10	8	.	.	.	.
Viola canadensis	.	.	.	.	.	.	.	.
Viola orbiculata	.	.	60	3	.	.	.	.

APPENDIX 2

- **Stocking, basal area and stand density index**
- **Site index and growth basal area**

Table 93. Trees per acre, total basal area, quadratic mean diameter, stand density index, and herbage production averaged by type.

TYPE	NUMBER TREES/AC[1]	TBA (ft^2/ac)[2]	QUADRATIC MEAN DIAMETER[3]	STAND DENSITY INDEX[4]	HERBAGE (lb/ac)[5]
ABGR/ACGLD/CLUN	589	258	9	491	19
ABGR/VAME/CLUN	392	261	11	457	64
ABGR/PHMA	302	252	12	423	92
ABGR/VACA	508	191	8	375	101
ABLA2/CARU	409	245	12	419	194
ABLA2/CLUN	563	254	9	481	43
ABLA2/COCA	338	238	11	413	39
ABLA2/LIBOL	392	232	12	407	18
ABLA2/RHAL	656	213	9	412	48
ABLA2/RHAL-XETE	557	222	10	411	12
ABLA2/TRCA3	638	270	8	517	167
ABLA2/VACA	437	151	8	301	125
ABLA2/VAME	975	237	7	498	66
ABLA2/VASC	1173	277	6	596	5
ABLA2/XETE	1040	236	7	499	5
PIAL	180	52	9	101	113
PICO/SHCA	779	173	6	375	75
PIEN/EQUIS	302	233	12	397	129
PIPO-PSME/AGSP	49	64	16	99	435
PSME/CARU	321	207	12	355	311
PSME/PHMA	310	240	13	405	47
PSME/PHMA-LIBOL	331	209	11	368	102
PSME/SYAL	174	186	13	297	65
PSME/SYOR	127	145	15	226	172
PSME/VACA	420	201	9	372	103
PSME/VAME	878	204	7	426	57
THPL/ARNU3	389	288	12	485	65
THPL/CLUN	547	258	10	476	28
THPL/OPHO	145	359	21	485	206
THPL/VAME	568	204	8	402	75
TSHE/ARNU3	498	237	10	436	128
TSHE/CLUN	547	258	10	476	28
TSHE/GYDR	406	420	18	632	54
TSHE/MEFE	273	233	14	382	60
TSHE/RUPE	223	390	19	550	43
TSHE/XETE	307	312	14	500	13

[1] Average number of trees per acre.
[2] Average total basal area.
[3] Average quadratic mean diameter (QMD). QMD is the diameter of a tree of average basal area.
[4] Average stand density index. Reineke's (1933) equation for mixed-conifer forests was used for all associations and community types in this table.
[5] Average dry weight of herb (grasses, forbs, and ferns) standing crop at sampling time.

Table 94. Site index and growth basal area by species and type, and volume growth estimates by type.

TYPE (SI base years)	ABGR (50)	ABLA2 (50)	LAOC (50)	PIEN (50)	PICO (50)	PIPO (100)	PIMO (50)	PSME (50)	THPL (50)	TSHE (50)	GBA VOL[1] (ft3/ac/yr)
ABGR/ACGLD/CLUN	59/456[2]	.	67/233	.	.	.	.	74/360	.	.	168
ABGR/PHMA	.	.	.	.	79/208	135/207	.	73/240	.	.	126
ABGR/VACA	.	.	66/168	.	60/164	114/190	.	68/205	.	.	92
ABGR/VAME/CLUN	72/361	.	43/169	.	.	.	.	58/278	.	.	119
ABLA2/CARU	.	.	49/192	.	52/170	.	.	48/188	.	.	65
ABLA2/CLUN	.	58/278	57/182	60/288	59/277	.	.	.	.	.	(PIEN) 114
ABLA2/COCA	.	48/199	68/169	68/237	.	.	.	59/251	.	.	111
ABLA2/LIBOL	.	60/202	62/182	62/210	.	.	.	57/202	.	.	73
ABLA2/RHAL	.	39/206	48/164	51/246	.	.	.	.	.	.	(PIEN) 95
ABLA2/RHAL-XETE	.	42/211	46/135	44/202	54/191	.	.	.	.	.	(PIEN) 60
ABLA2/TRCA3	62/134	66/242	57/272	65/216	53/251	.	.	62/283	.	.	124
ABLA2/VACA	.	.	65/108	.	60/110	.	.	47/169	.	.	55
ABLA2/VAME	.	57/259	60/252	64/257	54/206	.	.	56/248	.	.	93
ABLA2/VASC	.	46/239	.	.	50/238	.	.	.	.	.	(PICO) 83
ABLA2/XETE	.	39/222	30/205	47/218	54/167	.	.	55/255	.	.	99
PIEN/EQUIS	.	.	.	63/191	.	.	.	.	.	.	(PIEN) 86
PIAL	.	.	.	.	.	.	.	25/101	.	.	17
PICO/SHCA	.	.	60/142	.	61/162	.	.	.	.	.	(LAOC) 72
PIPO-PSME/AGSP	.	.	.	.	.	79/73	.	.	.	.	(PIPO) 25

Table 94 (cont.). Site index and growth basal area by species and type, and volume growth estimates by type.

TYPE (SI base years)	ABGR (50)	ABLA2 (50)	LAOC (50)	PIEN (50)	PICO (50)	PIPO (100)	PIMO (50)	PSME (50)	THPL (50)	TSHE (50)	GBA VOL (ft3/ac/yr)
PSME/CARU	.	.	49/161	.	.	98/153	.	49/173	.	.	59
PSME/PHMA	.	.	.	.	.	.	.	61/220	.	.	96
PSME/PHMA-LIBOL	.	.	57/151	.	66/169	92/170	.	53/178	.	.	64
PSME/SYAL	.	.	.	.	.	103/234	.	76/234	.	.	117
PSME/SYOR	.	.	.	.	.	81/82	.	47/126	.	.	34
PSME/VACA	.	.	57/191	.	50/164	.	.	.	.	.	(LAOC) 79
PSME/VAME	.	.	60/208	.	60/210	.	.	61/185	.	.	80
THPL/ARNU3	.	.	81/376	64/254	.	122/316	.	69/371	.55/380	.	183
THPL/CLUN	65/301	.	65/173	.	65/140	114/179	.	64/235	43/317	.	102
THPL/OPHO	.	.	.	.	.	.	.	.	58/473	.	(THPL) 200
THPL/VAME	74/292	.	57/163	.	50/149	.	.	57/180	.	.	75
TSHE/ARNU3	81/286	.	73/270	.	.	128/315	66/270	65/209	.	69/287	(LAOC) 139
TSHE/CLUN	66/286	.	68/246	59/199	59/199	118/254	54/283	69/245	45/317	68/285	120
TSHE/GYDR	78/373	.	70/412	.	.	.	.	.	57//496	76/506	(LAOC) 208
TSHE/MEFE	.	49/238	61/310	54/261	.	.	.	66/310	.	.	135
TSHE/RUPE	.	58/289	.	70/409	.	.	.	.	.	.	(PIEN) 176
TSHE/XETE	.	.	.	61/375	.	.	.	.	.	56/362	(PIEN) 122

[1] Average GBA volume production for each type. GBA VOL is an empirical estimate of cubic wood production that is the product of GBA x SI x c, where c is a species-specific constant. The constant for Douglas-fir (PSME) is used unless otherwise noted.

[2]Numbers in this part of the table use this format: site index/growth basal area (SI/GBA). These are average values for that species in that type.

APPENDIX 3

- **Birds of the Colville National Forest**
- **Mammals of the Colville National Forest**
- **Reptiles and Amphibians of the Colville National Forest**
- **Fishes of the Colville National Forest**

Table 95. Birds of the Colville National Forest and vicinity. Data compiled by T. Burke and J. Nisbet (1979). Nomenclature from American Birding Association. Abundance codes: C=common, U=uncommon, I=introduced, O=occassional. Seasonality codes: P=permanent resident, S=summer resident, W=winter visitor, M=migrant.

	Species name	Scientific name	Abundance and Seasonality
Family- ***Gaviidae***			
1	COMMON LOON	*Gavia immer*	U/SM
2	ARCTIC LOON	*Gavia arctica*	O/M
Family- ***Podicipedidae***			
3	RED-NECKED GREBE	*Podiceps grisegena*	U/SM
4	HORNED GREBE	*Podiceps auritus*	U/SM
5	EARED GREBE	*Podiceps nigricollis*	U/SM
6	WESTERN GREBE	*Aechmophorus occidentalis*	C/SM
7	PIED-BILLED GREBE	*Podilymbus podiceps*	C/SM
Family- ***Pelicanidae***			
8	AMERICAN WHITE PELICAN	*Pelecanus erythrorhynchos*	U/M
Family- ***Ardeidae***			
9	GREAT BLUE HERON	*Ardea herodias*	C/S
10	BLACK-CROWNED NIGHT HERON	*Nycticorax nycticorax*	O/M
11	AMERICAN BITTERN	*Botaurus lentiginosus*	U/B
Family- ***Anatidae***			
12	TUNDRA SWAN	*Cygnus columbianus*	O/W
13	TRUMPETER SWAN	*Olor buccinator*	O/M
14	CANADA GOOSE	*Branta canadensis*	C/S
15	GREATER WHITE-FRONTED GOOSE	*Anser albifrons*	U/M
16	SNOW GOOSE	*Chen caerulescens*	U/M
17	ROSS' GOOSE	*Chen rossii*	O/M
18	MALLARD	*Anas platyrhynchos*	C/S
19	GADWALL	*Anas strepera*	U/S
20	NORTHERN PINTAIL	*Anas acuta*	C/S
21	GREEN-WINGED TEAL	*Anas crecca*	C/S
22	BLUE-WINGED TEAL	*Anas discors*	C/S
23	CINNAMON TEAL	*Anas cyanoptera*	C/S
24	AMERICAN WIDGEON	*Anas americana*	C/SM
25	NORTHERN SHOVELER	*Anas clypeata*	C/S
26	WOOD DUCK	*Aix sponsa*	U/S
27	REDHEAD	*Aythya americana*	C/S
28	RING-NECKED DUCK	*Aythya collaris*	C/S
29	CANVASBACK	*Aythya valisineria*	U/M
30	GREATER SCAUP	*Aythya marila*	U/M
31	LESSER SCAUP	*Aythya affinis*	C/S
32	COMMON GOLDENEYE	*Bucephala clangula*	C/MW
32	COMMON GOLDENEYE	*Bucephala clangula*	C/MW

Table 93. (cont.). Birds of the Colville National Forest and vicinity.

	Species name	Scientific name	Abundance and Seasonality
Family- *Anatidae*, cont.			
33	BARROW'S GOLDENEYE	*Bucephala islandica*	C/SW
34	BUFFLEHEAD	*Bucephala albeola*	C/SW
35	HARLEQUIN DUCK	*Histrionicus histrionicus*	O/M
36	WHITE-WINGED SCOTER	*Melanitta fusca*	O/M
37	RUDDY DUCK	*Oxyura jamaicensis*	C/S
38	HOODED MERGANSER	*Lophodytes cucullatus*	C/SW
39	COMMON MERGANSER	*Mergus merganser*	U/SW
Family- *Cathartidae*			
40	TURKEY VULTURE	*Cathartes aura*	U/S
Family- *Accipitridae*			
41	NORTHERN GOSHAWK	*Accipiter gentilis*	U/S
42	SHARP-SHINNED HAWK	*Accipiter striatus*	C/S
43	COOPER'S HAWK	*Accipiter cooperii*	C/S
44	RED-TAILED HAWK	*Buteo jamaicensis*	C/SW
45	SWAINSON'S HAWK	*Buteo swainsoni*	O/M
46	ROUGH-LEGGED HAWK	*Buteo lagopus*	C/W
47	FERRUGINOUS HAWK	*Buteo regalis*	O/M
48	GOLDEN EAGLE	*Aquila chrysaetos*	U/SW
49	BALD EAGLE	*Haliaeetus leucocephalus*	T/W
50	NORTHERN HARRIER	*Circus cyaneus*	C/S
51	OSPREY	*Pandion haliaetus*	C/S
Family- *Falconidae*			
52	GYRFALCON	*Falco rusticolus*	O/W
53	PRAIRIE FALCON	*Falco mexicanus*	O/M
54	PEREGRINE FALCON	*Falco peregrinus*	E/M
55	MERLIN	*Falco columbaris*	U/S
56	AMERICAN KESTREL	*Falco sparverius*	C/S
Family- *Phasianidae*			
57	BLUE GROUSE	*Dendragapus obscurus*	C/P
58	SPRUCE GROUSE	*Dendragapus canadensis*	U/P
59	RUFFED GROUSE	*Bonasa umbellus*	C/P
60	WHITE-TAILED PTARMIGAN	*Lagopus leucurus*	NA
61	CALIFORNIA QUAIL	*Callipepla californicus*	I/P
62	RING-NECKED PHEASANT	*Phasianus colchicus*	I/P
63	CHUKAR	*Alectoris chukar*	I/P
64	GRAY PARTRIDGE	*Perdix perdix*	I/P
65	WILD TURKEY	*Meleagris gallopavo*	I/P
Family- *Gruidae*			
66	SANDHILL CRANE	*Grus canadensis*	U/M

Table 95 (cont.). Birds of the Colville National Forest and vicinity.

	Species name	Scientific name	Abundance and Seasonality
Family- ***Rallidae***			
67	VIRGINIA RAIL	*Rallus limicola*	C/S
68	SORA	*Porzana carolina*	C/S
69	AMERICAN COOT	*Fulica americana*	C/SW
Family- ***Charadriidae***			
70	KILLDEER	*Charadrius vociferus*	C/S
71	BLACK-BELLIED PLOVER	*Pluvialus squatarola*	O/M
Family- ***Scolopacidae***			
72	COMMON SNIPE	*Gallinago gallinago*	C/S
73	LONG-BILLED CURLEW	*Numenius americanus*	O/M
74	SPOTTED SANDPIPER	*Actitus macularia*	C/S
75	SOLITARY SANDPIPER	*Tringa solitaria*	U/M
76	GREATER YELLOWLEGS	*Tringa melanoleuca*	C/M
77	LESSER YELLOWLEGS	*Tringa flavipes*	C/M
78	PECTORAL SANDPIPER	*Calidris melanotos*	U/M
79	BAIRD'S SANDPIPER	*Calidris bairdii*	U/M
80	LEAST SANDPIPER	*Calidris minutilla*	C/M
81	SEMIPALMATED SANDPIPER	*Calidris pusilla*	U/M
82	WESTERN SANDPIPER	*Calidris mauri*	C/M
83	SANDERLING	*Calidris alba*	O/M
84	LONG-BILLED DOWITCHER	*Limnodromus scolopaceus*	U/M
85	STILT SANDPIPER	*Micropalama himantopus*	O/M
87	WILSON'S PHALAROPE	*Phalaropus tricolor*	U/SM
88	RED-NECKED PHALAROPE	*Phalaropus lobatus*	O/M
Family- ***Recurvirostridae***			
86	AMERICAN AVOCET	*Recurvirostrata americana*	O/M
Family- ***Laridae***			
89	HERRING GULL	*Larus argentatus*	O/M
90	CALIFORNIA GULL	*Larus californicus*	U/M
91	RING-BILLED GULL	*Larus delawarensis*	C/M
92	BONAPARTE'S GULL	*Larus philadelphia*	O/M
93	FORSTER'S TERN	*Sterna forsteri*	U/M
94	BLACK TERN	*Chlidonias niger*	C/S
Family- ***Columbidae***			
95	ROCK DOVE	*Columba livia*	I/P
96	MOURNING DOVE	*Zenaida macroura*	C/SW
Family- ***Strigidae***			
97	WESTERN SCREECH OWL	*Otus kennicottii*	C/P
98	FLAMMULATED OWL	*Otus flammeolus*	O/S
99	GREAT-HORNED OWL	*Bubo virginianus*	C/P
100	SNOWY OWL	*Nyctea scandiaca*	O/W

Table 95 (cont.). Birds of the Colville National Forest and vicinity.

	Species name	Scientific name	Abundance and Seasonality
Family- ***Strigidae*, cont.**			
101	NORTHERN HAWK OWL	*Surnia ulula*	O/W
102	NORTHERN PYGMY OWL	*Glaucidium gnoma*	C/P
103	BURROWING OWL	*Athene cunicularia*	O/M
104	BARRED OWL	*Strix varia*	U/P
105	GREAT GRAY OWL	*Strix nebulosa*	O/W
106	LONG-EARED OWL	*Asio otus*	C/S
107	SHORT-EARED OWL	*Asio flammeus*	U/P
108	BOREAL OWL	*Aegolius funereus*	O/W
109	NORTHERN SAW-WHET OWL	*Aegolius acadicus*	U/P
Family- ***Caprimulgidae***			
110	COMMON POORWILL	*Phalaenoptilis nuttallii*	C/S
111	COMMON NIGHTHAWK	*Chordeiles minor*	C/S
Family- ***Apodidae***			
112	VAUX'S SWIFT	*Chaetura vauxi*	C/S
113	WHITE-THROATED SWIFT	*Aeronautes saxatalis*	U/S
Family- ***Trochilidae***			
114	BLACK-CHINNED HUMMINGBIRD	*Archilochus alexandri*	C/S
115	RUFOUS HUMMINGBIRD	*Selasphorus rufus*	C/S
116	CALLIOPE HUMMINGBIRD	*Stellula calliope*	C/S
Family- ***Alcedinidae***			
117	BELTED KINGFISHER	*Ceryle alcyon*	C/P
Family- ***Picidae***			
118	NORTHERN FLICKER	*Colaptes auratus*	C/P
119	PILEATED WOODPECKER	*Dryocopus pileatus*	C/P
120	LEWIS' WOODPECKER	*Melanerpes lewis*	U/S
121	YELLOW-BELLIED SAPSUCKER	*Sphyrapicus varius*	C/S
122	WILLIAMSON'S SAPSUCKER	*Sphyrapicus thyroideus*	O/SM
123	HAIRY WOODPECKER	*Picoides villosus*	C/P
124	DOWNY WOODPECKER	*Picoides pubescens*	C/P
125	WHITE-HEADED WOODPECKER	*Picoides albolarvatus*	U/P
126	BLACK-BACKED WOODPECKER	*Picoides arcticus*	U/P
127	THREE-TOED WOODPECKER	*Picoides tridactylus*	U/P
Family- ***Tyrannidae***			
128	EASTERN KINGBIRD	*Tyrannus tyrannus*	C/S
129	WESTERN KINGBIRD	*Tyrannus verticalis*	C/S
130	SAY'S PHOEBE	*Sayornis saya*	U/S
131	WILLOW FLYCATCHER	*Empidonax traillii*	C/S
132	LEAST FLYCATCHER	*Empidonax minimus*	O/S
133	HAMMOND'S FLYCATCHER	*Empidonax hammondii*	C/S
134	DUSKY FLYCATCHER	*Empidonax oberholseri*	C/S

Table 95 (cont.). Birds of the Colville National Forest and vicinity.

	Species name	Scientific name	Abundance and Seasonality
Family- *Tyrannidae*, cont.			
135	PACIFIC-SLOPE FLYCATCHER	*Empidonax difficilis*	U/S
136	WESTERN WOOD-PEWEE	*Contopus sordidulis*	C/S
137	OLIVE-SIDED FLYCATCHER	*Contopus borealis*	C/S
Family- *Alaudidae*			
138	HORNED LARK	*Eremophila alpestris*	C/MW
Family- *Hirundinidae*			
139	VIOLET-GREEN SWALLOW	*Tachycineta thalassina*	C/S
140	TREE SWALLOW	*Tachycineta bicolor*	C/S
141	BANK SWALLOW	*Riparia riparia*	C/S
142	NORTHERN ROUGH-WINGED SWALLOW	*Stelgidopteryx serripennis*	C/S
143	BARN SWALLOW	*Hirundo rustica*	C/S
144	CLIFF SWALLOW	*Hirundo pyrrhonota*	C/S
Family- *Corvidae*			
145	GRAY JAY	*Perisoreus canadensis*	C/P
146	STELLER'S JAY	*Cyanocitta stelleri*	C/P
147	BLACK-BILLED MAGPIE	*Pica pica*	C/P
148	COMMON RAVEN	*Corvus corax*	C/P
149	AMERICAN CROW	*Corvus brachyrhynchos*	C/S
150	CLARK'S NUTCRACKER	*Nucifraga columbiana*	C/P
Family- *Paridae*			
151	BLACK-CAPPED CHICKADEE	*Parus atricapillus*	C/P
152	MOUNTAIN CHICKADEE	*Parus gambeli*	C/P
153	BOREAL CHICKADEE	*Parus hudsonicus*	R/P
154	CHESTNUT-BACKED CHICKADEE	*Parus rufescens*	U/P
Family- *Sittidae*			
155	WHITE-BREASTED NUTHATCH	*Sitta carolinensis*	C/P
156	RED-BREASTED NUTHATCH	*Sitta canadensis*	C/P
157	PYGMY NUTHATCH	*Sitta pygmaea*	U/P
Family- *Certhiidae*			
158	BROWN CREEPER	*Certhia americana*	C/P
Family- *Cinclidae*			
159	AMERICAN DIPPER	*Cinclus mexicanus*	C/P
Family- *Troglodytidae*			
160	HOUSE WREN	*Troglodytes aedon*	U/S
161	WINTER WREN	*Troglodytes troglodytes*	C/P
162	MARSH WREN	*Cistothorus palustris*	CP/SC
163	CANYON WREN	*Catherpes mexicanus*	U/P
164	ROCK WREN	*Salpinctes obsoletus*	U/P

Table 95 (cont.). Birds of the Colville National Forest and vicinity.

	Species name	Scientific name	Abundance and Seasonality
Family- ***Mimidae***			
165	GRAY CATBIRD	*Dumetella carolinensis*	C/S
Family- ***Muscicapidae***			
166	AMERICAN ROBIN	*Turdus migratorius*	C/SM
167	VARIED THRUSH	*Ixoreus naevius*	C/S
168	HERMIT THRUSH	*Catharus guttatus*	C/S
169	SWAINSON'S THRUSH	*Catharus ustulatus*	C/S
170	VEERY	*Catharus fuscescens*	C/S
171	WESTERN BLUEBIRD	*Sialia mexicana*	U/S
172	MOUNTAIN BLUEBIRD	*Sialia currucoides*	C/S
173	TOWNSEND'S SOLITARE	*Myadestes townsendi*	C/S
174	GOLDEN-CROWNED KINGLET	*Regulus satrapa*	C/P
175	RUBY-CROWNED KINGLET	*Regulus calendula*	C/S
Family- ***Motacillidae***			
176	WATER PIPIT	*Anthus spinoletta*	C/M
Family- ***Bombycillidae***			
177	BOHEMIAN WAXWING	*Bombycilla garrulus*	C/W
178	CEDAR WAXWING	*Bombycilla cedrorum*	C/S
Family- ***Laniidae***			
179	NORTHERN SHRIKE	*Lanius excubitor*	C/W
180	LOGGERHEAD SHRIKE	*Lanius ludovicianus*	U/S
Family- ***Sturnidae***			
181	EUROPEAN STARLING	*Sturnus vulgaris*	I/P
Family- ***Vireonidae***			
182	SOLITARY VIREO	*Vireo solitarius*	C/S
183	RED-EYED VIREO	*Vireo olivaceus*	C/S
184	WARBLING VIREO	*Vireo gilvus*	U/S
Family- ***Passeridae***			
185	HOUSE SPARROW	*Passer domesticus*	I/S
Family- ***Emberizidae***			
186	TENNESSEE WARBLER	*Vermivora peregrina*	O/M
187	ORANGE-CROWNED WARBLER	*Vermivora celata*	C/S
188	NASHVILLE WARBLER	*Vermivora ruficapilla*	C/S
189	YELLOW WARBLER	*Dendroica petechia*	C/S
190	YELLOW-RUMPED WARBLER	*Dendroica coronata*	C/S
191	TOWNSEND'S WARBLER	*Dendroica townsendi*	U/S
192	NORTHERN WATERTHRUSH	*Seiurus noveboracensis*	O/S
193	MacGILLIVRAY'S WARBLER	*Oporornis tolmiei*	C/S
194	COMMON YELLOWTHROAT	*Geothlypis trichas*	C/S

Table 95 (cont.). Birds of the Colville National Forest and vicinity.

	Species name	Scientific name	Abundance and Seasonality
Family- *Emberizidae*, cont.			
195	YELLOW-BREASTED CHAT	*Icteria virens*	U/S
196	WILSON'S WARBLER	*Wilsonia pusilla*	C/S
197	AMERICAN REDSTART	*Setophaga ruticilla*	C/S
198	BOBOLINK	*Dolichonyx oryzivorus*	U/S
199	WESTERN MEADOWLARK	*Sturnella neglecta*	C/S
200	YELLOW-HEADED BLACKBIRD	*Xanthocephalus xanthcep.*	C/S
201	RED-WINGED BLACKBIRD	*Agelaius phoeniceus*	C/S
202	NORTHERN ORIOLE	*Icterus galbula*	U/S
203	BREWER'S BLACKBIRD	*Euphagus cyanocephalus*	C/S
204	BROWN-HEADED COWBIRD	*Molothrus ater*	C/S
205	BLACK-HEADED GROSBEAK	*Pheucticus melanocephalu*	U/S
206	LAZULI BUNTING	*Passerina amoena*	C/S
207	WESTERN TANAGER	*Piranga ludoviciana*	C/S
208	RUFOUS-SIDED TOWHEE	*Pipilo erythrophthalmus*	C/S
209	SAVANNAH SPARROW	*Passerculus sandwichensis*	C/M
210	GRASSHOPPER SPARROW	*Ammodramus savannarum*	U/S
211	VESPER SPARROW	*Pooecetes gramineus*	C/S
212	DARK-EYED JUNCO	*Junco hyemalis*	C/P
213	AMERICAN TREE SPARROW	*Spizella arborea*	U/M
214	CHIPPING SPARROW	*Spizella passerina*	C/S
215	CLAY-COLORED SPARROW	*Spizella pallida*	O/S
216	BREWER'S SPARROW	*Spizella breweri*	U/S
217	WHITE-CROWNED SPARROW	*Zonotrichia leucophrys*	C/SM
218	FOX SPARROW	*Passerella iliaca*	C/SW
219	LINCOLN'S SPARROW	*Melospiza lincolnii*	O/M
220	SONG SPARROW	*Melospiza melodia*	C/P
221	LAPLAND LONGSPUR	*Calcarius lapponicus*	O/W
222	SNOW BUNTING	*Plectrophenax nivalis*	O/W
Family- *Fringillidae*			
223	EVENING GROSBEAK	*Coccothraustes vespertinus*	C/SW
224	PURPLE FINCH	*Carpodacus purpureus*	O/W
225	CASSIN'S FINCH	*Carpodacus cassinii*	C/SW
226	HOUSE FINCH	*Carpodacus mexicanus*	C/SW
227	PINE GROSBEAK	*Pinicola enucleator*	C/P
228	ROSY FINCH	*Leucosticte arctoa*	U/W
229	COMMON REDPOLL	*Carduelis flammea*	U/W
230	HOARY REDPOLL	*Carduelis hornemanni*	O/W
231	PINE SISKIN	*Carduelis pinus*	C/P
232	AMERICAN GOLDFINCH	*Carduelis tristis*	C/S
233	RED CROSSBILL	*Loxia curvirostra*	C/P
234	WHITE-WINGED CROSSBILL	*Loxia leucoptera*	U/W

Table 96. Mammals of the Colville National Forest and vicinity. Data compiled by T. Burke (1976). Abundance codes: C= common, U= uncommon, X= unknown, I= introduced, R= rare.

	Species name	Scientific name	Abundance
Order- ***Insectivora***			
1	PYGMY SHREW	*Microsorex hoyi*	X
2	MASKED SHREW	*Sorex cinereus*	U
3	NORTHERN WATER SHREW	*Sorex palustris*	U
4	VAGRANT SHREW	*Sorex vagrans*	C
5	DUSKY SHREW	*Sorex obscurus*	C
Order- ***Chiroptera***			
6	LITTLE BROWN MYOTIS	*Myotis lucifugus*	C
7	YUMA MYOTIS	*Myotis yumanensis*	X
8	LONG-EARED MYOTIS	*Myotis evotis*	X
9	FRINGED MYOTIS	*Myotis thysanodes*	U
10	LONG-LEGGED MYOTIS	*Myotis volans*	X
11	CALIFORNIA MYOTIS	*Myotis californicus*	C
12	SMALL-FOOTED MYOTIS	*Myotis subulatus*	X
13	SILVER-HAIRED BAT	*Lasionycteris noctivagans*	X
14	BIG BROWN BAT	*Eptesicus fuscus*	C
15	RED BAT	*Lasiurus borealis*	X
16	HOARY BAT	*Lasiurus cinereus*	X
17	TOWNSEND'S BIG-EARED BAT	*Plecotus towsendi*	X
18	PALLID BAT	*Antrozous pallidus*	X
Order- ***Lagomorpha***			
19	PIKA	*Ochotona princeps*	C
20	SNOWSHOE HARE	*Lepus americanus*	C
21	MOUNTAIN COTTONTAIL	*Sylvilagus nuttalli*	X
Order- ***Rodentia***			
22	YELLOW PINE CHIPMUNK	*Eutamias amoenus*	C
23	RED-TAILED CHIPMUNK	*Eutamias ruficaudus*	C
24	WOODCHUCK	*Marmota monax*	X
25	YELLOW-BELLIED MARMOT	*Marmota flaviventris*	C
26	HOARY MARMOT	*Marmota caligata*	U
27	COLUMBIAN GROUND SQUIRREL	*Citellus columbianus*	C
28	MANTLED GROUND SQUIRREL	*Citellus lateralis*	U
29	RED SQUIRREL	*Tamiasciurus hudsonicus*	C
30	NORTHERN FLYING SQUIRREL	*Glaucomys sabrinus*	C
31	NORTHERN POCKET GOPHER	*Thomomys talpoides*	C
Order- ***Rodentia***			
32	GREAT BASIN POCKET MOUSE	*Perognathus parvus*	X
33	BEAVER	*Castor canadensis*	C
34	DEER MOUSE	*Peromyscus maniculatus*	C
35	BUSHY-TAILED WOODRAT	*Neotoma cinerea*	C
36	BOREAL RED-BACKED VOLE	*Clethrionomys gapperi*	C
37	HEATHER VOLE	*Phenacomys intermedius*	U

Table 96 (cont.). Mammals of the Colville National Forest and vicinity.

	Species name	Scientific name	Abundance
Order- *Rodentia*, cont.			
38	MEADOW VOLE	*Microtus pennsylvanicus*	C
39	MOUNTAIN VOLE	*Microtus montanus*	X
40	LONG-TAILED VOLE	*Microtus longicaudus*	X
41	WATER VOLE	*Arvicola richardsoni*	X
42	SAGEBRUSH VOLE	*Lagurus curtatus*	X
43	MUSKRAT	*Ondatra zibethicus*	C
44	NORTHERN BOG LEMMING	*Synaptomys borealis*	U
45	NORWAY RAT	*Rattus norvegicus*	IX
46	HOUSE MOUSE	*Mus musculus*	I
47	WESTERN JUMPING MOUSE	*Zapus princeps*	C
48	PORCUPINE	*Erethizon dorsatum*	C
Order- *Carnivora*			
49	COYOTE	*Canis latrans*	C
50	GRAY WOLF	*Canis lupus*	X
51	RED FOX	*Vulpes fulva*	X
52	BLACK BEAR	*Ursus americanus*	C
53	GRIZZLY BEAR	*Ursus arctos*	R
54	RACCOON	*Procyon lotor*	C
55	AMERICAN MARTEN	*Martes americana*	C
56	FISHER	*Martes pennanti*	R
57	SHORT-TAILED WEASEL	*Mustela erminea*	C
58	LONG-TAILED WEASEL	*Mustela frenata*	C
59	MINK	*Mustela vison*	C
60	WOLVERINE	*Gulo luscus*	R
61	BADGER	*Taxidea taxus*	U
62	STRIPED SKUNK	*Mephitis mephitis*	C
63	RIVER OTTER	*Lutra canadensis*	U
64	MOUNTAIN LION	*Felis concolor*	C
65	LYNX	*Lynx canadensis*	U
66	BOBCAT	*Lynx rufus*	C
Order- *Artiodactyla*			
67	ROCKY MOUNTAIN ELK	*Cervus canadensis*	C
68	MULE DEER	*Odocoileus hemionus*	C
69	WHITE-TAILED DEER	*Odocoileus virginianus*	C
70	MOOSE	*Alces alces*	U
71	WOODLAND CARIBOU	*Rangifer tarandus*	R
72	MOUNTAIN GOAT	*Oreamnos americanus*	I
73	ROCKY MOUNTAIN BIGHORN SHEEP	*Ovis canadensis*	I

Table 97. Reptiles and amphibians found on the Colville National Forest and vicinity. Data from Slater (1963, 1964).

	Common name	Scientific name
1	BLOTCHED TIGER SALAMANDER	*Ambystoma tigrinum*
2	CENTRAL LONG-TOED SALAMANDER	*Ambystoma macrodactylum*
3	GREAT BASIN SPADEFOOT	*Scaphiopus inermontanus*
4	WESTERN TOAD	*Bufo boreus*
5	PACIFIC TREE FROG	*Hyla regilla*
6	SPOTTED FROG	*Rana pretiosa*
7	NORTHERN LEOPARD FROG	*Rana pipens*
8	BULLFROG	*Rana catesbeiana*
9	PAINTED TURTLE	*Chrysemys picta*
10	WESTERN SKINK	*Eumeces skiltonianus*
11	NORTHERN ALLIGATOR LIZARD	*Gerrhonotus coeruleus*
12	ROCKY MOUNTAIN RUBBER BOA	*Charina bottae*
13	WESTERN YELLOW-BELLIED RACER	*Coluber constrictor*
14	GREAT BASIN GOPHER SNAKE	*Pituophis melanoleucus*
15	VALLEY GARTER SNAKE	*Thamnophis sirtalis*
16	WANDERING GARTER SNAKE	*Thamnophis elegans*
17	NORTHERN PACIFIC RATTLESNAKE	*Crotalus viridus*

Table 98. Fishes of the Colville National Forest and vicinity.

	Species name	Scientific name
1	White Sturgeon	*Acipenser transmontanus*
2	Kokanee (Silver Trout)*	*Onchorhynchus nerka kennerlyi*
3	Westslope Cutthroat Trout*	*Onchorhynchus clarki lewisi*
4	Coastal Rainbow Trout*	*Oncorhynchus mykiss irideus*
5	Redband Trout (Interior Rainbow)*	*Oncorhynchus mykiss gairdneri*
6	Brown Trout*	*Salmo trutta*
7	Brook Trout*	*Salvelinus fontinalis*
8	Bull Trout*	*Salvelinus confluentus*
9	Lake Trout*	*Salvelinus namaycush*
10	Pygmy Whitefish*	*Prosopium coulteri*
11	Mountain Whitefish*	*Prosopium williamsoni*
12	Grass Pickerel	*Esox americanus*
13	Common Carp*	*Cyprinus carpio*
14	Tench*	*Tinca tinca*
15	Tui Chub	*Gila bicolor*
16	Redside Shiner*	*Richardsonius balteatus*
17	Northern Squawfish*	*Ptychocheilus oregonensis*
18	Peamouth	*Mylocheilus caurinus*
19	Chiselmouth	*Acrocheilus alutaceus*
20	Longnose Dace	*Rhinichthys cataractae*
21	Leopard Dace	*Rhinichthys falcatus*
22	Speckled Dace*	*Rhinichthys osculus*
23	Bridgelip Sucker*	*Catostomus columbianus*
24	Largescale Sucker*	*Catostomus macrocheilus*
25	Black Bullhead	*Ictalurus melas*
26	Yellow Bullhead	*Ictalurus natalis*
27	Brown Bullhead*	*Ictalurus nebulosus*
28	Threespine Stickleback	*Gasterosteus aculeatus*
29	Burbot (Lingcod)*	*Lota lota*

Table 98 (cont.). Fishes of the Colville National Forest and vicinity.

Species name		Scientific name
30	Smallmouth Bass*	*Micropterus dolomieui*
31	Largemouth Bass*	*Micropterus salmoides*
32	Black Crappie*	*Pomoxis nigromaculatus*
33	Green Sunfish	*Lepomis cyanellus*
34	Pumpkinseed Sunfish*	*Lepomis gibbosus*
35	Walleye	*Stizostedion vitreum*
36	Yellow Perch*	*Perca flavescens*
37	Prickly Sculpin (1)	*Cottus asper*
38	Mottled Sculpin (1)	*Cottus bairdi*
39	Piute Sculpin*	*Cottus beldingi*
40	Torrent Sculpin (1)	*Cottus rhotheus*
41	Shorthead Sculpin (1)	*Cottus confusus*
42	Slimy Sculpin*	*Cottus cognatus*
43	Arctic Grayling*	*Thymallus arcticus*

* Species found in waters on the Colville N.F. proper.

(1) Sculpin are present in waters on the Forest, but data on species is incomplete.

APPENDIX 4

- **Field Form for Plant Association Identification**

ECOLOGY FIELD FORM - COLVILLE NATIONAL FOREST

DATE___/___/___ T___N R___E SEC___E

DISTRICT________________

COMPARTMENT __________ CELL _______ OBSERVER____________________________

GENERAL
LOCATION____

PLANT ASSOCIATION______________________ COMMUNITY TYPE_______________________

ELEVATION _________FT. SLOPE ________% ASPECT_________________

POSITION:(circle)	SLOPE CONFIGURATION:(circle)
1-Ridge	1-Convex
2-Upper 1/3	2-Straight(flat)
3-Mid slope	3-Concave
4-Lower 1/3	
5-Bench or flat	
6-Valley bottom	

% CROWN COVER: (1/10th acre)

PERCENT	AREA(ft.^{2})	RADIUS (ft.)
Trace	<43.6	<3.7
1%	43.6	3.7
5%	217.8	8.3
10%	435.6	11.8

Scientific name	Code	Common name	%COVER OS(>12')	%COVER US(<12')
TREES				
1 *Abies grandis*	ABGR	grand fir	____	____
2 *Abies lasiocarpa*	ABLA2	subalpine fir	____	____
3 *Betula papyrifera*	BEPA	paper birch	____	____
4 *Larix occidentalis*	LAOC	western larch	____	____
5 *Picea engelmannii*	PIEN	Engelmann spruce	____	____
6 *Pinus albicaulis*	PIAL	whitebark pine	____	____
7 *Pinus contorta*	PICO	lodgepole pine	____	____
8 *Pinus monticola*	PIMO	western white pine	____	____
9 *Pinus ponderosa*	PIPO	ponderosa pine	____	____
10 *Populus tremuloides*	POTR	quaking aspen	____	____
11 *Populus trichocarpa*	POTR2	black cottonwood	____	____
12 *Pseudotsuga menziesii*	PSME	Douglas-fir	____	____
13 *Thuja plicata*	THPL	western redcedar	____	____
14 *Tsuga heterophylla*	TSHE	western hemlock	____	____

SHRUBS AND SUBSHRUBS			
1 *Acer glabrum* var. *Douglasii*	ACGLD	Douglas maple	____
2 *Alnus sinuata*	ALSI	Sitka alder	____
3 *Amelanchier alnifolia*	AMAL	serviceberry	____
4 *Arctostaphylos uva-ursi*	ARUV	bearberry	____
5 *Berberis aquifolium*	BEAQ	Oregon grape	____
6 *Cornus canadensis*	COCA	bunchberry dogwood	____
7 *Cornus stolonifera*	COST	red-osier dogwood	____
8 *Holodiscus discolor*	HODI	ocean-spray	____
9 *Linnaea borealis*	LIBOL	twinflower	____
10 *Menziesia ferruginea*	MEFE	rusty menziesia	____
11 *Oplopanax horridum*	OPHO	devil's club	____
12 *Pachistima myrsinites*	PAMY	pachistima	____
13 *Physocarpus malvaceus*	PHMA	ninebark	____
14 *Pyrola secunda*	PYSE	sidebells pyrola	____

ECOLOGY FIELD FORM - COLVILLE NATIONAL FOREST

Scientific name	Code	Common name	%COVER
SHRUBS AND SUBSHRUBS			
15 *Rhododendron albiflorum*	RHAL	Cascade azalea	____
16 *Ribes lacustre*	RILA	prickly currant	____
17 *Rubus parviflorus*	RUPA	thimbleberry	____
18 *Rubus pedatus*	RUPE	five-leaved bramble	____
19 *Salix scouleriana*	SASC	Scouler willow	____
20 *Shepherdia canadensis*	SHCA	russet buffaloberry	____
21 *Sorbus scopulina*	SOSC2	mountain ash	____
22 *Spirea betulifolia* var. *lucida*	SPBEL	shiny-leaf spirea	____
23 *Symphoricarpos albus*	SYAL	common snowberry	____
24 *Symphoricarpos oreophilus*	SYOR	mountain snowberry	____
25 *Vaccinium caespitosum*	VACA	dwarf huckleberry	____
26 *Vaccinium membranaceum*	VAME	big huckleberry	____
27 *Vaccinium myrtillus*	VAMY	low huckleberry	____
28 *Vaccinium scoparium*	VASC	grouse huckleberry	____
29 *Xerophyllum tenax*	XETE	beargrass	____
HERBS			
1 *Actaea rubra*	ACRU	baneberry	____
2 *Adenocaulon bicolor*	ADBI	pathfinder	____
3 *Agropyron spicatum*	AGSP	bluebunch wheatgrass	____
4 *Aralia nudicaulis*	ARNU3	wild sarsaparilla	____
5 *Arnica cordifolia*	ARCO	heartleaf arnica	____
6 *Asarum caudatum*	ASCA3	wild ginger	____
7 *Athyrium filix-femina*	ATFI	lady-fern	____
8 *Balsamorhiza sagittata*	BASA	arrowleaf balsamroot	____
9 *Calamagrostis rubescens*	CARU	pinegrass	____
10 *Clintonia uniflora*	CLUN	queencup beadlily	____
11 *Equisetum arvense*	EQAR	common horsetail	____
12 *Equisetum sylvaticum*	EQSY	wood horsetail	____
13 *Fetsuca idahoensis*	FEID	Idaho fescue	____
14 *Galium triflorum*	GATR	sweetscented bedstraw	____
15 *Goodyera oblongifolia*	GOOB	w. rattlesnake plantain	____
16 *Gymnocarpium dryopteris*	GYDR	oak-fern	____
17 *Lupinus* species	LUPIN	lupine species	____
18 *Luzula hitchcockii*	LUHI	smooth woodrush	____
19 *Senecio triangularis*	SETR	arrowleaf groundsel	____
20 *Smilacina racemosa*	SMRA	feather solomonplume	____
21 *Smilacina stellata*	SMST	starry solomonplume	____
22 *Streptopus amplexifolius*	STAM	claspleaf twisted-stalk	____
23 *Tiarella unifoliata*	TIUN	coolwort foamflower	____
24 *Trautvetteria caroliniensis*	TRCA3	false bugbane	____
25 *Trillium ovatum*	TROV	white trillium	____
26 *Valeriana sitchensis*	VASI	Sitka valeriana	____
27 *Viola orbiculata*	VIOR2	round-leaved violet	____

ADDITIONAL SPECIES OR
OBSERVATIONS____

GLOSSARY OF TERMS

Absent Not found in the plot, community or association.

Abundant When relating to plant canopy cover in association descriptions or key, any species with 25% or more cover (after Pfister *et al.* 1977).

Accidental A species infrequently found in a particular habitat that is present as an accident or fluke of establishment.

All-aged A condition of a forest or stand that contains trees of all or almost all age classes. It is generally a primary stand where individuals have entered at various times when and where suitable conditions such as space has allowed. (*See* **Uneven-aged**).

Allelopathy The influence of one plant upon another by products of metabolism. "Chemical warfare of plants".

Alpine The part of a mountain above the tree line; or refers to plants that grow in that environment. Thus by definition there is no such thing as an alpine tree because alpine means "above the tree line".

Annual A plant that grows, matures, produces seed and dies in only one year.

Association a. A unit of vegetation classification based on the projected climax community type. b. A group of plants growing together in a climax state. c. An assemblage of species recognized and characterized by certain characteristic dominates. d. R. Daubenmire: "...a particular combination of climax tree and understory dominants..." (Daubenmire 1968).

Awn A slender bristle or hairlike projection.

Biennial A plant that completes its life cycle in 2 years and then dies.

Bunchgrass A grass that grows from a bunch or clump (*see* **Caespitose**, *Contrast with* **Rhizomatous**.)

Caespitose Growing in dense tufts, *i.e.* bunchgrass.

Canopy The cover of branches and foliage formed collectively by the crowns of adjacent trees.

Clearcut The cutting method that describes the silvicultural system in which harvesting removes most or all of the existing trees over a considerable area at one time. An even-aged forest usually results.

Climax A self-replacing association or species; with no evidence of replacement by other plants.

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. Viewed as the final stage or end-point in plant succession for a site. The climax community develops and maintains itself in steady state conditions (without disturbance). Often termed the association.

Climax species Species that are self perpetuating in the absence of disturbance without evidence of replacement by other species. Usually considered the most shade tolerant and competitive species.

Climax vegetation The pattern or complex of climax communities in a landscape corresponding to the pattern of environmental gradients or habitats (Gabriel and Talbot 1984).

Clone A group of individuals that originated vegetatively from a single individual.

Codominant Species in a mixed stand that are about equally numerous and vigorous, forming part of the upper canopy of a forest.

Common When used in association descriptions or keys any species with 1% or more cover in the stand (several individuals present) (after Pfister *et al.* 1977). Often may include species with cover values somewhat less than 1% since trace was not recorded in the Colville N.F. data.

Community A general term for an assemblage of plants living together and interacting among themselves in a specific location; no particular ecological status is implied.

Community type An aggregation of all plant communities with similar structure and floristic composition. A unit of vegetation within a classification with no particular successional status implied.

Constancy The number of occurrences of a species in a series of plots divided by the total number of plots (expressed as a percentage and all plots must be the same size). *i.e.* If a particular association has 10 plots and a species is found in 8 of the 10 then its constancy is 80%.

Cover Usually meant as canopy cover which is the gross outline of the foliage of an individual plant or group of plants within a stand or plot. Expressed as a percent of the total area of the plot and may exceed 100% if more than one layer is considered.

Decumbent Lying on the ground with a prostrate base and erect tips.

Depauperate Poorly developed in terms of both species and cover of individuals.

Dominant A taxon or group of taxa which by their collective size, mass, or numbers exert the most influence on other components of the ecosystem (Daubenmire 1978).

Duff The partially decomposed organic matter (litter of leaves, flowers and/or fruits) found beneath plants, as on a forest floor.

Ecotone The boundary or transition zone between plant communities.

Edaphic Refers to the soil.

Ephemeral Lasting only a short time.

Epiphyte An organism that grows on another plant, but is not parasitic on it.

Even-aged management The application of a combination of actions that results in the creation of stands in which trees of essentially the same age grow together. The difference in age between trees forming the main canopy level of a stand usually does not exceed 20 percent of the age of the level of a stand at maturity. Cutting methods producing even-aged stands are clearcut, shelterwood, or seed tree.

Evergreen Foliage remains green throughout the year; not deciduous.

Forb An herb. Any herbaceous plant that is not grasslike.

Genus A taxonomic class below a family and above a species (*e.g.* all pines are of one genus).

Graminoid Refers to an herb with long narrow leaves such as grasses and grasslike plants (sedges and rushes).

Grass Any member of the family Gramineae.

Grasslike Includes plants such as sedges and rushes that resemble grasses in gross morphology but are not part of the family Gramineae. *See* **Graminoid**.

Group selection The cutting method which describes the silvicultural system in which trees are removed periodically in small groups resulting in openings that do not exceed 1 to 2 acres in size. This usually leads to the formation of an uneven-aged stand.

Habit The general growth form and appearance of a species.

Habitat The area or type of environment in which an organism or population normally lives or occurs.

Habitat type Defined originally by R. Daubenmire to mean: "All the area that now supports, or within recent time has supported, and presumably is still capable of supporting, one plant association..." (Daubenmire 1968). An aggregation of all land areas capable of supporting similar plant communities at climax (Pfister *et al.* 1977).

Herb A plant with a fleshy stem that dies back to ground level each year. A non-woody plant.

Herbaceous Leaf-like in color and texture; non-woody.

Hydric A relative term used with xeric and mesic to denote the wetness of a site. Xeric-mesic-hydric indicates from dry to wet. Hygric is a synonymous term that is probably more appropriate (or correct).

Hygric *See* **Hydric**.

Increaser A native plant that increases under disturbance (usually grazing). It carries a negative connotation for determination of range condition.

Indicator species A species which is sensitive to important environmental feature of a site such that its constancy or abundance reflect significant changes in environmental factors. A plant whose presence indicates specific site conditions or a type.

Individual tree selection The cutting method that describes the silvicultural system in which trees are removed individually over an entire stand over time. This usually results in uneven-aged stands.

Invader A introduced plant that increases after its introduction into a site; generally after some type of disturbance. As used in range management the term carries the connotation of being undesirable for grazing.

Krummholz The stunted growth habit, literally crooked wood, caused by wind and found in certain tree species at their upper limit of distribution.

Layering The ability of a plant to form roots where its stem comes in contact with the ground. (*e.g.* western redcedar or Pacific yew)

Litter The uppermost layer of organic debris on a forest floor consisting essentially of freshly fallen or only slightly decomposed vegetative matter.

Mesic A relative term used with xeric and hydric to denote the wetness of a site. Xeric-mesic-hydric indicates from dry to wet. Characterized by intermediate moisture conditions, neither decidedly wet nor dry.

Meso-, or Mes A prefix used to indicate middle or intermediate condition such as mesic (intermediate in terms of moisture and/or temperature; or along a gradient of riparian conditions such as riparian, meso-riparian, xero-riparian to non-riparian communities or species).

Microsite A small area (usually only a few square feet) of different site or habitat conditions from that surrounding it. (*e.g.* A small concave area within a larger area of convex slope.)

Moderate Used in the context of not extreme in terms of temperature, elevation and moisture.

Montane The biogeographic zone made up of relatively moist cool upland slopes between the lower and upper timberlines, generally characterized by large evergreen trees as a dominant life form.

Mottling Variation of coloration in soils as represented by localized spots, patches, or blotches of contrasting color. Commonly develops under alternating wet and dry periods with associated reduction and oxidation environments. Mottling generally indicates poor aeration and impeded drainage (Youngblood *et al.* 1985).

Old-growth Stands which are generally well past the age of maturity as defined by the culmination of mean annual increment and often exhibit characteristics of decadence. These characteristics may include, but are not limited to: low growth rates, dead and dying trees, snags, and down woody material. The stands are usually characterized by large diameter trees relative to species and site potential, multi-layered canopies and a range in tree diameter sizes. The specific attributes of an old-growth stand are primarily dependent on plant associations and forest cover type (Burns and Honkala 1990).

Perennial A plant that lives more than 2 years.

Pioneer A plant capable of invading a newly exposed soil surface and persisting there until supplanted by successor species.

Plot A circumscribed sampling area for vegetation (Lincoln *et al.* 1982).

Poorly represented When relating to plant coverage in association descriptions or keys, includes any species with less than 5% cover, including absent. In practice often indicates species that are not especially apparent (after Pfister *et al.* 1977).

Pole-size A young tree generally with a d.b.h. of not less than 4 in. or greater than 12 in.

Presence The state or fact of being present; or similar to constancy except that all the plots need not be the same size.

Present Found in the plot (not obviously restricted to atypical microsites) (after Pfister *et al.* 1977).

Principal layer The layer which defines the characteristic physiognomy of the vegetation (at any geographic or classification scale) being considered.

Prostrate Growing flat along the ground.

Pumice A volcanic glass full of cavities and very light in weight.

Regolith "All loose earth material above the underlying solid rock; more or less equivalent to the term soil..." (Lincoln *et al.* 1982).

Reproducing successfully An evaluation of the reproductive success of trees where a species appears capable of reproducing itself under current conditions (mainly applied to closed canopy conditions). Generally 10 or more individuals per acre is used as an arbitrary starting point for evaluation. Other items normally considered include 1) the health and vigor of individuals, 2) the species in question are not restricted to atypical microsites and 3) are usually in more than one size class in the understory (after Pfister *et al.* 1977).

Rhizomatous Having rhizomes.

Rhizome A root-like underground stem that sends out shoots from its upper surface and roots from the under surface.

Riparian That land, next to water, where plants dependent on a perpetual source of water occur (Kovalchik 1987).

Riparian ecosystem Interacting system between aquatic and terrestrial situation, identified by soil characteristics, and distinctive vegetation that requires or tolerates free or unbound water (Youngblood *et al.* 1985).

Riparian species Plant species occurring within the riparian zone. Obligate species require the environmental conditions within the riparian zone; facultative species tolerate the environmental conditions, therefore may also occur away from the riparian zone (Youngblood *et al.* 1985).

Riparian zone A geographically delineated portion of the riparian ecosystem (Youngblood *et al.* 1985).

Rootstock Rhizome.

Rosette A basal cluster of leaves, flowers, etc.; arranged in a circle or disc.

Rush Grasslike plants of the family Juncaceae, with hollow or pithy stems that are usually round in shape and without nodes.

Sapling A tree more than 3 ft. in height and less than 4 inches in d.b.h.

Scarce When relating to plant coverage in association descriptions or keys, includes any species absent or with less than 1% cover (only one or two small plants).

Secund Having the flowers or branches all on one side of the axis (*e.g. Pyrola secunda*).

Sedge A grasslike plant of the family Cyperaceae that resemble grasses but have solid (often triangular) stems without nodes.

Seedling A tree grown from seed that has not yet reached a height of 3 ft. or exceeded 2 inches in d.b.h.

Seed tree The cutting method that describes the silvicultural system in which the dominant feature is the removal of all trees except for a pre-determined number of seed bearers left singly or in small groups. The seed trees are often harvested when regeneration is established. This usually results in an even-aged stand.

Seral A species or plant community that is replaced by another (over time) as succession progresses. *See* **Sere**.

Sere The complete sequence of ecological communities successively occupying an area.

Series An aggregation of taxonomically related associations that takes the name of climax species that dominate the principal layer (Driscoll *et al.* 1984). A group of associations or habitat types with the same dominant climax species.

Serotinous Late in developing; particularly applied to fruit and cones that remain closed for a year or more after the seeds mature.

Serpentine A mineral or rock consisting essentially of a hydrous magnesium silicate. It usually has a dull green color and often a mottled appearance.

Shelterwood The cutting method that describes the silvicultural system in which trees are harvested in two or more successive cuttings. This process provides a source of seed and/or protection for regeneration. An even-aged stand usually results.

Shrub A woody perennial that differs from trees in that it is typically smaller in stature and has multiple stems from the ground. They tend to be categorized as follows: Low shrubs are up to 2 feet tall; Medium shrubs are 2 to 6 feet high; and tall shrubs are more than 6 feet tall. *See* **Subshrub**.

Site An area delimited by fairly uniform climatic and soil conditions. Similar to habitat.

Site index (SI) A measure of site class based upon the height of the dominant trees in a stand at an arbitrarily chosen age, most commonly 100 years.

Solum The upper and most weathered part of the soil profile, i.e., the A and B horizons.

Species A taxonomic class below that of genus; generally refers to organisms capable of interbreeding.

Stable The condition of little or no perceived change in plant communities that are in relative equilibrium with existing environmental conditions; describes persistent but not necessarily culminating stages (climax) in plant succession (Youngblood *et al.* 1985).

Stand Vegetation occupying a specific area and sufficiently uniform in species composition, age arrangement, structure and condition as to be distinguished from the vegetation on adjoining areas. A group of plants with a more-or-less uniform condition(s) such as composition, age, structure, condition, etc. Stands are real entities and can be sampled. Compare association, habitat type, community.

Stolon A creeping stem above the ground that roots at the nodes. *Compare with* **Rhizome**.

Stoloniferous Having or bearing stolons.

Subalpine A forested zone just below the treeless (alpine) zone. *See* **Alpine**.

Subshrub A very low (usually less than 1foot tall) and semi-woody plant with a persistent, somewhat woody base. Some consider them as woody herbs. PYSE, CHUMO and LIBOL are examples of subshrubs. (**Suffrutescent** is the proper botanical term for semi-shrubby plants.)

Succession The replacement of one type of community or species by another. Often given the connotation of leading towards the climax but this is not necessarily so in all uses.

Succulent With thick, fleshy stems or leaves.

Suffrutescent Semi-woody, or half shrubby. *See* **Subshrub**.

Suppressed Very slowly growing trees with crowns in the lower layer of the canopy. Such trees are subordinate to dominants, codominants, and intermediates in the crown canopy.

Tiller A shoot from the base of a grass.

Timberline The upper or lower limit beyond which trees do not grow. The lower timberline is usually related to drought and the upper to low temperatures. *See* **Tree line**.

Trailing Prostrate, but not rooting.

Tree A woody plant with a single stem (usually) and more than 8 feet tall.

Tree line The limit beyond which trees do not grow except perhaps in a stunted form. *Compare with* **Timberline**.

Undergrowth A generalized term that refers to the plants under a taller canopy of vegetation such as shrubs under a canopy of trees. *See* **Understory**.

Understory Sometimes has the same meaning as undergrowth but usually carries the connotation of meaning small trees.

Uneven-aged A condition of forest or stand that contains a mix of trees that differ markedly in age.

Well represented When relating to plant coverage in association descriptions or keys, any species with more than 5% canopy cover (readily apparent) (after Pfister *et al.* 1977).

Wintergreen Green throughout the year. Evergreen but without the connotation that evergreen carries of being specific to tree foliage.

Xero- A Greek prefix meaning dry; *i.e.* xerophyte = a dryness enduring or drought tolerant plant. Compare with the meaning of **Mesic** and **Hydric** (hygric).

Xeric Characterized by or adapted to a dry habitat. *Compare with* **Hydric**.

Zone The geographic area of uniform macroclimate where the climatic associations share the same characteristic species of the principal layer. Note: The zone has been used by Daubenmire (1978) to describe the geographical area over which one association is climatic climax. His definition is more specific than the definition given above. The definition as used herein approximates the geographical area of a series, or possibly portions of other series, rather than the area of one association.

Williams, Clinton K.; Kelley, Brian F.; Smith, Bradley G.; Lillybridge, Terry R. 1995. Forested plant associations of the Colville National Forest. Gen. Tech. Rep. PNW-GTR-360. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 375 p. In cooperation with: Pacific Northwest Region, Colville National Forest.

A classification of forest vegetation is presented for the Colville National Forest in northeastern Washington State. It is based on potential vegetation with the plant association as the basic unit. The classification is based on a sample of approximately 229 intensive plots and 282 reconnaisance plots distributed across the forest from 1980 to 1983. The hierarchical classification includes 5 forest tree series and 39 plant associations or community types. Diagnostic keys are presented for each tree series and plant association or community type. Descriptions include information about plant association or community species composition, occurrences, distribution, environment and soils, forest productivity, management implications and relations to other vegetation classifications. Background information is also presented on the ecology, geology, soils, climate, and fire history of the Colville National Forest.

Keywords: Vegetation classification, climax plant communities, potential vegetation, plant association, vegetation series, forest ecology, fire, wildife, range, northeastern Washington.

Pacific Northwest Research Station
333 S.W. First Avenue
P.O. Box 3890
Portland, Oregon 97208-3890