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# Plant Association and Management Guide for the Grand Fir Zone

## Gifford Pinchot National Forest



## **Cover Photograph**

View of the south side of Mount Adams with Trout Lake in the foreground, taken by Ray Filloon about 1935. The Grand Fir Zone on the Gifford Pinchot National Forest includes the low elevation area near the eastern Forest boundary visible on the south side of Mt. Adams and also an area in and near the Little White Salmon River drainage between Trout Lake (the town) and the Columbia River. The lake in the photo is now almost entirely filled in. Forest structure within this area has also changed greatly since pre-settlement times.

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# **Plant Association and Management Guide for the Grand Fir Zone**

## **Gifford Pinchot National Forest**

**By Christopher Topik, Associate Area Ecologist**

# Table of Contents

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## Chapter One

Introduction .....	1
Area Covered .....	1
Why We Classify Plant Associations .....	1
Plant Association Classification Terminology .....	1
Definition of Forest Zones .....	1
Ecoclass Codes .....	2
Overview of Forest Series .....	2
Methods .....	6
Climate .....	9
Soils .....	11
Timber .....	13
Wildlife and Range .....	23

## Chapter Two

How to Key Out Sites to Plant Association .....	33
Key to Coniferous Forest Series: Gifford Pinchot National Forest .....	33
Association Keys:	
Grand Fir Series .....	34
Western Redcedar Series .....	35
Douglas-fir Series .....	35
List of Common Plant Species Within the Grand fir, Douglas-fir and Western Redcedar Series on the Gifford Pinchot National Forest .....	36

## Chapter Three

Explanation of Data in the Plant Association Descriptions .....	43
Association Descriptions:	
Douglas-fir Series	
Douglas-fir/Vine maple/Western fescue .....	45
Grand fir Series	
Grand Fir/Pinegrass .....	49
Grand Fir/Elk sedge .....	53
Grand Fir/Vine maple-tall Oregongrape/Starflower .....	57
Grand Fir/Oceanspray .....	61

Grand Fir/Creeping snowberry/Vanillaleaf .....	65
Grand Fir/California hazel/Vanillaleaf .....	69
Grand Fir/Dwarf Oregon grape/Vanillaleaf .....	73
Grand Fir/Pacific dogwood/Vanillaleaf .....	77
Grand Fir/Thimbleberry/Fairybells .....	81
Grand Fir/Big huckleberry/Twinflower .....	85
Grand Fir/Big huckleberry/Queencup beadlily .....	89
Western Redcedar Series	
Western Redcedar/Vanillaleaf .....	93
Literature Cited .....	97
Appendix One, Canopy Cover of Main Plant Species by Association .....	101
Appendix Two, Comparison Chart for Estimation of Foliage Cover .....	109
Acknowledgements .....	110

# List of Figures

---

1. Idealized distribution of forest series within a temperature-moisture grid .....	4
2. Idealized distribution of the plant associations on a temperature and moisture grid .....	5
3. Estimated annual precipitation for the southeastern portion, Gifford Pinchot NF .....	8
4. Distribution of plots by aspect for each association .....	9
5. Slope of sample plots within each plant association .....	10
6. Estimated annual precipitation for each plant association .....	11
7. Elevation of sample plots within each plant association .....	11
8. Effective soil depth for the plant associations .....	12
9. Average percent overstory canopy cover by plant association .....	15
10. Number of trees per acre on sample plots by plant association .....	16
11. Mean and standard error of the live stand basal area on sample plots, by plant association .....	17
12. Mean and standard error of site index values for Douglas-fir and ponderosa pine by plant association .....	20
13. Mean and standard error of site index values for Grand fir by plant association .....	21
14. Mean and standard error of an index of potential yield at culmination of mean annual increment by plant association .....	21
15. Average growth basal area (GBA) for each plant association .....	22
16. Number of snags per acre by decomposition condition class for plant association groups .....	26
17. Number of snags having noticeable cavities for plant association groups .....	26
18. Weight of fuels by diameter size class for plant association groups .....	27
19. The number of large, down logs for the plant association groups .....	27
20. Weight of fine fuels by diameter size class .....	27

# List of Tables

---

1. List of plant associations of the Grand fir, Douglas-fir and Western Redcedar Series ...	3
2. Distribution of tree species by plant association .....	14
3. Current timber stand characteristics .....	18
4. Summary of some silvicultural characteristics .....	24
5. List of plant species common within the Grand fir, Douglas-fir and Western Redcedar series .....	36

# **Chapter 1**

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## **Introduction and Background**





# Introduction

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## Area Covered

This Plant Association and Management Guide describes the forested plant associations on the lower elevation, eastern portion of the Gifford Pinchot National Forest. This classification covers primarily the Grand Fir Zone, that area east of the Cascades crest where grand fir is the climax dominant. The area is bounded by Mt. Adams on the north and the Columbia River on the south. The western boundary runs east of the Big Lava Bed and east of Mann Butte, Peterson Prairie, Cakey Butte and Haystack Butte. The study area's eastern boundary is the eastern border of the Forest. This zone is almost entirely on the southeastern portion of the Mt. Adams Ranger District. Because of the very steep west-east rainfall gradient characteristic of the Cascades crest, this classification does not apply to areas east of the Gifford Pinchot National Forest.

This study examines two distinct geographic areas within the Gifford Pinchot National Forest. The main area includes most of the forested area below about 4000 feet in elevation on the south flank of Mount Adams and east of Cakey and Haystack Buttes near the White Salmon River. This area's upper elevation ranges from about 3200 feet on the west near the White Salmon River to nearly 5000 feet on the eastern Forest boundary. The second major portion of the Grand Fir Zone includes most of the Little White Salmon River drainage on the extreme southeastern part of the Forest. A one to two mile wide strip along the eastern boundary of the Forest between the Little White Salmon River drainage and the White Salmon River (the Cave Creek area) also includes primarily Grand Fir Series plant associations. However, the vegetation there intergrades with the more moist Pacific Silver Fir Zone just a couple of miles west of the Forest boundary. Some low elevation, south slopes near the Columbia River on the Wind River Ranger District (west of the Cascade crest), also include Grand Fir Series vegetation.

## Why We Classify Plant Associations

Plant associations are groupings of plant species which re-occur on the landscape within particular environmental tolerances. By knowing the plant association of a site we can infer a number of climatic attributes and anticipate site response to various treatments. Associations can be used as a basis for inventory of the productive potential of vegetation and other resources which depend upon vegetation for their quality or quantity. Associations also provide a framework for communicating management experiences and research results.

## Four main uses of associations are:

- Describing key environmental features of sites.
- Providing site specificity for understanding management experience and research results.
- Prescription of appropriate management activities to sites, based on a better ability to predict site response to treatment.
- A natural inventory system of land resources.

Though the study area includes only about 60,000 acres on the National Forest, it is environmentally diverse, leading to differences in the productive potential of timber, wildlife and forage, and in responses to treatment. Careful attention to vegetation helps us understand environmental gradients and prescribe habitat-specific activities which consider the limitations and opportunities inherent to the site. Where particular environments exist in unusual geographic settings, knowledge of plant associations reduces the chances of making costly management mistakes or forgoing opportunities.

## Plant Association Classification Terminology

The term "plant association" refers to a stable grouping of plant species capable of self-perpetuation. Plant associations are climax plant communities. They are named after the diagnostic or dominant species in the tree, shrub and herb layers. The name of an association does not necessarily describe its vegetation, but merely designates important species. These species help characterize that plant community which would occur at a stable vegetative condition capable of sustaining itself rather than being replaced by other species. When we refer to the land on which an association occurs we are referring to a "habitat type" (Daubenmire 1968). The collection of plant associations having the same species in the dominant layer is a "series". Thus, the Grand Fir Series includes all of the grand fir plant associations. We use the term "forest zone" to describe the land-base on which a particular series dominates the landscape. Hence, within the Grand Fir Zone, most stands are Grand Fir Series plant associations, but some sites, usually reflecting special characteristics, may support other Series. The most common inclusions are Western Redcedar, Douglas-fir, Western hemlock, and Pacific Silver Fir Series or non-forest sites such as wetlands or rock-outcrops.

## Definition of Forest Zones

Forest zones are defined by the dominant species in stable, mature stands approximating climax conditions. The various forest zones reflect substantially different overall environments, so it is very important that we attempt to understand zone boundaries. Most of the

stands in the sample area are younger than 150 years and have been strongly influenced by fire prevention activities. Nevertheless, we can infer stable state forest composition of a site from the seedling and sapling populations. Thus, in mature Douglas-fir forests, the presence of grand fir regeneration indicates that the stand is part of the Grand Fir Zone. If Douglas-fir were the only regenerating species, the stand would belong in the Douglas-fir Zone.

Even though ponderosa pine is present in many stands on the Gifford Pinchot National Forest, a Ponderosa Pine Zone is lacking on the Forest because these stands have sufficient grand fir regeneration to be regarded as part of the Grand Fir Zone. The Ponderosa Pine Zone lacks appreciable regeneration of either Douglas-fir or grand fir. It is well represented east of the Forest and at lower elevations near Trout Lake having lower precipitation than on the National Forest proper. Newly acquired lands in the Columbia River Gorge National Scenic Area include a wide range of dry-site forest and non-forest vegetation, but these are not covered in this paper.

## Ecoclass Codes

Ecoclass codes are 6-digit computer codes that designate individual plant associations (Hall 1988a). The first two digits designate a life-form and series. We use "C" as the first digit to designate coniferous forest. The second digit for the study area is either "W" (white or grand fir series), "D" (Douglas-fir series), or "C" (western red-cedar series). The third character of the code is a letter describing the stature of the dominant understory, either "S" for shrub, "F" for forb, or "G" for grass or sedge. Ecoclass codes for the associations described in this paper are listed in Table 1.

## Overview of Forest Series

We have hypothesized the relative placement of the forest series and associations along temperature and effective moisture gradients (see Figure 1). The plant associations of the Grand Fir Series are placed within a similar environmental grid in Figure 2. The polygon sizes on these figures are roughly representative of series and association abundance on the landscape.

Effective soil moisture is far and away the dominant factor affecting the distribution and abundance of these series. The effective moisture gradient is largely affected by elevation because more precipitation falls at higher elevations. Precipitation drops off rapidly east of the Cascades crest. Rocky soils and ridgetop sites also have lower effective moisture. The temperature gradient is also affected most by elevation, but anomalies do occur (for example, flatter sites at moderate elevations where cold air accumulates).

## Grand fir Series

This series includes those areas where grand fir is expected to comprise at least ten percent of the canopy in stable state (>200 years) or climax stands. Forests in this zone are usually dominated by Douglas-fir and include several other conifers, such as ponderosa pine and western larch, but Grand fir dominates the seedling layer. The upper elevation limit of the Grand Fir Zone occurs where abundant moisture and cool temperatures allow development of stands dominated by Pacific silver fir, subalpine fir, or mountain hemlock. Lower elevation boundaries appear where insufficient precipitation prevents Grand fir establishment and only more drought tolerant species, such as Douglas-fir, can naturally regenerate.

The Grand Fir Zone occupies most of the lower elevation area near the eastern boundary of the Gifford Pinchot National Forest. The portion on the south flank of Mt. Adams varies from dense, productive stands having many conifer species to much dryer, sparse stands. This corresponds to the great precipitation gradient varying from about 85 inches per year at the western part of the zone on the White Salmon River to less than 50 inches per year on the lower west slope of King Mountain. The portion of this Zone within the Little White Salmon River drainage includes substantial acreage at lower elevations having moderately moist (mesic) environments. The forests in this area generally have high timber productivity and excellent wildlife habitat. This area is more similar to western Cascades areas than other more typical eastside Grand Fir Zone habitats in the Northwest. Although these two portions of the Grand Fir Zone on the Gifford Pinchot National Forest are distinctive, many associations occur, at least to some extent, in both areas.

The warmest and driest portion of the Grand Fir Series includes the Grand fir/Pinegrass association. These sites include abundant ponderosa pine in relatively open stands. Two other warm-, dry-site associations are most abundant on the south side of Mt. Adams near the Forest boundary: the Grand fir/Vine maple-tall Oregongrape/Starflower and Grand fir/Oceanspray associations. Grand fir/Elk sedge and Grand fir/Creeping snowberry/Vanillaleaf commonly occur on other fairly dry, harsh sites in this area.

Several shrub-rich, productive associations blanket the Little White Salmon River drainage with well-stocked forests. Upper slopes having substantial snowfall are often sites for the Grand fir/Thimbleberry/Fairybells association. Warmer, well watered sites transitional to the Western Hemlock Series typically include the Grand fir/Pacific dogwood/Vanillaleaf association. Upland, well-drained slopes are frequently the site of the Grand fir/Dwarf Oregongrape/Vanillaleaf or, on warmer sites, the Grand fir/California hazel/Vanillaleaf association. Cooler stands throughout this Series usually include the

Table 1. List of plant associations of the Grand fir, Douglas-fir and Western Redcedar Series on the Gifford Pinchot National Forest.

ALPHA CODE	COMMON NAME	SCIENTIFIC NAME	ECOCLASS CODE	CODE IN FIGURES 4-15	PAGE IN BOOK
DOUGLAS-FIR SERIES					
PSME/ACCI/FEOC	Douglas-fir/Vine maple/ Western fescue	<i>Pseudotsuga menziesii/Acer circinatum/ Festuca occidentalis</i>	CDS2 41	FEOC	45
GRAND FIR SERIES					
ABGR/CARU	Grand Fir/Pinegrass	<i>Abies grandis/Calamagrostis rubescens</i>	CWG1 23	CARU	49
ABGR/CAGE(GP)	Grand Fir/Elk Sedge	<i>Abies grandis/Carex geyeri</i>	CWG1 22	CAGE	53
ABGR/ACCI-BEAQ/TRLA2	Grand Fir/Vine maple-tall Oregongrape/Starflower	<i>Abies grandis/Acer circinatum-Berberis aquifolium/Trientalis latifolia</i>	CWS5 35	BEAQ	57
ABGR/HODI(GP)	Grand Fir/Oceanspray	<i>Abies grandis/Holodiscus discolor</i>	CWS5 34	HODI	61
ABGR/SYMO/ACTR	Grand Fir/Creeping Snowberry/ Vanillaleaf	<i>Abies grandis/Symphoricarpos mollis/ Achlys triphylla</i>	CWS3 32	SYMO	65
ABGR/COCO2/ACTR	Grand Fir/California hazel/ Vanillaleaf	<i>Abies grandis/Corylus cornuta var. californica/Achlys triphylla</i>	CWS5 36	COCO2	69
ABGR/BENE/ACTR	Grand Fir/Dwarf Oregongrape/ Vanillaleaf	<i>Abies grandis/Berberis nervosa/ Achlys triphylla</i>	CWS2 24	BENE	73
ABGR/CONU/ACTR	Grand Fir/Pacific dogwood/ Vanillaleaf	<i>Abies grandis/Cornus nuttallii/ Achlys triphylla</i>	CWS5 37	CONU	77
ABGR/RUPA/DIHO	Grand Fir/Thimbleberry/ Fairybells	<i>Abies grandis/Rubus parviflorus/ Disporum hookeri</i>	CWS2 23	RUPA	81
ABGR/VAME/LIBO2	Grand Fir/Big huckleberry/ Twinflower	<i>Abies grandis/Vaccinium membranaceum/ Linnaea borealis</i>	CWS2 21	VAMEL	85
ABGR/VAME/CLUN	Grand Fir/Big huckleberry/ Queencup beadlily	<i>Abies grandis/Vaccinium membranaceum/ Clintonia uniflora</i>	CWS2 22	VAMEC	89
WESTERN REDCEDAR SERIES					
THPL/ACTR	Western Redcedar/Vanillaleaf	<i>Thuja plicata/Achlys triphylla</i>	CCF2 12	ACTR	93

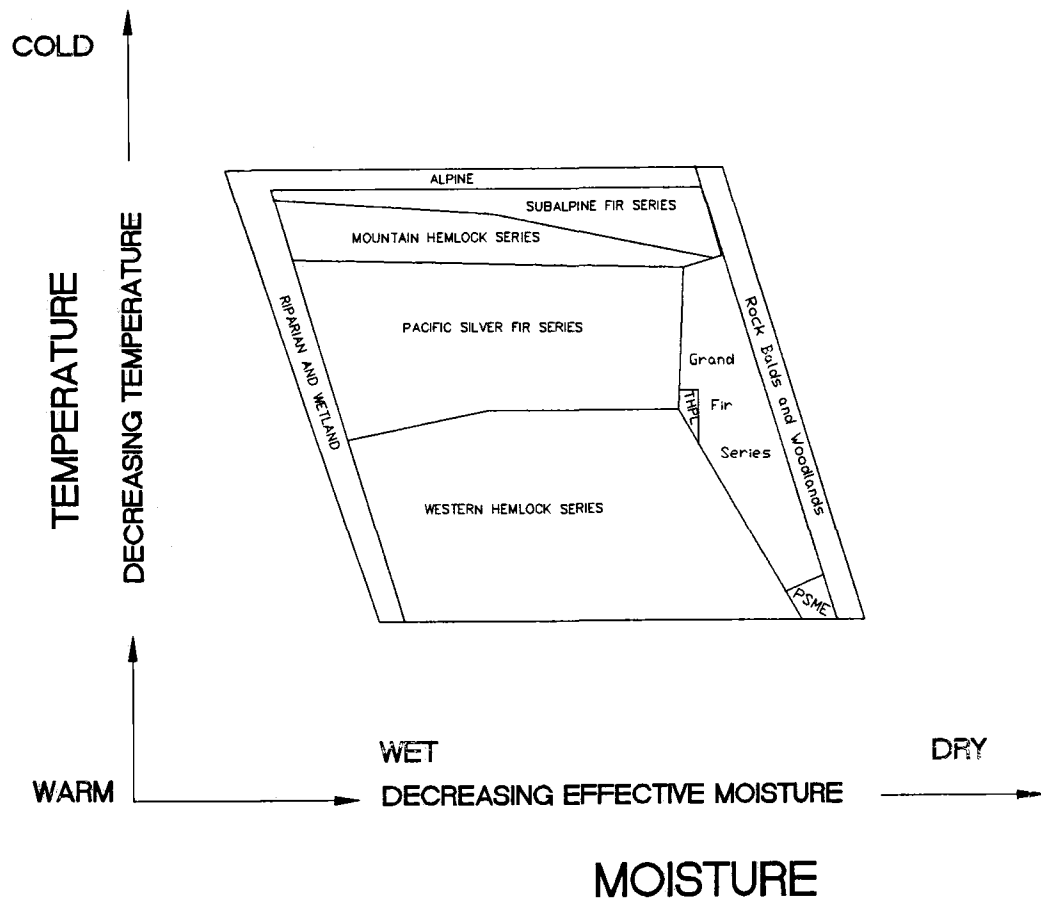


Figure 1. Idealized distribution of forest series within a temperature and moisture grid for the Gifford Pinchot National Forest. These axes integrate elevation and aspect-related climatic phenomena. The moisture axis represents precipitation, as well as the moisture-holding and supplying capacity of the soil. The relative sizes of the polygons are roughly proportional to the abundance on the landscape of that series although the Grand Fir Series has been exaggerated for this paper. THPL refers to the Western Redcedar Series and PSME refers to the Douglas-fir Series.

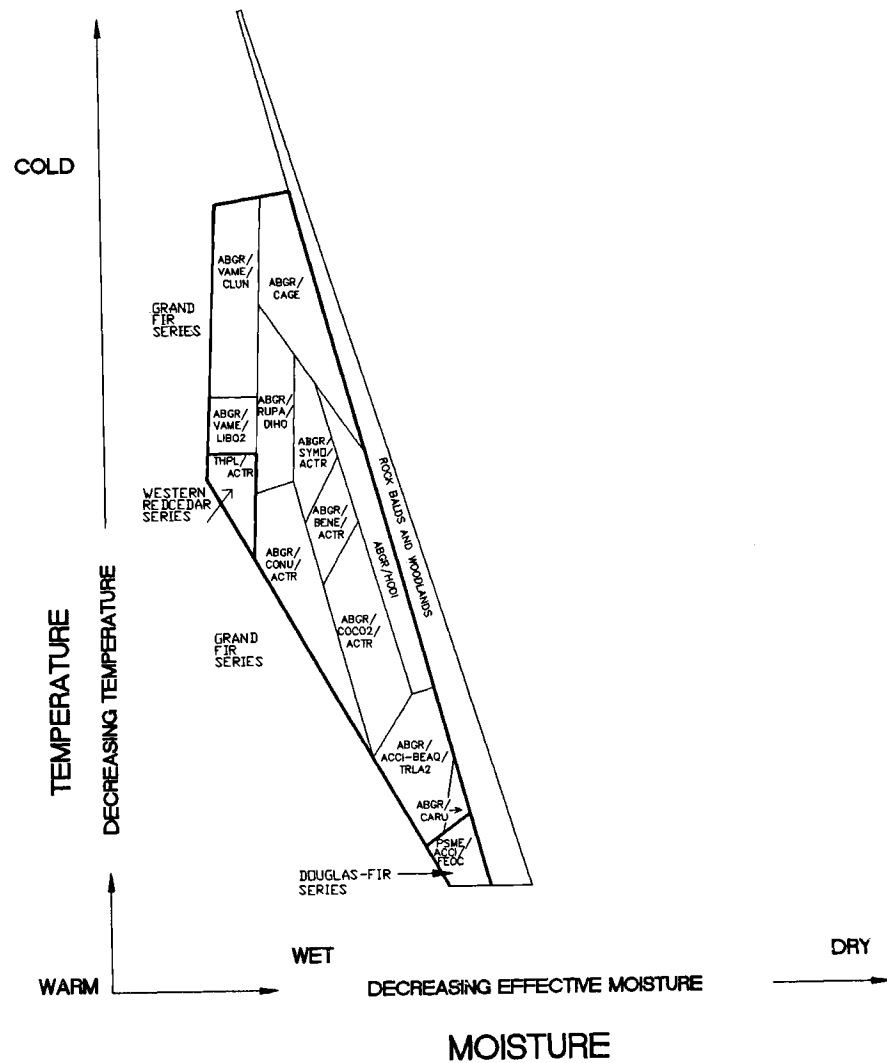


Figure 2. Idealized distribution of the plant associations described in this paper on a temperature and moisture grid. The size of the polygons is roughly proportional to the abundance of the association on the landscape. The English and Latin names for these acronyms are listed in Table 1.

Grand fir/Big huckleberry/Queencup beadlily or Grand fir/Big huckleberry/Twinflower association. These two types are transitional to the more moist, and cooler, Pacific Silver Fir Series (see Brockway et al. 1983, Plant Association and Management Guide for the Pacific Silver Fir Zone, Gifford Pinchot National Forest).

### **Douglas-fir Series**

This series includes vegetation where the effective site moisture is insufficient to support grand fir (or other more moisture-demanding species) establishment, but sufficient for Douglas-fir regeneration. These climax Douglas-fir sites are infrequent on the Forest. Steep, predominantly south-facing slopes and ridges in the Little White Salmon River drainage are home to the Douglas-fir/Vine maple/Western fescue association.

### **Western Redcedar Series**

Warm, mesic sites which experience a bit too much summer drought for western hemlock regeneration support this series. It occupies an environmental middle-ground between Grand Fir, Pacific Silver Fir and Western Hemlock Series sites. The Western redcedar/Vanillaleaf association has high plant species diversity. High structural diversity and common proximity to streams suggest that these are also important wildlife sites.

### **Other Series not included in this report**

Earlier plant association and management guides described most of the forested acreage on the Gifford Pinchot National Forest: the Western Hemlock Series (Topik et al. 1986), the Pacific Silver Fir Series (Brockway et al. 1983) and the more productive portion of the Mountain Hemlock Series (Brockway et al. 1983). Our highest elevation forests are included in the Mountain Hemlock Series. A classification of the highest elevation forested associations is in preparation. Other Area Ecology Program work in progress will classify riparian areas and wetlands. These zones are not discussed in this paper.

## **Methods**

This classification reports data from 86 sample plots located in relatively undisturbed, mature timber stands throughout the eastern portion of the Gifford Pinchot National Forest. Other plots established during this study fall in other series or special habitats (eg. the Big Lava Bed) and so are not reported here. Most samples are intensive plots established in 1983 which include vegetation, timber and snag measurements. A few reconnaissance plots emphasizing vegetation sampling were subsequently installed to increase our database.

## **Reconnaissance Plots**

These plots were selected subjectively without preconceived bias (Muller-Dombois and Ellenberg 1974). We used aerial photos and our knowledge of the study area to select sites having as little disturbance as possible and yet representative of the area's floristic variation. On these 500 m<sup>2</sup> circular plots we made complete lists of the vascular flora and ocular estimates of their percent foliar cover (see Appendix 2.) We also noted a variety of physical attributes of the site such as elevation, slope, aspect, landform, etc. We sampled one or two site trees representative of the best growth in the plot vicinity and we did a variable radius basal area measurement at plot center using either a 20 or 40 BAF prism. We also photographed each plot.

## **Intensive plots**

Each of these plots included a reconnaissance plot as well as these additional measurements:

## **Live tree stocking and growth**

We sampled 3-5 site trees of each major species present on the plot. These site tree data include height, crown ratio, diameter at breast height (DBH), age at breast height, bark thickness, sapwood thickness, recent decade's radial growth, and basal area of the surrounding stand (for growth basal area calculation, Hall 1988b). The major species site index curves used are Curtis (1974) for Douglas-fir, Barrett (1978) for ponderosa pine, and Cochran (1979) for grand fir. The latter is a 50 year base curve whereas the former two curves are indexed to age 100. Other site index curves used were Cochran (1985) for western larch, Dahms (1975) for lodgepole pine, Brickell (1970) for Engelmann spruce and western white pine, and Barnes (1962) for western hemlock. Each intensive plot included 5 variable radius basal area plots: one at plot center and one at each cardinal direction 100 feet away (slope corrected distance). In those situations where abrupt ecotones existed, we adjusted the placement of the outlying plots to be on parallel lines within the relatively homogeneous sample area. We measured the diameter of each "in" tree in the variable radius plots so we could calculate number of trees per acre by size class and species, as well as Reineke's (1933) stand density index (SDI).

## **Snags**

We sampled snags with two different techniques. Most samples (the 1983 data) measured snag abundance (minimum size 6 inch DBH and 12 feet tall) in 500 m<sup>2</sup> fixed area circular plots, slope adjusted where necessary. We recorded condition class and species of each snag. The snag condition classes used are becoming standard in the region (Maser and Trappe 1984):

**Condition 1:** fine branches and bark intact

**Condition 2:** a few larger limbs present, bark present

**Condition 3:** limb stubs may be present, bark only partly intact

**Condition 4:** bark nearly gone; solid buckskin

**Condition 5:** rotted, soft and crumbly

We also noted the diameter class (6-11, 12-19 or 20 inches) and height class (12-30, 31-60, 60 feet) of snags having cavities. Data presented for snags having cavities come from these fixed area plots. Later stands sampled to enhance our database used 3 variable radius plots and a 40 BAF wedge prism (see Topik et al. 1986 or Topik et al. 1988 for details). The total snags per acre and snags per acre by condition class data presented were calculated by averaging per plot values of whichever technique was used.

## Fallen trees and fine fuels

We utilized the plane transect method of Brown (1974) to quantify down woody debris and fine fuels (less than 3 inch diameter) on 26 plots. We used two parallel 100 foot long transects for coarse woody debris on each intensive plot and four short transects for the fine fuels: 10 feet long for 1-3 inch diameter pieces, 6 feet long for 1/4-1 inch diameter pieces, and 3 feet long for 1/4 inch diameter pieces. The fine fuels are categorized as 1-hour (1/4 inch diameter), 10-hour (1/4 to 1 inch diam.), and 100-hour (1-3 inch diam.) fuels (Deeming et al. 1978). Our calculations of fine fuel weights used Brown's composite values for squared average-quadratic mean diameters and his "others" values for the average secant of nonhorizontal particle angle for correcting orientation bias. Coarse woody debris (greater than 3 inch diameter) were tallied according to size and deterioration condition classes. Diameter and length were also recorded, thus allowing us to calculate total volume and weight. The size classes are:

**Size 1:** Piece does not contain a segment which is at least 6 in. in diameter for a length of at least 5 feet.

**Size 6:** Piece contains a segment which is 6 inches in diameter or larger for a length of at least 5 feet.

**Size 12:** Piece contains a segment which is 12 inches in diameter or larger for a length of at least 5 feet.

**Size 20:** Piece contains a segment which is 20 inches in diameter or larger for a length of at least 5 feet.

Condition classes indicate relative states of decomposition. We modified the classification of Maser and Trappe (1984):

**Condition 1:** intact bark and wood, fine branches present (Maser and Trappe (1984) condition class 1)

**Condition 2:** bark loose, fine branches absent, wood intact or partly soft. slightly sagging (Maser and Trappe (1984) condition class 2)

**Condition 3:** bark usually absent, no fine branches, wood soft to powdery, may be somewhat oval in cross-section, all of piece is on the ground (Maser and Trappe (1984) condition classes 3 and 4)

We did not tally highly decomposed pieces (Maser and Trappe (1984) condition class 5).

Because of our small sample size, down woody material data are presented for groups of plant associations having similar environmental and floristic characteristics

## Soils

Soil profiles (64 total) were described on the intensive plots. A soil pit was excavated to a depth of 100 cm or to bedrock if less than 100 cm. The soil profile was described in accordance with standards and methodology contained in the Soil Survey Manual (Soil Survey Staff 1975) and the National Soils Handbook (USDA, Soil Conservation Service). The soil pit was located as close to plot center as possible, except when that location was deemed not representative.

## Determining the classification

Individual plant associations were designated on the basis of four classification criteria (Hall 1988a):

- Do they have a distinctive flora?
- Do they have different productive potentials?
- Are there distinctive management implications?
- Are they identifiable on the ground?

We used a combination of subjective and objective classification methods. Computer-based methods involved construction of initial plot ordering tables (Volland and Connelly 1978) which were compared with results from detrended correspondence analysis (DECORANA) (Gauch 1977 plus supplements; Gauch 1982). Two-step indicator species analysis (TWINSPAN) was used to examine the classification value of various species and plot groups. These results were used to re-order the subjective association groupings. Old-growth plots were more heavily weighted as they reflect the eventual floristic composition which define associations.

Similar ecological data from the Grand Fir Zone on the Mt. Hood National Forest were combined with these data to evaluate the possibility of using one classification

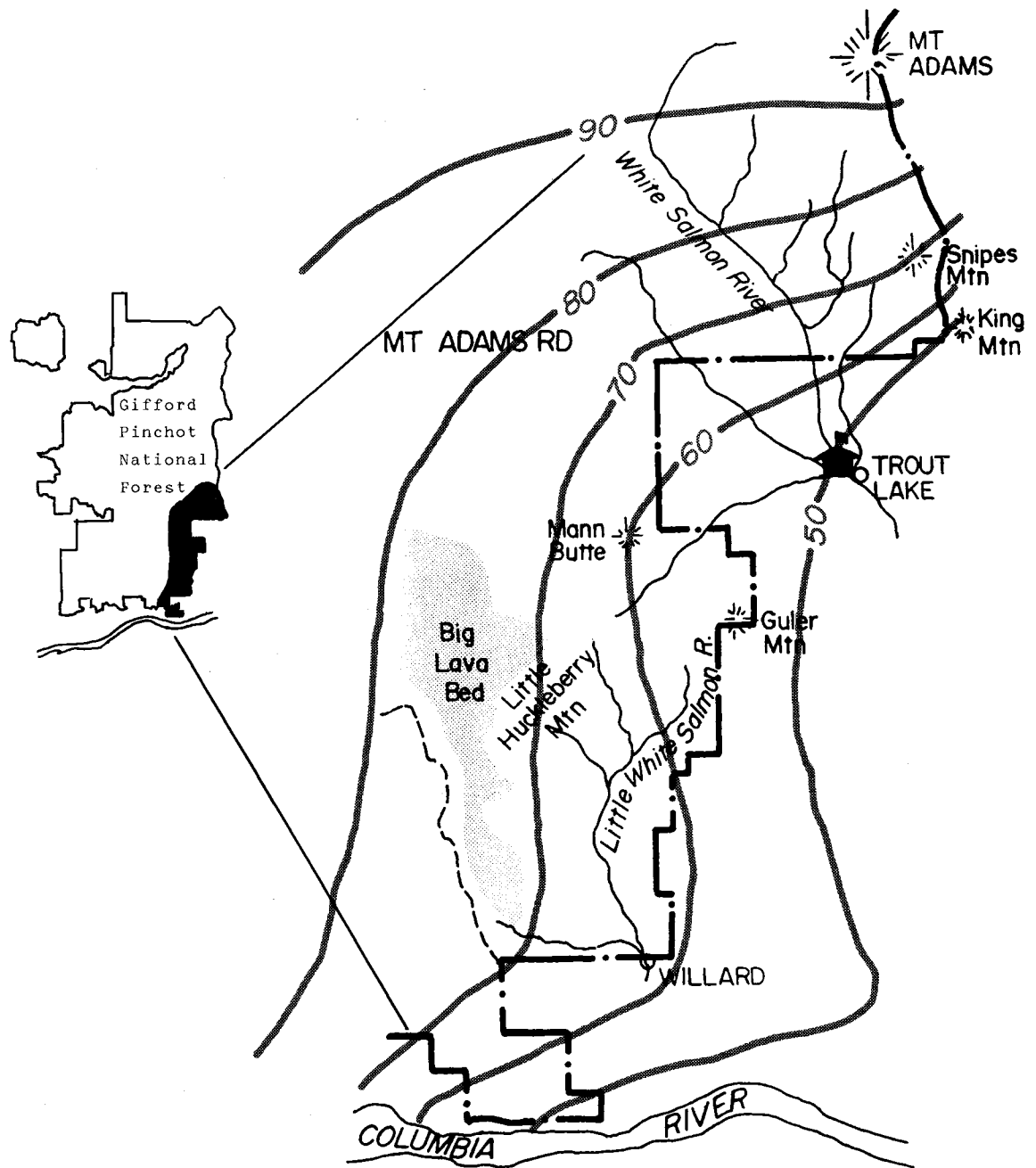


Figure 3. Estimated annual precipitation in inches for the southeastern portion of the Gifford Pinchot National Forest including that area where the Grand Fir, Douglas-fir and Western Redcedar associations are found. This is based on a regional map (U.S. Weather Bureau 1965).



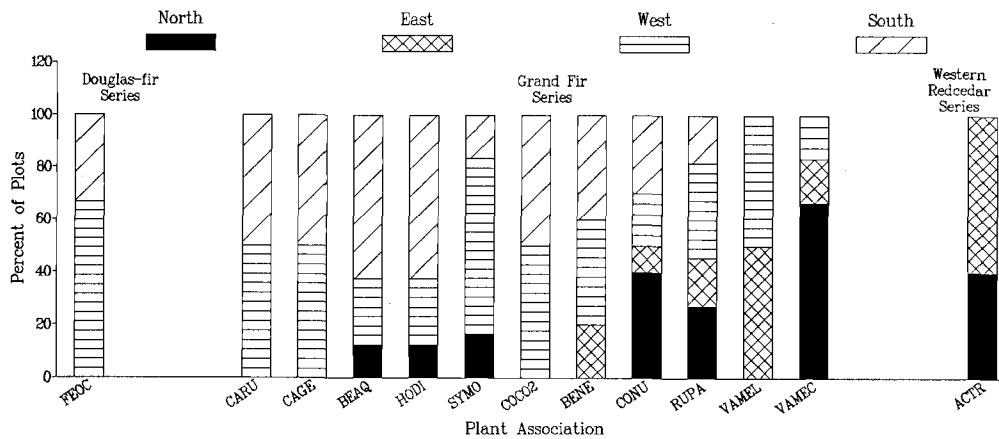


Figure 4. Percent of plots within each plant association having north, east, west or south aspects. See Table 1 for key to the plant association codes.

for these zones on both National Forests. Several associations on both National Forests are somewhat similar floristically, but substantial differences in productive potential and therefore, management implications, argues against lumping these data to describe single associations.

The preliminary association classification and keys were field-tested to examine their identifiability and integrity, and to accumulate management implications information.

## Climate

The climate on the east slope of the Cascades combines features of maritime and continental regimes (Franklin and Dyrness 1973). Dominant characteristics are the rain shadow effects of the Cascade crest, elevation-related temperature differences, and very low summer precipitation.

In general, increasing elevation is associated with lower temperatures, more precipitation as snowfall, and higher precipitation levels, because cooler air masses have lower moisture holding capacity. The rapid decline in precipitation with distance east of the Cascade crest is clearly illustrated in the annual precipitation map (Figure 3), showing a drop from 80 to 50 inches per year. The actual local patterns are probably much more complex than indicated on this diagram (Johnson and Dart 1982). This major precipitation decrease east of the crest is due to both the rain shadow effect as well as the general eastward decrease in elevation. On the south flank of Mt. Adams this general gradient is altered slightly by the presence of King Mountain and several smaller buttes near the eastern Forest boundary. Hence, the lowest precipitation area is probably not the extreme eastern edge of the Forest, but rather, the lower elevation area 2-3 miles west of King Mountain. Precipitation in the Lit-

tle White Salmon River drainage also must vary much more than diagrammed judging by substantial vegetation changes which correspond to the large elevation gradient.

Summer drought begins earlier in the season east of the Cascades crest for several reasons. Not only is there less total annual precipitation and smaller snowpacks than further west, but small late spring and summer maritime storms lose their precipitation before they get as far east as the Grand Fir Zone. Another substantial difference is the general lack of precipitation as fog drip, which can add large amounts of moisture to low elevation, west-side valleys which first intercept moisture moving in from the ocean. Cloudless, low humidity conditions prevail for more of the year under the continental climatic regime which influences the Grand Fir Zone. This leads to high evapotranspiration rates which deplete soil moisture during the growing season. These features are of primary importance to vegetation composition and productivity.

The effective moisture concept integrates the factors which affect water availability for plant growth and evapotranspiration. Though incident moisture varies from 50 to 80 inches per year, effective moisture is much more variable. It is strongly affected by local soil and topographic characteristics, such as bedrock fracture, slope, soil depth, stoniness, texture, structure, organic matter content, and aspect. When we discuss moist- or dry-site plant associations, we are referring to the effective moisture of the site. Plant associations in this area are strongly influenced by moisture, and thus are good indicators of differences in moisture between sites.

Aspect greatly affects local climates. The aspect breakdown of plots in each association is presented in Figure 4. In general, moisture is most abundant on north and east slopes because evaporational demand is less than on south or west slopes. The cooler, more moist-site indicating associations occurred much more frequently in our sampling on north slopes than the dry-site types.

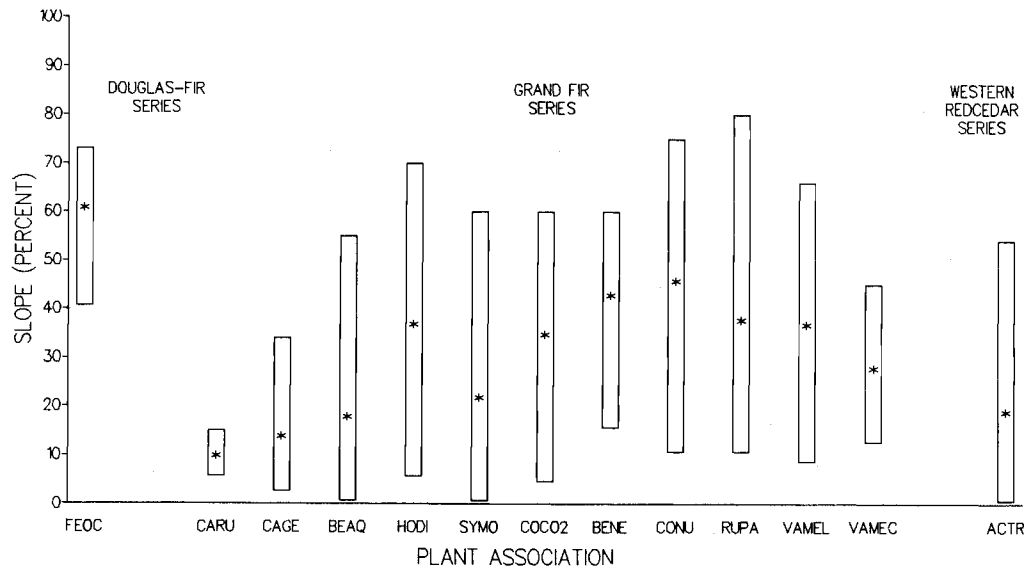


Figure 5. Range (height of bar) and mean (\*) slope of the plots sampled for each plant association. See Table 1 for key to the plant association codes.

The Grand fir/Big huckleberry/Queencup beadlily association was usually found on north slopes of the small buttes dotting the south flank of Mt. Adams and Western redcedar/Vanillaleaf on east and north aspects near valley bottoms. The other clear aspect-plant association relationship is the distinct dominance of south and west aspects in the dry-site associations, especially the Douglas-fir/Vine maple/Western fescue, Grand fir/Pinegrass, Grand fir/Elk sedge and Grand fir/California hazel/Vanillaleaf association. Aspect-related environmental variation explains much of the difference between two of the most common plant associations within the Little White Salmon River drainage: Grand fir/California hazel/Vanillaleaf (dry-sites) and Grand fir/Pacific dogwood/Vanillaleaf (mesic sites).

Slope also has large effects on local climates by affecting soil water movement, soil accumulation and solar interception. The range and mean slopes of our sample plots within each plant association are illustrated in Figure 5. Most associations occur on both steep and nearly flat sites. The average slope values indicate which types more commonly occur on steeper, middle and upper slopes, such as the Grand fir/Oceanspray, Grand fir/Dwarf Oregongrape/Vanillaleaf and Grand fir/Pacific dogwood/Vanillaleaf associations. Douglas-fir/Vine maple/Western fescue is restricted to steep slopes whereas our few samples representing the Grand fir/Pinegrass association were on nearly flat terrain. In general, the associations dominant in the highly dissected Little White Salmon River drainage have steeper average slopes than the types characteristic of the gentle terrain on the south side of Mt. Adams.

within and among plant associations. These averages are based on plot values estimated from the U.S. Weather Bureau statewide isohyetal map depicted in Figure 3. This figure illustrates the problem of using a statewide model to predict local phenomena. It is difficult to separate physical site characteristics leading to various effective moistures from true incident precipitation variation. The height of the individual bars in Figure 6 depicts the range of predicted precipitation for our sample plots within individual plant associations. A wide range within an association indicates either high moisture variability, or that the different precipitation levels lead to relatively similar effective soil moisture due to different soil and topographic characteristics.

Elevation affects climate greatly and is especially important as the controlling factor of temperature and precipitation. A good deal of the precipitation variation of associations is due to elevation effects. Figure 7 shows the elevation ranges of plant associations in this area. Most of the associations have overlapping ranges in elevation of occurrence. Two associations clearly violate this pattern. The Grand fir/Big huckleberry/Queencup beadlily type is restricted to high elevation and the Douglas-fir/Vine maple/Western fescue is restricted to low elevation sites. Plant associations characteristic of the Little White Salmon River drainage generally have lower elevation average occurrences and those typical for the south side of Mt. Adams are generally found higher. The exception to this trend is the high elevation dominance of Grand fir/Thimbleberry/Fairybells on the upper slopes of the Little White Salmon River.

Figure 6 illustrates variation in annual precipitation

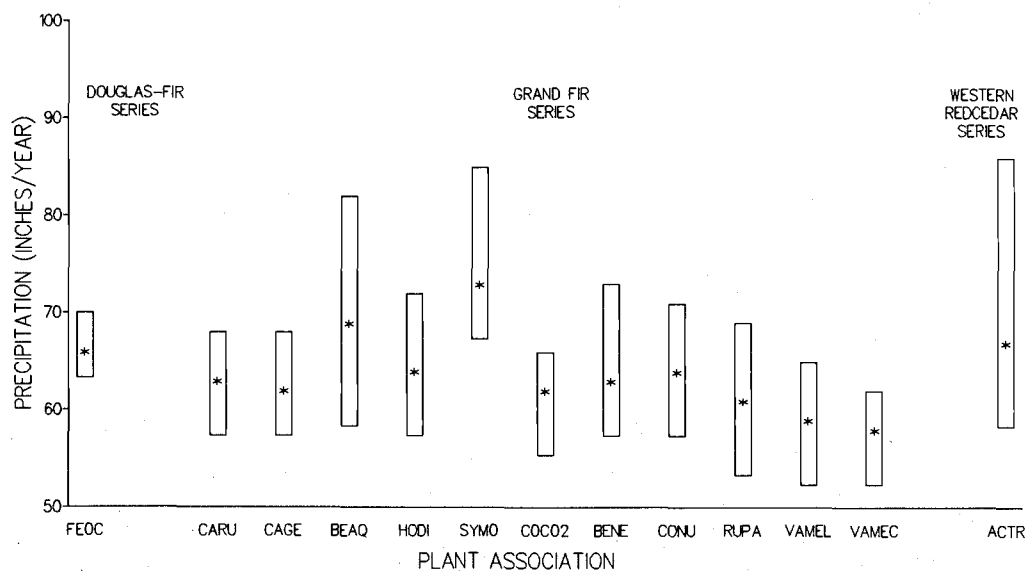


Figure 6. Estimated annual precipitation for the study plots for each plant association. The height of the bar indicates the range in values and the "\*" indicates the mean for that association. The plot values are taken from the U.S. Weather Bureau map of estimated precipitation (Figure 3). See Table 1 for key to the plant association codes.

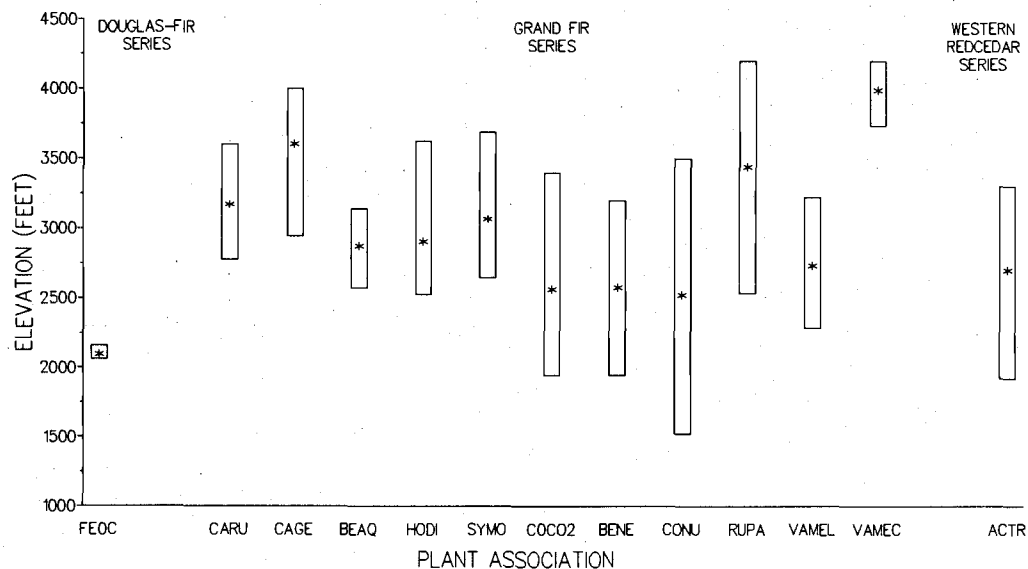


Figure 7. Range (height of bar) and mean (\*) elevation of the plots sampled for each plant association. See Table 1 for key to the plant association codes.

## Soils

The soils found throughout the Grand Fir Zone are relatively homogeneous. Most have formed from basalts and include substantial amounts of aerally deposited ash and loess. There are good indications that much of the study area on the south side of Mt. Adams was glaciated by alpine flows during the maximum extent of continental glaciation circa 15,000 years ago (Hammond 1980). The Little White Salmon drainage probably was not so

recently glaciated. Other important surface geological features having great effects on soils are the abundant recent lava flows. Nearly all of the parent material in the study area is extrusive lava or ash, with intrusives being limited to Mann Butte and a few other small outcrops (Hammond 1980). Some breccias intersperse the various basalt layers. These breccias are often more easily weathered than the basalts and can, in the proper topographic position, form deep soils with good moisture holding capacity.

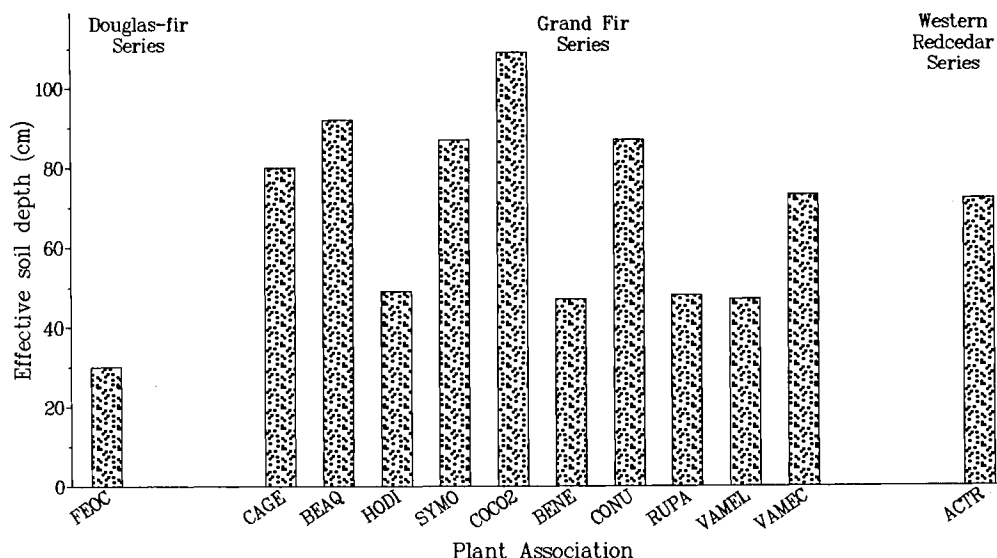


Figure 8. Effective soil depth for the plant associations. Effective soil depth is an index of the soil depth available for rooting activity (not composed of gravel or rock greater than 2 mm in size). See text for more information. See Table 1 for key to the plant association codes.

Since the end of the last ice age, there has been extensive deposition of volcanic ash from nearby volcanos (in particular, Mt. St. Helens). Loess deposition also contributed substantial quantities of silt-sized particles to the soil. This loess deposition followed the retreat of the glaciers and the Missoula flood events in the Columbia River. The loess is wind-blown silt that originated on the Columbia River floodplains after glacial floodwaters receded. The texture of this material is very fine silt to fine silt. This material has undergone very little alteration since deposition. Structure is weak and little organic matter has accumulated. Volcanic ash forms the surface layer of almost all of the soils in this area. It holds considerable amounts of water, a fact of primary importance to plant distribution and productivity. The abundance of the ash and loess contributes greatly to the overall soil moisture holding capacity of soils in this area and makes the good growth of conifers possible.

Soil temperature has an important influence on the biological, chemical and physical processes in the soil. Soil temperature regimes relate closely to growing season length. Most of the Grand Fir Zone is included in the frigid soil temperature regime which has cool average annual temperatures but is warm during the growing season. Some of the lower elevation portions of the study area (up to about 2500 feet) in the Little White Salmon River drainage are included in the mesic temperature regime. Cryic regimes are cold; they probably are not found in the Grand Fir Zone on the Gifford Pinchot National Forest.

The soil moisture regime is an index of the supply of moisture during the growing season. The Xeric soil moisture regime is characterized by soils that are dry during most of this period. It is highly likely that virtually all of the plant associations described in this paper are found on xeric soil moisture regime sites.

Soil fertility depends largely on the soil's ability to supply roots with moisture, chemical nutrients, and oxygen. Soil organic matter supplies critical nutrients, as well as cation exchange and moisture holding capacity. Precipitation, temperature and the chemical quality of the material control the rate at which organic matter is decomposed and incorporated into the soil. As organic matter incorporation into the soil proceeds, nutrients are released and made available to plants.

Soil texture, organic matter content, and rock fragment content strongly influence the total amount of water that the soil can store. An index of soil rockiness and depth is called "effective soil depth". Values are presented for each association in Figure 8. Effective soil depth is calculated by multiplying the soil profile depth by the proportion of the soil consisting of sand or finer size particles. Thus, this index excludes that proportion of the soil occupied by coarse fragments (which do not supply effective rooting) from the total soil depth. There was substantial variability within an association. However, small effective soil depths for several associations indicate substantially lower moisture-holding capacity than most other types. The very low value for the Douglas-fir/Vine maple/Western fescue association reflects the

shallow, rocky nature of its soils. Similarly, the Grand fir/Oceanspray association occurs on upper slopes and ridgetops where shallow soils and high rock content are common. The low value for the Grand fir/Thimbleberry/Fairybells association is surprising because it is usually includes a number of moisture-loving plant species and has high timber productivity. The fact that this type has relatively poor soils suggests that something else, probably much higher precipitation levels than predicted on our rainfall map, account for this effectively moist environment.

## Soil Management Considerations

Of the environmental factors necessary for plant growth, soil moisture, temperature and nutrients are the most likely to be impacted by management activities. Soil organic matter, including the forest floor (duff layers), plays a key role in determining soil fertility, and it is also easily impacted by some treatments.

In undisturbed conditions forest soils have a great capacity to absorb moisture and the overland flow of water rarely occurs. The forest floor (litter or duff layer) absorbs water readily and transmits it to the mineral soil below. This is especially important since the exposed surface of the volcanic ash topsoil is inherently water-repellent. Without a litter layer, raindrops striking the ground can detach soil particles and seal the surface pores of the soil. This can cause overland flow, reducing the amount of water available to plants, and resulting in erosion and loss of fertility. The litter layer also helps to conserve soil moisture by reducing evaporation from the soil surface.

Soil temperatures in the root zone of tree seedlings can reach lethal levels on south-facing slopes with no shade or litter cover. On these sites leaving shelter trees for shade may be necessary to maintain cooler soil temperatures. Maintaining some litter cover insulates the mineral soil from high daytime temperatures and helps keep the soil warm at night.

In addition to moderating soil temperatures and helping to conserve soil moisture, the forest floor contains most of the nutrients which are cycled through the soil. Also, decomposing woody material is important for free-living, nitrogen-fixing bacteria, for the development of mycorrhizal fungi, and as an excellent water-saturated rooting medium.

Site preparation objectives often require removal or displacement of some of the duff layer to aid in the establishment of tree seedlings. Even where exposure of mineral soil is desired for natural seedling establishment, the amount should be limited. Twenty to thirty percent mineral soil exposure is usually adequate if it is evenly distributed throughout the area. Where tree planting is prescribed, removal of the litter and duff should be confined to only that which is necessary to plant the trees.

Plant growth can also be limited by disturbance to the mineral soil through compaction by heavy equipment. This results in a loss of large pore space which, in turn, reduces the available moisture in the soil. Soil compaction also impedes root growth and reduces the gaseous exchanges necessary for healthy roots.

Loss of nutrients through topsoil erosion can reduce plant growth. The surface mineral soil layers are by far the most critical for root uptake of nutrients. The low density of surface layers is due to the volcanic ash material and high organic matter contents. These surface soils can be easily displaced and eroded by overland flow of water, severely impacting the long-term productive potential of the site.

The key to maintaining soil fertility is conserving and enhancing soil organic matter, either in the form of surface litter layers or humus incorporated into the mineral soil matrix. Organic matter has high concentrations of readily available nutrients, high moisture-holding capacity and high nutrient exchange potential. It fosters soil structure development which enhances water, air, and root movement throughout the soil profile. Soil biological activity is dependent upon a sufficient quantity and quality of soil organic matter.

## Timber

The plant associations described in this paper include a diverse mixture of 12 conifer species, occurring in a great variety of combinations. An understanding of their different ecological tolerances and successional roles helps us classify the environment into meaningful units, plant associations, which have distinctive implications to timber managers. Although the plant associations are described and named according to their dominant tree species at long term stable conditions (climax), these shade tolerant species are frequently less abundant than early successional species. Indeed, higher timber production or other resource values may be seen in stands composed of early successional species.

### Successional status of tree species

During pre-settlement times fire was a critical and constant part of eastern Cascade ecosystems. The advent of fire suppression has allowed shade tolerant, fire sensitive species, such as Grand fir, to dominate much of their environmental zone. Without fire suppression, the Grand Fir Zone would be dominated by ponderosa pine and Douglas-fir, two species with superior fire resistance when they attain large size. Nevertheless, the Zone would still be properly termed "the Grand Fir Zone" because this species is capable of eventually out-competing ponderosa pine and Douglas-fir where sufficient moisture

Table 2. Distribution of tree species by plant association. C = major climax species, c = minor climax species; S = major seral species, s = minor seral species. See Table 1 for plant association names in English or Latin and Table 5 for English and Latin names of the plant association acronyms.

PLANT ASSOCIA- TION	PSME	ABGR	PIPO	THPL	LAOC	PICO	PIEN	PIMO	ACMA	QUGA	TSHE	ABAM	ABPR
DOUGLAS-FIR SERIES													
PSME/ACCI/ FEOC	C	c	s						c	s			
GRAND FIR SERIES													
ABGR/CARU	S,c	C	S			s				s			
ABGR/CAGE(GP)	S	C	S		s	S		s		s			
ABGR/ACCI- BEAQ/TRLA2	S	C	S			s				s			
ABGR/HODI(GP)	S,c	C	S		s	s				s			
ABGR/SYMO/ ACTR	S	C	S		s	s							
ABGR/COCO2/ ACTR	S,c	C	s						c				
ABGR/BENE/ ACTR	S	C	s						c		c		
ABGR/CONU/ ACTR	S	C	s	C					c		c	c	
ABGR/RUPA/ DIHO	S	C	s		s		c	s	c		c	c	s
ABGR/VAME/ LIBO2	S	C	s		s			s					
ABGR/VAME/ CLUNE	S	C	s		s	s	c	s			c	c	
WESTERN REDCEDAR SERIES													
THPL/ACTR	S,c	c		C	s			s			c		s

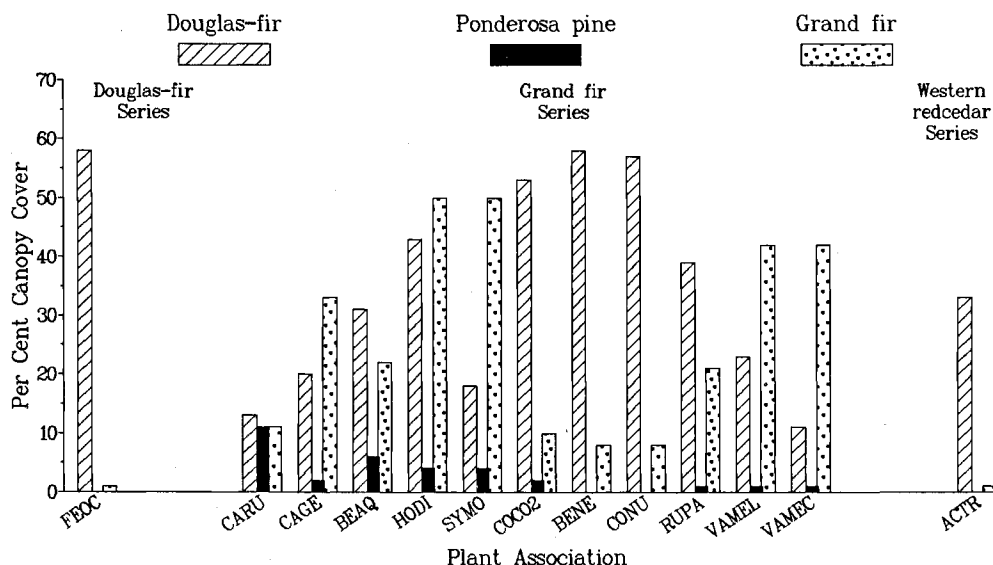


Figure 9. Average percent overstory canopy, by plant association, for ponderosa pine, Douglas-fir and grand fir. See Table 1 for key to the plant association codes. Note: these are not mean relative cover values as presented in Appendix 1 and the association descriptions.

is available. True climax species are those which can persist and reproduce in their own shade in the absence of disturbance.

Individual tree species can serve either pioneer (early successional) or climax (late successional) roles, depending on their adaptation to the environment. Our major pioneer species are not shade tolerant and play climax roles only where dry or harsh conditions prevent dense canopy formation. The pioneers include high value timber species: ponderosa pine, Douglas-fir, western larch, noble fir, and western white pine, as well as Oregon white oak and lodgepole pine. Several of our species are rarely abundant in young, early successional stands. These include shade tolerant species: grand fir, western hemlock, western redcedar, and Pacific silver fir. Subalpine fir and mountain hemlock have intermediate shade tolerance. They can be either pioneers in intermediate environments, where they would eventually be excluded by grand fir or Pacific silver fir, or climax species, where cold and harsh conditions prevent the less cold-adapted trees to persist.

## Tree species distribution

Fifteen tree species were included in our sampling and at least 2 others occur in small amounts on some sites. Canopy cover and constancy of occurrence (per cent of plots within an association where the species are present) are all listed in Appendix 1. We have summarized tree distribution information in Table 2 indicating those plant associations where the major species play seral or climax roles, and are either major or minor members. This provides a good overview of tree dis-

tributions on the Forest when coupled with similar tables in our Pacific Silver Fir and Western Hemlock Zone guides (Brockway et al. 1983, Topik et al. 1986).

Canopy coverage, by association (Figure 9), of the three main tree species (ponderosa pine, Douglas-fir and grand fir) represents the relative stand dominance of these species. Ponderosa pine is a constant, yet minor, component of nearly all plant associations within the Grand Fir Zone, except two which are restricted to the Little White Salmon River drainage (Grand fir/Dwarf Oregongrape/Vanillaleaf and Grand fir/Pacific dogwood/Vanillaleaf). Ponderosa pine only achieved co-dominance in the Grand fir/Pinegrass association. Douglas-fir prevails in the canopies of most associations, yet several types prevalent on the south side of Mt. Adams have as much, if not more, grand fir in their canopies. These latter associations include the two big huckleberry dominated types as well as Grand fir/Creeping snowberry/Vanillaleaf and Grand fir/Oceanspray. The forests sampled in the middle and lower elevation portions of the Little White Salmon River drainage (AGBR/BENE/ACTR, AGBR/COCO2/ACTR and ABGR/CONU/ACTR) feature overstory canopies composed almost entirely of Douglas-fir.

Several other conifer species contribute to forest diversity in more localized, specific habitats (see Appendix 1 for complete species cover and constancy data by plant association). Western larch was never abundant in our samples, though it is fairly common in the more moist associations of the Grand Fir Zone (ABGR/VAME/LIBO2 and ABGR/VAME/CLUN) and in the Western redcedar/Vanillaleaf association. Lodgepole pine was absent from most samples, but

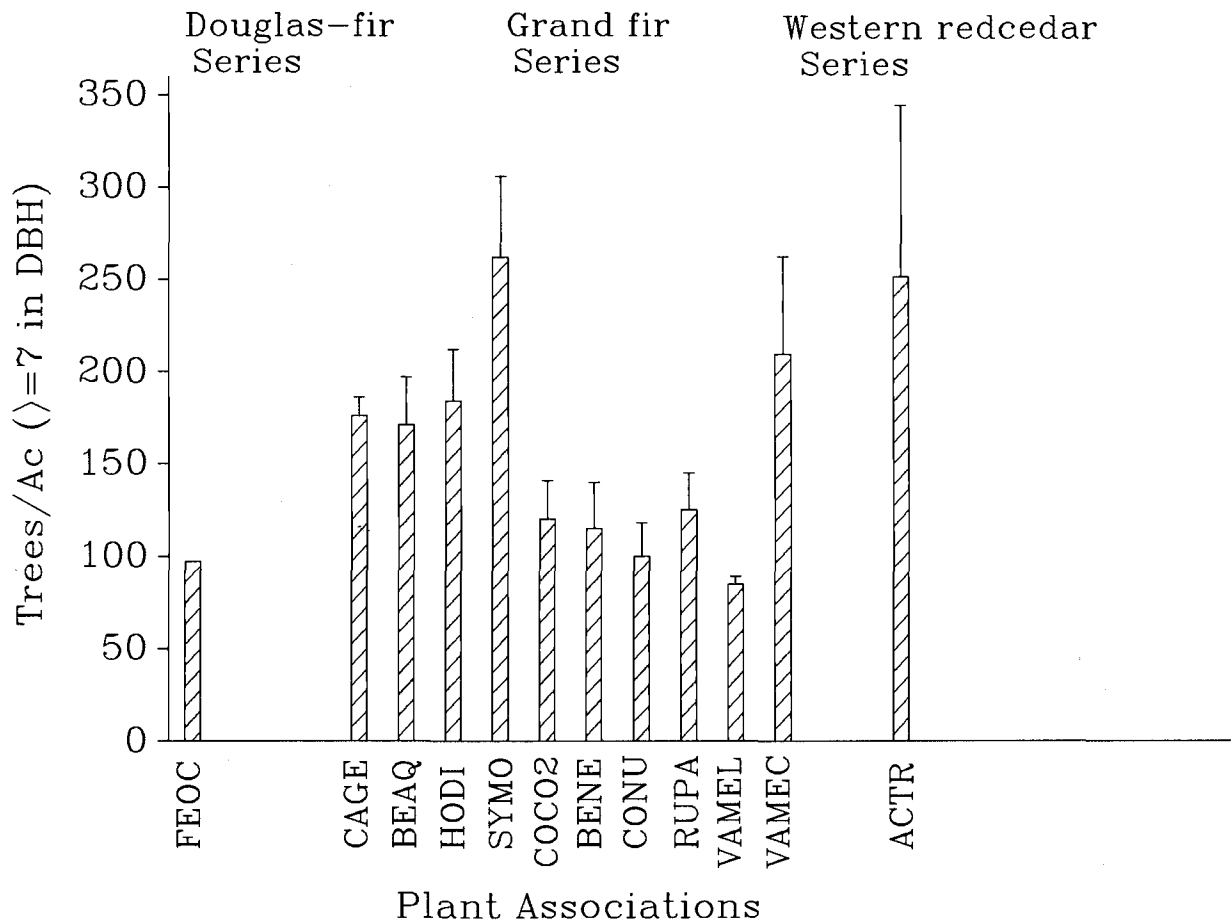


Figure 10. Mean and standard error of the number of trees per acre greater than or equal to 7 inches diameter at breast height, by plant association. The wide bars indicate the mean values and the lines above the bars indicate the values for the mean plus one standard error of the mean. See Table 1 for key to the plant association codes.

where present because of past hot wildfires, it had high canopy cover. Both noble fir and western white pine play occasional roles in upper elevation Grand Fir Series sites and in the Western redcedar series.

Those plant associations representing the environmental interface with other series tend to have much more diverse tree structure and composition. Western hemlock appears, in small amounts, in Grand Fir Series associations transitional to the Western Hemlock Series (eg. ABGR/CONU/ACTR and ABGR/BENE/ACTR). Likewise, Pacific silver fir individuals are frequently encountered in associations transitional to that zone (eg. ABGR/VAME/CLUN). Some of the most diverse tree stands inhabit ABGR/RUPA/DIHO sites as well as those stands in the Western redcedar series which are on the environmental threshold of both the Pacific silver fir and Western Hemlock Zones.

Hardwood trees rarely maintain much canopy cover in mature stands within this study area. Frequently, burned or logged areas may have abundant Scouler's willow, cottonwood, or bitter cherry, but these species die as conifers overtop them later in succession. Oregon white oak

is also most abundant in such openings, and it can hang-on in mature stands on sites which do not support dense canopies, such as in some ABGR/CARU or ABGR/HODI forests. Quaking aspen also plays an early successional role in some moist sites on the south side of Mt. Adams, but where water tables are not too near the surface, grand fir and other conifers gradually overtop the aspen leading to their eventual demise. Big-leaf maple is frequently a minor species in warm-site associations transitional to the Western Hemlock Series in the Little White Salmon River drainage, such as ABGR/CONU/ACTR.

## Timber stocking

Timber stocking data summarized from our plots indicate a relative uniformity across the Grand Fir Zone, with slightly lower values for the Douglas-fir Series and higher values for the Western Redcedar Series. Tree stocking (# trees/acre greater than or equal to 7 inches diameter at breast height, DBH; Figure 10) was generally highest for the dryer-site associations, although we



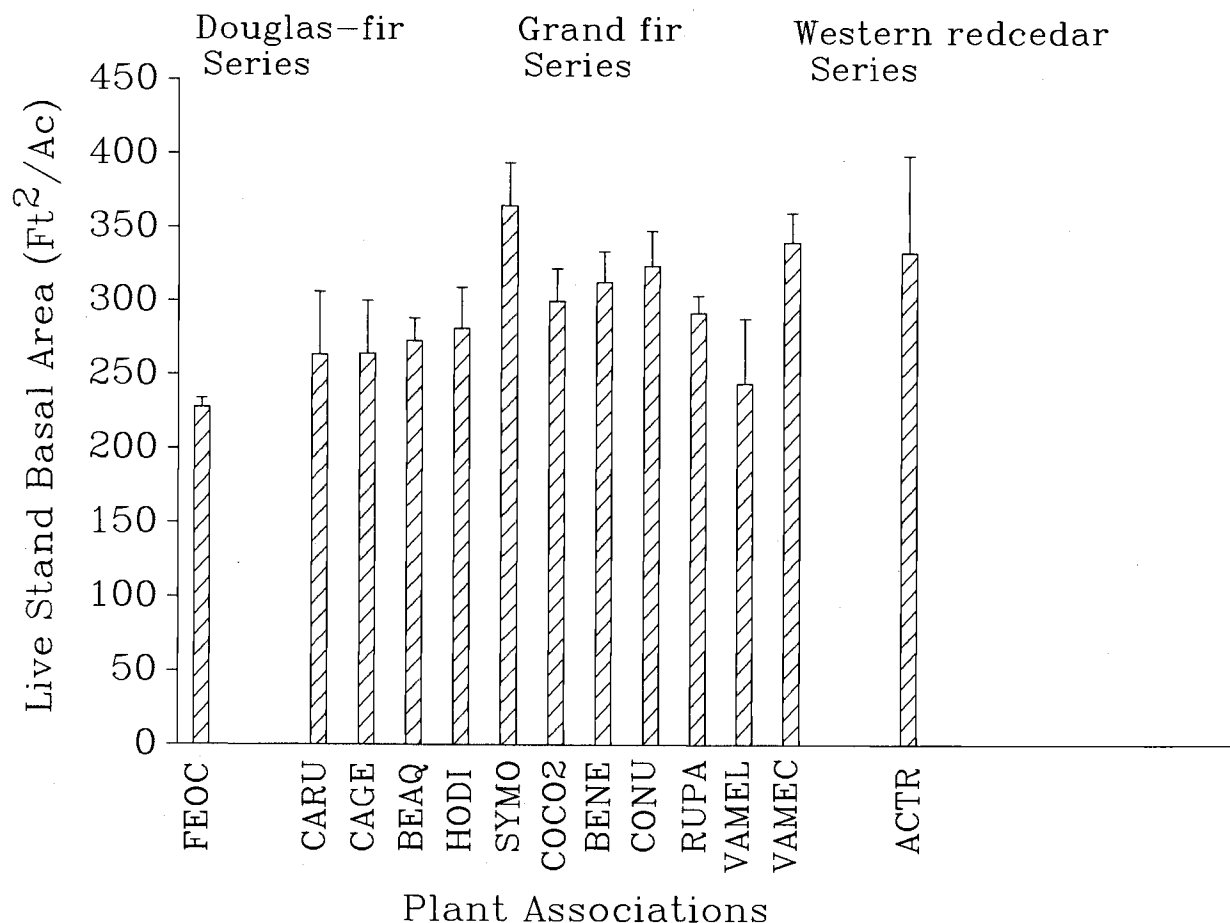


Figure 11. Mean and standard error of the live stand basal area, by plant association. The wide bars indicate the mean values and the lines above the bars indicate the values for the mean plus one standard error of the mean. See Table 1 for key to the plant association codes.

lack these data for the driest-site Grand Fir Series association (ABGR/CARU). The associations representing a more mesic environment (e.g. ABGR/BENE/ACTR and ABGR/CONU/ACTR) are also those dominating the Little White Salmon River drainage. Their average live stand basal area (Figure 11) was as high or higher than that sampled in the dryer-site associations. This is consistent with our finding stands of large individual trees dominant in these mesic types. The very high stocking values, both number of trees per acre and live stand basal area, in the ABGR/SYMO/ACTR association reflects the typical occurrence of highly productive, dense stands of grand fir in this grouping.

Our estimates of total stand volume and average stand diameter (Table 3) also indicate excellent stocking and high timber values. Associations which dominate the impressive timber stands in the Little White Salmon River watershed had large stand volumes, as did the Grand

fir/Creeping snowberry/Vanillaleaf association which is common on the south side of Mt. Adams.

The overall timber stocking pattern for the Grand Fir Zone plant association plots was in general very similar to that found in our Pacific Silver Fir Zone study (Brockway et al. 1983. Association averages of trees per acre and live stand basal area values for these two zones showed great overlap. However, our Western Hemlock Zone study plots in the western Cascades had consistently higher plant association averages for these two stocking variables (Topik et al. 1986).

### Timber growth and productivity

Site indices serve as useful guides to relative site productivity by indexing maximum tree height growth to a common age (either 100 or 50 years). With only one exception (the Grand fir/Oceanspray association), Douglas-fir plant association average site indices were consistently

Table 3. Current timber stand characteristics and potential timber productivity indices of the Grand Fir, Western Redcedar and Douglas-fir Series plant associations. See the text for explanation of these indices and see Table 1 for English and Latin names of the plant association acronyms. Quadratic mean diameter is the DBH in inches of the tree of average basal area. Stand density is Reinekes (1933). Total stand volume is cubic feet per acre, total stem to 1 foot stump with no defect deduction. SDI-based productivity index is an index of maximum production in cubic feet per acre per year at culmination of mean annual increment. Current volume index is the last decade's stand production in cubic feet per acre per year. Mean annual increment is the stand volume divided by the stand age.

Plant Association		Number of Plots	Trees per Acre	Tree/Ac > = 7" DBH	Quad. Mean Diameter	Stand Density Index	Total Stand Volume
DOUGLAS-FIR SERIES							
PSME/ACCI/FEOC	Mean	1	97	97	20.5	297	8623
	St.error		.	.	.	.	.
GRAND FIR SERIES							
ABGR/CAGE(GP)	Mean	6	254	176	12.6	368	8076
	St.error		37	10	0.8	56	1995
ABGR/ACCI-BEAQ/TRLA2	Mean	8	257	171	15.0	426	11488
	St.error		50	26	1.6	35	1131
ABGR/HODI(GP)	Mean	8	266	184	14.8	413	9473
	St.error		55	28	1.9	34	1431
ABGR/SYMO/ACTR	Mean	6	273	262	16.7	560	15055
	St.error		49	44	1.0	53	1786
ABGR/COCO2/ACTR	Mean	10	131	120	21.3	401	13539
	St.error		18	21	1.4	43	1559
ABGR/BENE/ACTR	Mean	10	160	115	23.4	396	13018
	St.error		62	25	2.8	39	1346
ABGR/CONU/ACTR	Mean	10	100	100	24.9	385	14937
	St.error		18	18	1.6	44	1700
ABGR/RUPA/DIHO	Mean	11	162	125	22.1	420	13846
	St.error		43	20	2.2	20	930
ABGR/VAME/LIBO2	Mean	2	126	85	19.6	330	10842
	St.error		37	4	4.6	25	2787
ABGR/VAME/CLUN	Mean	6	431	209	16.0	502	11446
	St.error		209	53	4.2	41	2001
WESTERN REDCEDAR SERIES							
THPL/ACTR	Mean	4	400	251	15.7	571	13200
	St.error		180	93	4.1	107	3197

Table 3 cont.

Plant Association		SDI-Based Product. Index	Current Volume Index	Mean Annual Incre.	Site tree age		
					Douglas-fir (# plots)	Pond. pine (# plots)	Grand fir (# plots)
DOUGLAS-FIR SERIES							
PSME/ACCI/FEOC	Mean	64	82	78	106(7)	.	.
	St.error	.	.	.	7		
GRAND FIR SERIES							
ABGR/CARU	Mean	.	.	.	71(2)	108(2)	50(1)
	St.error				5	35	.
ABGR/CAGE(GP)	Mean	126	145	90	62(4)	126(2)	69(5)
	St.error	45	35	10	7	14	5
ABGR/ACCI-BEAQ/TRLA2	Mean	162	194	141	90(8)	170(3)	74(6)
	St.error	17	25	20	17	9	4
ABGR/HODI(GP)	Mean	106	92	97	108(7)	190(3)	89(3)
	St.error	17	5	11	10	57	23
ABGR/SYMO/ACTR	Mean	206	226	139	90(3)	165(3)	83(5)
	St.error	42	23	15	11	18	3
ABGR/COCO2/ACTR	Mean	125	124	85	112(9)	101(2)	89(4)
	St.error	12	12	8	11	23	18
ABGR/BENE/ACTR	Mean	108	119	96	127(10)		130(3)
	St.error	18	28	14	14		18
ABGR/CONU/ACTR	Mean	135	133	115	129(10)		105(3)
	St.error	17	21	16	6		13
ABGR/RUPA/DIHO	Mean	133	136	94	152(11)	75(1)	109(8)
	St.error	8	16	33	25	.	11
ABGR/VAME/LIBO2	Mean	89	71	62	180(2)		137(1)
	St.error	13	24	21	18		.
ABGR/VAME/CLUN	Mean	169	102	83	216(4)		163(4)
	St.error	29	27	29	55		52
WESTERN REDCEDAR SERIES							
THPL/ACTR	Mean	171	126	92	212(4)		106(2)
	St.error	26	52	33	96		26

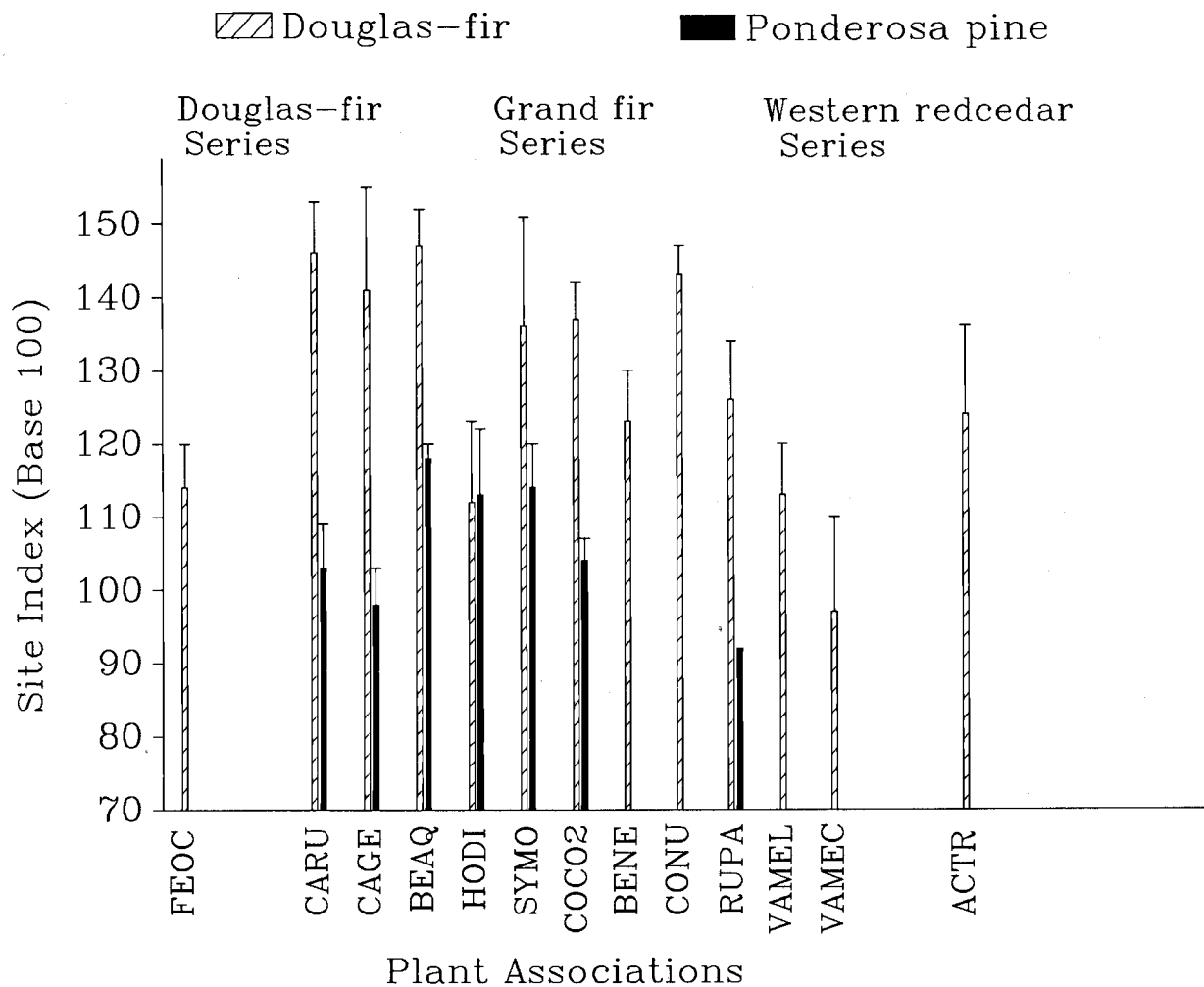


Figure 12. Mean and standard error of site index values for Douglas-fir (Curtis et al. 1974) and ponderosa pine (Barrett 1978), by plant association. Both indices equate measured tree heights on sample plots to predicted heights at age 100. The wide bars indicate the mean values and the lines above the bars indicate the values for the mean plus one standard error of the mean. See Table 1 for key to the plant association codes.

much higher than ponderosa pine (Figure 12). This difference may reflect sample differences. For instance, the preponderance of older individual ponderosa pine trees may lead to lower site index values. Yet, these data do indicate substantially better height growth for Douglas-fir in most associations where it co-occurs with ponderosa pine. Other factors, such as unknown differences in age to breast height or risk of regeneration failure, may be more important evaluation criteria when deciding which species to plant.

Grand fir site indices were relatively constant among the Grand fir Series plant associations except for lower values for the two types featuring big huckleberry and the Grand fir/Oceanspray association (Figure 13). The Douglas-fir and Western Redcedar Series associations also had lower average grand fir site indices than most

of the Grand Fir Series types.

The overall pattern of site index variation among the associations in this study was remarkably similar between grand fir and Douglas-fir. Though the base age of these site indices differs (100 vs. 50 years), adjustment of the grand fir values to an equivalent 100 year base makes the values for the two species very similar for almost all of the associations where we have data from both species.

Another productivity index, growth basal area (GBA, Hall 1988b), indexes site stocking capability. It is defined as that basal area at which trees on average increase one inch radially per decade at age 100. The variation among Grand Fir Series associations showed a very surprising decrease from the dry-site to the more moist-site types (Figure 14) for both Douglas-fir and ponderosa pine. Grand fir had a somewhat similar pat-

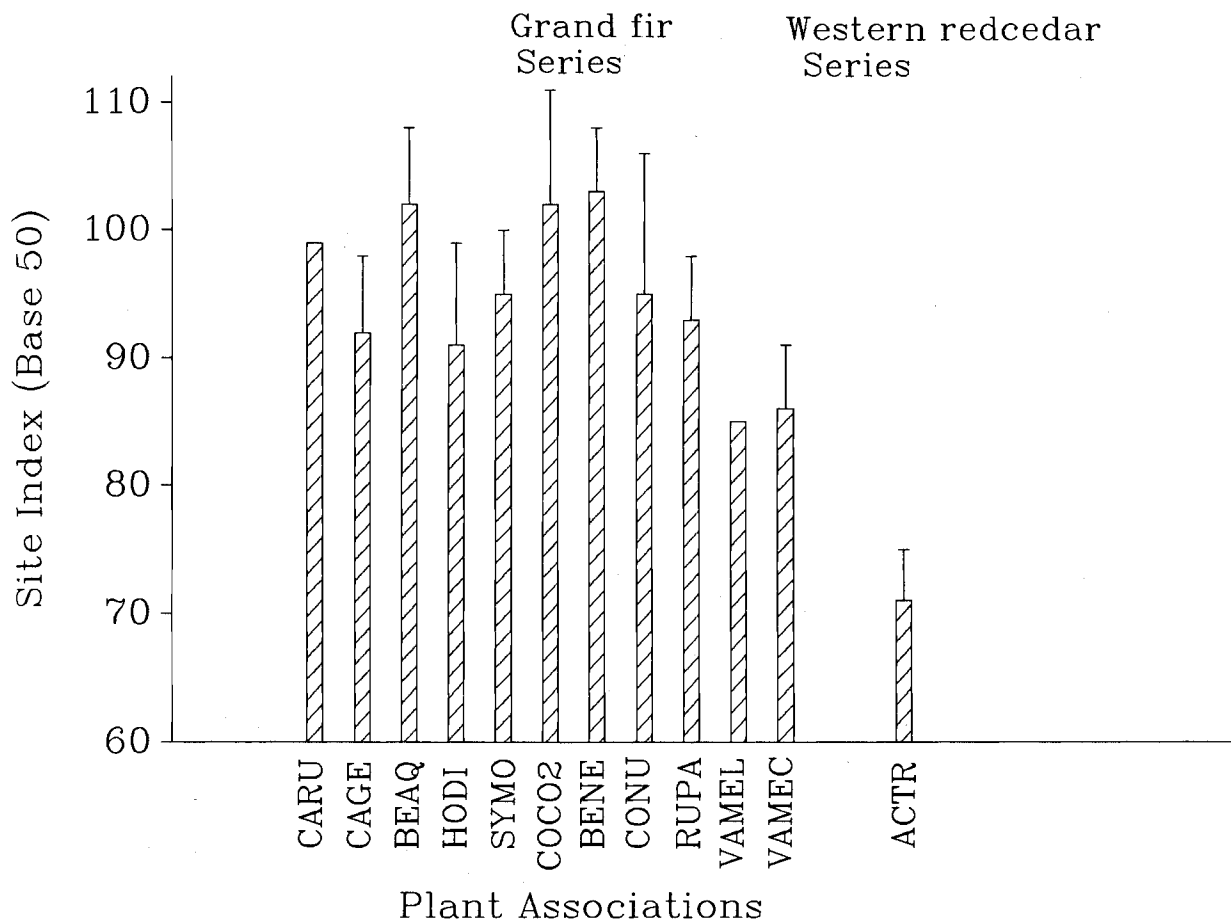


Figure 13. Mean and standard error of site index values for grand fir (Cochran 1979), by plant association. This index equates measured tree heights on sample plots to predicted heights at age 50. Grand fir was absent from our Douglas-fir Series association. The wide bars indicate the mean values and the lines above the bars indicate the values for the mean plus one standard error of the mean. See Table 1 for key to the plant association codes.

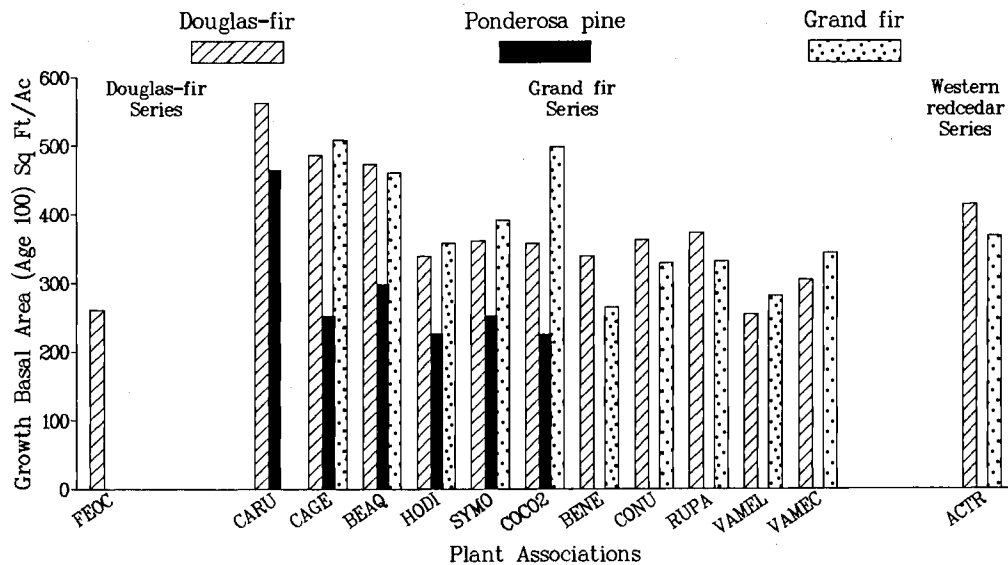


Figure 14. Average growth basal area (GBA) for each plant association, indexed to 100 years, for Douglas-fir, ponderosa pine and grand fir. Growth basal area (Hall 1988b) is an index of stocking capability. It is defined as that basal area at which dominant trees have one inch per decade radial growth. See Table 1 for key to plant association codes.

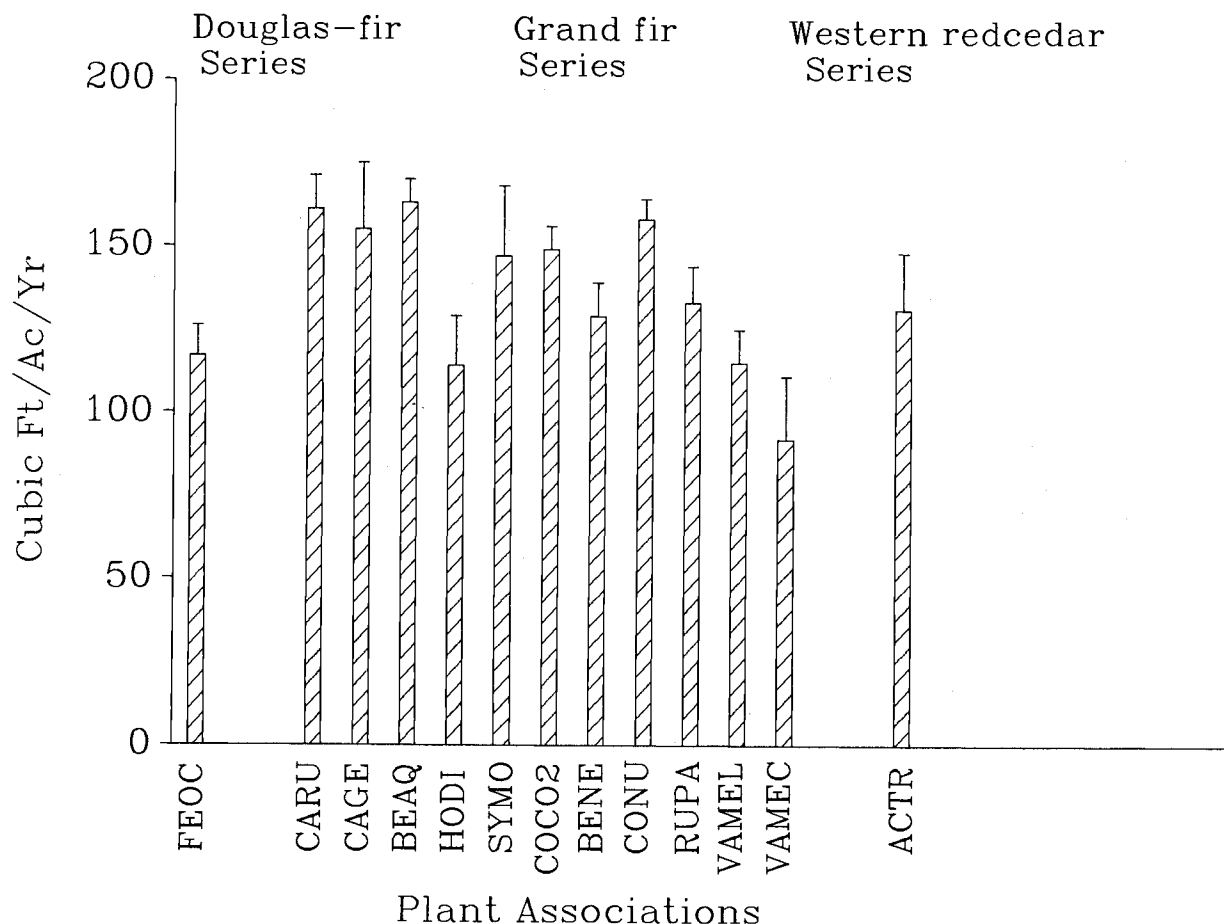


Figure 15. Mean and standard error of an index of potential yield at culmination of mean annual increment, by plant association. This index is based on normal yield tables, as adjusted by average Douglas-fir site index. The wide bars indicate the mean values and the lines above the bars indicate the values for the mean plus one standard error of the mean. See Table 1 for key to the plant association codes.

tern but with more variation. Normally we expect that GBA is highly correlated with site moisture, especially east of the Cascades crest. Within an association, grand fir and Douglas-fir had fairly similar growth basal areas. Ponderosa pine always had a lower GBA, indicating its lower stocking capability, and perhaps the older age of our samples for that species.

We have estimated the total timber volume on our study plots (Table 3) in the manner described in our earlier plant association papers for the Gifford Pinchot National Forest (Brockway et al. 1983 and Topik et al. 1986). This is an estimate of total stem volume to a 1 foot stump with no reduction for defect.

Timber volume productivity can be estimated in many ways. We present one method in Figure 15 which is based on normal yield tables as estimated by site index values for each sample plot (equations used in Region 6 stand exam program, D. Guenther personal communica-

tion). This productivity index is useful primarily to compare relative values among associations. The values index potential maximum production (total cubic volume/acre/year) at culmination of mean annual increment. This figure shows high values for most of the Grand Fir Series, with lower potential productivity in the two big huckleberry associations and the Grand Fir/Oceanspray association. The Douglas-fir Series type also had a lower productivity index than most of the Grand Fir or Western Redcedar Series.

Three other ways of calculating productivity indices are presented in Table 3. The SDI-based index is based on site index adjusted normal yield tables with further adjustment for stocking using Reineke's (1933) stand density index. This is another index of maximum potential productivity at culmination of mean annual increment. The second index (current annual increment) estimates current volume increment by examining the last 10 year's

diameter growth of site trees and using site index tables to estimate recent height growth (Hemstrom 1983, see Topik et al. 1986 for more explanation). The third index (mean annual increment) is an estimate of the mean annual net production calculated by dividing the estimate of stand volume by the stand age. All of these indices indicate relatively high productivity in the study area but with slightly different patterns among the associations depending on the index. The SDI-based index is highly variable because it is so dependent on our sample stand stocking. The current volume increment values were also very high, indicating that sampled stands are producing at or near their maximum potential.

The overall timber production indices were generally higher than those found in our Pacific Silver Fir Zone study (Brockway et al. 1983) and fairly similar to those in our Western Hemlock Zone study (Topik et al. 1986). A very big factor in this overall pattern is the great difference in stand age among these zones. The Pacific Silver Fir Zone samples were primarily old stands (200 years) and old stands were very common in our Western Hemlock Zone samples. In contrast, only a few Grand Fir Series plots had trees over 200 years old, and many samples were in the 80-90 and 120-130 year age classes (see Table 3). When we compare similar aged stands in the Grand Fir and Western Hemlock series, the later generally have higher production indices. However, several Grand Fir Series associations (eg. Grand fir/Creeping snowberry/Vanillaleaf and Grand fir/Vine maple-tall Oregongrape/Starflower) were every bit as productive as the low elevation western Cascade associations.

## Long-term site productivity

Long-term site productivity refers to the ability of a site to continue to produce, during the course of multiple harvest rotations, biological products as well as maintain ecosystem functions. Biological production includes timber production as well as the maintenance of individuals of many species (biological diversity). Ecosystem functions include energy, nutrient, and hydrological cycling. Rates and efficiencies of these cycles determine the ability of an ecosystem to convert light into biomass (photosynthesis), reduce erosion, maintain and enhance soil organic matter and nutritional status, and maintain stream flows.

Plant associations vary considerably in their resilience to management-caused disturbances. The association description text highlights those associations most sensitive to such detrimental effects as soil compaction, loss of surface and soil organic matter and depletion of ecosystem nutrients. Because timber management in this area is still primarily harvesting sites for the first time, we have to make extrapolations regarding possible detrimental effects of various management practices. Heavy equipment used in logging operations and slash

piling, and nutrient depletion from slash burning, may result in long-term reductions of site potential. It is possible our stand management practices, such as excluding natural underburning and reducing plant species diversity, may adversely affect timber productive potential and increase susceptibility to pest outbreaks.

One of the key long term site productivity concerns regards soil nutritional balance of managed stands which may proceed through shortened early seral stages. Nitrogen is the most limiting nutrient in most Cascadian sites, and it is added to the ecosystem only through precipitation and biological nitrogen-fixation. The biochemistry of nitrogen fixation demands large amounts of energy, hence greatest amounts of fixation occur when plants having symbiotic nitrogen-fixing bacteria receive full sunlight. Throughout most of the Grand Fir Zone, little nitrogen fixation probably occurs in closed stands except within the oxygen-free environment of moist, rotting log interiors, (and some terrestrial lichens, such as *Peltigera* species). Forb and shrub seral stages following natural disturbances are frequently dominated by nitrogen-fixing herbs, such as peavines and vetch, and shrubs, such as ceanothus. Where our forest management succeeds at excluding these species, the ecosystem result is lowered nitrogen levels and perhaps eventually, decreased productivity. When our management allows establishment of legumes, such as in some forage-seeding mixtures, or some ceanothus, following broadcast burns, nitrogen levels will be enhanced. Silviculturists must balance the long-term site benefits received from such biological nitrogen fixation with potential detrimental competitive effects on seedling establishment, especially on dry sites.

## Silviculture

We have summarized various silvicultural concerns in Table 4. Our recommendations for activities appropriate for different associations are based on observation and interpretation of environmental gradients indicated by the associations. As we acquire more management experience of the response of different associations to treatments, our prescription ability will increase. The association descriptions include more explanatory text concerning these management concerns. A great deal of pertinent and useful silvicultural information is presented by Seidel and Cochran (1981). Details regarding those critical reforestation pests, pocket gophers, are reported by Teipner et al. (1983).

## Wildlife and Range

Overall habitats and flora are fairly similar between this study area and the northern portion of the Blue Mountains of Oregon and Washington. The plant associations

Table 4. Summary of some silvicultural characteristics of the Grand Fir, Western Redcedar and Douglas-fir Series plant associations on the Gifford Pinchot National Forest. See Table 1 for the English and Latin equivalents to these plant association acronyms and Table 5 for the names of the brush and tree species.

PLANT ASSOCIATION	RELATIVE REGENERATION HAZARD			SUITABLE SPECIES	
	Brush Competition	Drought Hazard	Gopher Potential	Planted	Natural Regeneration
DOUGLAS-FIR SERIES					
PSME/ACCI/FEOC	moderate	high after hot burns	low	PSME,	PSME PIPOQUGA
GRAND FIR SERIES					
ABGR/CARU	moderate	high after hot burns	moderate	PIPO	PIPO,PSME PSMEABGR
ABGR/CAGE	low	high	severe	PIPO,	PIPO,PSME PSMEABGR
ABGR/BEAQ-ACCI/TRLA2	moderate (ACCI,CEVE)	medium	moderate	PIPO, PSME	PIPO,PSME ABGR
ABGR/HODI	severe (HODI,AMAL CEIN,CEVE)	high	moderate	PIPO, PSME	PSME,PIPO LAOC,QUGA ABGR
ABGR/SYMO/ACTR	moderate after hot burns(CEVE)	medium	high	PIPO, PSME	PSME,PIPO ABGR
ABGR/COCO2/ACTR	moderate (COCO2,ACCI) (CEVE after hot burns)	medium	moderate if slope <15	PSME, PIPO	PSME,ABGR PIPO
ABGR/BENE/ACTR	moderate after site disturbance	medium	low	PSME, PIPO	PSME,PIPO ABGR
ABGR/CONU/ACTR	moderate (CEVE,CEIN ACCI,SYMO)	low for Zone	moderate if slope <15%	PSME	PSME, ABGR
ABGR/RUPA/DIHO	moderate (RIVI) (CEVE after hot burns)	low for Zone	moderate if slope <15%	PSME PIMO LAOC ABPR	ABGR,LAOC PSME some PIMO possible
ABGR/VAME/LIBO2	low	low	low for Zone	PSME	PSME,ABGR LAOC PIMO PIPO
ABGR/VAME/CLUN	low	low	moderate for Zone	PSME after site disturbance	PSME,ABGR LAOC,PIMO ABAM PIPO
WESTERN REDCEDAR SERIES					
THPL/ACTR	low	low	moderate	PSME LAOC, PIMO THPL	THPL,ABGR LAOC,PIMO PSME,TSHE



described are also fairly similar (Hall 1988c). Many of the management recommendations included in the Blue Mountains wildlife book (Thomas 1979) are appropriate here as well. The discussion below focuses on two key habitat attributes which are easily manipulated by land managers: dead trees (snags and down logs) and winter range forage (forage seeding).

## Deer and elk

There is a large body of literature and knowledge regarding these important game and "watchable" wildlife species. Individual plant association descriptions in this publication include discussion of the forage, winter range value and stand-structure components important to deer and elk.

Winter forage and thermal protection are critical habitat elements for deer and elk. Because winter forage is so critical, range condition is particularly important in low snow-fall areas. Knowledge of plant associations can aid in determining the general climatic setting of sites and evaluations of their winter range value. Careful timber management of winter range provides for a useful mixture of thermal cover and foraging sites. The different plant associations have different timber growth and stocking capability, thus plant associations can aid in prescribing appropriate silviculture to provide necessary wildlife habitat.

## Edges

One major concept emphasized in the Blue Mountains wildlife book (Thomas 1979), the value of "edge" and "edge contrast" between neighboring plant communities, is now being re-evaluated. The emphasis of "edge" as a surrogate measure for species diversity (Thomas et al. 1979) has been re-examined as we learn more regarding the landscape ecology of patches (eg. Franklin and Forman 1987). Recent work (eg. Lande 1988) emphasizes two possible negative effects of edges. First, there is a deterioration of habitat quality in the blocks of forest which are near the edges of openings. As more and more of our forest landscape is harvested, the sizes of remaining patches decreases as does their habitat integrity for forest-requiring species. The second negative edge effect concerns the increased failure rates of forest-requiring individuals which disperse into unsuitable habitats. We currently lack information regarding the crucial patch size of forests for various plant or animal species. It is clear that although edges may support more species than either openings or forests, many of these are disturbance-loving species which are abundant regionally. Regional species diversity may depend on the maintenance of several sites representative of pre-settlement conditions.

## Snags and fallen trees

Recent research has increasingly pointed out the importance of snags and fallen trees as habitat for a myriad of organisms having important ecosystem roles. Snags in the Blue Mountains of Oregon provide habitat for 62 species of cavity-dwelling birds and mammals (Thomas et al. 1979). In their publication, "The Seen and Unseen World of the Fallen Tree", Maser and Trappe (1984) emphasize down logs as important habitat for nitrogen-fixing bacteria, many wildlife species, fish, and in-stream invertebrates. Fallen trees are also important rooting substrates and provide structure which aids stream stability and habitat quality. Down logs are now known to be vital to soil properties (Harvey et al. 1987), particularly in sites having poor nutritional status, such as most of this study area (see soils discussion). In their paper summarizing years of research in Inland Northwest forests fairly similar to much of our Grand Fir Zone, Harvey et al. (1987) state: *"Our studies show that quantities of organic matter and their distribution, especially decaying wood and humus, have integral and sometimes critical roles to play in supporting the growth of forest trees"*.

### Snags and fallen trees: relationship with plant association groups

We have summarized our snag and fallen tree data by groups of plant associations representing substantially different portions of the environmental gradient. We split the Grand fir Series into four groups: hot, dry graminoid-dominated associations; hot, dry brush-dominated associations; moderately moist (mesic) associations; and cool (also moist) associations. The Western Redcedar Series association comprises a fifth group. We lack data for the Douglas-fir series association.

There are many snags on most of our study plots, however many lack desirable qualities for primary cavity dwellers. Many of the snags, particularly on the south side of Mt. Adams, are grand fir, which do not contain good cavities and are not likely to persist for very many years. Others are well rotted, soft (condition 4 and 5) snags which have low value for primary cavity nesters (Figure 16). Few of the snags in our samples actually had cavities (Figure 16). Many of the snags with cavities were small trees which have short useful spans for wildlife use.

The relationship of snag abundance and quality to the plant association groups is difficult to interpret. Although most of our Grand Fir Zone samples had many snags, large snags with noticeable cavities were fairly rare, averaging at most 4 per acre in the hot, dry, grass-rich plant association group (Figure 17). Because our snag data are sparse, we should not over-interpret the results. For instance, the lack of larger snags having

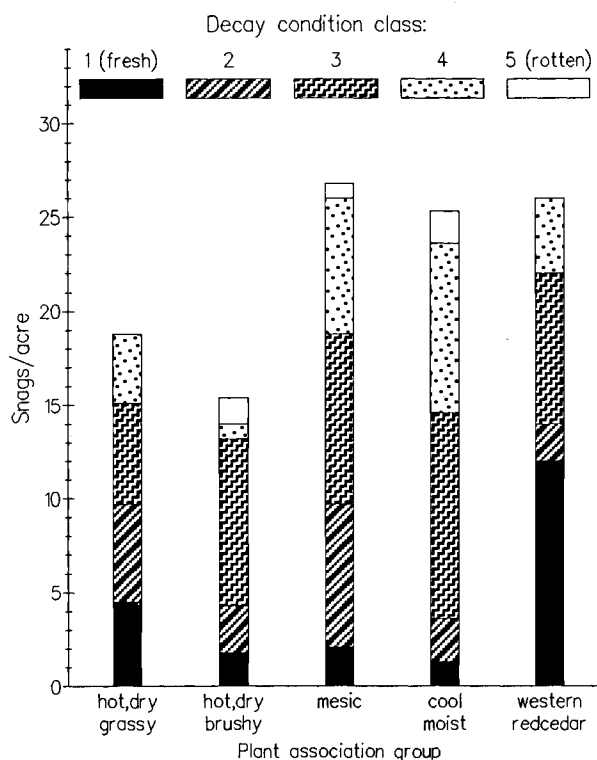


Figure 16. The number of snags per acre (minimum 6 inches DBH and 10 feet tall) by decomposition condition class (see text), for groups of plant associations. The hot, dry grassy group (11 plots) includes Grand fir/Elk sedge, Grand fir/Pinegrass and the Douglas-fir/Vine maple/Western fescue associations. The hot, dry brushy group (16 plots) includes Grand fir/Oceanspray and the Grand fir/Vine maple-tall Oregongrape/Starflower associations, the mesic group (35 plots) includes the Grand fir/Creeping snowberry/Vanillaleaf, Grand fir/California hazel/Vanillaleaf, Grand fir/Dwarf Oregongrape/Vanillaleaf and the Grand fir/Pacific dogwood/Vanillaleaf associations, and the cool, moist group (19 plots) includes the Grand fir/Thimbleberry/Fairybells, Grand fir/Big huckleberry/Twinflower and the Grand fir/Big Huckleberry/Queencup beadlely associations. The western redcedar group (4 plots) includes the lone Western Redcedar Series association.

felling for safety and salvage purposes did occur on many plots. If so, we need to carefully attend to future snag management in order to provide sufficient habitat for the many species depending on snags for nesting and foraging.

Figure 18 presents the weight of down woody material, by diameter size classes, for our plant association groups within the Grand Fir Series. The total amount of fallen logs was very similar among the groups but in the cool, moist group there was a preponderance of large material (20 inches + in diameter). Our samples included few large logs per acre, ranging from only 2 in the hot, dry brushy plant association group to 10 in the cool, moist plant association group (Figure 19). Smaller logs, which provide lower quality small animal habitat and decay faster, were much more abundant in our samples. It is

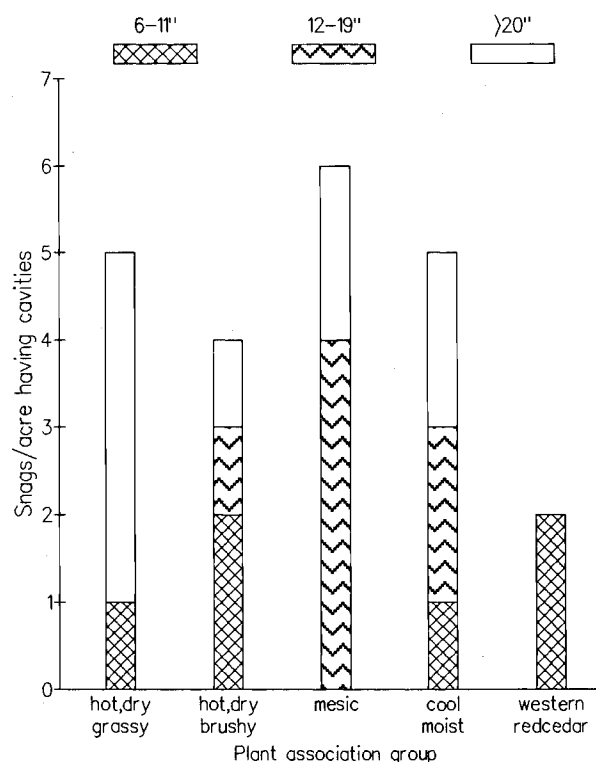


Figure 17. The number of snags having noticeable cavities (minimum 6 inches DBH and 10 feet tall) by diameter size classes for the plant association groups. The plant associations comprising the groups are listed in Figure 16. The number of sample plots per group was: hot, dry grassy (6); hot, dry brushy (13); mesic (27); cool, moist (15); and western redcedar (4). These values are only from the 1983 samples.

however the larger logs which have have greatest ecosystem functions. Such large pieces remain moist for most of the year, allowing tree rooting as well as anaerobic nitrogen-fixation. These larger down logs also provide the best habitat for our herpetofauna and also help reduce surface erosion on steeper slopes.

The weight of fine fuels (Figure 20) was relatively similar in the various plant association groups. This material is affected most by current stand structure and may be more related to stand age and stocking than environment. These values are in general fairly similar to those observed in our Western Hemlock Zone forests (Topik et al. 1986).

### Management tips regarding snags and fallen trees

During the recent past our concern for the importance of snags and down woody material as wildlife habitat has resulted in specific management standards. The draft Forest plan for the Gifford Pinchot National Forest sug-

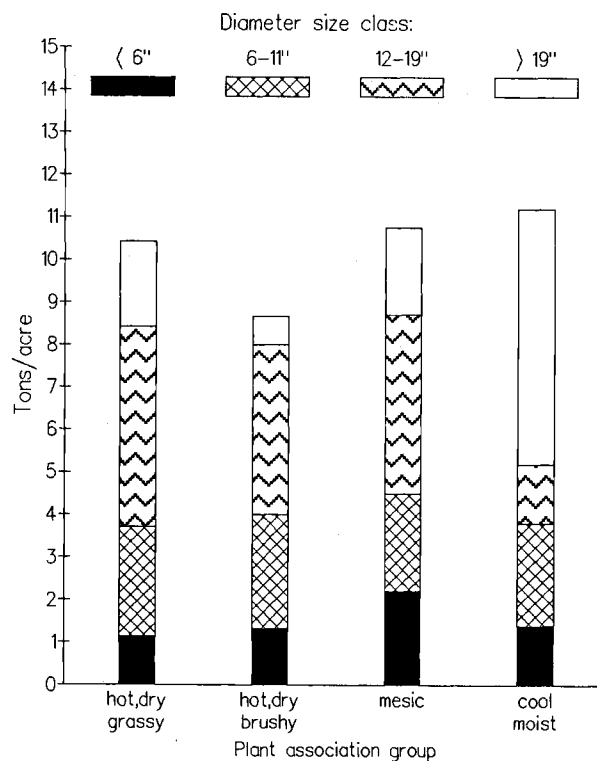


Figure 18. The weight of fuels (greater than 3 inch diameter) by diameter size class for the plant association groups. The plant associations comprising the groups are listed in Figure 16. The number of sample plots per group was: hot, dry grassy (7); hot, dry brushy (3); mesic (14); cool, moist (5).

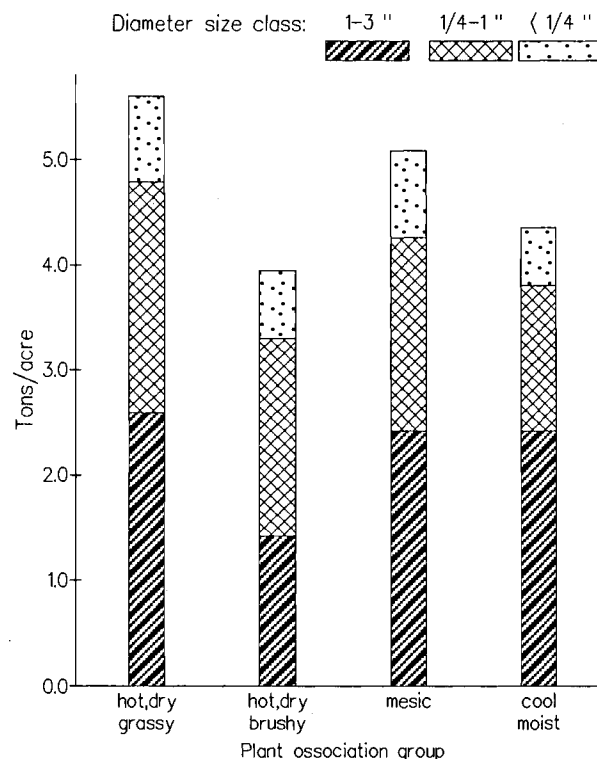


Figure 20. The weight of fine fuels by diameter size class (1-3 in. diameter, the 100 hour fuels; 1/4-1 in. diameter, the 10 hour fuels; 1/4 in. diameter, the 1 hour fuels; Deeming et al. 1978) for the plant association groups. The plant associations comprising the groups are listed in Figure 16. The number of sample plots per group was: hot, dry grassy (7); hot, dry brushy (4); mesic (14); cool, moist (5).

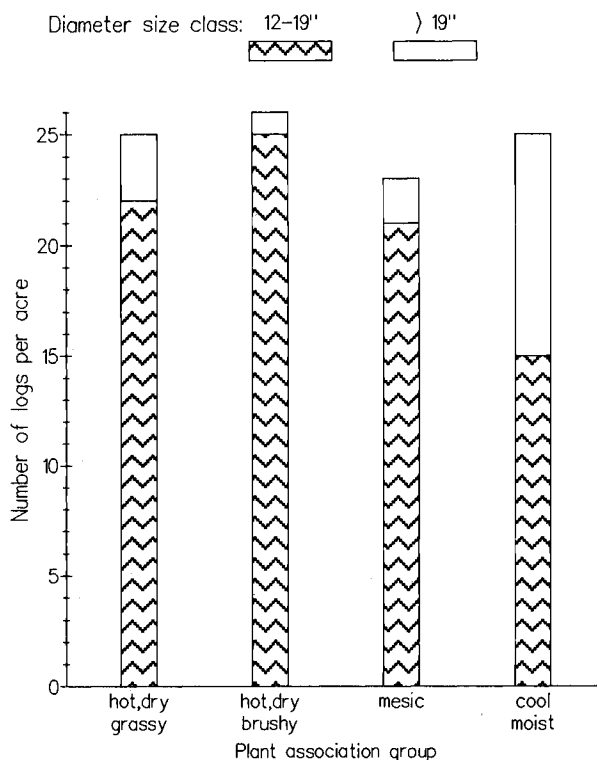


Figure 19. The number of large, down logs either 12-19 or 20 and greater inches in diameter, for the plant association groups. The plant associations comprising the groups are listed in Figure 16. The number of sample plots per group was: hot, dry grassy (7); hot, dry brushy (3); mesic (14); cool, moist (5).

gests maintaining an average of two snags per acre, preferably Douglas-fir, larch or ponderosa pine, that are at least 40 feet tall and 21 inches DBH. These should be evenly distributed wherever practicable. In addition, where possible, 3 down logs (at least 21 inches in diameter at the large end and 16 feet long) should be maintained. These minimum levels should be protected from harvest and fuel treatment operations, firewood cutting and future salvage activities. Snags providing high quality nesting habitat for primary cavity nesters are not abundant in most of the Grand Fir Zone. Many of the snags in our samples are grand fir with small diameters having low utility to most cavity dwellers and which have short useful periods before they fall apart. Snag management emphasizing ponderosa pine and Douglas-fir is especially important in this study area compared to the other coniferous forest zones on the Gifford Pinchot National forest.

especially important in this study area compared to the other coniferous forest zones on the Gifford Pinchot National Forest.

The Blue Mountain wildlife book (Maser et al. 1979) suggests a number of management guidelines for down woody material. Our study area has somewhat similar habitats as portions of the Blue Mountains. Some of these guidelines are: 1. Woody debris should be retained for wildlife cover on 10% of the area clearcut; 2. Slash should be reduced to a depth of 8 inches or less on at least 75% of an area with an established priority for livestock grazing and untreated slash should be retained as wildlife habitat on 25% of the area; 3. Continuous concentrations of slash should be avoided because they restrict the travel of big game; 4. At least 2 uncharred class 1 or 2 logs per acre and all class 3, 4 and 5 class logs should be retained as wildlife habitat.

The paucity of large logs (20 inch and larger diameter) in our Grand Fir Zone samples suggests that this material should be left on-site following timber harvest. Their various ecosystem functions and small animal habitat value are as important in this Zone as in the Western Cascades.

A comparison of the snag and down woody material data from this study with those reported from the Western Hemlock Zone (Topik et al. 1986) indicates that management of this material is more of a challenge in the Grand Fir Zone than the moist, more productive westside. Similar measurement and analysis methods were used for both reports although we have very few down woody material sample plots. In general, the Western Hemlock zone had fairly similar numbers of snags, but more of the large Douglas-fir having high wildlife value. Down woody material appears to be much more abundant (3 to 5 times), both in weight and in number of large logs, in the Western Hemlock Zone.

## Winter Range Forage Seeding

Many factors affect the efficacy of forage seeding programs. The local physical and biological environment, the extent of disturbance by harvest and site preparation, and the composition, amount, and timing of seeding are primary considerations. A successful program involves site analysis and planning appropriate applications by considering clear primary and secondary site management objectives. Just as importantly, the program must monitor the growth and utilization of the seeded forage and effects on other management objectives.

We can reduce confusion regarding relative seeding intensity by expressing our seeding rates in terms of pure live seed (PLS) per square foot. Each species has a different seed size and so a different number of seeds per pound. Each seed lot also may differ in its purity and its germination rate so each seed lot requires some adjust-

ment to achieve desired planting density objectives. Large-seeded species do tend to establish more quickly and as more robust individuals so far fewer seeds per square foot are required to provide a similar initial plant cover as small-seeded species.

Plant associations can be used to predict environmental characteristics and vegetation composition and growth patterns. The groups of plant associations listed below serve as a stratification of relatively similar climatic and vegetation units. These association groups should aid us to more accurately predict site response to forage seeding and better understand patterns of vegetation growth. Because we have little forage seeding experience within our Grand Fir Zone, this discussion is general and subject to change as our knowledge increases. The discussion is based on interpretation of seeding experience in other climatic areas and initial local experience.

### Associations on cool, moist sites

- Grand fir/Thimbleberry/Fairybells
- Grand fir/Big huckleberry/twinflower
- Grand fir/Big huckleberry/Queencup beadlelily

#### Forage conditions in clearcuts without seeding:

These sites should normally have rapid regrowth of a variety of shrubs including vine maple, Rocky mountain maple, creeping snowberry, thimbleberry, big huckleberry, trailing blackberry and others. The herb layer also will reestablish rapidly but may not include many palatable species. Grasses and sedges are likely a minor part of the flora.

#### Forage seeding considerations:

These sites are unlikely to be in winter range. Spring or summer range forage enhancement could be beneficial to big game when alpine areas having high quality forage remain snow covered.

### Associations on mesic (moderately dry and warm) sites

- Grand fir/Pacific dogwood/Vanillaleaf
- Grand fir/Dwarf Oregongrape/Vanillaleaf
- Grand fir/California hazel/Vanillaleaf
- Grand fir/Creeping snowberry/Vanillaleaf

#### Forage condition in clearcuts without seeding:

Depending on the extent of site disturbance and slash burning, sites in this group will revegetate moderately quickly with a variety of shrubs. Creeping snowberry is likely to dominate, but where site disturbance is not severe, redstem ceanothus, currants, thimbleberry, Pacific dogwood, dwarf Oregongrape, or California hazel can proliferate. A great diversity of weedy herbs having low palatability may also invade before shrubs

and conifers shade them out. Broadcast burns are likely to encourage dense stands of snowbrush ceanothus. Grasses and sedges are likely to be sparse.

#### **Forage seeding considerations:**

This group offers opportunities for forage seeding. These sites are sufficiently dry that low seeding rates and careful monitoring is essential if conifer regeneration is a primary or secondary goal within the winter range. Browse will usually be very abundant and may be more available to big game than seeded forage when snow packs prevail. Seed should not be applied much in advance of tree planting. Seeding edges, tractor paths and other disturbed ground within clearcuts will provide the highest quantity of useable forage. Such partial unit seeding is likely to accrue nearly the potential benefit for big game on the site and still minimize potential moisture competition with conifer seedlings.

#### **Shrub-rich associations on hot, dry sites**

- Grand fir/Oceanspray
- Grand fir/Vine maple-tall Oregon grape/Starflower
- Douglas-fir/Vine maple/Western fescue

#### **Forage conditions in clearcuts without seeding:**

Unless sites in this group are severely disrupted by harvest or site preparation, shrubs will rapidly resprout and provide high quality and quantity of browse. Palatable herbs are not abundant, but native grasses are likely to provide at least some forage. Slash burning will normally encourage snowbrush ceanothus establishment.

#### **Forage seeding considerations:**

These sites are quite dry during the growing season. If conifer establishment is a site objective, forage seeding needs to be done sparsely and it needs to be carefully monitored. Browse will normally be abundant so seeded forage may not be a necessary management goal. Where seeding is conducted, application to clearcut edges and soil disturbance patches is a desirable way to gain maximum wildlife benefit with less risk of plantation failure. Many of these sites are on steep slopes where winter range forage use is difficult for big game. The more exposed, south slopes having either the Grand fir/Oceanspray or Douglas-fir/Vine maple/Western fescue association may be difficult to reforest if much forage seed is applied.

#### **Grass-rich associations on hot, dry sites**

- Grand fir/Elk sedge
- Grand fir/Pinegrass

#### **Forage conditions in clearcuts without seeding:**

Both the elk sedge and pinegrass are able to increase their abundance following soil disturbance from logging

and site preparation. Browse of California hazel or oceanspray will also increase and should provide adequate supplies which can remain available despite the presence of snow-packs. These sites are also likely to have substantial cover of other native grasses including blue wild rye, and several fescue species.

#### **Forage seeding considerations:**

This group provides native forage of fair quality and very good quantity. These sites are so difficult to regenerate that if conifer establishment is a management goal, forage seeding should be avoided or conducted very selectively. Spot application of forage seed should be tried rather than broadcast seeding and sod-forming grasses should be avoided. Timothy and orchardgrass should be avoided because they are thought to increase pocket gopher abundance.

#### **The Western redcedar association (found on warm and moist sites)**

- Western redcedar/Vanillaleaf

#### **Forage conditions in clearcuts without seeding:**

Vegetation regrowth is rapid and dense. Shrubs are very likely to provide quality browse soon after harvest or site preparation in the absence of hot broadcast burning. Besides vine maple resprouting, other palatable shrubs likely to proliferate are elderberry, currants, thimbleberry, and blackberry species. Palatable herbs occur but are likely to be overtopped by shrubs.

#### **Forage seeding considerations:**

Sites within this group usually will respond to clearcutting with good quality and quantity of browse. Seeded grass and legumes should grow well to enhance elk forage. Soil moisture stays high well into the growing season, so seeding will lead to much less soil moisture competition with conifer seedlings than in any other eastside plant association group.

### **Range**

The Grand Fir Zone on the Gifford Pinchot National Forest has a long history of livestock use. The pattern of livestock use has changed greatly as has the overall appearance of much of this area due to fire suppression. The area around Mt. Adams received particularly heavy use by Indians and unchecked wildfires were probably commonplace. Though we do not know that Indians set fire for range enhancement, they did start many fires which had that effect. Much of the area on the south side of Mt. Adams in the Grand Fir Zone was covered with open ponderosa pine stands and a patch-work of fire-maintained prairies before European settlement.

European settlement of the Trout Lake-Guler area began in the 1880's. By the turn of the century the area had a number of small farms and ranches as well as

several very large livestock operations. The first lumber mill in the area was built around 1903. Very little Federal management was provided for this area before the establishment of the USDA-Forest Service in 1907 following transfer of the Mt. Rainier Forest Reserve from the Department of the Interior to the Department of Agriculture under the leadership of Gifford Pinchot.

Early range administration on the Columbia National Forest (the name was changed to Gifford Pinchot in 1949) involved range assessments and establishment of cattle and sheep allotments. Early settlers grazed tremendous numbers of cattle and sheep in much of this study area although the bulk of the use was by a small number of huge outfits.

Since about the 1920's our fire suppression activities have allowed grand fir to grow up from below these stands and form the dense grand fir forests which currently prevail in this area. The current stands produce much less forage than the open, fire-maintained forests. The reduction of grazing carrying capacity is due to the successional development of the forests, to range damage from over-grazing, as well as a reduction of the land base available to livestock.

Today most use is confined to transitory range on sites following timber harvest. Non-forest range lands are not at all abundant now that fire suppression has allowed

trees to establish throughout most of the National Forest. Transitory range includes those areas where forage grows for a number of years during the successional transition of a site from grasses, herbs and shrubs following disturbance to closed forest with low range value. Transitory range abundance and quality is highly dependent on management activities. Clearcut timber harvests allow high forage productivity for a few years until timber regrows. The use of forage seed of non-native grasses and legumes can enhance forage productivity, but in the drier plant associations, such seeding can make reforestation extremely difficult. We are only beginning to evaluate the use of native forage species for seeding projects.

The plant association descriptions in this publication discuss the potential forage productivity for livestock of particular sites. We currently lack quantitative data regarding herbage production. However, in this area where transitory range is the rule, forage production is dependent on cultural treatment, successional status, as well as site potential related to plant associations. Future research will deal with forage production in transitory forest types and production following various silvicultural and fuels treatments, such as the underburning conducted in our pine/oak area.

## **Chapter 2**

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### **Keys to Forest Series and Plant Associations**





# How to Key Out Sites to Plant Association

The following keys are used to determine the plant association of relatively undisturbed, mature forest stands. A fairly homogeneous area should be used. Proximity to a road, stand edge or other phenomenon that would influence the vegetation should be avoided. A good plot configuration is a roughly circular area between 40 and 50 feet in radius.

After selecting the plot area, list all tree (canopy and regenerating), shrub, forb and grass species. Estimate each species' percent cover by projecting the total crown perimeter of plants to a plane surface and estimating the percent of the plot area covered. Use Appendix 2 as a guide for making percent cover estimates.

After thoroughly examining the plot area, begin with the Key to Forest Series. Then use the appropriate Key to Plant Associations being careful to read each couplet of choices completely and follow the number sequence for the more correct choice. Start at the top of the key and carefully follow the numbered sequences. Select one of the 2 choices as best fitting your sample plot and then

follow the sequence number listed for that choice.

Where your site seems to fit both couplets, work through both branches of the key. Evaluate your answer by reading the association descriptions and checking the vegetation summary data in Appendix 1.

In some stands the canopy may be so dense that the understory may be severely limited. In such cases, relative dominance rather than actual percentages may be used to determine plant association.

Much forest-land has had sufficient ground disturbance to alter the understory plant composition. Be careful to check sample plots for skidding tracks or compacted areas which may have plants that increase with disturbance. Attempt to evaluate whether a plant is abundant because of its adaptation to the site or to the disturbance history. Familiarity with where different associations occur along environmental gradients will aid in making such interpretations. Future work on early seral vegetation will aid in selecting the correct plant association for disturbed sites.

## NOTE: The Key is Not the Classification!

*Before accepting the results of keying out an association, be sure the vegetation and site fit the association description and are consistent with the species tables in Appendix 1.*

### Key to Coniferous Forest Series: Gifford Pinchot National Forest

- 1a Subalpine fir  $\geq 2\%$  cover in understory and  $\geq 10\%$  cover in overstory . . . . . **Subalpine Fir Series**<sup>1</sup>
- 1b Not as above. . . . . **2**
- 2a Mountain hemlock  $\geq 2\%$  cover in understory or  $\geq 10\%$  cover in overstory. . . **Mountain Hemlock Series**<sup>2</sup>
- 2b Not as above. . . . . **3**
- 3a Pacific silver fir  $\geq 2\%$  cover in understory or  $\geq 10\%$  cover in overstory. . . . . **Pacific Silver Fir Series**<sup>3</sup>
- 3b Not as above. . . . . **4**
- 4a Western hemlock  $\geq 2\%$  cover in understory or  $\geq 10\%$  cover in overstory. . . **Western Hemlock Series**<sup>4</sup>
- 4b Not as above. . . . . **5**
- 5a Western redcedar  $\geq 2\%$  cover in understory or  $\geq 10\%$  cover in overstory. . . **Western Redcedar Series** page 35
- 5b Not as above. . . . . **6**
- 6a Grand fir  $\geq 2\%$  cover in understory or  $\geq 10\%$  cover in overstory. . . . . **7**
- 6b Not as above. . . . . **8**
- 7a West of Cascade crest and on alluvial terrace: see Western Hemlock Series Key<sup>4</sup>
- 7b East of Cascade crest or dry upland site on Wind River District. . . . . **Grand Fir Series** page 34
- 8a Douglas-fir  $\geq 2\%$  cover in understory or  $\geq 10\%$  cover in overstory . . . **Douglas-fir Series** page 35
- 8b Not as above: Not part of a coniferous forest Series.

1. Subalpine Fir and Mountain Hemlock Series classification in preparation, available in 1989.

2. See Plant Association and Management Guide for the Pacific Silver Fir Zone, Brockway et al. 1983, for partial Mountain Hemlock Series coverage, or see complete Subalpine Fir and Mountain Hemlock Series classification in preparation.

3. See Plant Association and Management Guide for the Pacific Silver Fir Zone, Brockway et al. 1983.

4. See Plant Association and Management Guide for the Western Hemlock Zone, Topik et al. 1986.

# Key to Plant Associations: Grand Fir (ABGR) Series

## Gifford Pinchot National Forest

1a Big huckleberry (VAME) cover $\geq$ 5%:	2
1b Not as above	3
2a Twinflower (LIBO2) cover $\geq$ 5%: <b>Grand fir/Big huckleberry/Twinflower</b> (ABGR/VAME/LIBO2) CWS2 21	Page 85
2a Twinflower (LIBO2) cover < 5%:	<b>Grand fir/Big huckleberry/Queencup beadlelily</b> (ABGR/VAME/CLUN) ... CWS2 22... Page 89
3a Pinegrass (CARU) cover $\geq$ 2%:	<b>Grand fir/Pinegrass</b> (ABGR/CARU) ... CWG1 23... Page 49
3b Not as above	4
4a Elk sedge (CAGE) cover $\geq$ 2%:	<b>Grand fir/Elk sedge</b> (ABGR/CAGE)... CWG1 22... Page 53
4b Not as above	5
5a Oceanspray (HODI) cover $\geq$ 5%:	<b>Grand fir/Oceanspray</b> (ABGR/HODI)... CWS5 34... Page 61
5b Not as above	6
6a Tall Oregongrape (BEAQ) cover $\geq$ 2%:	<b>Grand fir/Vine maple-Oregongrape/Starflower</b> (ABGR/ACCI-BEAQ/TRLA2) ... CWS5 35... Page 57
6b Not as above	7
7a Sum of Fairybells (DIHO) + Queencup beadlelily (CLUN) cover $\geq$ 5% and also Thimbleberry (RUPA) cover $\geq$ 2%:	<b>Grand fir/Thimbleberry/Fairybells</b> (ABGR/RUPA/DIHO) ... CWS2 23... Page 81
7b Not as above	8
8a Sum of Vanillaleaf (ACTR) + 3-leaved anemone (ANDE) + Starry Solomonplume (SMST) cover $\geq$ 5%	9
8b Not as above	12
9a Western redcedar (THPL) overstory $\geq$ 10% and also regeneration $\geq$ 2%. See Western Redcedar Series Key.	
9b Not as above	10
10a Pacific dogwood (CONU) cover $\geq$ 2%:	<b>Grand fir/Pacific dogwood/Vanillaleaf</b> (ABGR/CONU/ACTR) ... CWS5 37... Page 77
10b Not as above	11
11a California hazel (COCO2) cover $\geq$ 5%:	<b>Grand fir/California hazel/Vanillaleaf</b> ABGR/COCO2/ACTR) ... CWS5 36... Page 69
11b Not as above	12
12a Dwarf Oregongrape (BENE) cover $\geq$ 5%:	<b>Grand fir/Dwarf Oregongrape/Vanillaleaf</b> (ABGR/BENE/ACTR) ... CWS2 24... Page 73
12b Not as above	13
13a Creeping snowberry (SYMO) cover $\geq$ 2%:	<b>Grand fir/Creeping snowberry/Vanillaleaf</b> (ABGR/SYMO/ACTR) ... CWS3 32... Page 65
13b Not as above. Begin key again. This time use lower cover percentages. Use relative cover percentages rather than absolute cover.	

## Key to Plant Associations: Western Redcedar (THPL) Series

### *Gifford Pinchot National Forest*

1a Sum of Vanillaleaf (ACTR) + fairybells (DIHO) + Starry Solomonplume (SMST) cover  $\geq$  5%:

**Western redcedar/Vanillaleaf (THPL/ACTR) . . . CCF2 12 . . . Page 93**

1b Not as above. Try key to other series, especially the Grand Fir Series Key or the Western Hemlock Series Key in Topik et al. 1986.

## Key to Plant Associations: Douglas-fir (PSME) Series

### *Gifford Pinchot National Forest*

1a Western or Bearded Fescue (FEOC or FESU) cover  $\geq$  2% and vine maple (ACCI) cover  $\geq$  5%:

**Douglas-fir/Vine maple/Western fescue (PSME/ACCI/FEOC) . . . CDS2 41 . . . Page 45**

1b Not as above. Try key to other series, especially the Grand Fir Series Key or the Western Hemlock Series Key in Topik et al. 1986.

Table 5. List of plant species common within the Grand fir, Douglas-fir and Western Redcedar Series on the Gifford Pinchot National Forest. See Garrison et al. (1976) for complete lists of species codes and Williams and Lillybridge (1987) or Halverson et al. (1986) for plant identification assistance.

Species Code <sup>1</sup>	Scientific Name	Common Name	Indicator Value
<b>TREES</b>			
ABAM *	<i>Abies amabilis</i>	Pacific silver fir	cool/moist
ABGR *	<i>Abies grandis</i>	Grand fir	
ABLA2 *	<i>Abies lasiocarpa</i>	Subalpine fir	cold
ABPR	<i>Abies procera</i>	Noble fir	cool
ACMA	<i>Acer macrophyllum</i>	Bigleaf maple	
ALRU	<i>Alnus rubra</i>	Red alder	warm/moist
LAOC	<i>Larix occidentalis</i>	Western larch	
PIEN	<i>Picea engelmannii</i>	Engelmann spruce	
PICO	<i>Pinus contorta</i>	Lodgepole pine	
PIMO	<i>Pinus monticola</i>	Western white pine	
PIPO	<i>Pinus ponderosa</i>	Ponderosa pine	dry
POTR	<i>Populus tremuloides</i>	Quaking aspen	moist
POTR2	<i>Populus trichocarpa</i>	Black cottonwood	wet or cool
PSME *	<i>Pseudotsuga menziesii</i>	Douglas-fir	
QUGA *	<i>Quercus garryana</i>	Oregon white oak	dry
TABR	<i>Taxus brevifolia</i>	Pacific yew	
THPL *	<i>Thuja plicata</i>	Western redcedar	moist
TSHE *	<i>Tsuga heterophylla</i>	Western hemlock	warm/moist
TSME *	<i>Tsuga mertensiana</i>	Mountain hemlock	cold
<b>SHRUBS</b>			
ACCI *	<i>Acer circinatum</i>	Vine maple	
ACGLD	<i>Acer glabrum</i> var. <i>douglassii</i>	Rocky mountain maple	warm
AMAL	<i>Amelanchier alnifolia</i>	Serviceberry	warm/dry
ARNE	<i>Arctostaphylos nevadensis</i>	Pinemat manzanita	hot/dry
ARPA	<i>Arctostaphylos patula</i>	Greenleaf manzanita	hot/dry
ARUV	<i>Arctostaphylos uva-ursi</i>	Kinnikinnick	open/dry
BEAQ *	<i>Berberis aquifolium</i>	Tall Oregongrape	warm/dry
BENE *	<i>Berberis nervosa</i>	Dwarf Oregongrape	
BERE	<i>Berberis repens</i>	Creeping hollygrape	hot/dry
CEIN	<i>Ceanothus integerrimus</i>	Deerbrush ceanothus	
CESA	<i>Ceanothus sanguineus</i>	Redstem ceanothus	
CEVE	<i>Ceanothus velutinus</i>	Snowbrush ceanothus	
CHUM	<i>Chimaphila umbellata</i>	Prince's pine	
CHNA	<i>Chrysothamnus nauseosus</i>	Gray rabbitbrush	hot/dry

Species Code <sup>1</sup>	Scientific Name	Common Name	Indicator Value
<u>SHRUBS CONT</u>			
COCO2 *	<i>Corylus cornuta var. californica</i>	California hazel	
CONU *	<i>Cornus nuttallii</i>	Pacific dogwood	
GASH	<i>Gaultheria shallon</i>	Salal	
HODI *	<i>Holodiscus discolor</i>	Oceanspray	warm/dry
LOCI	<i>Lonicera ciliosa</i>	Trumpet honeysuckle	
NONE	<i>Nothochelone nemorosa</i>	Nothochelone	
PAMY	<i>Pachistima myrsinites</i>	Oregon boxwood	
PREM	<i>Prunus emarginata</i>	Bitter cherry	
PUTR	<i>Purshia tridentata</i>	Bitterbrush	hot/dry
RHDI	<i>Rhus diversiloba</i>	Poison oak	warm/dry
RILA	<i>Ribes lacustre</i>	Prickly currant	
RIVI	<i>Ribes viscosissimum</i>	Sticky currant	
ROGY	<i>Rosa gymnocarpum</i>	Baldhip rose	
RONU	<i>Rosa nutkana</i>	Nootka rose	warm/dry
RULA	<i>Rubus lasiococcus</i>	Dwarf bramble	cool/moist
RUPA	<i>Rubus parviflorus</i>	Thimbleberry	
RUUR	<i>Rubus ursinus</i>	Trailing blackberry	
SASC	<i>Salix scouleriana</i>	Scouler willow	burned
SOSI	<i>Sorbus sitchensis</i>	Sitka mountain-ash	
SPBE	<i>Spirea betulifolia</i>	White spirea	
SYAL	<i>Symphoricarpos albus</i>	Common snowberry	
SYMO *	<i>Symphoricarpos mollis</i>	Creeping snowberry	
SYMPH *	<i>Symphoricarpos spp.</i>	Snowberry	
VAME *	<i>Vaccinium membranaceum</i>	Big huckleberry	cool
VAOV	<i>Vaccinium ovalifolium</i>	Oval-leaf huckleberry	cool/moist
VAPA	<i>Vaccinium parvifolium</i>	Red huckleberry	mesic
<u>HERBS</u>			
ACMI	<i>Achillea millefolium</i>	Western yarrow	
ACTR *	<i>Achlys triphylla</i>	Vanillaleaf	mesic
ADBI	<i>Adenocaulon bicolor</i>	Pathfinder	mesic
ALAC	<i>Allium acuminatum</i>	Tapertip onion	warm/dry
ANDE *	<i>Anemone deltoidea</i>	Three-leaved anemone	cool/moist
ANOR	<i>Anemone oregana</i>	Oregon anemone	
ANRA	<i>Antennaria racemosa</i>	Raceme pusseytoes	
AQFO	<i>Aquilegia formosa</i>	Sitka columbine	
APAN	<i>Apocynum androsaemifolium</i>	Dogbane	disturbance

Species Code <sup>1</sup>	Scientific Name	Common Name	Indicator Value
<u>HERBS cont.</u>			
ARCO	<i>Arnica cordifolia</i>	Heartleaf arnica	
ARLA	<i>Arnica latifolia</i>	Mountain arnica	cool
ARMA3	<i>Arenaria macrophylla</i>	Bigleaf sandwort	
CASC2	<i>Campanula scouleri</i>	Scouler's bellflower	
CLLA	<i>Claytonia lanceolata</i>	Springbeauty	
CLUN *	<i>Clintonia uniflora</i>	Queencup beadlely	cool
COPA	<i>Collinsia parviflora</i>	Littleflower collinsia	
COHE	<i>Collomia heterophylla</i>	Varied-leaf collomia	
COUM	<i>Comandra umbellata</i>	Common comandra	
COMA3	<i>Corallorhiza maculata</i>	Spotted coralroot	
DIHO *	<i>Disporum hookeri</i>	Fairy bells	
FRVE	<i>Fragaria vesca</i>	Woods strawberry	
FRVI	<i>Fragaria virginiana</i>	Broadpetal strawberry	
FRLA	<i>Fritillaria lanceolata</i>	Checker lily, mission bells	
GAAP	<i>Galium aparine</i>	Catchweed bedstraw	
GAAS	<i>Galium aspernum</i>	Rough bedstraw	
GATR	<i>Galium triflorum</i>	Sweetscented bedstraw	
GOOB	<i>Goodyera oblongifolia</i>	Rattlesnake plantain	
HAUN	<i>Habenaria unalascensis</i>	Alaska rein-orchid	
HIAL	<i>Hieracium albiflorum</i>	White hawkweed	
HIAL2	<i>Hieracium albertinum</i>	Yellow hairy hawkweed	dry
LALA2	<i>Lathyrus lanszwertii</i>	Thickleaf peavine	
LANE	<i>Lathyrus nevadensis</i>	Nuttall's peavine	
LICO4	<i>Lilium columbianum</i>	Columbia lily	
LIBO2 *	<i>Linnaea borealis</i>	Twinflower	cool
LIGL	<i>Lithophragma glabra</i>	Smooth prairie star	dry
LOTR	<i>Lomatium triternatum</i>	Nineleaf lomatium	dry
LUCA	<i>Lupinus caudatus</i>	Tailcup lupine	
LULE	<i>Lupinus leucophyllus</i>	Velvet lupine	dry
LULA	<i>Lupinus latifolia</i>	Broadleaf lupine	
LUNA2	<i>Luina nardosmia</i>	Silvercrown luina	
DIDI	<i>Mitella diversifolia</i>	Varied-leaved mitella	
NEPA	<i>Nemophila parviflora</i>	Smallflower nemophila	
OSCH	<i>Osmorhiza chilensis</i>	Mountain sweet-cicely	mesic
OSPU	<i>Osmorhiza purpurea</i>	Purple sweet-cicely	moist
PEEU	<i>Penstemon euglaucus</i>	Glaucous penstemon	dry
POGL	<i>Potentilla glandulosa</i>	Gland cinquefoil	
POPU	<i>Polemonium pulcherrimum</i>	Skunk-leaved polemonium	cool
POMU	<i>Polystichum munitum</i>	Swordfern	

Species Code <sup>1</sup>	Scientific Name	Common Name	Indicator Value
<u>HERBS cont.</u>			
PTAQ	<i>Pteridium aquilinum</i>	Bracken fern	
PYPI	<i>Pyrola picta</i>	Whitevein pyrola	
PYSE	<i>Pyrola secunda</i>	Sidebells pyrola	
SADO	<i>Satureja douglasii</i>	Yerba buena	
SMRA	<i>Smilacina racemosa</i>	False solomonseal	mesic
SMST *	<i>Smilacina stellata</i>	Starry solomonseal	moist
TITRU	<i>Tiarella trifoliata</i> var. <i>unifoliata</i>	1-leaved coolwort foamflower	moist
TRLA2 *	<i>Trientalis latifolia</i>	Starflower	
TROV	<i>Trillium ovatum</i>	Trillium	
VASI	<i>Valeriana sitchensis</i>	Sitka valarian	moist
VAHE	<i>Vancouveria hexandra</i>	Inside-out flower	mesic/moist
VIAM	<i>Vicia americanum</i>	American vetch	
VISA	<i>Vicia sativa</i>	Common vetch	
VIGL	<i>Viola glabella</i>	Pioneer violet	cool/moist
VIOR2	<i>Viola orbiculata</i>	Vetch violet	mesic
WISE	<i>Viola sempervirens</i>	Redwoods violet	
XETE	<i>Xerophyllum tenax</i>	Beargrass	cool/dry
<u>GRASSES AND SEDGES</u>			
AGSP	<i>Agropyron spicatum</i>	Bluebunch wheatgrss	hot/dry
BRCA	<i>Bromus carinatus</i>	California brome	hot/dry
BRMO	<i>Bromus mollis</i>	Soft brome	
BRTE	<i>Bromus tectorum</i>	Cheatgrass brome	disturbance
BRVU	<i>Bromus vulgaris</i>	Columbia brome	cool/moist
CARU *	<i>Calamagrostis rubescens</i>	Pinegrass	warm
CAGE *	<i>Carex geyeri</i>	Elk sedge	harsh
ELGL	<i>Elymus glaucus</i>	Blue wildrye	
FEID	<i>Festuca idahoensis</i>	Idaho fescue	warm/dry
FEOC *	<i>Festuca occidentalis</i>	Western fescue	warm/dry
FEOV	<i>Festuca ovina</i>	Sheep fescue, hard fescue	
FESU	<i>Festuca subulata</i>	Bearded fescue	warm/dry
KOCR	<i>Koeleria cristata</i>	Prairie Junegrass	
LUCA2	<i>Luzula campestris</i>	Common woodrush	
LUPA	<i>Luzula parviflora</i>	Small-flowered woodrush	
POBU	<i>Poa bulbosa</i>	Bulbous bluegrass	disturbance
PONE	<i>Poa nervosa</i>	Wheeler bluegrass	
SIHY	<i>Sitanion hystrix</i>	Bottlebrush squirreltail	dry
STOC	<i>Stipa occidentalis</i>	Western needlegrass	hot/dry

\* Species used in the keys to associations and series

<sup>1</sup> See Garrison and others (1976) for complete list of species codes





# Chapter 3

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## Plant Association Descriptions

### Douglas-fir Series

Douglas-fir/Vine maple/Western Fescue .....	45
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### Grand fir Series

Grand Fir/Pinegrass .....	49
Grand Fir/Elk sedge .....	53
Grand Fir/Vine maple-tall Oregongrape/Starflower .....	57
Grand Fir/Oceanspray .....	61
Grand Fir/Creeping snowberry/Vanillaleaf .....	65
Grand Fir/California hazel/Vanillaleaf .....	69
Grand Fir/Dwarf Oregongrape/Vanillaleaf .....	73
Grand Fir/Pacific dogwood/Vanillaleaf .....	77
Grand Fir/Thimbleberry/Fairybells .....	81
Grand Fir/Big huckleberry/Twinflower .....	85
Grand fir/Big huckleberry/Queencup beadleily .....	89

### Western Redcedar Series

Western Redcedar/Vanillaleaf .....	93
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# Explanation of data in the plant association descriptions

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The association descriptions are presented in order approximating a moisture gradient. The dry-site Douglas-fir series association is first, followed by all of the Grand Fir Series (from dry- to moist-site types) and the lone Western Redcedar Series association. Each association description presents similar information.

## Photographs

The photos are intended to give the reader a feel for the overall appearance of a representative stand. Variation in stand appearance is typical within an association. The pictures should be used as examples of the appearance of a site with that association, not as guides to what a site with that association should look like.

## Environment and distribution

The plot location maps include all plots, reconnaissance and intensive. The precipitation values are estimates for each plot derived from the statewide isohyetal map (see Figure 3) and so are rough approximations. The other values are based on all study plots within the association.

## Vegetation: structure and composition

The discussion and dominant vegetation table are based on all study plots within the association. The codes are from Garrison et al. (1976). Per cent cover (%Cov) is the mean cover for that species calculated only for those plots within the association where the species was present (hence, zero values are excluded from the averaging). Constancy ("Cons") is the percent of the plots within the association where that species was present.

## Timber productivity and management

These data (mean and standard error of the mean, s.e.) are based only on intensive plots. One exception is the use of reconnaissance plot data for the Grand Fir/Pinegrass association because we lack intensive plots there. Site index curves used are Curtis (1974) for Douglas-fir, Barrett (1978) for ponderosa pine, and Cochran (1979) for grand fir. The latter is a 50 year base curve whereas the former two curves are indexed to age 100. Growth basal area (Hall 1988) is an index of basal area growth and stockability. It is defined as that basal area at which dominant trees will grow one inch in diameter per decade at age 100. Ten year radial growth is the most recent decadal growth, in tenths of inches, of our site trees which are representative of the best growth on the plot. Yield capacity is an index of potential maximum productivity at culmination of mean annual incre-

ment. It is based on equations from the Region 6 stand exam handbook. SDI growth estimate is another estimate of maximum timber productivity at culmination which is based on site index and stocking, using the stand density index (SDI) of the plot. The trees per acre data are based on 5 variable radius plots per intensive plot and include all trees greater than 1 inch DBH. Reineke's stand density index of stocking is defined as the number of 10 inch DBH trees required to equal the average stand basal area (Reineke 1933). The bar graphs of live basal area use the tree codes from Garrison (1976) which are also listed in Table 5. The tree codes are listed in order approximating an elevation gradient. These values are based on the 5 variable radius plots on each intensive plot within the association.

## Wildlife, Range and Fuels

The snag data were tabulated from 3 variable radius basal area plots on each intensive plot within the association. Only snags greater than 10 inches DBH and greater than 10 feet tall were measured. Because down woody material and fine fuels data were collected on only a subset of our plots, these data are presented only for plant association groups in Chapter 1.

## Soils

The soils information comes from the 1983 intensive plot sampling. Effective soil depth is an index of the soil volume usable by roots. It is calculated by discounting the depth of the soil profile by the proportion occupied by coarse fragments ( $\geq 2$  mm).

## Similar associations

This section contrasts the similar associations in this guide and indicates the affinity to associations and habitat types in the literature.



**Douglas-fir/Vine maple/Western fescue**  
*Pseudotsuga menziesii*/*Acer circinatum*/*Festuca occidentalis*  
 PSME/ACCI/FEOC CDS2 41

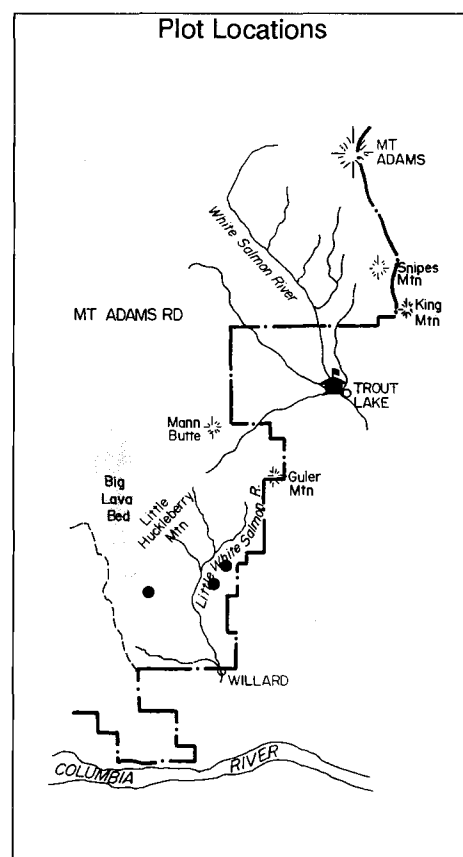


## Environment and Distribution

This association is found on hot and dry sites, primarily in the Little White Salmon River drainage. The effectively dry environment is enhanced by the presence of south or west aspects. These sites occupy ridges and upper slopes having steep, shallow soils. These sites have a limited distribution within the National Forest, but are more common on neighboring areas to the south and west of the Little White Salmon River drainage. Precipitation as snow is minor; it is likely that much of what does fall may be blown off these exposed sites.

	Range	Average
Elevation (ft):	2040-2160	2100
Precipitation (in/yr):	63-70	66
Slope (%):	40-73	61

Number of Plots:	3 (Intensive = 2)
Common Aspects:	West and South
Topographic Positions:	Ridgetops and Upper Slopes



PSME/ACCI/FEOC

## Vegetation: Structure and Composition

A wide variety of dry-site shrubs and the presence of grasses, even in closed forests, are the distinguishing characteristics of this association. The overstory is virtually entirely Douglas-fir, although grand fir does occur as occasional individuals. The understory tree layer includes scattered grand fir (ABGR) as well as big-leaf maple (ACMA) and Oregon white oak (QUGA). The grand fir seedlings and saplings are so sparse that we feel that sites having this association will remain dominated by Douglas-fir even in later seral stages. The shrub layer is particularly diverse and abundant. Dry-site shrubs commonly include serviceberry (AMAL), California hazel (COCO2), oceanspray (HODI), creeping snowberry (SYMO) and white spirea (SPBE). Two other less common species are excellent hot-site indicators: tall Oregongrape (BEAQ) and Rocky Mountain maple (ACGLD). Vine maple, dwarf Oregongrape (BENE) and baldhip rose (ROGY) are all abundant within this association. The herb layer is rarely very thick but it includes these dry-site indicators: western fescue (FEOC), Columbia brome (BRVU), bigleaf sandwort (ARMA3), white hawkweed (HIAL), and Pacific peavine (LAPO). A variety of other grasses or even elk sedge (CAGE) are also commonly found.

### Dominant Vegetation

	Code	%Cov	Cons
<b>Overstory Trees</b>			
Douglas-fir	PSME	58	100
Grand fir	ABGR	2	33
<b>Understory Trees</b>			
Grand fir	ABGR	1	66
Bigleaf maple	ACMA	1	33
Oregon white oak	QUGA	1	33
<b>Shrubs</b>			
Vine maple	ACCI	6	100
California hazel	COCO2	6	100
Creeping snowberry	SYMO	12	100
Baldhip rose	ROGY	4	100
Dwarf Oregongrape	BENE	3	100
Serviceberry	AMAL	2	66
Oceanspray	HODI	3	66
Tall Oregongrape	BEAQ	1	33
Redstem ceanothus	CESA	1	33
<b>Forbs</b>			
Bigleaf sandwort	ARMA3	3	100
Starflower	TRLA2	2	100
White hawkweed	HIAL	1	100
Pacific peavine	LAPO	50	33
Broadleaf lupine	LULA	1	33
<b>Grasses &amp; Sedges</b>			
Western fescue	FEOC	3	66
Columbia brome	BRVU	2	66

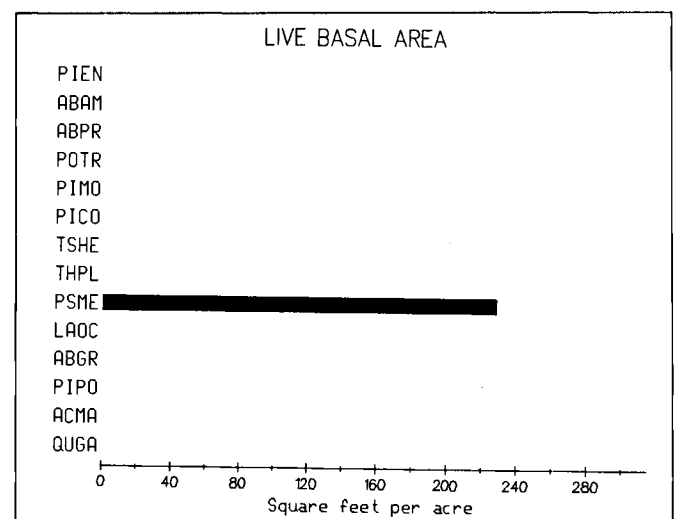
PSME/ACCI/FEOC

## Timber Productivity and Management

Sites having this association have relatively low productivity and generally support low timber stocking. Site index for Douglas-fir and growth basal area (GBA, Hall 1988) are both lower for this association than in the Grand Fir series. Stocking guidelines for managed stands should reflect the lower natural stockability of this association. The extremely hot environments make reforestation of clearcuts difficult. Timber management activities need to focus on these droughty conditions and use combinations of harvest methods and planting strategies to shade young seedlings. Shelterwood harvest systems are a particularly useful manner to achieve partial shading of seedlings as well as encourage establishment trees having genotypes adapted to these specialized, hot environments. Although Douglas-fir are the most useful species to plant, these sites will support excellent growth of ponderosa pine as well.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PSME	100	114	6	261	8	11	1

Yield Capacity		SDI Growth Estimate		Trees per Acre		Stand Density Index (SDI)	
ft <sup>3</sup> /ac/yr		ft <sup>3</sup> /ac/yr		#		trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
117	9	64	-	97	-	297	-



## Wildlife, Range and Fuels

Sites having this association provide important winter range for big-game. Sites typically stay snow-free and have abundant browse, forage and hiding cover for deer and elk. These ridge habitats likely are important travel routes for other wide ranging wildlife species, such as bears. The warm environment causes earlier spring plant growth than most other nearby sites, hence this association has great local importance for a wide variety of wildlife. Following timber harvest, shrubs sprout back vigorously, providing high quality and quantity browse as transitory range. Herbs and grasses normally proliferate as well. Winter range forage seeding is likely to make reforestation difficult. Sites in this association have little livestock range value. Both snags and down logs were less abundant in this association than in any of those of the Grand Fir Series. All of the snags in our sample plots were Douglas-fir. Slash burns should be avoided or carefully monitored to remain cool because these sites benefit greatly from the soil-holding and moisture-retaining properties of rotten logs

Snags - Number/Acre    n=2					
Total/ Acre	Condition Class				
	1	2	3	4	5
4	0	4	0	0	0

## Soils

This association represents an edaphic climax where the shallow soils and south aspects lead to effectively dry sites. Our lone soil pit had a very low effective rooting depth reflecting its skeletal, rocky composition. The sandy loam textured soil also leads to low moisture holding capacity for this soil, despite it forming from breccias which, in lower slope positions, often have deep, fine-textured soils.

Number of Soil Pits:	1
Effective Soil Depth (cm):	30
Soil Surface Texture:	Sandy loam
Parent Materials:	breccias

## Similar Associations

This association is distinguished from others on the Gifford Pinchot National Forest by the near absence of either western hemlock or grand fir. This indicates long term Douglas-fir domination even in the absence of disturbance. Floristics and management are most similar to other Douglas-fir climax associations such as those described on the Willamette National Forest (eg. PSME/HODI/Grass, Hemstrom et al. 1987) and the rain-shadow side of the Olympic National Forest (eg. PSME/HODI-ROGY, Henderson and Peter 1983). This association has much more vine maple and higher timber productivity than the Douglas-fir/Western fescue association common on the eastern portion of the Mt. Hood National Forest (Topik et al. 1988). No similar types have been described in Rocky Mountain areas or eastern Oregon and Washington.





## Grand fir/Pinegrass

*Abies grandis*/*Calamagrostis rubescens*

ABGR/CARU

CWG1 23

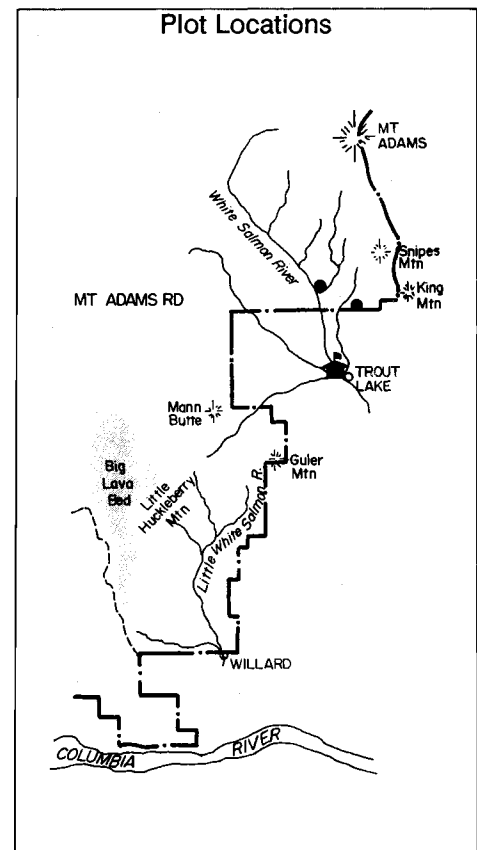


## Environment and Distribution

This association is restricted to some of the hottest and driest forested sites on the south flank of Mount Adams. Our plots for this association are near the Forest boundary north of Trout Lake, though this association also occurs in the Little White Salmon River drainage to a limited extent. Sites are usually fairly flat, occupying broad ridgetops or benches. South and west aspects are typical.

	Range	Average
Elevation (ft):	2750-3600	3175
Precipitation (in/yr):	57-68	63
Slope (%):	5-15	10

Number of Plots:	2
Common Aspects:	South and West
Topographic Positions:	Ridges, Benches



ABGR/CARU

## Vegetation: Structure and Composition

This association includes the best sites for ponderosa pine on the Gifford Pinchot National Forest. Large "yellow bellies" are common, and even some saplings and seedlings are found within mature stands. Overstory canopies are fairly open and include equal amounts of Douglas-fir and grand fir along with lesser amounts of ponderosa pine. Grand fir seedlings are common and abundant and may be accompanied by seedlings of Douglas-fir or even a few Oregon whiteoak. The shrub layer is very patchy and may include scattered dense patches of oceanspray (HODI) or California hazel (COCO2). The few Scouler's willows (SASC) found are remnant reminders of hot fires earlier this century. Other shrub species present, which also indicate hot and dry climates, include tall Oregongrape (BEAQ) and common snowberry (SYAL). The herb layer is clearly dominated by grasses, especially the dense swards of pinegrass (CARU). Several other grasses, as well as elk sedge (CAGE), are also common. Forbs are sparse. Bingleaf sandwort (ARMA3) and white hawkweed (HIAL) are good dry-site indicators which also happen to be the most abundant forbs we encountered within this association.

### Dominant Vegetation

	Code	%Cov	Cons
<b>Overstory Trees</b>			
Douglas-fir	PSME	13	100
Grand fir	ABGR	11	100
Ponderosa pine	PIPO	11	100
<b>Understory Trees</b>			
Grand fir	ABGR	4	100
Ponderosa pine	PIPO	8	50
Douglas-fir	PSME	2	50
Oregon white oak	QUGA	1	50
<b>Shrubs</b>			
Creeping snowberry	SYMO	4	100
Baldhip rose	ROGY	1	100
Oceanspray	HODI	10	50
California hazel	COCO2	6	50
Tall Oregongrape	BEAQ	1	50
Common snowberry	SYAL	5	50
Scouler willow	SASC	5	50
<b>Forbs</b>			
Bingleaf sandwort	ARMA3	2	100
Vanillaleaf	ACTR	1	100
White hawkweed	HIAL	1	100
Bracken fern	PTAQ	3	50
<b>Grasses &amp; Sedges</b>			
Pinegras	CARU	11	100
Elk sedge	CAGE	10	50
Idaho fescue	FEID	1	50
Prairie Junegrass	KOCR	1	50
Blue wildrye	ELGL	1	50

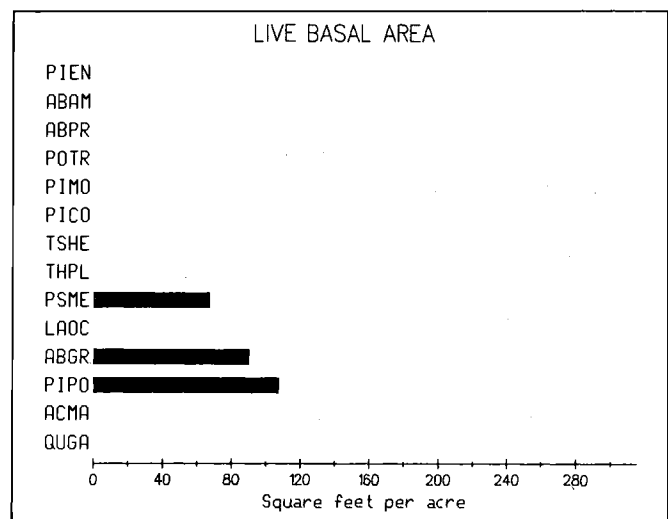
ABGR/CARU

## Timber Productivity and Management

Our sample size is very small because this association is so limited in distribution on the Gifford Pinchot National Forest. The mature stands we sampled have both good stocking and height growth. Ponderosa pine grows very well and this species is an excellent reforestation choice because of its resistance to drought. Douglas-fir grows well also, but its establishment is likely to be much more difficult. The mix of ponderosa pine, Douglas-fir and grand fir observed on our sample plots is a mix which maximizes site production because each of these species utilizes a slightly different portion of the site's light and soil resources.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	103	6	465	3	17	3
PSME	100	146	7	562	1	28	6
ABGR	50	99	-	641	-	26	-

Yield Capacity ft <sup>3</sup> /ac/yr		SDI Growth Estimate ft <sup>3</sup> /ac/yr		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
161	10	-		-		-	



## Wildlife, Range and Fuels

Sites in this association have high winter range value and they provide large amounts of browse year-around. Although the pinegrass has low nutritional value, its abundance and availability throughout the year can make it important for ungulates when other forage is unavailable. Acorns from the Oregon whiteoaks are excellent food for deer, squirrels, and other wildlife. Following site disturbance, such as timber harvesting, shrubs, herbs and the pinegrass will rapidly revegetate the site and provide highly valuable transitory range for both wildlife and livestock. Forage seeding for winter range is usually not needed. If reforestation is a site goal, forage seeding should be avoided or lightly applied and carefully monitored. Mature stands have low livestock range value. We lack data on snags and down woody material for this association. Broadcast burns and widespread operation of heavy machinery for slash piling should be avoided because these dry sites need the moisture-holding and water infiltration help provided by down logs, intact litter layers and uncompacted soils..

## Soils

We lack soil data for this association.

## Similar Associations

This association is similar to Grand fir/Elk sedge on the Gifford Pinchot National Forest but has substantial pinegrass, higher ponderosa pine abundance and greater abundance of dry-site species, such as Oregon white oak. The Grandfir/Elk sedge association on the eastern portion of the Mt. Hood National Forest (Topik et al. 1988) has much lower timber productivity. A very similar-Grand fir/Pinegrass association has been described from the adjacent Yakima Indian Reservation (John et al. 1988) and also in the Blue Mountains (Hall 1988). Sites having analogous floras, but more severe management restrictions, have been described in the Douglas-fir Series in both northern Washington and Idaho (Williams and Lillybridge 1983; Cooper et al. 1987), Montana (Pfister et al. 1977) and other Rocky Mountain areas.



## Grand fir/Elk sedge

*Abies grandis*/*Carex geyeri*

ABGR/CAGE-GP

CWG1 22

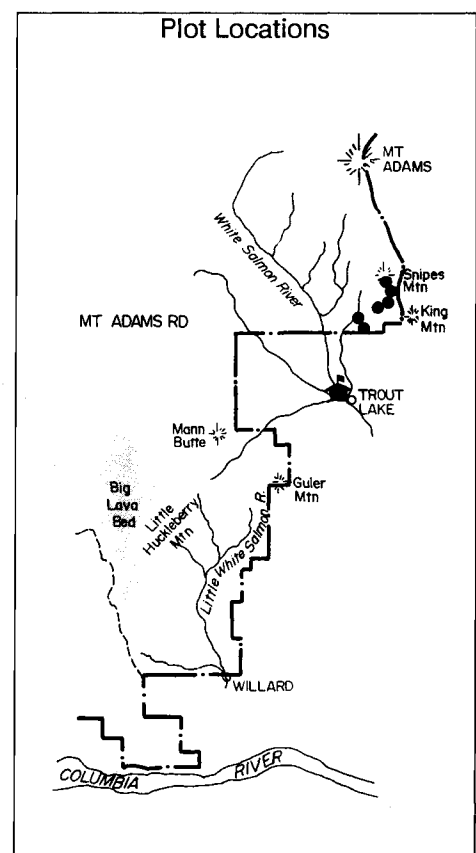


## Environment and Distribution

The extreme eastern corner of the Gifford Pinchot National Forest is the most common site for this association. These sites are dry and hot and also experience cold winters and relatively short growing seasons. Snow packs typically accumulate each winter but melt off in early spring. Our plots were usually on fairly flat ground, often on benches or broad ridgetops. South and west aspects are the rule. This combination of environmental features coupled with the relatively low (for this National Forest) annual precipitation makes sites with this association some of the harshest which support closed forest stands on the Gifford Pinchot National Forest.

	Range	Average
Elevation (ft):	2920-4000	3610
Precipitation (in/yr):	57-68	62
Slope (%):	2-34	14

Number of Plots:	6 (Intensive = 6)
Common Aspects:	South and West
Topographic Positions:	Flats, Upper Slopes



ABGR/CAGE-GP

## Vegetation: Structure and Composition

This association includes a variety of species characteristic of dry forests. The mature forest stands are generally dense and closed. Grand fir dominates, but Douglas-fir is often similarly abundant. Ponderosa pine is frequent, but never very abundant. Several of our plots within this association had many lodgepole pine which colonized following hot fires earlier this century. The understory tree layer always includes grand fir. The shrub layer is usually sparse or patchy. Low shrubs, such as creeping snowberry (SYMO) and baldhip rose (ROGY), are often present in small amounts. The most common tall shrub is California hazel (COCO2), but small patches of vine maple (ACCI) or Rocky Mountain maple (ACGLD) also occur. The herb layer is clearly dominated by elk sedge (CAGE). It usually occurs as widespread patches, but in some areas it can form a virtual turf. Grasses are found in small amounts, as are quite a variety of forbs. Elk sedge abundance increases with site disturbance. Use the association key carefully where slight disturbance has enhanced elk sedge abundance but the abundance of vine maple, oceanspray or more mesic-site indicating herbs (e.g. vanillaleaf) indicates associations.

### Dominant Vegetation

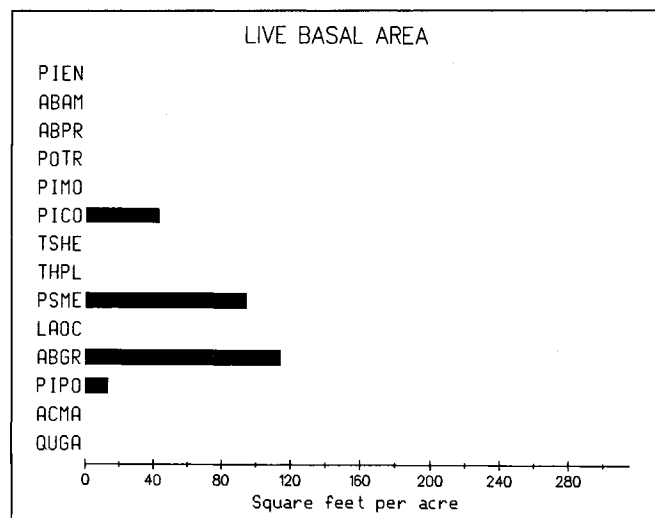
	Code	%Cov	Cons
<b>Overstory Trees</b>			
Grand fir	ABGR	33	100
Douglas-fir	PSME	30	66
Ponderosa pine	PIPO	3	66
Lodgepole pine	PICO	20	33
<b>Understory Trees</b>			
Grand fir	ABGR	5	100
Lodgepole pine	PICO	15	16
Subalpine fir	ABLA2	2	16
<b>Shrubs</b>			
Creeping snowberry	SYMO	2	83
California hazel	COCO2	12	50
Baldhip rose	ROGY	2	66
<b>Forbs</b>			
Sidebells pyrola	PYSE	2	83
White hawkweed	HIAL	1	83
Starry Solomonseal	SMST	3	50
<b>Grasses &amp; Sedges</b>			
Elk sedge	CAGE	7	100
Idaho fescue	FEID	5	16

## Timber Productivity and Management

Considering the relative harshness of sites supporting this association, timber production is high. Our samples are well-stocked stands having a mix of grand fir and Douglas-fir, with a few scattered ponderosa pine. One sample plot is a lodgepole pine-dominated site which established following a hot wildfire. Before the advent of fire suppression, it is likely that these sites supported primarily fairly open stands of ponderosa pine with lesser amounts of Douglas-fir. Volume productivity is maximized by the present mix which includes grand fir, but these stands are quite susceptible to various root rot diseases. Management which minimizes the role of grand fir is likely to lead to higher future timber values. Silvicultural systems should maximize shading for regeneration, either from shelterwood cuts or small clearcuts. Reforestation can rely on mixtures of ponderosa pine and Douglas-fir, with emphasis on the former because of the dry nature of these sites.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	98	5	252	14	10	5
PSME	100	141	14	486	63	22	3
ABGR	50	92	6	509	97	21	5

Yield Capacity ft <sup>3</sup> /ac/yr		SDI Growth Estimate ft <sup>3</sup> /ac/yr		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
155	20	126	45	254	37	368	56



## Wildlife, Range and Fuels

Most of our forests in this association have dense coniferous canopies and low production of browse and forage. Elk sedge is one exception: it can provide some important nutrition when other more palatable grass and herbs are unavailable in early spring. Few stands provide winter range, although the dense canopies can provide important thermal cover for big game. It is likely that the fairly uniform forest canopy and flora in mature stands does not support a very diverse fauna. Disturbed sites, such as clearcuts, provide a wider variety of vegetation as transitory range and hiding cover. In some sites, especially where frost pockets or compacted soils slow tree growth, elk sedge can form a virtual turf, precluding formation of a diverse flora. Forage seeding may increase the abundance of transitory range for both wildlife and livestock. Mature stands have low livestock range value because of low forage quality and abundance. Where reforestation is the primary site goal following timber harvest, forage seeding should be lightly applied or applied in patches near unit edges where big game use is highest. Pocket gophers may be quite abundant in many sites having this association. It is likely that forage seeding will enhance gopher populations, making yet another problem for reforestation of these fairly harsh sites. Although both snags and down dead wood were abundant in our samples, the snags were nearly all grand fir, a species with low value for cavity dwellers. Slash disposal should avoid destroying the protective forest floor layers and avoid soil compaction which lowers soil moisture holding capacity.

Snags - Number/Acre n = 6					
Total/ Acre	Condition Class				
	1	2	3	4	5
30	5	8	9	7	0

## Soils

Many soils on sites having this association are relatively shallow, primarily weathered ash and have low rock and stone composition. One sample having a deep soil brought the association average effective rooting depth up to a value typical for the Grand Fir Zone. Because sites are generally fairly flat, heavy machines are easily operated. Yet, the prevalent ashy soils are easily compacted when moist. Considerable care should be exercised to avoid soil compaction from tractor logging or slash piling which would further reduce moisture-holding capacity and rooting penetration.

Number of Soil Pits:	4
Effective Soil Depth (cm):	80
Soil Surface Texture:	Sandy loams
Parent Materials:	Andesites with ash

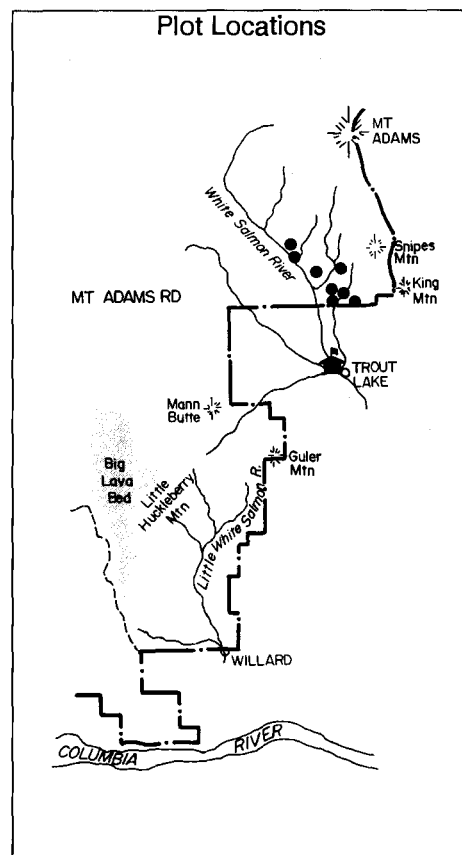
## Similar Associations

This association differs from other dry-site Grand Fir Series associations on the Gifford Pinchot National Forest by its paucity of tall shrubs (eg. vine maple, oceanspray) or pinegrass. The Grand fir/Elk sedge association on the eastern portion of the Mt. Hood National Forest has such substantially lower timber productivity that it is distinct (Topik et al. 1988). Floristically similar types have also been described from the Yakima Indian Reservation (ABGR/CAGE, John et al. 1988) and the Warm Springs Indian Reservation (Mixed Conifers/SYMPH/CAGE, Marsh et al. 1987). Plant community analyses from Rocky Mountain areas (eg. Cooper et al. 1987; Pfister et al. 1977), eastern Oregon (Hall 1988; Volland 1985), and eastern Washington (Williams and Lillybridge 1983) lack analogous types in the Grand Fir Series.





**Grand fir/Vine maple-tall Oregongrape/Starflower**  
*Abies grandis/Acer circinatum-Berberis aquilifolium/Trientalis latifolia*  
 ABGR/ACCI-BEAQ/TRLA2 CWS5 35



## Environment and Distribution

This association is widespread on hot, dry, low elevation sites on the south flank of Mount Adams. It also occurs a bit in the Little White Salmon River drainage. The effective dryness of these sites is enhanced by the predominant south or west aspects and the prevalence of ridge-top or upper slope positions. When not found on a ridgetop, sites having this association are usually quite steep.

	<u>Range</u>	<u>Average</u>
Elevation (ft):	2550-3140	2879
Precipitation (in/yr):	58-82	69
Slope (%):	0-55	18
Number of Plots:	8 (Intensive = 8)	
Common Aspects:	South and West	
Topographic Positions:	Flats, Upper Slopes	

## Vegetation: Structure and Composition

This association is rich in species (particularly shrubs) characteristic of lower elevation, hot, dry environments. Canopies contain predominantly Douglas-fir and grand fir. Ponderosa pine often form a conspicuous and important part of the overstory. Sites in this association are among the best for ponderosa pine on the Gifford Pinchot National Forest. The regeneration layer is entirely grand fir. Tall shrubs are very prominent, with dense, tall patches of vine maple (ACCI) occurring in nearly all mature forest stands. California hazel (COCO2) is also an abundant tall shrub on these sites. Small patches of oceanspray (HODI) were found on half of our plots. Low shrubs are very diverse and usually form a discrete layer. Tall Oregongrape (BEAQ) is a key indicator of hot, low elevation sites. Other species in this low shrub layer include creeping snowberry (SYMO), boxwood (PAMY), baldhip rose (ROGY), trailing blackberry (RUUR) and thimbleberry (RUPA). The herb flora is also diverse and some sites forms a nearly continuous layer. Starflower (TRLA2) is rarely very abundant, but it grows sparsely on nearly all sites having this association. Vanillaleaf (ACTR), twinflower (LIBO2) and starry Solomonseal (SMST) can all be present in large amounts. Many other herbs and even small amounts of grasses are usually found.

### Dominant Vegetation

	Code	%Cov	Cons
<b>Overstory Trees</b>			
Douglas-fir	PSME	31	100
Grand fir	ABGR	22	100
Ponderosa pine	PIPO	9	62
<b>Understory Trees</b>			
Grand fir	ABGR	5	100
<b>Shrubs</b>			
Vine maple	ACCI	17	100
Tall Oregongrape	BEAQ	2	100
Creeping snowberry	SYMO	6	100
California hazel	COCO2	4	87
Baldhip rose	ROGY	3	87
Oregon boxwood	PAMY	2	87
<b>Forbs</b>			
Starflower	TRLA2	2	100
Vanillaleaf	ACTR	11	75
Bigleaf sandwort	ARMA3	2	75
Starry solomonseal	SMST	3	75
Twinflower	LIBO2	17	50
White vein pyrola	PYPI	1	100
White hawkweed	HIAL	2	75
Oregon anemone	ANOR	2	50

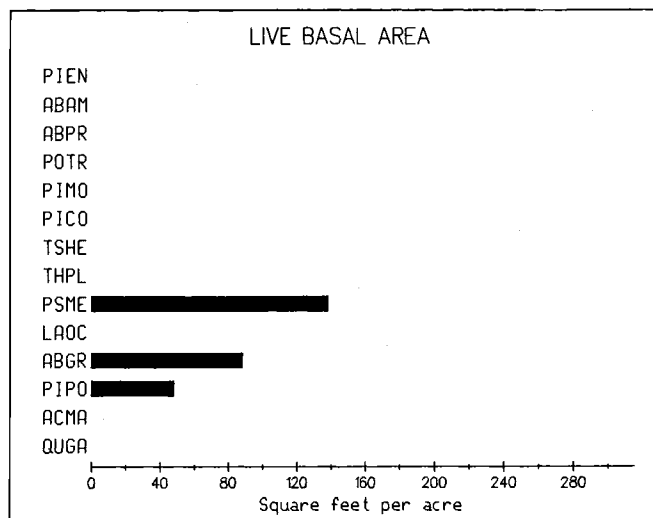
ABGR/ACCI-BEAQ/TRLA2

## Timber Productivity and Management

High timber productivity in established stands and drought-related regeneration problems are prevalent characteristics of this association. Douglas-fir dominates existing stands. Ponderosa pine is also abundant and achieves its highest average site index on the Forest in this association, as does grand fir. Grand fir generally became established beneath the Douglas-fir and ponderosa pine overstories. The grand fir in unmanaged stands is usually 20 years younger than the other two overstory species. Before fire suppression, grand fir was probably a much less important component of these stands. Silvicultural systems should emphasize shade, either through the use of patch cuts in scenic areas, or shelterwoods and small clearcuts elsewhere. Planting a mix of Douglas-fir and ponderosa pine provides good chances of reforestation success. These sites are probably too hot and dry for successful establishment of western larch. This association offers excellent opportunities for ponderosa pine management for timber, scenic and wildlife benefits. Ponderosa pine provides the greatest assurance of successful plantation establishment as well as high value, long-term timber production. This association is common at the low elevation gateways to the Mt. Adams recreation area where ponderosa pine

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	118	2	298	119	7	4
PSME	100	147	5	473	40	20	2
ABGR	50	102	6	461	52	18	2

Yield Capacity		SDI Growth Estimate		Trees per Acre		Stand Density Index (SDI)	
ft <sup>3</sup> /ac/yr		ft <sup>3</sup> /ac/yr		#		trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
163	7	162	17	257	50	426	35



forms an important part of the scenic qualities sought by Forest visitors. Live and dead ponderosa pine provide nesting habitat and food for many wildlife species.

## Wildlife, Range and Fuels

Sites in this association provide important winter range and high quality habitat for deer and elk. The diverse flora and stand characteristics also suggests that these sites provide excellent habitat for a wide variety of wildlife. Rapid revegetation of logged sites provides abundant browse and forage for both wildlife and live-stock. The rapid regrowth of dense vine maple shortens the time during which transitory range has much live-stock value. Mature stands are non-range for livestock because of low forage abundance and quality. Seeding legumes and grasses can enhance the quantity and quality of winter range forage. These sites are sufficiently moisture-limited that seeding should be lightly applied and carefully monitored if conifer re-establishment is desired. The snags present on our sample plots include primarily Douglas-fir, but there are also many grand fir and ponderosa pine. The Douglas-fir and ponderosa pine snags provide important habitat for a wide variety of primary cavity dwellers. This association offers particularly good opportunities for long-term maintenance of ponderosa pine populations on the Gifford Pinchot National Forest. Our samples had a very large number of down, dead logs but they were primarily small so the total weight was just average for the Grand Fir Series. Fuels managers should attempt to leave as much down wood on site as possible because these dry sites benefit greatly from the moisture-holding properties of well-rotted wood.

Snags - Number/Acre n = 8					
Total/ Acre	Condition Class				
	1	2	3	4	5
18	3	1	11	2	2

## Soils

Our soil samples for this association were generally deep, non-rocky weathered ash on basalt or andesite. The effective rooting depth of 92 cm is among the highest in the Grand Fir Zone, and the highest of any Grand Fir Series association restricted to the south flank of Mt. Adams. Because sites with this association receive about the lowest precipitation on the Forest, soil and organic matter management is important. Avoiding compaction and preserving duff and large woody debris will help to maintain soil water infiltration rates, protect the insulation and evaporation reduction functions of the duff, and maintain the shade and high moisture-holding capacity of rotten logs.

Number of Soil Pits:	4
Effective Soil Depth (cm):	80
Soil Surface Texture:	Sandy loams
Parent Materials:	Andesites with ash

## Similar Associations

This association differs from other warm-site Grand fir Series types on the Gifford Pinchot National Forest by its abundance of various shrubs (vine maple, California hazel) and the presence of tall Oregon grape. Mesic-site indicating herbs, such as vanillaleaf, twinflower and starflower, are more abundant than in dryer-site associations (Grand fir/Pinegrass and Grand fir/Elk sedge). The Grand fir/Vine maple/Vanillaleaf association on the eastern portion of the Mt. Hood National Forest (Topik et al. 1988) is slightly similar to this type, as are the Grand fir/Vine maple associations described from the Yakima and Warm Springs Indian Reservations (John et al. 1988; Marsh et al. 1987).



**Grand fir/Oceanspray**  
*Abies grandis/Holodiscus discolor*-GP  
 ABGR/HODI-GP CWS5 34

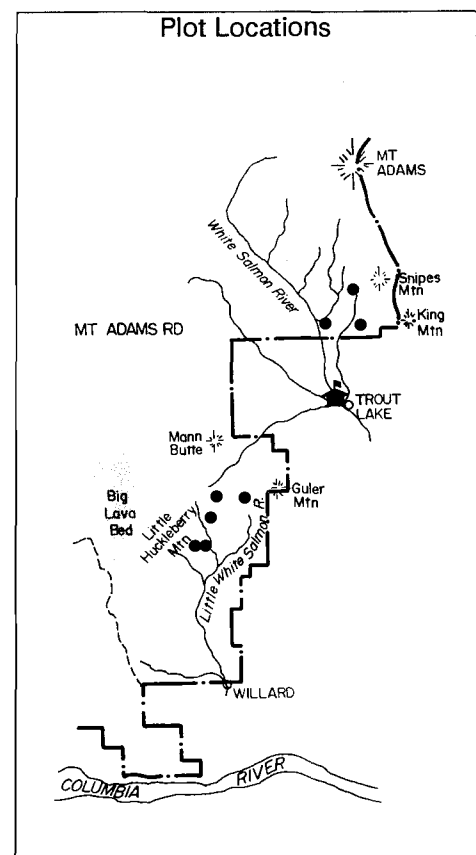


## Environment and Distribution

This association is common on exposed, south-facing slopes in the Little White Salmon River drainage and on similar sites near the Forest boundary on the south side of Mount Adams. These sites are usually either on ridgetops or on adjacent, steep slopes. Though precipitation is similar to other parts of the Grand Fir Zone, the topographic positions and south or west-facing aspects lead to effectively dry environments. Sites having this association remain snow-free much of the year and probably experience extensive summer drought.

	Range	Average
Elevation (ft):	2500-3625	2912
Precipitation (in/yr):	57-72	64
Slope (%):	5-70	37

Number of Plots:	8 (Intensive = 8)
Common Aspects:	South
Topographic Positions:	Ridgetops, Upper Slopes



ABGR/HODI-GP

## Vegetation: Structure and Composition

Douglas-fir forests with fairly open canopies and dense patches of oceanspray (HODI) characterize sites having this association. The overstory also has smaller amounts of grand fir, ponderosa pine, Oregon white oak or even western larch. Grand fir dominates the understory tree layer, though occasional Douglas-fir or white oak regenerate where light is sufficient. Shrub cover can be extensive, especially with tall species such as oceanspray (HODI), California hazel (COCO2), vine maple (ACCI) or serviceberry (AMAL). Many species of low shrubs are commonly encountered, especially creeping snowberry (SYMO) and baldhip rose (ROGY). A variety of forbs and grasses occur sparsely, and in some locales grasses dominate the herb layer.

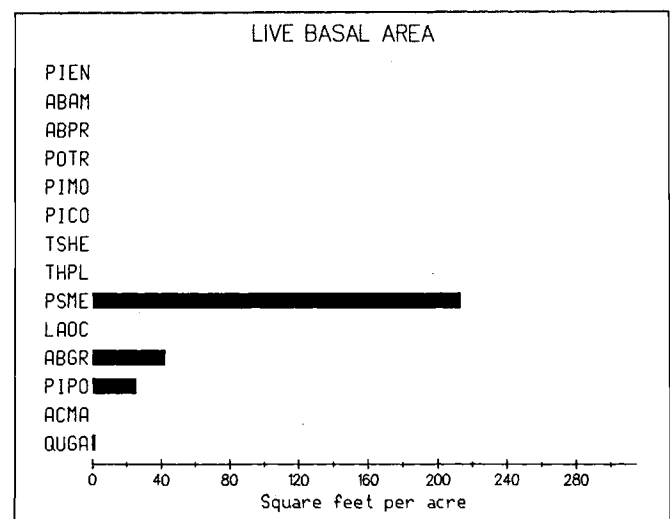
Dominant Vegetation			
	Code	%Cov	Cons
<b>Overstory Trees</b>			
Douglas-fir	PSME	43	100
Grand fir	ABGR	18	50
Ponderosa pine	PIPO	11	37
Oregon white oak	QUGA	3	25
Western larch	LAOC	1	12
<b>Understory Trees</b>			
Grand fir	ABGR	7	75
Douglas-fir	PSME	2	37
Oregon white oak	QUGA	4	25
<b>Shrubs</b>			
Oceanspray	HODI	15	100
Baldhip rose	ROGY	6	100
Creeping snowberry	SYMO	9	87
California hazel	COCO2	17	62
Vine maple	ACCI	9	62
Serviceberry	AMAL	3	50
<b>Forbs</b>			
Starflower	TRLA2	2	87
Bigleaf sandwort	ARMA3	3	75
Vanillaleaf	ACTR	4	50
White hawkweed	HIAL	2	62
<b>Grasses &amp; Sedges</b>			
Miscellaneous grass		22	62

## Timber Productivity and Management

Timber height growth and stockability are lower in this association than in most of the Grand Fir Zone. The hot, drought-prone environment should be the major consideration in planning timber management activities. This is the only Grand Fir Series association where ponderosa pine had a higher average site index than Douglas-fir. Any treatment which reduces soil moisture should be avoided. This includes soil compaction and destruction of soil organic matter (including litter layers). Hot broadcast burns eliminate soil surface organic matter which enhances soil water infiltration, reduces evaporative loss, and even holds some moisture. Grass seeding also may adversely affect plantation establishment in sites with this association by competing with tree seedlings for moisture. Shade maximizing silvicultural treatments warranted in this association include shelterwood cuts, small patch cuts, clearcuts designed to cast shade, seedling shade cards and use of drought-tolerant species (ponderosa pine). Douglas-fir may also be planted in the mix with ponderosa pine, but other more moisture demanding species, such as western larch, will likely be difficult to establish.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	113	9	226	62	11	2
PSME	100	112	11	339	32	13	3
ABGR	50	91	8	358	93	22	8

Yield Capacity ft <sup>3</sup> /ac/yr		SDI Growth Estimate ft <sup>3</sup> /ac/yr		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
114	15	106	17	266	55	413	34



## Wildlife, Range and Fuels

The fairly brushy stands typical for this association remain snow-free for much of the year. Mature stands have relatively open canopies allowing a substantial understory grass cover. This provides highly valuable winter range for a wide variety of wildlife. Shrubs sprout back vigorously after site disturbance such as timber harvest. The native vegetation will provide high quantity and quality transitory range for wildlife and livestock for at least 10 years after logging. Forage seeding is probably not needed in most instances. If applied, forage seeding should be light and patchy because sites in this association are difficult to reforest. Our sample plots had fewer snags than any other Grand Fir Series association, but many of the snags were ponderosa pine or Douglas-fir, both species which have high value and longevity for cavity nesting wildlife. Down woody material may also be sparse. Its protection is especially important in this association because the down logs can help stabilize steep slopes, and when rotted, provide much needed moisture for conifers late in the growing season.

Snags - Number/Acre n = 8					
Total/ Acre	Condition Class				
	1	2	3	4	5
13	1	4	7	0	1

## Soils

Most soils supporting this association are fairly shallow and rocky. Five of our 7 samples were less than 1 meter deep. Most also have such a high coarse fraction composition that they have low effective soil depths. Many sites were also steep, upper slopes where soil formation favors shallow, low moisture-holding capacity material. Soil organic matter is especially important in these sites, hence the forest floor and coarse woody debris should be maintained as much as possible. The down wood not only can provide shade and rooting medium when well rotted, but it can help reduce soil surface erosion.

Number of Soil Pits:	4
Effective Soil Depth (cm):	80
Soil Surface Texture:	Sandy loams
Parent Materials:	Andesites with ash

## Similar Associations

This association differs from others within the Gifford Pinchot National Forest Grand Fir Series by its prolific oceanspray and other tall shrubs, its relative paucity of dry-site graminoids (eg. pinegrass or elk sedge) and its low abundance of mesic-site herbs (vanillaleaf, starry Solomonplume, twinflower). The Grand fir/Oceanspray association on the eastern portion of the Mt. Hood National Forest has distinctively lower timber productivity and more severe management restrictions (Topik et al. 1988). The Grand fir/California hazel association on the Yakima Indian Reservation (John et al. 1988) is fairly similar. Slightly analogous floras are found in the ABGR/CLUN habitat type, ninebark phase in northern Idaho (Cooper et al. 1987) and the PSME/PHMA habitat type in Montana (Pfister et al. 1977).





Grand fir/Creeping snowberry/Vanillaleaf  
*Abies grandis*/*Symphoricarpos mollis*/*Achlys triphylla*  
 ABGR/SYMO/ACTR CWS3 32

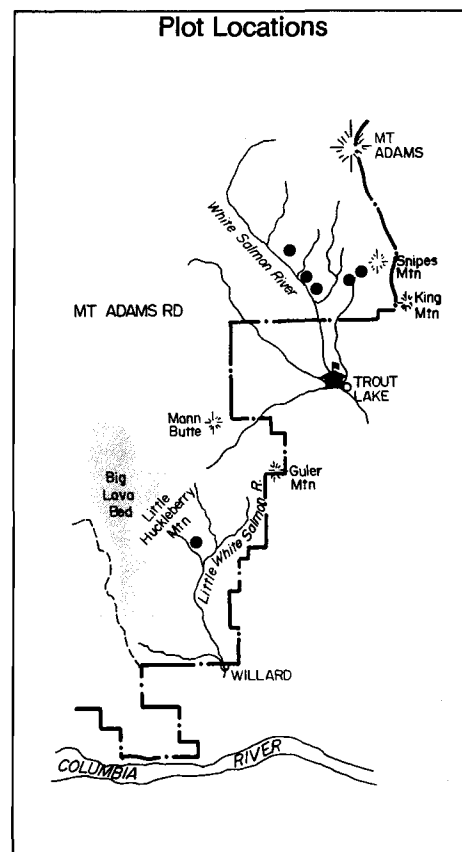


## Environment and Distribution

This association is fairly common in the area between Gotchen Creek and the White Salmon River on the south side of Mount Adams. It is infrequently found in the Little White Salmon River drainage. Sites having this association are usually on the lower portions of gentle, west-facing slopes. These sites are quite dry and experience extensive summer drought. Effective soil moisture is intermediate for the Grand Fir Zone.

	Range	Average
Elevation (ft):	2620-3690	3073
Precipitation (in/yr):	67-85	73
Slope (%):	0-60	22

Number of Plots:	6 (Intensive = 6)
Common Aspects:	Usually West
Topographic Positions:	Lower Slopes



AGBR/SYMO/ACTR

## Vegetation: Structure and Composition

This association usually includes stands of dense grand fir and Douglas-fir. Ponderosa pine was found in most of the mature, natural stands we sampled, but it was always a minor portion of the canopy. The understory tree layer consists of scattered grand fir seedlings. The shrub and herb layers are characterized by the strong dominance of vanillaleaf (ACTR). Tall shrubs, including California hazel (COCO2), vine maple (ACCI), and serviceberry (AMAL), sometimes occur in small patches. The ubiquitous low shrubs are creeping snowberry (SYMO) and baldhip rose (ROGY). The herb layer often has abundant vanillaleaf and a variety of small species characteristic of dense forests, including white-vein pyrola (PYPI), rattlesnake plantain (GOOB) and bigleaf sandwort (ARMA3).

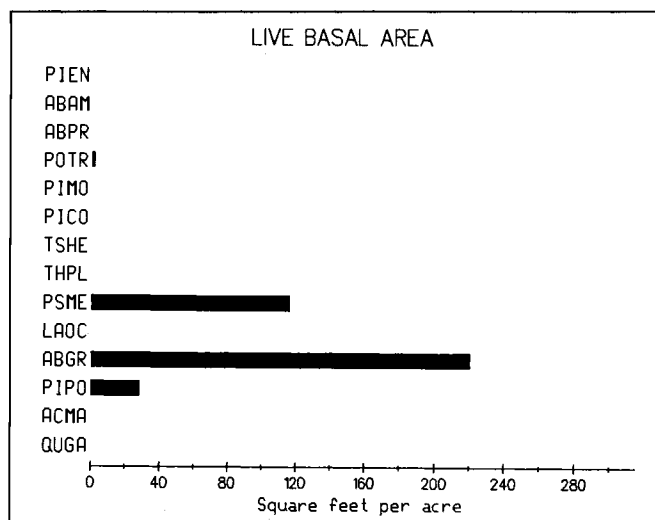
## Timber Productivity and Management

Mature stands in this association are generally dominated by dense, productive grand fir and lesser amounts of Douglas-fir and ponderosa pine. This association is ideal for providing high site volume production with a mixture of these three species. Our sample plots had the highest average stand basal area and tree stocking (trees 7 inches DBH) of any Grand Fir Series association. Productivity indexes were also high; ponderosa pine site index had the second highest average of any Grand Fir Series association. Most of the grand fir present grew up following fire suppression early this century from beneath the Douglas-fir and ponderosa pine dominated overstories. Although these sites are hot and dry, reforestation of clearcuts with Douglas-fir and ponderosa pine will normally succeed. Shelterwood cuts may be useful on large, flat benches where frost may be a problem. This association is prone to having moderate to extreme pocket gopher damage to seedlings.

Dominant Vegetation			
	Code	%Cov	Cons
<b>Overstory Trees</b>			
Grand fir	ABGR	60	83
Douglas-fir	PSME	22	83
Ponderosa pine	PIPO	5	83
<b>Understory Trees</b>			
Grand fir	ABGR	5	66
<b>Shrubs</b>			
Creeping snowberry	SYMO	2	100
California hazel	COCO2	2	66
Vine maple	ACCI	2	66
Baldhip rose	ROGY	2	100
Serviceberry	AMAL	2	50
Little prince's pine	CHUM	3	83
<b>Forbs</b>			
Vanillaleaf	ACTR	10	100
Starflower	TRLA2	2	66
White-vein pyrola	PYPI	2	83
Rattlesnake plantain	GOOB	2	83
Bigleaf sandwort	ARMA3	3	66

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	114	6	252	36	5	1
PSME	100	136	15	362	87	13	1
ABGR	50	95	5	392	23	15	1

Yield Capacity ft <sup>3</sup> /ac/yr		SDI Growth Estimate ft <sup>3</sup> /ac/yr		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
147	21	206	42	273	49	560	53



AGBR/SYMO/ACTR

## Wildlife, Range and Fuels

The wildlife values for this association are probably fairly low because of the relatively low variation in species composition and stand structure typical for mature stands in this association. The dense stands so typical can supply important thermal cover as well as habitat having small snow accumulations because of canopy snow intercept. Browse and forage are not abundant in closed stands which are marginal livestock range. Following timber harvest, there will be a more abundant shrub and herb flora providing fair transitory range for wildlife and livestock for up to ten years. This association offers excellent opportunities for enhancing this transitory range with legume and grass seeds, particularly along the edges of clearcuts where big-game can fully utilize the forage. Our sample plots had a large number of snags, including many ponderosa pine which can provide exceptional habitat for many cavity dwellers. We also sampled many grand fir, primarily the suppression mortality in dense stands. Douglas-fir snags were absent from our plots. Fuels treatments can utilize burning with ordinary cautions but conservation of downwood and litter layers aids soil moisture-holding capacity. Sites in this association are prone to soil compaction from machine piling.

Snags - Number/Acre    n = 6					
Total/ Acre	Condition Class				
	1	2	3	4	5
52	8	14	7	19	5

## Soils

Soils are generally deep and fine textured with fairly low rock content. The effective soil depth of 87 cm is very high for the Grand Fir Zone and indicates a good moisture holding and releasing capacity. Many soils have predominantly weathered ash surface layers which are susceptible to compaction, especially when wet. This ash material also appears to be favored habitat for pocket gophers.

Number of Soil Pits:	5
Effective Soil Depth (cm):	87
Soil Surface Texture:	Loams and sandy loams
Parent Materials:	Mixed ash, andesites and basalts

## Similar Associations

This association is floristically quite similar to both the Grandfir/California hazel/Vanillaleaf and Grand fir/Dwarf Oregongrape/Vanillaleaf associations but it lacks the greater abundance and diversity of shrubs which characterize these two types. Abundant mesic-site herbs and little oceanspray distinguish this type from Grand fir/Oceanspray. This association has greater timber productivity and abundance of mesic-site herbs than does the Grandfir/Snowberry association described on the eastern portion of the Mt. Hood National Forest (Topik et al. 1988). The Grand fir/Creeping snowberry association on the Yakima Indian Reservation and the Mixed conifer/Snowberrytype on the Warm Springs Indian Reservation are similar but also have drier site characteristics.



## Grand fir/California hazel/Vanillaleaf

*Abies grandis*/*Corylus cornuta* var. *californica*/*Achlys triphylla*

ABGR/COCO2/ACTR

CWS5 36

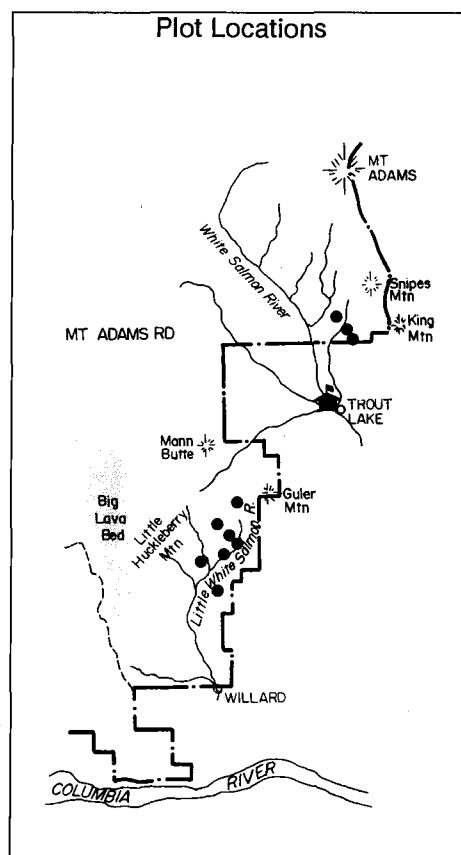


## Environment and Distribution

This association is common on warm sites in lower portions of the Little White Salmon River drainage and in the vicinity of Gotchen Creek on the south side of Mount Adams near the Forest boundary. Most sites having this association are on upper slopes near ridges and have south or west aspects: both features enhance the effectively dry environments. Because this association typically occurs at low elevations for this zone, these sites remain snow-free much of the year and may experience extended summer drought.

	Range	Average
Elevation (ft):	1920-3400	2571
Precipitation (in/yr):	55-66	62
Slope (%):	4-60	35

Number of Plots: 10 (Intensive = 10)  
Common Aspects: South and West  
Topographic Positions: Usually Upper Slopes



ABGR/COCO2/ACTR

## Vegetation: Structure and Composition

Douglas-fir and tall shrubs dominate the forests characteristic of this association. The Douglas-fir are often large and well-spaced. Grand fir is usually present, but as scattered individuals within the primarily Douglas-fir canopies. Some stands also include ponderosa pine and bigleaf maple in the overstory. Tree regeneration within mature stands is mostly grand fir. The occasional Douglas-fir seedlings sampled within mature stands indicates that this association is transitional to Douglas-fir climax stands more common in the western Oregon Cascades. Tall shrubs are particularly abundant and diverse. California hazel (COCO2) and vine maple (ACCI) grow on most sites both as scattered individuals and in dense patches. Pacific dogwood (CONU), oceanspray (HODI), and serviceberry (AMAL) are also frequently present but in small amounts. Low shrubs usually form a distinct layer with substantial cover. Dominants include creeping snowberry (SYMO), dwarf Oregongrape (BENE), baldhip rose (ROGY) and small Prince's pine (CHME). The herb layer is also abundant, with species characteristic of well-drained, mesic sites (Vanillaleaf (ACTR), starflower (TRLA2), and pathfinder (ADBI).

### Dominant Vegetation

	Code	%Cov	Cons
<b>Overstory Trees</b>			
Douglas-fir	PSME	53	100
Grand fir	ABGR	14	70
Ponderosa pine	PIPO	8	20
Bigleaf maple	ACMA	10	10
<b>Understory Trees</b>			
Grand fir	ABGR	6	90
Douglas-fir	PSME	3	30
<b>Shrubs</b>			
California hazel	COCO2	12	100
Vine maple	ACCI	22	80
Creeping snowberry	SYMO	8	100
Baldhip rose	ROGY	6	100
Dwarf Oregongrape	BENE	6	70
Pacific dogwood	CONU	3	60
Oceanspray	HODI	3	60
<b>Forbs</b>			
Vanillaleaf	ACTR	4	90
Starflower	TRLA2	5	90
Bigleaf sandwort	ARMA3	3	80
Pathfinder	ADBI	2	60
White hawkweed	HIAL	3	70
<b>Grasses &amp; Sedges</b>			
Miscellaneous grasses		4	50

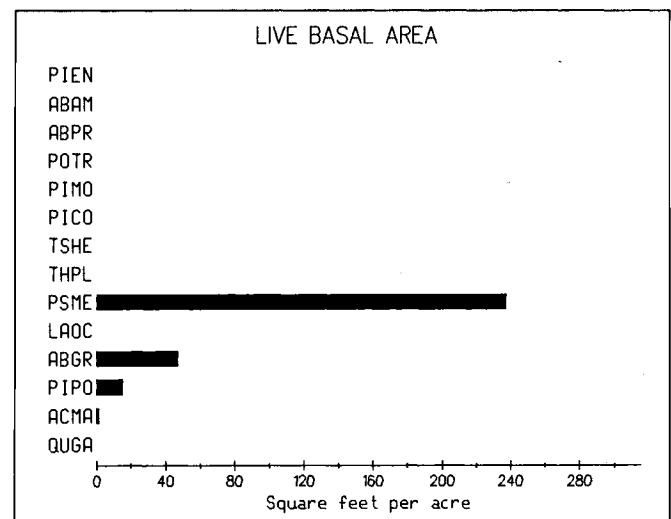
AGBR/COCO2/ACTR

## Timber Productivity and Management

Sites in this association have densely stocked, highly productive Douglas-fir stands. Grand fir is much less abundant but achieves similar individual tree growth as Douglas-fir. Ponderosa pine can grow well on these sites, but was not as common on our study plots. It is likely that ponderosa pine was more widespread in this association before fire suppression. Silvicultural activities should emphasize shade for newly planted seedlings in clearcuts. This can be achieved with clearcuts designed to cast some shade or with shade-cards in the most exposed portions of plantations. Douglas-fir is the most appropriate species to plant. Addition of some ponderosa pine assures higher establishment success on hot sites and also enhances the species diversity. It is likely that grand fir will naturally establish in most logged areas once they have regrown to small pole size. Hence, harvested grand fir does not need to be replaced with planted seedlings to maintain the original tree species diversity.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	104	3	225	28	8	5
PSME	100	137	5	358	48	14	2
ABGR	50	102	9	499	156	19	7

Yield Capacity		SDI Growth Estimate		Trees per Acre		Stand Density Index (SDI)	
ft <sup>3</sup> /ac/yr		ft <sup>3</sup> /ac/yr		#		trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
149	7	125	12	131	18	401	43



## Wildlife, Range and Fuels

Sites in this association provide excellent browse and winter range. These sites stay snow-free for much of the year. The high density and variety of shrubs make outstanding hiding cover for big game. Thermal cover is provided by the well developed coniferous canopies. Clearcuts are rapidly revegetated by a variety of shrubs depending on site preparation. With no burning or cool-burns, California hazel, vine maple, oceanspray, blue elderberry, thimbleberry and dogwood flourish. Hot broadcast burns will encourage dense snowbrush-ceanothus establishment. Native grasses and forbs normally invade disturbed sites, although forage seeding legumes and grasses can enhance winter range values, particularly along the edges of clearcuts where big game utilize more of the forage. Mature stands are non-range for livestock because of low forage abundance and availability as well as the preponderance of this type on steep slopes. Snags, mostly Douglas-fir, were moderately abundant on our sample plots. Down woody material is important at reducing erosion on steep sites and when rotted, provides soil moisture for much of the growing season. Fuels treatments should be lightly applied because of these down wood values as well as the soil insulation and water infiltration benefits of the litter layers.

Snags - Number/Acre n = 10					
Total/ Acre	Condition Class				
	1	2	3	4	5
17	0	4	11	2	0

## Soils

Soils in this association are among the deepest with the highest effective soil depth of any Grand Fir Series association on the Gifford Pinchot National Forest. Fine textures prevail and rock content is generally fairly low. These soils provide high moisture holding capacity and excellent rooting medium for coniferous trees.

Number of Soil Pits:	7
Effective Soil Depth (cm):	109
Soil Surface Texture:	Loams, silt loams, and clay loams
Parent Materials:	Basalts and breccias

## Similar Associations

This association is characterized by its bountiful tall shrub flora which distinguishes it from the somewhat similar Grand fir/Creeping snowberry/Vanillaleaf and Grand fir/Dwarf Oregongrape/Vanillaleaf types. The Grand fir/Pacific dogwood/Vanillaleaf association has an even more lush tall shrub layer including abundant dogwood which is present only in small amounts in this type. This association has higher timber productivity than those types on the eastern portion of the Mt. Hood National Forest which share some of the same flora (Topik et al. 1988). There are no comparable associations in other eastern Oregon or eastern Washington locales, nor in the Rocky Mountains. Forest management implications of this type are more similar to climax Douglas-fir sites in the western Cascades of Oregon (eg. Hemstrom et al. 1987) than in most Grand Fir Series associations typical in eastern Cascades or Rocky Mountain areas.





Grand fir/Dwarf Oregongrape/Vanillaleaf  
*Abies grandis*/*Berberis nervosa*/*Achlys triphylla*  
 ABGR/BENE/ACTR CWS2 24

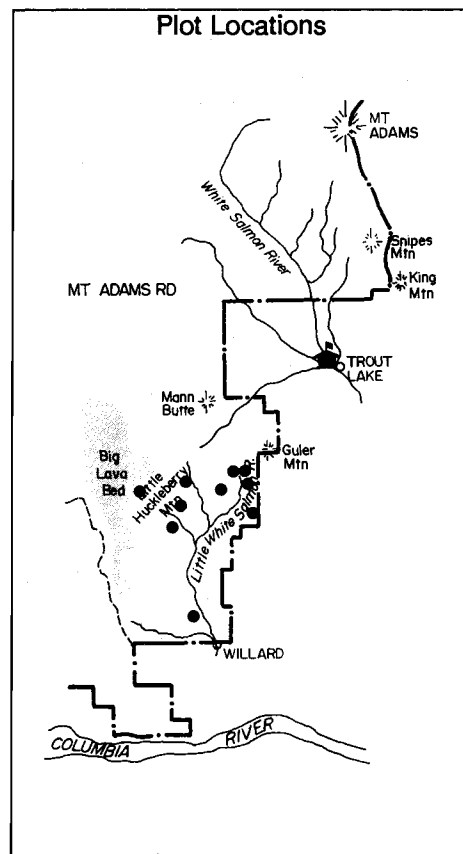


## Environment and Distribution

This association is one of the most widespread within the Little White Salmon River drainage and the near-by areas; it is nearly absent from the Grand Fir Zone on the south side of Mount Adams. It represents the environmental middle-ground for this zone. Sites having this association are on well-drained soils at lower elevations and usually occupy middle or upper slope positions. Summer drought may be extensive though the variability of aspects suggests that environments represented are not so severe as other associations within the Little White Salmon River watershed.

	Range	Average
Elevation (ft):	1920-3200	2585
Precipitation (in/yr):	57-73	63
Slope (%):	15-60	43

Number of Plots:	10 (Intensive = 10)
Common Aspects:	All Except North
Topographic Positions:	Upper & Middle Slopes



ABGR/BENE/ACTR

## Vegetation: Structure and Composition

Forests exhibiting this association are Douglas-fir dominated, having relatively small amounts of Grand fir in either the overstory or understory. A few individuals of big-leaf maple and western hemlock are occasionally encountered. The shrub layer is dominated by dense and tall vine maple (ACCI). Low shrubs form a conspicuous layer, consisting primarily of dwarf Oregongrape, baldhip rose (ROGY) and creeping snowberry (SYMO). Small amounts of other shrubs characteristic of similar plant associations are common. These include Pacific dogwood (CONU), California hazel (COCO2), and thimbleberry(RUPA). The herb layer is usually fairly lush with vanillaleaf and starflower(TRLA2). This association often has several species characteristic of mesic conditions similar to the west slope of the Cascades, including sweet cicily(OSCH), queencup beadlily (CLUN) and inside-out-flower (VAHE).

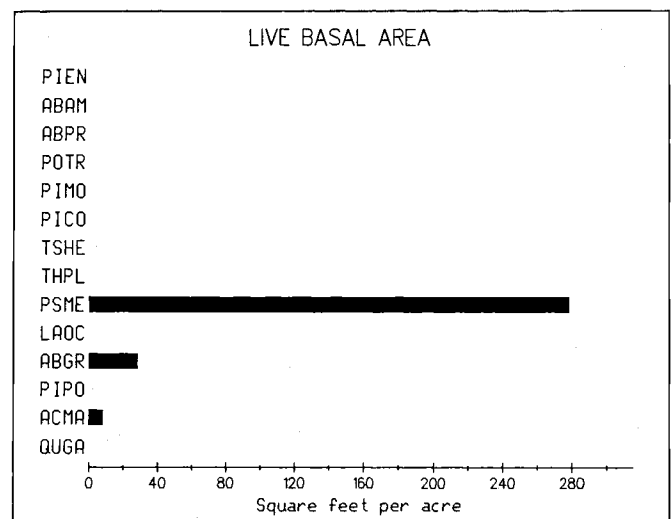
Dominant Vegetation			
	Code	%Cov	Cons
<b>Overstory Trees</b>			
Douglas-fir	PSME	58	100
Grand fir	ABGR	16	50
Bigleaf maple	ACMA	11	20
Western hemlock	TSHE	2	10
<b>Understory Trees</b>			
Grand fir	ABGR	3	50
Western hemlock	TSME	2	20
<b>Shrubs</b>			
Dwarf Oregongrape	BENE	10	100
Baldhip rose	ROGY	4	100
Vine maple	ACCI	35	90
Pacific dogwood	CONU	2	60
California hazel	COCO2	2	40
Creeping snowberry	SYMO	3	90
Thimbleberry	RUPA	1	70
<b>Forbs</b>			
Vanillaleaf	ACTR	10	90
Starflower	TRLA2	3	90
Mountain sweet-cicely	OSCH	2	70
Queencup beadlily	CLUN	2	60
Pathfinder	ADBI	2	60
Inside-out-flower	VAHE	2	60

## Timber Productivity and Management

Highly productive, well-stocked stands of Douglas-fir are typical for sites in this association. Our sample plots are mainly of mature, even-aged stands of Douglas-fir which include scattered grand fir individuals. The grand fir individuals reaching the upper canopy are among the largest trees in the stands and have, on average, substantially higher site indexes than the Douglas-fir. This association generally indicates that a site is suitable for most normal timber management practices. There are generally no particular problems with either clearcut harvesting or reforestation with planted Douglas-fir. Hot broadcast burns will probably encourage establishment of dense ceanothus (CEVE) patches which could decrease initial plantation stocking and growth. Cooler burns may encourage sufficient ceanothus to enhance soil nitrogen content without reducing initial conifer growth

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	127	7	339	43	14	3
PSME	100	103	5	264	32	6	1

Yield Capacity		SDI Growth Estimate		Trees per Acre		Stand Density Index (SDI) trees/acre	
ft <sup>3</sup> /ac/yr		ft <sup>3</sup> /ac/yr		#			
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
129	10	108	18	160	62	396	39



ABGR/BENE/ACTR

## Wildlife, Range and Fuels

Forests in this association form a large portion of the winter range available in the Little White Salmon River drainage. Snow-free periods prevail during winter and the well stocked stands provide excellent thermal cover. Dense patches of vine maple and scattered Pacific dogwood and California hazel supply big game with excellent browse as well as hiding cover. Clearcuts rapidly revegetate with these shrub species as well as blue elderberry, blackberry, thimbleberry and other shrubs if site preparation excludes broadcast burning or includes cool burns. Seeding grasses and legumes can enhance transitory range value without unduly lowering chances of reforestation success. Mature stands are non-range for livestock because of low forage availability and quality as well as the preponderance of steep slopes. Douglas-fir snags dominated our snag samples and provide abundant potential foraging and nesting habitat for a wide variety of wildlife. Long term site productivity will be enhanced by careful application of fuels treatments to maintain as much down woody debris as possible. This also protects the forest floor layers which insulate the soil surface. Intact litter layers enhance precipitation infiltration, thus reducing potential erosion which can be extensive on the steep slopes so common to this association.

Snags - Number/Acre    n = 6					
Total/ Acre	Condition Class				
	1	2	3	4	5
23	2	7	12	2	0

## Soils

Soils are generally either fairly shallow, or if deep, they have a high rock content. The effective soil depth was the lowest of any Grand fir Series association and much lower than the other associations abundant in the Little White Salmon River watershed. The relatively poor soil moisture-holding capacity of these soils suggests careful management of organic matter is crucial. The forest floor (duff) can greatly aid water infiltration rates and reduce soil surface evaporation. Coarse woody debris provides, when decayed, important rooting substrate with moisture content well into the summer and is the site of nitrogen-fixation.

Number of Soil Pits:	8
Effective Soil Depth (cm):	47
Soil Surface Texture:	Loams and sandy loams
Parent Materials:	Usually basalts, possibly breccias and ash

## Similar Associations

This association is floristically akin to both the Grand fir/California hazel/Vanillaleaf and Grand fir/Pacific dogwood/Vanillaleaf associations but it lacks the hazel and dogwood and has lower timber productivity than the other two types. This type has a higher abundance of species most prevalent in the western Cascades, such as dwarf Oregongrape and vine maple, than does the Grand fir/Creeping snowberry/Vanillaleaf association. Similar associations are lacking in other eastern Cascades or Rocky Mountain studies, however some sites within the ABGR/ACTR association on the eastern portion of the Mt. Hood National Forest are floristically similar, but have generally lower timber productivities (Topik et al. 1988). Forest management implications of this type are more similar to climax Douglas-fir sites in the western Cascades of Oregon (eg. Hemstrom et al. 1987) than most Grand fir Series associations typical in the eastern Cascades or Rocky Mountain areas.



**Grand fir/Pacific dogwood/Vanillaleaf**  
*Abies grandis*/*Cornus nutallii*/*Achlys triphylla*  
 ABGR/CONU/ACTR CWS5 37

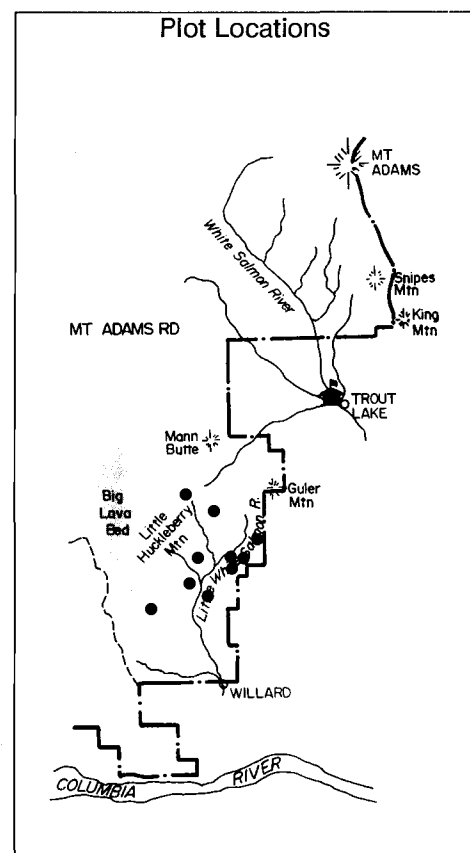


## Environment and Distribution

This association is one of the most widespread within and adjacent to the Little White Salmon River drainage. It is virtually absent from the south side of Mount Adams, but it does occur to a minor extent on the southern tip of the Wind River Ranger District within a few miles of the Columbia River. This association is prevalent at low elevations having warm and fairly dry climates. All aspects are represented and characteristic topography includes various side slope positions.

	Range	Average
Elevation (ft):	1500-3500	2533
Precipitation (in/yr):	57-71	64
Slope (%):	10-75	46

Number of Plots:	10 (Intensive = 9)
Common Aspects:	All Aspects
Topographic Positions:	Middle, Upper and Lower Slopes



ABGR/CONU/ACTR

## Vegetation: Structure and Composition

Lush herbs and tall shrub dominate the forests of large Douglas-fir that characterize this association. Grand fir is often absent from the overstory of mature stands and is not always present in the understory. We feel that these stands will eventually be invaded by grand fir which, given enough time without disturbance, will become the dominant species. Hence, this association is included within the Grand Fir Series even though grand fir is occasionally absent. Big-leaf maple (ACMA) has its best development within the Grand Fir Series in this association. Western hemlock does occur, though rarely and in small amounts. The overwhelming characteristic of this association is the dense and diverse tall shrub and herb flora. Pacific dogwood (CONU), vine maple (ACCI), and California hazel (COCO2) form a distinct mid-canopy layer within mature stands. Low shrubs, especially dwarf Oregongrape (BENE), baldhip rose (ROGY), and creeping snowberry (SYMO), are also very abundant. A great variety of herbs combine to form the lush ground cover which is unique for the Grand fir Zone. This association has the greatest abundance of vanillaleaf (ACTR) of any on the Gifford Pinchot National Forest. Species commonly co-occurring with vanillaleaf are also common and abundant; these include pathfinder (ADBI), inside-out-flower (VAHE), starry solomonseal (SMST) and 3-leaved anemone (ANDE).

### Dominant Vegetation

	Code	%Cov	Cons
<b>Overstory Trees</b>			
Douglas-fir	PSME	57	100
Grand fir	ABGR	25	30
Bigleaf maple	ACMA	6	60
<b>Understory Trees</b>			
Grand fir	ABGR	7	50
Douglas-fir	PSME	5	20
Western hemlock	TSHE	3	10
<b>Shrubs</b>			
Pacific dogwood	CONU	17	100
Vine maple	ACCI	26	100
California hazel	COCO2	6	80
Dwarf oregongrape	BENE	9	90
Baldhip rose	ROGY	4	100
Creeping snowberry	SYMO	3	100
Oceanspray	HODI	3	30
<b>Forbs</b>			
Vanillaleaf	ACTR	27	100
Pathfinder	ADBI	2	90
Oregon anemone	ANDE	3	80
Inside-out-flower	VAHE	5	90
Starflower	TRLA2	5	90
Fairybells	DIHO	2	80

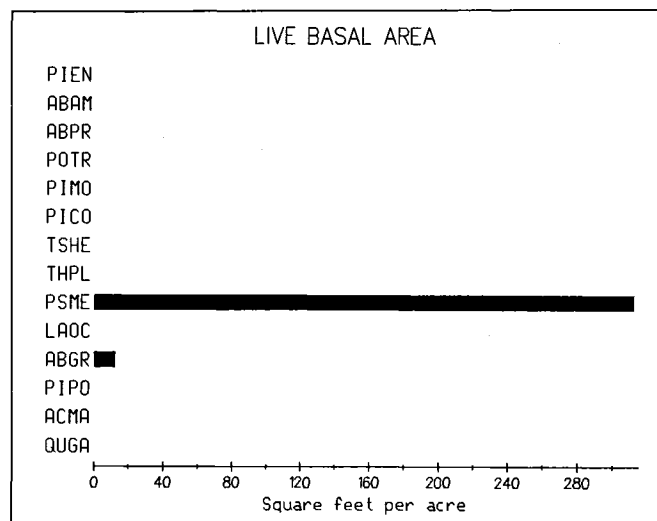
ABGR/CONU/ACTR

## Timber Productivity and Management

This association includes sites which are consistently among the most productive within the Grand Fir Zone. Large, well-stocked stands of mature Douglas-fir are typical. Grand fir is a minor component of most existing stands in the Little White Salmon River drainage. Clearcuts can usually be readily reforested with planted Douglas-fir. It is important to use seedling stock from appropriate seed zones because these sites are considerably drier than westside Douglas-fir forests. Brush competition can be a problem for reforestation, especially where hot broadcast burns encourage the establishment of dense ceanothus (CEVE). Managing for moderate ceanothus abundance is an excellent way to enhance soil nitrogen levels.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	143	4	363	45	13	1
PSME	100	95	11	329	74	16	2

Yield Capacity ft <sup>3</sup> /ac/yr		SDI Growth Estimate ft <sup>3</sup> /ac/yr		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
158	6	135	17	100	18	385	44



## Wildlife, Range and Fuels

The diverse flora, abundant shrubs and snags, and large trees characteristic of this association combine to make excellent wildlife habitat. Most sites provide winter range of high quality and quantity and the multi-layered canopies make good thermal cover for big game. Shrubs flourish in clearcuts. Transitory range will include a variety of grasses and forbs as well as blue elderberry, thimbleberry, blackberry, snowberry and resprouts of Pacific dogwood, vine maple, California hazel and oceanspray. Seeding legumes and grasses can enhance winter range forage for several years until the shrubs, and later conifers, dominate the site. Mature stands are marginal livestock range because of the preponderance of steep slopes as well as the low forage quality of most forbs. All snags on our plots were Douglas-fir, although many were well-rotted, soft snags with low usefulness for primary cavity nesters. Down woody material was more abundant than in most Grand Fir Series associations, reflecting the good timber productivity of these sites. This down wood provides valuable habitat for small mammals and salamanders and also helps prevent erosion on steep slopes and provides valuable rooting space retaining late summer moisture.

Snags - Number/Acre n = 9					
Total/ Acre	Condition Class				
	1	2	3	4	5
25	0	8	5	11	0

## Soils

Deep soils with low rock content are typical for sites with this association. Rooting depths and effective soil depths are among the highest in the Grand Fir Zone. Soil moisture is also favored by the usual lower slope position whereby down-slope water movement helps ameliorate the sites. The sandy loam or coarse sandy loam textured soils are very well-drained. Surface organic matter, either duff or large woody debris, play important soil hydrology and nutrient cycling roles and hence their destruction by slash burning should be avoided.

Number of Soil Pits:	7
Effective Soil Depth (cm):	87
Soil SurfaceTexture:	Sandy loams, loams or coarse sandy loams
Parent Materials:	Basalt

## Similar Associations

The lush herb and tall shrub understory dominated by Pacific dogwood distinguishes this association from others on the Gifford Pinchot National Forest. Floristics and management implications, including the high timber productivity, are more similar to the Western hemlock/Pacific dogwood/Vanillaleaf association common in nearby areas on Wind River Ranger District (Topik et al. 1986) than other Grand fir Series types. No comparable associations have been described in the eastern Cascades of Oregon or Washington nor in the Rocky Mountains.





**Grand fir/Thimbleberry/Fairybells**  
*Abies grandis*/*Rubus parviflorus*/*Disporum hookeri*  
 ABGR/RUPA/DIHO CWS2 23

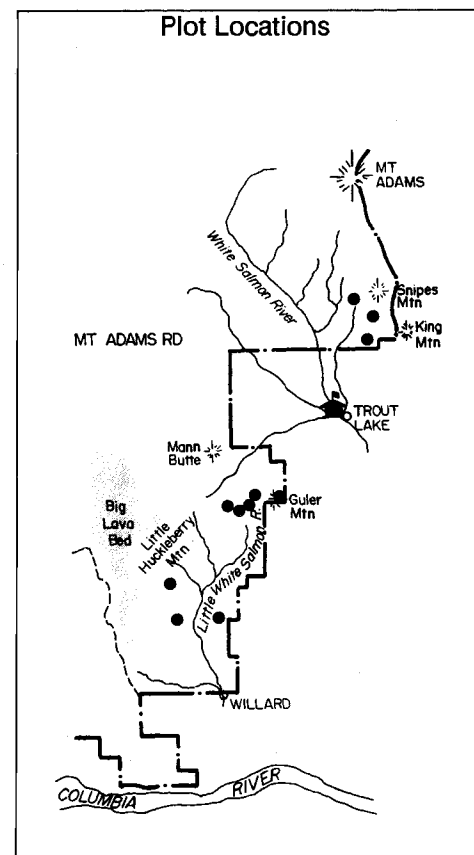


## Environment and Distribution

This association is common at the higher elevations within the Little White Salmon River drainage, though it also occurs on the south side of Mount Adams north of Trout Lake. It indicates fairly moist and cold sites within the Grand Fir Zone which get substantial snow-packs. These sites also probably get more total precipitation and have longer drought-free seasons than sites having other plant associations within the Little White Salmon River watershed. All aspects and various topographic positions are represented al-

	Range	Average
Elevation (ft):	2510-4200	3445
Precipitation (in/yr):	53-69	61
Slope (%):	10-80	38

Number of Plots:	11 (Intensive = 11)
Common Aspects:	Various, often west
Topographic Positions:	Various side slopes, often upper slopes



ABGR/RUPA/DIHO

though many of our sample plots have west aspects and are on upper slopes.

## Vegetation: Structure and Composition

This association is characterized by its diverse overstory and its lush shrubs and herbs. Douglas-fir and grand fir codominate the canopy, which also may include lesser amounts of noble fir, big-leaf maple, western white pine, western larch, ponderosa pine and even Engelmann spruce. Dense foliage of thimbleberry is conspicuous at many sites having this association. Vine maple (ACCI) usually forms a mid-story canopy, and in some stands is joined by small patches of California hazel (COCO2), oceanspray (HODI) or Pacific dogwood (CONU). The herb layer is remarkably thick and diverse. Many mesic-site species are present in large amounts: fairybells (DIHO), vanillaleaf (ACTR), queencup beadleily (CLUN) and starry Solomonseal (SMST). Other herb species common in this association are just as likely to be found in mesic-site western hemlock or silver fir zone associations.

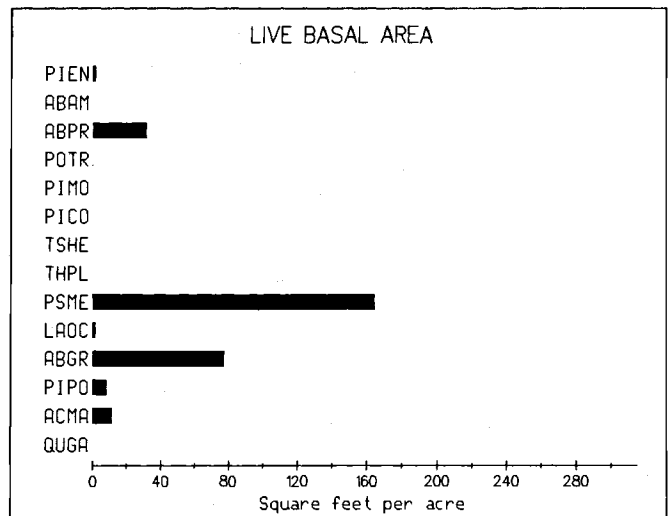
Dominant Vegetation			
	Code	%Cov	Cons
<b>Overstory Trees</b>			
Douglas-fir	PSME	30	100
Grand fir	ABGR	26	81
Noble fir	ABPR	22	27
Western white pine	PIMO	2	18
<b>Understory Trees</b>			
Grand fir	ABGR	6	72
Bigleaf maple	ACMA	5	27
Pacific silver fir	ABAM	2	9
Western hemlock	TSHE	1	9
<b>Shrubs</b>			
Thimbleberry	RUPA	11	100
Vine maple	ACCI	20	81
Creeping snowberry	SYMO	5	81
California hazel	COCO2	4	63
Oceanspray	HODI	4	45
Pacific dogwood	CONU	7	27
<b>Forbs</b>			
Vanillaleaf	ACTR	12	100
Fairybells	DIHO	11	90
Queencup beadleily	CLUN	7	90
Starry Solomonseal	SMST	3	81
False Solomonseal	SMRA	3	72
Three-leaved anemone	ANDE	2	72
Bigleaf sandwort	ARMA3	2	81
Sweetscented bedstraw	GATR	3	81

## Timber Productivity and Management

Very high timber productivity and stocking are characteristic of this association. Large, well spaced Douglas-fir and grand fir are common. Some of the largest grand fir individuals are found in this association. Timber management concerns revolve more around stocking control or created frost pockets than heat and drought as in most of the rest of the Grand fir Zone. Both clearcut and selective logging are practical. Where the latter is practiced, high volume growth of grand fir can be expected following harvest treatments. Clearcuts can be reforested with planted Douglas-fir, and to a lesser degree, planted noble fir and western white pine. Some clearcuts in this association become densely vegetated with sticky current (*Ribes viscosissimum*).

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PIPO	100	92	-			23	--
PSME	100	126	8	376	36	16	4
ABGR	50	93	5	332	34	11	1

Yield Capacity		SDI Growth Estimate		Trees per Acre		Stand Density Index (SDI) trees/acre	
ft <sup>3</sup> /ac/yr		ft <sup>3</sup> /ac/yr		#			
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
133	11	133	8	162	43	420	20



ABGR/RUPA/DIHO

## Wildlife, Range and Fuels

The unusually lush vegetation (for the Grand Fir Zone) characteristic of this association provides abundant summer forage and thermal cover for a variety of wildlife. Few sites in this association are considered winter range. Clearcuts and shelterwood harvested sites are rapidly revegetated by dense swords of forbs and shrubs. The abundant browse and hiding cover in logged sites includes thimbleberry, vine maple, California hazel, snowberry, blackberry and sticky currant. Forage seeding will only rarely be useful because of the naturally lush revegetation and the rarity of sites being in winter range. Mature stands have low livestock range value because of low forage palatability. Mature stands are generally well stocked with large Douglas-fir and grand fir which create thick, multi-layered canopies. Mature stands in this association have great diversity of tree species and canopy structure for this series. Our plots had abundant snags, primarily Douglas-fir but also some noble and Grand fir. A wide range of fuels treatments can be utilized, although as in other forested sites, retention of down woody material and forest floor layers will enhance long term site productivity for both timber and wildlife.

Snags - Number/Acre n = 11					
Total/ Acre	Condition Class				
	1	2	3	4	5
26	2	3	13	8	1

## Soils

Soils are generally shallow to moderately deep; six of our samples had total soil depths less than 1 meter deep. Most of the soils have low rock content but are well drained because of their fairly coarse texture. Because many sites in this association stay moist longer than others in the Grand Fir Zone, careful use of heavy machinery is important to avoid soil compaction. Conservation of soil surface organic matter in harvested units will aid soil nutrition as well as provide physical protection from erosion.

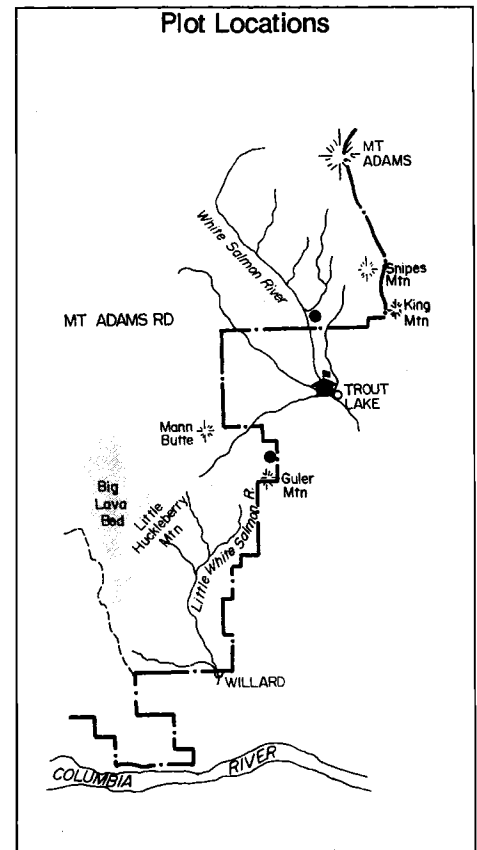
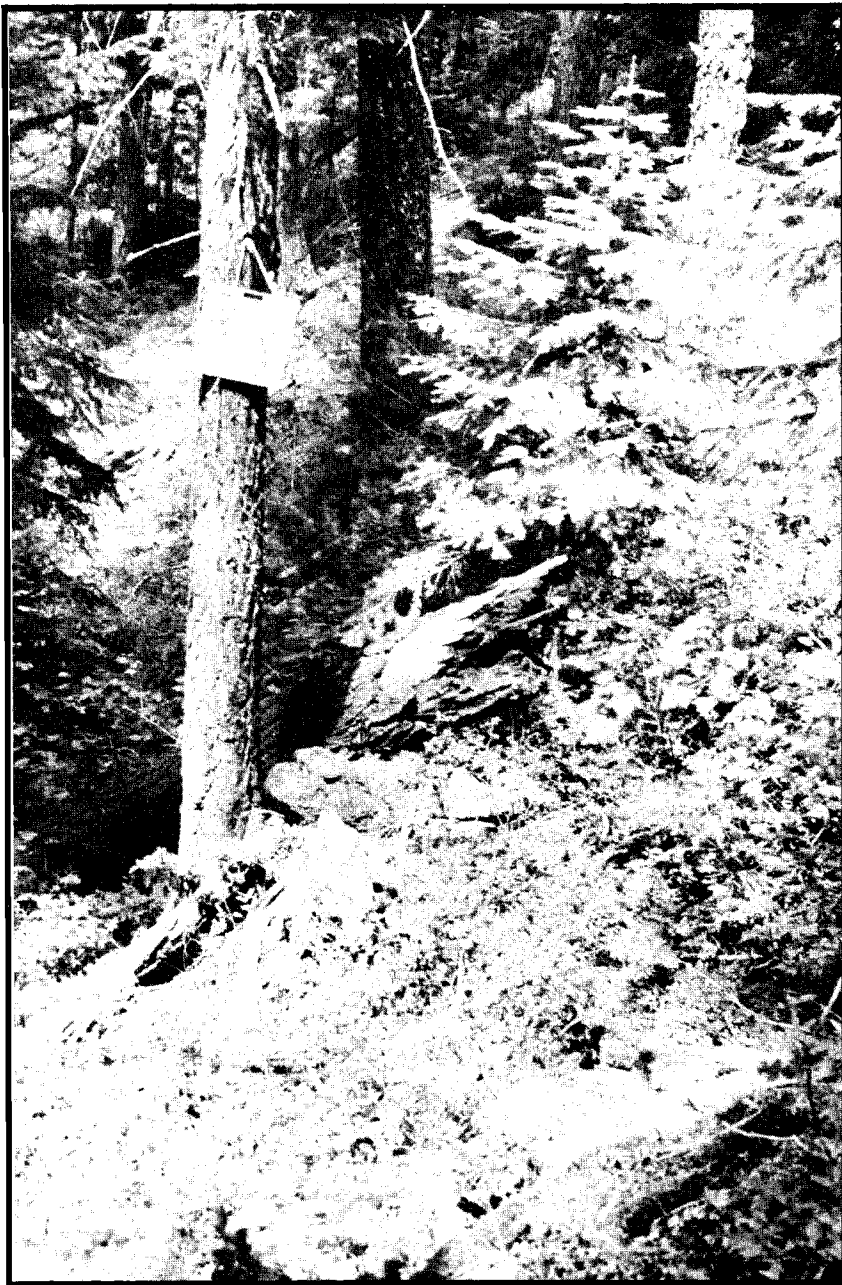
## Similar Associations

Number of Soil Pits:	9
Effective Soil Depth (cm):	48
Soil Surface Texture:	Sandy loam
Parent Materials:	Basalt, andesite or breccia

This association is distinguished by a lush herb layer, an abundance of thimbleberry even within mature stands, and a lack of Pacific dogwood. The abundance of fairybells, 3-leaved anemone, and queencup beadlily helps distinguish this association from Grand fir/Creeping snowberry/Vanillaleaf, Grand fir/California hazel/Vanillaleaf and Grand fir/Dwarf Oregongrape/Vanillaleaf. Though big huckleberry may be found, it is in much lower abundance than in Grand fir/Big huckleberry/Twinflower and Grand fir/Big huckleberry/Queencup beadlily. This association is transitional to, and somewhat similar in floristics and management, to the Pacific silver fir/Vanillaleaf-queencup beadlily association (Brockway et al. 1983). Similar associations have not been described in other eastern Cascade locales, although the ABGR/CLUN habitat type, CLUN phase in Northern Idaho has floristic overlap but lower timber productivity (Cooper et al. 1987).



Grand fir/Big huckleberry/Twinflower  
*Abies grandis*/*Vaccinium membranaceum*/*Linnaea borealis*  
 ABGR/VAME/LIBO2 CWS2 21



## Environment and Distribution

This association is restricted to sites where cool air draining from the mountains brings effectively cooler climates to lower elevations than is typical for the Grand Fir Zone. These sites are usually on benches above streams where solar input may also be restricted due to the shading effect of the neighboring slopes. Our scant sampling for this association does reflect its relative rarity, though it is common along the White Salmon River. It occupies sites which are transitional to the other more mesic forest series: the Western Redcedar, Pacific Silver fir and the Western Hemlock series.

	Range	Average
Elevation (ft):	2260-3220	2740
Precipitation (in/yr):	52-65	59
Slope (%):	8-66	37
Number of Plots:	2 (Intensive = 2)	
Common Aspects:	Any	
Topographic Positions:	Benches	

ABGR/VAME/LIBO2

## Vegetation: Structure and Composition

This association is characterized by the abundance of big huckleberry (VAME) and twinflower (LIBO2) with Grand fir seedlings and saplings. Grand fir and Douglas-fir dominate the overstory within this association. Western larch and ponderosa pine also may be present in small amounts. Grand fir regenerates prolifically within mature stands. Big huckleberry dominates the shrub layer. Other shrub species are either sparse or present in scattered patches. The herb layer is similarly dominated by one species: twinflower. Other mesic-site herbs are also common within this association, including vanillaleaf (ACTR), starflower (TRLA2), and fairybells (DIHO).

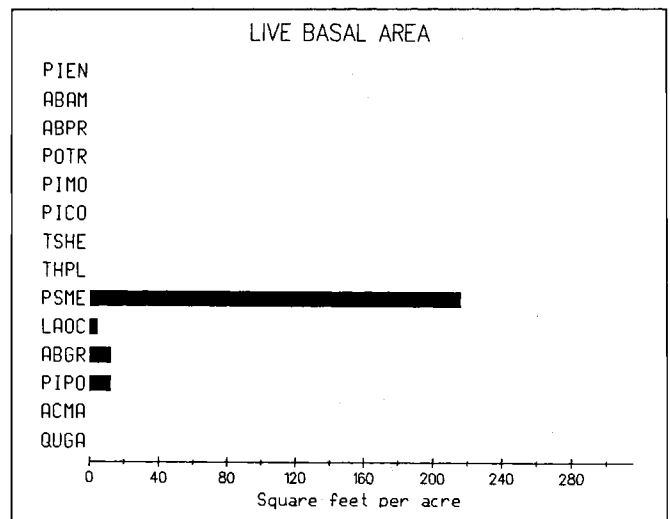
Dominant Vegetation			
	Code	%Cov	Cons
<b>Overstory Trees</b>			
Grand fir	ABGR	18	100
Douglas-fir	PSME	23	100
Western larch	LAOC	2	100
Ponderosa pine	PIPO	2	50
<b>Understory Trees</b>			
Grand fir	ABGR	13	100
Douglas-fir	PSME	2	50
<b>Shrubs</b>			
Big huckleberry	VAME	45	100
California hazel	COCO2	4	100
Pacific dogwood	CONU	6	100
Dwarf Oregongrape	BENE	3	100
Trailing blackberry	RUUR	4	100
Creeping snowberry	SYMO	15	50
Vine maple	ACCI	25	50
<b>Forbs</b>			
Twinflower	LIBO2	19	100
Vanillaleaf	ACTR	6	100
Fairybells	DIHO	4	100
Starflower	TRLA2	4	100
Queencup beadlily	CLUN	3	50
Pathfinder	ADBI	2	50

## Timber Productivity and Management

This association has slightly lower timber productivity and stocking than most of the rest of the Grand Fir series. Mature stands are dominated by Douglas-fir. The canopy also includes an abundance of small Grand fir which have regenerated from beneath the shade of the Douglas-fir. Ponderosa pine and western larch are also common, but minor, stand components. The full variety of silvicultural systems can be utilized, but because so many stands of this association are near streams, shelterwood or selective logging may be most suitable. Cold air accumulations may cause growing season frost in clearcuts at lower elevations than normally encountered. Created openings may become frost pockets unless the harvest design allows for cold air drainage. This association includes sites where planted mixtures of Douglas-fir, western larch and ponderosa pine should successfully reforest most logged sites.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PSME	100	113	7	254	69	9	0.4
ABGR	50	85	-	281	-	9	-

Yield Capacity		SDI Growth Estimate		Trees per Acre		Stand Density Index (SDI)	
ft <sup>3</sup> /ac/yr		ft <sup>3</sup> /ac/yr		#		trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
115	10	420	20	162	43	133	8



## Wildlife, Range and Fuels

Sites in this association have their greatest wildlife value in their role of providing thermal cover and winter forage in areas near major streams. Forage production in mature stands is relatively low, but the abundance of California hazel and Pacific dogwood provide good browse and hiding cover for big game. Logged sites will likely be revegetated by blackberry, snowberry and vine maple, although hot broadcast burns will stimulate dense snowbrush ceanothus dominance. Seeding legumes and grasses in clearcuts may provide transitory winter forage for wildlife. Mature stands are non-range for livestock because of very low forage availability and palatability. Our plots had a moderate abundance of snags, including some western larch, which can provide excellent habitat over long time periods for primary cavity nesters. Because sites in this association are likely to be near large streams, down logs may provide especially important herpetofauna habitat. Fuels treatments should strive to leave as much down wood on-site as possible and to avoid soil compaction by heavy machinery used to pile slash.

Snags - Number/Acre n = 2					
Total/ Acre	Condition Class				
	1	2	3	4	5
32	4	4	4	20	0

## Soils

Both of our soil samples representing this association were fairly shallow with substantial rock content. The effective soil depth of 47 cm is the lowest for the Grand Fir Series. Surface organic matter conservation is especially important in this association. The forest floor (duff) is not only a critical nutrient reservoir, but it aids water infiltration and reduces surface evaporation. Large fallen logs are the site of nitrogen-fixation when decayed and can provide moist rooting substrate when other soil moisture is depleted.

Number of Soil Pits:	2
Effective Soil Depth (cm):	47
Soil SurfaceTexture:	Loam or sandy loam
Parent Materials:	Basalt or ash

## Similar Associations

The flora of this association is quite similar to the Grand fir/Big huckleberry/Queencup beadrily association except it has high abundance of twinflower and Pacific dogwood, low abundance of queencup, occurs at lower elevations and has somewhat higher timber productivity. The other Grand Fir Series associations on the Gifford Pinchot National Forest lack much big huckleberry and represent warmer and drier environments. The Grand fir/Myrtleblueberry/Twinflower association on the Yakima Indian Reservation (John et al. 1988) indicates considerably colder environments. The Grand fir/Big huckleberry type on the Warm Springs Indian Reservation (Marsh et al. 1987) includes similar sites, but generally includes colder environments than those representative of this association. Considerable floristic overlap also exists with the ABGR/VAME/LIBO2 association in the Blue Mountains (Hall 1988), except that type includes other species, such as creeping hollygrape (BERE), and the ABGR/CLUN habitat type, TABR phase in Northern Idaho (Cooper et al. 1987).





**Grand fir/Big huckleberry/Queencup beadlily**  
*Abies grandis/Vaccinium membranaceum/Clintonia uniflora*  
**ABGR/VAME/CLUN CWS2 22**

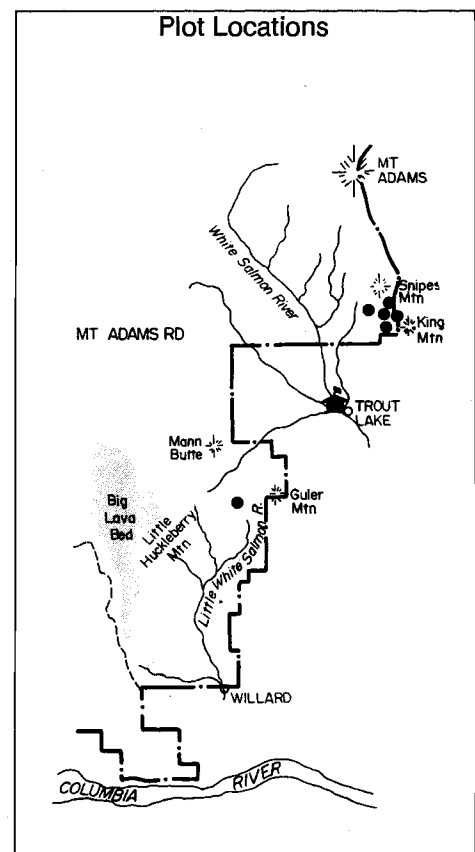


## Environment and Distribution

This association is common at higher elevations where the Grand Fir Zone intergrades with the Pacific Silver Fir Zone. It is abundant on the south side of Mount Adams. These sites receive high precipitation, including considerable snow. Sites having this association are usually on north aspects, on the north sides of the various small buttes and cinder cones flanking the south side of Mount Adams. Slopes are generally moderate, but flats adjacent to sites having this association are typically too frost-prone to support Grand fir.

	Range	Average
Elevation (ft):	3710-4200	3997
Precipitation (in/yr):	52-62	58
Slope (%):	12-45	28

Number of Plots: 6 (Intensive = 6)  
 Common Aspects: Usually north  
 Topographic Positions: Various side slopes



ABGR/VAME/CLUN

## Vegetation: Structure and Composition

Dense Grand fir stands dominate this association. Other conifers include Douglas-fir, western larch (LAOC), Pacific silver fir (ABAM) and ponderosa pine (PIPO). Lodgepole pine dominates one of our sample plots burned by a fairly recent fire. In general, understories are dominated by grand fir, but a few Pacific silver fir or western hemlock seedlings occur in some mature stands. Shrubs are relatively sparse, consisting mainly of big huckleberry and dwarf bramble (RULA). Vine maple is uncommon, but where present, may occur in dense patches. Herbs are also fairly sparse. Queencup beadlily (CLUN) may have appreciable cover, and is joined by such typical mesic-site species as vanillaleaf (ACTR), false Solomonseal (SMRA) and fairybells (DIHO). Many other herb species present are also common to warm-site Pacific Silver Fir Zone associations.

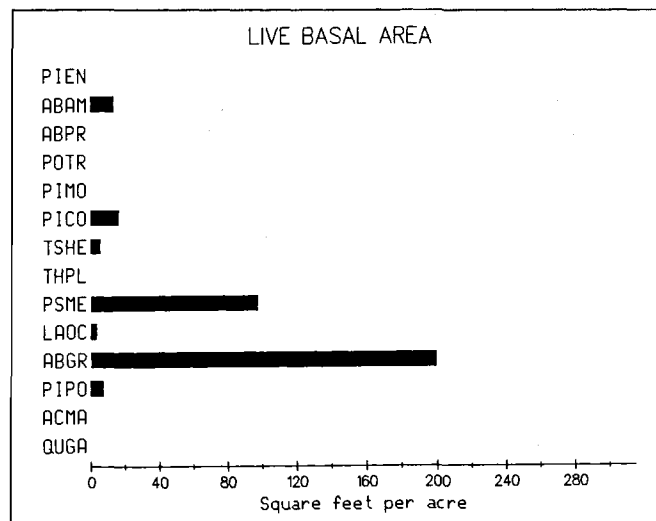
Dominant Vegetation			
	Code	%Cov	Cons
<b>Overstory Trees</b>			
Grand fir	ABGR	42	100
Douglas-fir	PSME	17	66
Lodgepole pine	PICO	20	16
Western larch	LAOC	3	33
Pacific silver fir	ABAM	10	33
Ponderosa pine	PIPO	4	16
<b>Understory Trees</b>			
Grand fir	ABGR	10	66
Pacific silver fir	ABAM	3	33
Western hemlock	TSHE	6	33
<b>Shrubs</b>			
Big huckleberry	VAME	8	100
Dwarf bramble	RULA	4	66
Creeping snowberry	SYMO	2	66
Vine maple	ACCI	15	16
<b>Forbs</b>			
Queencup beadlily	CLUN	8	83
Vanillaleaf	ACTR	5	100
False Solomonseal	SMRA	2	83
Sidebells pyrola	PYSE	3	100
Fairybells	DIHO	2	66
<b>Grasses &amp; Sedges</b>			
Elk sedge	CAGE	1	16

## Timber Productivity and Management

The cold Grand Fir Series sites represented by this association have lower timber productivity than most of this zone. Our sample plots include well-stocked stands dominated by Grand fir and Douglas-fir. Grand fir are particularly prevalent because of past fire suppression which has allowed sub-canopy individuals to survive to overstory status. Past management also selectively removed many western white pine (salvage of blister-rust damaged trees) and ponderosa pine individuals. The relatively cold environment presents the greatest challenge to timber managers. The grand fir are so prone to disease from physical damage that selective logging is likely to be unacceptable. Shelterwood harvests having Douglas-fir and western larch as leave trees will protect seedlings from frost and also provide seeds of high timer value species well-suited to these sites. Western white pine and a bit of ponderosa pine make good minor additions to the planting mix.

Site Index				Growth Basal Area		10 yr. radial Grwth (in/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PSME	100	97	13	305	33	10	2
ABGR	50	86	5	344	63	11	3

Yield Capacity ft <sup>3</sup> /ac/yr		SDI Growth Estimate ft <sup>3</sup> /ac/yr		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
92	19	169	29	431	209	502	41



## Wildlife, Range and Fuels

The high tree density in mature stands provides excellent hiding and thermal cover for big game. Browse and forage quantity and quality is fairly low in mature stands, but logged sites may support more palatable vegetation for several years while conifers struggle to reforest the site. Low forage quality and abundance indicate that mature stands are non-range for livestock. This association does not occur in winter range so forage seeding could only benefit transitory summer range. Our sample plots had only fairly small Douglas-fir and lodgepole snags, but this association could provide a greater diversity of snag species than most other vegetation types. It appears that many blister rust-killed western white pine were salvaged on sites having this association. Fuel treatments which avoid extensive burning will benefit rapid reforestation by allowing the survival of advance conifer regeneration.

Snags - Number/Acre n = 6					
Total/ Acre	Condition Class				
	1	2	3	4	5
21	0	1	9	7	4

## Soils

Soils are generally moderately deep with fairly low rock content. Surface horizons are predominantly weathered ash which is compactable when wet. It also appears to be good habitat for pocket gophers. Protecting the forest floor (duff) and large woody debris is important to maintain nutrients on-site and maintain the important ecosystem functions of these materials.

Number of Soil Pits:	4
Effective Soil Depth (cm):	73
Soil SurfaceTexture:	Sandy loam or loam
Parent Materials:	Basalt mixed with ash

## Similar Associations

The abundance of big huckleberry and queencup beadlily distinguish this association within the Grand Fir Series on the Gifford Pinchot National Forest. This association lacks species indicative of dryer or warmer environments, such as oceanspray, California hazel or Pacific dogwood. This type is transitional to the Pacific Silver Fir Series, as exemplified by the presence of some dwarf bramble, Pacific silver fir, broadleaf arnica and other species more abundant in wetter habitats than common in the Grand Fir Zone. The Grand fir/Big huckleberry association on the Warm Springs Indian Reservation is quite similar to this type. The ABGR/VAME/MIST2 association in the Blue Mountains (Hall 1988) and the ABGR/CLUN habitat type, TABR phase in Northern Idaho (Cooper et al. 1987) have many of the same plant species and occupy somewhat similar environments as this association.



Western redcedar/Vanillaleaf

*Thuja plicata*/*Achlys triphylla*

THPL/ACTR

CCF2 12

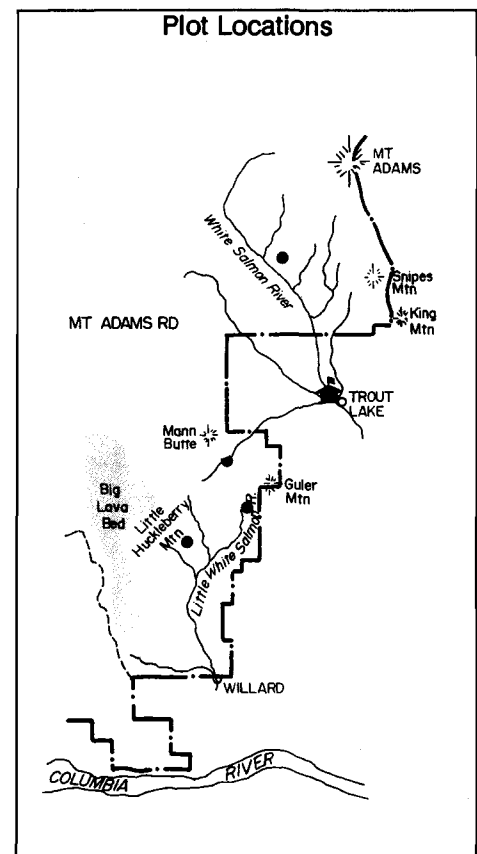


## Environment and Distribution

Sites having this association are found at fairly low elevations transitional to either Western Hemlock or Grand Fir Series vegetation. It occupies a fairly restricted area near valley bottoms in the Little White Salmon River drainage, Cave Creek and along the White Salmon River. The environment is fairly moist for the east slope of the Cascades. Evaporative demand is probably low because of the shaded, lower slope positions. The temperature regime is also moderate for this area. Although snow may accumu-

	Range	Average
Elevation (ft):	2400-3300	2909
Precipitation (in/yr):	58-86	68
Slope (%):	0-54	23

Number of Plots:	4 (Intensive = 4)
Common Aspects:	North and east
Topographic Positions:	Middle slopes to valley bottoms



THPL/ACTR

late, sites having this association probably remain snow-free for much of the year.

## Vegetation: Structure and Composition

The prominent feature of this association is the abundance of western redcedar in both the overstory and understory within mature forest stands. Douglas-fir and Grand fir dominate overstories. The presence of western hemlock and a little noble fir suggests that this association is transitional between the Western Hemlock and Pacific Silver Fir Series. Both the shrub and herb layers are usually fairly sparse. Occasional patches of vine maple (ACCI) are encountered, but other tall shrubs are usually absent. Most shrub layers consist of scattered baldhip rose (ROGY), creeping snowberry (SYMO) and dwarf Oregongrape (BENE). Vanillaleaf is the most prominent herb species; it is usually accompanied by lesser amounts of starflower (TRLA2), trillium (TROV), 3-leaved anemone (ANDE) or fairybells (DIHO).

### Dominant Vegetation

	Code	%Cov	Cons
<b>Overstory Trees</b>			
Douglas-fir	PSME	33	100
Grand fir	ABGR	23	100
Western redcedar	THPL	10	100
Western hemlock	TSHE	8	75
Western white pine	PIMO	10	25
<b>Understory Trees</b>			
Western redcedar	THPL	6	50
Western hemlock	TSHE	4	50
Grand fir	ABGR	3	25
<b>Shrubs</b>			
Vine maple	ACCI	8	75
Baldhip rose	ROGY	2	100
Dwarf Oregongrape	BENE	2	75
Creeping snowberry	SYMO	2	75
<b>Forbs</b>			
Vanillaleaf	ACTR	4	75
Fairy bells	DIHO	2	75
Starflower	TRLA2	2	100
Three-leaved anemone	ANDE	1	75
Pacific trillium	TROV	2	75

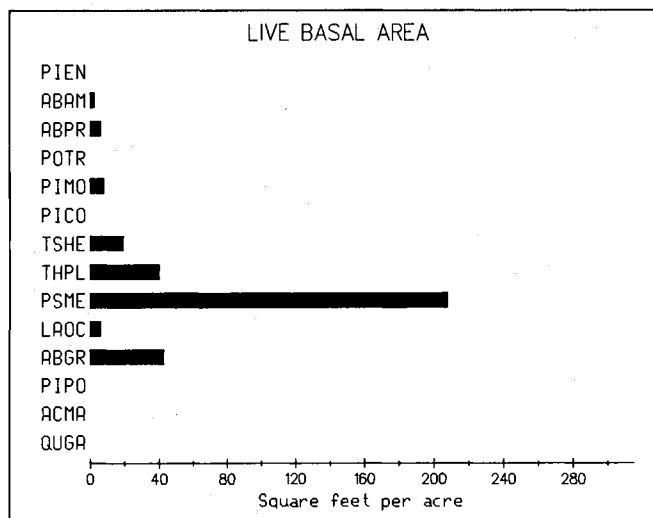
THPL/ACTR

## Timber Productivity and Management

Timber management in this association needs to consider the especially diverse tree populations as well as the common occurrence of sites near streams or in important winter range areas. Timber productivity is fair compared to the Grand Fir Zone, but our sample plots are very well stocked with large, old trees. Many of these sites offer excellent potential for uneven-aged management using group selection techniques. Such silviculture will result in minor disruptions to wildlife winter range and thermal cover needs and also assure the continual production of western redcedar, a high value timber species. Because some sites in this association have elevated water tables, heavy machinery should be used with caution, especially in winter and spring. This association offers an important opportunity to maintain the natural diversity of tree species on the Gifford Pinchot National Forest. Western redcedar and western larch should be encouraged in plantations, either by planting or leaving seed-trees. Large created openings may result in frost pockets because of the prevalence of this association in valley bottoms where cold air accumulates.

Site Index				Growth Basal Area		10 yr. radial Grwth (In/10)	
species	base	mean	s.e.	mean	s.e.	mean	s.e.
PSME	100	115	10	425	46	11	2
ABGR	100	71	4	368	4	9	3

Yield Capacity ft <sup>3</sup> /ac/yr		SDI Growth Estimate ft <sup>3</sup> /ac/yr		Trees per Acre #		Stand Density Index (SDI) trees/acre	
mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
131	17	171	26	400	180	571	107



## Wildlife, Range and Fuels

Mature stands in this association have high floristic diversity providing a great variety of structures and food for wildlife. Most sites are important winter range and have excellent thermal and hiding cover habitat. Besides having valuable site attributes, most stands are situated along major streams and so play a major role in providing safe migratory habitat. Clearcuts will rapidly revegetate with many palatable shrubs including vine maple, blue elderberry, currants, and blackberry where cool burns or no slash burning occurs. Seeding legumes and grasses can enhance transitory winter range for elk without unduly risking plantation establishment success. Low forage palatability in mature stands suggests that such stands are non-range for livestock. Our sample plots had abundant Grand fir, Douglas-fir and western redcedar snags which provide outstanding nesting and foraging habitat for a wide variety of animal species because these sites tend to be near streams. Similarly, down logs provide especially valuable herpetofauna habitat so fuels management should attempt to leave as much down woody debris on-site as possible.

Snags - Number/Acre n = 4					
Total/ Acre	Condition Class				
	1	2	3	4	5
26	12	2	8	4	0

## Soils

Soils in this association are moderately deep and generally have low rock content. Surface horizons are predominantly weathered ash which is compactable when wet. It also appears to be good habitat for pocket gophers. Protecting the forest floor (duff) and large woody debris is important to maintain nutrients on-site and maintain the important ecosystem functions of these materials.

Number of Soil Pits:	4
Effective Soil Depth (cm):	72
Soil SurfaceTexture:	Coarse sandy loam, loam or silt loam
Parent Materials:	Basalt mixed with weathered ash

## Similar Associations

This association is distinguished by its high abundance of western redcedar as well as some western hemlock. The understory is very diverse and includes more consistent, substantial amounts of mesic-site herbs (eg. coolwort foamflower, fairybells, 3-leaved anemone, and vanillaleaf) than most of the Grand Fir Series associations. The ABGR-THPL/ACTR association on the eastern portion of the Mt. Hood National Forest is similar, but has lower timber productivity, more Grand fir regeneration, and less western hemlock (Topik et al. 1988). The THPL/COCA association on the Yakima Reservation is also quite similar (John et al. 1988). Similar floristics and environments characterize the THPL/CLUN habitat types, CLUN phase described in Northern Idaho (Cooper et al. 1987) and Montana (Pfister et al. 1977).





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# **Appendix One**

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## **Canopy cover of main plant species by association**

**Percent cover is the average foliar cover for each species in each association calculated only for those plots where the species was present (zero cover values are excluded from the calculations).**

**Constancy is the percent of plots within an association having that species present.**

**Species are grouped by life form: Overstory trees, Understory trees, Shrubs, Forbs, Grasses and Sedges.**

# Appendix One

# PLOTS	PSME/ ACCI/ FEOC	ABGR/ CARU	ABGR/ CAGE (GP)	ABGR/ ACCI- BEAQ/ TRLA2	ABGR/ HODI (GP)
	3	2	6	8	8
	%COV CONS	%COV CONS	%COV CONS	%COV CONS	%COV CONS
<b>OVERSTORY TREES</b>					
ABAM					
ABGR	2 33	11 100	33 100	22 100	18 50
ABLA2			2 16		
ABPR					
ACMA					
LAOC			1 16		1 12
PICO			20 33		
PIEN					
PIMO			1 16		
PIPO		11 100	3 66	9 62	11 37
PSME	58 100	13 100	30 66	31 100	43 100
QUGA		2 50			3 25
THPL					
TSHE					
<b>UNDERSTORY TREES</b>					
ABAM					
ABGR	1 66	4 100	5 100	5 100	7 75
ABLA2			2 16		
ACMA	1 33				
PICO			15 16		
PIEN					
PIPO		8 50			
PSME		2 50	1 16		2 37
QUGA	1 33	1 50			4 25
THPL					
TSHE					
TSME					
<b>SHRUBS</b>					
ACCI	6 100		2 33	17 100	9 62
ACGLD	1 33		3 33	2 12	1 37
AMAL	2 66			2 25	3 50
BEAQ	1 33	1 50	1 16	2 100	2 37
BENE	3 100				3 62
CHME	1 33	1 50	2 16	2 75	1 62
CHUM	1 33	2 50	1 50	4 100	2 62
COCO2	6 100	6 50	12 50	4 87	17 62
CONU	1 66				1 25
HODI	3 66	10 50	1 33	2 50	15 100
LOCI	1 33		2 33	2 37	2 25
NONE					1 12
PAMY	1 33		1 50	2 87	2 25
ROGY	4 100	1 100	2 66	3 87	6 100
RULA				1 12	
RUPA			1 33	2 62	2 37
RUUR		1 100	2 16	2 87	2 37
SOSI			1 16		
SPBE	1 66		1 16	1 25	2 12
SYAL		5 50	4 33		
SYMO	12 100	4 100	2 83	6 100	9 87
VAME					1 25
VAOV				5 12	
VAPA					

# Appendix One (cont.)

# PLOTS	PSME/ ACCI/ FEOC		ABGR/ CARU		ABGR/ CAGE (GP)		ABGR/ ACCI- BEAQ/ TRLA2		ABGR/ HODI (GP)	
	3		2		6		8		8	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
<b>FORBS</b>										
ACTR			1	100	1	50	11	75	4	50
ADBI	1	66					1	12	3	25
ANDE									2	25
ANOR					1	33	2	50		
AQFO									1	12
ARLA									1	12
ARMA3	3	100	2	100	1	33	2	75	3	75
CASC2			1	50	2	33	1	12	1	37
CLUN					2	16	2	37	1	12
COCA										
COHE	2	33								
COMA3										
DIHO	1	33			1	33	3	50	1	25
GAAP			1	50	1	33				
GATR					2	50	2	50	1	25
GOOB			1	50	2	16	2	37	1	25
HAL	1	100	1	100	1	83	2	75	2	62
LIB02					1	16	17	50	2	25
MIDI									1	12
OSCH			1	50	1	50			1	25
POMU	1	33			1	16			1	25
POPU										
PTAQ			3	50			2	50	2	12
PYPI			1	50	2	33	1	100	1	37
PYSE			1	50	2	83	2	75	1	25
SMRA					1	33	1	37	1	25
SMST			1	50	3	50	3	75	1	62
TITRU									1	12
TRLA2	2	100			1	16	2	100	2	87
TROV					2	33	1	87	1	37
VAHE	1	33							2	37
VIGL							1	12		
VIOR2							2	12	2	12
WISE					1	16				
XETE										
<b>GRASSES &amp; SEDGES</b>										
BRVU	2	66								
CAGE	1	33	10	50	7	100	2	25	1	12
CARU			11	100						
ELGL			1	50						
FEID			1	50	5	16				
FEOC	3	66								
FESU	2	33								
KOCR			1	50						
POA	3	66			2	16	2	62	22	62

# Appendix One (cont.)

# PLOTS	ABGR/ SYMO/ ACTR 6		ABGR/ COCO2/ ACTR 10		ABGR/ BENE/ ACTR 10		ABGR/ CONU/ ACTR 10	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
<b>OVERSTORY TREES</b>								
ABAM							1	10
ABGR	60	83	14	70	16	50	25	30
ABLA2								
ABPR								
ACMA			10	10	11	20	6	60
LAOC								
PICO								
PIEN								
PIMO								
PIPO	5	83	8	20				
PSME	22	83	53	100	58	100	57	100
QUGA								
THPL							1	10
TSHE					2	10	10	10
<b>UNDERSTORY TREES</b>								
ABAM								
ABGR	5	66	6	90	3	50	7	50
ABLA2								
ACMA			5	10	1	10	2	30
PICO								
PIEN								
PIPO								
PSME			3	30			5	20
QUGA								
THPL								
TSHE					2	20	3	10
TSME								
<b>SHRUBS</b>								
ACCI	2	66	22	80	35	90	26	100
ACGLD	1	16					2	20
AMAL	2	50	3	40	3	40	2	30
BEAQ	1	16	1	20	1	30		
BENE	2	33	6	70	10	100	9	90
CHME	2	83	1	80	1	40	2	50
CHUM	3	83	3	50	2	50		
COCO2	2	66	12	100	2	40	6	80
CONU	1	33	3	60	2	60	17	100
HODI	1	16	3	60	3	40	3	30
LOCI	1	16	3	50	2	60	2	20
NONE								
PAMY	1	50	1	20	2	20	1	10
ROGY	2	100	6	100	4	100	4	100
RULA	2	16						
RUPA			2	40	1	70	2	70
RUUR	2	66	3	40	2	40	2	30
SOSI					1	10		
SPBE	1	16	1	20			1	20
SYAL			2	10				
SYMO	2	100	8	100	3	90	3	100
VAME					2	10	1	10
VAOV	1	16			5	10		
VAPA					1	30	2	20



# Appendix One (cont.)

# PLOTS	ABGR/ SYMO/ ACTR 6		ABGR/ COCO2/ ACTR 10		ABGR/ BENE/ ACTR 10		ABGR/ CONU/ ACTR 10	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
<b>FORBS</b>								
ACTR	10	100	4	90	10	90	27	100
ADBI	2	50	2	60	2	60	2	90
ANDE	1	16	3	40	2	60	3	80
ANOR							2	10
AQFO	2	33						
ARLA							1	10
ARMA3	3	66	3	80	2	70	4	80
CASC2	2	50	2	30	2	50	3	60
CLUN	2	16			2	60	3	80
COCA	1	16						
COHE			1	10	2	20	1	10
COMA3			1	10	1	10	1	30
DIHO	2	50	2	40	2	40	2	80
GAAP			1	10	1	10	1	10
GATR	2	50	2	50	2	70	3	70
GOOB	2	83	2	30	1	30		
HIAL	2	50	3	70	2	80	3	60
LIBO2	2	16	2	20	2	20	2	30
MIDI					1	10	1	10
OSCH	2	50	2	20	2	70	3	60
POMU	1	16	2	20	1	60	2	40
POPU								
PTAQ	1	50	3	20	1	10	2	10
PYPI	2	83	2	20	1	90	1	40
PYSE	3	66					2	30
SMRA	2	16	2	20	2	40	2	60
SMST	2	33	1	50	1	70	3	70
TITRU	6	50			2	20	2	40
TRLA2	2	66	5	90	3	90	5	90
TROV	2	66	1	50	2	20	2	50
VAHE	2	33	4	20	2	60	5	90
VIGL	2	33					2	10
VIOR2					4	40	2	50
WISE			2	20	1	20	2	20
XETE			3	10	2	10		
<b>GRASSES &amp; SEDGES</b>								
BRVU					1	10	1	30
CAGE			1	10				
CARU			2	20				
ELGL								
FEID								
FEOC	1	16					1	10
FESU							1	10
KOCR								
POA	2	33	4	50	3	50	3	30

# Appendix One (cont.)

# PLOTS	ABGR/ RUPA/ DIHO 11		ABGR/ VAME/ LIB02 2		ABGR/ VAME/ CLUN 6		THPL/ ACTR 4	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
<b>OVERSTORY TREES</b>								
ABAM					10	33		
ABGR	26	81	18	100	42	100	23	100
ABLA2								
ABPR	22	27					4	25
ACMA	16	18						
LAOC	3	9	2	100	3	33	5	25
PICO					20	16		
PIEN	10	9			1	33		
PIMO	2	18					10	25
PIPO	4	9	2	50	4	16		
PSME	39	100	23	100	17	66	33	100
QUGA								
THPL							10	100
TSHE					10	16	8	75
<b>UNDERSTORY TREES</b>								
ABAM	2	9			3	33		
ABGR	6	72	13	100	10	66	3	25
ABLA2								
ACMA	5	27						
PICO								
PIEN	4	9						
PIPO								
PSME	2	18	2	50			2	25
QUGA								
THPL							6	50
TSHE	1	9			6	33	4	50
TSME							1	25
<b>SHRUBS</b>								
ACCI	20	81	25	50	15	16	8	75
ACGLD	3	36	5	50	2	50		
AMAL	1	27	3	50				
BEAQ	1	9						
BENE	7	36	3	100	1	33	2	75
CHME	2	54	2	50	2	83	3	50
CHUM	2	36	2	50	1	83	3	50
COC02	4	63	4	100	2	16		
CONU	7	27	6	100			3	25
HODI	4	45			2	16		
LOCI	1	27	5	50			1	25
NONE	2	54	1	50	2	66	1	25
PAMY	3	27	3	50	1	66	4	25
ROGY	2	81	4	100	2	66	2	100
RULA	2	9			4	66	2	50
RUPA	11	100	5	50	1	50		
RUUR	1	27	4	100			2	75
SOSI	2	18			1	50	1	25
SPBE					1	16		
SYAL	1	9			1	16		
SYMO	5	81	15	50	2	66	2	75
VAME	3	54	45	100	8	100	1	25
VAOV							1	25
VAPA								

# Appendix One (cont.)

# PLOTS	ABGR/ RUPA/ DIHO 11		ABGR/ VAME/ LIB02 2		ABGR/ VAME/ CLUN 6		THPL/ ACTR 4	
	%COV	CONS	%COV	CONS	%COV	CONS	%COV	CONS
<b>FORBS</b>								
ACTR	12	100	6	100	5	100	4	75
ADBI	2	54	2	50	2	33	2	25
ANDE	2	72			3	33	1	75
ANOR								
AQFO	3	18			1	16		
ARLA					5	50		
ARMA3	2	81	2	50	1	50	2	25
CASC2	2	36			2	33		
CLUN	7	90	3	50	8	83	3	25
COCA	4	9					1	25
COHE	1	9						
COMA3	2	36			1	16	2	25
DIHO	11	90	4	100	2	66	2	75
GAAP	1	18			5	16		
GATR	3	81	3	50	2	33	2	50
GOOB	2	63			1	83	1	25
HIAL	1	36	3	100	1	50		
LIB02			19	100	2	33		
MIDI	2	18						
OSCH	3	63	3	50	2	33		
POMU					1	16	2	25
POPU	2	9			1	16	1	25
PTAQ	2	9					1	25
PYPI	2	63	3	50	2	66	2	50
PYSE	3	54	2	100	3	100	3	25
SMRA	3	72	1	100	2	83	2	50
SMST	3	81			4	50	2	50
TITRU	6	36			5	16	3	50
TRLA2	3	72	4	100	1	16	2	100
TROV	2	72	2	100	1	50	2	75
VAHE	3	54			3	16	5	25
VIGL	2	36	2	50	2	33	2	25
VIOR2	2	18			2	33		
WISE					1	33	3	25
<b>XETE</b>								
<b>GRASSES &amp; SEDGES</b>								
BRVU					1	16		
CAGE					1	16		
CARU								
ELGL								
FEID								
FEOC								
FESU								
KOCR								
POA	2	36			2	16		



## Appendix Two

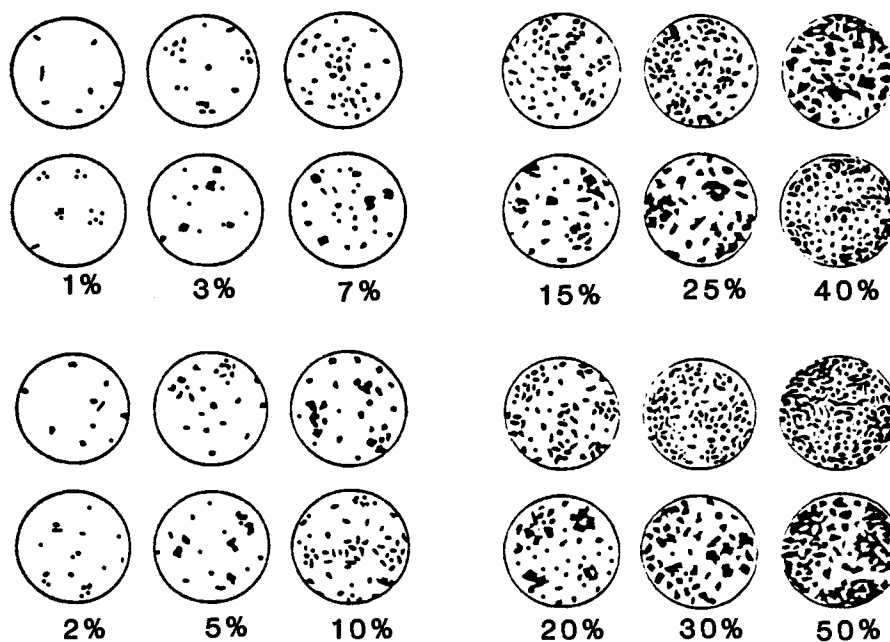
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### Charts used to estimate percent cover of both understory and overstory species.

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SOIL CONSERVATION SERVICE

#### COMPARISON CHARTS FOR VISUAL ESTIMATION OF FOLIAGE COVER 1



1. Developed by Richard D. Terry and George V. Chilingar. Published by the Society of Economic Paleontologist and Mineralogist in its Journal of Sedimentary Petrology 25 (3): 229-234, September, 1955.

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