A PRELIMINARY CLASSIFICATION OF FOREST COMMUNITIES IN THE CENTRAL PORTION OF THE WESTERN CASCADES IN OREGON

C. T. Dyrness, J. F. Franklin

Forestry Sciences Laboratory, USDA Forest Service, Corvallis, Oregon

and W. H. Moir

Rodeo, New Mexico

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ABSTRACT

Forest communities in the central portion of Oregon's western Cascades are arrayed along moisture and temperature gradients. With the aid of reconnaissance data and a computerized ordination technique, 23 forest communities have been provisionally recognized in two distinct forest zones, the *Tsuga heterophylla* (300 to 1050 m in elevation) and the *Abies amabilis* (1050 to 1550 m). The location of these zones is largely a function of temperature (elevation), while distribution of individual communities within a zone is controlled mainly by moisture availability. Eleven climax or near-climax associations and three seral communities were recognized within the *Tsuga heterophylla* zone. Associations range from the *Pseudotsuga/Holodiscus* on very dry sites to the *Tsuga/Polystichum-Oxalis* on wet sites. In the *Abies amabilis* zone, nine units were identified--seven climax or near-climax associations and two seral communities. Driest habitats in the zone are occupied by the *Abies--Tsuga mertensiana/Xerophyllum* association and wettest sites support the *Chamaecyparis/Oplopanax* association. Characteristics of all 23 forest communities are described and relationships among them are discussed.

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INTRODUCTION

In the past 15 years there has been considerable progress in classifying and describing the natural vegetation of Oregon. In forested areas this information has proved to be extremely useful in both management and research activities. A recent summary of available information on forest communities in Oregon and Washington (Franklin and Dyrness 1973) shows, however, that very few data have been collected for the forest vegetation on the western slopes of the Cascade Range in Oregon.

The subject of this paper is a reconnaissance-level study of the forest vegetation of the western Cascades initiated in 1967. The major portion of this work is centered on the H. J. Andrews Experimental Forest, an intensive study site for the Coniferous Forest Biome of the International Biological Program. The information presented here is being used to stratify areas for the extensive ecological research planned for this program. In order to make the results of the study as widely applicable as possible, additional stands were sampled both to the north and south of the Andrews Forest. These additional sampling areas extended to the Santiam River drainage on the north and to the South Fork of the McKenzie River on the south. Thus the total area studied amounted to some 64 km (north-south) by 32 km (east-west). This area encompasses portions of the *Tsuga heterophylla*, *Abies amabilis*, and *Tsuga mertensiana* zones as defined by Franklin and Dyrness (1973).

Primary objectives of the study were to devise a workable classification of the rather complex forest vegetation and to describe the resultant units in a preliminary manner. A reconnaissance approach to data collection was adopted in order to allow for the sampling of a large number of stands representing the entire range of sites available. The classification procedure was facilitated by the use of computer ordination of sampled stands.

The only vegetation classification work conducted in the area prior to the present study was associated with studies of plant succession following logging and slash burning (Dyrness 1965, Rothacher et al. 1967). Six forest communities were tentatively defined, all within the *Tsuga heterophylla* zone at rather low elevations. With one exception, these units also have been recognized in the present study and are here defined much more satisfactorily.

Other Oregon work involving forest community classification in the *Tsuga heterophylla* zone has been limited largely to the Coast Range. Corliss and Dyrness (1965), working in the Alsea River drainage, identified ten reoccurring plant communities and used these units in mapping the vegetation of the area. These plant groupings spanned a moisture gradient ranging from *Pseudotsuga menziesii/Holodiscus discolor/Gaultheria shallon* at the dry end to *Tsuga heterophylla/Polystichum munitum--Oxalis oregana* on very moist sites. Bailey (1966) identified and described five climax associations in the southern Oregon Coast Range; they are, from very moist to dry: *Thuja/Adiantum-Athyrium*, *Tsuga/Polystichum/Oxalis*, *Tsuga/Acer/Berberis*, *Tsuga-Pseudotsuga/Rhododendron/Berberis*, and *Pseudotsuga/Holodiscus/Gaultheria*. Bailey and Poulton (1968) also described a number of seral communities in the Tillamook Burn.

Descriptive work within communities representative of the higher elevational *Abies amabilis* and *Tsuga mertensiana* zones in the Cascade Range is limited to Washington. Franklin (1966) recognized 15 distinctive plant associations within true fir-hemlock stands in the southern Washington Cascade Range. He identified the *Abies amabilis/Vaccinium alaskaense* association as the climatic climax in the *Abies* zone of the Mount Rainier Province. In the Mount Adams Province the comparable association was the *Abies--Tsuga heterophylla/Vaccinium membranaceum*. Franklin identified the *Abies amabilis--Tsuga mertensiana/Vaccinium membranaceum* association as the climatic climax in the southern Washington *Tsuga mertensiana* zone.

DESCRIPTION OF STUDY AREA

Elevations within the study area range from about 500 to 1600 m. The topography is well dissected and mature, especially at lower elevations, with an abundance of steep slopes. There are some areas at higher elevations (above 1000 m) that exhibit gentle slopes, poorly developed drainage patterns, and hummocky relief. Rock escarpments also occur at scattered locations throughout the area. In some areas, notably along the McKenzie River, local valley glaciation during the Pleistocene undoubtedly influenced present day landforms. Most geomorphic surfaces in the area, however, are post-Pleistocene in age. Available evidence indicates that most landforms have resulted from mass wasting processes (mainly landslides and soil creep), coupled with removal of the products of this erosion by stream action.

Bedrock in the study area is composed entirely of Tertiary volcanic rocks. Peck et al. (1964) have mapped and described three main geologic types: Little Butte Volcanic Series, Sardine Formation, and volcanic rocks of the High Cascades. The Little Butte Volcanic Series, found at lowest elevations, originated during the Oligocene and early Miocene. It is made up largely of massive beds of andesitic and dacitic tuff, with smaller amounts of mostly flows and breccia of olivine basalt and andesite. The Sardine Formation, deposited on top of rocks in the Little Butte Series, was laid down during middle to late Miocene times. Thick hypersthene andesite flows compose more than half the formation. The remainder of the Sardine is made up of massive tuff breccia originating from mudflow, ash flow, or landslide deposits.

High Cascade volcanic rocks, as mapped by Peck et al. (1964), include andesitic and basaltic flows and breccia of Pliocene and Pleistocene age. Recent studies, however, indicate that "these areas of 'High Cascade' rocks which have been mapped within the western Cascade Province are not to be associated in time or place of origin with High Cascade volcanism" (Taylor 1968). Thus these rocks are now considered to be part of the Eocene to Miocene volcanic rocks of the western Cascades.

A soil survey of the H. J. Andrews Forest resulted in the mapping and description of twelve soil series.[1] These soils can be conveniently

[1]F. Stephens. Soil survey report of the H. J. Andrews Experimental Forest, Willamette National Forest. Inservice report, 1964, USDA For. Serv., Pac. Northwest For. Range Exp. Stn., Corvallis, Oreg. 85 p. (mimeo.)

grouped into six soil associations.

1. Reddish Brown and Yellowish Brown Lateritic soils are located at low to medium elevations on moderate slopes. These soils are found in residuum and colluvium from tuff and breccia bedrock and are generally silt loam to silty clay loam in texture.

2. Lithosols and Regosols are found at low to medium elevations on generally steep slopes. They have poorly developed profiles and lack B horizons.

3. Soils found in deep landslide material, generally andesitic, are found at moderate to high elevations. These soils most often have weak profile development and textures ranging from loam to sandy loam.

4. Ando-like soils, derived from andesite or basalt, are located at medium to high elevations on a variety of slopes. Soils are generally dark brown or black silt loams.

5. Brown Podzolic soils occupy the high divide ridges of the forest. Such soils are loam textured and are derived from andesite or basalt.

6. Alluvial soils occupy terrace positions along major streams and are of limited extent.

Climatic conditions are typical for this maritime area--mild, wet winters and warm, dry summers. At a low elevation in the H. J. Andrews Forest, the January mean temperature is 2.3°C and the July mean is 20.6°C (Rothacher et al. 1967). Extreme temperatures range from about -18°C to 38°C. Annual precipitation averages about 2300 mm at lower elevations and may amount to over 2500 mm on some higher ridges. Amounts of snowfall increase with elevation; higher areas in the *Abies amabilis* zone have a winter snowpack of 1-3 m. Because of high temperatures and low precipitation during summer months, potential evapotranspiration exceeds available water supplies by about 84 mm. Calculated potential evapotranspiration for the H. J. Andrews is about 538 mm (Rothacher et al. 1967).

Wildfires in the study area have resulted in timber stands of two general age classes, either 125 or 450 years. The 450-year-old stands are generally dominated by *Pseudotsuga menziesii* averaging 120-140 cm dbh and 45-75 m in height, with timber volumes averaging 350-750 m^3/ha. The 125-year-old forests, sometimes called "second growth," are typically dominated by *Pseudotsuga menziesii* (*Tsuga heterophylla* zone) or *Abies procera* (*Abies amabilis* zone).

METHODS

Collection of Data

A large sampling that covers the broad spectrum of environmental variation is important where the primary objective is the initial stratification of vegetation into relatively homogeneous and easily recognizable units. We used a reconnaissance method of vegetation sampling to accomplish both a regional survey and an initial vegetation classification of the central portion of the western Cascades in Oregon. Our main sampling objectives,

for which reconnaissance techniques seemed advantageous, were to acquire data over a wide range of environments and to ensure a reasonable degree of completeness in representation of different stand types. Thus we needed a large number of sample data in a comparatively short sampling period.

Circular plots approximately 15-20 m in diameter were located in areas of vegetation homogeneity as judged visually. Each plot was at or near the center of an appreciably larger area of similar vegetation homogeneity to ensure that edge effects were not reflected in the sample. We also avoided areas of recent natural or man-caused disturbance or those that lacked reasonable uniformity of soil, slope, aspect, or other important physical or landform features. We attempted to locate plots at all elevations, slopes, aspects, and soil types in approximate proportion to their importance in the region. A total of 300 plots was sampled: 235 within the H. J. Andrews Experimental Forest; 27 south and east of the Andrews, mostly in the general area of the South Fork of the McKenzie River; 25 in the Santiam River drainage; and 13 in the Wildcat Mountain Research Natural Area north of the Andrews Forest.

In each circular plot visual estimates were made of canopy coverage (Daubenmire 1959) of each understory vascular plant species. These estimates were made to the nearest percentage up to 10% and to the nearest 5% thereafter. Abundance and canopy coverage were visually estimated for all tree species of both mature and reproductive size classes. Abundance was estimated by class (abundant, common, occasional, rare) and coverage to the nearest 5%. Estimates were also made of tree canopy density (four classes from very dense to very open), forest age by class (450-year-old, old-growth with dense pole understory, 200- to 300-year growth, 125-year-old second-growth, second-growth with scattered old trees), and classes of site quality (height in relationship to age of dominant and codominant trees).

Environmental data from each plot included landform, elevation, slope, and aspect. A soil profile description in an area of representative understory vegetation provided information on soil series and thickness, color, stoniness, texture, and structure of exposed horizons. Estimates were also made of the effective rooting depth and conditions of internal drainage within the profile.

Details of the reconnaissance method of data collection used in this study are contained in an earlier paper (Franklin et al. 1970).

Analysis of Data

Vegetation data were subjected to ordination analysis using SIMORD, a reference stand technique (Dick-Peddie and Moir 1970). A total of 50 vegetation characteristics from both tree and understory species were chosen as classificatory descriptors. Plots from distinct and extreme environments were selected as end reference stands of an environmental axis on the basis of either the classifier's ecological judgment or from a computer search of eligible plots. All other plots were then arranged along this axis according to their similarities and dissimilarities to the reference-stand plots (at the ends of the axis). Plots equally dissimilar to both stands remained at the center of the axis. Similarity

between plots i and j was calculated as:

$$SIM(i,j) = \frac{1}{n} \sum_{K=1}^{50} \frac{2 \min (a_{ik}, a_{jk})}{a_{ik} + a_{jk}}$$

where a_{ik} and a_{jk} are values of the kth vegetation descriptor in each plot.

To minimize contributions of minor and accidental species to the similarity value the summation was eliminated whenever a particular descriptor was less than some dominance value (we used 3% cover) in both plots. When high dominance values are employed in the calculation of similarities the resultant ordination is based upon comparatively few, major species; conversely, a low dominance value (1%) always uses the full set of 50 descriptors in all similarity computations.

After end reference stands for X and Y axes were selected, we evaluated the ordination by two criteria: (1) was the environmental field represented by the ordination plane reasonably square, and (2) were dissimilar forest plots placed close together in the plane. A square ordination field implies that the X and Y axes are independent and represent fundamentally distinct environmental gradients. The square field must be filled with sample plots for assurance that the complex environmental gradients extending from one reference stand to the other at the corners of the field represent actual environmental conditions in the study area and not artifacts (Figure 1). The second criterion was a test of the ordination efficacy in identifying important environmental gradients that affect the distribution and dominance of most species used as classifiers. If highly dissimilar plots are proximate in the ordination plane, then causative environmental factors of vegetation distribution have not been resolved, for those plots.

Our initial ordinations involved all 300 plots and were not satisfactory. We decided, therefore, to stratify plots into two groups--those belonging to the high-elevation *Abies amabilis* zone and those found within the low-elevation *Tsuga heterophylla* zone. The two sets totaled 82 and 218 plots, respectively. In each zone we used a different set of 50 classifiers. Several SIMORD runs finally yielded satisfactory reference stands and ordinations in both zones.

Association tables were also developed from the plot data. The position of each forest plot in its appropriate ordination plane was an important clue to finding similar plots from the collection of 300. The tables were thus constructed, in part, on the basis of clusterings in the ordination planes; but other important criteria not used in the ordinations nevertheless influenced the development and resolution of associations. Decisions to include any doubtful plot in one or another association were aided by examination of the similarity matrix containing the doubtful plot and all plots from the related associations. Plots within an association usually show high similarities to each other and low similarities (under 30%) to plots of other associations. For certain plots, however, decisions to include or exclude in particular associations were not based upon similarities. Consideration was given to the seral status of the plot as shown

by the age structure of trees or by representation of characteristic understory species such as *Pteridium aquilinum*. Definitive association features often include a narrow range of soil or site characteristics that help decisions about doubtful plots. In some instances site quality was useful in distinguishing between associations.

RESULTS AND DISCUSSION

Interpretation of the Ordinations

Within any geographic region numerous biotic and physical factors limit the distribution and representation of any particular species. Seldom is it possible to implicate and quantify a single, particular environmental factor, such as the water-holding capacity of the A soil horizon, as a primary control for different species over the entire range of environments within the region. Gradient analysis, however, is a useful analytical technique for simultaneously resolving the distribution of numerous species along one or several major environmental gradients, each incorporating in complex manners a number of related, causative biotic and abiotic factors. The theory and techniques of gradient analysis have been reviewed and discussed by Whittaker (1967) and McIntosh (1967). Along complex environmental gradients different species are variously distributed according to their adaptive tolerances and competitive abilities. The relative proportion of species in any given stand is an expression of these tolerances and abilities for utilizing critical resources of that particular environment at that time. Two stands of the same seral status and having similar vegetation are presumed to have the same underlying availability of critical environmental resources. If some set of causative environmental factors varies slightly between two stands, then the relative proportions between certain species also shift so that the two stands become slightly dissimilar. If these factors become more and more extreme, species tolerant of the original factors may be replaced by other species until few common species exist in both stands.

Reference-stand ordination defines complex environmental gradients according to environments represented by the selected stands. Vegetation plots arranged in a floristically continuous manner represent intergrading environments from one end reference stand to the other. If environmental differences between the reference-stand plots are of only minor causative significance, then many dissimilar stands will be positioned together and erratic, haphazard distribution of most species will result along the gradient.

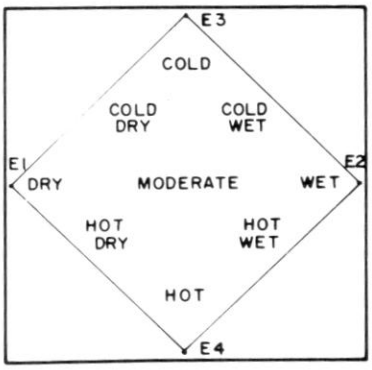


Figure 1. Generalized environmental field in the X-Y ordination plane. The field is defined by extreme environments of reference-stand plots E1, E2, E3, and E4. The X and Y axes are environmental gradients of complex moisture and complex temperature factors.

Our ordinations yielded two primary complex environmental gradients. Reference-stand plots for the *X* axis represented highly divergent environmental conditions along a complex moisture gradient. The *Y* axis represented a complex temperature (or thermal) gradient. The generalized ordination plane is shown in Figure 1. More detailed descriptions of these gradients in each vegetation zone are given and discussed below.

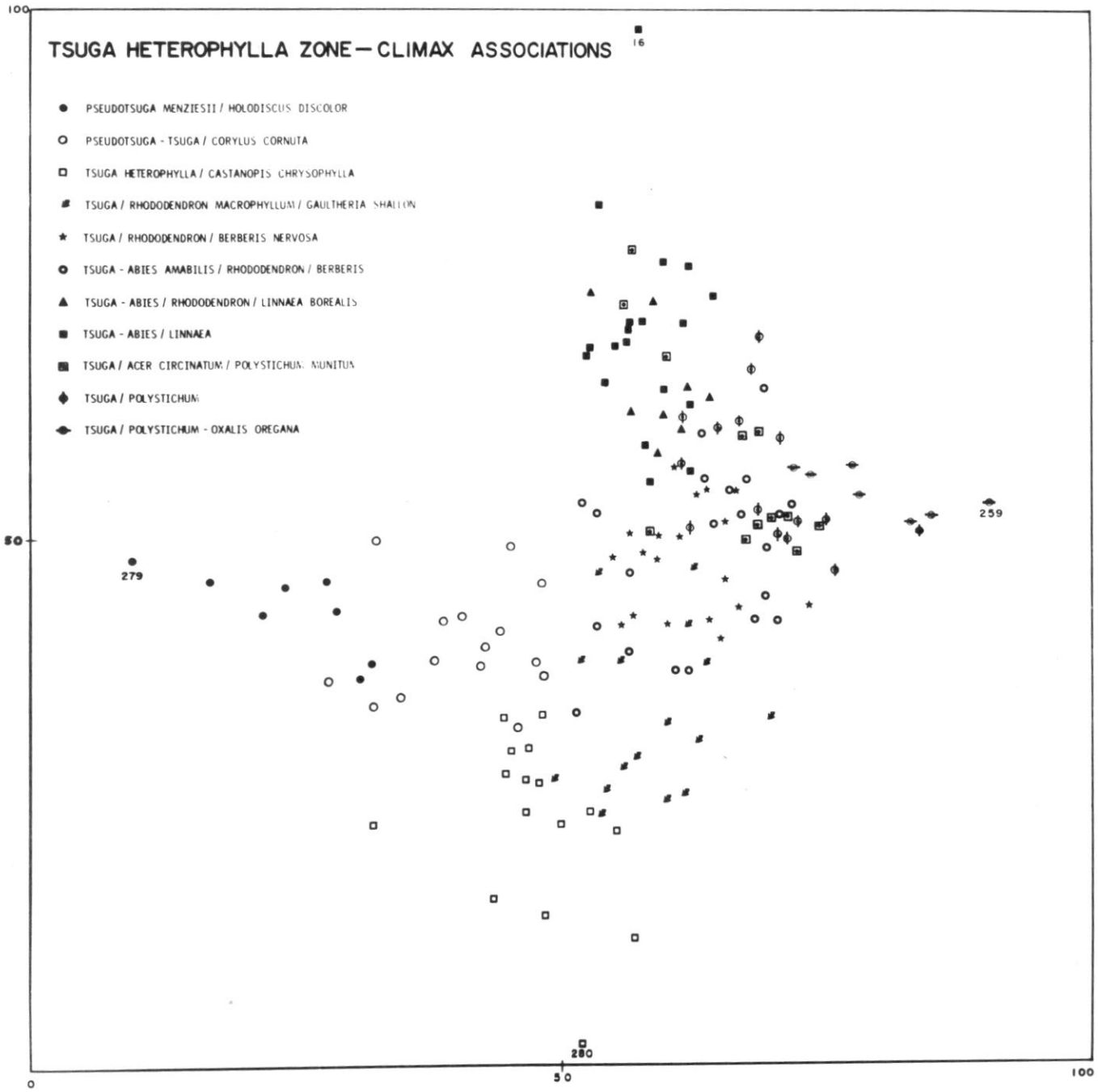


Figure 2. Two-dimensional ordination of stands representative of climax associations within the *Tsuga heterophylla* zone.

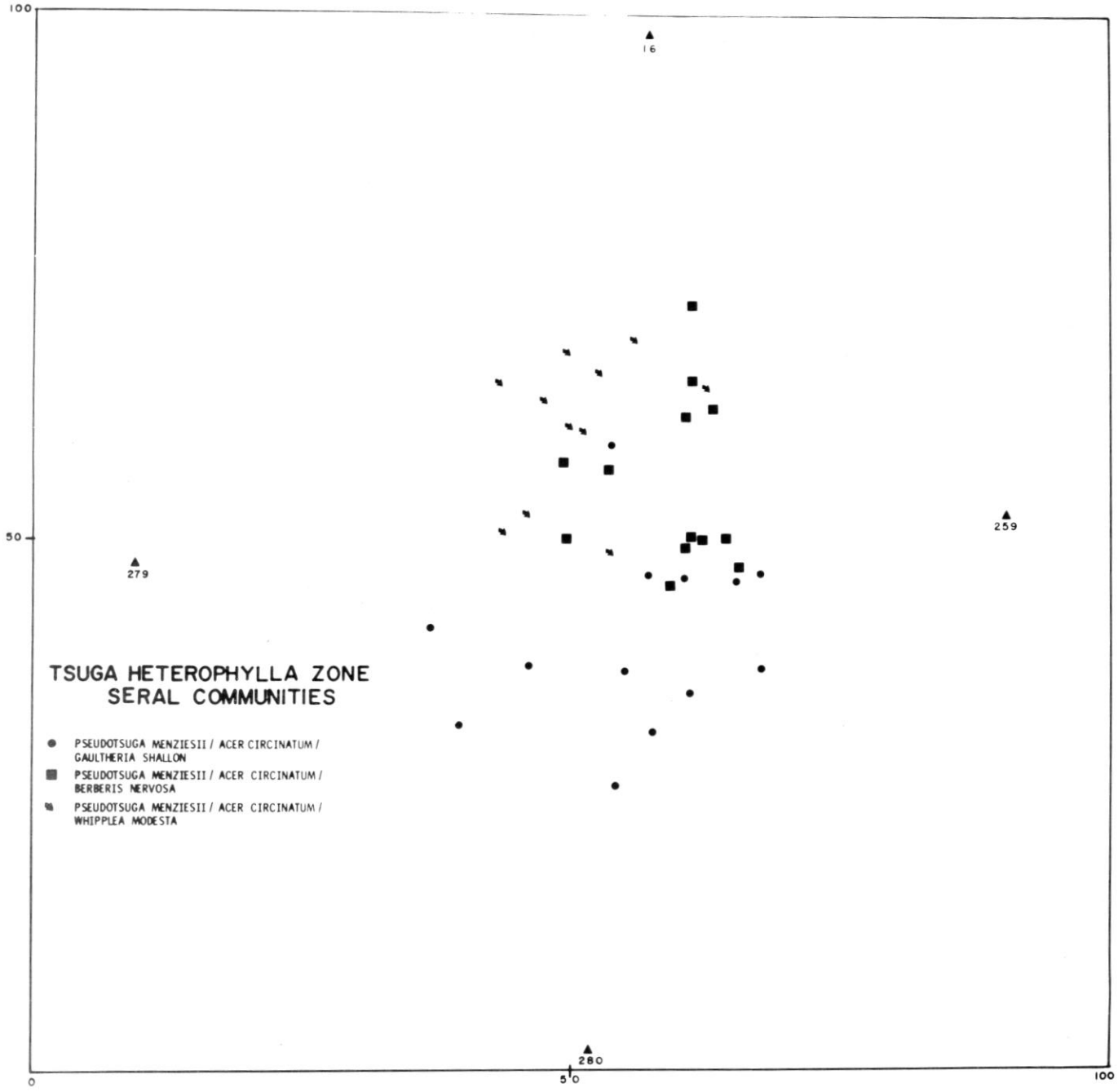


Figure 3. Two-dimensional ordination of stands representative of seral communities within the *Tsuga heterophylla* zone.

Tsuga heterophylla *(Tshe) zone*

Plots 279 and 259 were selected at extreme dry and wet ends, respectively, of the complex moisture gradient (Figures 2 and 3). Plot 279 of the *Pseudotsuga menziesii/Holodiscus discolor* association is situated at 520 m elevation on a steep (65% slope) midslope of southwest-facing exposure. Dominant trees are young-growth Douglas-fir of poor growth rates and moderate (50%-60%) overstory canopy density. Douglas-fir is extremely abundant in reproductive strata of the understory, but other tree species are absent in these strata. Herbs and shrubs are very sparse, principal species being *Holodiscus, Whipplea modesta,* and *Berberis nervosa.* These vegetation and site characteristics suggest generally a very dry environment. Soil profile features in plot 279 were not described, but similar plots from the same association have deep, well-drained but stony (20%-80%) profiles with thin (5-15 cm) A1 horizons.

Plot 279 represents the wettest forest environment of the *Tsuga heterophylla* zone. It is located on a steep (60%), north-facing lower slope at 430 m elevation. The deep, well-drained soil is somewhat atypical among similar plots in its high degree of stoniness (50%-80%). The A1 horizon is very thin. Dominant trees are western hemlock and Douglas-fir of very high growth rates. Western redcedar and bigleaf maple are minor trees of the overstory. Western hemlock and redcedar are the only tree species reproducing. Major understory herbs and shrubs include *Oxalis oregana, Polystichum munitum,* and *Acer circinatum.* These three species account for 65% canopy coverage.

The broad gamut of environments between the extremes of plots 279 and 259 accounts for most of the variations in the complex moisture regimes of the study area. Among factors contributing to the complex moisture gradient are seasonal evaporation stresses as affected by elevation and exposure; patterns of rainfall and runoff that are influenced by landform and position of forest plots in the landscape; soil factors affecting internal drainage, effective rooting depth, and water-holding capacity; atmospheric factors of wind, temperature, and solar radiation; and the degree to which all these influences are modified by variations in vegetation structure. Our designation of the *X* axis as a complex moisture gradient recognized the subtle variations and potentially interactive effects of each of these possible influences in the range of dry to wet environments as defined by the extremes of plots 279 and 259.

Plots 280 and 16 were chosen as reference stands for the *Y* axis. The former, of the *Tsuga/Castanopsis* association, occurs on a low-elevation (430-m) ridgetop of moderate (40%), southwest-facing slope. By contrast, plot 16, of the *Tsuga-Abies/Linnaea* association, is found at high elevation (1040 m) on a nearly level (3% slope) bench. Both plots have very low vegetation similarities to plots 279 and 259 of the complex moisture gradient (*X* axis) and are at "moderate" positions near the center of that gradient. The pronounced elevational and site differences between plots 280 and 16 suggest that they define a complex temperature gradient from low to high elevations. Plot 280 at the hot extreme contains Douglas-fir as the sole overstory tree dominant. There is no evidence in this plot of any successful tree reproduction, but in similar stands of the same association both Douglas-fir and western hemlock can be well represented in understory strata. Dominant

shrubs are *Gaultheria shallon*, *Rhododendron macrophyllum*, and *Castanopsis chrysophylla*, whose collective cover totals 156%. Herbs have negligible coverage.

At the high-elevation, cool extreme of the temperature gradient plot 16 is dominated by Douglas-fir and Pacific silver fir in the mature overstory. The latter shares with western hemlock reproductive potential in the plot. *Acer circinatum* is the main shrub (15% cover), and the herb layer is dominated by *Linnaea borealis*, *Viola sempervirens*, and *Coptis laciniata* (collectively 95% cover).

The range of environments between plots 280 and 16 encompasses the remaining 216 plots of the *Tsuga heterophylla* zone. Temperature lapse rates, length of growing season, air drainage patterns in mountain topography, and many other atmospheric and soil factors contribute to the complex temperature gradient.

Abies amabilis *zone*

The *Abies amabilis* zone presented a more difficult problem in the selection of end-reference-stand plots because of relatively obscure moisture and temperature gradients. For this reason, although we selected the stands at extremes of the complex moisture gradient (*X* axis), the *Y* axis stands were computer selected. This measure resulted in valuable insights into vegetational relationships, which aided considerably in the formulation of community classification criteria.

In the resultant ordination of *Abies amabilis* zone stands there were no stands in the warm-dry portion of the ordination plane (Figure 4). Such warm-dry sites do exist, but they were not included within our sample. In the area studied these sites support meadow vegetation or very open stands of young *Pseudotsuga menziesii*, *Abies grandis*, *Libocedrus decurrens*, and *Quercus garryana*. These stands, studied by D. B. Zobel (unpublished MS), are those in which *Abies grandis* reaches its greatest relative importance at high elevations.

Plots 276 and 265 were selected at extreme dry and wet ends, respectively, of the complex moisture gradient. Plot 276 of the *Abies amabilis--Tsuga mertensiana/Xerophyllum tenax* association is located at 1620 m elevation on a 40% smooth slope with a southeast aspect. Dominant trees are primarily 130-year-old, poorly growing mountain hemlock with a moderately dense (70%-80%) canopy. The only tree reproduction is represented by scattered stems of Pacific silver fir and mountain hemlock. The shrub layer is very poorly developed, consisting entirely of scattered *Vaccinium membranaceum*. The herb layer is made up of a fairly dense stand of *Xerophyllum tenax* with virtually no additional species. The soil contains more than 50% stones and the effective rooting depth is estimated at less than 1 m. Both vegetative and site characteristics are indicative of dry growing conditions.

Plot 265 represents comparatively wet growing conditions within the *Abies amabilis* zone and is classed with the *Abies amabilis/Tiarella unifoliata* association. It is situated on a level stream terrace at 1010 m elevation. The soil is deep and well drained. The overstory is made up of Pacific

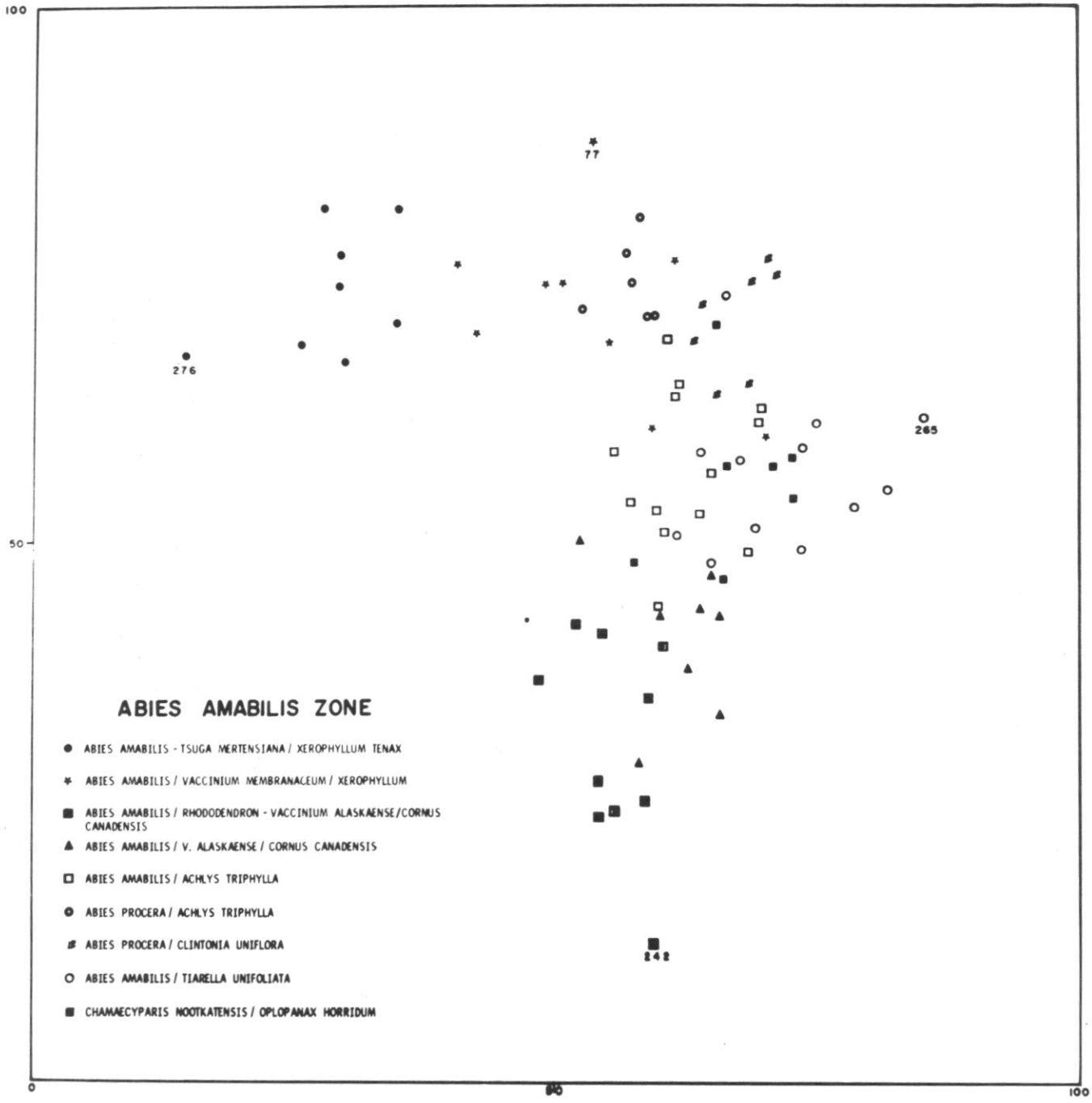


Figure 4. Two-dimensional ordination of stands within the *Abies amabilis* zone.

silver fir and Engelmann spruce of moderate density (70%-80% canopy coverage). Tree reproduction is predominantly silver fir and western hemlock. Three species make up the bulk of understory cover--*Tiarella unifoliata*, *Smilacina stellata*, and *Clintonia uniflora*. Together these three species total 80% cover.

The computer-selected end reference stands for the *Y* axis were plots 242 and 77. Plot 242 is representative of the *Abies amabilis/Rhododendron--Vaccinium alaskaense/Cornus canadensis* association and is located on a 40% north-facing slope at an elevation of 910 m. Plot 77 is classed with the *Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax* association and occupies a ridgetop position at a considerably higher elevation (1280 m). The vegetational and elevational difference between these end reference stands indicates that once again the gradient along the *Y* axis represents, at least partially, a complex temperature gradient. This gradient is not nearly so pronounced as the *Tsuga heterophylla* zone *Y* axis and other factors are undoubtedly as important. The fact remains, however, that selection of plots 242 and 77 as end reference stands resulted in a good distribution of points across the ordination plane and successfully eliminated pileup of points along the midportion of the *X* axis.

Description of Forest Communities

A total of 23 plant groupings were identified. These include 11 climax or near-climax associations and three seral communities in the *Tsuga heterophylla* zone and seven climax and two seral units in the *Abies amabilis* zone. A diagramatic representation showing our preliminary interpretation of environmental relationships among these communities is shown in Figure 5.

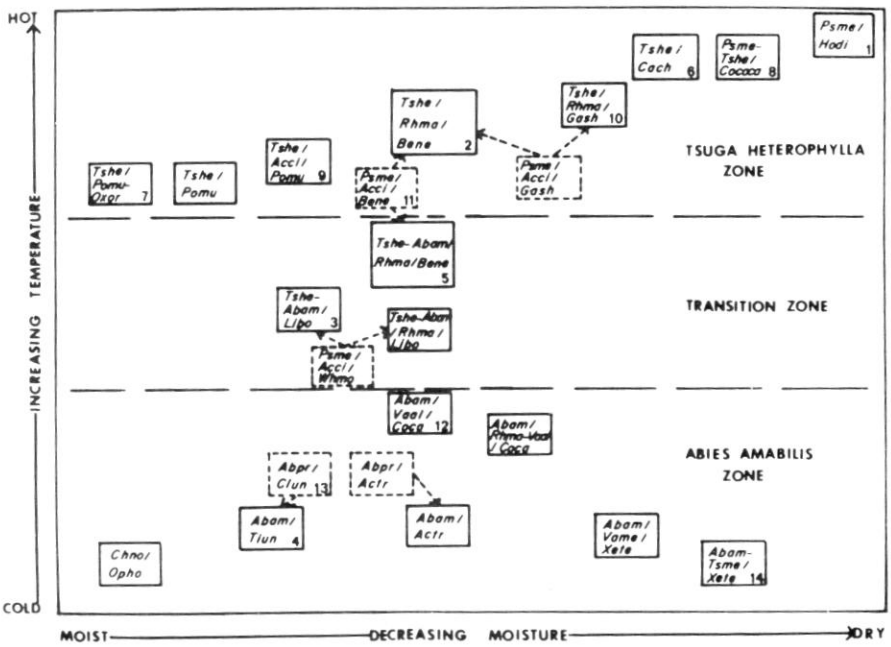


Figure 5. Hypothesized relationships among 23 forest communities of the western Cascades showing their inferred relative position along moisture and temperature gradients.

The four units labeled "transitional" are included within the *Tsuga heterophylla* zone even though they share many characteristics with the *Abies amabilis* zone.

The forest communities, listed in approximate order of increasing effective moisture, are as follows:

1. *Tsuga heterophylla* zone
   - 1.1. *Pseudotsuga menziesii/Holodiscus discolor* (Psme/Hodi)
   - 1.2. *Pseudotsuga menziesii--Tsuga heterophylla/Corylus cornuta* v. *californica* (Psme-Tshe/Cococa)
   - 1.3. *Tsuga heterophylla/Castanopsis chrysophylla* (Tshe/Cach)
   - 1.4. *Pseudotsuga menziesii/Acer circinatum/Gaultheria shallon*[2] (Psme/Acci/Gash)
   - 1.5. *Tsuga heterophylla/Rhododendron macrophyllum/Gaultheria shallon* (Tshe/Rhma/Gash)
   - 1.6. *Tsuga heterophylla/Rhododendron macrophyllum/Berberis nervosa* (Tshe/Rhma/Bene)
   - 1.7. *Tsuga heterophylla--Abies amabilis/Rhododendron macrophyllum/Berberis nervosa* (Tshe-Abam/Rhma/Bene)
   - 1.8. *Pseudotsuga menziesii/Acer circinatum/Berberis nervosa*[2] (Psme/Acci/Bene)
   - 1.9. *Pseudotsuga menziesii/Acer circinatum/Whipplea modesta*[2] (Psme/Acci/Whmo
   - 1.10. *Tsuga heterophylla--Abies amabilis/Rhododendron macrophyllum/Linnaea borealis* (Tshe-Abam/Rhma/Libo)
   - 1.11. *Tsuga heterophylla--Abies amabilis/Linnaea borealis* (Tshe-Abam/Libo)
   - 1.12. *Tsuga heterophylla/Acer circinatum/Polystichum munitum* (Tshe/Acci/Pomu)
   - 1.13. *Tsuga heterophylla/Polystichum munitum* (Tshe/Pomu)
   - 1.14. *Tsuga heterophylla/Polystichum munitum--Oxalis oregana* (Tshe/Pomu-Oxor)

2. *Abies amabilis* zone
   - 2.1. *Abies amabilis--Tsuga mertensiana/Xerophyllum tenax* (Abam-Tsme/Xete)
   - 2.2. *Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax* (Abam/Vame/Xete)
   - 2.3. *Abies amabilis/Rhododendron macrophyllum--Vaccinium alaskaense/Cornus canadensis* (Abam/Rhma-Vaal/Coca)
   - 2.4. *Abies amabilis/Vaccinium alaskaense/Cornus canadensis* (Abam/Vaal/Coca)
   - 2.5. *Abies procera/Achlys triphylla*[2] (Abpr/Actr)
   - 2.6. *Abies amabilis/Achlys triphylla* (Abam/Actr)
   - 2.7. *Abies procera/Clintonia uniflora*[2] (Abpr/Clun)
   - 2.8. *Abies amabilis/Tiarella unifoliata* (Abam/Tiun)
   - 2.9. *Chamaecyparis nootkatensis/Oplopanax horridum* (Chno/Opho)

1. Tsuga heterophylla *zone*

1.1. Pseudotsuga menziesii/Holodiscus discolor *(Psme/Hodi) association.* The *Pseudotsuga/Holodiscus* association represents the driest sites within the *Tsuga heterophylla* zone. It is the only community in this zone that is virtually entirely lacking in *Tsuga* reproduction (Table 1). Stands of

[2]Seral community.

Table 1. Average cover and constancy values (in percent) for important plant species in 14 forest communities in the *Tsuga heterophylla* zone.

Species		Psme/Hodi		Psme-Tshe/Cococa[a]		Tshe/Cach		Psme/Acci/Gash		Tshe/Rhma/Gash		Tshe/Rhma/Bene		Tshe-Abam/Rhma/Bene		Psme/Acci/Bene		Psme/Acci/Whmo		Tshe-Abam/Rhma/Libo		Tshe-Abam/Libo		Tshe/Acci/Pomu		Tshe/Pomu		Tshe/Pomu-Oxor	
		Cov.	Con.	Cov.	Con.	Cov.	Con.	Cov.	Con.	Cov.	Con.	Cov.	Con.	Cov.	Con.	Cov.	Con.	Cov.	Con.	Cov.	Con.	Cov.	Con.	Cov.	Con.	Cov.	Con.	Cov.	Con.
TREE LAYER																													
Tsuga heterophylla	R[b]	0[c]	25	2	67	4	81	8	100	8	100	8	100	8	100	11	100	16	100	10	100	15	100	7	100	9	100	11	100
	M			3	47	7	56	5[d]	38	20	76	43	100	48	100	31	79	5	45	29	83	42	95	21	75	44	100	29	100
Pseudotsuga menziesii	R	8	100	8	93	5	75	Tr	23							Tr	7							Tr	8				
	M	41	100	37	100	36	100	60	100	45	100	45	100	33	100	58	100	68	100	42	100	40	100	49	100	42	100	38	100
Thuja plicata	R			Tr	27	1	31	Tr	38	1	29	2	56	1	50	2	43	1	27	1	50	2	52	2	67	3	53	2	38
	M			1	20	Tr	12	Tr	15	3	47	13	72	3	45	6	50	2	36	18	92	14	67	5	42	16	80	13	75
Libocedrus decurrens	R	3	38	1	13	Tr	6																						
	M	6	50	1	20	Tr	19	Tr	15	1	12					Tr	7												
Pinus lambertiana	R	Tr	38	Tr	20	1	38	Tr	15	Tr	6																		
	M	1	50	Tr	13	Tr	12	0	15	2	12																		
Acer macrophyllum	R	Tr	12	Tr	7			1	8	Tr	6	Tr	11			Tr	7	Tr	9					Tr	8	Tr	13		
	M	2	25	4	53	Tr	6	3	38	1	12					1	29							2	58	2	47	7	62
Arbutus menziesii	R	Tr	12			Tr	12	0	8																				
	M	2	38	1	20	1	25	0	15																				
Abies grandis	R									Tr	6					Tr	21	3	64	Tr	8	1	10						
	M															Tr	7					1	10					Tr	12
Abies amabilis	R			0	7									1	45	2	36	Tr	36	3	83	1	67						
	M									Tr	6	Tr	6	2	64	2	21			2	33	2	43						
Abies procera	R			0	7											Tr	7	Tr	45	Tr	8	Tr	14						
	M																	Tr	18			1	5						
Pinus monticola	R																												
	M	—		—		—		—		Tr	6	Tr	6	—		Tr	7	2	36	—		0	10	—		—		—	
Total	R	11		11		11		9		9		10		10		15		20		14		19		9		12		13	
	M	52		47		44		68		72		101		86		98		77		91		100		77		104		87	
TALL SHRUB LAYER																													
Acer circinatum		19	88	36	93	18	88	36	100	21	88	9	83	10	91	18	93	22	100	19	83	7	86	36	100	2	87	6	88
Vaccinium parvifolium		1	62	2	87	1	75	2	85	2	71	1	83	1	73	1	57	1	55	4	75	2	86	1	75	2	87	3	100
Cornus nuttallii		2	50	5	80	5	94	3	54	3	53	2	50	1	23	Tr	36	1	64	Tr	17	Tr	33	1	42	1	33	1	38
Castanopsis chrysophylla		1	50	6	87	23	100	1	77	2	82	2	78	1	59	Tr	36	1	73	1	58	1	43	1	42	Tr	13	Tr	25
Holodiscus discolor		5	88	Tr	13	Tr	12	Tr	8									Tr	9										
Corylus cornuta v. californica		7	88	11	100	1	56	Tr	31	Tr	12	Tr	11			Tr	36	1	36			Tr	10	1	17	Tr	33	Tr	12
Rhus diversiloba		Tr	25	1	33	Tr	6	Tr	8																				
Lonicera ciliosa		Tr	25	Tr	27	Tr	6	Tr	8															Tr	8				
Rhododendron macrophyllum		0	12	2	33	40	100	2	54	40	100	13	89	18	95	0	7	1	9	35	100	1	38	3	67	1	67	Tr	12
Taxus brevifolia		4	38	7	87	5	81	1	38	6	59	7	78	16	91	3	64	2	27	6	83	7	76	5	58	4	47	1	50
Vaccinium membranaceum						Tr	12	Tr	98	Tr	6	Tr	39	1	64	Tr	43	Tr	55	1	75	1	62			Tr	7		
Vaccinium alaskaense												Tr	6	1	23	0	7			1	33	1	29			Tr	7	1	12
Pachistima myrsinites		Tr	12	Tr	7	—		Tr	8	—		Tr	6	1	59	1	43	1	82	1	33	Tr	19	—		—		—	
Total		40		70		94		45		74		34		51		23		30		68		20		48		10		13	
LOW SHRUB LAYER																													
Berberis nervosa		16	100	13	100	10	100	19	100	14	100	11	100	14	100	19	100	23	91	12	83	8	95	20	100	8	100	13	100
Rubus ursinus		1	75	1	87	1	75	1	85	1	65	2	83	1	82	1	100	3	100	2	83	2	95	1	75	1	67	1	75
Gaultheria shallon		7	62	22	93	40	100	35	100	40	100	4	89	Tr	14	1	36	Tr	9	Tr	8	Tr	10	3	83	2	53	4	75
Symphoricarpos mollis		2	88	Tr	33	0	6	Tr	31			2	17	Tr	9	1	43	2	91	Tr	17	1	24	0	8				
Rosa gymnocarpa		1	62	Tr	27	1	56	Tr	38	Tr	18	Tr	11	Tr	14	Tr	36	2	91	1	50	1	48	Tr	8				
Rubus nivalis		—		Tr	7	—		—		Tr	6	1	33	2	77	1	43	1	55	2	92	2	86	—		1	53	1	25
Total		27		36		52		55		55		18		17		23		31		17		14		24		12		19	

HERB LAYER

Achlys triphylla	Tr	50	2	87	1	56	1	46	Tr	29	Tr	33	Tr	36	1	64	2	73	1	33	1	57	1	67	1	47	2	75
Anemone deltoidea	Tr	38	1	60	1	62	1	46	1	41	1	44	Tr	5	Tr	43	1	64	Tr	17	1	52	1	50	1	27	Tr	25
Goodyera oblongifolia	1	88	1	73	Tr	50	1	62	Tr	47	1	83	1	68	1	64	1	82	1	58	1	76	1	75	1	73		
Viola sempervirens	Tr	12	1	60	1	62	2	85	1	65	2	83	1	45	2	93	8	100	5	100	9	100	1	75	2	73	1	62
Trillium ovatum			Tr	40	Tr	19	Tr	38	Tr	29	1	56	Tr	23	r	50	Tr	45	1	58	1	62	1	67	1	87	1	62
Polystichum munitum	4	100	4	100	1	75	2	85	1	65	4	94	1	77	2	50	2	55	1	42	3	90	21	100	26	100	27	100
Linnaea borealis	3	75	6	93	5	100	2	69	5	82	13	100	3	95	2	79	21	100	20	100	25	100	4	83	13	80	11	50
Vancouveria hexandra	Tr	25	1	87	Tr	38	1	54	Tr	6	Tr	39	Tr	9	Tr	36	1	55	Tr	17	2	52	1	50	Tr	27	4	88
Galium triflorum	Tr	38	1	60			Tr	38	Tr	18	Tr	11			1	29	1	73			Tr	19	1	67	1	60	1	38
Pteridium aquilinum	Tr	12	Tr	20	Tr	50	1	38	1	24			Tr	5	Tr	29	1	45	Tr	8	Tr	5	Tr	17			Tr	25
Trientalis latifolia	1	100	2	93	1	69	1	62	Tr	29	Tr	44	Tr	9	1	64	1	55	Tr	8	Tr	38	1	58	Tr	27	0	12
Lathyrus polyphyllus	3	38	Tr	7			Tr	8																				
Madia gracilis	1	50	Tr	7			Tr	8																				
Collomia heterophylla	1	38	Tr	20	Tr	6	Tr	15																				
Listera caurina	Tr	12	Tr	7	Tr	25	1	54			Tr	6							Tr	17	Tr	29			Tr	13	Tr	12
Hieracium albiflorum	1	62	1	93	Tr	38	Tr	23	Tr	12	Tr	28	Tr	9	Tr	29	1	45					Tr	25	Tr	20	Tr	25
Synthyris reniformis	4	75	3	80	Tr	31	1	31	Tr	12	Tr	17			Tr	21	1	55			Tr	24	1	25				
Xerophyllum tenax	2	25	1	33	10	81	2	31	2	53	2	50	1	45	0	7	Tr	18	1	33	Tr	19			0	7		
Adenocaulon bicolor	Tr	50	1	53	Tr	25	Tr	31	Tr	12							Tr	27	Tr	8	Tr	5			Tr	13	1	12
Iris tenax	1	62	1	47	Tr	25	Tr	31	Tr	6							Tr	27					Tr	17				
Festuca occidentalis	1	88	1	100	0	6	Tr	8	0	6					Tr	14	Tr	9					Tr	8	Tr	7		
Bromus sp.	2	75	1	67	Tr	12	Tr	15	0	12					Tr	7	1	36					Tr	25	Tr	7		
Whipplea modesta	8	100	4	93	Tr	38	2	54	1	29	1	17	Tr	9	1	50	12	91	Tr	8	Tr	14	Tr	50	Tr	20		
Campanula scouleri	1	50	Tr	47	Tr	19	0	8							Tr	7	Tr	9	Tr	8	Tr	5	0	8			Tr	25
Chimaphila umbellata	1	88	3	93	1	69	1	69	2	82	4	83	1	82	2	93	8	91	5	92	3	90	Tr	25	Tr	53	1	38
Chimaphila menziesii	Tr	12			Tr	19	Tr	23	Tr	35	Tr	44	1	59	Tr	43	Tr	45	Tr	50	Tr	38	Tr	50	Tr	33	0	12
Coptis laciniata			1	20	1	25	Tr	31	1	53	4	89	Tr	14	1	21	1	9	3	50	12	67	5	83	3	73	1	25
Corallorhiza mertensiana			Tr	7			Tr	15					1	50	1	50	Tr	45	Tr	42	1	62			Tr	13	Tr	12
Cornus canadensis													1	45	Tr	21	Tr	27	6	75	1	86			Tr	13	Tr	12
Pyrola picta					Tr	31	Tr	31	Tr	24	Tr	39	Tr	32	Tr	36	1	64			Tr	33			Tr	20		
Pyrola secunda							Tr	8					Tr	27	Tr	36	1	55	Tr	17	Tr	19			Tr	13		
Pyrola asarifolia			Tr	13	Tr	19			1	41	Tr	28	1	50	Tr	14			3	100	Tr	43			Tr	7		
Fragaria vesca v. *bracteata*	Tr	25															1	55										
Tiarella unifoliata									Tr	12	Tr	28	1	41	1	57	1	36	3	83	5	95	Tr	25	4	73	Tr	12
Disporum hookeri			Tr	40			Tr	31	Tr	18	Tr	17	Tr	5	Tr	21			Tr	17	Tr	14	Tr	50	Tr	27	1	50
Asarum caudatum													Tr	5	Tr	29	3	45	Tr	17	Tr	24	0	8	Tr	27	1	25
Athyrium filix-femina																					Tr	10			Tr	13	Tr	12
Blechnum spicant																					Tr	5			1	27	1	38
Oxalis oregana	—		—		—		—		—		—		—		—		—		—		—		—		Tr	7	38	100
Total	36		36		22		19		16		33		13		16		70		50		54		39		54		94	
TOTAL UNDERSTORY	114		153		179		128		154		95		91		77		151		149		107		120		88		139	
TOTAL ALL LAYERS	166		200		223		196		226		196		177		175		228		240		207		197		192		226	

[a]Psme = *Pseudotsuga menziesii*, Hodi = *Holodiscus discolor*, Tshe = *Tsuga heterophylla*, Cococa = *Corylus cornuta* var. *californica*, Cach = *Castanopsis chrysophylla*, Acci = *Acer circinatum*, Gash = *Gaultheria shallon*, Rhma = *Rhododendron macrophyllum*, Bene = *Berberis nervosa*, Abam = *Abies amabilis*, Whmo = *Whipplea modesta*, Libo = *Linnaea borealis*, Pomu = *Polystichum munitum*, Oxor = *Oxalis oregana*.

[b]R = trees in the reproduction size-class (seedlings and saplings). M = trees in the mature size-class (crowns contribute to overstory tree cover).

[c]Zero indicates species occurred in trace amounts only in all sampled stands.

[d]Trace indicates average cover less then 0.5%.

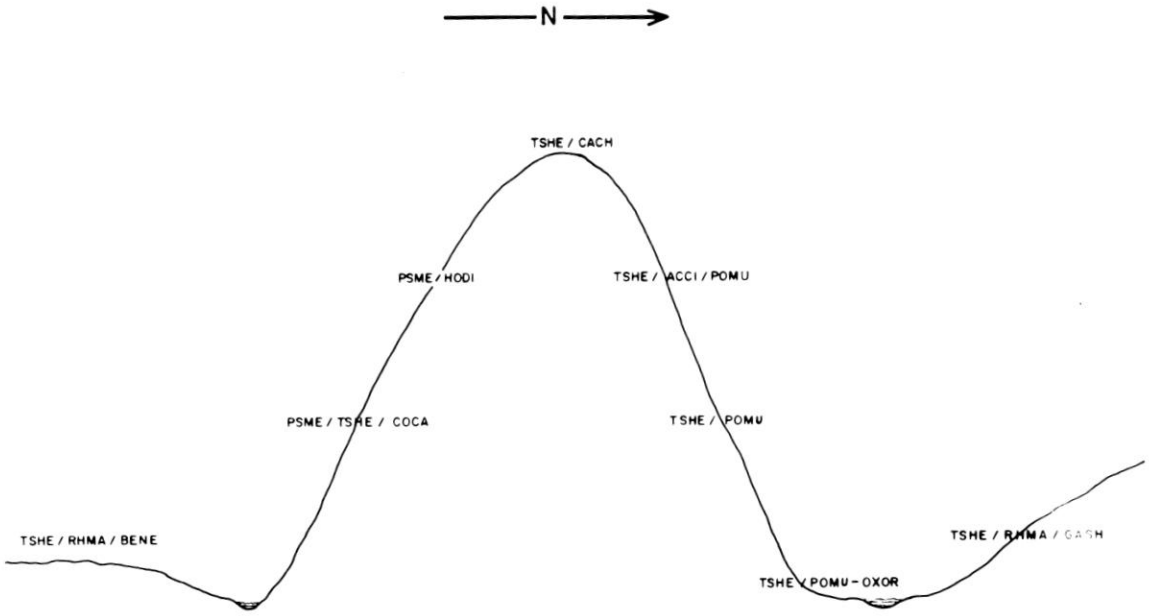


Figure 6. Landform-aspect-community relationships in the *Tsuga heterophylla* zone.

Figure 7. A stand representative of the *Pseudotsuga menziesii/Holodiscus discolor* association. Note the open nature of the stand and reproduction of *Pseudotsuga*, which is climax here.

Pseudotsuga/Holodiscus association are generally found on smooth, south- and southwest-facing slopes (Figure 6) at lowest elevations within the study area (460-610 m). As a result of elevation and aspect, temperatures tend to be relatively high during the growing season. Soils of this association are generally stony, shallow loams and silt loams derived from tuff and breccia parent materials (Appendix). These soils are classed as Lithosols and Regosols and their shallow nature is reflected by effective rooting depths, which are usually less than 1 m.

Most stands typical of the *Pseudotsuga/Holodiscus* association are composed of rather open (30%-60% crown coverage) old-growth Douglas-fir (Figure 7). The climax status of *Pseudotsuga* is indicated by the fact that it is by far the most abundant tree species in the reproduction size class (8% average cover) in those stands sampled. In some stands young *Libocedrus decurrens* is codominant, or as abundant as young *Pseudotsuga*. The only other coniferous tree species of any importance is *Pinus lambertiana*, which is scattered through about half the stands. Frequent presence of two sclerophyllous species, *Arbutus menziesii* and *Castanopsis chrysophylla*, sometimes results in stands that markedly resemble those found in the mixed-evergreen zone of the western Siskiyou Mountains (Franklin and Dyrness 1969). Both *Arbutus* and *Castanopsis* are of fairly low fidelity, however, occurring in only half of those stands typical of the *Pseudotsuga/Holodiscus* association (Table 1). Deciduous tree species sometimes present include *Acer macrophyllum* and *Cornus nuttallii*.

Tall shrub cover of the *Pseudotsuga/Holodiscus* association is made up of relatively small amounts of three main species, *Acer circinatum*, *Holodiscus discolor*, and *Corylus cornuta* var. *californica*. In most stands *Acer circinatum*, which is extremely widespread throughout the study area, is dominant. Although *Holodiscus* cover averages only 5% (Table 1), considerable diagnostic value is placed on *Holodiscus* because this is the only community in which it occurs in more than trace amounts. The low shrub layer is generally dominated by the ubiquitous *Berberis nervosa*. Other common low shrubs in stands typical of this association are *Gaultheria shallon* (8% cover) and *Symphoricarpos mollis* (2% cover).

The herb layer in *Pseudotsuga/Holodiscus* stands is typically very poorly developed. The dominant herb is generally *Whipplea modesta* (8% cover) followed in order of importance by *Polystichum munitum*, *Synthyris reniformis*, *Linnaea borealis*, and several grass species (Figure 8). Species present in at least half the stands but contributing very little cover include *Chimaphila umbellata*, *Goodyera oblongifolia*, *Hieracium albiflorum*, *Rubus ursinus*, *Trientalis latifolia*, *Campanula scouleri*, and *Iris tenax*. *Whipplea* and *Synthyris* are of greatest diagnostic value because, although they are not restricted to the *Pseudotsuga/Holodiscus* association, they reach their maximum abundance here (see Figure 35).

A *Pseudotsuga/Holodiscus/Gaultheria* association has been described in the Oregon Coast Range by Bailey (1966) and Corliss and Dyrness (1965). Although the tree layer is apparently very similar to our *Pseudotsuga/Holodiscus*, shrub cover in the Coast Range is generally much more dense. For example, Bailey reports average coverages of 30% *Holodiscus*, 52% *Gaultheria shallon*, and 44% *Berberis nervosa*. Herb species present also differ in the two locations. In both the Cascades and Coast Range, however, the *Holodiscus* community represents the dry end of the moisture spectrum.

Figure 8. Herb layer within the *Pseudotsuga menziesii/Holodiscus discolor* association. Herbs visible here are *Synthyris reniformis*, *Trientalis latifolia*, *Whipplea modesta*, and *Iris tenax*; principal low shrubs are *Symphoricarpos mollis* and *Berberis nervosa*; grasses are *Festuca occidentalis* and *Bromus* sp.

Figure 9. A stand representative of the *Pseudotsuga menziesii--Tsuga heterophylla/Corylus cornuta* association. Tall shrubs visible here are principally *Acer circinatum* and *Corylus cornuta* var. *californica*; abundant low shrubs are *Gaultheria shallon* and *Berberis nervosa*.

1.2. Pseudotsuga menziesii--Tsuga heterophylla/Corylus cornuta *var.* californica *(Psme-Tshe/Cococa) association.* The *Pseudotsuga-Tsuga/Corylus* association is floristically intermediate between the *Pseudotsuga/Holodiscus* and the *Tsuga/Rhododendron* associations. Characteristics that differentiate this community from the *Pseudotsuga/Holodiscus* include significant amounts of *Tsuga heterophylla,* decreased occurrence of *Holodiscus discolor,* and substantially increased coverage of *Gaultheria shallon.* Herb layers are poorly developed in both communities with species following approximately the same order of ranking in dominance.

The best examples of the *Pseudotsuga-Tsuga/Corylus* association are generally found on low-elevation sites (460-610 m), although some stands may occur at higher elevations. Typical sites are smooth, steep (50%-80%) slopes with south, southwest, and west exposure, and usually at upper to midslope position. Soils are similar to those supporting the *Pseudotsuga/Holodiscus* association--Lithosols and Regosols developed from tuff and breccia parent materials. These soils are generally stony (averaging 40%-50% stone content by volume) and effective rooting depth usually ranges from 1 to 2 m.

Tree layers may be dominated by either old-growth trees or a mixture of scattered old growth within a matrix of younger trees. Tree canopy coverage is low, totaling 20%-50%. The overstory is dominated by *Pseudotsuga* with a scattering of *Tsuga* in half the stands. Apparently both *Pseudotsuga* and *Tsuga* regenerate successfully (Table 1), which may be attributed largely to the open nature of the stand; both may be codominant in climax stands. Tree species sporadically represented include *Arbutus menziesii, Libocedrus decurrens, Pinus lambertiana,* and *Thuja plicata.* Hardwoods occasionally encountered are *Acer macrophyllum* and *Cornus nuttallii.*

Four tall shrub species are present in virtually all *Pseudotsuga-Tsuga/Corylus* stands (Table 1; Figure 9). The presence of appreciable *Corylus cornuta* var. *californica,* coupled with the virtual absence of *Holodiscus discolor,* is a diagnostic feature of this community. Although *Acer circinatum* is by far the most abundant, its ubiquitous habit gives it little indicator significance (see Figure 36). Moderate amounts of *Castanopsis chrysophylla* and *Vaccinium parvifolium* are also characteristic.

The low shrub layer is generally well developed in the *Pseudotsuga-Tsuga/Corylus* association. Although there is considerable stand-to-stand variation (Appendix), *Gaultheria shallon* typically ranks first (22% cover), followed by *Berberis nervosa* (13% cover).

The scattered plants in the herb layer in the *Pseudotsuga-Tsuga/Corylus* community average only 20%-30% total cover. *Polystichum munitum* is the only ubiquitous species, but it has low coverage (average 3%). Two creeping herbs contribute the most cover, *Linnaea borealis* and *Whipplea modesta.* Other significant and characteristic species are *Achlys triphylla, Chimaphila umbellata, Synthyris reniformis, Trientalis latifolia,* and *Festuca occidentalis* (Table 1). Minor species include *Viola sempervirens, Adenocaulon bicolor, Campanula scouleri,* and *Iris tenax.*

1.3. Tsuga heterophylla/Castanopsis chrysophylla *(Tshe/Cach) association.* The *Tsuga/Castanopsis* association is characteristic of relatively dry, exposed sites similar to those occupied by the *Holodiscus* and *Corylus* communities. Species composition differs by increased occurrence of *Tsuga heterophylla,*

Castanopsis, and *Rhododendron macrophyllum*. The *Tsuga/Castanopsis* community is also differentiated by a much greater shrub cover than is characteristic of the other two units.

Stands representative of this association are generally found on or just off ridgetops at rather low elevations (460-790 m). In almost all cases where stands are located below the ridge, slopes are steep and have either a south or southwest aspect. The *Tsuga/Castanopsis* association spans a variety of soils; however, almost all of them are poorly developed and derived from tuff and breccia parent materials (Appendix). The most common soil series is the Frissell, a Regosol derived from reddish pyroclastic rocks. Soil stoniness and effective rooting depth are highly variable, but most soils are toward the shallow, stony end of the range.

Figure 10. A stand representative of the *Tsuga heterophylla/Castanopsis chrysophylla* association; note the dense tall shrub layer dominated by *Castanopsis* and *Rhododendron macrophyllum*. The characteristic herb, *Xerophyllum tenax*, is visible in the foreground.

Most sampled stands belonging to this association are open old growth, but four are second growth. The low tree canopy coverage (20%-60%), is characteristic of ridgetops and south-slope stands. Once again *Pseudotsuga* is the unquestioned overstory dominant; three-fourths of the sampled stands also contain *Pseudotsuga* reproduction (Table 1). *Tsuga heterophylla*, the other climax tree species, is abundant as reproduction in the understory of most stands. Another important tree in the *Tsuga/Castanopsis* association

is *Cornus nuttallii*, which is more abundant in this unit than in any other. Characteristic tree species that occur as scattered individuals include *Arbutus menziesii*, *Pinus lambertiana*, and *Thuja plicata*.

The *Tsuga/Castanopsis* association is identified largely on the basis of shrub layer characteristics (Figure 10). Typical stands have relatively large amounts of three shrub species, *Castanopsis* (23% cover), *Rhododendron* (39% cover), and *Gaultheria shallon* (40% cover). Although these three species are always present, amounts vary. In some side-slope locations, *Gaultheria* cover becomes so dense that it approaches 100%. On the other hand, on ridgetop sites *Rhododendron* often forms dense, almost impenetrable thickets. The only other shrub species contributing appreciable amounts of cover are the ubiquitous *Acer circinatum* and *Berberis nervosa*.

Because of complete dominance by shrubs in the *Tsuga/Castanopsis* association, the herb layer is very poorly developed. Only two herbaceous species average more than 1% cover, *Xerophyllum tenax* (10%) and *Linnaea borealis* (5%). The presence of *Xerophyllum* has considerable diagnostic value since this is the only association within the *Tsuga* zone in which it occurs with high constancy and coverage. Other species of minor importance include *Chimaphila umbellata*, *Polystichum munitum*, *Pteridium aquilinum*, *Trientalis latifolia*, and *Viola sempervirens*.

1.4. Pseudotsuga menziesii/Acer circinatum/Gaultheria shallon *(Psme/Acci/Gash) community*. Almost all stands belonging to the *Pseudotsuga/Acer/Gaultheria* community are composed of second-growth (125-year-old) Douglas-fir; consequently, it is considered a seral grouping. With advancing succession we believe stands of this community type will evolve into climax stands belonging to either the *Tsuga/Rhododendron/Gaultheria* or *Tsuga/Rhododendron/Berberis* associations. Stands are found on smooth slope and bench landforms at elevations ranging from 370 to 850 m. Slope steepness and aspect both vary, although southerly aspects are more common. The *Pseudotsuga/Acer/Gaultheria* community occurs on several different soil series derived from tuffs, breccias, and andesite residuum and colluvium (Appendix). Most often these are zonal silt loam or silty clay loam soils with moderate stone contents. Effective rooting depth varies from 1 to 2.5 m.

Almost all overstory tree cover is composed of *Pseudotsuga;* this ranges from 50% to 80%. Tree canopy coverage is often reflected in understory density with greater coverage of species such as *Acer circinatum* in the more open stands. *Tsuga*, despite its minor contribution to the overstory, is abundant as reproduction in all sampled stands (Table 1). This hemlock abundance and the general absence of *Pseudotsuga* reproduction clearly indicate that *Tsuga heterophylla* is the principal climax tree species. Other tree species that occur sporadically are *Acer macrophyllum*, *Cornus nuttallii*, and *Thuja plicata*.

As the name implies, tall and low shrub layers of the *Pseudotsuga/Acer/Gaultheria* community are dominated by *Acer circinatum* and *Gaultheria shallon*, respectively (Figure 11). Both species have 100% constancy and average 35% cover (Table 1). Over half the stands contain at least small quantities of *Rhododendron*, which may increase if these areas are protected from future disturbance. Three other shrubs, *Castanopsis*

chrysophylla, *Berberis nervosa*, and *Vaccinium parvifolium*, occur in over 80% of the sampled stands, but none have indicator significance.

Figure 11. A stand representative of the *Pseudotsuga menziesii/Acer circinatum/Gaultheria shallon* community. The trees here are second-growth Douglas-fir; note the western hemlock sapling and the extremely dense low shrub layer dominated by *Gaultheria shallon*.

The herbaceous layer of the *Pseudotsuga/Acer/Gaultheria* community is composed principally of widely distributed species. Since no herbaceous species had 100% constancy and none averaged more than 2% cover, it is difficult to select "characteristic" species. The most typical species may be the three with over 75% constancy, *Viola sempervirens*, *Pyrola asarifolia*, and *Rubus ursinus*. The only species with maximum constancy and coverage in the *Pseudotsuga/Acer/Gaultheria* community is *Listera caurina*, an infrequent species in other units. Other species occurring in small amounts in over half the stands include *Linnaea borealis*, *Chimaphila umbellata*, *Whipplea modesta*, and *Trientalis latifolia*.

Corliss and Dyrness (1965) recognized a *Tsuga heterophylla/Acer circinatum/Gaultheria shallon* seral community in second-growth Douglas-fir in the Oregon Coast Range. The two units appear approximately the same except for differences in the herb layer. In the Coast Range, the most common herbs are two ferns, *Polystichum munitum* and *Pteridium aquilinum*.

1.5. Tsuga heterophylla/Rhododendron macrophyllum/Gaultheria shallon *(Tshe/Rhma/Gash) association.* In our two-dimensional ordination (Figure 2),

the *Tsuga/Rhododendron/Gaultheria* association falls midway between the *Tsuga/Castanopsis* and *Tsuga/Rhododendron/Berberis* units. The ordination and unpublished environmental data clearly indicate that the *Tsuga/Rhododendron/Gaultheria* association characterizes cooler and moister sites than the *Tsuga/Castanopsis* association.

The *Tsuga/Rhododendron/Gaultheria* association is found on a variety of landforms: ridgetops, both smooth and uneven side slopes, benches, and stream terraces. It is located at relatively low elevations, ranging from 490 to 850 m. Slope steepness (0%-80%) and aspect are highly variable. Soils supporting the *Tsuga/Rhododendron/Gaultheria* association are most often Regosols derived from tuffs and breccias, having relatively low stone contents (usually 5%-30%). Surface soil textures are loam or silt loam grading to silty clay or clay loam subsoils in those soils showing some profile development. Most soils are fairly deep (1-2 m) and well drained; however, the unit has also been found on poorly drained soils in bench locations.

Figure 12. A stand representative of the *Tsuga heterophylla/Rhododendron macrophyllum/Gaultheria shallon* association showing the typically dense shrub layer. Tall shrubs are largely *Rhododendron*; low shrubs are *Gaultheria*.

Both old-growth and second-growth timber stands are included in the *Tsuga/Rhododendron/Gaultheria* association. Crown canopy coverage is generally around 50%-80%, although very open stands with 30%-40% coverage are some-

times encountered. This unit differs markedly from the four already described in that it has much more mature *Tsuga* (20% cover) and completely lacks *Pseudotsuga* regeneration (Table 1). *Tsuga* reproduction is at least common in all sampled stands, indicating its role as the major climax species. The only other tree species of importance is *Thuja plicata*, which was present in mature form in about half the stands and as reproduction in about one-fourth of the total.

Understory species composition and average cover values in the *Tsuga/Rhododendron/Gaultheria* association are very similar to those for the *Tsuga/Castanopsis* unit (Table 1; Figures 12 and 13). For example, average cover is the same for *Gaultheria* (40%), *Rhododendron* (30%), *Linnaea* (5%), and *Polystichum* (1%) in both units. In fact, the only real difference in understory vegetation between the two associations is the much greater importance of *Castanopsis chrysophylla*, *Xerophyllum tenax*, and *Pseudotsuga* regeneration in the *Tsuga/Castanopsis* association. The fact that these two units are so similar floristically is not surprising when one considers their close relationship.

Figure 13. Low shrub layer within the *Tsuga heterophylla/Rhododendron macrophyllum/Gaultheria shallon* association. The dense cover of *Gaultheria* and *Berberis nervosa* severely curtails development of the herb layer.

1.6. Tsuga heterophylla/Rhododendron macrophyllum/Berberis nervosa *(Tshe/Rhma/Bene) association.* The *Tsuga/Rhododendron/Berberis* association is

one of the most commonly occurring units in the study area and represents the climatic climax at low to middle elevations. Stands are located on gentle to moderate slopes (10%-40%) and are dominated by old-growth Douglas-fir and western hemlock. Elevations range from 490 to 910 m. Soils are generally deep, with effective rooting depths of at least 1-2 m, and exhibit some profile development. Soil parent materials are tuff and breccia residuum and colluvium, andesite colluvium, and mixed colluvium. Soil profiles are generally relatively low in stone content (5%-30%) with loam or silt loam surface horizons and silt loam, silty clay loam, or silty clay texture in the subsoil. The most frequently occurring soil series is the McKenzie River, a well-developed soil with a textural B horizon, derived from reddish tuffs and breccias (Appendix).

Old-growth stands characteristic of the *Tsuga/Rhododendron/Berberis* association usually have fairly dense overstories, with total coverage varying from 60% to 90%. Overstory dominance is shared by *Pseudotsuga* and *Tsuga*, each averaging about 45% cover (Table 1). The Douglas-fir are large, sometimes decadent, 450- to 500-year-old trees, which, as they drop out of the stand, are immediately replaced by younger, more vigorous hemlock (Figure 14). *Tsuga* regeneration is also common in all sampled

Figure 14. A stand representative of the *Tsuga heterophylla/Rhododendron macrophyllum/Berberis nervosa* association. This unit occurs on gentle slopes and deep soils and is interpreted as constituting the climatic climax for this portion of the *Tsuga heterophylla* zone. Trees in the background are old-growth Douglas-firs and younger western hemlocks.

stands, averaging 7% cover. *Thuja plicata* occurred in about three-fourths of the stands and in a few contributed as much as 30%-40% overstory cover. Only about 25% of the sampled stands contained sufficient *Thuja* regeneration to qualify it for a secondary climax role.

Because of the dense overstory, the shrub layer in the *Tsuga/Rhododendron/Berberis* association is rather sparse. Even *Rhododendron*, which is the dominant species, averages only 12% cover (Table 1). Next in importance are *Berberis nervosa* with 11% and *Acer circinatum* with 8%. *Taxus brevifolia* is a relatively abundant understory tree species in this association with 7% average cover and 77% constancy.

Figure 15. Shrub and herb layers within the *Tsuga heterophylla/Rhododendron macrophyllum/Berberis nervosa* association. Visible here are *Rhododendron* and *Berberis* in the shrub layer, and *Linnaea borealis* and *Viola sempervirens* in the herb layer.

Linnaea borealis is the only herb present in all sampled stands in the *Tsuga/Rhododendron/Berberis* association (Figure 15). *Linnaea* cover was highly variable (1%-50%), despite the 13% average (Appendix). Other species that are commonly found in this association are *Polystichum munitum*, *Coptis laciniata*, *Chimaphila umbellata*, *Viola sempervirens*, and *Rubus ursinus*. Unfortunately, with the possible exception of *Coptis*, all these species are widely distributed throughout the *Tsuga heterophylla* zone. Herbs present in about half the stands include *Xerophyllum tenax*, *Trillium ovatum*, *Trientalis latifolia*, *Anemone deltoidea*, *Chimaphila menziesii*, and *Corallorhiza mertensiana*.

Bailey (1966) has described a *Rhododendron macrophyllum/Berberis nervosa* association in the southern Coast Range in Oregon. His association generally occurs on south slopes and ridgetops, where *Pseudotsuga menziesii* as well as *Tsuga heterophylla* may be climax. He also lists *Castanopsis chrysophylla* as a useful indicator of his *Rhododendron/Berberis* association. Apparently Bailey's unit is much more closely related to our *Tsuga/Castanopsis* association than to the *Tsuga/Rhododendron/Berberis*.

1.7. Tsuga heterophylla--Abies amabilis/Rhododendron macrophyllum/Berberis nervosa *(Tshe-Abam/Rhma/Bene) association.* The *Tsuga-Abies/Rhododendron/Berberis* association is the higher elevation equivalent of the *Tsuga/Rhododendron/Berberis*. The main difference between the two units involves increased importance of *Abies amabilis*. The species composition of the two associations is otherwise very similar, although there are minor differences in the relative importance of some species such as *Taxus brevifolia* and *Linnaea borealis*.

Stands typical of the *Tsuga-Abies/Rhododendron/Berberis* association are generally situated on smooth side slopes or benches at 820-1130 m elevation. Slope steepness is variable (0%-90%), but almost without exception aspect is north, northeast, or northwest. Virtually all stands are located on soils derived from andesite colluvium parent material. About three out of every four stands are associated with the Carpenter soil series, a loam-textured soil formed in deep andesitic landslide material, showing very little evidence of profile development. Soils are moderately stony (averaging about 40% stones by volume) and effective rooting depth ranges from 1 to 3 m.

All stands classified as belonging to the *Tsuga-Abies/Rhododendron/Berberis* association are old growth dominated by mature *Tsuga heterophylla* and *Pseudotsuga menziesii*. Although *Abies amabilis* is absent from about one-third of the sampled stands, it is potentially at least a minor component of the climax stand at each plot location. *Thuja plicata* is also a conspicuous element in many stands, although it occurs less frequently here than in the lower elevational *Tsuga/Rhododendron/Berberis* (Table 1). Total overstory canopy coverage is generally in the 60%-80% range, but one-fourth of the sampled stands have less than 50% total coverage.

Shrub-layer characteristics in the *Tsuga-Abies/Rhododendron/Berberis* association are very similar to those in the *Tsuga/Rhododendron/Berberis;* that is, *Rhododendron* is dominant with 17% average cover, followed by *Berberis nervosa* and *Acer circinatum*. The greatest difference between the two units is an appreciable increase in importance of *Taxus brevifolia* in the *Tsuga-Abies/Rhododendron/Berberis* association (Table 1). In fact, *Taxus* reaches its maximum development within this community with an average cover of 17%.

The *Tsuga-Abies/Rhododendron/Berberis* association has the lowest total cover of herbaceous vegetation of any community within the *Tsuga heterophylla* zone. The only herb averaging over 1% cover is *Linnaea borealis* (3%), which averages 13% in the *Tsuga/Rhododendron/Berberis* association. Herbaceous species averaging 1% cover include *Polystichum munitum, Chimaphila umbellata, Rubus ursinus,* and *Xerophyllum tenax* (Table 1). Four species characteristic of the *Tsuga-Abies/Rhododendron/Berberis* association that

Figure 16. A stand representative of the *Pseudotsuga menziesii/Acer circinatum/Berberis nervosa* community. Large trees are second-growth Douglas-firs; note the scattered western hemlock seedlings and *Acer circinatum*. Abundant low shrubs are *Berberis*.

Figure 17. A stand representative of the *Pseudotsuga menziesii/Acer circinatum/Whipplea modesta* community. Overstory is made up of a uniform stand of 130-year-old *Pseudotsuga*; note the abundance of *Acer circinatum* and *Tsuga heterophylla* regeneration in the understory.

are not as common at lower elevations are *Cornus canadensis*, *Pyrola asarifolia*, *Rubus nivalis*, and *Tiarella unifoliata*.

1.8. Pseudotsuga menziesii/Acer circinatum/Berberis nervosa *(Psme/Acci/Bene) community*. The *Pseudotsuga/Acer/Berberis* community is a tentative grouping closely allied to the aforementioned *Rhododendron/Berberis* units; both occupy the same area on the ordination graphs (Figures 2 and 3). The main difference between the *Rhododendron/Berberis* and *Acer/Berberis* communities is the complete lack of *Rhododendron* and an increase in *Acer circinatum* in the latter unit. Soil and site characteristics are also very similar with one exception. Stands of the *Pseudotsuga/Acer/Berberis* community are generally found on south- and southwest-facing slopes, while the *Tsuga-Abies/Rhododendron/Berberis* association is largely restricted to north-facing slopes.

The *Pseudotsuga/Acer/Berberis* community is found at elevations ranging from 640 to 1160 m, usually on moderate slopes. Soils tend to be deep, loam textured, and derived from andesite colluvium. They are of moderate stoniness and range from 1 to 2 m in effective rooting depth.

The majority of sampled stands are in old-growth timber with an overstory coverage between about 60% and 90% (Figure 16). Dominant mature trees are, again, *Pseudotsuga menziesii* and *Tsuga heterophylla*, with *Tsuga* clearly the major climax species. Many of the higher elevation stands contain both mature and reproduction-size *Abies amabilis*, indicating at least a minor climax role for *Abies* in these areas. Small amounts of *Abies grandis* also occur in some sampled stands. The widely distributed *Thuja plicata* is about as abundant as in the *Rhododendron/Berberis* units (Table 1).

Acer circinatum and *Berberis nervosa* are the only shrubs of any importance in the *Pseudotsuga/Acer/Berberis* community and both average 18% cover. The most abundant herbaceous species are also those that are most common in the *Rhododendron/Berberis* associations--*Rubus ursinus*, *Chimaphila umbellata*, *Viola sempervirens*, *Linnaea borealis*, and *Polystichum munitum*. Perhaps the most noticeable difference in the herb layer of the *Acer/Berberis* community is the more frequent occurrence of *Achlys triphylla* and *Whipplea modesta*.

1.9. Pseudotsuga menziesii/Acer circinatum/Whipplea modesta *(Psme/Acci/Whmo) community*. The *Pseudotsuga/Acer/Whipplea* community is a seral grouping of second-growth (125-year-old) Douglas-fir stands found high in the *Tsuga heterophylla* zone. With advancing succession, climax vegetation developed on these sites would probably be classified as belonging either to the *Tsuga-Abies/Rhododendron/Linnaea* or *Tsuga-Abies/Linnaea* associations. Although it occupies only limited areas, the *Pseudotsuga/Acer/Whipplea* community is distinguished by its well-developed herb layer.

The *Pseudotsuga/Acer/Whipplea* community is found in midslope positions at 940-1160 m. On most sampled plots, slopes are moderate and south-facing. Soils are sandy loams, loams, or silt loams derived from andesitic parent materials, often with considerable influence from aeolian deposits of volcanic ash. Soils are medium with respect to both stoniness and rooting depth, with estimated depth averaging between 1 and 2 m.

Virtually all stands have canopies of medium density (60% crown cover), which are dominated by second-growth Douglas-fir (Figure 17). Because of the

youthfulness of the stands, very little *Tsuga* is present in the overstory, but its reproduction cover averaged 16% (Table 1). This community contains more *Abies grandis* than any other studied. In one-third to one-half of the sampled stands, *Abies grandis* constitutes a secondary climax tree species. Despite its very minor role at present, *Abies amabilis* would also be expected in climax timber stands on these sites.

The tall shrub layer of the *Pseudotsuga/Acer/Whipplea* community is characteristically dominated by *Acer circinatum* and contains no *Rhododendron macrophyllum*. As in most associations, the dominant low shrub is *Berberis nervosa* (Figure 18). Three shrubs that reach maximum development here and therefore have considerable diagnostic value are *Rosa gymnocarpa*, *Pachistima myrsinites*, and *Symphoricarpos mollis* (Table 1). *Vaccinium membranaceum* is also present in about half the sampled stands.

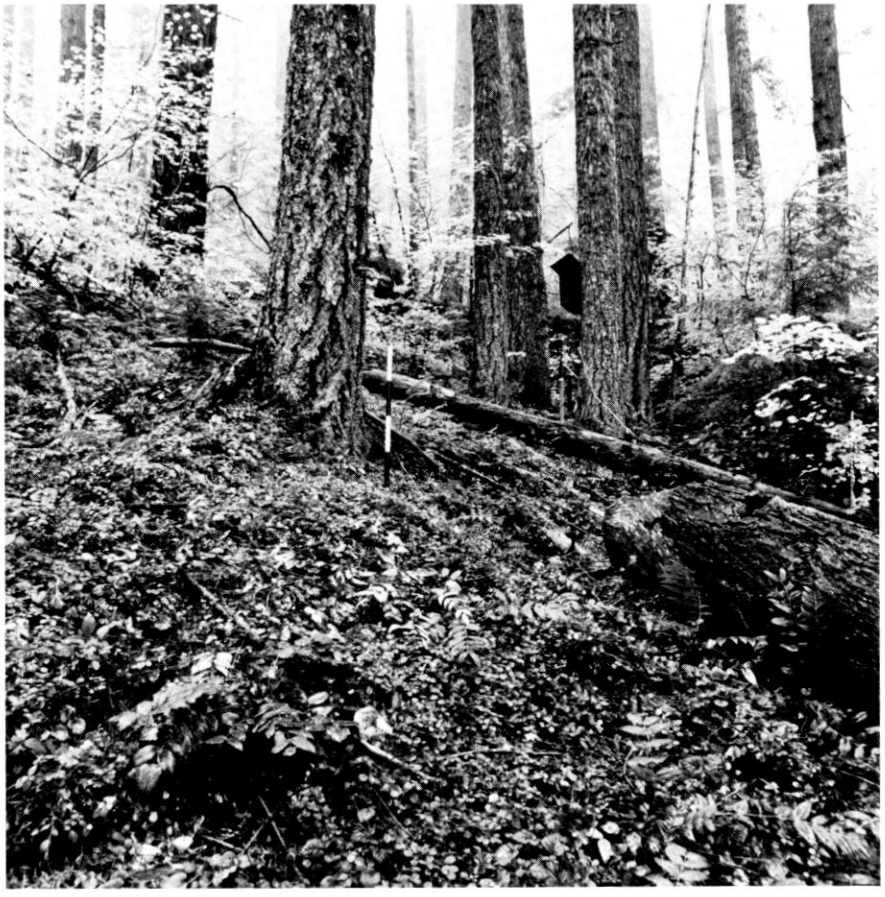


Figure 18. Low shrub and herb layer within the *Pseudotsuga menziesii/Acer circinatum/Whipplea modesta* community. Dominant low shrubs are *Berberis nervosa* and *Rubus nivalis*; principal herbs are *Linnaea borealis* and *Whipplea modesta*.

The herb layer of the *Pseudotsuga/Acer/Whipplea* community has an average cover of 68%, which is second only to the *Polystichum-Oxalis* association in the *Tsuga heterophylla* zone. This dense layer is made up of many species, most of which are widely distributed throughout the zone (Table 1). The bulk of the cover is provided by five species that occurred in virtually every sampled stand: *Linnaea borealis* (21%), *Whipplea modesta* (11%), *Viola*

sempervirens (7%), *Chimaphila umbellata* (7%), and *Rubus ursinus* (3%). *Chimaphila* and *Whipplea* have maximum values in this community. Other less abundant herbs that reach maximum development for the *Tsuga* zone in this community include *Achlys triphylla*, *Asarum caudatum*, and *Galium triflorum*. Species that have only about 50% constancy but have considerable indicator significance are *Synthyris reniformis*, *Pyrola picta*, *Pyrola secunda*, *Rubus nivalis*, and *Fragaria vesca*.

1.10. Tsuga heterophylla--Abies amabilis/Rhododendron macrophyllum/Linnaea borealis *(Tshe-Abam/Rhma/Libo) association.* The *Tsuga-Abies/Rhododendron/Linnaea* association is closely related to the *Tsuga-Abies/Rhododendron/Berberis* unit but occupies sites that are slightly moister and cooler (Figure 5). The principal vegetative difference between the two units is the much better developed herb layer--the average herb layer cover is 13% and 51% in the *Rhododendron/Berberis* and *Rhododendron/Linnaea* associations, respectively.

Stands belonging to this association occur on gentle slopes at elevations of 790-1190 m. Characteristic landforms are benches and hummocky topography in areas of deep landslide or glacial till deposits. The soils supporting the *Tsuga-Abies/Rhododendron/Linnaea* association are generally deep, moderately stony, and loam textured, and have formed in deposits of andesitic colluvium. Although soils are usually well drained, the association is also found on imperfectly drained soils in localized depressions.

Sampled *Rhododendron/Linnaea* stands, with one exception, are dominated by old-growth trees and have a moderately dense canopy (50%-70%). Tree-layer characteristics are typical for old-growth stands at mid to high elevations in the *Tsuga heterophylla* zone. Overstory dominance is shared by mature *Pseudotsuga* and *Tsuga* with only scattered *Thuja plicata*. Tree regeneration, however, is often dominated by *Thuja*, with an average cover of 18%, versus 10% for *Tsuga*. The majority of the stands also have at least some *Abies amabilis* regeneration (Table 1). *Thuja plicata* was assigned secondary climax status in place of *Abies amabilis* in one-third of the sampled stands.

The shrub layer of the *Rhododendron/Linnaea* association is very similar to that of several other units within the *Tsuga* zone. Dominant species are the widely distributed *Rhododendron macrophyllum*, *Acer circinatum*, and *Berberis nervosa*. Other less abundant species include *Rosa gymnocarpa*, *Taxus brevifolia*, *Vaccinium membranaceum*, and *Vaccinium parvifolium*. Of these only *Vaccinium membranaceum* reaches maximum development within this unit.

The herb layer is quite well developed and includes a sizable number of characteristic species. Three species occur in all sampled stands: *Linnaea borealis*, *Viola sempervirens*, and *Pyrola asarifolia*. Despite the greater coverage of *Linnaea* (Table 1), *Pyrola asarifolia* may be more diagnostic since the *Rhododendron/Linnaea* unit is the only one in which it gains prominence. Other herbaceous species of relatively high cover and constancy include *Cornus canadensis*, *Chimaphila umbellata*, *Rubus nivalis*, *Rubus ursinus*, *Tiarella unifoliata*, and *Coptis laciniata*.

1.11. Tsuga heterophylla--Abies amabilis/Linnaea borealis *(Tshe-Abam/Libo) association.* The *Tsuga-Abies/Linnaea* association is similar to the *Tsuga-Abies/Rhododendron/Linnaea*, differing mainly in the depauperate shrub layer. The reasons for decreased occurrence of shrubs is not clear, but it appears that the *Linnaea* association occupies slightly cooler and moister sites than

the *Rhododendron/Linnaea* (Figure 5). Collection of additional environmental data will aid in determining whether these two units should remain separated or be combined into one. Both the *Linnaea* and *Rhododendron/Linnaea* associations do, however, occupy the coolest sites within the *Tsuga heterophylla* zone and are the only associations that interface directly with the *Abies amabilis* zone (Figure 5).

The *Tsuga-Abies/Linnaea* association is found on gentle slopes at elevations of 610-1070 m. It occupies soils that are very similar to those characteristic of the *Rhododendron/Linnaea*--deep, loamy soils formed largely in deposits of andesitic landslide materials. Generally these soils are moderately stony and are well to moderately well drained.

Sampled stands are in old-growth timber, which typically has a relatively open canopy (30%-50% overstory cover). Two-thirds of the stands have significant amounts of *Abies amabilis* regeneration, while *Abies grandis* and *Abies procera* are encountered only occasionally. Overstory dominance is shared by *Pseudotsuga menziesii* and *Tsuga heterophylla*, both averaging about 40% crown cover (Table 1). *Thuja plicata* is also important in over half the sampled stands.

Figure 19. A stand representative of the *Tsuga heterophylla--Abies amabilis/Linnaea borealis* association; note that tall shrubs are almost completely absent except for scattered *Acer circinatum* and *Taxus brevifolia*.

Shrub cover is low and composed mainly of *Acer circinatum*, *Berberis nervosa*, and *Taxus brevifolia* (Table 1; Figure 19). Other shrubs with at least 50%

constancy include *Rosa gymnocarpa*, *Vaccinium membranaceum*, and *Vaccinium parvifolium*. One indication of low importance of shrubs in the *Tsuga-Abies/Linnaea* association is the absence of any shrub species with 100% constancy.

The *Tsuga-Abies/Linnaea* association generally has a well-developed herb layer with total cover averaging about 68%. Two species are present in significant quantities in every stand, *Linnaea borealis* and *Viola sempervirens*. Other species typically in substantial quantities are *Tiarella unifoliata*, *Chimaphila umbellata*, *Cornus canadensis*, and *Coptis laciniata* (Table 1). *Polystichum munitum*, *Rubus ursinus*, and *Rubus nivalis* are present in almost every stand with an average cover of about 2%. Species with 50% constancy and minor coverage include *Goodyera oblongifolia*, *Achlys triphylla*, *Vancouveria hexandra*, *Anemone deltoidea*, *Corallorhiza mertensiana*, and *Trillium ovatum*.

Figure 20. A stand representative of the *Tsuga heterophylla/Acer circinatum/Polystichum munitum* association. Tree stems visible here are dominantly western hemlock; tall shrubs are *Acer circinatum* and the dominant in the herb layer is *Polystichum munitum*.

1.12. Tsuga heterophylla/Acer circinatum/Polystichum munitum *(Tshe/Acci/Pomu) association.* The *Tsuga/Acer/Polystichum* association is intermediate between the *Tsuga/Rhododendron/Berberis* and *Tsuga/Polystichum* groupings (Figure 5.) This association has a limited distribution, usually occupying steep to very steep smooth slopes (50%-95%) at 460-820 m elevation. It is found on all aspects but most frequently on north- and east-facing slopes. Soils, derived from

either andesite or breccias, are generally moderately stony and fairly shallow. Effective rooting depth for these loam or silt textured soils is typically around 1 m.

Stands belonging to this association can be either second-growth or old-growth age classes. Canopy densities are generally 60%-70%. The overstory tree layer is dominated by large *Pseudotsuga menziesii* (average cover of 49%), with substantial amounts of mature *Tsuga heterophylla* (Table 1). *Thuja plicata* has abundant regeneration and is interpreted as a secondary climax tree species in one-half the sampled stands. In common with most low elevational units, the *Tsuga/Acer/Polystichum* generally contains at least scattered *Acer macrophyllum* stems.

The shrub layer is usually dense and invariably dominated by *Acer circinatum* (Table 1; Figure 20). *Berberis nervosa* was also present in every stand, but has extremely variable cover (3%-80%; Appendix). Other common but minor shrubs include *Gaultheria shallon*, *Rhododendron macrophyllum*, *Taxus brevifolia*, and *Vaccinium parvifolium*.

Polystichum munitum typically dominates the herb layer with an average cover of 21% (Table 1). Other herbaceous species are minor and total herb layer coverage generally averages only 35%-40%. The two most abundant of these are *Coptis laciniata* and *Linnaea borealis*. Other herbs with at least 50% constancy include *Rubus ursinus*, *Viola sempervirens*, *Goodyera oblongifolia*, *Achlys triphylla*, *Vancouveria hexandra*, *Galium triflorum*, and *Trillium ovatum*.

A vine maple--sword fern community has been described in the Oregon Coast Range by Corliss and Dyrness (1965). This community has an understory similar in species composition to our *Tsuga/Acer/Polystichum* association; however, it occurred most frequently in 90-year-old stands dominated by *Pseudotsuga menziesii* and was interpreted as a seral community. Climax vegetation for those vine maple--sword fern areas of the Coast Range was believed to be *Tsuga heterophylla/Polystichum munitum*.

1.13. Tsuga heterophylla/Polystichum munitum *(Tshe/Pomu) association.* The *Tsuga/Polystichum* association is similar to the *Tsuga/Acer/Polystichum*, but has substantially less tall shrub cover and a corresponding increase in herb cover. The *Tsuga/Polystichum* unit contains only scattered *Acer circinatum* and less than half as much *Berberis nervosa* cover as well. Principal herb layer differences are larger amounts of such species as *Linnaea borealis* and *Tiarella unifoliata* in this association as compared with the *Tsuga/Acer/Polystichum*.

Stands belonging to the *Tsuga/Polystichum* association occur on bench and smooth slope landforms at elevations ranging from 460 to 850 m. Slopes vary from level to steep (0%-75%) with predominantly northerly aspects. They are found on a variety of soil series derived from tuffs, breccias, and andesite colluvium. Most often these soils are moderately stony (5%-30%) and moderately deep (effective rooting depths of 1 to 2 m), with silt loam surface soil texture. Although most are well drained, several plots are located on imperfectly drained soils.

Stands typical of this association are generally made up of old-growth *Pseudotsuga menziesii* and *Tsuga heterophylla*, which typically provide a relatively dense overstory averaging 70%-80% canopy coverage. In addition,

Thuja plicata is usually present in the overstory in significant quantities (Table 1); *Thuja* reproduction is sufficient in about half the stands to qualify it as one of the climax species.

The sparse shrub layer is almost always dominated by *Berberis nervosa*. Other virtually ubiquitous shrubs are *Acer circinatum* and *Vaccinium parvifolium*. Less common shrubs include *Gaultheria shallon*, *Rhododendron macrophyllum*, and *Taxus brevifolia*.

Figure 21. *Polystichum munitum* is the major understory dominant in stands representative of the *Tsuga heterophylla/Polystichum munitum* association.

The only constant herbaceous species is *Polystichum munitum* with an average cover of 25% (Table 1; Figure 21). Other important species with constancies of at least 75% are *Linnaea borealis*, *Tiarella unifoliata*, and *Coptis laciniata*. Less abundant but commonly occurring species include: *Trillium ovatum*, *Viola sempervirens*, *Rubus ursinus*, *Rubus nivalis*, and *Galium triflorum*. Although *Blechnum spicant* occurs in only one-fourth of the stands, it is a significant indicator since it is found only in stands belonging to the *Tsuga/Polystichum* and *Tsuga/Polystichum-Oxalis* associations.

Corliss and Dyrness (1965) describe a sword fern community in the Alsea River drainage of the Oregon Coast Range that is apparently very similar to our *Tsuga/Polystichum*. Both occur under rather dense *Tsuga-Pseudotsuga*-dominated timber stands; both have poorly developed shrub layers and, with minor exceptions, understory species composition is similar.

1.14. Tsuga heterophylla/Polystichum munitum--Oxalis oregana *(Tshe/Pomu-Oxor) association.* The *Tsuga/Polystichum-Oxalis* association occupies the moistest and most productive sites in the *Tsuga heterophylla* zone. All plots within this association are estimated as at least site class II for *Pseudotsuga* growth (Appendix). The *Polystichum-Oxalis* unit is restricted to small, localized, extremely moist sites. It posesses the most luxurient herb layer of all units within the *Tsuga heterophylla* zone, largely because of an abundance of *Polystichum munitum* and *Oxalis oregana.*

Stands belonging to the *Tsuga/Polystichum-Oxalis* association occur on a variety of landforms ranging from steep, smooth slopes to alluvial fans at elevations of 340-730 m. Slope gradients vary from gentle to steep (from 5% to 90%) with virtually all aspects represented. Soils are generally deep, relatively stone free, and moderately fine textured (silt loam surface and silty clay loam subsoil). The most frequently encountered parent materials are deep, fine-textured, andesite colluvium. Although most soils are well drained, imperfectly drained soils are not uncommon.

Figure 22. Lush herb layer typical of the *Tsuga heterophylla/Polystichum munitum--Oxalis oregana* association; dominants are *Polystichum* and *Oxalis*. This association occupies wettest sites within the *Tsuga heterophylla* zone.

The *Tsuga/Polystichum-Oxalis* association is characterized by old-growth *Pseudotsuga-Tsuga* timber stands of medium density, averaging 60%-70% canopy coverage. In about half the stands *Thuja plicata* shares climax status with

Tsuga heterophylla; however, *Tsuga* will obviously dominate most climax stands (Table 1). In addition to the three coniferous species, scattered stems of mature *Acer macrophyllum* are also frequently encountered.

Characteristics of the shrub layer are variable, with total cover ranging from 5% to 70%. Ubiquitous species are *Berberis nervosa, Acer circinatum,* and *Vaccinium parvifolium.* Species that are sometimes important but have lower constancies include *Gaultheria shallon* and *Taxus brevifolia* (Table 1).

The herb layer is unusually dense and may approach 100% total cover. *Oxalis oregana* and *Polystichum munitum* completely dominate with an average of about 65% cover (Figure 22). Other herbs common to this association are *Linnaea borealis, Vancouveria hexandra, Achlys triphylla, Rubus ursinus, Tiarella unifoliata, Viola sempervirens, Disporum hookeri,* and *Blechnum spicant.*

Both Corliss and Dyrness (1965) and Bailey (1966) identify a *Tsuga heterophylla/Polystichum munitum--Oxalis oregana* association in the Oregon Coast Range. Since their descriptions closely match the characteristics of our *Polystichum-Oxalis* unit, we can conclude that these units are the same for all practical purposes.

2. Abies amabilis *zone*

2.1. Abies amabilis--Tsuga mertensiana/Xerophyllum tenax *(Abam-Tsme/Xete) association.* Stands belonging to this association occur on shallow soils at highest elevations within the study area. Site productivity is very low, with both *Abies amabilis* and *Tsuga mertensiana* showing very slow rates of growth. The association is easily identified by the complete dominance of *Xerophyllum tenax* in the understory and the relative lack of accompanying shrubs and herbs.

The *Abies-Tsuga/Xerophyllum* association is characteristically located on or near ridgetops at elevations of 1400-1620 m. It generally occupies gentle to moderate slopes on almost the entire range of aspects. All stands within this association were found on poorly developed Brown Podzolic soils derived from aerially deposited volcanic ash and pumice overlying andesite bedrock. These soils are fine sandy loams that are markedly light weight (i.e., of low bulk density) and "fluffy." Effective rooting depth is typically less than 1 m and stone content, usually andesite, ranges up to 75% by volume.

The tree layer in this association is often scattered and open, with total canopy coverage ranging from about 30% to 70%. The codominant trees in the overstory, both climax, are *Abies amabilis* and *Tsuga mertensiana* (Table 2). The *Abies-Tsuga/Xerophyllum* association is the only one within the *Abies amabilis* zone that is completely devoid of *Tsuga heterophylla* (Table 2). Seral tree species that occurred with some regularity are *Abies procera, Pinus monticola,* and old-growth *Pseudotsuga menziesii.*

The *Abies-Tsuga/Xerophyllum* association possesses a unique, virtually monospecific understory (*Xerophyllum tenax;* Figure 23). *Xerophyllum* is often dense and coverage averages 64% (Table 2). The only other species present in all stands is *Vaccinium membranaceum,* which generally occurs as scattered individuals and averages only 6% cover. None of the remaining species assumes

much significance and none surpasses 0.5% coverage (Table 2). Seven species in this category occurred in 50%-75% of the sampled stands: *Achlys triphylla*, *Chimaphila menziesii*, *Goodyera oblongifolia*, *Pyrola secunda*, *Rubus lasiococcus*, *Viola sempervirens*, and *Anemone oregana*.

Figure 23. A stand representative of the *Abies amabilis--Tsuga mertensiana/Xerophyllum tenax* association. The only understory species visible here is *Xerophyllum tenax*.

Franklin (1966) describes both an *Abies amabilis/Xerophyllum* and a *Tsuga mertensiana/Xerophyllum* association in the southern Washington Cascade Range. Our association closely resembles his *Tsuga/Xerophyllum* grouping. He describes it as occurring "on high ridgetops or steep slopes covered by only a skim of lithosolic soil," and mentions that, with regard to species composition, "*Xerophyllum* is the only understory species of consequence, although *Vaccinium membranaceum* and *Pyrola secunda* are usually present."

2.2. Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax *(Abam/Vame/Xete) association*. Stands belonging to the *Abies/Vaccinium/Xerophyllum* association are found on habitats that are slightly more moist and warmer than those supporting the *Abies-Tsuga/Xerophyllum* association (Figure 5). These differences are indicated by the occurrence of the *Vaccinium/Xerophyllum* grouping at lower elevations, on noticeably deeper soils, and by the presence of a richer variety of herbaceous species when compared with the previously described *Xerophyllum* unit. These differences are also reflected in comparative timber site quality; whereas site quality is estimated to be class V in all stands of the *Abies-*

Table 2. Average cover and constancy values (in percent) for important plant species in nine forest communities within the *Abies amabilis* zone.

Species		Abam-Tsme/Xete[a] Cov.	Con.	Abam/Vame/Xete Cov.	Con.	Abam/Rhma-Vaal/Coca Cov.	Con.	Abam/Vaal/Coca Cov.	Con.	Abpr/Actr Cov.	Con.	Abam/Actr Cov.	Con.	Abpr/Clun Cov.	Con.	Abam/Tiun Cov.	Con.	Chno/Opho Cov.	Con.
TREE LAYER																			
Abies amabilis	R[b]	11	100	13	100	7	100	6	100	6	100	12	100	5	100	8	100	10	100
	M	20	88	22	100	4	73	12	88	1	50	6	69	9	100	14	100	16	86
Abies procera	R			1	44					2	50	3	38	1	71				
	M	16	62	33	100	1	55	1	12	45	100	5	54	53	100	5	58	0[c]	14
Pseudotsuga menziesii	R			Tr[d]	11									Tr	29	Tr	8		
	M	1	50	19	67	36	91	33	100	21	83	53	100	14	86	37	100	20	71
Tsuga heterophylla	R			1	44	3	73	7	100	1	33	3	85	1	86	5	100	3	86
	M			4	33	43	100	43	100	Tr	17	17	46	3	29	28	92	2	57
Pinus monticola	R			Tr	22									Tr	14				
	M	2	50	3	67	Tr	45	Tr	12	1	33	3	38	5	57	2	33		
Tsuga mertensiana	R	4	88	1	33					1	17			Tr	14				
	M	39	100	2	44					2	50			1	29				
Pinus contorta	R																		
	M	Tr	12											Tr	14				
Abies grandis	R									1	33	1	38						
	M	0	12									3	15			Tr	8		
Thuja plicata	R					1	18					Tr	15					Tr	14
	M					6	45	6	50							Tr	8	5	29
Picea engelmannii	R																		
	M											Tr	8			3	8		
Chamaecyparis nootkatensis	R																	3	71
	M			0	11													28	57
Total	R	15		16		11		13		11		19		7		13		16	
	M	78		83		90		95		70		87		85		89		71	
TALL SHRUB LAYER																			
Vaccinium membranaceum		7	100	13	100	1	64	1	88	3	100	3	85	6	100	4	83	1	57
Acer circinatum		0	12	Tr	11	2	45	4	75	14	67	3	69	2	43	5	67	16	71
Rhododendron macrophyllum		0	12			29	100	1	38	Tr	17	1	8	0	14	Tr	25	1	14
Vaccinium alaskaense						16	100	10	88					0	14	2	42	0	14
Vaccinium parvifolium						1	55	1	75			Tr	8	Tr	14	Tr	25		
Taxus brevifolia						6	55	2	75							Tr	25	Tr	14
Pachistima myrsinites				1	11	1	55	1	62	1	50	1	54			Tr	8		
Amelanchier alnifolia		0	12							1	50	Tr	8	Tr	29				
Rubus parviflorus				Tr	11					1	50	Tr	8	Tr	14				
Sorbus sitchensis		Tr	12							Tr	17			1	57				
Ribes lacustre				Tr	11							Tr	38	Tr	43	1	33	1	86
Rubus spectabilis												Tr	8			Tr	17	1	71
Oplopanax horridum												0	8			1	50	13	100
Total		7		14		56		20		20		9		8		13		33	
LOW SHRUB LAYER																			
Rubus lasiococcus		1	75	6	78	1	64	1	62	4	67	2	46	5	100	2	67	2	43
Rosa gymnocarpa				2	33	Tr	9	Tr	12	1	50	1	62	1	57	Tr	42	Tr	14
Rubus ursinus						1	82	1	100	1	50	1	85	1	57	1	67	Tr	14
Berberis nervosa				Tr	11	5	82	5	62			3	54	0	14	1	8	Tr	29
Symphoricarpos mollis				1	22	Tr	9			1	33	2	54	1	14	Tr	8		
Total		1		9		7		7		7		9		8		4		2	
HERB LAYER																			
Achlys triphylla		1	50	9	89	1	64	1	88	12	100	14	100	7	100	11	100	3	86
Anemone deltoidea		Tr	38	1	44	Tr	27	Tr	38	1	67	2	69	1	100	1	67	1	71
Viola sempervirens		1	62	1	56	1	73	1	88	1	67	4	77	7	100	2	83	1	43
Chimaphila menziesii		Tr	50	1	78	1	45	Tr	50	1	67	1	77	1	86	1	67	Tr	43
Chimaphila umbellata		Tr	25	1	33	2	82	2	75	2	50	4	85	7	100	1	42	Tr	14
Pyrola secunda		1	62	2	100	Tr	18	1	75	2	100	1	62	3	100	1	67	Tr	29
Goodyera oblongifolia		Tr	50	Tr	33	1	64	1	50	1	50	1	62	1	71	1	67	Tr	14
Trillium ovatum		0	25	1	78	Tr	27	1	88	1	67	1	54	1	86	1	67	1	86
Polystichum munitum		0	12	Tr	11	Tr	18	1	50	Tr	33	1	69	Tr	43	1	83	2	100
Smilacina stellata		0	12	10	56	Tr	27	2	62	15	100	2	85	9	85	7	92	9	100
Tiarella unifoliata				2	44	1	27	2	100	1	17	5	85	3	71	12	100	6	100
Clintonia uniflora		1	38	3	78	2	73	2	62	3	83	2	69	9	100	9	67	1	57
Cornus canadensis				1	56	4	100	5	100	Tr	17	2	46	10	71	11	100	5	71
Xerophyllum tenax		64	100	39	100	8	64	1	38	1	33	2	31	1	57	Tr	25	Tr	14
Linnaea borealis				Tr	33	3	100	2	100	1	17	5	77	2	29	1	42	Tr	43
Grasses		Tr	12	1	44					1	50	2	69	1	71	Tr	25	1	57
Galium oreganum				1	33	Tr	9			6	83	1	54	3	100	Tr	33	1	43
Pyrola asarifolia						1	73	1	50					Tr	14				
Pyrola picta				Tr	44	0	9	0	12	1	83	1	77	1	100	Tr	33	Tr	43
Hieracium albiflorum		Tr	25	Tr	22					Tr	33	1	54	1	86	Tr	8		
Listera caurina		Tr	25	Tr	11			Tr	12	1	50	Tr	54	1	100	1	50		
Arnica latifolia				4	22					1	17	Tr	8	2	43	1	8		
Pteridium aquilinum				Tr	22			Tr	12	5	83	7	46	5	86	2	25		
Viola glabella				1	22					1	67	4	62	1	86	Tr	25	Tr	14
Campanula scouleri		Tr	12	Tr	11					1	33	1	46	2	57	Tr	17	Tr	29
Asarum caudatum				Tr	11			Tr	12	Tr	33	5	85	Tr	43	1	67		
Adenocaulon bicolor						Tr	9			Tr	17	2	62	0	14	1	50	1	57
Osmorhiza purpurea				1	22					1	33	1	62	1	57	Tr	8	1	71
Corallorhiza mertensiana				Tr	11	Tr	18	Tr	38	Tr	17	Tr	38	Tr	14	Tr	42	Tr	29
Vancouveria hexandra				1	44			Tr	25	Tr	17	1	62	2	43	2	67	2	57
Disporum hookeri				Tr	11	0	9	1	38			Tr	23	0	14	1	67	1	57
Galium triflorum				Tr	11					Tr	33	1	54	Tr	29	Tr	33	1	57
Streptopus roseus var. *curvipes*				Tr	22			Tr	38			1	8	Tr	14	4	50	Tr	29
Athyrium filix-femina										Tr		17	1	8			1	67	3
Montia sibirica												1	31	Tr	14	1	25	10	71
Circaea alpina																		3	57
Hydrophyllum sp.																		3	43
Tolmiea menziesii																		2	43
Total		68		85		26		24		65		88		67		80		63	
TOTAL UNDERSTORY		91		124		103		64		103		125		90		110		114	
TOTAL ALL LAYERS		169		207		193		159		173		212		175		199		185	

[a] Abam = *Abies amabilis*, Tsme = *Tsuga mertensiana*, Xete = *Xerophyllum tenax*, Vame = *Vaccinium membranaceum*, Rhma = *Rhododendron macrophyllum*, Vaal = *Vaccinium alaskaense*, Coca = *Cornus canadensis*, Abpr = *Abies procera*, Actr = *Achlys triphylla*, Clun = *Clintonia uniflora*, Tiun = *Tiarella unifoliata*, Chno = *Chamaecyparis nootkatensis*, Opho = *Oplopanax horridum*.

[b] R = trees in the reproduction size class (seedlings and saplings). M = trees in the mature size class (crowns contribute to overstory tree cover).

[c] Zero indicates species occurred in trace amounts only in all sampled stands.

[d] Trace indicates average cover less than 0.5%.

Figure 24. A representative stand of the *Abies amabilis/Vaccinium membranaceum* association. The understory is dominated by *Vaccinium membranaceum* and *Xerophyllum tenax*.

Figure 25. A representative stand within the *Abies amabilis/Rhododendron macrophyllum--Vaccinium alaskaense/Cornus canadensis* association. Trees are largely *Tsuga heterophylla* with scattered young *Abies amabilis*.

Tsuga/Xerophyllum association, most stands included in the *Abies/Vaccinium/Xerophyllum* type were placed within class IV (Appendix).

Like the *Abies-Tsuga/Xerophyllum*, representative stands of the *Abies/Vaccinium/Xerophyllum* association occur on ridgetops or upper one-third of smooth side slopes. Sampled stands occupy a relatively narrow elevational range (1280-1430 m). Slopes tend to be moderately steep (about 20%-40%) and predominant aspects are west and northwest. With only one exception, soils are Brown Podzolics derived from andesitic parent material, volcanic ash and pumice, or both. Soil texture ranges from loam to sandy loam and stone content from about 10% to 40% by volume. Estimated effective rooting depth ranges from about 1 to 2 m.

The tree layer in two-thirds of the sampled stands is rather open (30%-40% coverage), while the remaining third has canopy densities in the 60%-70% class. Codominant overstory trees are *Abies amabilis* and *Abies procera* (Table 2), and these are the most important climax and seral species, respectively. A consideration of species--size class relationships indicates a secondary climax role for *Tsuga heterophylla* and *Tsuga mertensiana* in several stands. Additional important seral tree species are *Pseudotsuga menziesii* and *Pinus monticola*. It is interesting to note that despite the open stand structure, there is limited reproduction of even the seral species in some stands (Table 2).

The only shrub of importance is *Vaccinium membranaceum* which averages 12% cover, roughly twice as much as in the previous *Xerophyllum* association (Figure 24). Important herbaceous species are *Xerophyllum tenax*, *Achlys triphylla*, *Rubus lasiococcus*, and *Smilacina stellata*. Other high-constancy species occurring in smaller quantities include: *Chimaphila menziesii*, *Pyrola secunda*, *Trillium ovatum*, and *Clintonia uniflora*.

The *Abies/Vaccinium/Xerophyllum* association is similar to the *Abies amabilis--Tsuga mertensiana/Vaccinium membranaceum* unit Franklin (1966) described in the southern Washington Cascades. Ours evidently has a considerably richer herb layer, for Franklin states, "The *Abies-Tsuga/Vaccinium* association is characterized by a very depauperate understory in which only *V. membranaceum*, *Xerophyllum tenax*, and *Rubus lasiococcus* are constant and conspicuous components."

2.3. Abies amabilis/Rhododendron macrophyllum--Vaccinium alaskaense/Cornus canadensis *(Abam/Rhma-Vaal/Coca) association*. In the area studied, stands belonging to this association are found on sites now dominated by old-growth *Pseudotsuga menziesii* and *Tsuga heterophylla* (Figure 25). These sites, however, are being vigorously invaded by *Abies amabilis*, which will clearly be the dominant climax tree species based on relative amounts of regeneration. *Abies/Rhododendron-Vaccinium/Cornus* stands occur on a variety of landforms at elevations varying from about 910 to 1220 m. They occupy predominantly moderate slopes (5%-40%) of many different aspects. Soils are most commonly deep Brown Podzolics of loam and sandy loam texture. These soils range from about 1.5 to 2.5 m in depth and are developed in deposits of andesite and colluvium.

The old-growth forest stands characteristic of this association vary in canopy density from about 40% to 80%. The three most abundant tree species

are the climax *Tsuga heterophylla* and *Abies amabilis*, plus large, old-growth *Pseudotsuga menziesii*. Seral tree species that are often present in relatively small numbers include *Abies procera*, *Pinus monticola*, and *Thuja plicata* (Table 2).

Shrubs typical of the *Abies/Rhododendron-Vaccinium/Cornus* are *Rhododendron macrophyllum*, *Vaccinium alaskaense*, and *Berberis nervosa* (Figure 26). Other shrubs occur only sporadically and in rather small quantities. Those with over 50% constancy include *Taxus brevifolia*, *Vaccinium membranaceum*, *Vaccinium parvifolium*, and *Pachistima myrsinites*.

Figure 26. Understory in the *Abies amabilis/Rhododendron macrophyllum--Vaccinium alaskaense/Cornus canadensis* association. Species visible here are *Rhododendron, Vaccinium alaskaense, Cornus canadensis, Clintonia uniflora,* and *Xerophyllum tenax.*

The herb layer is generally not well developed and only two species were present in every sampled stand, *Cornus canadensis* and *Linnaea borealis*. The only other species of importance are *Achlys triphylla*, *Chimaphila umbellata*, *Pyrola asarifolia*, *Rubus ursinus*, *Viola sempervirens*, *Xerophyllum tenax*, and *Clintonia uniflora*. Of these, *Xerophyllum* is by far the most abundant, averaging 7% cover (Table 2).

Franklin (1966) has described a *Berberis-Xerophyllum* phase of the *Abies amabilis/Vaccinium alaskaense* association in the southern Cascades of Washington which, except for the absence of *Rhododendron*, is very similar to our *Abies/Rhododendron-Vaccinium/Cornus* unit.

2.4. Abies amabilis/Vaccinium alaskaense/Cornus canadensis *(Abam/Vaal/Coca) association.* The *Abies/Vaccinium/Cornus* association is very similar to the *Abies/Rhododendron-Vaccinium/Cornus*, but there are indications that member stands of the former occupy sites that are noticeably more moist and productive than those belonging to the latter (Figure 5). Both units are associated with old-growth timber stands with very similar species composition. Shrub cover decreased in the *Abies/Vaccinium/Cornus* association, however; in particular, *Rhododendron* occurs in only small quantities. Species composition of the herb layer is similar in both units, except for greatly decreased importance of *Xerophyllum tenax* and increased occurrence of *Tiarella unifoliata* in the *Abies/Vaccinium/Cornus* association.

Stands belonging to this association are found on a variety of landforms ranging from ridgetops to stream terraces at elevations of 880-1160 m. Slopes are generally moderate (10%-35%) with northerly aspects. The most common soils are rather poorly developed Brown Podzolics forming deposits of andesite colluvium. These are generally stony, loam-textured soils with estimated effective rooting depth varying from 1 to 3 m.

Figure 27. A stand typical of the *Abies amabilis/Vaccinium alaskaense/Cornus canadensis* association; note the old-growth *Pseudotsuga* and abundance of young *Abies amabilis* stems.

The old-growth timber stands are dominated by *Pseudotsuga menziesii* and *Tsuga heterophylla* (Figure 27). *Abies amabilis* also contributes 11% cover in the

overstory and 6% cover as understory regeneration (Table 2). The only other important tree species is *Thuja plicata*, which is often significant in the overstory but is not reproducing. Climax tree species in this association are *Abies amabilis* and *Tsuga heterophylla*.

The shrub layer in the *Abies/Vaccinium/Cornus* association is not dense, averaging perhaps 20%-25% total cover. Although it did not occur in all sampled stands, *Vaccinium alaskaense* is by far the most important shrub species (Table 2). Other common shrub species include *Acer circinatum*, *Berberis nervosa*, *Taxus brevifolia*, *Vaccinium membranaceum*, and *Vaccinium parvifolium*.

The herb layer of the *Abies/Vaccinium/Cornus* association is also poorly developed, averaging about 20%-25% total cover. Species occurring in rather small quantities but in all sampled stands are *Cornus canadensis*, *Linnaea borealis*, *Tiarella unifoliata*, and *Rubus ursinus*. Species averaging at least 1% cover and occurring in over half the sampled stands are *Chimaphila umbellata*, *Achlys triphylla*, *Viola sempervirens*, *Clintonia uniflora*, and *Smilacina stellata*.

This association appears to be similar to the *Berberis* phase of the *Abies amabilis/Vaccinium alaskaense* association described by Franklin (1966). In the southern Cascade Range of Washington, this phase occurs on steep, south-facing slopes at elevations between 610 and 820 m.

2.5. Abies procera/Achlys triphylla *(Abpr/Actr) community*. The *Abies procera/Achlys* community is a seral grouping associated with "second-growth" forest stands dominated by *Abies procera*. As succession proceeds on these sites, climax stands will develop that belong to the *Abies amabilis/Achlys triphylla* association. This community is found on smooth slopes and ridge-tops at elevations of 1280-1430 m. Slopes are moderate to steep (20%-60%), with a variety of aspects. All stands belonging to this community type were on Brown Podzolic soils derived largely from volcanic ash and pumice. These soils are generally a "fluffy," fine, sandy loam, with 20%-50% stones and an effective rooting depth varying from 1 to 2 m.

Many of these second-growth forest stands are markedly open; total overstory coverage ranges from about 20% to 60%. Although *Abies procera* is dominant in the overstory, *Pseudotsuga menziesii* also contributes appreciable amounts of cover (Table 2). Tree regeneration is dominantly *Abies amabilis*, clearly indicating its climax status. *Tsuga heterophylla* is present only in small quantities and undoubtedly will increase in importance as succession advances. Other tree species present in some stands include *Abies grandis*, *Pinus monticola*, and *Tsuga mertensiana*.

The *Abies procera/Achlys* community characteristically has very little shrub cover. The only shrub contributing more than 10% cover in a single stand was *Acer circinatum*, but it is present in only two-thirds of the sampled stands (Table 2). *Vaccinium membranaceum* (3% average cover) is the only shrub with 100% constancy. Four species occur in small amounts in half the sampled stands: *Rosa gymnocarpa*, *Amelanchier alnifolia*, *Pachistima myrsinites*, and *Rubus parviflorus*.

The herb layer of the *Abies procera/Achlys* community is generally well developed with an average total cover of about 65%. In most stands dominance is shared by *Smilacina stellata* and *Achlys triphylla*. Other species contributing substantial amounts of cover include *Galium oreganum*, *Pteridium aquilinum*, *Rubus lasiococcus*, *Clintonia uniflora*, and *Pyrola secunda*. Species of less importance, but occurring in one-half or more of the stands, include *Pyrola picta*, *Chimaphila umbellata*, *Anemone deltoidea*, *Chimaphila menziesii*, *Viola glabella*, and *Viola sempervirens*.

2.6. Abies amabilis/Achlys triphylla *(Abam/Actr) association.* The *Abies amabilis/Achlys* association is the climax equivalent of the seral *Abies procera/Achlys* community. Since timber stands representative of this association are old growth, *Abies procera* is much less important in the tree layer than in the *Abies procera/Achlys* community. Understories of the two units are quite similar in appearance, however, despite shifts in dominance involving several major species. The most pronounced differences in the herb layer involve substantially smaller amounts of *Smilacina stellata* and *Galium oreganum* with corresponding increases in importance of *Tiarella unifoliata* and *Asarum caudatum* in the *Abies amabilis/Achlys* association, as compared with the *Abies/procera/Achlys* grouping. As its name would indicate, *Achlys triphylla* remains the dominant understory species in the *Abies amabilis/Achlys* unit.

Stands representing the *Abies/Achlys* association generally occupy upper and midslope positions at elevations ranging from 1190 to 1400 m. Slope gradient varies from gentle to steep, with most slopes facing in southerly or westerly directions. Soils are Brown Podzolics most often derived from andesite colluvium or residuum. Soil texture varies from sandy loam to silt loam and most soils are at least moderately stony. Effective rooting depth almost without exception fell within the 1- to 2-m range.

The tree layer was highly variable in density, with total canopy coverage varying from 30% to 80%. The dominant tree cover was provided by old-growth *Pseudotsuga menziesii* with an average of 53% (Table 2). Both major climax trees, *Abies amabilis* and *Tsuga heterophylla*, were of substantially less importance in the overstory. Both were common in regeneration size classes, however, with 12% and 3% cover, respectively. *Abies grandis* is fairly common and in several stands constitutes an additional climax tree species. Seral *Pinus monticola* was also present in approximately one-third of the sampled stands.

The *Abies amabilis/Achlys* association typically has very little shrub cover. Although a variety of shrub species occur, only *Vaccinium membranaceum* can be considered characteristic, since it is the only one occurring in virtually every stand. Other frequently encountered species are *Acer circinatum*, *Berberis nervosa*, *Rosa gymnocarpa*, *Symphoricarpos mollis*, and *Pachistima myrsinites*.

The herb layer is very well developed with a total of 57 species having an average total cover of 80%-85% (Figure 28). *Achlys triphylla* had highest cover (14%) and was the only species encountered in all sampled stands (Table 2). Other common species providing at least 4% or more cover were *Tiarella unifoliata*, *Asarum caudatum*, *Chimaphila umbellata*, *Linnaea borealis*, *Pteridium aquilinum*, *Viola sempervirens*, and *Viola glabella*. Other less conspicuous, but generally encountered, herbs include *Smilacina stellata*, *Anemone deltoidea*,

Figure 28. Understory typical of the *Abies amabilis/Achlys triphylla* association. Visible here are *Acer circinatum*, *Berberis nervosa*, *Achlys triphylla*, and scattered *Abies amabilis* seedlings.

Clintonia uniflora, *Adenocaulon bicolor*, *Chimaphila menziesii*, *Cornus canadensis*, *Pyrola secunda*, *Polystichum munitum*, *Rubus lasiococcus*, *Galium oreganum*, and *Osmorhiza purpurea*.

This association is apparently almost identical to the *Abies amabilis/Achlys triphylla* association Franklin (1966) described for the Mount Adams Province in the southern Washington Cascade Range.

2.7. Abies procera/Clintonia uniflora *(Abpr/Clun) community*. The *Abies procera/Clintonia* community is a seral grouping that is replaced in succession by the climax *Abies amabilis/Tiarella* association. As a seral type it is always associated with second-growth timber stands dominated by *Abies procera*. The *Abies/Clintonia* community occupies sites that tend to be more moist and productive than sites characteristic of the *Abies/Achlys* association (Figure 5).

Stands belonging to this community occur on a variety of landforms at elevations within the narrow range of 1250-1310 m. Slopes are gentle to moderate (3%-35%) with aspects covering virtually the entire range. Soils supporting the *Abies/Clintonia* community are Brown Podzolics on andesite bedrock, but they have formed largely from aerially deposited pumice and volcanic ash. Soil texture is generally a stony loam, with effective rooting depth varying from 1 to 2 m.

Figure 29. A representative stand of the *Abies procera/Clintonia uniflora* community; note the absence of shrubs. Tree regeneration is exclusively *Abies amabilis*.

Figure 30. Shade phase of the *Abies procera/Clintonia uniflora* community. The dense overstory has severely reduced amounts of understory vegetation.

Tree layers in the *Abies/Clintonia* community tend to be fairly dense (60%-80% cover), although two very open stands (20%-40%) were also sampled. *Abies procera* sharply dominates the overstory, with no other trees averaging as much as 15% cover. Other seral species in the overstory are *Pseudotsuga menziesii* and *Pinus monticola*. The ultimate climax species, *Abies amabilis*, is present in sizable quantities in every sampled stand, especially in the understory (Table 2).

Shrub cover in this community is extremely sparse (Figures 29 and 30), with only *Vaccinium membranaceum* and *Rosa gymnocarpa* occurring in more than half the sampled stands.

The herb layer of the *Abies/Clintonia* community is very well developed with an average total cover of about 80%-85%. Dominant species, each with an average cover of 5%-10% and occurring in virtually every stand, are: *Clintonia uniflora*, *Viola sempervirens*, *Achlys triphylla*, *Smilacina stellata*, *Cornus canadensis*, *Rubus lasiococcus*, and *Pteridium aquilinum*. Other species also having high constancy values but occurring in smaller amounts include *Galium oreganum*, *Pyrola secunda*, *Pyrola picta*, *Tiarella unifoliata*, *Anemone deltoidea*, *Chimaphila menziesii*, *Chimaphila umbellata*, *Listera caurina*, *Trillium ovatum*, and *Viola glabella*.

2.8. Abies amabilis/Tiarella unifoliata *(Abam/Tiun) association.* This association is the climax equivalent of the *Abies procera/Clintonia* community and all member stands are in old-growth age classes. The tree layer of the *Abies/Tiarella* association includes very little *Abies procera*, but large numbers of *Abies amabilis* in both overstory and regeneration size classes. General appearance and species composition of the understory are similar in this climax association and its seral equivalent. Both units have very little shrub cover but an abundant herb layer that virtually carpets the ground surface. Principal differences in the herb layer involve decreased importance of *Pteridium aquilinum* and *Rubus lasiococcus*, and a substantial increase in cover of *Tiarella unifoliata* in the *Abies/Tiarella* association as compared with the *Abies/Clintonia* community.

Stands representative of the *Abies/Tiarella* association occur on warmer and more moist sites than those belonging to the *Abies/Achlys* association. Comparative habitat productivity of the two units is reflected by recorded site qualities of classes III and IV for stands of the *Abies/Achlys* association.

Stands of the *Abies/Tiarella* association occur on a variety of landforms at elevations ranging from 1000 to 1280 m. Slope steepness varies from level to 55%, with almost all aspects represented. Soils supporting the unit are moderately deep Brown Podzolics derived from andesite residuum and colluvium. These soils are generally moderately stony silt loams, which typically appear to be slightly finer textured than soils supporting related plant communities.

The tree layer in these old-growth stands is usually dominated by *Pseudotsuga menziesii* and *Tsuga heterophylla* (Figure 31). Seral *Abies procera* and *Pinus monticola* occur in the overstory as scattered individuals. Only two tree species are regenerating in any quantity, *Abies amabilis* and *Tsuga heterophylla*. Thus we infer that in climax stands these two species will be codominant.

Figure 31. A representative stand of the *Abies amabilis/Tiarella unifoliata* association. Although abundant young stems of *Abies amabilis* are present, this stand is still dominated by large, old-growth *Pseudotsuga*.

Figure 32. Dense herb layer typical of the *Abies amabilis/Tiarella unifoliata* association. Species visible here include *Achlys triphylla, Vancouveria hexandra, Tiarella unifoliata, Cornus canadensis,* and *Athyrium filix-femina*.

The shrub layer is insignificant in this association, totaling less than 15% cover in most sampled stands. Once again, the only shrubs of any consequence are *Vaccinium membranaceum* and *Acer circinatum* (Table 2). Even these species, however, fall far short of 100% constancy.

Three species share dominance in the well-developed herb layer, *Tiarella unifoliata*, *Achlys triphylla*, and *Cornus canadensis* (Table 2; Figure 32). In addition, *Clintonia uniflora*, *Smilacina stellata*, and *Streptopus roseus* var. *curvipes* were often abundant, although not generally dominant. Species that commonly occurred in small quantities include *Viola sempervirens*, *Vancouveria hexandra*, *Rubus lasiococcus*, *Polystichum munitum*, *Anemone deltoidea*, *Pyrola secunda*, *Rubus ursinus*, *Asarum caudatum*, *Athyrium filix-femina*, *Disporum hookeri*, and *Adenocaulon bicolor*.

Although there are several minor differences, our *Abies/Tiarella* association appears similar to the unit of the same name described by Franklin (1966) in the southern Washington Cascade Range. Our unit lacks *Vaccinium parvifolium* and includes considerably more *Acer circinatum*. Also, our stands have herb layers with substantially larger amounts of *Cornus canadensis* and *Smilacina stellata* and smaller amounts of *Rubus lasiococcus* than did the *Abies/Tiarella* stands described by Franklin.

2.9. Chamaecyparis nootkatensis/Oplopanax horridum *(Chno/Opho) association.* The *Chamaecyparis/Oplopanax* association has limited distribution on steep, north-facing slopes at elevations from 1160 to 1370 m. Because of elevation and aspect, these are very cool and wet sites of low productivity. Snowpacks persist much later in the growing season than on most other sites at comparable elevations. The most frequently encountered soil is a black, loam-textured, Ando-like soil derived from andesite colluvium. These are generally stony soils, well drained, and with an effective rooting depth of 1-2 m.

With one exception, sampled stands are in old-growth forest processing a relatively dense overstory canopy (about 60%-90% coverage). Most tree layers are markedly mixed, with the dominant species being *Chamaecyparis nootkatensis*, *Pseudotsuga menziesii*, *Abies amabilis*, and *Tsuga heterophylla* (Table 2). The dominant climax tree is undoubtedly *Abies amabilis* mixed with varying amounts of one or two secondary climax species, *Chamaecyparis nootkatensis* and, perhaps, *Tsuga heterophylla*.

The moderately dense shrub layer is composed mainly of *Acer circinatum* and *Oplopanax horridum*, which average 16% and 13% cover, respectively (Table 2). Other shrubs generally present in small amounts are *Vaccinium membranaceum*, *Ribes lacustre*, and *Rubus spectabilis*.

The herb layer of the *Chamaecyparis/Oplopanax* association is quite well developed (about 60%-65% total cover) and composed largely of species having high moisture requirements. The most abundant herbs are *Smilacina stellata*, *Tiarella unifoliata*, *Montia sibirica*, *Cornus canadensis*, *Achlys triphylla*, *Asarum caudatum*, *Polystichum munitum*, and *Athyrium filix-femina*. Other commonly encountered species that are indicative of wet growing conditions include *Circaea alpina*, *Trillium ovatum*, *Hydrophyllum tenuipes*, *Dicentra formosa*, and *Tolmiea menziesii*.

Table 3. Elevational distribution of tree species (percentage of plots in each elevational band with mature [M] and reproduction-size [R] specimens).

		Elevation (meters)							
		335-499	500-649	650-799	800-949	950-1099	1100-1249	1250-1399	1400-1600
		Number of plots							
Species		13	56	41	60	53	31	28	18
Pseudotsuga menziesii	R	38	45	12	10	4	3	11	0
	M	100	100	100	100	98	97	89	61
Tsuga heterophylla	R	85	80	95	100	98	90	78	11
	M	54	66	66	77	83	81	40	17
Thuja plicata	R	23	39	39	53	43	10	7	0
	M	31	46	46	60	57	16	4	0
Abies amabilis	R	0	0	5	30	64	90	100	57
	M	0	0	2	23	49	74	82	78
Libocedrus decurrens	R	15	4	5	8	0	0	4	0
	M	23	12	17	10	0	0	0	0
Pinus lambertiana	R	15	16	7	2	0	0	0	0
	M	8	9	10	3	0	0	0	0
Arbutus menziesii	R	0	2	7	0	0	0	0	0
	M	8	7	15	2	0	0	0	0
Abies procera	R	0	0	0	3	9	16	43	33
	M	0	0	0	2	8	42	82	72
Pinus monticola	R	0	0	0	2	0	0	7	6
	M	0	0	0	10	15	23	54	33
Tsuga mertensiana	R	0	0	0	0	0	0	14	44
	M	0	0	0	0	0	0	21	61
Chamaecyparis nootkatensis	R	0	0	0	0	0	10	4	0
	M	0	0	0	0	0	3	11	6
Acer macrophyllum	R	8	5	10	2	6	0	0	0
	M	62	32	27	13	6	0	0	0
Abies grandis	R	15	4	2	5	15	13	18	22
	M	8	4	0	0	6	0	7	17

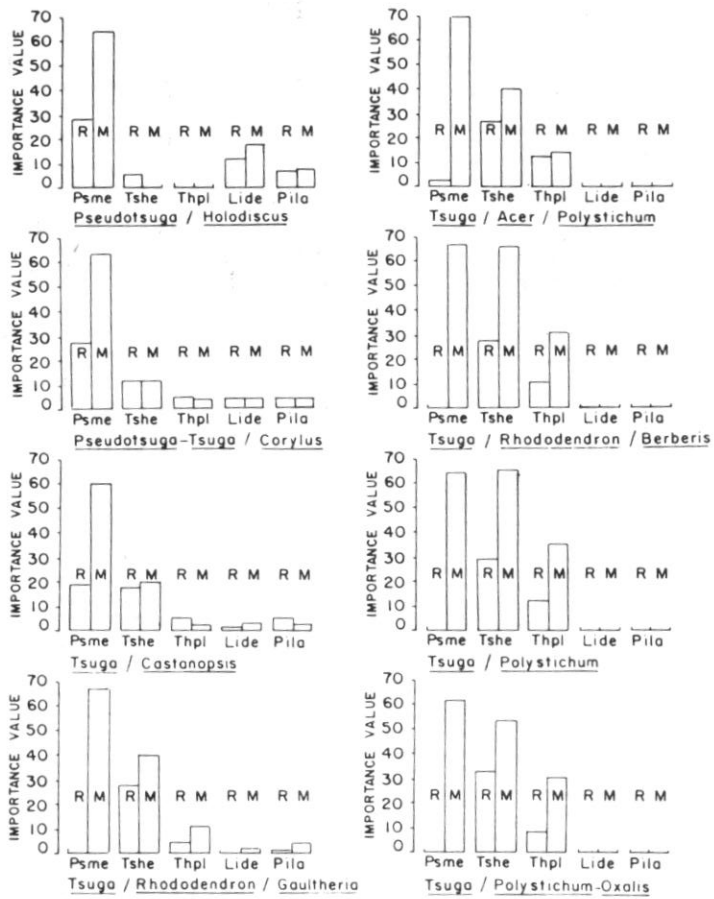


Figure 33. Relative importance of coniferous tree species in eight forest communities within the *Tsuga heterophylla* zone. Psme = *Pseudotsuga menziesii*, Tshe = *Tsuga heterophylla*, Thpl = *Thuja plicata*, Lide = *Libocedrus decurrens*, Pila = *Pinus lambertiana*, R = reproduction, M = mature.

Distribution and Successional Status of Individual Tree Species

In this section we will consider briefly the distribution of the various tree species along the elevational (which approximates temperature) and moisture gradients as well as their successional status. Several tree species that never attain a position in the overstory canopy (e.g., Pacific yew and western dogwood) are discussed in the section on understory. Two other tree species, lodgepole pine and Engelmann spruce, are minor subalpine elements and will not be considered further.

Douglas-fir is, without question, the most important single tree species in the study area. It is very widely distributed in the dominant canopy, occurring in 100% of the stands below 1000 m. Douglas-fir is also a frequent constituent in the subalpine forests of the *Abies amabilis* zone, occurring in 61% of the stands above 1500 m (Table 3). Its abundance is, however, much less in higher than in lower elevation stands. Mature Douglas-fir trees are broadly distributed across the moisture gradient within the *Tsuga heterophylla* zone (Figures 5 and 33), i.e., it has comparable importance values on both the driest and moistest forest habitats.

Distribution of Douglas-fir reproduction is much more restricted, however. Based on reproductive success, Douglas-fir can be considered a climax species only on the warm, dry habitats found at the dry end of the moisture gradient at low elevations (Figures 5 and 33). Except on these warm, dry habitats more shade-tolerant species relegate Douglas-fir to its typical role as a long-lived seral species; i.e., Douglas-fir reproduction is extremely sparse or absent. In one 16-ha section of old-growth forest on modal habitat the Douglas-firs exhibit a classic, bell-shaped size class distribution (Figure 34) with a median dbh in the 100- to 110-cm size class.

Western hemlock is the second most important tree species and the most important in terms of climax potential (Table 3). It is abundant along the elevational gradient up to almost 1300 m, but is generally absent or unimportant in forests above that elevation. Similarly, it is abundant from the middle to the moist end of the moisture gradient in the *Tsuga heterophylla* zone but is absent, or nearly so, at the dry end of the moisture gradient (e.g., in the *Pseudotsuga/Holodiscus* association).

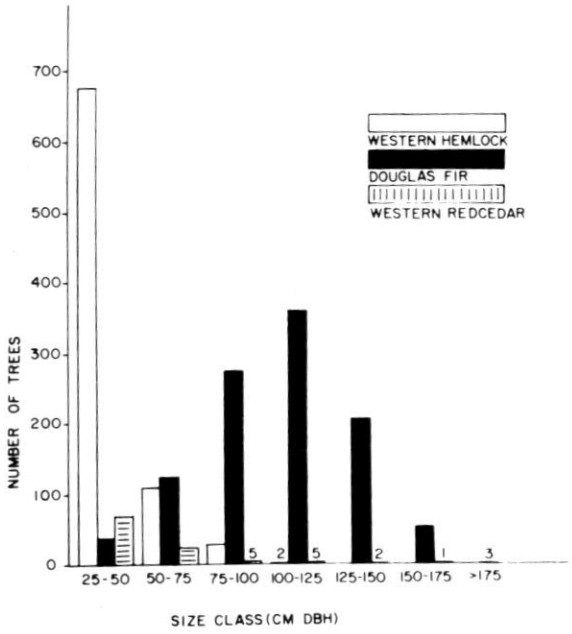


Figure 34. Distribution of trees by diameter class and species on tract of *Tsuga/Rhododendron/Berberis* habitat type.

Western hemlock is, without question, the major climax species in the *Tsuga* zone, although it is essentially excluded from the driest habitat and reproduction comes in relatively slowly on some of the other dry habitats (e.g., *Pseudotsuga-Tsuga/Corylus* habitats). Generally, however, reproduction is very abundant, much more so than in other species. Size class

distribution on a mesic 16-ha area within the *Tsuga* zone further substantiates its climax status; even with trees less than 10 cm dbh excluded a classic J-shaped curve is represented (Figure 34). At middle elevations (above 1000 m) western hemlock reproduction begins to give way to that of Pacific silver fir and within the *Abies amabilis* zone it is relegated to a seral status (Figure 5). This change in successional status of western hemlock with elevation and its replacement by Pacific silver fir at higher elevations has been described by numerous other authors in the Cascade and Coast Ranges of Oregon and Washington (see, e.g., Franklin 1966, Fonda and Bliss 1969, and Thornburgh 1969). At least part of hemlock's inability to compete with Pacific silver fir involves superior ability of the latter's seedlings to withstand effects of heavy litterfall and snowpacks (Thornburgh 1969).

Western redcedar is the third most important species within the lower elevation *Tsuga heterophylla* zone. It occurs in approximately 50% of the stands below 1010 m (Table 3). Above that elevation it declines in importance quite rapidly and occurs in only three stands (11%) above 1250 m and none above 1400 m (Table 3). Within the *Tsuga* zone western redcedar shows even less tolerance than western hemlock for warm, dry habitats (e.g., *Pseudotsuga/Holodiscus*, *Pseudotsuga-Tsuga/Corylus*, and *Tsuga/Castanopsis*; Figure 5); it is completely absent from the driest (*Pseudotsuga/Holodiscus*). Reproduction of western redcedar is found in many stands in the *Tsuga* zone and is assigned the status of a minor climax species in several associations for that reason. Western hemlock reproduction is typically much more abundant, however. Also, much of the redcedar reproduction recorded in this study actually consists of individuals developed from branches of saplings that were knocked down and have since rooted.

Pacific silver fir is the most widely distributed "subalpine" species although a few individuals were found as low as about 550 m. In general, Pacific silver fir is found above 910 m with maximum abundance between 1100 m and 1400 m (Table 3). In many transitional zone plots Pacific silver fir appears only as reproduction at present. Since a strongly developed moisture gradient is absent from our sample in the *Abies amabilis* zone, the behavior of Pacific silver fir in relation to moisture stress is not clear.

Pacific silver fir is the major climax species throughout the *Abies amabilis* zone, i.e., above about 1200 m. Silver fir reproduction is almost invariably the most abundant in higher elevation stands, even in those dominated by mountain hemlock. It also appears that Pacific silver fir will increase in importance over time in many midelevation stands, at the expense of western hemlock. Silver fir is a heavy seeded, fire sensitive species that migrates into areas relatively slowly after being eliminated by wildfire. Present patterns of size classes suggest it may still be in the process of invading some potentially suitable sites.

Incense cedar, Pacific madrone, and sugar pine are relatively minor species that exhibit similar distributional patterns. With a singular exception they are found below 950 m and, most often, below 800 m (Table 3). Furthermore, they are found only on the warmer and drier habitats within the *Tsuga heterophylla* zone (Figure 5), with their greatest abundance at the dry end of the moisture gradient. Neither sugar pine nor Pacific madrone reproduces well under a closed canopy and both are judged to be seral species. Forest stands on the warmer, drier habitats are frequently of low density, however,

and often contain small openings. Consequently, individual seedlings, saplings, or poles of these two species are occasionally encountered.

Incense cedar appears to differ somewhat from sugar pine and Pacific madrone in its successional position and does occur in one high-elevation stand (over 1250 m). This high-elevation occurrence could be judged accidental but, in fact, appears to be a minor example of the distributional pattern incense cedar commonly exhibits in some parts of southwestern Oregon. For example, along the divide between the Rogue and Umpqua Rivers incense cedar is a common component of high-elevation forests (Mitchell 1972). Incense cedar is also found invading high-elevation meadows in one or two locations on the H. J. Andrews Experimental Forest, a phenomenon that becomes increasingly common toward the south. Successionally, incense cedar appears to have at least a minor climax role on the hottest, driest habitats at low elevations. In some stands on these habitats seedling- and sapling-size specimens of incense cedar were, in fact, more abundant than those of Douglas-fir. The relative tolerance and successional relationships of these two species is uncertain and will require additional study over a wider geographic range and analyses of age classes as well as size classes before it is resolved.

The distributions of noble fir and western white pine are closely correlated and both appear to be distinctly seral species. Noble fir and western white pine are essentially confined to the *Abies amabilis* zone (above 1000 m; Table 3). There is no evidence for differential distribution along the weakly developed moisture gradient found in the subalpine zone. Noble fir is a major component of forests in this zone as an overstory dominant and is often essentially "pure" in younger (130-year-old) stands. Western white pine is not nearly as abundant although it shows relatively high constancy in several associations (Table 2). Neither noble fir nor western white pine is reproducing in significant numbers within closed stands although occasional seedlings and saplings may be encountered. Small noble fir seedlings may be found in abundance on the forest floor following a good seed year but usually survive for only one or two years.

Mountain hemlock and Alaska-cedar have similar distributional patterns and successional roles. Both are found only at the highest elevations (above 1250 m; Table 3). Mountain hemlock is an abundant species at these elevations and on the poorest sites (*Abies amabilis--Tsuga mertensiana/Xerophyllum tenax* habitat type) may form pure stands in which it is the only major overstory component. Alaska-cedar is relatively rare in forest situations. Almost all plot records are confined to a single association (*Chamaecyparis/Oplopanax*) which is found on cold, wet north slopes at high elevations. It is also found on dry rock outcrops along the ridgetops (Franklin and Dyrness 1971). Studies by Hickman (1970) indicate that the moisture stress cedar is subject to on these two habitats is very different; in effect Alaska-cedar occupies both low and moderately high moisture stress environments in the subalpine zone. Relations between moisture regime and distribution of mountain hemlock are not known.

Both mountain hemlock and Alaska-cedar appear to be major seral and minor climax species in most forest stands. Mountain hemlock reproduction is often

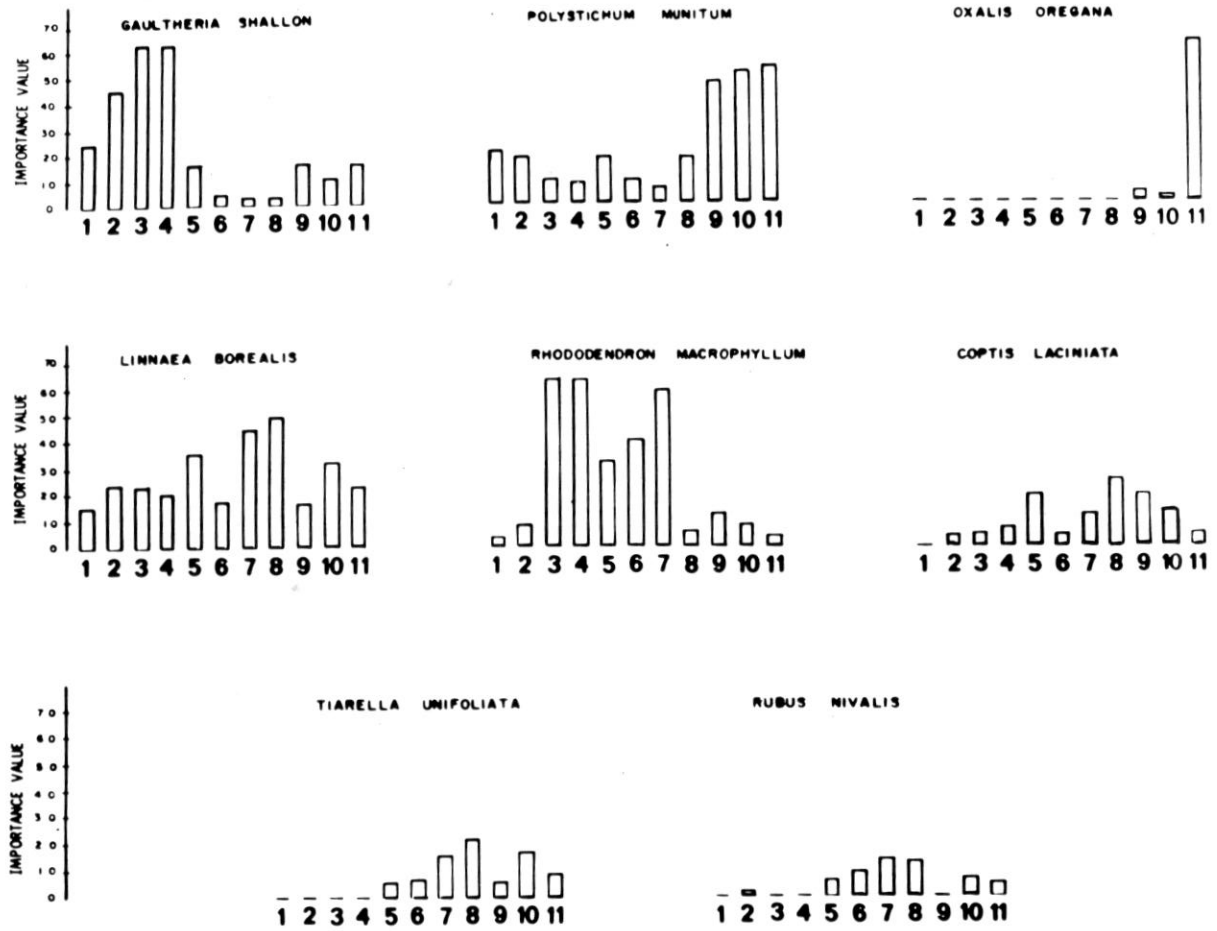
absent under closed forest stands that it dominates. On these sites Pacific silver fir regeneration is often common or abundant. In older, more open stands scattered seedlings or saplings of mountain hemlock are typically present. Alaska-cedar exhibits a similar pattern; i.e., scattered seedlings and saplings are often present but in fewer numbers and with lower vitality than those of Pacific silver fir.

Grand fir has an unusual distributional pattern that appears related to genetic variability in local populations of this taxon (D. B. Zobel, unpublished M.S., 1972). It is encountered as a minor component of low-elevation forests, primarily on streamside benches and terraces; this is "typical" grand fir. At higher elevations it reappears as a component, sometimes a significant one, of forest stands, particularly around meadows and on warmer, drier habitats. These populations appear to have some genetic elements of white fir (*Abies concolor*) and exhibit different physiological behavior than those at lower elevation (D. B. Zobel, personal communication). The two groups of populations are essentially disjunct. Neither group appears to have a major climax role although scattered reproduction is encountered, even in closed-canopy stands in both cases.

Bigleaf maple is the only tree-sized hardwood species commonly encountered in natural forest stands (except for streamside areas). It is primarily a low-elevation (*Tsuga heterophylla* zone) species (Table 3), although individuals have been observed at over 1370 m. It exhibits a bimodal distribution along the moisture gradient; i.e., it is more abundant in stands occupying the moister and drier habitats than on modal sites. Stands at these extremes have in common a tendency toward relatively open overstory conditions and maple is apparently able to survive well only under these situations of reduced competition. Bigleaf maple is a seral species; reproduction is very sparse in the majority of stands where it is present in the overstory (Table 1). Significant numbers of seedlings and saplings were observed in only one stand, an open stand of 130-year-old Douglas-fir.

Distribution of Individual Shrub and Herb Species

Most understory species in the central portion of the western Cascades have broad ranges of occurrence in numerous habitats. Only a very few are narrowly restricted to, or important dominants in, only one or two associations. These restricted species typically reach greatest importance on extreme or marginal habitats. Figures 35-38 show distribution patterns of selected shrubs and herbs in the *Abies amabilis* and *Tsuga heterophylla* zones. The histograms (Figures 35 and 36) give importance values within associations that have been arranged by their proximities along a complex moisture gradient from dry to wet. Patterns of cover for selected understory species are also shown by plotting stands in the ordination planes of the *Tsuga heterophylla* and *Abies amabilis* zones (Figures 37 and 38). These patterns of importance and cover are rarely identical for any two species, but several recurring patterns can nevertheless be distinguished on the basis of amodal (indifferent species) and modal (preferential species) distribution. The discussion below is based primarily upon the general patterns shown by the histograms (Figures 35 and 36) and species plots in the ordination planes (Figures 37 and 38).


GAULTHERIA SHALLON
POLYSTICHUM MUNITUM
OXALIS OREGANA
LINNAEA BOREALIS
RHODODENDRON MACROPHYLLUM
COPTIS LACINIATA
TIARELLA UNIFOLIATA
RUBUS NIVALIS
IMPORTANCE VALUE
0 10 20 30 40 50 60 70
1 2 3 4 5 6 7 8 9 10 11

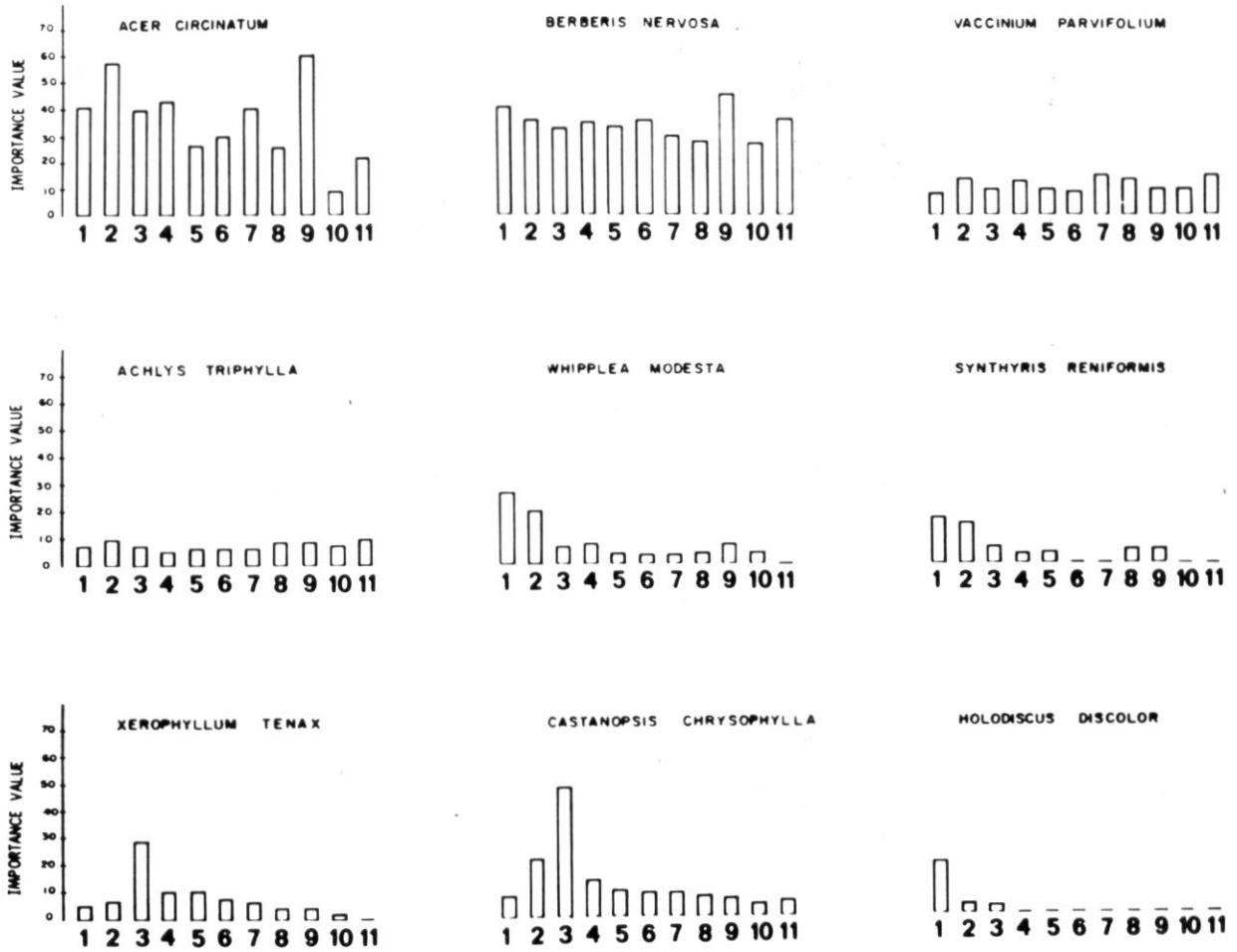


Figure 35. Relative importance of selected shrub and herb species in 11 forest communities within the *Tsuga heterophylla* zone. Importance values are multiplicative means of average percentage of cover and constancy. 1 = *Pseudotsuga/Holodiscus*, 2 = *Pseudotsuga-Tsuga/Corylus*, 3 = *Tsuga/Castanopsis*, 4 = *Tsuga/Rhododendron/Gaultheria*, 5 = *Tsuga/Rhododendron/Berberis*, 6 = *Tsuga-Abies/Rhododendron/Berberis*, 7 = *Tsuga-Abies/Rhododendron/Linnaea*, 8 = *Tsuga-Abies/Linnaea*, 9 = *Tsuga/Acer/Polystichum*, 10 = *Tsuga/Polystichum*, 11 = *Tsuga/Polystichum-Oxalis*.

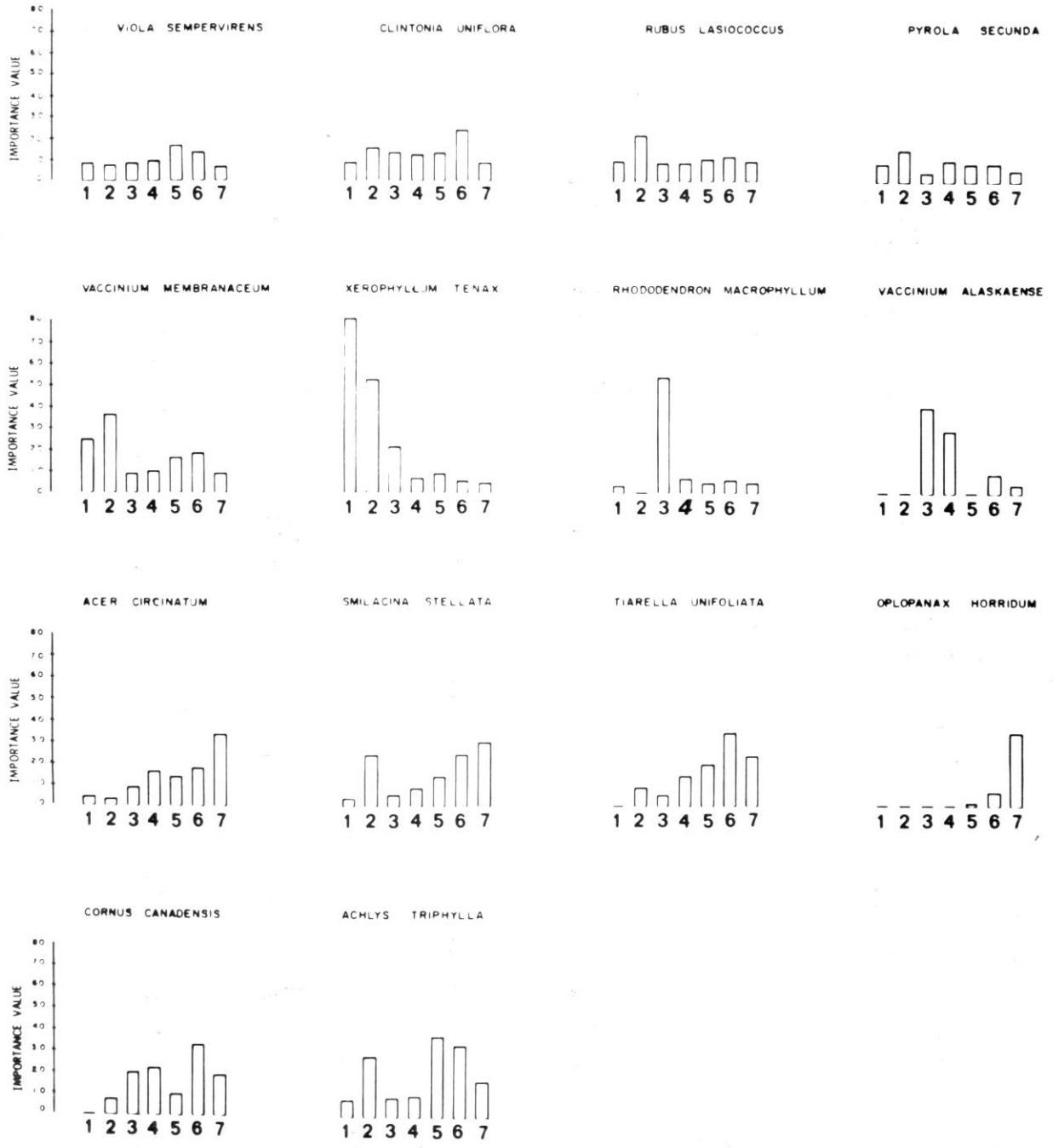


Figure 36. Relative importance of selected shrub and herb species in seven forest communities with the *Abies amabilis* zone. Importance values are multiplicative means of average percentage of cover and constancy. 1 = *Abies--Tsuga mertensiana/Xerophyllum*, 2 = *Abies/V. membranaceum/Xerophyllum*, 3 = *Abies/Rhododendron--V. alaskaense/Cornus*, 4 = *Abies/V. alaskaense/Cornus*, 5 = *Abies/Achlys*, 6 = *Abies/Tiarella*, 7 = *Chamaecyparis/Oplopanax*.

Indifferent species

Species of widespread occurrence whose importance is relatively unaffected from habitat to habitat include *Berberis nervosa*, *Vaccinium parvifolium*, *Achlys triphylla*, and *Acer circinatum* in the *Tsuga heterophylla* zone, and *Pyrola secunda* and *Clintonia uniflora* in the *Abies amabilis* zone. There are no pronounced shifts in cover or importance values of these indifferent species in the associations of the histograms or in the ordination planes. A host of minor understory shrubs and herbs of erratic and infrequent occurrence might also be regarded as indifferent species. Whether of high or low importance values, these species typically have a rather uniform probability of representation in any stand in the *Tsuga* or *Abies* zones. Therefore the pattern of cover distribution of species such as *Berberis nervosa* or *Chimaphila menziesii* in the ordination planes is a general reflection of sampling density shown by stand distribution plots of Figures 10 and 11.

Preferential species

The remaining patterns of Figures 35-38 are those of species having various affinities or aversions to environmental conditions of the associations and ordination planes. Preferential species have discernible modes among related associations and have higher probabilities of cover representation in some stands than others within the *Tsuga heterophylla* and *Abies amabilis* zones.

Species with restricted distributions are *Holodiscus discolor* (dry sites in the *Tsuga* zone), *Oxalis oregana* (very wet sites in the *Tsuga* zone), and *Oplopanax horridum* (cool, wet sites in the *Abies* zone). These species are unimportant or, more typically, completely absent from the general gamut of environments in the study region. Their distributional patterns suggest that, at least in some instances, their peak importance might lie outside the range of environments in the study area. The *Holodiscus discolor* pattern is also suggested by *Whipplea modesta* and *Synthyris reniformis*, both having similar preferences for drier sites. Both *Whipplea* and *Synthyris*, however, unlike *Holodiscus*, have minor importance values in other, more mesic habitats of the *Tsuga* zone.

Tiarella unifoliata, *Rubus nivalis*, and *Coptis laciniata* show importance modes in those associations of the *Tsuga heterophylla* zone that are generally at intermediate elevations and at moderate positions along the complex moisture gradient. Commonly in these environments *Abies amabilis* shares climax status with *Tsuga heterophylla* (as discussed above). The ordination maps of *Tiarella* and *Coptis* indicate greater cover distribution at the upper (cool) portion of the environmental field and low cover (*Coptis*) or absence (*Tiarella*) in warm portions of the environmental field. Similar distributions are suggested by the histograms, with *Coptis* having somewhat longer attenuation than *Tiarella* among the warmer and drier associations.

Polystichum munitum and *Gaultheria shallon* are important species that have clear modes at respective wet and dry parts of the complex moisture gradient in the *Tsuga heterophylla* zone. Similarly, the mesic areas of the ordination plane contain most high-cover stands of *Polystichum* while the warmer areas (low Y values) contain most of the low-cover stands. The distributions along the X (moisture) axis for *Polystichum* and *Whipplea* are complementary, as seen also by their histograms. *Xerophyllum tenax* and *Castanopsis chrysophylla*

have histogram patterns similar to *Gaultheria*, although with clear differences in the sharpness of the mode (*Xerophyllum* important [28%] in only the *Tsuga/Castanopsis* association). The stand map of the *Tsuga* zone shows *Xerophyllum* with high cover primarily at warmer areas (low *Y* values) of the ordination plane. In the *Abies* zone *Xerophyllum* has optimum distribution toward the xeric end of the complex moisture gradient.

Rhododendron macrophyllum and *Linnaea borealis* have somewhat diffuse or multimodal histograms in the *Tsuga* zone, as does *Achlys triphylla* in the *Abies* zone. *Linnaea* is apparently an almost indifferent species (compare with *Acer circinatum*), and it is not clear just what environmental factors affect its importance. Species with several distinct modes might have distinctive ecotypes in the study area. It is more likely, however, that these species are responsive to environmental factors or gradients that have not been identified by axes of the ordination planes or that do not vary in any continuous, predictable manner with the complex of environmental factors that underlie the *X* and *Y* axes.

Pteridium aquilinum reveals the position of seral stands in the *Abies amabilis* zone, for it has high cover and constancy in *Abies procera/Achlys* and *Abies procera/Clintonia*, both seral communities. The cover distribution of *Clintonia uniflora* in the ordination plane of the *Abies* zone is generally that of an indifferent species. *Clintonia* achieves high cover in both the seral *Abies procera/Clintonia* community and in the climax *Abies amabilis/Tiarella* association, however, and high-cover stands in both communities can be seen in the ordination plane where *Clintonia* has been mapped.

A KEY TO THE FOREST COMMUNITIES

(using modal or typical stands)

0. *Abies amabilis* reproduction ≥3% (cover): *Abies amabilis* zone 14
0. *Abies amabilis* reproduction ≤2% or absent: *Tsuga heterophylla* zone 1

TSUGA HETEROPHYLLA ZONE

1. *Pseudotsuga menziesii* reproduction usually over 1% cover (dry community types) 2
1. *Pseudotsuga menziesii* reproduction absent 4

2. *Rhododendron macrophyllum* cover usually over 10%, typically 40%: *Tsuga heterophylla/Castanopsis chrysophylla* association
2. *Rhododendron macrophyllum* <3% cover or absent 3

3. *Holodiscus discolor* ≥2% cover: *Pseudotsuga menziesii/Holodiscus discolor* association
3. *Holodiscus discolor* usually absent, if present under 1% cover: *Pseudotsuga menziesii--Tsuga heterophylla/Corylus cornuta* association

4. *Polystichum munitum* usually ≥10% cover (occasionally 5%-10%) 5
4. *Polystichum munitum* usually <5% cover 7

5. *Oxalis oregana* usually absent, when present less than 1% cover 6
5. *Oxalis oregana* always ≥6% cover: *Tsuga heterophylla/Polystichum munitum--Oxalis oregana* association

6. *Acer circinatum* ≥10% cover: *Tsuga heterophylla/Acer circinatum/Polystichum munitum* association
6. *Acer circinatum* ≤5% cover: *Tsuga heterophylla/Polystichum munitum* association

7. *Gaultheria shallon* usually present with high or low cover 8
7. *Gaultheria shallon* usually absent (rarely present with cover ≤2%) 10

8. *Gaultheria shallon* usually ≤7% cover; *Coptis laciniata* usually present; *Rhododendron macrophyllum* sometimes with over 10% cover (up to 65%): *Tsuga heterophylla/Rhododendron macrophyllum/Berberis nervosa* association
8. *Gaultheria shallon* usually ≥12% cover, *Coptis laciniata* present or absent 9

9. *Rhododendron macrophyllum* >10% cover, commonly about 40% or more cover: *Tsuga heterophylla/Rhododendron macrophyllum/Gaultheria shallon* association
9. *Rhododendron macrophyllum* ≤5% cover or absent: *Pseudotsuga menziesii/Acer circinatum/Gaultheria shallon* association

10. *Linnaea borealis* ≤5% cover 11
10. *Linnaea borealis* ≥10% cover 12

11. *Rhododendron macrophyllum* ≥4% cover: *Tsuga heterophylla--Abies amabilis/Rhododendron macrophyllum/Berberis nervosa* association
11. *Rhododendron macrophyllum* usually absent (rarely <1% cover: *Pseudotsuga menziesii/Acer circinatum/Berberis nervosa* community

12. *Whipplea modesta* present, *Pyrola asarifolia* absent: *Pseudotsuga menziesii/Acer circinatum/Whipplea modesta* community
12. *Whipplea modesta* absent, *Pyrola asarifolia* present or absent 13

13. *Rhododendron macrophyllum* ≥5% cover (usually over 20%), *Pyrola asarifolia* present: *Tsuga heterophylla--Abies amabilis/Rhododendron macrophyllum/Linnaea borealis* association
13. *Rhododendron macrophyllum* usually absent (sometimes up to 5% cover): *Tsuga heterophylla--Abies amabilis/Linnaea borealis* association

ABIES AMABILIS ZONE

14. *Tsuga mertensiana* always present with ≥20% cover; *Xerophyllum tenax* always present with >40% cover: *Abies amabilis--Tsuga mertensiana/Xerophyllum tenax* association
14. *Tsuga mertensiana* usually absent (≤5% cover, if present), *Xerophyllum tenax* >15% cover 15

15. *Xerophyllum tenax* present, usually ≥15% cover; *Rhododendron macrophyllum* and *Vaccinium alaskaense* absent: *Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax* association
15. *Xerophyllum tenax* absent; or if *Xerophyllum tenax* present ≥10% cover with *Rhododendron macrophyllum* or *Vaccinium alaskaense* or both as associates 16

16. *Vaccinium alaskaense* or *Rhododendron macrophyllum* or both present in significant quantities (>5% cover) 17
16. Not as above 18

17. *Rhododendron macrophyllum* and *Vaccinium alaskaense* always present, cover usually ≥20% and ≥10%, respectively; *Xerophyllum tenax* may be present in large amounts: *Abies amabilis/Rhododendron macrophyllum--Vaccinium alaskaense/Cornus canadensis* association
17. *Rhododendron macrophyllum* usually absent (if present cover is ≤3%); *Vaccinium alaskaense* present (average cover 10%), and *Xerophyllum tenax* usually absent (if present cover ≤2%): *Abies amabilis/Vaccinium alaskaense/Cornus canadensis* association

18. Mature *Chamaecyparis nootkatensis* and/or *Thuja plicata* usually present; *Oplopanax horridum* always present; found on steep north-facing slopes: *Chamaecyparis nootkatensis/Oplopanax horridum* association
18. Not as above 19

19. *Abies procera* major overstory dominant (average cover 50%) 20
19. *Abies procera* absent or codominant in overstory (cover usually ≤20%). 21

20. Herbaceous understory dominated by *Achlys triphylla* and/or *Smilacina stellata: Abies procera/Achlys triphylla* community
20. Herbaceous understory dominated by a richer selection of succulent herbs including *Clintonia uniflora, Viola sempervirens, Cornus canadensis, Smilacina stellata,* and *Achlys triphylla: Abies procera/Clintonia uniflora* community

21. *Tiarella unifoliata* and *Cornus canadensis* always present in significant amounts (average cover of 12% and 11%, respectively): *Abies amabilis/Tiarella unifoliata* association

22. *Tiarella unifoliata* and *Cornus canadensis* absent or present in minor amounts: *Abies amabilis/Achlys triphylla* association

SUMMARY AND CONCLUSIONS

Forest communities in the central portion of Oregon's western Cascades are arrayed along moisture and temperature gradients. By means of reconnaissance data and a computerized ordination technique, a total of 23 forest communities have been provisionally recognized. These communities occur in two distinct forest zones, the *Tsuga heterophylla* and *Abies amabilis*. In addition, it is possible to discern a transitional zone between the two main zones. In this discussion, however, we have generally treated the transitional as comprising the upper, cooler portion of *Tsuga heterophylla* zone. The location of principal forest zones is largely a function of temperature or, in our area, elevation. The distribution of individual communities within a zone is to a large extent controlled by availability of moisture. Thus, within each of the two main zones there is an array of forest communities extending from dry to wet sites (Figure 5).

The *Tsuga heterophylla* zone within the study area occupies an approximate elevational range of 300-1050 m. With the exception of very dry sites where *Pseudotsuga menziesii* is climax, *Tsuga heterophylla* is the dominant climax tree species within the zone. Fourteen vegetation units have been recognized within the *Tsuga heterophylla* zone--11 climax or near-climax associations and three seral communities. These units range from the *Pseudotsuga/Holodiscus* on very dry sites to the *Tsuga/Polystichum-Oxalis* association, which occupies wet sites. Of the more commonly occurring communities situated on more modal sites, the *Tsuga/Rhododendron/Berberis* is most abundant. This association occurs on relatively gentle slopes and deep soils and has been tentatively assigned the climatic climax role within the studied portion of the *Tsuga heterophylla* zone.

The *Abies amabilis* zone extends from approximately 1050 to 1550 m in elevation. Although at the highest elevations *Tsuga mertensiana* may share climax dominance, the zone is generally characterized by dominance of *Abies amabilis* in climax stands. The most abundant seral tree species within the zone is *Abies procera*, with *Pseudotsuga menziesii* commonly occurring especially near the transition of the *Tsuga heterophylla* zone. Nine plant groupings have been tentatively identified within the *Abies amabilis* zone, seven climax or near-climax associations and two seral communities. The driest habitats in the zone are occupied by the *Abies--Tsuga mertensiana/Xerophyllum* association and the wettest sites studied supported vegetation classified as the *Chamaecyparis/Oplopanax* association. Modal sites within the *Abies amabilis* zone are generally occupied by either the *Abies/Achlys* or *Abies/Tiarella* associations. Relationships among communities in this zone are often obscure and undoubtedly additional refinements will be made in our provisional classification system.

The western Cascade Range of Oregon is not an easy area in which to construct a workable synecological classification. Most plant species are widely distributed throughout the area; thus at least some classification units must be based on shifts in species abundance rather than on presence and absence data. Only a few species show restricted ecologic amplitudes and these are generally limited to extreme habitats--either very warm and dry or cool and moist. For this reason those communities occupying the extremes of the gradients are

generally easily recognizable. Examples of such distinctive associations are the *Tsuga/Polystichum-Oxalis* and *Abies--Tsuga mertensiana/Xerophyllum*. On the other hand, classification of units on more modal sites is generally based on more subtle, less easily recognized differences. In these areas high-fidelity species are rare or lacking. Therefore several communities may have approximately the same species composition and can be separated only by taking into account shifts in dominance or relative abundance.

The classification system suggested here will undoubtedly be revised and improved. Such an evolutionary process is a fundamental characteristic of any good classification system. In this first approximation we have consciously attempted to be "splitters" rather than "lumpers" because we feel it would be much easier to put units together later than it would be to separate them. Thus we fully expect that after additional analytical and environmental information has been obtained, some communities presently in the classification will be found to lack validity and will be combined with others.

Much additional work remains to quantify the vegetative and environmental features of the units. Work presently under way includes quantitative sampling of the communities in order to characterize them more adequately. This involves sampling on analytic plots installed in stands representative of each community. Cover of cryptogams will be determined as well as vascular plants. Other ongoing work includes environmental and biologic monitoring in 20 reference stands typifying 19 forest communities. In addition to phenological observations, measurements include soil and air temperature, dry season plant moisture stress, growing season soil moisture levels, and complete characterization of soil physical and chemical properties. Preliminary results of environmental monitoring have, for the most part, borne out our hypothesized relationships among the communities with respect to relative moisture and temperature regimes (Figure 5).

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APPENDIX

1. *Tsuga heterophylla* zone

1.1.1. *Pseudotsuga menziesii/Holodiscus discolor* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
28	460	60	S	uneven slope middle 1/3	Frissell	reddish tuffs and breccias	60-90	10-15	sandy loam		70-80	well drained	old growth >300	*Pseudotsuga*		60-70	III-
98	850	99	W	smooth slope middle 1/3	Lithosol	andesite	30-60	5-10	loam		40-50	well drained	young 100-150	*Libocedrus*	*Pseudotsuga*	50-60	V
137	520	40	S	smooth slope upper 1/3	Lithosol	reddish tuffs and breccias	30-60	5-10	silt loam		50-60	well drained	old growth >300	*Pseudotsuga*		20-30	V
143	670	75	SW	smooth slope upper 1/3	Limberlost	greenish tuffs and breccias	90-120	10-15	silty clay loam		30-40	well drained	old growth >300	*Pseudotsuga*	*Libocedrus*	60-70	III-
145	610	70	SW	smooth slope upper 1/3	Lithosol	greenish tuffs and breccias	30-60	10-15	loam		20-30	well drained	old growth >300	*Libocedrus*	*Pseudotsuga*	30-40	V
278	490	50	SW	ridgetop									old growth >300	*Pseudotsuga*		40-50	V
279	520	65	SW	smooth slope middle 1/3									young 100-150	*Pseudotsuga*		50-60	IV
287	610	85	SW	smooth slope lower 1/3									old growth >300	*Pseudotsuga*		30-40	IV+

1.1.2. *Pseudotsuga menziesii/Holodiscus discolor* association--stand table (values in percent).

Species		Plot number 28	98	137	143	145	278	279	287	Avg cover	Constancy
TREE LAYER											
Tsuga heterophylla	R[a]	Tr[b]	Tr							0[c]	25
	M									0	0
Pseudotsuga menziesii	R	15	2	15	4	10	3	2	10	8	100
	M	35	40	30	40	40	40	65	40	41	100
Libocedrus decurrens	R		10		1	10				3	38
	M		10		15	20		5		6	50
Pinus lambertiana	R	1			1	1				Tr	38
	M	1			1			5	2	1	50
Acer macrophyllum	R	1								Tr	12
	M	10							10	2	25
Arbutus menziesii	R			1						Tr	12
	M			5	8	5				2	38
Total	R	17	12	16	6	21	3	2	10	11	
	M	46	50	35	64	65	40	75	52	52	
TALL SHRUB LAYER											
Acer circinatum		25	3	12	30		8	2	70	19	88
Rhododendron macrophyllum			Tr							0	12
Castanopsis chrysophylla		1		2	2				1	1	50
Taxus brevifolia		20	1				10			4	38
Cornus nuttallii		1		7				2	3	2	50
Corylus cornuta var. *californica*		25	5	5		3	11	2	7	7	88
Holodiscus discolor		6	2	15		2	8	3	2	5	88
Vaccinium parvifolium		1		2			2	1	2	1	62
Rhamnus purshiana			Tr				Tr			0	25
Acer glabrum var. *douglasii*		Tr	1							Tr	25
Amelanchier alnifolia				5			Tr		1	1	38
Pachistima myrsinites			2							Tr	12
Rhus diversiloba		1						Tr		Tr	25
Lonicera ciliosa				1				1		Tr	25
Total		80	14	49	32	5	39	11	86	40	
LOW SHRUB LAYER											
Berberis nervosa		35	25	5	25	1	7	4	27	16	100
Gaultheria shallon		Tr		4	50	2			2	7	62
Rosa gymnocarpa		1	1			1	1	1		1	62
Rubus ursinus		1		1	1		1	1	1	1	75
Symphoricarpos mollis		1		7	1	1	3	1	1	2	88
Berberis aquifolium			Tr							0	12
Total		38	26	17	77	5	12	7	31	27	
HERB LAYER											
Linnaea borealis		4		10	2		1	1	3	3	75
Polystichum munitum		4	1	2	3	1	3	3	18	4	100
Viola sempervirens									1	Tr	12
Trientalis latifolia		3	1	1	1	2	1	1	1	1	100
Galium triflorum							1	Tr	1	Tr	38
Hieracium albiflorum		3	2			2	1	1		1	62
Whipplea modesta		4	7	5	1	10	10	17	7	8	100
Synthyris reniformis		15		4		2	2	3	8	4	75
Achlys triphylla		1					Tr	Tr	1	Tr	50
Chimaphila umbellata		2	1		1	2	Tr	1	1	1	88
Chimaphila menziesii		1								Tr	12
Anemone deltoidea				1			Tr	1		Tr	38
Anemone lyallii				1		1				Tr	25
Xerophyllum tenax				10	2					2	25
Adenocaulon bicolor				1			Tr	Tr	1	Tr	50
Goodyera oblongifolia		1	1		1	1	Tr	Tr	1	1	88
Vancouveria hexandra		1						Tr		Tr	25
Bromus sp.		3	3	2			2	1	1	2	75
Festuca occidentalis		3	1	2	1		1	1	1	1	88
Luzula intermedia						1	1	1		Tr	38
Pteridium aquilinum					1					Tr	12
Listera caurina			1							Tr	12
Smilacina racemosa								Tr	Tr	0	25
Galium oreganum		1								Tr	12
Iris tenax				1		2	1	1	1	1	62
Campanula scouleri				1		2		1	3	1	50
Collomia heterophylla						5	1	1		1	38
Lathyrus polyphyllus					1	20		1		3	38
Vicia americana var. *villosa*						4	1		1	1	38
Fragaria vesca var. *bracteata*			1				1			Tr	25
Osmorhiza chilensis									1	Tr	12
Arenaria macrophylla		1	1				1	Tr		Tr	50
Madia gracilis				3		1	1	1		1	50
Polypodium glycyrrhiza			Tr	1						Tr	25
Brodiaea congesta							1			Tr	12
Epilobium watsonii							1	1		Tr	25
Epilobium minutum						1				Tr	12

1.1.2. *Pseudotsuga menziesii/Holodiscus discolor* association (continued).

Species	Plot number 28	98	137	143	145	278	279	287	Avg. cover	Constancy
HERB LAYER (continued)										
Lotus micranthus					Tr	1	1		Tr	38
Habenaria unalascensis				Tr			1		Tr	25
Senecio sylvaticus							1		Tr	12
Cryptantha intermedia						1			Tr	12
Total	47	20	45	14	57	33	40	51	36	
TOTAL UNDERSTORY	182	72	127	129	88	87	60	178	114	
TOTAL ALL LAYERS	228	122	162	193	153	127	135	230	166	

[a]R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover). [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.

1.2.1. *Pseudotsuga menziesii--Tsuga heterophylla/Corylus cornuta* var. *californica* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
22	610	60	S	smooth slope upper 1/3	Frissell	reddish tuffs and breccias	60-90	10-15	loam		60-70	well drained	old growth >300	*Tsuga*	*Pseudotsuga*	30-40	V
25	670	65	S	smooth slope upper 1/3	Frissell	reddish tuffs and breccias	90-120	5-10	loam	silt loam	20-30	well drained	old growth >300	*Pseudotsuga*	*Tsuga*	20-30	III-
29	520	60	SW	smooth slope middle 1/3	Frissell	reddish tuffs and breccias	90-120	5-10	sandy loam		30-40	well drained	old growth >300	*Pseudotsuga*		30-40	III+
88	790	75	S	smooth slope middle 1/3	Lithosol	andesite	30-60	3-5	loam		40-50	well drained	old growth >300	*Pseudotsuga*	*Libocedrus*	20-30	V
123	580	50	SW	smooth slope upper 1/3	Lithosol	reddish tuffs and breccias	<30	3-5	sandy loam		50-60	well drained	old growth >300	*Pseudotsuga*		10-20	V
136	490	60	S	smooth slope middle 1/3	Frissell	reddish tuffs and breccias	90-120	10-15	silt loam		60-70	well drained	young with old growth	*Tsuga*	*Pseudotsuga*	40-50	III
138	550	50	NW	smooth slope upper 1/3	Frissell	reddish tuffs and breccias	90-120	10-15	silt loam		40-50	well drained	old growth with poles	*Pseudotsuga*	*Tsuga*	30-40	III-
142	580	75	SE	smooth slope middle 1/3	Limberlost	greenish tuffs and breccias	90-120	15-20	silt loam		40-50	well drained	young 100-150	*Tsuga*	*Pseudotsuga*	60-70	III
146	580	65	SE	smooth slope upper 1/3	Lithosol	greenish tuffs and breccias	<30	5-10	silt loam		20-30	well drained	old growth >300	*Pseudotsuga*	*Tsuga*	40-50	III
160	490	30	SW	smooth slope middle 1/3	Frissell	reddish tuffs and breccias	120-150	5-10	silty clay loam		20-30	well drained	old growth >300	*Pseudotsuga*	*Tsuga*	50-60	III
207	980	65	S	smooth slope upper 1/3	Carpenter	deep andesitic colluvium	180-210			sandy loam	40-50	well drained	old growth >300	*Tsuga*		20-30	III-
283	490	80	NW	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	old growth >300	*Tsuga*	*Pseudotsuga*	20-30	III
284	460	60	SW	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young with old growth	*Pseudotsuga*	*Tsuga*	20-30	IV
285	550	70	SW	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young with old growth	*Pseudotsuga*	*Tsuga*	40-50	IV
286	670	70	W	smooth slope lower 1/3	ND	ND	ND	ND	ND	ND	ND	ND	old growth >300	*Tsuga*	*Pseudotsuga*	50-60	III-

1.2.2. *Pseudotsuga menziesii--Tsuga heterophylla/Corylus cornuta* var. *californica* association--stand table (values in percent).

Species		Plot number 22	25	29	88	123	136	138	142	146	160	207	283	284	285	286	Avg. cover	Constancy
TREE LAYER																		
Tsuga heterophylla	R[a]	10	2		1		5	2	3	1[b]	2	7				3	2	67
	M	10	5				10			Tr			10	10	5		3	47
Pseudotsuga menziesii	R	10	10	15	6	10	2	10	5	10	3	2		10	10	11	8	93
	M	25	20	35	30	30	40	35	65	45	60	20	25	25	50	50	37	100
Thuja plicata	R	1	1					3		2							Tr	27
	M	5	5							Tr							1	20
Libocedrus decurrens	R				10					3							1	13
	M	5	1		10												1	20
Pinus lambertiana	R				2			5		Tr							Tr	20
	M		1					Tr									Tr	13
Abies amabilis	R									Tr							0[c]	7
	M																0	0
Abies procera	R				Tr												0	7
	M																0	0
Acer macrophyllum	R											2					Tr	7
	M			5	5	3	10			10	15	8		7			4	53
Arbutus menziesii	R																0	0
	M		10	2	3												1	20
Total	R	21	13	15	19	10	7	20	8	16	5	11	0	10	10	14	11	
	M	45	42	42	48	33	60	35	65	55	75	28	35	42	55	50	47	
TALL SHRUB LAYER																		
Acer circinatum		35	70	15		10	15	75	5	30	40	50	20	31	60	77	36	93
Rhododendron macrophyllum							7	3	1	20						Tr	2	33
Castanopsis chrysophylla		2	5	3	5	30	5	7	5	3	10	10			1	1	6	87
Taxus brevifolia		2	1	4	Tr		1	5	1	1	1	15	40	28		4	7	87
Cornus nuttallii		1		6	5		15	10	1	2	20	2	2	2	6		5	80
Corylus cornuta var. *californica*		25	1	20	8	20	10	3	30	15	2	3	6	13	8	5	11	100
Holodiscus discolor					Tr								1				Tr	13
Vaccinium parvifolium		5		2		7	3	5	2	1	2	2	Tr	5	1	1	2	87
Rhamnus purshiana									1				Tr				Tr	13
Acer glabrum var. *douglasii*														2			Tr	7
Rubus parviflorus					Tr							1					Tr	13
Amelanchier alnifolia									1						1		Tr	13
Pachistima myrsinites												1					Tr	7
Rhus diversiloba						7	3	2	1	1							1	33
Lonicera ciliosa							1		1				Tr			Tr	Tr	27
Total		70	77	50	18	74	60	110	49	73	75	84	69	81	77	88	70	
LOW SHRUB LAYER																		
Berberis nervosa		10	25	35	5	5	15	12	10	5	25	10	5	3	24	8	13	100
Gaultheria shallon		25	55	30	10	1	25	40	5	25	17		2	5	44	47	22	93
Rosa gymnocarpa					1			1				1			1		Tr	27
Rubus ursinus			3	3	1	1	1		2	2	2	1	Tr	2	2	1	1	87
Rubus nivalis												1					Tr	7
Symphoricarpos mollis			3	1				1						1	1		Tr	33
Total		35	86	69	17	7	41	54	17	32	44	13	7	11	72	56	36	
HERB LAYER																		
Linnaea borealis		5	10	5		2	5	3	7	25	3	15	4	5	6	2	6	93
Polystichum munitum		1	1	7	1	1	3	3	7	5	3	5	5	3	6	4	4	100
Viola sempervirens							1	1	1	1	2	6	2		2	1	1	60
Trientalis latifolia		5		3	1	1	3	3	1	2	1	1	1	1	Tr	1	2	93
Coptis laciniata											1		10	Tr			1	20
Galium triflorum				1			1		1	1	2	1	1		1	1	1	60
Hieracium albiflorum		1	1	2	1	1	1	1	1	1	1	1	1	Tr		1	1	93
Whipplea modesta		5	10	7	Tr	1	4		4	1	10	10	3	1	1	4	4	93
Synthyris reniformis		2	5	8	3	3	5	8		1			3	2	3	1	3	80
Achlys triphylla		2		4	1		1	1	1	2	3	1	1	1	2	3	2	87
Chimaphila umbellata		2	15	1	2	2	1	Tr		2	1	5	1	1	4	5	3	93
Trillium ovatum		1							1	1	1		Tr	Tr			Tr	40
Anemone deltoidea						1	1	1	2	1	1		1	1		1	1	60
Anemone lyallii						1		1	1	1			1	1		1	Tr	47
Xerophyllum tenax		1			10			3	2	1							1	33
Adenocaulon bicolor				3	1			1	1	1	2				1	2	1	53
Goodyera oblongifolia		1			Tr			1	1	1	1	1	Tr	1	Tr	1	1	73
Pyrola asarifolia					1					1							Tr	13
Vancouveria hexandra		1		1	Tr	1	1	1	1	1	1		1	Tr	1	Tr	1	87
Bromus sp.			1	2	Tr			Tr		Tr	2	1	1		1	1	1	67
Festuca occidentalis		Tr	1	2	Tr	2	2	1	1	Tr	2	2	Tr	Tr	1	1	1	100
Luzula intermedia				1		1				1							Tr	20
Pteridium aquilinum					1				1							Tr	Tr	20
Listera caurina															1		Tr	7
Smilacina racemosa							1		1	1				1		1	Tr	33
Smilacina stellata						1											Tr	7
Disporum hookeri								1	1	1			Tr	Tr	1		Tr	40
Galium oreganum				1										Tr			Tr	13
Montia sibirica													1				Tr	7
Iris tenax		1	1	1				2	1			1			1		1	47

1.2.2. *Pseudotsuga menziesii--Tsuga heterophylla/Corylus cornuta* var. *californica* association--(continued)

	Plot number															Avg.	Con-
	22	25	29	88	123	136	138	142	146	160	207	283	284	285	286	cover	stancy
HERB LAYER (continued)																	
Campanula scouleri		1		Tr				1		1		1		1	1	Tr	47
Corallorhiza mertensiana				1												Tr	7
Collomia heterophylla					1							1	Tr			Tr	20
Lathyrus polyphyllus										1						Tr	7
Vicia americana var. *villosa*		3	Tr											1		Tr	20
Arenaria macrophylla											1					Tr	7
Actea arguta												Tr				0	7
Malia gracilis									1							Tr	7
Polypodium glycyrrhiza				Tr	Tr											0	13
Brodiaea congesta			Tr	Tr												0	13
Epilobium paniculatum												Tr	Tr			0	13
Senecio sylvaticus													Tr			0	7
Stachys palustris				Tr						2						Tr	13
Trisetum cernuum										2						Tr	7
Aralia californica			Tr													0	7
Anaphalis margaritacea			1													Tr	7
Total	28	49	50	13	29	30	32	38	53	43	51	39	18	34	32	36	
TOTAL UNDERSTORY	154	225	184	67	120	138	216	112	174	167	159	115	120	193	190	153	
TOTAL ALL LAYERS	199	267	226	115	153	198	251	177	249	242	187	150	162	248	240	200	

[a]R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover). [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.

1.3.1. *Tsuga heterophylla/Castanopsis chrysophylla* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
26	490	80	S	smooth slope middle 1/3	Frissell	reddish tuffs and breccias	90-120	5-10	sandy loam	loam	40-50	well drained	old growth >300	*Pseudotsuga*	*Tsuga*	10-20	III-
32	760	25	S	smooth slope upper 1/3	McKenzie River	reddish tuffs and breccias	180-210	10-15	loam	silty clay loam	0-10	well drained	young with old growth	*Tsuga*	*Thuja*	20-30	III
34	730	5	S	ridgetop	Lithosol	reddish tuffs and breccias	30-60	5-10	loam		20-30	well drained	young 100-150	*Tsuga*	*Thuja*	50-60	IV
36	460	35	S	smooth slope upper 1/3	Frissell	reddish tuffs and breccias	30-60	5-10	loam		30-40	well drained	old growth >300	*Pseudotsuga*	*Thuja*	10-20	IV
61	760	10	SW	ridgetop	Flunky	basalt	30-60	5-10	loam		50-60	well drained	old growth >300	*Tsuga*		20-30	IV
105	790	20	NW	ridgetop	"andesite colluvium"	deep colluvium	150-180	10-15	sandy loam		40-50	well drained	young 100-150	*Tsuga*	*Pseudotsuga*	20-30	V
112	610	50	SW	smooth slope upper 1/3	Frissell	reddish tuffs and breccias	120-150	15-20	silty clay loam		40-50	well drained	old growth >300	*Pseudotsuga*	*Tsuga*	20-30	IV
118	670	30	S	ridgetop	Budworm	greenish tuffs and breccias	150-180	25-38	silty clay loam	silty clay	0-10	moderately well drained	young 100-150	*Tsuga*	*Thuja*	50-60	III
119	640	90	S	smooth slope upper 1/3	Limberlost	greenish tuffs and breccias	60-90	10-15	silt loam		50-60	well drained	young 100-150	*Pseudotsuga*	*Thuja*	20-30	IV
139	580	0		ridgetop	Frissell	reddish tuffs and breccias	60-90	5-10	silt loam		70-80	well drained	young with old growth	*Tsuga*	*Pseudotsuga*	50-60	III
141	610	35	S	smooth slope upper 1/3	Frissell	reddish tuffs and breccias	90-120	10-15	silty clay loam		0-10	well drained	old growth >300	*Tsuga*	*Pseudotsuga*	40-50	III-
280	580	40	SW	ridgetop	ND	ND	ND	ND	ND	ND	ND	ND	old growth >300	*Pseudotsuga*	*Tsuga*	50-60	III
288	610	70	W	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	old growth >300	*Tsuga*	*Pseudotsuga*	40-50	III-
289	610	55	S	uneven slope upper 1/3	ND	ND	ND	ND	ND	ND	ND	ND	old growth >300	*Tsuga*	*Pseudotsuga*	50-60	III
294	490	75	S	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	old growth >300	*Tsuga*	*Pseudotsuga*	40-50	III-
295	550	70	S	uneven slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	old growth >300	*Tsuga*	*Pseudotsuga*	40-50	III-

1.3.2. *Tsuga heterophylla/Castanopsis chrysophylla* association--stand table (values in percent).

Species		Plot number 26	32	34	36	61	105	112	118	119	139	141	280	288	289	294	295	Avg. cover	Constancy
TREE LAYER																			
Tsuga heterophylla	R[a]		15	1	5	1	2	2	3		6	6		8	3	2	2	4	81
	M	10	Tr[b]			15	10		25		25	1		14		10		7	56
Pseudotsuga menziesii	R	15			5		5	10	3	15	5	5		3	7	1	4	5	75
	M	15	50	50	25	25	40	35	55	30	45	35	60	25	20	32	38	36	100
Thuja plicata	R		1	10					5	3					2			1	31
	M		Tr						5									Tr	12
Libocedrus decurrens	R						2											Tr	6
	M		2				Tr										1	Tr	19
Pinus lambertiana	R				1				1		1				5	1	6	1	38
	M		2	Tr										8				Tr	12
Acer macrophyllum	R																	0[c]	0
	M													6				Tr	6
Arbutus menziesii	R			Tr						2								Tr	12
	M			Tr	5					5	10							1	25
Total	R	15	16	11	11	1	9	12	12	20	12	11	0	11	17	4	12	11	
	M	25	52	50	30	40	50	35	85	35	80	36	60	53	20	42	39	44	
TALL SHRUB LAYER																			
Acer circinatum		45	35	3	1	10	40	35		5		20	2	51	14	20	14	18	88
Rhododendron macrophyllum		70	20	15	3	20	75	70	20	40	70	30	41	26	48	46	38	40	100
Castanopsis chrysophylla		10	25	10	6	15	10	40	20	50	15	30	16	10	44	15	53	23	100
Taxus brevifolia		10	4	1	2	15		20	2	2	10			4	2	1	1	5	81
Cornus nuttallii		8	2		4	2	2	5	10	2	7	10	2	8	3	11	5	5	94
Corylus cornuta var. *californica*		6	1			2		1		5		1	Tr			Tr	1	1	56
Holodiscus discolor							2			5								Tr	12
Vaccinium parvifolium		2	Tr	1	3		1	1	2	1	6			1		3	2	1	75
Vaccinium membranaceum									Tr	2								Tr	12
Rhamnus purshiana																Tr		0	6
Amelanchier alnifolia		9			1						5							1	19
Rhus diversiloba											1							Tr	6
Lonicera ciliosa											1		1					Tr	6
Total		160	87	30	20	64	130	172	54	112	115	91	61	100	111	95	114	94	
LOW SHRUB LAYER																			
Berberis nervosa		6	15	35	3	4	10	3	7	5	40	5	7	10	7	3	4	10	100
Gaultheria shallon		35	35	25	45	70	5	60	20	25	10	40	99	53	52	26	42	40	100
Rosa gymnocarpa		2			1					2	1	2		1	1	Tr	1	1	56
Rubus ursinus		1	1	1		1			1		1	1	1	2	1	Tr	1	1	75
Symphoricarpos mollis														Tr				0	6
Total		44	51	61	49	75	15	63	28	32	52	48	107	66	61	29	48	52	
HERB LAYER																			
Linnaea borealis		10	10	1	2	2	5	2	10	5	5	20	1	3	1	2	3	5	100
Polystichum munitum		6	1	1		1	1	1	1	1		4		3	1		Tr	1	75
Viola sempervirens			2		1				2		1	1	Tr	1	1	Tr	1	1	62
Trientalis latifolia			1	1	1		1		1	1	1			1	1	Tr	Tr	1	69
Coptis laciniata		6					2							3		1		1	25
Hieracium albiflorum		1			1						1			Tr		1	1	Tr	38
Whipplea modesta					1			2			1	2	1	1				Tr	38
Synthyris reniformis		4			1					1				1		1		Tr	31
Achlys triphylla		2				1		1		1		2		1	1	1	1	1	56
Chimaphila umbellata			5	2	2	2	1	1	2	3	1	2	1					1	69
Chimaphila menziesii			1				1			1								Tr	19
Trillium ovatum							1							1			Tr	Tr	19
Anemone deltoidea		2	1		1		1				1	2		1	Tr	1	1	1	62
Anemone lyallii		1															1	Tr	12
Xerophyllum tenax		35		15	35		Tr	3	5	10	12	2		1	7	16	22	10	81
Adenocaulon bicolor		1										1	Tr	Tr				Tr	25
Goodyera oblongifolia			1	1	1	1	1		1					Tr	1			Tr	50
Pyrola picta					1		1						Tr		Tr		Tr	Tr	31
Pyrola asarifolia							1		1				Tr					Tr	19
Vancouveria hexandra		2			1					1	1			1			1	Tr	38
Bromus sp.									1	1								Tr	12
Festuca occidentalis		Tr																0	6
Pteridium aquilinum			1		1				Tr	2		1		Tr	Tr	Tr		Tr	50
Listera caurina									1				1	1	1			Tr	25
Smilacina racemosa		1	1				1							Tr	1	Tr	1	Tr	44
Smilacina stellata										1								Tr	6
Montia sibirica														Tr				0	6
Iris tenax		2								1					1	Tr		Tr	25
Campanula scouleri					1											Tr	1	Tr	19

1.3.2. *Tsuga heterophylla/Castanopsis chrysophylla* association--(continued)

Species	Plot number 26	32	34	36	61	105	112	118	119	139	141	280	288	289	294	295	Avg. cover	Constancy
HERB LAYER (continued)																		
Collomia heterophylla															1		Tr	6
Lilium columbianum		1	1														Tr	12
Epilobium angustifolium														1	Tr	Tr	Tr	19
Epilobium paniculatum							Tr										0	6
Habenaria unalascensis														Tr	Tr		0	12
Senecio sylvaticus							Tr									Tr	0	12
Total	73	25	22	50	7	17	10	25	29	24	37	4	19	17	24	33	22	
TOTAL UNDERSTORY	292	179	124	130	147	171	257	119	193	203	187	172	196	206	152	207	179	
TOTAL ALL LAYERS	317	231	174	160	187	221	292	204	228	283	223	232	249	226	194	246	223	

[a]R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover). [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.

1.4.1. *Pseudotsuga menziesii/Acer circinatum/Gaultheria shallon* community--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
33	730	80	S	smooth slope upper 1/3	Frissell	reddish tuffs and breccias	90-120	3-5	silt loam	silt loam	10-20	well drained	young 100-150	*Tsuga*		60-70	IV
68	730	20	SW	smooth slope middle 1/3	Carpenter	andesite colluvium	180-210	15-20	sandy loam	loam	30-40	well drained	young 100-150	*Tsuga*		60-70	III-
70	790	70	SW	smooth slope upper 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young 100-150	*Tsuga*		60-70	IV+
134	490	20	SW	bench	McKenzie River	reddish tuffs and breccias	90-120	20-25	silt loam	silty clay loam	0-10	well drained	young 100-150	*Tsuga*		30-40	III
135	460	65	SE	smooth slope middle 1/3	Frissell	reddish tuffs and breccias	120-150	15-20	silt loam		40-50	well drained	young 100-150	*Tsuga*	*Pseudotsuga*	70-80	III-
144	640	70	S	smooth slope middle 1/3	Limberlost	greenish tuffs and breccias	90-120	10-15	clay loam		50-60	well drained	young 100-150	*Tsuga*		60-70	IV
210	850	40	SE	smooth slope middle 1/3	Tidbits	andesite colluvium	120-150	15-20	silt loam	silt loam	20-30	well drained	young 100-150	*Tsuga*		40-50	III
212	820	20	S	smooth slope lower 1/3	Tidbits	andesite colluvium	90-120	15-20	silt loam	silt loam	60-70	well drained	old growth >300	*Tsuga*	*Thuja*	50-60	III
231	610	20	W	bench	Budworm	greenish tuffs and breccias	120-150	15-20	silt loam	silty clay loam	0-10	moderately well drained	young 100-150	*Tsuga*	*Thuja*	60-70	III
250	670	85	SW	smooth slope middle 1/3	fragmental soil	andesite	60-90	5-10	loam		70-80	well drained	mature 150-300	*Tsuga*		50-60	IV
258	370	10	E	toe slope	deep colluvium	deep, fine colluvium	90-120	10-15	silty clay loam	silty clay	0-10	well drained	old growth >300	*Tsuga*		50-60	II-
281	610	55	SW	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young with old growth	*Tsuga*	*Pseudotsuga*	60-70	IV+
290	610	80	S	smooth slope lower 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young with old growth	*Tsuga*	*Pseudotsuga*	30-40	IV+

1.4.2. *Pseudotsuga menziesii/Acer circinatum/Gaultheria shallon* community--stand table (values in percent).

Species		Plot number 33	68	70	134	135	144	210	212	231	250	258	281	290	Avg. cover	Constancy
TREE LAYER																
Tsuga heterophylla	R[a]	2	8	4	5	3	1	10	50	10	1	2	5	2	8	100
	M					15			10		10	30		1	5	38
Pseudotsuga menziesii	R					1							2	3	Tr[b]	23
	M	60	60	65	45	75	70	75	55	70	50	40	80	30	60	100
Thuja plicata	R	Tr			1			1	1	3					Tr	38
	M								2					1	Tr	15
Libocedrus decurrens	R														0[c]	0
	M			Tr						2					Tr	15
Pinus lambertiana	R	Tr												1	Tr	15
	M	Tr								Tr					0	15
Acer macrophyllum	R				10										1	8
	M			3	1	1				Tr				30	3	38
Arbutus menziesii	R	Tr													0	8
	M	Tr					Tr								0	15
Total	R	2	8	4	16	4	1	11	51	13	1	2	7	6	9	
	M	60	60	68	46	91	70	75	67	72	60	60	80	62	68	
TALL SHRUB LAYER																
Acer circinatum		25	15	40	20	25	75	60	65	25	3	10	50	53	36	100
Rhododendron macrophyllum		3	3		2	5		5		1				10	2	54
Castanopsis chrysophylla		3	1	1	1	1	1	6	1			2		1	1	77
Taxus brevifolia			1			7		1	1					3	1	38
Cornus nuttallii			2	1		15			1	1		15		9	3	54
Corylus cornuta var. *californica*				1		1				1			1		Tr	31
Holodiscus discolor						1									Tr	8
Vaccinium parvifolium			2	3	2	3	1	1		2	6	8	2	1	2	85
Vaccinium membranaceum						1									Tr	8
Rhamnus purshiana													1		Tr	8
Amelanchier alnifolia				Tr							1				Tr	15
Pachistima myrsinites			1										1		Tr	8
Osmaronia cerasiformis												2			Tr	8
Rhus diversiloba						1									Tr	8
Lonicera ciliosa														1	Tr	8
Total		31	25	46	25	60	77	73	68	30	10	37	54	78	45	
LOW SHRUB LAYER																
Berberis nervosa		35	30	25	35	7	10	20	6	20	10	15	23	6	19	100
Gaultheria shallon		45	50	15	75	30	15	70	35	35	5	50	4	32	35	100
Rosa gymnocarpa			1	1	1			1					Tr		Tr	38
Rubus ursinus		3	3	1		2	1	3	1	1	1	2		1	1	85
Symphoricarpos mollis			2	2						1			1		Tr	31
Total		83	86	44	111	39	26	94	42	57	16	67	28	39	55	
HERB LAYER																
Linnaea borealis			5	1		2		1	1	3	3		1	3	2	69
Polystichum munitum		1		5	5	4	4	1	2		2	1	3	4	2	85
Viola sempervirens		1	10	1	3	1	1	1		2	1		4	1	2	85
Trientalis latifolia				1		1	1	1		1	1		1	1	1	62
Coptis laciniata								1		1		1		2	Tr	31
Galium triflorum				2		1	1	1						Tr	Tr	38
Hieracium albiflorum				1			1						Tr		Tr	23
Whipplea modesta			1	1		3	15	1			1		1		2	54
Synthyris reniformis						4		1			2			1	1	31
Achlys triphylla				1		1				1	1		1	13	1	46
Chimaphila umbellata		1	1	1		1	1		1		1		1	1	1	69
Chimaphila menziesii				1				1	1						Tr	23
Trillium ovatum				1		1			1	1				1	Tr	38
Anemone deltoidea			1	1		1			1	1				10	1	46
Xerophyllum tenax		1			1	Tr					25				2	31
Adenocaulon bicolor				1		1				1			Tr		Tr	31
Goodyera oblongifolia			1	1		1	1	1	1		1		Tr		1	62
Pyrola picta				1					1	1			1		Tr	31
Pyrola secunda														1	Tr	8
Vancouveria hexandra			1	1		1			1	1			1	1	1	54
Bromus sp.							2						1		Tr	15
Festuca occidentalis							1								Tr	8
Grasses		1	1	1											Tr	23
Pteridium aquilinum			3		2	1				2		1			1	38
Listera caurina			1		1	1		1	1	1				1	1	54
Smilacina racemosa				1		1							Tr	1	Tr	31
Smilacina stellata										1					Tr	8
Disporum hookeri		1		1								1	Tr		Tr	31
Circaea alpina											1				Tr	8
Iris tenax					1	Tr	1							1	Tr	31

1.4.2. *Pseudotsuga menziesii/Acer circinatum/Gaultheria shallon* community (continued).

Species	Plot number 33	68	70	134	135	144	210	212	231	250	258	281	290	Avg. cover	Constancy
HERB LAYER (continued)															
Campanula scouleri												Tr		0	8
Corallorhiza mertensiana			1				1							Tr	15
Collomia heterophylla			1			3								Tr	15
Lathyrus polyphyllus						2								Tr	8
Apocynum androsaemifolium			1											Tr	8
Osmorhiza chilensis		1												Tr	8
Actaea arguta									1					Tr	8
Madia gracilis						1								Tr	8
Senecio sylvaticus						1								Tr	8
Stachys palustris							1							Tr	8
Pterospora andromedea												1		Tr	8
Total	6	26	27	13	26	36	13	11	18	39	4	16	42	19	
TOTAL UNDERSTORY	122	145	121	165	129	140	191	172	118	66	110	105	165	128	
TOTAL ALL LAYERS	182	205	189	211	220	210	266	230	190	126	170	185	227	196	

[a]R = trees in the reproduction size class (seedlings and saplings). M = trees in the mature size class (crowns contribute to overstory tree cover). [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.

1.5.1. *Tsuga heterophylla/Rhododendron macrophyllum/Gaultheria shallon* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
23	760	60	SW	smooth slope lower 1/3	Frissell	reddish tuffs and breccias	60-90	10-15	silt loam		50-60	well drained	old growth >300	*Tsuga*	*Thuja*	50-60	III-
31	790	5	SE	ridgetop	Limberlost	greenish tuffs and breccias	30-60	3-5	loam		20-30	well drained	young 100-150	*Tsuga*		60-70	III
35	490	0		stream terrace	alluvium	alluvium	90-120	20-25	loam		30-40	well drained	old growth >300	*Tsuga*		40-50	II
38	610	10	SE	ridgetop	McKenzie River	reddish tuffs and breccias	90-120	10-15	silt loam	clay loam	0-10	well drained	young 100-150	*Tsuga*	*Thuja*	60-70	III-
39	790	5	NW	bench	Slipout	greenish tuffs and breccias	120-150	15-20	clay loam	silty clay	10-20	imperfectly drained	old growth >300	*Tsuga*		60-70	II
43	850	60	NW	ridgetop	andesite colluvium	andesite colluvium	90-120	10-15	loam		60-70	well drained	young 100-150	*Tsuga*		40-50	IV+
87	790	45	SE	smooth slope upper 1/3	Frissell	reddish tuffs and breccias	60-90	5-10	silt loam		10-20	well drained	young 100-150	*Tsuga*		30-40	IV
90	550	10	N	uneven lower 1/3	Carpenter	andesite colluvium	120-150	5-10	loam		60-70	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	III
110	670	70	S	smooth slope middle 1/3	Limberlost	greenish tuffs and breccias	150-180	10-15	loam		0-10	well drained	old growth >300	*Tsuga*		10-20	IV
115	730	10	SE	ridgetop	McKenzie River	reddish tuffs and breccias	90-120	10-15	loam	silty clay	0-10	moderately well drained	young 100-150	*Tsuga*		30-40	III
116	730	20	S	bench	Budworm	greenish tuffs and breccias	120-150	15-20	silt loam	silty clay loam	10-20	well drained	young 100-150	*Tsuga*		50-60	IV
124	580	5	E	ridgetop	Frissell	reddish tuffs and breccias	90-120	10-15	silt loam		30-40	well drained	old growth with poles	*Tsuga*	*Thuja*	70-80	III+
149	490	0		stream terrace	alluvium	alluvium	120-150	5-10	sandy loam	sandy loam	0-10	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	III
156	820	30	N	uneven slope middle 1/3	Carpenter	andesite colluvium	180-210	10-15	loam	loam	10-20	well drained	old growth >300	*Tsuga*		20-30	IV
249	490	25	S	smooth slope middle 1/3	deep colluvium	deep, fine colluvium	150-180	5-10	silt loam	silty clay	0-10	well drained	mature 150-300	*Tsuga*		70-80	III
260	790	30	NE	ridgetop	McKenzie River	reddish tuffs and breccias	180-210	15-20	silt loam	silty clay	0-10	well drained	old growth >300	*Tsuga*		50-60	III
292	550	80	SE	smooth slope upper 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young with old growth	*Tsuga*	*Thuja*	60-70	III

1.5.2. *Tsuga heterophylla/Rhododendron macrophyllum/Gaultheria shallon* association--stand table (values in percent).

Species		Plot number 23	31	35	38	39	43	87	90	110	115	116	124	149	156	249	260	292	Avg. cover	Constancy
TREE LAYER																				
Tsuga heterophylla	R[a]	10	5	10	5	10	5	3	5	1	5	3	30	5	15	10	3	3	8	100
	M	25	Tr[b]	40	2	25	5		35				25	45	35	35	40	30	20	76
Pseudotsuga menziesii	R																		0[c]	0
	M	60	75	40	45	40	40	30	50	25	45	65	35	45	25	60	50	35	45	100
Thuja plicata	R	5			2				5				10	2					1	29
	M	20	Tr	Tr	4				10				1	15				6	3	47
Libocedrus decurrens	R																		0	0
	M								15		1								1	12
Pinus lambertiana	R																	2	Tr	6
	M							30									5		2	12
Abies grandis	R															1			Tr	6
	M																		0	0
Abies amabilis	R																		0	0
	M					1													Tr	6
Pinus monticola	R																		0	0
	M																1		Tr	6
Acer macrophyllum	R																	1	Tr	6
	M									1								10	1	12
Total	R	15	5	10	7	10	5	3	10	1	5	3	40	7	15	11	3	6	9	
	M	105	75	80	51	66	45	60	110	26	46	65	61	105	60	95	96	81	72	
TALL SHRUB LAYER																				
Acer circinatum		20	50	4	40		35	2	2	35	35		35	40	20	4	10	32	21	88
Rhododendron macrophyllum		10	45	4	60	40	70	60	20	35	50	2	70	45	95	10	40	22	40	100
Castanopsis chrysophylla		Tr	2	1	2	2	2	2		5	4	2	5	1	10			2	2	82
Taxus brevifolia		3		20	8	30				10			1	10	5	2		11	6	59
Cornus nuttallii				3	2			10		5	10		1		15	2		7	3	53
Corylus cornuta var. *californica*										3				1					Tr	12
Vaccinium parvifolium			3	20			1		1	2	3	2	1	3		1	3	3	2	71
Vaccinium membranaceum														1					Tr	6
Rhamnus purshiana														1					Tr	6
Total		33	100	52	112	72	108	74	23	95	102	6	113	102	145	19	53	77	74	
LOW SHRUB LAYER																				
Berberis nervosa		30	30	2	10	10	5	20	10	10	15	55	2	8	5	7	15	2	14	100
Gaultheria shallon		65	65	20	65	7	50	60	30	70	35	85	20	35	30	20	10	13	40	100
Rosa gymnocarpa		1						1		1									Tr	18
Rubus ursinus		1	2	2			1	1		1	1	1		3	1			1	1	65
Rubus nivalis															1				Tr	6
Total		97	97	24	75	17	56	82	40	82	51	141	22	46	37	27	25	16	55	
HERB LAYER																				
Linnaea borealis		15	6	2	20	5	Tr		1	2	3	2	2	25	1			3	5	82
Polystichum munitum		Tr		3		1	1		Tr	1	1	1	2	5				3	1	65
Viola sempervirens		2	1	1				1	1	1	1	2	1	2				1	1	65
Trientalis latifolia						1		Tr	Tr	2								Tr	Tr	29
Coptis laciniata			2			1	1	1	1		2			9	2			3	1	53
Galium triflorum							1					1						1	Tr	18
Hieracium albiflorum		1								1									Tr	12
Whipplea modesta		5					1			2	Tr	1							1	29
Synthyris reniformis		3																1	Tr	12
Achlys triphylla		1						1		2	1	1							Tr	29
Chimaphila umbellata		10	5	2	1	2	1		1	3	10	1	1	1	1			Tr	2	82
Chimaphila menziesii			1			1	1		1		Tr		1						Tr	35
Trillium ovatum									Tr	1		1		2				1	Tr	29
Anemone deltoidea				1			1	1					1	3	1			1	1	41
Xerophyllum tenax			1		Tr	2	1				1		1		1	1	20		2	53
Adenocaulon bicolor												1		1					Tr	12
Goodyera oblongifolia					1	1	1		1	1			1	1		1			Tr	47
Pyrola picta			1				1	1	Tr										Tr	24
Pyrola asarifolia			1	1		1		1		1	2			3					1	41
Tiarella unifoliata				2										1					Tr	12
Tiarella trifoliata				1															Tr	6
Vancouveria hexandra																		1	Tr	6
Bromus sp.											Tr	Tr							0	12
Festuca occidentalis												Tr							0	6
Pteridium aquilinum								1			5	2				1			1	24
Disporum hookeri			1								1			1					Tr	18
Iris tenax		1																	Tr	6
Clintonia uniflora				1										2					Tr	12
Habenaria unalascensis										Tr									0	6
Total		38	19	14	22	15	10	7	6	17	27	13	10	56	6	3	20	15	16	
TOTAL UNDERSTORY		183	221	100	216	114	179	166	79	195	185	163	185	211	203	60	101	114	154	
TOTAL ALL LAYERS		288	296	180	267	180	224	226	189	221	231	228	246	316	263	155	197	195	226	

[a]R = trees in the reproduction size class (seedlings and saplings). M = trees in the mature size class (crowns contribute to overstory tree cover). [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.

1.6.1. *Tsuga heterophylla/Rhododendron macrophyllum/Berberis nervosa* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
3	910	10	S	ridgetop	Carpenter	andesite colluvium	90-120			loam	30-40	well drained	young with old growth	*Tsuga*		50-60	III-
9	790	7	SE	bench	McKenzie River	reddish tuffs and breccias	90-120	5-10	loam	silt loam	10-20	well drained	old growth >300	*Tsuga*		60-70	III+
10	670	20	S	smooth slope upper 1/3	McKenzie River	reddish tuffs and breccias	90-120	5-10	loam	silty clay loam	0-10	moderately well drained	old growth >300	*Tsuga*		50-60	II-
21	700	20	NE	bench	"andesite colluvium"	andesite colluvium	120-150	10-15	sandy loam	silt loam	0-10	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	II
24	670	53	NW	ridgetop	McKenzie River	reddish tuffs and breccias	90-120	5-10	loam	silt loam	0-10	well drained	old growth with poles	*Tsuga*	*Thuja*	80-90	III+
37	790	25	E	uneven slope middle 1/3	Budworm	greenish tuffs and breccias	120-150	10-15	silt loam	silty clay loam	10-20	well drained	old growth with poles	*Tsuga*	*Thuja*	80-90	II
57	520	15	SE	toe slope	McKenzie River	reddish tuffs and breccias	120-150	5-10	loam	clay loam	20-30	moderately well drained	old growth with poles	*Tsuga*	*Thuja*	60-70	II-
59	490	5	NW	ridgetop	"deep, fine textured"	mixed colluvium	90-120	10-15	loam	silty clay loam	30-40	well drained	old growth >300	*Tsuga*		70-80	III
60	490	25	SW	smooth slope upper 1/3	"deep, fine textured"	mixed colluvium	180-210	15-20	loam	silty clay loam	10-20	well drained	old growth with poles	*Tsuga*		60-70	III+
86	820	20	SE	ridgetop	Budworm	greenish tuffs and breccias	150-180	15-20	clay loam	clay loam	0-10	well drained	old growth >300	*Tsuga*		60-70	III+
108	760	5	N	bench	Limberlost	greenish tuffs and breccias	90-120	10-15	sandy loam		50-60	well drained	old growth >300	*Tsuga*		60-70	III
111	640	35	W	ridgetop	"andesite colluvium"	andesite colluvium	150-180	10-15	loam		30-40	well drained	old growth >300	*Tsuga*		70-80	III
120	610	15	S	bench	Slipout	greenish tuffs and breccias	90-120	5-10	silt loam	silt loam	0-10	imperfectly drained	old growth with poles	*Tsuga*	*Thuja*	80-90	III+
140	610	70	NW	smooth slope upper 1/3	McKenzie River	reddish tuffs and breccias	120-150	10-15	silt loam	silty clay	0-10	well drained	old growth > 300	*Tsuga*		80-90	III+
147	550	40	S	smooth slope lower 1/3	Limberlost	greenish tuffs and breccias	120-150	15-20	silt loam		10-20	well drained	old growth with poles	*Tsuga*	*Thuja*	70-80	III+
148	520	25	NE	uneven slope upper 1/3	Frissell	reddish tuffs and breccias	120-150	15-20	silt loam		0-10	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	III+
153	980	40	N	uneven slope lower 1/3	"andesite colluvium"	andesite colluvium	180-210	10-15	loam		60-70	well drained	old growth >300	*Tsuga*		60-70	III
248	790	10	S	smooth slope middle 1/3	"fine textured imperf. drained	andesite colluvium	60-90	10-15	loam	silty clay	10-20	imperfectly drained	old growth with poles	*Tsuga*	*Thuja*	70-80	III

1.6.2. *Tsuga heterophylla/Rhododendron macrophyllum/Berberis nervosa* association--stand table (values in percent).

Species		Plot number 3	9	10	21	24	37	57	59	60	86	108	111	120	140	147	148	153	248	Avg. cover	Constancy
TREE LAYER																					
Tsuga heterophylla	R[a]	10	10	10	5	8	10	5	4	3	5	10	5	5	10	10	8	15	5	8	100
	M	5	60	60	65	35	60	35	25	35	40	30	30	70	35	60	40	45	50	43	100
Pseudotsuga menziesii	R																			0[b]	0
	M	50	40	50	35	40	40	40	50	40	50	60	65	20	70	50	50	25	40	45	100
Thuja plicata	R	3			2	4	5	1						8		5	5	1	2	2	56
	M	5		5	30	40	35	20	1	15				35	19	1	5		15	13	72
Abies amabilis	R																			0	0
	M		8																	Tr[c]	6
Pinus monticola	R																			0	0
	M	5																		Tr	6
Acer macrophyllum	R																			0	0
	M											2			1					Tr	11
Total	R	13	10	10	7	12	15	6	4	3	5	10	5	13	10	15	13	16	7	10	
	M	65	108	115	130	115	135	95	76	90	90	92	95	125	125	111	95	70	105	101	
TALL SHRUB LAYER																					
Acer circinatum			15	35	2	5	2		2	1	5		10	25	25	7	10	8	5	9	83
Rhododendron macrophyllum		10	65	20	35	5	5		Tr		4	25	7	15	10	6	15	5	5	13	89
Castanopsis chrysophylla		2	10	1	2	1	1	1	Tr		Tr				7	2	1	1	1	2	78
Taxus brevifolia		2		10	50		2	5			1	5	3	2	3	7	5	30	2	7	78
Cornus nuttallii				1				2	1	2	Tr			5	10	5		5		2	50
Corylus cornuta var. *californica*				1										1						Tr	11
Vaccinium parvifolium		3	3		1		1	1	3	3	Tr	1	2	1		1	1	1	1	1	83
Vaccinium membranaceum		2	3		1					Tr	Tr						1		1	Tr	39
Vaccinium alaskaense					3															Tr	6
Amelanchier alnifolia																			1	Tr	6
Pachistima myrsinites				1																Tr	6
Total		19	96	69	94	11	11	9	6	6	10	31	22	49	55	28	33	50	16	34	
LOW SHRUB LAYER																					
Berberis nervosa		62	35	10	15	1	2	10	3	4	8	10	7	2	5	9	4	8	3	11	100
Gaultheria shallon			Tr	1	25	3	1	5	2	5	1	4	3	7	4	2	1		Tr	4	89
Rosa gymnocarpa		2									Tr									Tr	11
Rubus ursinus		10		1	3		1	1	1	1	1	1		2	1	1	1	1	1	2	83
Rubus nivalis		2			6						1	1						2	1	1	33
Symphoricarpos mollis		2	33																1	2	17
Total		78	68	12	49	4	4	16	6	10	11	16	10	11	10	12	6	11	6	18	
HERB LAYER																					
Linnaea borealis		12	15	5	35	1	5	25	35	50	1	2	1	10	2	7	25	1	10	13	100
Polystichum munitum			1	1	1	2	1	5	2	2	1	20	5	5	3	5	3	7	1	4	94
Viola sempervirens		10	1	1	3	1		5	1	3	1	2		2		1	1	1	3	2	83
Trientalis latifolia						1	1	1		1			1	1		1			1	Tr	44
Coptis laciniata			9	1	15	2	5	5		1	1	2	1	1	15	5	8	5	3	4	89
Galium triflorum					1					1										Tr	11
Hieracium albiflorum					1		1		1				1				1			Tr	28
Whipplea modesta		7				1							1							1	17
Synthyris reniformis				Tr			1							1						Tr	17
Achlys triphylla					2				1	1	1					1	1			Tr	33
Chimaphila umbellata		30	9	1	3	1	1	2	15	2	1			1		1	2	1	1	4	83
Chimaphila menziesii		1		1	1	1				1	Tr		1			1				Tr	44
Trillium ovatum				1	1			1		1		1	1	1	1	1			1	1	56
Anemone deltoidea				1	2			1	1	1				1	1	1				1	44
Anemone lyallii				Tr																0	6
Xerophyllum tenax		37	Tr			1	2	Tr	Tr					2	1	1				2	50
Goodyera oblongifolia		1	1		1	1	1	1	Tr	1	Tr		1	1		1	1	1	1	1	83
Pyrola picta		Tr		1		1	1		1	1								1		Tr	39
Pyrola asarifolia			2	1	2					1								1		Tr	28
Tiarella unifoliata			1		2						Tr	2							1	Tr	28
Vancouveria hexandra				1	1			1	1	1						1	1			Tr	39
Pteridium aquilinum		2																		Tr	6
Oxalis oregana								Tr												0	6
Listera caurina				1																Tr	6
Disporum hookeri											Tr		1		1					Tr	17
Corallorhiza maculata									1	1										Tr	11
Pedicularis racemosa		3																		Tr	6
Total		103	39	16	71	13	19	47	59	69	6	29	14	26	24	27	43	18	22	33	
TOTAL UNDERSTORY		213	213	107	221	40	49	78	75	88	32	86	51	99	99	82	95	95	51	95	
TOTAL ALL LAYERS		278	321	222	351	155	184	173	151	178	122	178	146	224	224	193	190	165	156	196	

[a] R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover).
[b] Zero indicates species occurred in trace amounts only in all sampled stands. [c] Tr = average cover less than 0.5%.

1.7.1. *Tsuga heterophylla--Abies amabilis/Rhododendron macrophyllum/Berberis nervosa* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
40	1070	10	N	ridgetop	"andesite colluvium"	andesite colluvium	180-210	10-15	loam	silty clay loam	10-20	well drained	young with old growth	*Tsuga*	*Thuja*	90-100	III
41	1040	35	N	smooth slope middle 1/3	"andesite colluvium"	andesite colluvium	90-120	5-10	loam		60-70	well drained	old growth >300	*Tsuga*	*Thuja*	70-80	III
42	910	2	NE	bench	"andesite colluvium"	andesite colluvium	180-210	10-15	loam		20-30	well drained	old growth >300	*Tsuga*		50-60	III+
44	850	15	N	bench	"fragmental soil"	andesite colluvium	60-90	5-10	loam		70-80	well drained	young 100-150	*Tsuga*		80-90	IV+
97	980	15	SW	uneven slope lower 1/3	Carpenter	andesite colluvium	180-210	10-15	sandy loam		10-20	well drained	old growth >300	*Tsuga*	*Abies*	50-60	III
151	1130	60	NE	smooth slope upper 1/3	Blue River	andesite	90-120	10-15	loam	loam	30-40	well drained	old growth >300	*Tsuga*	*Abies*	40-50	IV
152	1100	50	NE	ridgetop	Blue River	andesite	60-90	10-15	loam	loam	40-50	well drained	old growth >300	*Tsuga*		60-70	IV
155	880	5	N	bench	Carpenter	andesite colluvium	210-300	15-20	loam	silt loam	30-40	well drained	old growth >300	*Tsuga*		30-40	III-
204	940	0		bench	Carpenter	andesite colluvium	180-210	15-20	loam	loam	20-30	well drained	old growth >300	*Tsuga*	*Thuja*	40-50	III
205	1040	20	S	smooth slope upper 1/3	Carpenter	andesite colluvium	210-300	15-20	loam	silt loam	0-10	well drained	old growth with poles	*Tsuga*		70-80	III
216	1070	45	NW	smooth slope middle 1/3	Carpenter	andesite colluvium	90-120			sandy loam	60-70	well drained	old growth >300	*Tsuga*	*Abies*	40-50	III
217	1040	50	W	smooth slope upper 1/3	Carpenter	andesite colluvium	120-150			sandy loam	50-60	well drained	old growth >300	*Tsuga*	*Abies*	60-70	III-
218	980	80	NE	smooth slope middle 1/3	Carpenter	andesite colluvium	180-210	10-15	loam	silt loam	30-40	well drained	old growth >300	*Tsuga*	*Abies*	60-70	III-
219	910	90	N	smooth slope middle 1/3	Carpenter	andesite colluvium	90-120			sandy loam	70-80	well drained	old growth >300	*Tsuga*	*Abies*	20-30	IV
220	820	80	NE	smooth slope middle 1/3	Carpenter	andesite colluvium	150-180			loam	40-50	well drained	old growth >300	*Thuja*	*Tsuga*	60-70	III-
226	1000	50	NW	smooth slope middle 1/3	Carpenter	andesite colluvium	210-300	15-20	loam	sandy loam	20-30	well drained	old growth >300	*Tsuga*	*Thuja*	70-80	III
227	910	70	NE	smooth slope lower 1/3	Carpenter	andesite colluvium	210-300			sandy loam	20-30	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	III
228	910	30	NW	smooth slope lower 1/3	Carpenter	andesite colluvium	180-210			loam	20-30	well drained	old growth >300	*Tsuga*		70-80	III
229	820	15	NW	uneven slope lower 1/3	Carpenter	andesite colluvium	90-120			loam	60-70	well drained	old growth >300	*Tsuga*	*Thuja*	50-60	III
240	1070	70	NW	smooth slope middle 1/3	Carpenter	andesite colluvium	150-180			sandy loam	70-80	well drained	old growth >300	*Tsuga*		60-70	III-
241	1000	40	N	smooth slope middle 1/3	Carpenter	andesite colluvium	210-300	10-15	sandy loam	sandy loam	10-20	well drained	old growth >300	*Tsuga*		70-80	IV+
298	880	35	W	smooth slope lower 1/3	Carpenter	andesite colluvium	180-210	25-38	sandy loam	sandy loam	10-20	well drained	old growth >300	*Tsuga*	*Thuja*	30-40	III

1.7.2. *Tsuga heterophylla--Abies amabilis/Rhododendron macrophyllum/Berberis nervosa* association--stand table (values in percent).

Species		Plot number 40	41	42	44	97	151	152	155	204	205	216	217	218	219	220	226	227	228	229	240	241	298	Avg. Cover	Constancy
TREE LAYER																									
Tsuga heterophylla	R[a]	2	5	3	10	4	30	5	15	5	5	15	5	10	3	1	10	5	5	5	10	5	10	8	100
	M	60	45	45	55	35	25	40	35	50	35	60	60	30	20	70	60	60	40	70	10	70	80	48	100
Pseudotsuga menziesii	R																							0[b]	0
	M	20	35	30	50	35	25	50	7	20	50	25	55	75	30	1	25	30	60	10	60	20	10	33	100
Thuja plicata	R	1	5			3				2						5	2	5		1	3	2	3	1	50
	M	3	15			20	5			5						1	2	5	10	5				3	45
Abies amabilis	R	1	1			4	1			1		1	1	1			2			1				1	45
	M			2			1		5	1	10	1	1	15	5		1	2		3	3		1	2	64
Total	R	4	11	3	10	12	31	5	15	8	5	16	6	11	3	6	14	10	5	7	13	7	13	10	
	M	83	95	77	105	90	56	90	47	76	95	86	116	120	55	72	88	97	110	88	73	90	91	86	
TALL SHRUB LAYER																									
Acer circinatum		7	2	5	8	2	2	3	20	2	10	7	17	60	8	15	10			10	15	8	10	10	91
Rhododendron macrophyllum		2	35	75	5	4	60	20	25	10	4	5	20	35		10	5	20	10	10	5	25	5	18	95
Castanopsis chrysophylla		1				1		2	1	1	1		1	1	5		1	1		1		1		1	59
Taxus brevifolia			5	10	2		15	25	50	2	7	5	20	2	50	40	2	25	7	15	50	5	15	16	91
Cornus nuttallii				1					15		2	2	1											1	23
Vaccinium parvifolium		1	1	1	1				1	1	1	2	1		2	1		2	2	3	1	1		1	73
Vaccinium membranaceum		1	1	1	Tr[c]	1	1	1		1		1	1	1				1	1				1	1	64
Vaccinium alaskaense						2						2				1						10	2	1	23
Rhamnus purshiana									1															Tr	5
Acer glabrum var. *douglasii*							2								12									1	9
Amelanchier alnifolia						Tr																		0	5
Pachistima myrsinites						1		3			1	1	1	1	2		2	4	1		1	1	2	1	59
Total		12	44	93	16	11	80	54	113	17	26	25	52	100	79	67	20	53	21	39	72	51	35	51	
LOW SHRUB LAYER																									
Berberis nervosa		3	15	40	20	1	25	15	17	2	2	15	15	25	10	4	16	20	10	5	10	15	20	14	100
Gaultheria shallon			3	Tr	Tr																			Tr	14
Rosa gymnocarpa										1							1						1	Tr	14
Rubus ursinus		1	1		1	1	1		1	2	1	1	1	1		1	1	1			1	1	2	1	82
Rubus nivalis		3		10	1		1		5	1	3	1	1			1	2	2	2	2	1	2	1	2	77
Rubus lasiococcus						1	1																1	Tr	14
Symphoricarpos mollis						Tr				1														Tr	9
Gaultheria ovatifolia		1	1																					Tr	9
Total		8	20	50	22	3	28	15	23	7	6	17	17	26	10	6	20	23	13	7	12	18	25	17	
HERB LAYER																									
Linnaea borealis		2	2	4	2	1	2	5	15	7	2	3	1	1	1	2	5	5		5	1	1	3	3	95
Polystichum munitum		1	1	Tr	6	Tr	1	1	3		1	3	1	2	3	5					5	1	2	1	77
Viola sempervirens						1				2		3	1	1			1	2			1	1	2	1	45
Trientalis latifolia			1													1								Tr	9
Coptis laciniata					1				2		6													Tr	14
Hieracium albiflorum																	1			1				Tr	9
Whipplea modesta		Tr									1													Tr	9
Achlys triphylla						Tr			1	1		1	1			1		1					1	Tr	36
Chimaphila umbellata		1	1	6		1	1	2	1	1	1	1	1		1		5	2	1	1		1	3	1	82
Chimaphila menziesii		1	1				1	1					1	1			1	1	1	1	1	1	1	1	59

1.7.2. *Tsuga heterophylla--Abies amabilis/Rhododendron macrophyllum/Berberis nervosa* association (continued).

Species	Plot number 40	41	42	44	97	151	152	155	204	205	216	217	218	219	220	226	227	228	229	240	241	298	Avg. Cover	Constancy
HERB LAYER (continued)																								
Trillium ovatum								1			1					1	1					1	Tr	23
Anemone deltoidea																			1				Tr	5
Xerophyllum tenax	1	1	1			Tr	7					Tr	5	3	1	1							1	45
Goodyera oblongifolia	1	1	1		1	1	1	1	1	1			1			1		1	1	1	1		1	68
Pyrola picta	Tr				1	1	1			1			1		1								Tr	32
Pyrola secunda					1				1			1			1	1			1				Tr	27
Pyrola asarifolia		2	2			2	1	1	1	1		1					1				1	1	1	50
Tiarella unifoliata				1		1			3	1	6						1	1		1		1	1	41
Vancouveria hexandra										1	1												Tr	9
Pteridium aquilinum					1																		Tr	5
Smilacina racemosa											1												Tr	5
Smilacina stellata									1		1												Tr	9
Asarum caudatum											1												Tr	5
Disporum hookeri											1												Tr	5
Clintonia uniflora																						1	Tr	5
Cornus canadensis					1				1	1	10	1			1	1				1	Tr	5	1	45
Corallorhiza mertensiana	1					1	1		1	1	1	1	1		1	1				1			1	50
Pyrola aphylla																				1			Tr	5
Total	8	10	14	10	8	11	20	25	20	18	34	10	13	8	14	19	14	4	11	13	7	21	13	
TOTAL UNDERSTORY	32	85	160	58	34	150	94	176	52	55	92	85	150	100	93	73	100	43	64	110	83	94	91	
TOTAL ALL LAYERS	115	180	237	163	124	206	184	223	128	150	178	201	270	155	165	161	197	153	152	183	173	185	177	

[a] R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover).
[b] Zero indicates species occurred in trace amounts only in all sampled stands. [c] Tr = average cover less than 0.5%.

1.8.1. *Pseudotsuga menziesii/Acer circinatum/Berberis nervosa* community--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
65	1040	25	S	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	old growth with poles	*Abies*	*Tsuga*	80-90	III+
66	850	20	S	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young 100-150	*Tsuga*	*Abies*	70-80	III
71	850	70	S	smooth slope upper 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young 100-150	*Tsuga*		60-70	III-
93	700	15	S	bench	Carpenter	andesite colluvium	150-180	10-15	silt loam	silty clay loam	10-20	well drained	young 100-150	*Tsuga*		40-50	III-
94	730	50	NE	smooth slope middle 1/3	"andesite colluvium"	andesite colluvium	180-210	5-10	loam		20-30	well drained	young 100-150	*Tsuga*		50-60	III-
99	670	10	SW	uneven slope lower 1/3	Carpenter	andesite colluvium	>300	15-20	sandy loam		0-10	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	III+
171	1010	20	SW	uneven slope lower 1/3	Carpenter	andesite colluvium	210-300	10-15	silt loam	silt loam	20-30	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	III
176	1160	40	SW	smooth slope middle 1/3	Carpenter	andesite colluvium	150-180	10-15	loam		30-40	well drained	old growth >300	*Tsuga*	*Thuja*	70-80	III
177	1040	40	SW	smooth slope middle 1/3	"andesite colluvium"	andesite colluvium	90-120	5-10	loam		60-70	well drained	old growth >300	*Tsuga*	*Thuja*	70-80	III+
208	880	40	SW	smooth slope lower 1/3	Slipout	greenish tuffs and breccias	120-150	15-20	silty clay loam	silty clay loam	10-20	moderately well drained	old growth >300	*Tsuga*	*Thuja*	70-80	III
209	880	35	S	smooth slope middle 1/3	Tidbits	andesite colluvium	150-180	10-15	silty clay loam	clay loam	0-10	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	III
239	1130	40	NW	smooth slope upper 1/3	Carpenter	andesite colluvium	210-300			sandy loam	40-50	well drained	old growth >300	*Tsuga*	*Abies*	60-70	III-
244	940	10	SW	bench	Carpenter	andesite colluvium	180-210	5-10	loam	loam	20-30	well drained	old growth >300	*Tsuga*	*Abies*	80-90	III+
282	640	70	W	smooth slope upper 1/3	ND	ND	ND	ND	ND	ND	ND	ND	mature 150-300	*Tsuga*		60-70	III-

1.8.2. *Pseudotsuga menziesii/Acer circinatum/Berberis nervosa* community--stand table (values in percent).

Species		Plot number 65	66	71	93	94	99	171	176	177	208	209	239	244	282	Avg. Cover	Constancy
TREE LAYER																	
Tsuga heterophylla	R[a]	5	10	10	2	5	10	60	5	15	5	1	15	4	6	11	100
	M	45	1		Tr[b]		20	35	65	20	50	80	50	65		31	79
Pseudotsuga menziesii	R			1												Tr	7
	M	65	50	70	50	45	65	35	60	70	55	70	60	40	70	58	100
Thuja plicata	R						5	5	5	10	3	1				2	43
	M						25	20	Tr	30	5	2		5		6	50
Libocedrus decurrens	R															0[c]	0
	M						2									Tr	7
Abies grandis	R		1						3	2						Tr	21
	M									1						Tr	7
Abies amabilis	R	2	2		Tr								15	2		2	36
	M	20											15	Tr		2	21
Abies procera	R								2							Tr	7
	M															0	0
Pinus monticola	R															0	0
	M								2							Tr	7
Acer macrophyllum	R					5										Tr	7
	M			10	Tr	5		Tr								1	29
Total	R	7	13	11	2	10	15	65	15	27	8	2	30	6	6	15	
	M	130	51	80	50	50	112	90	127	121	110	152	125	110	70	98	
TALL SHRUB LAYER																	
Acer circinatum		1	5	40	70	5	2	10	30		15	10	10	8	49	18	93
Rhododendron macrophyllum			Tr													0	7
Castanopsis chrysophylla			1	1		1	1		1							Tr	36
Taxus brevifolia		1			Tr		1	3	2	5		2	16	15		3	64
Cornus nuttallii				1	Tr	1	2			1						Tr	36
Corylus cornuta var. *californica*				1	1				1			Tr			3	Tr	36
Vaccinium parvifolium			4	2			1				1	1	1	1	2	1	57
Vaccinium membranaceum		2	1			1	Tr		1					1		Tr	43
Vaccinium alaskaense			Tr													0	7
Vaccinium ovalifolium			Tr													0	7
Rhamnus purshiana			1						1							Tr	14
Pachistima myrsinites		1	2					2	1	2			1			1	43
Total		5	14	45	71	8	7	15	37	8	16	13	28	25	54	23	
LOW SHRUB LAYER																	
Berberis nervosa		5	70	30	25	30	10	5	10	15	2	10	20	4	26	19	100
Gaultheria shallon				2	10	2	1					Tr				1	36
Rosa gymnocarpa			2	1		1				1				1		Tr	36
Rubus ursinus		1	1	1	3	1	1	1	1	2	1	1	2	1	1	1	100
Rubus nivalis					1			3	1		2	3		2		1	43
Symphoricarpos mollis			3	1	1				1		10	1				1	43
Total		6	76	35	40	34	12	9	13	18	15	15	22	8	27	23	
HERB LAYER																	
Linnaea borealis			5		1	4	2	5	1	2	1	3		3	1	2	79
Polystichum munitum					Tr		1	3	2		5			1	9	2	50
Viola sempervirens		1	1	1	1	4	3		3	4	2	2	1	4	1	2	93
Trientalis latifolia		1			Tr	Tr	1	1			1	1		1	1	1	64
Coptis laciniata					1						3			4		1	21
Galium triflorum			1	3		1									4	1	29
Hieracium albiflorum				1		Tr								1	1	Tr	29
Whipplea modesta				10		1		1			1	3		1	2	1	50
Synthyris reniformis											1	1			1	Tr	21
Achlys triphylla			1			1	Tr	1	1			1	1	1	Tr	1	64
Chimaphila umbellata		1	1	1		Tr	1	2	1	7	1	1	10	2	2	2	93
Chimaphila menziesii		1		1		Tr	Tr		1					1		Tr	43
Trillium ovatum		1	1				Tr	1	1				1	1		Tr	50
Anemone deltoidea				1	Tr	1	1				1				1	Tr	43
Anemone lyallii				1												Tr	7
Anemone oregana							Tr									0	7
Xerophyllum tenax			Tr													0	7
Goodyera oblongifolia				1		Tr	Tr	1	1	1	1	1		1		1	64
Pyrola picta		1					1		1	1		1				Tr	36
Pyrola secunda								1	1	1			1	1		Tr	36
Pyrola asarifolia								1					1			Tr	14
Tiarella unifoliata		2					Tr	2	1		1	1	1	2		1	57
Vancouveria hexandra						1			1			1		1	Tr	Tr	36
Bromus sp.															1	Tr	7
Festuca occidentalis				Tr											1	Tr	14
Grasses						1					Tr					Tr	14
Pteridium aquilinum			2	1		2	1									Tr	29
Smilacina racemosa															Tr	0	7
Smilacina stellata			1										1	1		Tr	21
Asarum caudatum					Tr			1	1					1		Tr	29
Disporum hookeri				1		Tr							1			Tr	21
Cornus canadensis			Tr			Tr							5			Tr	21

1.8.2. *Pseudotsuga menziesii/Acer circinatum/Berberis nervosa* community (continued).

Species	Plot number 65	66	71	93	94	99	171	176	177	208	209	239	244	282	Avg. Cover	Constancy
HERB LAYER (Continued)																
Campanula scouleri			1												Tr	7
Corallorhiza mertensiana	1		1					1		1	1	1	1		1	50
Corallorhiza maculata			1												Tr	7
Senecio harfordii								1							Tr	7
Epilobium angustifolium			1												Tr	7
Pterospora andromedea										1				Tr	Tr	14
Eburophyton austiniae										Tr					0	7
Total	9	13	26	3	16	11	20	18	16	20	17	24	28	25	16	
TOTAL UNDERSTORY	27	116	117	116	68	45	109	83	69	59	47	104	67	112	77	
TOTAL ALL LAYERS	157	167	197	166	118	157	199	210	190	169	199	229	177	182	175	

[a]R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover). [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.

1.9.1. *Pseudotsuga menziesii/Acer circinatum/Whipplea modesta* community--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
15	1070	50	S	uneven slope middle 1/3	Tidbits	andesite	120-150	25-38	loam	loam	40-50	well drained	young 100-150	*Tsuga*		60-70	III
101	1100	25	E	smooth slope middle 1/3	Carpenter	andesite colluvium	180-210	5-10	sandy loam	sandy loam	20-30	well drained	young 100-150	*Tsuga*	*Abies amabilis*	30-40	III-
172	1040	40	S	smooth slope lower 1/3	Carpenter	andesite colluvium	180-210	10-15	loam	loam	10-20	well drained	old growth >300	*Tsuga*	*Thuja*	70-80	III-
173	1070	30	SW	ridgetop	"andesite colluvium"	andesite colluvium	120-150	10-15	silt loam		40-50	well drained	young 100-150	*Tsuga*		40-50	IV+
174	1160	40	S	smooth slope upper 1/3	Blue River	volcanic ash and pumice	90-120			silt loam	30-40	well drained	young with old growth	*Tsuga*	*Abies grandis*	70-80	III-
175	1160	60	SW	smooth slope middle 1/3	Blue River	volcanic ash and pumice	120-150			loam	0-10	well drained	young with old growth	*Tsuga*	*Abies grandis*	60-70	III-
194	940	20	S	smooth slope middle 1/3	Budworm	greenish tuffs and breccias	90-120	15-20	silt loam	silty clay loam	20-30	moderately well drained	young 100-150	*Tsuga*	*Abies grandis*	30-40	III-
195	1010	25	S	smooth slope upper 1/3	Blue River	volcanic ash and pumice	90-120			sandy loam	0-10	well drained	young 100-150	*Tsuga*	*Abies grandis*	60-70	III-
196	1040	20	S	smooth slope upper 1/3	Blue River	andesite	60-90			sandy loam	30-40	well drained	young 100-150	*Tsuga*		60-70	III-
198	1070	20	S	uneven slope upper 1/3	Tidbits	andesite colluvium	120-150	25-38	silt loam	silt loam	0-10	moderately well drained	young 100-150	*Tsuga*	*Thuja*	20-30	III-
201	980	25	SE	uneven slope lower 1/3	Carpenter	andesite colluvium	150-180	10-15	sandy loam	sandy loam	30-40	well drained	young 100-150	*Tsuga*	*Thuja*	70-80	III

1.9.2. *Pseudotsuga menziesii/Acer circinatum/Whipplea modesta* community--stand table (values in percent).

Species		Plot number 15	101	172	173	174	175	194	195	196	198	201	Avg. Cover	Constancy
TREE LAYER														
Tsuga heterophylla	R[a]	20	7	20	5	2	15	25	20	40	3	20	16	100
	M	5	10	20		2					20		5	45
Pseudotsuga menziesii	R												0[b]	0
	M	65	35	60	65	80	80	55	75	75	80	75	68	100
Thuja plicata	R			5							1	2	1	27
	M	2		20	5	Tr[c]							2	36
Abies grandis	R				Tr	1	10	1	20	2	1		3	64
	M												0	0
Abies amabilis	R		1	1			Tr	1					Tr	36
	M												0	0
Abies procera	R		1			1	1	1				1	Tr	45
	M		1						1				Tr	18
Pinus monticola	R												0	0
	M		15					1	5			1	2	36
Acer macrophyllum	R				2								Tr	9
	M												0	0
Total	R	20	9	26	7	4	26	28	40	42	5	23	20	
	M	72	61	100	70	82	80	56	81	75	100	76	77	
TALL SHRUB LAYER														
Acer circinatum		55	20	2	15	50	15	Tr	40	7	30	6	22	100
Rhododendron macrophyllum								10					1	9
Castanopsis chrysophylla			1		1	1	1	2	1	2	1		1	73
Taxus brevifolia				15	3		2						2	27
Cornus nuttallii			1	2	1	1		1	4			2	1	64
Corylus cornuta var. *californica*				1			2		1	3			1	36
Holodiscus discolor							2						Tr	9
Vaccinium parvifolium		2	1					5	2	4		1	1	55
Vaccinium membranaceum		Tr		1			1	1		1		1	Tr	55
Rhamnus purshiana						1							Tr	9
Rubus parviflorus							1			1	1		Tr	27
Pachistima myrsinites				3	3	2	1	1	1	1	1	1	1	82
Total		57	23	24	23	55	25	20	49	19	33	11	30	
LOW SHRUB LAYER														
Berberis nervosa		60	50	30	20	1	1	40	20	30		3	23	91
Gaultheria shallon								2					Tr	9
Rosa gymnocarpa		2	1	2	5		3	2	1	2	3	1	2	91
Rubus ursinus		10	2	3	3	5	3	3	1	2	2	2	3	100
Rubus nivalis				1	3		1	1	1			1	1	55
Rubus lasiococcus			1										Tr	9
Symphoricarpos mollis		8	1		3	2	2	2	2	2	1	2	2	91
Total		80	55	36	34	8	10	50	25	36	6	9	31	
HERB LAYER														
Linnaea borealis		30	20	10	30	40	20	15	10	15	7	35	21	100
Polystichum munitum		7	1	5			1			1	2		2	55
Viola sempervirens		9	20	15	8	8	5	5	3	5	1	4	8	100
Trientalis latifolia		1	1		1	1	1	1					1	55
Coptis laciniata		6											1	9
Galium triflorum		9	1		1	1	1			1	1	1	1	73
Hieracium albiflorum		2	1					1	1			1	1	45
Whipplea modesta		30		7	40	30	10	1	1	8	2	1	12	91
Synthyris reniformis		7		5		1		1		1	1		1	55
Achlys triphylla		1	Tr	2	2	1	15			1	1		2	73
Chimaphila umbellata			5	7	20	40	7	1	1	1	1	1	8	91
Chimaphila menziesii			Tr		1	1					1	1	Tr	45
Trillium ovatum		1		1	1				1			1	Tr	45
Anemone deltoidea			1			1	1	1	1	1		1	1	64
Anemone lyallii						1		1					Tr	18
Xerophyllum tenax								1		1			Tr	18
Adenocaulon bicolor						1			1			1	Tr	27
Goodyera oblongifolia		1	1		1	1		1	1	1	1	1	1	82
Pyrola picta		1	1					1	1	1	1	1	1	64
Pyrola secunda			1	1	1	1	1					1	1	55
Tiarella unifoliata		1	2			1	2						1	36
Vancouveria hexandra		1			1		1	1		2	1		1	55
Bromus sp.			1		3	1	2						1	36
Festuca occidentalis							1						Tr	9
Grasses								3	1		1		Tr	27
Pteridium aquilinum			2					1	1		2	1	1	45
Smilacina racemosa							1					1	Tr	18
Smilacina stellata							3						Tr	9
Asarum caudatum		Tr		1		5	15				15		3	45
Galium oreganum			1				1			1	1	1	Tr	45
Iris tenax					1	1		1					Tr	27
Clintonia uniflora							1					1	Tr	18
Cornus canadensis			1								1	2	Tr	27
Viola glabella							1						Tr	9

1.9.2. *Pseudotsuga menziesii/Acer circinatum/Whipplea modesta* community (continued).

Species	Plot number 15	101	172	173	174	175	194	195	196	198	201	Avg. Cover	Constancy
HERB LAYER (continued)													
Campanula scouleri						1						Tr	9
Corallorhiza mertensiana	Tr	Tr		1				1		1		Tr	45
Corallorhiza maculata				Tr				1		1		Tr	27
Fragaria vesca var. *bracteata*		1			1	2	1		1	1		1	55
Osmorhiza chilensis						1				1		Tr	18
Pedicularis racemosa											1	Tr	9
Lilium columbianum	1											Tr	9
Total	108	61	54	112	137	94	37	25	41	44	57	70	
TOTAL UNDERSTORY	265	148	140	176	204	155	135	139	138	88	100	151	
TOTAL ALL LAYERS	337	209	240	246	286	235	191	220	213	188	176	228	

[a] R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover).
[b] Zero indicates species occurred in trace amounts only in all sampled stands. [c] Tr = average cover less than 0.5%.

1.10.1. *Tsuga heterophylla--Abies amabilis/Rhododendron macrophyllum/Linnaea borealis* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
5	880	10	SE	broad ridgetop	Carpenter	andesite colluvium	150-180	5-10	loam	clay loam	20-30	well drained	old growth >300	*Tsuga*	*Thuja*	20-30	III-
6	880	2	NE	hummocky upland	Carpenter	andesite colluvium	120-150	5-10	loam	clay loam	50-60	well drained	old growth >300	*Abies amabilis*	*Tsuga*	40-50	III
8	820	3	SW	bench	McKenzie River	reddish tuffs and breccias	60-90	10-15	loam	silty clay loam	30-40	moderately well drained	old growth >300	*Tsuga*		50-60	III+
19	850	5	NW	bench	"andesite colluvium"	andesite colluvium	90-120	10-15	sandy loam	sandy loam	0-10	well drained	old growth >300	*Tsuga*	*Thuja*	50-60	II-
20	790	25	NE	smooth slope lower 1/3	"andesite colluvium"	andesite colluvium	210-300	5-10	loam	sandy loam	0-10	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	II-
47	940	15	W	bench	Carpenter	andesite colluvium	90-120	5-10	sandy loam	silt loam	50-60	well drained	old growth >300	*Tsuga*	*Abies amabilis*	50-60	III-
92	880	5	SW	bench	Slipout	greenish tuffs and breccias	90-120	20-25	silty clay loam	clay	10-20	imperfectly drained	young 100-150	*Tsuga*	*Thuja*	60-70	III
150	1190	60	E	smooth slope upper 1/3	Blue River	andesite	90-120	10-15	sandy loam	sandy loam	30-40	well drained	old growth >300	*Tsuga*	*Abies amabilis*	60-70	IV
154	940	5	N	bench	Carpenter	andesite colluvium	150-180	10-15	silt loam	silt loam	30-40	well drained	old growth >300	*Tsuga*	*Abies amabilis*	50-60	III+
178	1010	0		hummocky upland	Carpenter	andesite colluvium	180-210	10-15	loam	silt loam	10-20	well drained	old growth >300	*Tsuga*	*Abies amabilis*	60-70	III
181	980	5	S	hummocky upland	Carpenter	andesite colluvium	180-210	3-5	loam		0-10	well drained	old growth >300	*Abies amabilis*	*Tsuga*	70-80	III
225	1100	35	N	smooth slope middle 1/3	Carpenter	andesite colluvium	180-210			loam	40-50	well drained	old growth with poles	*Abies amabilis*	*Tsuga*	60-70	III

1.10.2. *Tsuga heterophylla--Abies amabilis/Rhododendron macrophyllum/Linnaea borealis* association--stand table (values in percent).

Species		Plot number 5	6	8	19	20	47	92	150	154	178	181	225	Avg. Cover	Constancy
TREE LAYER															
Tsuga heterophylla	R[a]	10	10	10	15	9	5	10	15	15	5	1	20	10	100
	M	50	15	40		60	1	10	50	30	40	50		29	83
Pseudotsuga menziesii	R													0[b]	0
	M	25	35	40	50	40	40	70	30	55	60	45	15	42	100
Thuja plicata	R	5	1		2	1		5					1	1	50
	M	25	35	20	30	15	40	5		2	30	Tr[c]	20	18	92
Abies grandis	R							3						Tr	8
	M													0	0
Abies amabilis	R		5	1		1	3	1	5	5	3	2	15	3	83
	M		15				5		5				5	2	33
Abies procera	R							2						Tr	8
	M													0	0
Total	R	15	16	11	17	11	8	21	20	20	8	3	36	14	
	M	100	100	100	80	115	86	85	85	87	130	95	40	91	
TALL SHRUB LAYER															
Acer circinatum		12	9	40	75	40			2	35	2	7	6	19	83
Rhododendron macrophyllum		85	65	65	55	20	30	15	7	20	30	25	5	35	100
Castanopsis chrysophylla		10				1	1	Tr	1	1	1			1	58
Taxus brevifolia		12	3	8	6	3	8	1	1	30		2		6	83
Cornus nuttallii		2				1								Tr	17
Vaccinium parvifolium		30	1	3	1		2	2		2	1	3		4	75
Vaccinium membranaceum		2	3		1		2	1	1	1	1		1	1	75
Vaccinium alaskaense			3		1	6						2		1	33
Oplopanax horridum									1					Tr	8
Acer glabrum var. *douglasii*									1					Tr	8
Pachistima myrsinites			8		1		1	1						1	33
Total		153	92	116	140	71	44	20	14	89	35	39	12	68	
LOW SHRUB LAYER															
Berberis nervosa		12		17	10	35	5	30	15	8		5	4	12	83
Gaultheria shallon											1			Tr	8
Rosa gymnocarpa		2		7		1		1	1			2		1	50
Rubus ursinus		3		10	1	3		3	1	1	1	2	1	2	83
Rubus nivalis		10		2	1	1	5	1	1	2	3	3	1	2	92
Rubus lasiococcus							1		1					Tr	17
Symphoricarpos mollis				2								1		Tr	17
Gaultheria ovatifolia			3					1						Tr	17
Total		27	3	38	12	40	11	36	19	11	5	13	6	17	
HERB LAYER															
Linnaea borealis		32	35	35	15	10	17	20	25	10	15	15	15	20	100
Polystichum munitum		Tr							3	Tr	1		2	1	42
Viola sempervirens		10	3	8	6	3	1	5	5	1	2	10	1	5	100
Trientalis latifolia													1	Tr	8
Coptis laciniata		7		6		6	10	2		10				3	50
Whipplea modesta		2												Tr	8
Achlys triphylla				8					1	1		2		1	33
Chimaphila umbellata		10	3	6	7	5	8	1	1	1	6	7		5	92
Chimaphila menziesii			1		1	1		Tr	1		1			Tr	50
Trillium ovatum		1	1	1	1				1		1		1	1	58
Anemone deltoidea								1	1					Tr	17
Xerophyllum tenax			3			1		3		Tr				1	33
Adenocaulon bicolor													1	Tr	8
Goodyera oblongifolia			1	1	1	1	1				1		1	1	58
Pyrola secunda								Tr			1			Tr	17
Pyrola asarifolia		9	7	1	1	3	1	Tr	2	2	3	1	1	3	100
Tiarella unifoliata		10	1	8	1			1	2	3	1	7	4	3	83
Vancouveria hexandra				1					1					Tr	17
Pteridium aquilinum								1						Tr	8
Listera caurina		1				1								Tr	17
Smilacina racemosa													1	Tr	8
Smilacina stellata				1							1	1	1	Tr	33
Asarum caudatum										1			2	Tr	17
Disporum hookeri									1	1				Tr	17
Clintonia uniflora						3							1	Tr	17
Cornus canadensis		30		8		15	5	1	3		2	7	5	6	75
Campanula scouleri									1					Tr	8
Corallorhiza mertensiana		1							1		1	1	1	Tr	42
Pedicularis racemosa			1											Tr	8
Pterospora andromedea				Tr										0	8
Total		113	56	84	33	49	43	35	49	30	36	51	38	50	
TOTAL UNDERSTORY		308	167	249	202	171	106	112	102	150	84	106	92	149	
TOTAL ALL LAYERS		408	267	349	282	286	192	133	187	237	214	201	132	240	

[a] R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover).
[b] Zero indicates species occurred in trace amounts only in all sampled stands. [c] Tr = average cover less than 0.5%.

1.11.1. *Tsuga heterophylla--Abies amabilis/Linnaea borealis* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
7	820	5	SW	bench	McKenzie River	reddish tuffs and breccias	150-180	15-20	silt loam	silty clay loam	0-10	moderately well drained	old growth >300	*Tsuga*	*Thuja*	60-70	II-
16	1040	3	SW	bench	Carpenter	andesite colluvium	210-300	5-10	loam	loam	0-10	well drained	old growth >300	*Tsuga*	*Abies amabilis*	60-70	II-
46	880	10	NW	bench	Carpenter	andesite colluvium	120-150	5-10	sandy loam	silt loam	10-20	well drained	old growth >300	*Tsuga*	*Abies amabilis*	50-60	III
48	760	8	S	bench	Carpenter	andesite colluvium	90-120	20-25	loam		40-50	well drained	old growth >300	*Tsuga*		60-70	III+
49	790	20	S	ridgetop	Carpenter	andesite colluvium	150-180	10-15	loam	silty clay loam	20-30	well drained	old growth >300	*Tsuga*	*Thuja*	50-60	III
85	790	15	SW	bench	"deep, fine textured"	mixed colluvium	180-210	5-10	silt loam	silty clay loam	0-10	well drained	old growth >300	*Tsuga*		50-60	III
122	580	10	NW	bench	Budworm	greenish tuffs and breccias	150-180	5-10	silt loam	silty clay loam	0-10	well drained	old growth >300	*Tsuga*	*Thuja*	80-90	III+
125	580	0		bench	Budworm	greenish tuffs and breccias	150-180	10-15	silt loam	silty clay loam	0-10	well drained	old growth with poles	*Tsuga*		80-90	II-
169	910	10	SW	uneven slope lower 1/3	Carpenter	andesite colluvium	180-210	5-10	silt loam		20-30	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	III
179	1010	30	W	hummocky upland	Carpenter	andesite colluvium	120-150	10-15	loam	silt loam	30-40	well drained	old growth >300	*Tsuga*	*Thuja*	30-40	III
180	1010	3	W	bench	"alluvial soil"	alluvium	150-180	25-38	silt loam	silty clay loam	0-10	moderately well drained	old growth >300	*Tsuga*	*Thuja*	70-80	III
192	1250	30	S	smooth slope lower 1/3	Carpenter	andesite colluvium	180-210	5-10	silt loam		30-40	well drained	old growth >300	*Abies amabilis*	*Abies grandis*	50-60	III
199	1070	30	SE	uneven slope middle 1/3	Tidbits	andesite	60-90	15-20	silt loam	silt loam	40-50	moderately well drained	old growth >300	*Abies amabilis*	*Tsuga*	80-90	III
200	1040	25	S	uneven slope lower 1/3	Tidbits	andesite	60-90	15-20	silt loam	clay	0-10	moderately well drained	old growth >300	*Tsuga*	*Abies amabilis*	50-60	III
202	940	10	SE	uneven slope lower 1/3	Slipout	greenish tuffs and breccias	90-120	15-20	silt loam	silty clay loam	0-10	moderately well drained	young 100-150	*Tsuga*	*Thuja*	60-70	III
206	1040	20	SE	smooth slope middle 1/3	Carpenter	andesite colluvium	210-300	20-25	loam	loam	20-30	well drained	old growth >300	*Tsuga*	*Abies amabilis*	40-50	III
221	790	25	N	toe slope	Carpenter	andesite colluvium	>300	20-25	loam	loam	20-30	well drained	old growth >300	*Tsuga*	*Thuja*	40-50	III
246	940	0		hummocky upland	Carpenter	andesite colluvium	180-210	20-25	sandy loam	sandy loam	20-30	well drained	old growth >300	*Tsuga*	*Abies amabilis*	40-50	III
247	980	10	S	hummocky upland	Carpenter	andesite colluvium	150-180	25-38	silt loam	silt loam	30-40	well drained	old growth >300	*Tsuga*	*Abies amabilis*	50-60	III
299	820	10	N	bench	Carpenter	andesite colluvium	150-180	10-15	sandy loam	sandy loam	50-60	moderately well drained	old growth >300	*Tsuga*	*Thuja*	30-40	III+
300	850	20	W	smooth slope lower 1/3	Carpenter	andesite colluvium	210-300	10-15	sandy loam	sandy loam	0-10	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	II

1.11.2. *Tsuga heterophylla--Abies amabilis/Linnaea borealis* association--stand table (values in percent).

Species		Plot number 7	16	46	48	49	85	122	125	169	179	180	192	199	200	202	206	221	246	247	299	300	Avg. Cover	Constancy
TREE LAYER																								
Tsuga heterophylla	R[a]	15	10	10	5	7	2	3	35	25	25	2	2	10	10	15	25	20	5	10	50	25	15	100
	M	30	45	35	25	45	55	20	15	25	20	50		80	55	40	70	70	35	80	15	70	42	95
Pseudotsuga menziesii	R																						0[b]	0
	M	50	50	25	50	40	35	55	65	50	10	70	40	30	70	65	25	35	35	30	1	5	40	100
Thuja plicata	R	3		1		2		5		10	5	5				8		2		1	5		2	52
	M	5		15	20	15	15	25		15	40	3						2	35	1	40	60	14	67
Abies grandis	R												15				1						1	10
	M												5				10						1	10
Abies amabilis	R	1	5	2		1				2			10	1	1	2	2	1	5	1	1		1	67
	M		20	Tr[c]			2						15	3	1		2		1	5			2	43
Abies procera	R		1										5		1								Tr	14
	M												20										1	5
Pinus monticola	R																						0	0
	M		Tr	Tr																			0	10
Total	R	19	16	13	5	10	2	8	35	37	30	7	32	11	12	25	28	23	10	12	56	25	19	
	M	85	115	75	95	100	107	100	80	90	70	123	80	113	126	105	107	107	106	116	56	135	100	
TALL SHRUB LAYER																								
Acer circinatum		3	15	5	15	Tr	10	5	10			1	15	15	10	Tr	10	2	6	15	15		7	86
Rhododendron macrophyllum				5			2	5	1		2	Tr							Tr			Tr	1	38
Castanopsis chrysophylla		3		Tr		1		2	1	1	1						1		1				1	43
Taxus brevifolia		3		2	4	8	25	10	10	5	25	5			1		2	3	3		25	18	7	76
Cornus nuttallii					2			1	1		1	1					1		3				Tr	33
Corylus cornuta var. *californica*								1											Tr				Tr	10
Vaccinium parvifolium		3	2	1	8	3	3	2		1	1	1			1	1	1	1	1	1	7	5	2	86
Vaccinium membranaceum		3		1	5	3	3	Tr		1			1		1	1	1		1		1		1	62
Vaccinium alaskaense				1	2					1								7			1	1	1	29
Acer glabrum var. *douglasii*						1																	Tr	5
Rubus parviflorus												1											Tr	5
Pachistima myrsinites					Tr	1				3										1			Tr	19
Total		15	17	15	36	17	43	26	23	12	30	9	16	15	13	2	16	13	15	17	49	24	20	
LOW SHRUB LAYER																								
Berberis nervosa		40		1	4	3	3	7	3	10	12	5	10	2	15	12	5	2	3	25	7	2	8	95
Gaultheria shallon							2		1														Tr	10
Rosa gymnocarpa		7	2		2		1			1	1		1			1		7	1				1	48
Rubus ursinus		8	10	1	3	1	2	1	1	1	3	3	2	1	1	2	1	2	3	2	1		2	95
Rubus nivalis		9	2	2	3		5	10		1	2	1		3	1	3	2	1	3	1	1	1	2	86
Rubus lasiococcus			2	2									4										Tr	14
Symphoricarpos mollis		6					1					3		1		2							1	24
Berberis aquifolium		2																					Tr	5
Total		72	16	6	12	4	14	18	5	13	18	12	17	7	17	20	8	12	10	28	9	3	14	
HERB LAYER																								
Linnaea borealis		60	35	4	20	60	35	80	30	15	17	12	17	10	20	10	3	60	2	3	7	20	25	100
Polystichum munitum		7	1		3	1	2	5	1	1	1	2	1	2	2		2	7	2	1	15	2	3	90
Viola sempervirens		35	30	2	10	10	10	15	4	2	20	5	2	1	3	3	3	3	5	2	3	15	9	100

1.11.2. *Tsuga heterophylla--Abies amabilis/Linnaea borealis* association (continued).

Species	Plot number																					Avg. Cover	Constancy
	7	16	46	48	49	85	122	125	169	179	180	192	199	200	202	206	221	246	247	299	300		
HERB LAYER (continued)																							
Trientalis latifolia	1					1	1	1		1	1			1				1				Tr	38
Galium triflorum													1		1					1	1	Tr	19
Coptis laciniata	2	30	10		1	30	20	3			40		1	30		35		20	20	2		12	67
Whipplea modesta					1					1					3							Tr	14
Synthyris reniformis	2				1					1			1	2								Tr	24
Achlys triphylla	7		Tr	1			1		2	1	1	1	1	1		1	1					1	57
Chimaphila umbellata	7		5	4	15	18	1	1	1	2	1	3	1	1	1	1		1	1	1	8	3	90
Chimaphila menziesii					1				1			1		1	1	1		1	1			Tr	38
Trillium ovatum	2	1	1	1	1	1	1	1	1		1				1		1				1	1	62
Anemone deltoidea	2	1		1		1	1				1	1	1					1	1		1	1	52
Anemone lyallii																			1			Tr	5
Xerophyllum tenax	Tr							Tr				1			2							Tr	19
Adenocaulon bicolor	6																					Tr	5
Goodyera oblongifolia	1	1	1	1	1	1	1	1	1	1				1		1		1	1	1	1	1	76
Pyrola picta					1				1	1		1	1	1	1							Tr	33
Pyrola secunda									1	1		1					1					Tr	19
Pyrola asarifolia			1	1	1	1		1	2									1		1	1	Tr	43
Tiarella unifoliata	9	8	1	25	1	1	1	1	1	3	5	5	3	7		2	15	3	3	5	10	5	95
Tiarella trifoliata	2				1																	Tr	10
Vancouveria hexandra	8	2	1	1	1						18			1		1	1	1		1		2	52
Melica subulata		1																				Tr	5
Grasses	1									1			Tr		1							Tr	19
Pteridium aquilinum															1							Tr	5
Listera caurina	1	1	Tr					1	1									1				Tr	29
Smilacina racemosa				1																		Tr	5
Smilacina stellata				5	1				1	1			1				10			2	1	1	38
Streptopus amplexifolius			Tr																			0	5
Asarum caudatum	1										1	1	1				1					Tr	24
Athyrium filix-femina																	1			2		Tr	10
Blechnum spicant																	2					Tr	5
Disporum hookeri															1		1			1		Tr	14
Galium oreganum															1							Tr	5
Clintonia uniflora				3			1	1									1			1		Tr	24
Cornus canadensis	9	9	2	15		1			2	5	4	1	Tr	2	4	1	12	1	1	4	1	1	86
Campanula scouleri														1								Tr	5
Corallorhiza mertensiana	1	1			1	1		1	1			1	1	1		1		1	1		1	1	62
Corallorhiza maculata		1																				Tr	5
Arnica latifolia		1																				Tr	5
Lysichitum americanum		1																				Tr	5
Senecio harfordii	1																					Tr	5
Pyrola aphylla																		1				Tr	5
Adiantum pedatum																				1		Tr	5
Dryopteris austriaca																				1		Tr	5
Total	165	124	28	92	99	103	128	47	34	57	92	37	26	75	31	52	117	43	36	49	63	54	
TOTAL UNDERSTORY	271	173	62	145	130	162	180	110	96	135	120	102	59	117	78	104	165	78	93	163	115	107	
TOTAL ALL LAYERS	356	288	137	240	230	269	280	190	133	205	243	182	172	243	183	211	272	184	209	219	250	207	

[a] R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover).
[b] Zero indicates species occurred in trace amounts only in all sampled stands. [c] Tr = average cover less than 0.5%.

1.12.1. *Tsuga heterophylla/Acer circinatum/Polystichum munitum* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
27	490	99	NW	smooth slope lower 1/3	Frissell	reddish tuffs and breccias	120-150	20-25	loam		0-10	well drained	old growth with poles	*Tsuga*		80-90	II
30	790	60	NW	smooth slope upper 1/3	Budworm	greenish tuffs and breccias	120-150	25-38	silt loam	silt loam	30-40	well drained	young - 100-150	*Tsuga*	*Thuja*	60-70	III
103	820	80	NW	smooth slope upper 1/3	"fragmental soil"	andesite colluvium	60-90	5-10	sandy loam		>80	well drained	young with old growth	*Tsuga*	*Thuja*	40-50	IV
104	820	35	NE	smooth slope upper 1/3	"andesite colluvium"	andesite colluvium	150-180	10-15	sandy loam		30-40	well drained	young with old growth	*Tsuga*		40-50	IV
109	700	50	E	smooth slope upper 1/3	Limberlost	greenish tuffs and breccias	120-150	5-10	silt loam		20-30	well drained	old growth >300	*Tsuga*		60-70	III+
114	580	75	N	smooth slope upper 1/3	Frissell	reddish tuffs and breccias	90-120	10-15	silt loam		10-20	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	III
117	700	70	E	smooth slope lower 1/3	Limberlost	greenish tuffs and breccias	90-120	10-15	silt loam		10-20	well drained	young 100-150	*Tsuga*	*Thuja*	60-70	III
121	610	5	SW	bench	Budworm	greenish tuffs and breccias	120-150	5-10	silt loam	clay loam	0-10	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	II
133	460	80	S	smooth slope middle 1/3	Frissell	reddish tuffs and breccias	60-90	10-15	silt loam	silty clay loam	20-30	well drained	young 100-150	*Tsuga*		60-70	III
251	610	60	W	smooth slope lower 1/3	"fragmental soil"	andesite	90-120	10-15	loam		>80	well drained	mature 150-300	*Tsuga*		60-70	III
293	490	80	E	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young 100-150	*Tsuga*	*Thuja*	50-60	III
296	460	80	NW	smooth slope lower 1/3	ND	ND	ND	ND	ND	ND	ND	ND	old growth with poles	*Tsuga*		70-80	III

1.12.2. *Tsuga heterophylla/Acer circinatum/Polystichum munitum* association--stand table (values in percent).

Species		Plot number 27	30	103	104	109	114	117	121	133	251	293	296	Avg. Cover	Constancy
TREE LAYER															
Tsuga heterophylla	R[a]	5	10	3	8	5	5	3	10	2	10	3	20	7	100
	M	70		20	20	25	25	15	25		10		40	21	75
Pseudotsuga menziesii	R											4		Tr[b]	8
	M	50	70	45	45	60	55	40	45	65	50	45	20	49	100
Thuja plicata	R		2	1	Tr		2	5	2			6	1	2	67
	M				Tr		5	35	10		5			5	42
Acer macrophyllum	R				5									Tr	8
	M		Tr		15	1		5			2	3	4	2	58
Total	R	5	12	4	13	5	7	8	12	2	10	13	21	9	
	M	120	70	65	80	86	85	95	80	65	67	48	64	77	
TALL SHRUB LAYER															
Acer circinatum		10	50	60	40	10	15	30	60	40	20	70	28	36	100
Rhododendron macrophyllum		3			5	5	3	2	1			8	5	3	67
Castanopsis chrysophylla			1					1	2	1			1	1	42
Taxus brevifolia		10	1				7	1	10			10	24	5	58
Cornus nuttallii					2	1	5	1				2		1	42
Corylus cornuta var. *californica*								1				6		1	17
Vaccinium parvifolium		2	1	1		1		1	1	2	3	1		1	75
Rhamnus purshiana										1		1		Tr	17
Lonicera ciliosa										1				Tr	8
Total		25	53	61	47	17	30	37	74	45	23	98	58	48	
LOW SHRUB LAYER															
Berberis nervosa		6	60	10	10	3	3	30	5	80	20	3	6	20	100
Gaultheria shallon		2	Tr		1	2		10	2	2	5	8	2	3	83
Rosa gymnocarpa												1		Tr	8
Rubus ursinus		1	2		1	1	1		2	1	2	1		1	75
Symphoricarpos mollis											Tr			0[c]	8
Total		9	62	10	12	6	4	40	9	83	27	13	8	24	
HERB LAYER															
Linnaea borealis		3	2	1	1	2		4	25		2	6	1	4	83
Polystichum munitum		35	40	25	10	5	12	25	10	20	15	42	15	21	100
Viola sempervirens		1	1		1	1		1	2		1	1	1	1	75
Trientalis latifolia		1	1		1	1	1	1				Tr		1	58
Coptis laciniata		6	4	1	1	15	4	5	10			3	13	5	83
Galium triflorum			1	1	1	1		1		1		1	Tr	1	67
Hieracium albiflorum						1			1			1		Tr	25
Whipplea modesta			1		1	1		1		1		Tr		Tr	50
Synthyris reniformis			2								1	3		1	25
Achlys triphylla		1	2		2			1		1	1	Tr	Tr	1	67
Chimaphila umbellata			1		1		1							Tr	25
Chimaphila menziesii			1	1		Tr	1		1		Tr			Tr	50
Trillium ovatum		1		1	1		1	1	1			Tr	1	1	67
Anemone deltoidea		1	1						1	1		1	1	1	50
Anemone lyallii						1						1		Tr	17
Xerophyllum tenax											1		Tr	Tr	17
Goodyera oblongifolia			1	1	1	1	1		1		Tr	Tr	Tr	1	75
Tiarella unifoliata						1			3				1	Tr	25
Vancouveria hexandra		1	4					2		3		1	1	1	50
Bromus sp.			1					1				1		Tr	25
Festuca occidentalis								1						Tr	8
Grasses			2											Tr	8
Luzula intermedia						1				1				Tr	17
Pteridium aquilinum								2		3				Tr	17
Oxalis oregana		1											1	Tr	17
Smilacina racemosa				1	1					1				Tr	25
Smilacina stellata		1										1	Tr	Tr	25
Asarum caudatum													Tr	0	8
Disporum hookeri			Tr		1			1		1		Tr	1	Tr	50
Iris tenax										1		Tr		Tr	17
Campanula scouleri												Tr		0	8
Collomia heterophylla												1		Tr	8
Senecio harfordii		Tr	1									1	1	Tr	33
Actaea arguta													Tr	0	8
Polypodium glycyrrhiza				Tr										0	8
Calypso bulbosa				Tr						Tr				0	17
Total		52	66	32	23	31	21	47	55	34	21	64	37	39	
TOTAL UNDERSTORY		91	193	107	95	59	62	132	150	164	81	188	124	120	
TOTAL ALL LAYERS		211	263	172	175	145	147	227	230	229	148	236	188	197	

[a]R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover). [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.

1.13.1. *Tsuga heterophylla/Polystichum munitum* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
17	980	0		bench	Carpenter	andesite colluvium	150-180	5-10	loam	loam	30-40	well drained	old growth >300	*Thuja*	*Tsuga*	70-80	II
18	850	12	NW	bench	"andesite colluvium"	andesite colluvium	120-150	20-25	loam		20-30	well drained	old growth >300	*Tsuga*	*Thuja*	50-60	II
45	790	20	NE	uneven slope upper 1/3	Slipout	greenish tuffs and breccias	120-150	15-20	clay loam	clay	10-20	imperfectly drained	old growth >300	*Tsuga*	*Thuja*	70-80	II
62	760	25	NW	smooth slope upper 1/3	Budworm	greenish tuffs and breccias	150-180	20-25	silt loam	silty clay	0-10	moderately well drained	young with old growth	*Tsuga*	*Thuja*	50-60	III
63	730	45	NW	smooth slope middle 1/3	"andesite colluvium"	andesite colluvium	90-120	10-15	loam		40-50	well drained	old growth >300	*Thuja*	*Tsuga*	70-80	II-
64	700	50	W	smooth slope middle 1/3	Budworm	greenish tuffs and breccias	120-150	10-15	loam	silt loam	30-40	well drained	old growth >300	*Tsuga*		70-80	III+
84	760	50	SE	smooth slope lower 1/3	Carpenter	andesite colluvium	210-300	10-15	silt loam	silt loam	10-20	well drained	old growth >300	*Tsuga*	*Thuja*	60-70	III+
106	760	5	NW	bench	Limberlost	greenish tuffs and breccias	60-90	5-10	silt loam		30-40	well drained	old growth >300	*Tsuga*	*Thuja*	70-80	II
107	760	70	E	smooth slope middle 1/3	"andesite colluvium"	andesite colluvium	150-180	10-15	sandy loam		40-50	well drained	old growth >300	*Tsuga*		50-60	III
113	610	75	N	smooth slope upper 1/3	Frissell	reddish tuffs and breccias	120-150	10-15	silty clay loam		0-10	well drained	old growth >300	*Tsuga*		70-80	III+
131	730	15	NW	bench	McKenzie River	reddish tuffs and breccias	90-120	10-15	silty clay loam	silty clay	20-30	moderately well drained	old growth >300	*Tsuga*		80-90	II
157	790	30	N	toe slope	Slipout	greenish tuffs and breccias	120-150	5-10	silt loam	silty clay loam	0-10	imperfectly drained	old growth with poles	*Tsuga*		90-100	III+
158	730	20	NE	bench	Budworm	greenish tuffs and breccias	210-300	38-51	silt loam	sandy loam	0-10	well drained	old growth >300	*Tsuga*		70-80	II
159	460	40	W	smooth slope middle 1/3	Frissell	reddish tuffs and breccias	120-150	10-15	silt loam		10-20	well drained	old growth with poles	*Tsuga*		70-80	III
291	580	53	S	smooth slope upper 1/3	ND	ND	ND	ND	ND	ND	ND	ND	old growth with poles	*Tsuga*		70-80	III

1.13.2. *Tsuga heterophylla/Polystichum munitum* association--stand table (values in percent).

Species		Plot number 17	18	45	62	63	64	84	106	107	113	131	157	158	159	291	Avg. Cover	Constancy
TREE LAYER																		
Tsuga heterophylla	R[a]	5	15	10	10	2	1	10	10	2	8	10	1	5	15	25	9	100
	M	15	40	50	50	25	50	50	40	30	45	70	90	25	10	74	44	100
Pseudotsuga menziesii	R																0[b]	0
	M	25	40	40	35	55	20	20	65	55	70	55	15	80	35	15	42	100
Thuja plicata	R	10	1	5	5	10		5	3							1	3	53
	M	60	60	30	10	7		35	1		Tr[c]	Tr		10	20	5	16	80
Acer macrophyllum	R					2	2										Tr	13
	M			3	1	10	1			10			Tr		5		2	47
Total	R	15	16	15	15	14	3	15	13	2	8	10	1	5	15	26	12	
	M	100	140	123	96	97	71	105	106	95	115	125	105	115	70	94	104	
TALL SHRUB LAYER																		
Acer circinatum		1	1	1	2		1	1	Tr	5	2		5	2	2	6	2	87
Rhododendron macrophyllum			1	Tr	1				2	1	1	1		2	7	2	1	67
Castanopsis chrysophylla				1											1		Tr	13
Taxus brevifolia		15	1				1	1			2			30	15		4	47
Cornus nuttallii								7			1		1		1	1	1	33
Corylus cornuta var. *californica*						2				1					2		Tr	33
Vaccinium parvifolium			5	2		1	2	1	1	2	1	1	1	3	1	2	2	87
Vaccinium membranaceum														1			Tr	7
Vaccinium alaskaense			1														Tr	7
Rhamnus purshiana								1									Tr	7
Total		16	9	4	3	3	4	11	3	9	7	2	7	38	29	11	10	
LOW SHRUB LAYER																		
Berberis nervosa		5	15	5	15	2	3	5	2	25	5	25	1	3	3	1	8	100
Gaultheria shallon			Tr		3				1	8		2		2	15	Tr	2	53
Rubus ursinus		5	2	1	1	3		1		1		1	1	3			1	67
Rubus nivalis		5	1	1				1	1			2	1	1			1	53
Total		15	18	7	19	5	3	7	4	34	5	30	3	9	18	1	12	
HERB LAYER																		
Linnaea borealis		10	40	4	5	1		3	2	1	1	50		70	10		13	80
Polystichum munitum		35	30	30	15	75	40	30	10	25	25	13	20	15	20	6	26	100
Viola sempervirens		1	10	1				2	2	1		1	1	8	1	1	2	73
Trientalis latifolia			1		1		1								1		Tr	27
Coptis laciniata				5		Tr	5	3	5	5	5		1	5	7	4	3	73
Galium triflorum		5	1	1	1				1	1			1	1	1		1	60
Hieracium albiflorum					Tr									1	1		Tr	20
Whipplea modesta					1		1		1								Tr	20
Achlys triphylla				1	1		3	1		1				1	1		1	47
Chimaphila umbellata			1	Tr					1		1	1		1	1	Tr	Tr	53
Chimaphila menziesii		1			1				1		1			1			Tr	33
Trillium ovatum		1	4		1	1	1	1	1	1	1		1	1	1	1	1	87
Anemone deltoidea		1	10				1		1								1	27
Xerophyllum tenax																Tr	0	7
Adenocaulon bicolor															1	Tr	Tr	13
Goodyera oblongifolia		1	1	1	1			1	Tr	Tr			1	1	1	1	1	73
Pyrola picta											1			1		Tr	Tr	20
Pyrola secunda			1													Tr	Tr	13
Pyrola asarifolia												1					Tr	7
Tiarella unifoliata		5	25	3	1	Tr	1	2	1			1	6	15			4	73
Vancouveria hexandra								2	Tr	1					1		Tr	27
Bromus sp.															1		Tr	7
Festuca occidentalis															1		Tr	7
Grasses									Tr								0	7
Oxalis oregana												1					Tr	7
Listera caurina		1										1					Tr	13
Smilacina stellata								1						1			Tr	13
Asarum caudatum		1			1				Tr					1			Tr	27
Athyrium filix-femina													3	1			Tr	13
Blechnum spicant				1								1	5	2			1	27
Disporum hookeri					1				Tr	1					1		Tr	27
Montia sibirica														1	1		Tr	13
Cornus canadensis								1						1			Tr	13
Corallorhiza mertensiana		1					1										Tr	13
Senecio harfordii															1		Tr	7
Actaea arguta			1														Tr	7
Boykinia elata													1				Tr	7
Calypso bulbosa									Tr								0	7
Total		63	125	47	30	77	54	47	26	37	35	70	39	128	52	13	54	
TOTAL UNDERSTORY		109	168	73	67	99	64	80	46	82	55	112	50	180	114	51	88	
TOTAL ALL LAYERS		209	308	196	163	196	135	185	152	177	170	237	155	295	184	145	192	

[a] R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover).
[b] Zero indicates species occurred in trace amounts only in all sampled stands. [c] Tr = average cover less than 0.5%.

1.14.1. *Tsuga heterophylla/Polystichum munitum--Oxalis oregana* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
56	490	5	SW	alluvial fan	"deep alluvium"	alluvium	90-120	5-10	silt loam	clay loam	20-30	imperfectly drained	young 100-150	*Tsuga*	*Thuja*	70-80	II
58	490	90	N	smooth slope upper 1/3	"deep, fine textured"	mixed colluvium	180-210	15-20	loam	silty clay loam	10-20	well drained	old growth >300	*Tsuga*	*Thuja*	40-50	II
130	730	10	NW	bench	Frissell	reddish tuffs and breccia	90-120	5-10	silt loam	silt loam	0-10	well drained	old growth >300	*Tsuga*		60-70	II
132	520	15	S	uneven slope lower 1/3	"deep, fine textured"	mixed colluvium	90-120	38-51	loam	silty clay loam	0-10	moderately well drained	old growth >300	*Tsuga*		60-70	II
168	490	10	W	toe slope	Limberlost	greenish tuffs and breccias	180-210	10-15	loam	silt loam	30-40	well drained	old growth >300	*Tsuga*	*Thuja*	50-60	II
257	340	50	NE	smooth slope middle 1/3	"deep, fine textured"	mixed colluvium	150-180	10-15	silt loam	silty clay	0-10	well drained	mature 150-300	*Tsuga*		70-80	II
259	430	60	N	smooth slope lower 1/3	"fragmental soil"	andesite	90-120	3-5	loam		70-80	well drained	old growth >300	*Tsuga*	*Thuja*	70-80	I
264	640	10	SW	bench	"deep, fine textured"	mixed colluvium	150-180	15-20	silt loam	silty clay loam	10-20	well drained	mature 150-300	*Tsuga*		70-80	II

1.14.2. *Tsuga heterophylla/Polystichum munitum--Oxalis oregana* association--stand table (values in percent).

Species		Plot number 56	58	130	132	168	257	259	264	Avg. Cover	Constancy
TREE LAYER											
Tsuga heterophylla	R[a]	3	7	10	10	40	10	5	5	11	100
	M	20	45	40	25	10	25	55	15	29	100
Pseudotsuga menziesii	R									0[b]	0
	M	1	30	60	40	25	50	25	70	38	100
Thuja plicata	R		2			15		3		2	38
	M	40	20	20		10		10	5	13	75
Abies grandis	R									0	0
	M	1								Tr[c]	12
Acer macrophyllum	R									0	0
	M	40	1			2	10	5		7	62
Total	R	3	9	10	10	55	10	8	5	13	
	M	102	96	120	65	47	85	95	90	87	
TALL SHRUB LAYER											
Acer circinatum		1	5		12	15	2	10	1	6	88
Rhododendron macrophyllum				1						Tr	12
Castanopsis chrysophylla			1			1				Tr	25
Taxus brevifolia		2	5	1		1				1	50
Cornus nuttallii			1			2	1			1	38
Corylus cornuta var. *californica*		2								Tr	12
Vaccinium parvifolium		1	2	1	2	3	1	5	5	3	100
Vaccinium alaskaense									8	1	12
Vaccinium ovalifolium									8	1	12
Oplopanax horridum							1	1		Tr	25
Rhamnus purshiana					1					Tr	12
Osmaronia cerasiformis		2								Tr	12
Total		8	14	3	15	22	5	16	22	13	
LOW SHRUB LAYER											
Berberis nervosa		1	10	40	30	3	15	3	3	13	100
Gaultheria shallon			1	5	20	3	1	1		4	75
Rubus ursinus		3	2		1	3	1	1		1	75
Rubus nivalis				3					1	1	25
Total		4	13	48	51	9	17	5	4	19	
HERB LAYER											
Linnaea borealis			1	10	1	70				11	50
Polystichum munitum		22	70	7	15	10	35	45	15	27	100
Viola sempervirens			1		1	1	1		3	1	62
Trientalis latifolia							Tr			0	12
Coptis laciniata			3						3	1	25
Galium triflorum		5	1				2			1	38
Hieracium albiflorum		Tr					1			Tr	25
Achlys triphylla			2		2	1	1	1	6	2	75
Chimaphila umbellata			Tr	1		3				1	38
Chimaphila menziesii			Tr							0	12
Trillium ovatum		1	2			1	1		1	1	62
Anemone deltoidea			1				1			Tr	25
Adenocaulon bicolor		5								1	12
Tiarella unifoliata		2	1	2	2	2				1	62
Tiarella trifoliata								1		Tr	12
Vancouveria hexandra		20	3		1	1	1	2	1	4	88
Melica subulata		1								Tr	12
Carex sp.									1	Tr	12
Luzula intermedia							1	1		Tr	25
Pteridium aquilinum					1		1			Tr	25
Oxalis oregana		90	10	65	20	40	6	20	50	38	100
Listera caurina				1						Tr	12
Smilacina racemosa			1							Tr	12
Smilacina stellata		Tr							5	1	25
Asarum caudatum		5					1			1	25
Athyrium filix-femina								1		Tr	12
Blechnum spicant			3				1	2		1	38
Disporum hookeri			1				2	2	2	1	50
Clintonia uniflora						2				Tr	12
Cornus canadensis									1	Tr	12

1.14.2. *Tsuga heterophylla/Polystichum munitum--Oxalis oregana* association (continued).

Species	Plot number 56	58	130	132	168	257	259	264	Avg. Cover	Constancy
HERB LAYER (continued)										
Campanula scouleri	1					1			Tr	25
Corallorhiza mertensiana		1							Tr	12
Osmorhiza chilensis	1								Tr	12
Polypodium glycyrrhiza						1			Tr	12
Stachys palustris	Tr								0	12
Aralia californica	2								Tr	12
Adiantum pedatum	5	1							1	25
Tellima grandiflora	Tr								0	12
Total	160	102	86	43	131	57	75	88	94	
TOTAL UNDERSTORY	175	138	147	162	215	89	104	119	139	
TOTAL ALL LAYERS	277	234	267	227	262	174	199	209	226	

[a] R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover).
[b] Zero indicates species occurred in trace amounts only in all sampled stands. [c] Tr = average cover less than 0.5%.

APPENDIX

2. *Abies amabilis* zone

2.1.1. *Abies amabilis--Tsuga mertensiana/Xerophyllum tenax* association--site and general stand characteristics.

Plot No.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
100	1400	10	W	ridgetop	Wildcat	volcanic ash and pumice	60-90	38-51	loam	clay loam	40-50	well drained	old growth >300	*Abies amabilis*	*Tsuga mertensiana*	20-30	IV
165	1520	30	NW	smooth slope upper 1/3	Wildcat	volcanic ash and pumice	60-90			sandy loam	30-40	well drained	young 100-150	*Abies amabilis*	*Tsuga mertensiana*	60-70	V
188	1490	15	NW	smooth slope upper 1/3	Wildcat	volcanic ash and pumice	90-120			silt loam	0-10	well drained	old growth >300	*Abies amabilis*	*Tsuga mertensiana*	30-40	V
193	1400	30	SE	smooth slope middle 1/3	Wildcat	volcanic ash and pumice	90-120	5-10	sandy loam	sandy loam	20-30	well drained	old growth >300	*Abies amabilis*	*Tsuga mertensiana*	30-40	V
271	1460	65	NE	smooth slope upper 1/3	Wildcat	volcanic ash and pumice	30-60				70-80	well drained	young 100-150	*Abies amabilis*	*Tsuga mertensiana*	40-50	V
272	1460	10	S	ridgetop	Wildcat	volcanic ash and pumice	30-60				60-70	well drained	young 100-150	*Abies amabilis*	*Tsuga mertensiana*	60-70	V
276	1620	39	SE	smooth slope upper 1/3	Wildcat	volcanic ash and pumice	60-90				50-60	well drained	young 100-150	*Abies amabilis*	*Tsuga mertensiana*	70-80	V
277	1460	5	NW	hummocky upland	ND	ND	ND	ND	ND	ND	ND	ND	old growth >300	*Abies amabilis*	*Tsuga mertensiana*	60-70	V

2.1.2. *Abies amabilis--Tsuga mertensiana/Xerophyllum tenax* association--stand table (values in percent).

Species		Plot number 100	165	188	193	271	272	276	277	Avg. Cover	Constancy
TREE LAYER											
Pseudotsuga menziesii	R[a]									0[b]	0
	M	10			Tr[c]	5	1			1	50
Abies grandis	R									0	0
	M	Tr								0	12
Abies amabilis	R	8	5	25	20	10	5	2	10	11	100
	M	15	40	35	25	10	15		20	20	88
Abies procera	R									0	0
	M	40		20	25	30	10			16	62
Pinus monticola	R									0	0
	M	10				2	1		5	2	50
Tsuga mertensiana	R	5		5	10	3	5	2	5	4	88
	M	20	50	25	30	35	40	70	45	39	100
Pinus contorta	R									0	0
	M								3	Tr	12
Total	R	13	5	30	30	13	10	4	15	15	
	M	95	90	80	80	82	67	70	73	78	
TALL SHRUB LAYER											
Acer circinatum								Tr		0	12
Rhododendron macrophyllum			Tr							0	12
Vaccinium membranaceum		2	6	6	12	4	5	3	18	7	100
Vaccinium scoparium									1	Tr	12
Amelanchier alnifolia								Tr		0	12
Sorbus sitchensis				1						Tr	12
Total		2	6	6	12	4	5	3	19	7	
LOW SHRUB LAYER											
Rubus lasiococcus		1	3		1	Tr	1	Tr		1	75
Vaccinium caespitosum									1	Tr	12
Total		1	3	0	1	0	1	0	1	1	
HERB LAYER											
Polystichum munitum								Tr		0	12
Viola sempervirens			1		1	1	1		1	1	62
Hieracium albiflorum								1	Tr	Tr	25
Achlys triphylla		1	1			2	1			1	50
Chimaphila umbellata				1					Tr	Tr	25
Chimaphila menziesii					1	1		Tr	Tr	Tr	50
Trillium ovatum								Tr	Tr	0	25
Anemone deltoidea							1	1	Tr	Tr	38
Anemone oregana						Tr	1	Tr	Tr	Tr	50
Xerophyllum tenax		90	85	40	70	53	90	62	18	64	100
Goodyera oblongifolia						1	1	Tr	1	Tr	50
Pyrola secunda			1	2		1	1		Tr	1	62
Bromus sp.								1		Tr	12
Carex sp.					1			Tr	Tr	Tr	38
Listera caurina			1						1	Tr	25
Smilacina stellata								Tr		0	12
Clintonia uniflora			1	3		1				1	38
Campanula scouleri							1			Tr	12
Fragaria vesca var. *bracteata*									Tr	0	12
Pedicularis racemosa									2	Tr	12
Ligusticum grayi								1		Tr	12
Hypopitys monotropa								1	Tr	Tr	25
Aster ledophyllus									Tr	0	12
Lupinus sp.									Tr	0	12
Total		91	90	47	73	60	97	67	23	68	
TOTAL UNDERSTORY		107	104	83	116	78	113	74	58	91	
TOTAL ALL LAYERS		202	194	163	196	160	180	144	131	169	

[a] R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover).
[b] Zero indicates species occurred in trace amounts only in all sampled stands. [c] Tr = average cover less than 0.5%.

2.2.1. *Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
1	1370	35	W	smooth slope upper 1/3	Blue River	andesite	120-150			loam	30-40	well drained	old growth >300	*Abies*		30-40	IV
2	1400	70	W	smooth slope upper 1/3	Lucky Boy	andesite	60-90	38-51	loam		70-80	well drained	mature 150-300	*Abies*		60-70	V
11	1400	30	S	smooth slope upper 1/3	Wildcat	volcanic ash and pumice	90-120	5-10	sandy loam	sandy loam	20-30	well drained	old growth >300	*Abies*		30-40	V
76	1310	35	NE	ridgetop	Blue River	andesite	90-120	10-15	loam	sandy loam	10-20	well drained	young 100-150	*Abies*	*Tsuga heterophylla*	60-70	IV
77	1280	40	NW	ridgetop	Blue River	andesite	60-90	5-10	loam	loam	20-30	well drained	young 100-150	*Abies*		60-70	III-
78	1430	15	NW	ridgetop	Wildcat	volcanic ash and pumice	60-90			loam	0-10	moderately well drained	old growth >300	*Abies*		30-40	IV
81	1370	35	NW	ridgetop	Blue River	andesite	60-90	10-15	loam	loam	30-40	well drained	young 100-150	*Abies*	*Tsuga mertensiana*	30-40	IV+
166	1400	40	W	smooth slope middle 1/3	Wildcat	volcanic ash and pumice	120-150			loam	20-30	well drained	mature 150-300	*Abies*	*Tsuga mertensiana*	30-40	III
270	1280	35	NW	uneven slope upper 1/3	ND	ND	ND	ND	ND	ND	ND	ND	old growth >300	*Abies*	*Tsuga heterophylla*	30-40	IV

2.2.2. *Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax* association--stand table (values in percent).

Species		Plot number 1	2	11	76	77	78	81	166	270	Avg. Cover	Constancy
TREE LAYER												
Tsuga heterophylla	R[a]	Tr[b]			3		2			2	1	44
	M	Tr					5			35	4	33
Pseudotsuga menziesii	R	1									Tr	11
	M	20	35	20	30	40				25	19	67
Abies amabilis	R	25	15	10	5	5	10	5	25	15	13	100
	M	20	20	25	15	15	45	40	2	15	22	100
Abies procera	R	5	1	2			2				1	44
	M	20	20	35	40	50	25	40	35	35	33	100
Pinus monticola	R						2			1	Tr	22
	M	5	10		5	3		1		Tr	3	67
Tsuga mertensiana	R				1			2	2		1	33
	M			5	1			5	5		2	44
Chamaecyparis nootkatensis	R										0[c]	0
	M								Tr		0	11
Total	R	31	16	12	9	5	16	7	27	18	16	
	M	65	85	85	91	108	75	86	42	110	83	
TALL SHRUB LAYER												
Acer circinatum										1	Tr	11
Vaccinium membranaceum		12	13	35	7	3	5	30	2	11	13	100
Rubus parviflorus						1					Tr	11
Pachistima myrsinites			8								1	11
Ribes lacustre										2	Tr	11
Total		12	21	35	7	4	5	30	2	14	14	
LOW SHRUB LAYER												
Berberis nervosa			2								Tr	11
Rosa gymnocarpa			10			3				1	2	33
Rubus lasiococcus		10		10		1	30	1	4	1	6	78
Symphoricarpos mollis			10	1							1	22
Total		10	22	11	0	4	30	1	4	2	9	
HERB LAYER												
Linnaea borealis		2			1					1	Tr	33
Polystichum munitum			2								Tr	11
Viola sempervirens		1	1		1				2	1	1	56
Galium triflorum			1								Tr	11
Hieracium albiflorum				1			1				Tr	22
Achlys triphylla		10	35		2	5	1	1	25	3	9	89
Chimaphila umbellata			8			1				1	1	33
Chimaphila menziesii		1		1	1		2	1	1	1	1	78
Trillium ovatum		1		1	1	1	1		1	1	1	78
Anemone deltoidea			2	1		1			1		1	44
Anemone lyallii				2					1		Tr	22
Xerophyllum tenax		62	37	85	55	15	5	55	15	26	39	100
Goodyera oblongifolia		1	1				1				Tr	33
Pyrola picta			1	Tr		1				1	Tr	44
Pyrola secunda		1	1	7	1	1	5	1	2	1	2	100
Tiarella unifoliata			10				1		2	3	2	44
Vancouveria hexandra			10		Tr	1				1	1	44
Grasses			8	Tr			2		1		1	44
Carex sp.							1				Tr	11
Luzula intermedia					1		1				Tr	22
Pteridium aquilinum		2							1		Tr	22
Listera caurina									1		Tr	11
Smilacina stellata		10	62			20		1	1		10	56
Streptopus roseus var. *curvipes*								1		1	Tr	22
Asarum caudatum						1					Tr	11
Disporum hookeri			2								Tr	11
Galium oreganum		2	2			1					1	33
Clintonia uniflora		10			1	1	7	3	4	5	3	78
Cornus canadensis					1	1	1	1		7	1	56
Viola glabella			10	1							1	22
Campanula scouleri					1						Tr	11
Corallorhiza mertensiana			1								Tr	11
Arnica latifolia			37							2	4	22
Fragaria vesca var. *bracteata*						1					Tr	11
Mitella sp.			2								Tr	11
Osmorhiza purpurea			10				1				1	22

2.2.2. *Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax* association (continued).

Species	Plot number 1	2	11	76	77	78	81	166	270	Avg. Cover	Constancy
HERB LAYER (continued)											
Pedicularis racemosa									30	3	II
Senecio harfordii					1					Tr	II
Valeriana sitchensis	2				2			1		1	33
Arenaria macrophylla		3	2							1	22
Lathyrus nevadensis		10	1							1	22
Veratrum viride								1		Tr	II
Trisetum cernuum						2				Tr	II
Lupinus sp.	1			Tr						Tr	22
Total	106	248	102	66	54	30	64	59	85	85	
TOTAL UNDERSTORY	159	307	160	82	67	81	102	92	119	124	
TOTAL ALL LAYERS	224	392	245	173	175	156	166	151	229	207	

[a]R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover). [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.

2.3.1. *Abies amabilis/Rhododendron macrophyllum--Vaccinium alaskaense/Cornus canadensis* association--site and general stand characteristics.

Plot No.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax Tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
50	940	30	SE	smooth slope lower 1/3	Frissell	reddish tuffs and breccias	120-150	10-15	sandy loam		50-60	well drained	old growth >300	*Abies*	*Tsuga*	50-60	III
51	910	5	SE	stream terrace	"alluvial soil"	alluvium	150-180	10-15	loam	loam	20-30	moderately well drained	old growth >300	*Abies*	*Tsuga*	40-50	III-
79	1100	20	NE	bench	Limberlost	greenish tuffs and breccias	90-120	5-10	loam	silt loam	0-10	well drained	old growth >300	*Abies*	*Tsuga*	60-70	III-
80	1190	20	SE	smooth slope middle 1/3	Carpenter	andesite colluvium	150-180	10-15	loam	loam	20-30	well drained	old growth >300	*Abies*	*Tsuga*	40-50	IV
96	1040	5	N	bench	Carpenter	andesite colluvium	180-210	10-15	sandy loam		10-20	well drained	old growth >300	*Abies*		60-70	IV+
242	910	40	N	smooth slope lower 1/3	Carpenter	andesite colluvium	210-300	15-20	sandy loam	sandy loam	20-30	well drained	old growth >300	*Tsuga*	*Abies*	70-80	IV
252	760	15	SW	uneven slope lower 1/3	"Brown Podzolic"	andesite colluvium	180-210			silt loam	10-20	well drained	old growth >300	*Tsuga*	*Abies*	60-70	III+
255	1190	2	NE	bench	"Brown Podzolic"	deep, mixed colluvium	120-150			loam	0-10	well drained	old growth >300	*Abies*	*Tsuga*	60-70	III
256	1160	10	N	ridgetop	Carpenter	andesite colluvium	150-180	10-15	sandy loam		20-30	well drained	old growth >300	*Abies*	*Tsuga*	70-80	III-
261	1040	40	N	smooth slope middle 1/3	Carpenter	andesite colluvium	150-180	5-10	sandy loam		50-60	well drained	old growth >300	*Tsuga*	*Abies*	60-70	III-
263	940	5	W	hummocky upland	Carpenter	andesite colluvium	60-90	5-10	sandy loam		40-50	poorly drained	mature 150-300	*Tsuga*	*Abies*	20-30	V

2.3.2. *Abies amabilis/Rhododendron macrophyllum--Vaccinium alaskaense/Cornus canadensis* association--stand table (values in percent).

Species		Plot number 50	51	79	80	96	242	252	255	256	261	263	Avg. Cover	Constancy
TREE LAYER														
Tsuga heterophylla	R[a]	2	1	1	5		1	10			2	10	3	73
	M	45	50	35	45	35	50	40	45	55	50	20	43	100
Pseudotsuga menziesii	R												0[b]	0
	M	35	50	50	35	40	25	50	35	35	40		36	91
Thuja plicata	R										6	10	1	18
	M	10				15	1	15				30	6	45
Abies amabilis	R	5	5	10	10	10	1	10	15	5	1	3	7	100
	M	5	15	2	15	3		2	1			1	4	73
Abies procera	R												0	0
	M		1	1	5	Tr[c]			1	Tr			1	55
Pinus monticola	R												0	0
	M		Tr				Tr			Tr	1	1	Tr	45
Total	R	7	6	11	15	10	2	20	15	5	9	23	11	
	M	95	116	87	100	93	76	107	82	90	91	52	90	
TALL SHRUB LAYER														
Acer circinatum		10	5		3			1			2		2	45
Rhododendron macrophyllum		20	30	45	40	20	20	5	7	65	30	35	29	100
Castanopsis chrysophylla		1					1				1		Tr	27
Taxus brevifolia		10	3				30	15			2	5	6	55
Vaccinium parvifolium		2	1				1	4			5	2	1	55
Vaccinium membranaceum		2		1	2	2		1		1	2		1	64
Vaccinium alaskaense		10	75	7	8	12	8	12	20	8	10	4	16	100
Pachistima myrsinites		2	1				1	4		1	1		1	55
Menziesia ferruginea												2	Tr	9
Total		57	115	53	53	34	61	42	27	75	53	48	56	
LOW SHRUB LAYER														
Berberis nervosa		13	3		3	1	10	10	1	3	8		5	82
Gaultheria shallon												25	2	9
Rosa gymnocarpa										1			Tr	9
Rubus ursinus		1	1	3	1		1	1	2	2	1		1	82
Rubus nivalis		1					1	2					Tr	27
Rubus lasiococcus			1	1	1		1	1	2	1			1	64
Symphoricarpos mollis				1									Tr	9
Gaultheria ovatifolia					2	1					1	2	1	36
Total		15	5	5	7	2	13	14	5	7	10	27	10	
HERB LAYER														
Linnaea borealis		3	5	5	2	1	1	5	5	4	1	2	3	100
Polystichum munitum		1						1					Tr	18
Viola sempervirens		1	1	1	1	1	1	2	1				1	73
Coptis laciniata								5	1		1		1	27
Whipplea modesta		1											Tr	9
Achlys triphylla		1	1	2	1				4	2	1		1	64
Chimaphila umbellata		1	3		5	2	1	4	2	1	1		2	82
Chimaphila menziesii			1	3			1		1	1			1	45
Trillium ovatum			1		1		1						Tr	27
Anemone deltoidea				1					1	1			Tr	27
Anemone oregana									1				Tr	9
Xerophyllum tenax			3		35	8	5			25	5	2	8	64
Adenocaulon bicolor									1				Tr	9
Goodyera oblongifolia		1		1	1	1	1	1				1	1	64
Pyrola picta						Tr							0	9
Pyrola secunda				1					2				Tr	18
Pyrola asarifolia		2	1	1	1	1	1		1	1			1	73
Tiarella unifoliata				1					4	1			1	27
Smilacina racemosa									1				Tr	9
Smilacina stellata			1	1					1				Tr	27
Disporum hookeri			Tr										0	9
Galium oreganum									1				Tr	9
Clintonia uniflora			10	1	1		1	1	2	1	1		2	73
Cornus canadensis		1	20	3	1	2	2	6	5	4	2	1	4	100
Corallorhiza mertensiana			1	1									Tr	18
Total		12	48	22	49	16	15	25	34	41	12	6	26	
TOTAL UNDERSTORY		91	174	91	124	62	91	101	81	128	84	104	103	
TOTAL ALL LAYERS		186	290	178	224	155	167	208	163	218	175	156	193	

[a] R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover).
[b] Zero indicates species occurred in trace amounts only in all sampled stands. [c] Tr = average cover less than 0.5%.

2.4.1. ***Abies amabilis/Vaccinium alaskaense/Cornus canadensis*** association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
54	1010	20	NE	toe slope	Carpenter	andesite colluvium	150-180	10-15	silt loam	silt loam	0-10	well drained	old growth >300	*Abies*	*Tsuga*	60-70	III
55	1040	35	NE	ridgetop	Carpenter	andesite colluvium	180-210	15-20	loam		60-70	moderately well drained	old growth >300	*Abies*	*Tsuga*	40-50	III-
95	1040	10	S	bench	Budworm	greenish tuffs and breccias	150-180	25-38	silt loam	silty clay loam	0-10	moderately well drained	old growth >300	*Abies*	*Tsuga*	60-70	III-
214	1160	30	N	smooth slope upper 1/3	Blue River	andesite	90-120			loam	20-30	well drained	young 100-150	*Abies*	*Tsuga*	80-90	IV+
232	1040	35	NE	uneven slope lower 1/3	Blue River	andesite	90-120			loam	40-50	well drained	old growth >300	*Abies*	*Tsuga*	50-60	III
233	1100	60	NE	smooth slope middle 1/3	Carpenter	andesite colluvium	210-300	5-10	sandy loam	sandy loam	20-30	well drained	old growth >300	*Tsuga*	*Abies*	70-80	III
243	910	15	S	bench	Carpenter	andesite colluvium	180-210	5-10	sandy loam	sandy loam	30-40	well drained	old growth >300	*Abies*	*Tsuga*	60-70	III
297	880	10	N	stream terrace	"alluvial soil"	alluvium	90-120				40-50	well drained	old growth >300	*Tsuga*	*Abies*	60-70	III+

2.4.2. *Abies amabilis/Vaccinium alaskaense/Cornus canadensis* association--stand table (values in percent).

Species		Plot number 54	55	95	214	232	233	243	297	Avg. Cover	Constancy
TREE LAYER											
Tsuga heterophylla	R[a]	3	5	1	2	7	10	5	20	7	100
	M	30	25	35	70	30	40	45	70	43	100
Pseudotsuga menziesii	R									0[b]	0
	M	45	30	45	Tr[c]	25	65	35	20	33	100
Thuja plicata	R									0	0
	M	Tr		25				5	20	6	50
Abies amabilis	R	5	10	10	5	5	5	3	2	6	100
	M	1	15	Tr	30	20	25		1	12	88
Abies procera	R									0	0
	M				5					1	12
Pinus monticola	R									0	0
	M							1		Tr	12
Total	R	8	15	11	7	12	15	8	22	13	
	M	76	70	105	105	75	130	86	111	95	
TALL SHRUB LAYER											
Acer circinatum		3	5		5	5		7	6	4	75
Rhododendron macrophyllum		1	Tr		3					1	38
Castanopsis chrysophylla			1					2		Tr	25
Taxus brevifolia			5	Tr		4	1	3	6	2	75
Cornus nuttallii			2							Tr	12
Vaccinium parvifolium			3	Tr	1		1	1	1	1	75
Vaccinium membranaceum		1	1	1	2	1	1	1		1	88
Vaccinium alaskaense		30	7	3		12	5	12	10	10	88
Acer glabrum var. *douglasii*							1			Tr	12
Pachistima myrsinites			1	Tr		1	1	1		1	62
Total		35	25	4	11	23	10	27	23	20	
LOW SHRUB LAYER											
Berberis nervosa			25		1	3	10	3		5	62
Rosa gymnocarpa								1		Tr	12
Rubus ursinus		1	1	1	1	1	1	1	1	1	100
Rubus nivalis						1			1	Tr	25
Rubus lasiococcus			1	1	1		1	1		1	62
Total		1	27	2	3	5	12	6	2	7	
HERB LAYER											
Linnaea borealis		1	1	3	1	1	1	5	2	2	100
Polystichum munitum			Tr			1	1		3	1	50
Viola sempervirens		1	1	1	1	1	2		1	1	88
Trientalis latifolia					Tr			1		Tr	25
Achlys triphylla		2	2	1		1	3	1	1	1	88
Chimaphila umbellata			7	1	Tr	2	2	2		2	75
Chimaphila menziesii		1		Tr	1		1			Tr	50
Trillium ovatum			1	Tr	1	1	1	1	1	1	88
Anemone deltoides				1	1				1	Tr	38
Anemone oregana				Tr						0	12
Xerophyllum tenax			2			1		2		1	38
Goodyera oblongifolia				1		1		1	1	1	50
Pyrola picta					Tr					0	12
Pyrola secunda		1	1	1	1	1		1		1	75
Pyrola asarifolia						1	1	1	1	1	50
Tiarella unifoliata		3	1	2	1	2	2	1	3	2	100
Vancouveria hexandra							1	1		Tr	25
Pteridium aquilinum					1					Tr	12
Listera caurina							1			Tr	12
Smilacina stellata		1	1			5	2		3	2	62
Streptopus roseus var. *curvipes*				1		1			1	Tr	38
Asarum caudatum									1	Tr	12
Blechnum spicant									3	Tr	12
Disporum hookeri		1				1			2	1	38
Clintonia uniflora		5	3			3		1	1	2	62
Cornus canadensis		10	3	2	1	7	6	7	3	5	100
Corallorhiza mertensiana			1				1		1	Tr	38
Pyrola aphylla							1			Tr	12
Lycopodium clavatum					1					Tr	12
Total		26	23	14	10	30	26	25	29	24	
TOTAL UNDERSTORY		70	90	31	31	70	63	66	76	64	
TOTAL ALL LAYERS		146	160	136	136	145	193	152	187	159	

[a] R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover). [b] Zero indicates species occurred in trace amounts only in all sampled stands. [c] Tr = average cover less than 0.5%.

2.5.1. *Abies procera/Achlys triphylla* community--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
73	1340	30	NW	ridgetop	ND	ND	ND	ND	ND	ND	ND	ND	young 100-150	*Abies amabilis*	*Tsuga heterophylla*	50-60	IV
163	1340	30	SW	smooth slope middle 1/3	Wildcat	volcanic ash and pumice	120-150			sandy loam	20-30	well drained	young 100-150	*Abies amabilis*	*Tsuga mertensiana*	50-60	III
164	1370	60	S	smooth slope middle 1/3	Wildcat	volcanic ash and pumice	90-120			sandy loam	60-70	well drained	young 100-150	*Abies amabilis*		60-70	III
167	1430	20	NW	bench	Wildcat	volcanic ash and pumice	90-120			loam	30-40	well drained	mature 150-300	*Abies amabilis*		20-30	III
190	1430	50	S	smooth slope middle 1/3	Wildcat	volcanic ash and pumice	90-120			loam	20-30	well drained	young 100-150	*Abies amabilis*	*Abies grandis*	50-60	IV
275	1280	50	S	smooth slope upper 1/3	Wildcat	volcanic ash and pumice	120-150			sandy loam	30-40	well drained	young 100-150	*Abies amabilis*	*Tsuga heterophylla*	20-30	III

2.5.2. *Abies procera/Achlys triphylla* community--stand table (values in percent).

Species		Plot number 73	163	164	167	190	275	Avg. cover	Constancy
TREE LAYER									
Tsuga heterophylla	R[a]	2					2	1	33
	M	1						Tr[b]	17
Pseudotsuga menziesii	R							0[c]	0
	M	40	10	45		10	20	21	83
Abies grandis	R	1				2		1	33
	M							0	0
Abies amabilis	R	5	3	2	20	3	5	6	100
	M	1		5	1			1	50
Abies procera	R	3				1	5	2	50
	M	25	70	40	25	75	35	45	100
Pinus monticola	R							0	0
	M	2	2					1	33
Tsuga mertensiana	R		3					1	17
	M		5	1	3			2	50
Total	R	11	6	2	20	6	12	11	
	M	69	87	91	29	85	55	70	
TALL SHRUB LAYER									
Acer circinatum		10	20	12			40	14	67
Rhododendron macrophyllum		1						Tr	17
Castanopsis chrysophylla							2	Tr	17
Vaccinium membranaceum		3	7	3	3	1	3	3	100
Acer glabrum var. *douglasii*				1				Tr	17
Rubus parviflorus				1		1	2	1	50
Amelanchier alnifolia			1	1			1	1	50
Pachistima myrsinites			1	2		1		1	50
Ribes viscosissimum var. *hallii*					1		Tr	Tr	33
Sorbus sitchensis							1	Tr	17
Ceanothus velutinus							1	Tr	17
Total		14	29	20	4	3	50	20	
LOW SHRUB LAYER									
Rosa gymnocarpa		3	1			1		1	50
Rubus ursinus		1				2	1	1	50
Rubus lasicococcus		2	2	2	20			4	67
Symphoricarpos mollis		2				2		1	33
Total		8	3	2	20	5	1	7	
HERB LAYER									
Linnaea borealis		5						1	17
Polystichum munitum				1	1			Tr	33
Viola sempervirens		1	1		3		2	1	67
Trientalis latifolia						1	1	Tr	33
Galium triflorum					1	1		Tr	33
Hieracium albiflorum					1	1		Tr	33
Achlys triphylla		16	10	6	35	5	3	12	100
Chimaphila umbellata		5		1			7	2	50
Chimaphila menziesii		1	2	1		1		1	67
Trillium ovatum			1	1	1	1		1	67
Anemone deltoidea		1		1	2	1		1	67
Anemone lyalli				1	5			1	33
Anemone oregana						1	1	Tr	33
Xerophyllum tenax		3	3					1	33
Adenocaulon bicolor						1		Tr	17
Goodyera oblongifolia		1	1	1				1	50
Pyrola picta		1		1	1	1	1	1	83
Pyrola secunda		1	5	2	1	1	1	2	100
Tiarella unifoliata					3			1	17
Vancouveria hexandra						1		Tr	17
Grasses		1	1					Tr	33
Carex sp.						1		Tr	17
Pteridium aquilinum		2	5	2		1	20	5	83
Listera caurina		1		1	1			1	50
Smilacina racemosa				1				Tr	17
Smilacina stellata		6	35	20	5	20	5	15	100
Asarum caudatum						1	1	Tr	33
Athyrium filix-femina					1			Tr	17
Galium oreganum			2	1	2	1	30	6	83
Clintonia uniflora		2	10	3	3	1		3	83
Cornus canadensis		1						Tr	17
Viola glabella			1	1	2	1		1	67
Campanula scouleri				2		1		1	33
Corallorhiza mertensiana				1				Tr	17

2.5.2. *Abies procera/Achlys triphylla* community (continued).

Species	Plot number 73	163	164	167	190	275	Avg. cover	Constancy
HERB LAYER (continued)								
Arnica latifolia				5			1	17
Fragaria vesca var. *bracteata*					1	1	Tr	33
Mitella sp.				5	1		1	33
Osmorhiza purpurea				2	1		1	33
Pedicularis racemosa	5				1		1	33
Valeriana sitchensis				1			Tr	17
Veratrum viride				1			Tr	17
Trisetum cernuum				5			1	17
Aralia californica			2		1		1	33
Lupinus sp.						1	Tr	17
Senecio triangularis				8			1	17
Total	53	77	50	95	48	74	65	
TOTAL UNDERSTORY	86	115	74	139	62	137	103	
TOTAL ALL LAYERS	155	202	165	168	147	192	173	

[a]R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover). [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.

2.6.1. *Abies amabilis/Achlys triphylla* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
12	1370	15	SE	bench	Lucky Boy	andesite	60-90	10-15	loam		30-40	moderately well drained	old growth >300	*Abies amabilis*		20-30	IV
13	1340	60	SW	smooth slope upper 1/3	Blue River	andesite	60-90	3-5	loam	sandy loam	50-60	well drained	old growth >300	*Abies amabilis*		50-60	IV+
72	1250	10	NW	ridgetop	ND	ND	ND	ND	ND	ND	ND	ND	young 100-150	*Abies amabilis*	*Tsuga*	70-80	IV
74	1220	25	S	uneven slope middle 1/3	"mixed colluvium"	deep, mixed colluvium	180-210	5-10	silt loam	silt loam	0-10	well drained	old growth >300	*Abies amabilis*	*Tsuga*	60-70	III
102	1400	15	SE	smooth slope lower 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young with old growth	*Abies amabilis*	*Tsuga*	30-40	III
129	1220	20	S	smooth slope middle 1/3	Carpenter	andesite colluvium	180-210	15-20	sandy loam	loam	10-20	well drained	old growth >300	*Abies amabilis*	*Tsuga*	60-70	IV+
183	1220	30	W	uneven slope middle 1/3	Carpenter	andesite colluvium	150-180	10-15	sandy loam		40-50	well drained	old growth >300	*Abies amabilis*	*Tsuga*	60-70	III-
184	1250	60	W	ridgetop	Carpenter	andesite colluvium	120-150	10-15	sandy loam		50-60	well drained	old growth >300	*Abies amabilis*	*Tsuga*	30-40	IV
185	1370	70	W	smooth slope upper 1/3	Blue River	volcanic ash and pumice	90-120			silt loam	20-30	well drained	old growth >300	*Abies amabilis*	*Tsuga*	60-70	IV
186	1370	70	SW	smooth slope upper 1/3	Blue River	volcanic ash and pumice	90-120			silt loam	20-30	well drained	young 100-150	*Abies amabilis*	*Abies grandis*	70-80	IV
191	1400	45	S	smooth slope middle 1/3	Carpenter	andesite colluvium	150-180	5-10	loam		30-40	well drained	mature 150-300	*Abies grandis*	*Abies amabilis*	60-70	III-
213	1190	20	S	smooth slope middle 1/3	Blue River	andesite	60-90			sandy loam	30-40	well drained	young 100-150	*Tsuga*	*Abies amabilis*	60-70	IV
269	1280	50	NW	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young 100-150	*Abies amabilis*	*Tsuga*	70-80	IV

2.6.2. *Abies amabilis/Achlys triphylla* association--stand table (values in percent).

Species		Plot number 12	13	72	74	102	129	183	184	185	186	191	213	269	Avg. Cover	Constancy
TREE LAYER																
Tsuga heterophylla	R[a]		3	5	3	2	2	2	3	5	1		5	3	3	85
	M			5	15	10	55	70	70						17	46
Pseudotsuga menziesii	R														0[b]	0
	M	20	40	55	50	25	55	50	30	75	80	80	80	50	53	100
Thuja plicata	R								1					1	Tr[c]	15
	M														0	0
Abies grandis	R		2							1	5	5	1		1	38
	M		10			25									3	15
Abies amabilis	R	10	5	5	10	8	10	35	13	50	2	Tr	2	5	12	100
	M	35		Tr	10	20	1	1	3	5		Tr			6	69
Abies procera	R	2	2									30	1	1	3	38
	M	15	25	8						1		20	1	1	5	54
Pinus montiocla	R														0	0
	M	1		20	Tr	10								5	3	38
Picea engelmannii	R														0	0
	M					5									Tr	8
Total	R	12	12	10	13	10	12	37	17	56	8	35	9	10	19	
	M	71	75	88	75	95	111	121	103	81	80	100	81	56	87	
TALL SHRUB LAYER																
Acer circinatum			10	8		1			2	2	1	1	10	5	3	69
Rhododendron macrophyllum					10										1	8
Castanopsis chrysophylla						1			1						Tr	15
Cornus nuttallii													1		Tr	8
Corylus cornuta var. *californica*											2				Tr	8
Holodiscus discolor			10	1							1				1	23
Vaccinium parvifolium													1		Tr	8
Vaccinium membranaceum		3	15	5	3	3	2	1	1		1		2	2	3	85
Oplopanax horridum		Tr													0	8
Rubus parviflorus													1		Tr	8
Rubus spectabilis		6													Tr	8
Amelanchier alnifolia														1	Tr	8
Pachistima myrsinites			1					1	1	1	1	Tr		10	1	54
Alnus sinuata		Tr													0	8
Ribes lacustre		Tr		1	1					1	3				Tr	38
Total		9	36	15	14	5	2	2	5	4	9	1	15	18	9	
LOW SHRUB LAYER																
Berberis nervosa					1			5	7	1		10	1	15	3	54
Rosa gymnocarpa			9	1					1	1	1	1	3	2	1	62
Rubus ursinus			1	1	1		2	1	1	1	1	2	1	7	1	85
Rubus lasiococcus		9		5	2	2	1						1		2	46
Symphoricarpos mollis			8	1					2	2	2		5	10	2	54
Total		9	18	8	4	2	3	6	11	5	4	13	11	34	9	
HERB LAYER																
Linnaea borealis				2	3		7	4	1	3	2	35	5	4	5	77
Polystichum munitum		1	1	Tr				1	1	1	7	1		2	1	69
Viola sempervirens			1	1	4	1	1	3	3			1	3	40	4	77
Trientalis latifolia					1				1	1	1	2		2	1	46
Coptis laciniata							5								Tr	8
Galium triflorum			7		1				1	1	3	1		5	1	54
Hieracium albiflorum			2			1			1	1		1	1	2	1	54
Synthyris reniformis										5				1	Tr	15
Achlys triphylla		30	30	10	10	2	2	2	10	30	10	25	12	10	14	100
Chimaphila umbellata			7	1	3	5	3	3	8	1		1	1	25	4	85
Chimaphila menziesii			1	1	1	1	1	1		1		1	1	1	1	77
Trillium ovatum		1		1		1	1				1	1	1		1	54
Anemone deltoidea		7	8		1	2		1	1	1		2	1		2	69
Anemone oregana					1	1									Tr	15
Xerophyllum tenax			10	10		1							2		2	31
Adenocaulon bicolor				1	2			1	8	5	10	3	1		2	62
Goodyera oblongifolia			1	1	1	1	1				1		1	1	1	62
Pyrola picta			1	1	1	1	1	1	1	1		Tr		1	1	77
Pyrola secunda			1	2		3	1	1			1		1	1	1	62
Tiarella unifoliata		1	9	8	5	2	1	1	4	5	25	2			5	85
Tiarella trifoliata										1					Tr	8
Vancouveria hexandra			Tr	1				1	2	1		1	1	1	1	62
Bromus sp.			8						1	1			1		1	31
Festuca occidentalis												1	1		Tr	15
Melica subulata													1		Tr	8
Grasses		7			1	1								3	1	31
Carex sp.		10	7			1									1	23
Luzula intermedia		1								1	1				Tr	23
Pteridium aquilinum		65	12	2		2							15	1	7	46
Listera caurina			Tr	1	1	1					1		1	1	Tr	54
Smilacina stellata			9	2	1	2	1	1	2	1	4		1	1	2	85
Streptopus roseus var. *curvipes*		9													1	8

2.6.2. *Abies amabilis/Achlys triphylla* association (continued).

Species	Plot number 12	13	72	74	102	129	183	184	185	186	191	213	269	Avg. Cover	Constancy
HERB LAYER (continued)															
Asarum caudatum	2			1	Tr	1	1	1	1	50	2	1	1	5	85
Athyrium filix-femina	9													1	8
Disporum hookeri			1		1				1					Tr	23
Galium oreganum	2	8			1				1	3		1	2	1	54
Montia sibirica	1							1	1	5				1	31
Dicentra formosa	8							1						1	15
Clintonia uniflora	10		2	1	10		1	3	1	2	1			2	69
Cornus canadensis			10	1	1	10	2					3		2	46
Viola glabella	30	10	1		1				1	3	1		1	4	62
Campanula scouleri		1					1	1	1	2	1			1	46
Corallorhiza mertensiana					1		1	1	1				1	Tr	38
Corallorhiza maculata											1			Tr	8
Arnica latifolia									3					Tr	8
Fragaria vesca var. *bracteata*		1								2		1	1	Tr	38
Mitella sp.	35													3	8
Nemophila parviflora										3				Tr	8
Osmorhiza purpurea		1	Tr		1			1	1	7	1	1		1	62
Pedicularis racemosa			10					1				1		1	23
Senecio harfordii								1	1	1				Tr	23
Arenaria macrophylla		7									1			1	15
Lathyrus nevadensis		9												1	8
Actaea arguta										2	1			Tr	15
Lilium columbianum		Tr												0	8
Veratrum viride	1													Tr	8
Stachys palustris										5	1			Tr	15
Trisetum cernuum								2	1	3	1		1	1	38
Aralia californica								1		4				Tr	15
Senecio triangularis	9													1	8
Total	241	154	70	40	45	36	27	59	75	159	89	59	109	88	
TOTAL UNDERSTORY	271	220	103	71	62	53	72	92	140	180	138	94	171	125	
TOTAL ALL LAYERS	342	295	191	146	157	164	193	195	221	260	238	175	227	212	

[a] R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover).
[b] Zero indicates species occurred in trace amounts only in all sampled stands. [c] Tr = average cover less than 0.5%.

2.7.1. *Abies procera/Clintonia uniflora* community--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
82	1310	20	N	uneven slope middle 1/3	Blue River	andesite	90-120	10-15	loam	silt loam	30-40	well drained	young 100-150	*Abies*	*Tsuga*	20-30	III
161	1280	15	SW	bench	Wildcat	volcanic ash and pumice	120-150			loam	30-40	well drained	young 100-150	*Abies*		70-80	II-
162	1310	20	SW	smooth slope middle 1/3	Wildcat	volcanic ash and pumice	120-150			loam	30-40	well drained	young 100-150	*Abies*		60-70	II
267	1280	25	NW	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young 100-150	*Abies*	*Tsuga*	70-80	IV
268	1280	35	N	smooth slope middle 1/3	ND	ND	ND	ND	ND	ND	ND	ND	young 100-150	*Abies*	*Tsuga*	30-40	IV
273	1250	15	W	hummocky upland	Wildcat	volcanic ash and pumice	180-210			loam	0-10	well drained	young 100-150	*Abies*		70-80	II
274	1280	3	S	ridgetop	Wildcat	volcanic ash and pumice	120-150			loam	20-30	well drained	young 100-150	*Abies*	*Tsuga*	70-80	III-

2.7.2. *Abies procera/Clintonia uniflora* community--stand table (values in percent).

Species		Plot number 82	161	162	267	268	273	274	Avg. Cover	Constancy
TREE LAYER										
Tsuga heterophylla	R[a]	2	1		1	2	Tr	1	1	86
	M				10	20			3	29
Pseudotsuga menziesii	R				1		1		Tr[b]	29
	M		10	25	10	35	15	1	14	86
Abies amabilis	R	5	5	2	10	5	3	5	5	100
	M	30	Tr	1	15	15	Tr	5	9	100
Abies procera	R	4	1		2	1	2		1	71
	M	50	50	60	50	40	70	50	53	100
Pinus monticola	R							1	Tr	14
	M			2	Tr	30		1	5	57
Tsuga mertensiana	R		1						Tr	14
	M			5				2	1	29
Pinus contorta	R								0[c]	0
	M				2				Tr	14
Total	R	11	8	2	14	8	6	7	7	
	M	80	60	93	87	140	85	59	85	
TALL SHRUB LAYER										
Acer circinatum					1		1	10	2	43
Rhododendron macrophyllum					Tr				0	14
Vaccinium parvifolium								1	Tr	14
Vaccinium membranaceum		3	7	5	6	5	12	5	6	100
Vaccinium alaskaense							Tr		0	14
Rubus parviflorus						1			Tr	14
Amelanchier alnifolia			Tr	1					Tr	29
Ribes lacustre		1	Tr			1			Tr	43
Sorbus sitchensis			1	2			Tr	1	1	57
Total		4	8	8	7	7	13	17	9	
LOW SHRUB LAYER										
Berberis nervosa					Tr				0	14
Rosa gymnocarpa			Tr		2	2	Tr		1	57
Rubus ursinus			Tr		4	1	Tr		1	57
Rubus lasiococcus		1	7	3	1	1	1	20	5	100
Symphoricarpos mollis					6				1	14
Total		1	7	3	13	4	1	20	8	
HERB LAYER										
Linnaea borealis					3	10			2	29
Polystichum munitum			Tr			1	2		Tr	43
Viola sempervirens		1	3	1	17	20	2	3	7	100
Trientalis latifolia			Tr		1		1		Tr	43
Galium triflorum					1			1	Tr	29
Hieracium albiflorum		1	Tr		1	1	1	1	1	86
Achlys triphylla		15	8	7	6	3	9	4	7	100
Chimaphila umbellata			1	1	1	1	1	2	1	86
Chimaphila menziesii		1	1	3	1	1	1	1	1	100
Trillium ovatum		1	1	1		1	1	1	1	86
Anemone deltoidea		1	1	1	1	1	1	3	1	100
Anemone lyallii			1						Tr	14
Anemone oregana		1			1		Tr		Tr	43
Xerophyllum tenax		1	1	2					1	57
Adenocaulon bicolor							Tr		0	14
Goodyera oblongifolia		1	2	1			Tr	1	1	71
Pyrola picta		1	1	1	1	1	1	2	1	100
Pyrola secunda		1	1	2	3	2	6	3	3	100
Pyrola asarifolia						1			Tr	14
Tiarella unifoliata		3	1			5	7	3	3	71
Vancouveria hexandra		2			4	5			2	43
Grasses			1					2	Tr	29
Luzula intermedia		1					Tr		Tr	29
Pteridium aquilinum		12	2	1	Tr		15	4	5	86
Listera caurina		1	1	1	1	1	1	1	1	100
Smilacina stellata							1		Tr	14
Streptopus roseus var. *curvipes*		1							Tr	14
Asarum caudatum			Tr				1	Tr	Tr	43
Disporum hookeri			Tr						0	14
Galium oreganum		1	3	1	2	5	4	3	3	100
Montia sibirica		1							Tr	14
Dicentra formosa		1							Tr	14
Clintonia uniflora		2	12	3	1	3	12	30	9	100
Cornus canadensis		1	1		9	60	2		10	71
Viola glabella		1	1	1	1		2	1	1	86

2.7.2. *Abies procera/Clintonia uniflora* community (continued).

Species	Plot number 82	161	162	267	268	273	274	Avg. Cover	Constancy
HERB LAYER (continued)									
Campanula scouleri	1	1		7	2			2	57
Corallorhiza mertensiana							1	Tr	14
Arnica latifolia	1			1	15			2	43
Fragaria vesca var. *bracteata*				1			2	Tr	29
Osmorhiza purpurea	1	Tr				1	2	1	57
Senecio harfordii				6	2			1	29
Valeriana sitchensis	1							Tr	14
Lilium columbianum						1		Tr	14
Veratrum viride			1			1	1	Tr	43
Trisetum cernuum	1			1		1		Tr	43
Pterospora andromedea		Tr						0	14
Hypopitys monotropa		Tr						0	14
Aster ledophyllus		Tr						0	14
Senecio triangularis							1	Tr	14
Total	57	44	28	71	141	75	73	67	
TOTAL UNDERSTORY	73	67	41	167	160	95	117	91	
TOTAL ALL LAYERS	153	127	134	254	300	180	176	176	

[a]R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover. [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.

2.8.1. *Abies amabilis/Tiarella unifoliata* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
14	1280	50	NW	smooth slope lower 1/3	Blue River	andesite	60-90	5-10	loam	loam	40-50	well drained	old growth >300	*Abies*		60-70	III+
52	1190	15	NW	uneven slope lower 1/3	Carpenter	andesite colluvium	120-150	10-15	silt loam	silt loam	30-40	moderately well drained	old growth >300	*Abies*	*Tsuga*	40-50	II-
53	1010	10	NW	toe slope	Carpenter	andesite colluvium	120-150	10-15	silt loam	silty clay loam	40-50	well drained	old growth >300	*Abies*	*Tsuga*	40-50	II
75	1160	10	SW	bench	"mixed colluvium"	deep, fine colluvium	90-120	5-10	silt loam	silt loam	10-20	moderately well drained	old growth >300	*Abies*	*Tsuga*	70-80	III+
83	1220	35	NE	uneven slope middle 1/3	Blue River	andesite	90-120	10-15	sandy loam	sandy loam	30-40	well drained	old growth >300	*Abies*		60-70	III+
182	1190	25	W	uneven slope middle 1/3	Blue River	volcanic ash and pumice	90-120	10-15	silt loam	silt loam	20-30	well drained	old growth >300	*Abies*	*Tsuga*	70-80	IV+
215	1070	25	N	uneven slope upper 1/3	Blue River	andesite	60-90			silt loam	20-30	well drained	old growth >300	*Abies*	*Tsuga*	60-70	III
238	1190	40	N	smooth slope middle 1/3	Tidbits	andesite colluvium	150-180	25-38	silt loam	silt loam	30-40	well drained	old growth >300	*Abies*	*Tsuga*	60-70	III
254	1220	20	SW	hummocky upland	"mixed colluvium"	pyroclastic colluvium	210-300	38-51	loam	silt loam	0-10	moderately well drained	old growth >300	*Abies*		40-50	III+
262	1220	55	W	smooth slope upper 1/3	"mixed colluvium"	pyroclastic colluvium	150-180	38-51	silt loam	silt loam	30-40	well drained	old growth >300	*Abies*	*Tsuga*	60-70	II
265	1010	0		stream terrace	ND	ND	ND	ND	ND	ND	ND	ND	old growth >300	*Abies*	*Tsuga*	70-80	III+
266	1160	0		hummocky upland	ND	ND	ND	ND	ND	ND	ND	ND	old growth >300	*Abies*	*Tsuga*	70-80	III

2.8.2. *Abies amabilis/Tiarella unifoliata* association--stand table (value in percent).

Species		Plot number 14	52	53	75	83	182	215	238	254	262	265	266	Avg. Cover	Constancy
TREE LAYER															
Tsuga heterophylla	R[a]	2	5	4	2	1	3	2	10	20	6	3	3	5	100
	M	10	25	25	40		70	70	1	15	70	1	15	28	92
Pseudotsuga menziesii	R												1	Tr[b]	8
	M	35	35	35	35	40	30	75	50	35	20	1	50	37	100
Thuja plicata	R													0[c]	0
	M			5										Tr	8
Abies grandis	R													0	0
	M											1		Tr	8
Abies amabilis	R	10	10	8	10	5	10	3	15	10	3	5	10	8	100
	M	20	20	10	15	15	2	2	25	1	1	35	25	14	100
Abies procera	R													0	0
	M	40			10	2				1	5	1	1	5	58
Pinus monticola	R													0	0
	M	1			Tr	25							1	2	33
Picea engelmannii	R													0	0
	M											35		3	8
Total	R	12	15	12	12	6	13	5	25	30	9	8	14	13	
	M	106	80	75	100	82	102	147	76	52	96	74	92	89	
TALL SHRUB LAYER															
Acer circinatum		3	18	7	5		1	3		15	5			5	67
Rhododendron macrophyllum								1		1	2			Tr	25
Taxus brevifolia								2		1		Tr		Tr	25
Vaccinium parvifolium			Tr	1						2				Tr	25
Vaccinium membranaceum		12		1	1	2		1	1	5	5	6	18	4	83
Vaccinium alaskaense				3				1			10	2	6	2	42
Oplopanax horridum			5	2				5	1		2	2		1	50
Rubus spectabilis									1			2		Tr	17
Pachistima myrsinites										2				Tr	8
Ribes lacustre						2			1		1	4		1	33
Total		15	23	14	6	4	1	13	4	26	25	16	24	13	
LOW SHRUB LAYER															
Berberis nervosa										10				1	8
Rosa gymnocarpa				1	1	1	1			1				Tr	42
Rubus ursinus			2	2	1	2	2	1		2			2	1	67
Rubus nivalis							1	1						Tr	17
Rubus lasiococcus		10			1	2		1	1	2		2	1	2	67
Symphoricarpos mollis										1				Tr	8
Gaultheria ovatifolia										2				Tr	8
Total		10	2	3	3	5	4	3	1	18		2	3	4	
HERB LAYER															
Linnaea borealis				1	2		1	1		3				1	42
Polystichum munitum		1	1	3	Tr	1	1	2	1		1		1	1	83
Viola sempervirens		2	2	3	3	1	5	2		4		Tr	1	2	83
Trientalis latifolia							1		1					Tr	17
Coptis laciniata								3		3	2			1	25
Galium triflorum			1			1	1		1					Tr	33
Hieracium albiflorum		1												Tr	8
Achlys triphylla		60	5	3	2	20	2	1	5	5	5	9	13	11	100
Chimaphila umbellata		1		1				1		6			Tr	1	42
Chimaphila menziesii		1			1	1	1	1	1			Tr	1	1	67
Trillium ovatum		1	1		1	1		1	1			1	1	1	67
Anemone deltoidea			2	1	1	1	1			1		3	1	1	67
Anemone lyallii		1												Tr	8
Anemone oregana													1	Tr	8
Xerophyllum tenax		2								2			Tr	Tr	25
Adenocaulon bicolor			1	2					1	1		2	3	1	50
Goodyera oblongifolia		1	1	1	1	1		1		1			1	1	67
Pyrola picta		1			1		1			1				Tr	33
Pyrola secunda		1	2	1	1	1	1			1			1	1	67
Tiarella unifoliata		30	10	20	15	2	10	10	10	1	3	25	6	12	100
Tiarella trifoliata							1							Tr	8
Vancouveria hexandra		8	1	10	1	3		1	2		2			2	67
Melica subulata									1					Tr	8
Grasses		2												Tr	8
Luzula intermedia									1					Tr	8
Pteridium aquilinum		10				8							6	2	25
Oxalis oregana											50			4	8
Listera caurina		1	1	1		1			1				1	1	50
Smilacina racemosa												1		Tr	8
Smilacina stellata		7	1	5	1	2	2	5	8		12	28	11	7	92
Streptopus roseus var. *curvipes*		8	7	15		2						12	6	4	50
Asarum caudatum			5	1	1	1	4	2	1			Tr		1	67
Athyrium filix-femina			2	Tr			1	Tr	1		1	2	2	1	67
Disporum hookeri			1	1				1	1	1	3	1	1	1	67
Galium oreganum		1				1						2	1	Tr	33
Montia sibirica							1		3		3			1	25
Dicentra formosa									1					Tr	8
Clintonia uniflora		30	7			5	1		5	2		28	27	9	67

2.8.2. *Abies amabilis/Tiarella unifoliata* association (continued).

Species	Plot number 14	52	53	75	83	182	215	238	254	262	265	266	Avg. Cover	Constancy
HERB LAYER (continued)														
Cornus canadensis	35	7	20	1	15	7	15	15	5	2	6	9	11	100
Viola glabella		1			1							1	Tr	25
Campanula scouleri					1			3					Tr	17
Corallorhiza mertensiana	1	1		1		1	1						Tr	42
Arnica latifolia	8												1	8
Osmorhiza purpurea											1		Tr	8
Pedicularis racemosa	1												Tr	8
Senecio harfordii								1					Tr	8
Actaea arguta								1			Tr		Tr	17
Veratrum viride											Tr		0	8
Trisetum cernuum					1								Tr	8
Total	215	60	89	33	71	43	48	66	37	84	121	95	80	
TOTAL UNDERSTORY	252	100	118	54	86	61	69	96	111	118	147	136	110	
TOTAL ALL LAYERS	358	180	193	154	168	163	216	172	163	214	221	228	199	

[a]R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover). [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.

2.9.1. *Chamaecyparis nootkatensis/Oplopanax horridum* association--site and general stand characteristics.

Plot no.	Elev. (m)	Slope (%)	Aspect	Landform	Soil series	Parent material	Eff. rooting depth (cm)	A-horizon thickness (cm)	Texture of A horizon	Texture of B horizon	Profile stoniness (% by vol)	Soil drainage	Stand age (years)	Climax tree species A	Climax tree species B	Tree canopy density (%)	Est. site class
222	1370	50	NW	smooth slope upper 1/3	Blue River	andesite	60-90			loam	40-50	well drained	young 100-150	*Abies amabilis*	*Chamaecyparis*	30-40	V
223	1280	70	N	smooth slope upper 1/3	Tidbits	andesite colluvium	120-150	25-38	silt loam	silt loam	50-60	well drained	old growth >300	*Abies amabilis*	*Tsuga*	60-70	IV
224	1160	55	N	smooth slope middle 1/3	Tidbits	andesite colluvium	120-150	10-15	silt loam	loam	30-40	well drained	old growth >300	*Abies amabilis*	*Thuja*	60-70	IV
234	1160	40	NE	smooth slope middle 1/3	Carpenter	andesite colluvium	150-180	5-10	loam	loam	60-70	well drained	old growth >300	*Abies amabilis*	*Tsuga*	80-90	IV+
235	1190	50	NE	uneven slope middle 1/3	Tidbits	andesite colluvium	150-180	5-10	loam	loam	10-20	well drained	old growth >300	*Abies amabilis*	*Chamaecyparis*	40-50	V
236	1220	80	NE	smooth slope middle 1/3	Tidbits	andesite colluvium	150-180	5-10	loam	loam	30-40	well drained	old growth >300	*Abies amabilis*	*Chamaecyparis*	60-70	V
237	1250	40	N	ridgetop	Tidbits	andesite colluvium	150-180	5-10	loam	loam	20-30	well drained	old growth >300	*Abies amabilis*	*Tsuga*	70-80	V

2.9.2. *Chamaecyparis nootkatensis/Oplopanax horridum* association--stand table (values in percent).

Species		Plot number 222	223	224	234	235	236	237	Avg. cover	Constancy
TREE LAYER										
Tsuga heterophylla	R[a]	3	5	1	5	2		5	3	86
	M	10	5		75	Tr[b]			2	57
Pseudotsuga menziesii	R								0[c]	0
	M	Tr	70	60	10		Tr		20	71
Thuja plicata	R			2					Tr	14
	M			25				10	5	29
Abies amabilis	R	15	5	1	25	5	8	10	10	100
	M	45	25	2		3	15	20	16	86
Abies procera	R								0	0
	M				Tr				0	14
Chamaecyparis nootkatensis	R	7			2	5	5	1	3	71
	M	33				40	45	80	28	57
Total	R	25	10	4	32	12	13	16	16	
	M	88	100	87	85	43	60	110	71	
TALL SHRUB LAYER										
Acer circinatum			5	90		15	2	2	16	71
Rhododendron macrophyllum		7							1	14
Taxus brevifolia		1							Tr	14
Vaccinium membranaceum		3			1		1	1	1	57
Vaccinium alaskaense					Tr				0	14
Oplopanax horridum		2	2	5	1	50	30	2	13	100
Acer glabrum var. *douglasii*						1			Tr	14
Rubus spectabilis		2	1	1		1	1		1	71
Ribes lacustre		3		1	1	2	2	1	1	86
Total		18	8	97	3	69	36	6	33	
LOW SHRUB LAYER										
Berberis nervosa			1		2				Tr	29
Rosa gymnocarpa			1						Tr	14
Rubus ursinus					1				Tr	14
Rubus lasiococcus		10	2				1		2	43
Total		10	4		3		1		2	
HERB LAYER										
Linnaea borealis		1	1		1				Tr	43
Polystichum munitum		1	2	5	2	2	3	1	2	100
Viola sempervirens			1	1	2				1	43
Galium triflorum		1	1	1	1		1		1	57
Achlys triphylla		5	10		1	2	2	3	3	86
Chimaphila umbellata					1				Tr	14
Chimaphila menziesii		1	1		1				Tr	43
Trillium ovatum		1	1		1	1	1	1	1	86
Anemone deltoidea			1	1		1	1	1	1	71
Xerophyllum tenax		1							Tr	14
Adenocaulon bicolor			1	1	1	1			1	57
Goodyera oblongifolia		1							Tr	14
Pyrola picta		1			1		1		Tr	43
Pyrola secunda		1			1				Tr	29
Tiarella unifoliata		5	10	2	3	5	15	4	6	100
Vancouveria hexandra			2	1	1		8		2	57
Bromus sp.							1		Tr	14
Melica subulata						1	1	1	Tr	43
Luzula intermedia		1					1		Tr	29
Smilacina racemosa							1	1	Tr	29
Smilacina stellata		1	7	5	2	5	20	20	9	100
Streptopus roseus var. *curvipes*		1					1		Tr	29
Asarum caudatum			1	10	1	8	3	1	3	86
Athyrium filix-femina		1		1		7	8	2	3	71
Disporum hookeri			1		1	1	2		1	57
Galium oreganum			1			1	1		1	43
Montia sibirica		1		1		20	8	40	10	71
Dicentra formosa						2	2	2	1	43
Circaea alpina				1		10	4	8	3	57
Clintonia uniflora		5			1		2	1	1	57
Cornus canadensis		3	15		8		1	6	5	71
Viola glabella							1		Tr	14

2.9.2. *Chamaecyparis nootkatensis/Oplopanax horridum* association (continued).

Species	Plot number 222	223	224	234	235	236	237	Avg. cover	Constancy
HERB LAYER (continued)									
Campanula scouleri		1	1					Tr	29
Corallorhiza mertensiana		1		1				Tr	29
Osmorhiza purpurea	1	1			1	2	1	1	71
Senecio harfordii		1				1	1	Tr	43
Actaea arguta					3	2	1	1	43
Hydrophyllum sp.					15	5	2	3	43
Tolmiea menziesii					10	3	1	2	43
Trisetum cernuum		2			1	1		1	43
Dryopteris austriaca						1		Tr	14
Total	33	62	31	31	97	104	98	63	
TOTAL UNDERSTORY	86	84	132	69	178	154	120	114	
TOTAL ALL LAYERS	174	184	219	154	221	214	230	185	

[a]R = trees in the reproduction size class (seedlings and saplings); M = trees in the mature size class (crowns contribute to overstory tree cover). [b]Tr = average cover less than 0.5%. [c]Zero indicates species occurred in trace amounts only in all sampled stands.