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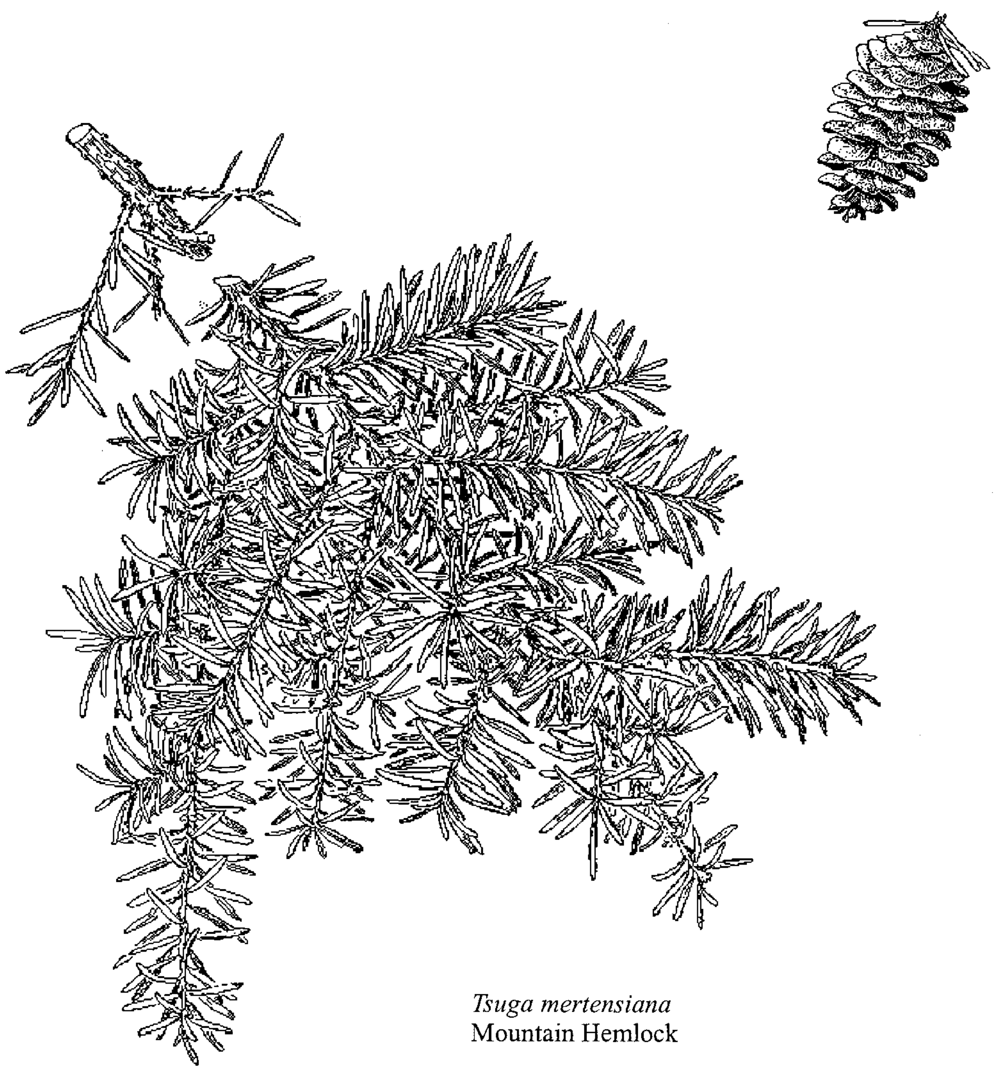
Plant Association and Management Guide for the Mountain Hemlock Zone

Gifford Pinchot and Mt. Hood National Forests



Tsuga mertensiana
Mountain Hemlock

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Plant Association and Management Guide for the Mountain Hemlock Zone

Gifford Pinchot and Mt. Hood National Forests

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INTRODUCTION

INTRODUCTION

The forest ecosystem is a mosaic of environments, each having a particular set of characteristics and processes that shape the communities of animals and plants that occur there, and circumscribe the opportunities and limitations for land management. In the Cascades of southwestern Washington and northwestern Oregon, environments can be stratified into broad ecological "zones" based on dominant potential natural vegetation, that reflect macroscale differences in climate (in this area, primarily a function of elevation, topography, and rainshadow effects). On the Gifford Pinchot and Mt. Hood National Forests, six forest zones are recognized: **Western Hemlock** (lower elevations, west of the Cascade crest and in some riparian areas east of the crest), **Pacific Silver Fir** (middle elevations on both sides of the Cascades), **Mountain Hemlock** (upper elevation on both sides), **Grand Fir** (low to middle elevations east of the Cascade crest in moister sites), **Douglas-fir** (drier sites east of the crest) and **Ponderosa Pine** (lowest, driest sites east of the crest).

This publication presents a classification of potential natural vegetation communities, or plant associations, that occur within the Mountain Hemlock Zone on the Gifford Pinchot and Mt. Hood National Forests. These are forests of upper elevations, and include the upper limit of tree growth on major mountain peaks within the area.

Due to the proximity to the Portland-Vancouver metropolitan area, the Mountain Hemlock Zone on both National Forests is expected to provide a both a high level and a wide range of human benefits, including timber production, high quality water, wildlife habitats, recreation opportunities (especially skiing and backcountry recreation), special forest products such as huckleberries and mushrooms, and more. In addition, the Mountain Hemlock Zone has traditionally been the location within which important Native American activities, such as huckleberry and pinenut gathering, have occurred. Land managers face significant challenges attempting to balance the pressures to continue to meet the expectations of diverse forest users within the context of environmental constraints that exist within the Mountain Hemlock Zone. This Guide attempts to provide a stratification of environments and a discussion of likely management effects in order to help land managers make decisions that fit within the capabilities of individual sites.

Objectives: Why We Classify Plant Associations

Under the authority of the national Environmental Policy Act of 1969 and the National Forest Management Act of 1976, the USDA Forest Service has undertaken a nation-wide effort to "develop an ecologically-based information system to aid in evaluating land capability, interpreting ecological relationships and improving multiple-use management" (FSM 2060.2). Ecological classifications integrate potential natural vegetation, soils, landscape features, water and climate, and address issues such as vegetation species composition and structure, productivity, disturbances and habitat relationships.

Ecological classifications are integral to Ecosystem Management. They provide a framework of interpretations from which ranges of natural conditions at a variety of scales can be understood, and from which desired future conditions can be developed and articulated. They provide essential information for predicting the outcomes of management strategies.

A **plant association** (= "potential natural vegetation community") is an assemblage of plant species that recurs across the landscape in similar effective environments (that is, where climate, topography and soils interact to produce similar conditions for plant growth). Plant associations are "mature" communities that represent the theoretical endpoint of successional processes, or trends in vegetation composition that follow a disturbance.

This guide presents an ecological classification of sites within the Mountain Hemlock Zone, using the framework of plant associations. The information it contains allows users to identify potential natural vegetation communities, and to understand their capabilities and functions. Information about climate, soils, topography, plant species, fire ecology, productivity and wildlife habitat relationships is included, and the likely effects of various management treatments are discussed. The plant associations themselves provide a framework for characterizing broad areas (for example, watersheds, planning areas, etc.) as a whole, through assessment of the plant associations present and the spatial relationships among them. The classification also provides a way of assessing equivalency among sites that may be in different stages of succession and thus currently have different plant communities.

METHODS

Sample Design and Data Collection

This classification of plant associations is based on a sample of 303 500 m^2 plots located throughout the Mountain Hemlock Zone on the Gifford Pinchot and Mt. Hood National Forests (see Maps 1 and 2). Plot locations were selected based on the concept of "subjective sampling without preconceived bias" (Mueller-Dombois and Ellenberg, 1974) and were spread throughout the area in order to represent the range of environmental conditions that occur. Since the classification is focussed on identifying potential natural vegetation types, disturbed and early successional stands were avoided.

At each plot location, environmental variables, stand structure and seral stage were recorded, and abundances of all vascular plant species present were estimated. Productivity was characterized by measurement of one to several site index trees on each plot, and by tallying basal area of live and dead trees. On a subset of plots, snags and logs were tallied according to size and condition classes, and soils information was collected.

Data Analysis

Plot data were classified into plant associations in an iterative analysis and interpretation process, relying primarily on numerical classification techniques (TWINSPAN; Gausch, 1979) and stepwise discriminant analysis. Plant community composition was the primary classification variable, followed by environmental variables (mainly elevation, topographic position, slope steepness, aspect and soils) and productivity (site index, stockability). Plant associations derived by this process were then compared to classifications in other areas of the Pacific Northwest, and consistent grouping and naming conventions were adopted.

SUBALPINE PARKLAND PLANT ASSOCIATIONS				
TSME-ABLA2/ASLE2	Mt. Hemlock-Subalp. Fir/Cascades Aster	*Tsuga mertensiana-Abies lasiocarpa/ Aster ledophyllus*		CAF311
TSME-ABLA2/FEVI	Mt. Hemlock-Subalp. Fir/Green Fescue	*Tsuga mertensiana-Abies lasiocarpa/ Festuca viridula*		CAG211
TSME-ABLA2/JUCO4	Mt. Hemlock-Subalp. Fir/Mt. Juniper	*Tsuga mertensiana-Abies lasiocarpa/ Juniperus communis*		CAS411
TSME-ABLA2/PONE4	Mt. Hemlock-Subalp. Fir/Newberry's Knotweed	*Tsuga mertensiana-Abies lasiocarpa/ Polygonum newberryi*		CAF211
TSME-PIAL/LUHI	Mt. Hemlock-Whitebark Pine/Hitchcock's Woodrush	*Tsuga mertensiana-Pinus albicaulis/ Luzula hitchcockii*		CAG312
TSME/PHEM-VADE	Mt. Hemlock/Red Mt. Heather-Blueleaf Huckleberry	*Tsuga mertensiana/Phyllodoce empetri-formis-Vaccinium deliciosum*		CAS211
CONTINUOUS FOREST PLANT ASSOCIATIONS				
TSME/LUHI	Mt. Hemlock/Hitchcock's Woodrush	*Tsuga mertensiana/Luzula hitchcockii*		CAG311
TSME/MEFE	Mt. Hemlock/Fools' Huckleberry	*Tsuga mertensiana/Menziesia ferruginea*		CMS221
TSME/RHAL	Mt. Hemlock/Cascades Azalea	*Tsuga mertensiana/Rhododendron albi-florum*		CMS223
TSME/RHMA	Mt. Hemlock/Rhododendron	*Tsuga mertensiana/Rhododendron macro-phyllum*		CMS612
TSME/VAME/CLUN	Mt. Hemlock/Big Huckleberry/Queencup bead-lily	*Tsuga mertensiana/Vaccinium membrana-ceum/Clintonia uniflora*		CMS218
TSME/VAME/XETE	Mt. Hemlock/Big Huckleberry/Beargrass	*Tsuga mertensiana/Vaccinium membrana-ceum/Xerophyllum tenax*		CMS216
TSME/VASC	Mt. Hemlock/Grouse huckleberry	*Tsuga mertensiana/Vaccinium scoparium*		CMS114

Table 1 . Codes and names of Mountain Hemlock Zone Plant Associations

PHYSICAL ENVIRONMENT

The climate, geology, landforms and soils of the Mountain Hemlock Zone set the stage for the distribution of organisms and the functioning of basic ecological processes that are characteristic of the Zone as a whole. The environment of the Mountain Hemlock Zone is significantly more stressful to plant and animal life compared to other forested zones in this area. The growing season is shorter, soils are colder and often less fertile, and in many areas, the rolling landforms foster growing season frost as well as conditions that favor wildfire ignition and spread. Below is a summary of the primary physical environmental factors that shape the vegetation and wildlife communities that inhabit these upper elevation forest and subalpine areas.

CLIMATE

The Mountain Hemlock Zone is the highest in elevation of the forested ecological zones. Its climate is cold and moist. Precipitation ranges from 100 to over 140 inches annually. Most of this occurs in winter as snow. The snowpack averages about 12 feet in depth and persists well into the summer months. Soil moisture is usually available through most of the brief growing season. The soil moisture regime is Udic which is defined as one in which the soil is not dry at a depth of 15 to 45 cm for more than 45 consecutive days following summer solstice (Soil Survey Staff, 1975).

The eight feet of water that percolates through the soil each year results in an intense leaching environment. Nutrients that are not tightly bound to the soil are removed to the ground water resulting in soils of low fertility. These highly leached soils are often characterized by a light colored, eluvial horizon at or near the soil surface.

	AP	MA	JN	JL	AU	SP	OC	NV
SUMMIT	38	43	45	50	52	51	47	41
SQUIRREL CR.	35	38	43	46	48	46	43	42

Table 2. Average monthly soil temperature (20 in.) at two Mountain Hemlock Zone locations, Mt. Hood National Forest.

While soil moisture is fairly high, soil temperatures are low. The soil temperature regime is Cryic which is defined as having a mean annual temperature between 0 and 8 degrees C. and a mean summer temperature that is less than 8 degrees C. at a depth of 50 cm (Soil Survey Staff, 1975). Table 2 shows mean monthly soil temperature at a depth of 20 inches for two Mountain Hemlock Zone sites. These temperatures are cold enough to affect biological activity in the soil, including root elongation in some conifer species (Meador, 1982). When organic matter decomposition proceeds slowly, thick forest floor layers form. Nutrients are released so slowly that the conifer species common in this zone tend to produce a disproportionately large amount of roots, especially in the forest floor, to maximize the capture of available nutrients. Another manifestation of the climate is the greater production of below-ground biomass, especially in mature stands, than the aboveground component. Root activity can continue throughout most of the winter due to the insulating effect of the snow blanket.

LANDFORMS

Solar energy and precipitation are probably the most important environmental factors causing the patterns of plant associations we see on the landscape. The distribution of energy and moisture is highly influenced by the shape of the land, or topography. Solar energy does not fall upon land. In the Cascades, the land has been uplifted, faulted and folded by tectonic forces, resulting in a great variety of landforms, ranging from steep, highly dissected slopes to gently sloping ridges, benches and valleys. Large volcanoes have erupted, and glaciers have carved the land surface and left deposits, further contributing to landform complexity.

The Mountain Hemlock Zone in this area occupies portions of two physiographic sections, the Western Cascades (including the western portion of the Mt. Hood National Forest, and all but the southeasternmost part of the Gifford Pinchot National Forest), and the High Cascades. The Western Cascades consist of older andesite and basalt flows with intermixed tuffs and breccias. The slopes are moderate to steep and generally well-dissected. In Washington, the landforms are generally mantled with significant deposits of volcanic pumice and ash. Glaciation has eroded some upper stream basins. In the Western Cascades, the Mountain Hemlock Zone typically occurs on upper slopes and ridges as a function of elevation; the pattern in map view shows a "finger" pattern as the Zone follows the spines of major ridge systems. The High Cascades consist of younger volcanic flows and ejecta that have created rolling plateaus and gentle slopes, punctuated by large volcanic peaks such as Mt. Hood. In these areas, the Mountain Hemlock zone occurs as extensive blocks on high elevation plateaus (such as Indian Heaven) or on the upper flanks of volcanic peaks. Parkland plant associations are more common in the High Cascades portion of the area.

SOILS

Parent Materials

The soil parent materials within the Mountain Hemlock Zone consist primarily of material that was erupted from the volcanoes in the Cascade Range. Numerous layers of volcanic ash and pumice blanket these high elevation areas. These tephra layers are underlain mainly by andesitic and basaltic lava flows. In many areas glacial activity has resulted in deposits of subangular rock underlying the tephra.

A distinct volcanic ash plume was deposited on the east side of Mt. Hood presumably originating from Mt. Hood itself. These ash deposits are thickest on the eastern flanks of the mountain and thin gradually to the east. This material has not been found on the west side of the mountain, probably because of the prevailing westerly winds. On the flanks of Mt. Hood the ash was deposited in two eruptive events with an interval between that was sufficient to allow the formation of an organic matter-enriched A horizon in the lower deposit. Further to the east this buried A horizon is less apparent, possibly due to lower rates of organic matter accumulation.

Further southeast of Mt. Hood a different volcanic ash layer mantles the landscape within the Mountain Hemlock Zone. This deposit is quite red in color as are the residual soils over which it lies. Its origin is unknown but is thought to be the same volcanic events that produced the extensive lava flows in the area.

In the Olallie Lake area a thin layer of volcanic ash is present. This layer could be from Mt. Mazama whose eruption and collapse formed Crater Lake about 6600 years ago. It may also have been erupted from Mt. Hood or Mt. Jefferson. Regardless of its origin, it was deposited within the last 10,000 years since it mantles a glacially modified landscape.

On the Gifford Pinchot National Forest there are several distinct tephra layers in most of the soils. The upper-most deposits are from the 1980 eruption of Mt. St. Helens. This eruptive event produced two layers. The upper layer is coarse sand while the lower one is very fine sandy loam. Below this is the old forest floor which is rapidly becoming humus. The old forest floor formed over various other tephra layers which have not been identified in this study. They consist mainly of Mt. St. Helens T, W. B. P seta with lesser amounts from Mt. Mazama and other volcanic deposits.

The structure of volcanic ash can be understood by visualizing frothy, bubbling lava being blown out of the volcanos by gases from below. The foamy lava cools quickly and hardens into glassy shards. The resulting shards are quite vesicular giving them a large surface area. As the ash weathers, amorphous clay minerals form, further enhancing the surface area. Soils that form from volcanic ash have several important properties that are due to the structure of the ash shards and the clay minerals produced by weathering. These soils have low bulk densities (weight per unit volume) and high porosity (High, 1989). This high porosity permits the rapid infiltration and percolation of water and also stores large quantities of available moisture. The large surface area with its attendant negative charge is very effective in binding cations, especially the triple positively charged phosphate ion. Where volcanic ash soils are cultivated, this phosphorus fixation can result in growth limiting deficiencies. This characteristic may have implications for forest fertilization of these soils. Nitrogen is usually the most limiting nutrient and is the principal if not only one supplied in most fertilization programs. It appears, however, that the supply of available phosphorus must be adequate for the nitrogen to be effective (Radwan & Shumway, 1985).

On the Gifford Pinchot National Forest pumice layers have been deposited along with ash. This material is coarse sand to fine ("pea") gravel which ranges in size from 2 mm to about 10 mm. Unlike volcanic ash (which is <2mm in size), this material is relatively inert. It has a small surface area per unit volume and is mostly unweathered. Thus, it retains little moisture and few nutrients. This is readily apparent by the scarcity of roots in these layers. It is interesting to note that volcanic ash and pumice, being from the same source and of the same composition, and differing only in their particle size, can produce soil materials that differ greatly in their productive capacity.

Soil/Organism Interactions

The dominant macrobiotic feature of the Mountain Hemlock zone is the coniferous forest that blankets the peaks, slopes and valleys at upper elevations. Tree species that dominate these stands, especially mountain hemlock and Pacific silver fir, produce litter that is quite acid. The slow rates of decomposition of this litter produce fulvic acids which facilitate the downward movement of organic matter and nutrients. This initiates the process of podzolization which will be further discussed below.

Microorganisms in the soil are responsible for organic matter decomposition and the fixation of atmospheric nitrogen. As mentioned above, these processes proceed slowly in the cold environment of the Mountain Hemlock Zone. The slow decomposition of organic matter results in a forest floor that has distinct layers. These layers are distinguished by the level of decomposition. The uppermost layer consists of fresh litter, mainly needles, twigs, cones and small branches. Beneath this is a fragmentation or fermentation layer. This layer is partially decomposed but plant structures are evident. The bottom layer is a humus layer which consists of mostly decomposed organic matter. This horizon is black in color and is soft and slick when rubbed. It is the layer with the greatest concentration of roots and is the source of most of the site's fertility.

Mycorrhizal fungi, which attach to the conifer root tips, optimize the uptake of water and nutrients in exchange for photosynthate. In a Pacific silver fir stand in the Cascades of western Washington the percentage of the root system that was infected with mycorrhizal fungi varied seasonally from 56 to 98 percent. The lowest levels coincided with periods of rapid shoot growth while maximum levels occurred in the fall and early spring (Vogt & Grier, 1981).

Mycorrhizal fungi are dependent upon organic matter, especially decomposing large woody debris (Larsen and others, 1979). Large woody debris is an excellent water-saturated medium for root growth, provides nutrients and is habitat for organisms that spread the spores of the fungi. Free-living nitrogen-fixing bacteria also depend upon this material as a substrate. These organisms convert atmospheric nitrogen to a form that is usable by plants. Rates of nitrogen fixation are very low. Most of the nitrogen in this ecosystem is recycled through the decomposition of litter and uptake by mycorrhizal roots in the forest floor.

Time

The length of time that the factors of soil development have had to operate in the Mountain Hemlock Zone is quite short. Most of the soil parent materials are very young. Volcanic tephra that mantles the entire area is probably no older than 10,000 years. Much of the Gifford Pinchot National Forest tephra is as young as 17 years. In addition, the surfaces upon which the tephra was deposited are themselves quite young. Alpine glaciation resulted in a landscape that is roughly 10,000 years old. Mudflows resulting from more recent volcanic eruptions have covered valley floors.

These frequent disruptions of the soil development processes have resulted in soils that are pedogenically quite young. Organic matter accumulation in A horizons is the most widespread feature of soil development. Weak spodic horizons have also developed in the oldest parent materials which are, apparently, the volcanic ash deposits on the east side of Mt. Hood.

Podzolization

The process of podzolization deserves special mention because it is likely the principal pedogenic process that is active in this zone and also because of the implications for soil fertility. Podzolization begins with the stripping by organic acids of iron and aluminum and other nutrients from the organic matter in the lower forest floor and upper mineral soil layers. Intense percolation of water moves these organic-mineral complexes to the subsoil where they are immobilized by weathered soil minerals (Ugolini, 1981).

The resultant soil profile is characterized by a light colored ("eluvial") surface horizon from which material has been removed and a dark reddish ("spodic") subsoil horizon where iron, aluminum and organic matter have accumulated.

Podsolization makes these soils less susceptible to nutrient losses by leaching. Conifer roots inhabiting the spodic horizon extract nitrogen, phosphorus and other nutrients and return them to the tree. The spodic horizon also provides an effective buffer to changes in streamwater chemistry by immobilizing potentially toxic metals in the soil.

Summary

The soils of the Mountain Hemlock Zone have formed mainly in young volcanic tephra deposits. These soils display only minor pedalogical development. They are relatively infertile, having low clay content, base saturation and cation exchange capacity. These soils are quite porous and have high rates of water infiltration, transmission and storage.

The soils of this zone are forming in a cold, wet climate. This results in low rates of organic matter decomposition and thick forest floor layers. Nutrient availability is low. One adaptation that the conifer species make to the low rates of nutrient release is to develop an extensive root network, especially in the lower forest floor layer (Grier and others, 1984). Another nutrient-conserving mechanism is the formation of a spodic horizon.

Soil Management Considerations

The importance of the forest floor should be readily apparent from the above discussion. In warmer ecosystems organic matter decomposition proceeds at greater rates than in these high elevation ecosystems and results in organic matter-enriched mineral soils. In contrast, in the Mountain Hemlock Zone the nutrients are, for the most part, cycled directly from the forest floor back into the vegetation. This has important implications for intermediate entries into these stands. With an abundance of fine feeder roots in the litter, equipment operations could seriously disrupt the nutrient cycling regime. Root damage could lead to weakened trees and root rot organisms could become more widespread. This may not be as serious if the entry is for regeneration by clear cutting. In a Pacific silver fir stand in the Washington Cascades it was observed that opening the stand accelerated the decomposition of the forest floor and the proliferation of herbaceous vegetation. Within 16 years an organic matter-enriched A1 horizon had formed (Ugolini, 1981). This condition is favorable for stand establishment as Pacific silver fir and mountain hemlock seedlings prefer to root in mineral soil. Also, this A horizon contains considerably more nitrogen than the eluvial surface layer that regeneration would have occurred in (Ugolini, 1981).

In any case, maintenance of the forest floor is important for several other reasons besides nutrient cycling. Cold soils may inhibit seedling establishment. The forest floor insulates the soil and moderates extreme diurnal temperature fluctuations. When regeneration is prescribed it may be advantageous to prepare the site with a cool prescribed burn. This would char the surface of the duff layer but not consume it. The resulting black surface should accelerate the warming of the mineral soil.

If the soil is to be prepared for natural regeneration some exposure of mineral soil may be desirable. This should be done in a manner which results in small patches of exposed soil. Twenty to thirty percent exposure should be sufficient if it is evenly distributed.

Plant growth can be adversely affected by compaction and displacement of the mineral soil by heavy equipment operations. Compaction of the soil by heavy equipment results in a loss of soil macropore space. Macropores are critical for root elongation, water and nutrient supply and gaseous exchanges. Numerous studies on a wide variety of soils, including volcanic ash, have shown significant growth losses associated with this impact (Froehlich, 1979).

Deep displacement of topsoil by equipment operations can also lower site productivity. Thick volcanic ash layers are particularly susceptible because they have low strength when wet and are very loose when dry. Deep displacement can result in a loss of nutrients, a loss of rooting space and interruption of the spodic horizon. The loss of function of the spodic horizon could lead to a further loss of nutrients to the groundwater and possible impacts to stream chemistry. Deep displacement can be minimized by operating when these soils have enough moisture to be cohesive but not so much that they are saturated and rutting occurs.

Slash piling with a crawler tractor should be avoided on these soils. If mechanical piling appears to be the only viable alternative, the use of a grapple-equipped track-hoe should be considered. This piece of equipment causes minimal impacts to the soil and has the advantage of selectivity of the material being piled. This is important in conserving the forest floor and large woody debris, both of which are necessary for the maintenance of long-term site productivity.

The cold, wet climate of the Mountain Hemlock Zone results not only in a short growing season but also in a very narrow window of opportunity for forest management activities. Some activities may result in a further narrowing of this window. Regeneration harvests, for example, that create openings in the forest may cause increased snow depth in the openings. This, together with the loss of transpiration by the trees, may result in soils that are saturated well into the summer months. Site preparation and reforestation activities may be more difficult to accomplish because of this moisture. Thus, careful planning and timing are essential in managing these high elevation ecosystems.

Recreation Impacts

Much of the Mountain Hemlock Zone is in classified Wilderness Areas, where the attempt is to manage so that there is "no trace" of human activity. This philosophy manifests itself in the direction to disperse use so that overuse of a particular area does not occur. In some cases popular camping spots which have been hardened by years of use are decreed off limits so that they might recover.

In some portions of the Mountain Hemlock Zone, this direction may be counterproductive. Cold temperatures, late-melting snowpacks and a very short growing season, together with readily compactable and easily displaced soils, results in a very low threshold for damage. Setting up camp in an undisturbed area, even for a short period of time, may result in a significant impact to that site (Cole,1982). In popular areas such as near lakes, where heavy use is inevitable, dispersing that use away from previously impacted sites may disperse the impacts over a greater and greater area. Once soil has been compacted, natural recovery takes decades or longer. Hardened sites will likely remain so unless tillage is applied. Vegetative recovery is very slow to nonexistent in compacted soils.

One way to lessen the impacts from human use is to direct that use to the most resistant or resilient areas. The most resistant areas are within timbered areas with thick duff layers that cushion the forces that compact the soil (for example, plant associations dominated by rhododendron or beargrass - see Plant Association Descriptions). Also, these areas typically have less easily trampled forbs. The least resistant and resilient areas are in open, forb-dominated communities with considerable bare soil and in communities that are always wet due to high water tables (for example, the TSME/RHAL and TSME/MEFE associations). Some degradation will, however, likely occur wherever human use is heavy. It may be better to dedicate the most popular camp sites in heavy use areas to that activity. Sites where vegetation has been eliminated and soil has been compacted are not likely to be degraded much further. One permanent fire ring may be better left rather than each camper creating their own somewhere else. Dedicating the most popular camp sites is unlikely to offend the sensibilities of most wilderness users, especially if it is with the knowledge that it is preventing damage elsewhere.

VEGETATION ECOLOGY/ PRODUCTIVITY & STAND STRUCTURE

VEGETATION ECOLOGY

Fig. 1 is a conceptual representation of how the plant associations of the Mountain Hemlock Zone sort themselves along gradients of temperature (X axis) and moisture (Y axis). The diagram depicts "effective environment", that is, the environment the organisms actually experience. For example, a site may be in the "warm" portion of the spectrum because it is either at a lower elevation with a longer growing season, or on a south-facing slope with high solar radiation; or, a site may be "dry" either because it is in a zone of low precipitation, or because the soils are very coarse-textured and do not retain moisture. Plant associations of the Mountain Hemlock Zone generally reflect the effective physical environment in which they are found, rather than being tied to specific elevations, slope aspects or soil types.

These are cold, upper-elevation sites characterized for the most part by deep snowpacks and a short growing season that may be punctuated by freezing temperatures (especially on clear nights) at almost any time. The conditions that favor a high rate of biological activity and foster high productivity - warm temperatures and high precipitation during the growing season - are mostly missing from the Mountain Hemlock Zone. In much of the zone, snowmelt occurs after the summer dry season has begun; sites go from deep winter to dry summer conditions with very little transition. Fire has historically been a significant factor in shaping the vegetation communities within the Mountain Hemlock Zone. Because it is typically found on ridgetops, the Mountain Hemlock Zone is prone to both lightning and wind, and is more susceptible to large, high-intensity fires than any other forested zone within the two National Forests. These are the harshest sites within which forest vegetation is found within this area, and includes subalpine areas (non-continuous forest cover) that are transitional to a true alpine ecosystem.

The coldest portion of the Mountain Hemlock Zone is occupied by subalpine parkland plant associations, dominated by patchy stands of mountain hemlock, subalpine fir and whitebark pine. These are sites with a very short growing season, at the outer limits of the environment's ability to produce forest vegetation.

Below the parkland zone, sites with a high water table support the TSME/RHAL and TSME/MEFE associations. Slightly drier sites support the TSME/VAME/CLUN association. These three associations are the productive heart of the Mountain Hemlock Zone, reflected in the diversity and high biomass of the herbaceous and shrub layers, and by the potential for tree growth. The TSME/RHMA association occupies warm and somewhat dry sites that may be somewhat limited in productivity due to low soil nitrogen content. The TSME/RHMA association occurs in the Oregon portion of the Mountain Hemlock Zone only. In slightly cooler, drier or more productive sites, the TSME/VAME/XETE association is found. It is probably the most common of the Mountain Hemlock Zone plant associations. And in the coolest, driest sites, the TSME/VASC association occurs; it has the lowest productivity of any of the forested Mountain Hemlock Zone associations.

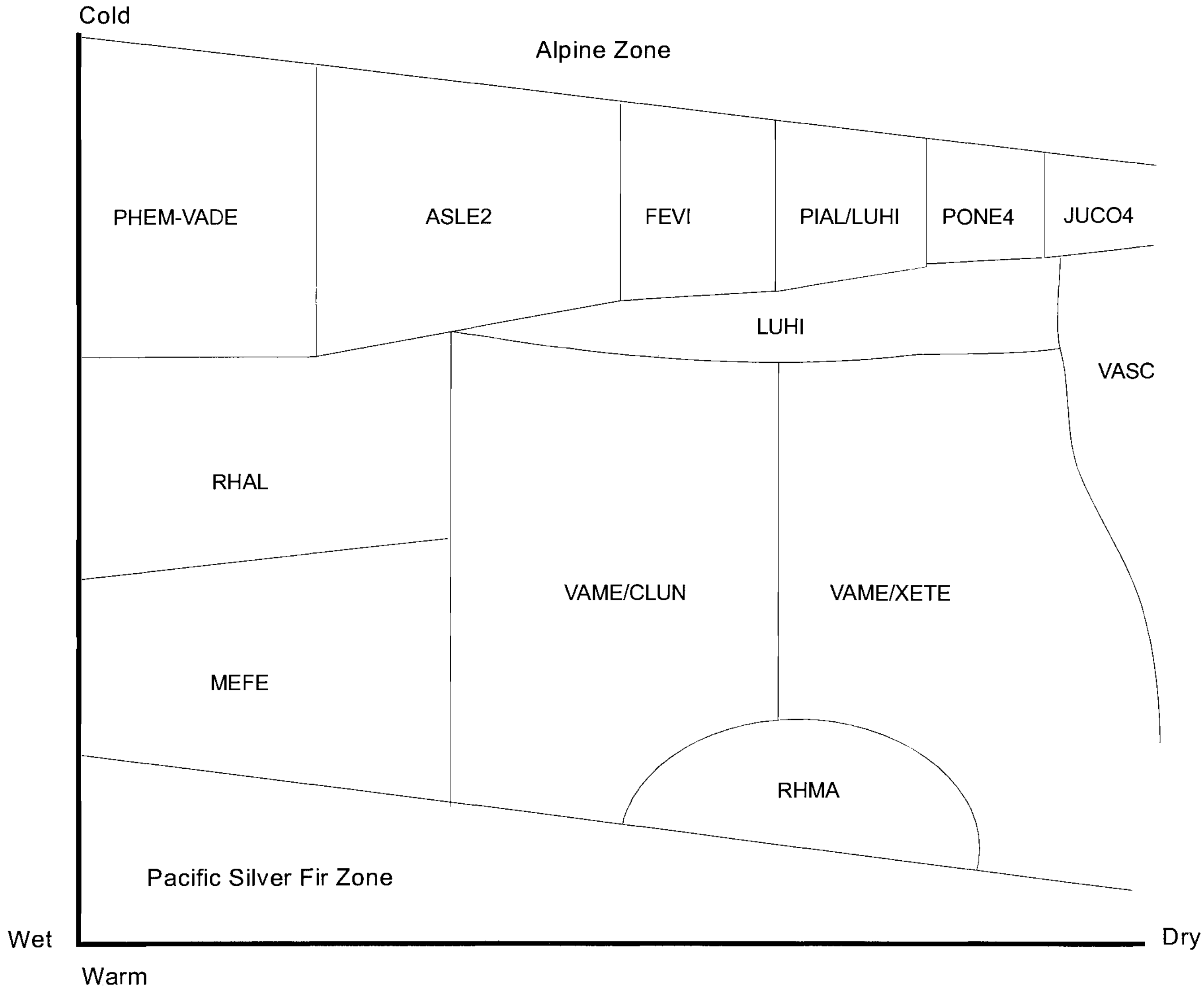


Fig. 1. Idealized distribution of plant associations along gradients of effective temperature and moisture. The axes integrate effects of climate, landform and soils. See Table 1, p. 4, for a key to the plant association codes.

PRODUCTIVITY AND STAND STRUCTURE

Tree Productivity

In general, site productivity is lower in the Mountain Hemlock Zone than in any other forested zone within the study area. The likely causes include a short, cool growing season, a slower-than-average rate of decomposition of organic matter (due to cool temperatures), and cold soils during the growing season (that may lower the ability of roots to take up water and nutrients). Tree mortality or reduction in growth can occur by a variety of means. Table 3 shows the relative resistance of Mountain Hemlock Zone conifers to the most common causes of damage.

Tree Species	**Relative resistance to . . .**					
	Shade	Frost	Drought	Snowbreak	Fire	Rootrot
Alaska yellow cedar	M	M	L	H	L	H
Douglas-fir	L	L	M	L	H	L
Engelmann spruce	L	H	M	H	L	M
Grand fir	H	M	M	M	M	L
Lodgepole pine	L	H	H	M	L	M
Mountain hemlock	H	H	L	H	M	L
Noble fir	L	M	L	M	M	M
Pacific silver fir	H	M	L	M	L	L
Subalpine fir	H	M	M	H	L	M
Western hemlock	H	L	L	H	L	M
Western larch	L	H	M	M	H	M
Western redcedar	H	L	M	M	L	H
Western white pine	M	H	M	M	M	M
Whitebark pine	L	H	H	H	L	L

Table 3. Relative resistance of Mountain Hemlock Zone conifers to common factors that cause growth reduction, damage or mortality (Minore, 1979; Hemstrom and others, 1982).

Table 4 compares two measures of tree productivity, site index and growth basal area, among the four most widespread forest zones on the Mt. Hood and Gifford Pinchot National Forests. **Site index** is an indicator of height growth potential; it approximates the height a tree can achieve in a given amount of time. **Growth basal area** (Hall, 1983) is an index of stockability, or the density of trees an area is capable of producing at a given rate of diameter growth. Douglas-fir was selected for Table 4 because it is a common tree among all four zones.

ZONE	AVE. SI (PSME; ft.; 100 yr)	AVE.GBA (PSME)
W. Hemlock	128.7	330.2
Pac. Silver Fir	105.5	164.6
Mt. Hemlock	87.2	280.3
Grand Fir	113.1	292.6

Table 4. Average Douglas-Fir Site Index (ft.) and Growth Basal Area by Forest Zone

Table 5 shows site index and growth basal area values for a variety of tree species among the Mountain Hemlock Zone plant associations. Not surprisingly, productivity is lower in the more extreme parkland environments than in the closed-canopy forest. In this sample, subalpine fir and Pacific silver fir gnerally grew faster than mountain hemlock in the parkland associations. The most productive parkland association was the TSME-ABLA2/FEVI association, which typically has adequate moisture and an abundance of fine graminoid roots in the upper soil horizon. The nitrogen fixer broadleaf lupine is also a characteristic species of this association. Of the closed-forest associations, the TSME/VAME/CLUN association exhibited the highest average site indices. This is a typically herb-rich association of mesic environments. Throughout the closed-forest portion of the Mountain Hemlock Zone, shade-intolerant species such as Douglas-fir, noble fir, and western white pine, along with Engelmann spruce, tended to exhibit the greatest height growth potential.

Growth basal area values in Table 5 are extremely variable. Growth basal area functions as a useful measure of site productivity primarily where tree density is moisture-limited. The fact that growth basal area is, in some cases, higher in the parkland associations than the closed forest (even though actual measured basal area is lower) suggests that other factors besides moisture (for example, extreme cold, wind desiccation, snowpack depth and rodent predation on seeds) are limiting tree density in these areas.

Table 6 shows average live tree basal area (a measure of current tree density) values found in this sample of the Mountain Hemlock Zone. Parkland associations generally had lower basal area than closed-forest associations. The highest basal areas occurred in the TSME/RHMA, TSME/RHAL and TSME/VAME/CLUN associations.

Stand Structure and Seral Stage

Figs. 2 and 3 illustrate stand structure class (based on average stand diameter) and seral stage for Mountain Hemlock Zone plant associations. The parkland associations and the TSME/LUHI and TSME/VASC closed-forest associations tend to be dominated by the sapling-pole and small-tree size classes at maturity, reflecting their lower productive potential. The other closed-forest associations tend to mostly fall into the large-tree structure class at maturity. Old growth structure (large, old (>250 yrs.) trees; multiple canopy layers; significant components of logs and snags) is most common in the moist/warm environments that support the TSME/MEFE, TSME/RHAL and TSME/VAME/CLUN associations.

Table 5. MT. HEMLOCK ZONE PLANT ASSOCIATIONS - SITE INDEX (SI) AND GROWTH BASAL AREA (GBA) (Shaded = Parkland)

PLANT ASSOCIATION	ECOCLASS	SPECIES	SITE INDEX Mean	SITE INDEX SD	SITE INDEX #	GBA Mean	GBA SD	GBA #
TSME-ABLA2/ASLE2	CAF311	ABAM	60		1	473		1
		ABLA2	50	23	4	183	64	4
		PIAL				151	105	2
		TSME	49	15	4	196	30	4
TSME-ABLA2/FEVI	CAG211	ABLA2	72	15	10	150	79	3
		TSME	66	20	7	135	21	2
TSME-ABLA2/JUCO4	CAS411	ABLA2	68	6	3	66		1
		ABPR	80		1	606		1
		PSME	85		1	227		1
		TSME	41		1	466		1
TSME-ABLA2/PONE4	CAF211	ABLA2	61	10	9	109	52	9
		PICO	49		1	146		1
		TSME	47	13	16	253	138	16
TSME-PIAL/LUHI	CAG312	ABAM	64		1	893		1
		ABLA2	67	8	11	81	30	1
		PIAL				92	66	6
		TSME	43	9	6	257	160	6
TSME/PHEM-VADE	CAS211	ABAM	61	20	15	233	132	14
		ABLA2	54	18	51	174	91	50
		PIEN	77	1	3	222	46	3
		TSME	51	15	54	269	135	50
TSME/LUHI	CAG311	ABAM	57	12	4	542	263	4
		ABLA2	57	20	15	255	102	15
		ABPR	47		1	252		1
		TSME	57	13	24	297	111	24
TSME/MEFE	CMS221	ABAM	75	19	40	220	60	12
		ABPR	107	23	4	227		1
		PSME	82	19	16	295	79	10
		TSHE	83	11	21	295	104	18
		TSME	69	16	29	215	76	11

PLANT ASSOCIATION	ECOCLASS	SPECIES	SITE INDEX Mean	SITE INDEX SD	SITE INDEX #	GBA Mean	GBA SD	GBA #
TSME/RHAL	CMS223	ABAM	73	20	105	358	159	32
		ABLA2	60	16	7	215	32	3
		ABPR	98	6	6	320		1
		LAOC	71	4	3			
		PIEN	87	10	18			
		PSME	86	14	23	284	92	5
		TSHE	92	9	9	272	45	3
		TSME	68	12	100	235	83	20
TSME/RHMA	CMS612	ABAM	62	15	15	337	75	12
		ABPR	77	11	4	357	123	4
		PSME	76	14	8	235	111	12
		TSHE	70	20	6	232	51	13
		TSME	63	10	7	249	58	10
TSME/VAME/CLUN	CMS218	ABAM	76	19	44	345	135	23
		ABLA2	62	19	9	256	61	3
		ABPR	101	19	10	481	198	9
		PIEN	89	17	6	235	77	5
		PSME	104	18	12	397	118	7
		TSHE	91	9	6			
		TSME	75	19	49	303	118	29
TSME/VAME/XETE	CMS216	ABAM	71	19	69	229	85	28
		ABLA2	72	21	21	174	110	25
		ABPR	88	16	20	321	153	19
		LAOC	37	15	3	279	45	10
		PICO	69	10	12	145	25	31
		PIMO	92		1	141		1
		PSME	90	16	42	244	112	34
		TSHE	81	18	29	212	86	30
		TSME	65	13	86	278	144	107
TSME/VASC	CMS114	ABAM	58	8	4	166	37	3
		ABLA2	75	12	26	182	88	21
		LAOC	84	5	2	235	44	2
		PICO	75	9	16	173	106	16
		PIEN	83	19	5	278	211	5
		TSME	58	10	16	195	124	13

See Appendix 3 for site index references.

ASSOCIATION	ECO-CLASS	Basal Area
TSME-ABLA2/ASLE2	CAF311	217
TSME-ABLA2/FEVI	CAG211	130
TSME-ABLA2/JUCO4	CAS411	227
TSME-ABLA2/PONE4	CAF211	204
TSME-PIAL/LUHI	CAG312	250
TSME/PHEM-VADE	CAS211	254
TSME/LUHI	CAG311	315
TSME/MEFE	CMS221	292
TSME/RHAL	CMS223	345
TSME/RHMA	CMS612	368
TSME/VAME/CLUN	CMS218	337
TSME/VAME/XETE	CMS216	314
TSME/VASC	CMS114	255

Table 6. Live tree basal area (ft^2), Mt. Hemlock Zone Plant Associations (shaded = parkland)

True old growth structure comprised less than 20% of the total stands sampled in these three types, even though many associations have a high percentage of stands in the "late seral" and "old" categories. In general, classic old growth structure, in the sense stated above, is not widely found within the Mountain Hemlock Zone, because many old stands have only a single canopy layer, or smaller trees.

Most associations in this sample are represented by a range of seral stages, reflecting the variable disturbance history of the study area. Of the closed forest associations, the TSME/VAME/XETE and TSME/VASC associations had the highest proportions of younger seral stages, possibly due to the susceptibility of these areas to wildfire. Older stands tended to be in the moister associations - TSME/MEFE, TSME/RHAL and TSME/VAME/CLUN, and in the TSME/LUHI type. Three parkland associations, TSME-ABLA2/ASLE2, TSME-ABLA2/FEVI and TSME-ABLA2/PONE4, were composed almost entirely of early and mid-seral stands;

Fig. 2. STRUCTURE CLASS BY PLANT ASSOCIATION

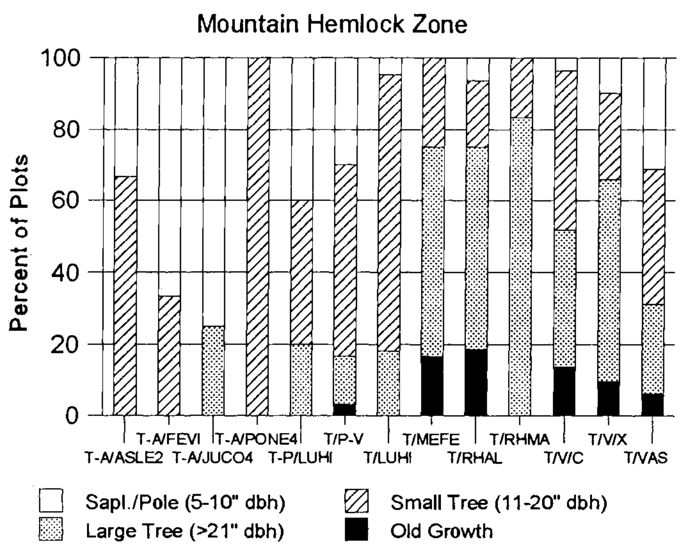
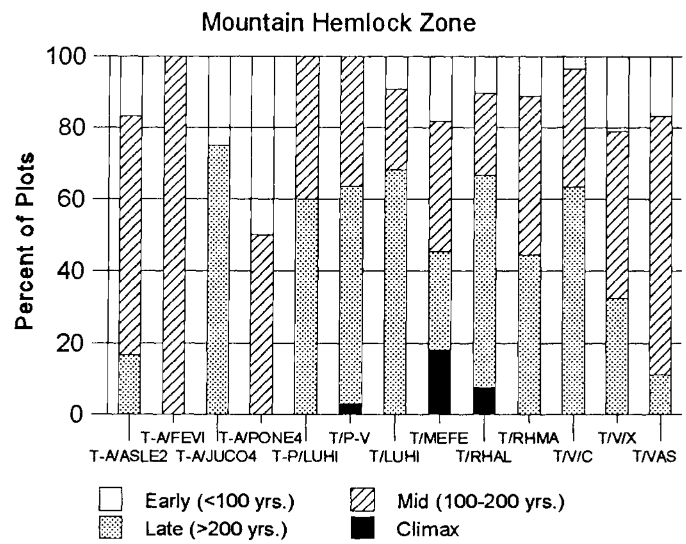


Fig. 3. SERAL STAGE BY PLANT ASSOCIATION



this may be due to a combination of recent fire history and a long tree-establishment period in the harsh subalpine environment.

The composition of the tree component of the plant community is a good indicator of seral stage; Table 7 shows the successional status of common Mountain Hemlock Zone conifers.

SUCCESSIONAL STATUS OF CONIFER SPECIES

Parkland Plant Associations						
	T-A/ASLE2	T-A/FEVI	T-A/JUCO4	T-A/PONE4	T-P/LUHI	T/PHEM-VADE
Lodgepole pine				x,x		X,x
Mountain hemlock	X,X	X,X	X,X	X,X	X,X	X,X
Pacific silver fir	x,X				x,x	
Subalpine fir	X,X	X,X	X,X	x,X	x,X	x,X
Whitebark pine	x,x	x,x	X,X	X,X	X,X	x,x

Closed Forest Plant Associations							
	T/LUHI	T/MEFE	T/RHAL	T/RHMA	T/V/C	T/V/X	T/VASC
Alaska yellow cedar			x,x		x,x		
Douglas-fir		X,x	X,x	X,x	x,x	X,x	
Engelmann spruce	x,x	x,x	x,X		x,x		x,x
Lodgepole pine		x,-	x,-		x,-	X,x	X,x
Mountain hemlock	X,X	X,X	X,X	X,X	X,X	X,X	X,X
Noble fir		x,x	x,x	X,x	X,x	X,x	x,x
Pacific silver fir	x,x	x,X	x,X	x,X	x,X	x,X	x,X
Subalpine fir	X,X		x,x		x,x	x,x	X,X
Western hemlock		x,X	x,x	x,X	x,x	x,X	
Western larch			x,-		x,-		x,-
Western redcedar		-,x					
Western white pine			x,x	x,x	x,x		x,x
Whitebark pine	x,x						

Table 7. Successional status of conifers in the Mountain Hemlock Zone. X = dominant species; x = minor species. First character of pair indicates status in early or mid-seral stands; second character indicates late seral stands (Brockway and others, 1983).

Snags and Down Wood

Dead trees, standing or fallen, are important structural features of Mountain Hemlock Zone forests. Snags provide perching and nesting habitat for a variety of birds and mammals, and constitute a long-term source of down wood for the forest floor. Down wood also provides habitat for a variety of organisms, including some that play a significant role in maintaining forest productivity (Maser and Trappe (1984)). In addition it acts as a reservoir for site moisture during the dry season, and serves as rooting medium for several plant species.

Table 8 shows the numbers of snags per acre found in closed-forest plant associations in this sample of the Mountain Hemlock Zone. The size of snags present tends to be positively correlated with site productivity. The total number of snags is fairly similar across plant

SNAGS 12.0-19.9" DBH								
HEIGHT	Snags 10-39' tall				Snags >=40' tall			
CONDITION	Hard		Soft		Hard		Soft	
	ave.	s.d.	ave.	s.d.	ave.	s.d.	ave.	s.d
TSME/LUHI	No Data							
TSME/MEFE	No Data							
TSME/RHAL	0.5	1.6	1.1	2.6	8.5	10.8	6.5	8.8
TSME/RHMA	2.1	4.7	0	0	6.4	6.9	4.2	6.9
TSME/VAME/CLUN	1.8	3.2	2.0	5.3	1.8	2.6	9.4	9.4
TSME/VAME/XETE	1.0	2.9	2.7	7.8	5.2	8.0	7.4	11.5
TSME/VASC	2.8	7.6	3.7	6.0	8.6	9.3	9.6	12.7
SNAGS >=20.0" DBH								
TSME/LUHI	No Data							
TSME/MEFE	No Data							
TSME/RHAL	0.4	1.4	1.1	3.6	1.8	2.9	1.1	2.1
TSME/RHMA	1.1	2.4	0	0	1.1	2.4	0	0
TSME/VAME/CLUN	0	0	2.8	3.9	1.1	2.2	1.4	2.4
TSME/VAME/XETE	0.2	1.1	1.2	2.6	1.9	3.1	1.8	3.9
TSME/VASC	0	0	0	0	1.0	2.1	0	0

Table 8. Number of Snags per Acre, Mountain Hemlock Zone

associations. A higher-than-average number of smaller snags occurs in the TSME/VASC association, possibly because many of these stands burned near the turn of the century, and presently have a significant component of early seral, shade intolerant lodgepole pine trees that are experiencing suppression mortality.

Tables 9 and 10 show amounts of down wood found in this sample of the Mountain Hemlock Zone. The average values can be somewhat misleading because there is significant variation in the data. Definitions of Condition and Size Classes are as follows:

Condition Class

1	Bark intact; twigs present; texture substantially unaltered; shape round; original color; elevated on support points
2	Bark loose or missing; twigs mostly absent; wood intact to partly soft; shape round; color beginning to fade; elevated portions mostly sagging
3	Bark and twigs absent; wood soft to powdery; shape round to oval; color faded; all of piece in contact with ground

Size Class (largest size class that qualifies is recorded)

1	Piece down not contain a segment which is at least 6" in diameter for a length of at least 5'.
6	Piece contains a segment which is at least 6" in diameter for a length of at least 5 feet.
12	Piece contains a segment which is at least 12" in diameter for a length of at least 5 feet.
20	Piece contains a segment which is at least 20" in diameter for a length of at least 5 feet.

Table 9. PIECES PER ACRE/DOWN WOOD - MT. HEMLOCK ZONE CLOSED FOREST PLANT ASSOCIATIONS

	SIZE CLASS 1						SIZE CLASS 6						SIZE CLASS 12						SIZE CLASS 20					
CONDITION[3]	1		2		3		1		2		3		1		2		3		1		2		3	
	ave.	s.d.	ave.	s.d.	ave.	s.d	ave.	s.d.	ave.	s.d.	ave.	s.d	ave.	s.d	ave.	s.d	ave.	s.d	ave.	s.d	ave.	s.d	ave.	s.d
TSME/MEFE			6	9	163	92			23	32							13	18						
TSME/RHAL	15	57	22	62	8	28	32	87	90	205	28	63	2	7	38	121	33	118	1	6	2	12		
TSME/VAME/ CLUN			2	6	119	233	2	5	9	16	77	215	3	6	10	17	36	34	3	8	1	2	4	15
TSME/VAME/ XETE	0.5	4	22	64	45	134	4	20	42	84	68	187	2	13	9	36	28	69	1	4	2	12	6	22
TSME/VASC	7	20	49	81	58	117	1	3	80	169	4	12	1	2	4	11			0.3	1				

Table 10. TONS PER ACRE/DOWN WOOD - MT. HEMLOCK ZONE CLOSED FOREST PLANT ASSOCIATIONS

	SIZE CLASS 1						SIZE CLASS 6						SIZE CLASS 12						SIZE CLASS 20					
CONDITION[3]	1		2		3		1		2		3		1		2		3		1		2		3	
	ave.	s.d.	ave.	s.d.	ave.	s.d	ave.	s.d.	ave.	s.d.	ave.	s.d	ave.	s.d	ave.	s.d	ave.	s.d	ave.	s.d	ave.	s.d	ave.	s.d
TSME/MEFE			0.5	.7	2	0.7			1	1.4							3	4.2						
TSME/RHAL	.09	.29	.18	.53	.09	.29	1	1.8	1.9	3.1	.8	1.8	1.2	5.4	3.5	6.3	3.1	7.3	1.4	6.7	.03	.18		
TSME/VAME/ CLUN					.5	1.2	.08	.29	.5	1	1.2	1.9	4	8.9	2.3	3.9	5.4	6.5	6.2	15	.75	2.6	1.8	6.3
TSME/VAME/ XETE			.24	.65	.31	.93	.20	.69	1.6	2.9	1.6	3.9	.08	.46	1.6	5.4	2.6	5.1	1.4	7.9	.9	5.6	1.1	4.4
TSME/VASC			.87	1.9	.13	.35	.07	.26	4.1	7.4	.2	.56	.27	.7	2.1	5.4			.13	.52				

WILDLIFE HABITAT RELATIONSHIPS

WILDLIFE HABITAT RELATIONSHIPS

Because of the harsh environment, the Mountain Hemlock Zone tends to support lower numbers of wildlife species than lower elevation areas. In the western Cascades, elevation appears to be the most important variable determining the number of vertebrate species that occur on a given site. In comparison to lower elevations, relative numbers of amphibian, reptile, and bird species are lower at higher elevations while species of mammals are relatively more abundant (Harris 1984). Trees do not usually reach the large size typical of "old growth" habitat so species tied to this habitat are generally absent. Hardwood trees do not occur widely in the Mountain Hemlock Zone so those species associated with hardwood forests are absent. However, some species of wildlife have adapted to take advantage of the niches available at higher elevations. The growing season is short but intense (similar to arctic environments) and species have adapted to take advantage of the short but intense bloom in insect populations, forb and flower production. The parkland types, with mosaics of meadow and tree islands or ribbons, provide an inherent, abundant edge habitat used by a number of wildlife species. Many of the species that use the Mountain Hemlock Zone are open habitat species and primarily use the meadows between the ribbons of trees in the parklands. Table 11 lists species using habitats in the Mountain Hemlock Zone.

Most mammals are year-round residents. They burrow beneath the snow or hibernate during winter. The exceptions are deer and elk that migrate to lower elevations during winter. Marmots only occur in high elevation meadows. They usually burrow under rocks in the meadow. Pikas occur on open talus slopes at higher elevations. Voles and gophers can easily burrow in the ashy, pumice, or sandy soils. Habitat for gray wolf, grizzly bear, lynx and wolverine exists primarily at high elevations. These species prey on small mammals and big game. Perhaps more important, a high proportion of the Mountain Hemlock Zone is in designated wilderness areas resulting in low road densities and low levels of human disturbance. Mountain goats use alpine areas during the summer but migrate down into the Mountain Hemlock Zone during winter, using mainly steep slopes, cliffs, and rocky areas. Many species of bats sexually segregate during the summer with the males using the higher elevations and the females and young remaining at lowerelevation, warmer sites. The native red fox occurs in high-elevation, open habitats. (The red fox seen in low-elevation valleys is a subspecies introduced from the East Coast).

Most birds using the Mountain Hemlock Zone are summer residents that migrate to lower elevations or lower latitudes during winter. Lincoln's sparrow, rosy finch, and American pipit are example of migrants that are unique to the higher elevations during the summer. Ptarmigan, chickadees, gray jays, nutcrackers, ravens, and crossbills are year-round residents of the Mountain Hemlock Zone. The corvids (ravens, jays, nutcrackers) are all omnivorous and store or cache food to make it through the winter. Some of the smaller seed eating birds like pine grosbeak and crossbills are year-round residents that rely on conifer seeds for food during the winter. Stands in the Mountain Hemlock Zone usually provide a diversity of conifer seed including pine and spruce. White-tailed ptarmigan survive all winter on catkins, buds, and conifer needles. In summer they eat leaves, flowers, fruit and seeds of forbs. Black-backed woodpecker habitat is rare on the two forests, but stands in the Mountain Hemlock Zone containing pine, spruce, and larch provide habitat for the bird. This woodpecker is given special protection as a "Protection Buffer" species in the Northwest Forest Plan. Bald eagles may forage at lakes and wetlands in the Mountain Hemlock Zone but trees are usually not large enough to support a nest.

Some amphibians and reptiles occur in the Mountain Hemlock Zone. Most of them occur at a wide range of elevations and are as common or more common at lower elevations. Exceptions are the Cascades frog, spotted frog, and western toad. The Cascades frog occurs only in high elevation wetlands, lakes, and ponds. The spotted frog used to occur at low elevations but has recently been restricted to high elevation lakes, ponds, and wetlands. The reason for its extirpation from low elevations is unknown, but is probably partially related to predation by introduced bullfrogs. Western toads occur at a variety of elevations but seem to reach their peak abundance at higher elevations. Reptiles key in on the open habitats of the parkland types.

Table 11. Wildlife species using habitats in the Mountain Hemlock Zone.

		HABITAT TYPES USED				
Common Name	Scientific Name	Open	Small Tree	Large Tree	Parklands	Riparian/Special
AMPHIBIANS						
Northwestern salamander	*Ambystoma gracile*	X		X	X	X
Long-toed salamander	*Ambystoma macrodactylum*	X			X	X
Pacific giant salamander	*Dicamptodon tenebrosus*		X	X		X
Oregon slender salamander	*Batrachoseps wrighti*			X		X
Ensatina	*Ensatina eschscholtzii*		X	X		X
Rough-skinned newt	*Taricha granulosa*	X	X	X	X	X
Western toad	*Bufo boreas*	X			X	X
Pacific treefrog	*Pseudacris regilla*	X	X	X	X	X
Tailed frog	*Ascaphus truei*		X	X		X
Cascades frog	*Rana cascadae*	X	X	X	X	X
Spotted frog	*Rana pretiosa*					X
BIRDS						
Common loon	*Gavia immer*					X
Pied-billed grebe	*Podilymbus podiceps*					X
Mallard	*Anas platyrhynchos*					X
Cinnamon teal	*Anas cyanoptera*					X
Ring-necked duck	*Aythya collaris*					X
Harlequin duck	*Histrionicus histrionicus*		X	X		X
Barrow's goldeneye	*Bucephala islandica*			X		X
Bufflehead	*Bucephala albeola*			X		X
Hooded merganser	*Lophodytes cucullatus*			X		X
Common merganser	*Mergus merganser*					X
Turkey vulture	*Cathartes aura*	X		X		X
Bald eagle	*Haliaeetus leucocephalus*					X
Northern harrier	*Circus cyaneus*	X				X
Sharp-shinned hawk	*Accipiter striatus*	X	X	X	X	X
Cooper's hawk	*Accipiter cooperii*		X	X		X
Northern goshawk	*Accipiter gentilis*			X		X
Red-tailed hawk	*Buteo jamaicensis*	X		X		X
Golden eagle	*Aquila chrysaetos*	X			X	X

Table 11 (con't).

		HABITAT TYPES USED				
Common Name	Scientific Name	Open	Small Tree	Large Tree	Parklands	Riparian/Special
American kestrel	*Falco sparverius*	X		X	X	X
Peregrine falcon	*Falco peregrinus*	X				X
Prairie falcon	*Falco mexicanus*	X				X
Blue grouse	*Dendragapus obscurus*	X	X	X	X	X
White-tailed ptarmigan	*Lagopus leucurus*	X			X	X
Mountain quail	*Oreortyx pictus*	X				X
Sandhill crane	*Grus canadensis*	X				X
Solitary sandpiper	*Tringa solitaria*					X
Spotted sandpiper	*Actitis macularia*					X
Common snipe	*Gallinago gallinago*	X				X
Western screech-owl	*Otus kennicottii*	X	X	X	X	X
Great horned owl	*Bubo virginianus*	X		X	X	X
Northern pygmy-owl	*Glaucidium gnoma*			X		X
Northern spotted owl[1]	*Strix occidentalis caurina*			X		
Barred owl	*Strix varia*			X		X
Northern saw-whet owl	*Aegolius acadicus*	X	X	X		X
Common nighthawk	*Chordeiles minor*	X			X	X
Black swift	*Cypseloides niger*	X				X
Vaux's swift	*Chaetura vauxi*	X	X	X		X
Calliope hummingbird	*Stellula calliope*	X			X	X
Rufous hummingbird	*Selasphorus rufus*	X	X	X	X	X
Red-naped sapsucker	*Sphyrapicus nuchalis*		X	X	X	X
Red-breasted sapsucker	*Sphyrapicus ruber*		X	X	X	X
Williamson's sapsucker	*Sphyrapicus thyroideus*		X	X	X	X
Hairy woodpecker	*Picoides villosus*			X		X
Three-toed woodpecker	*Picoides tridactylus*			X	X	X
Black-backed woodpecker	*Picoides arcticus*			X	X	X
Northern flicker	*Colaptes auratus*	X		X	X	X
Pileated woodpecker[1]	*Dryocopus pileatus*			X		
Olive-sided flycatcher	*Contopus borealis*	X		X		X
Western wood-pewee	*Contopus sordidulus*	X	X			X

Table 11 (con't).

		HABITAT TYPES USED				
Common Name	Scientific Name	Open	Small Tree	Large Tree	Parklands	Riparian/Special
Hammond's flycatcher	*Empidonax hammondii*	X		X	X	X
Dusky flycatcher	*Empidonax oberholseri*	X				X
Pacific slope flycatcher	*Empidonax difficilis*			X		X
Cordilleran flycatcher	*Empidonax occidentalis*			X		X
Horned lark	*Eremophila alpestris*	X				X
Tree swallow	*Tachycineta bicolor*	X		X	X	X
Violet-green swallow	*Tachycineta thalassina*	X		X	X	X
Gray jay	*Perisoreus canadensis*	X	X	X	X	X
Steller's jay	*Cyanocitta stelleri*	X	X	X	X	X
Clark's nutcracker	*Nucifraga columbiana*	X	X	X	X	X
American crow	*Corvus brachyrhynchos*	X	X	X	X	X
Common raven	*Corvus corax*	X	X	X	X	X
Mountain chickadee	*Parus gambeli*	X	X	X	X	X
Chestnut-backed chickadee	*Parus rufescens*	X	X	X		X
Red-breasted nuthatch	*Sitta canadensis*		X	X	X	X
Brown creeper	*Certhia americana*		X	X		X
Winter wren	*Troglodytes troglodytes*		X	X		X
American dipper	*Cinclus mexicanus*					X
Golden-crowned kinglet	*Regulus satrapa*	X	X	X	X	X
Ruby-crowned kinglet	*Regulus calendula*	X	X	X		X
Mountain bluebird	*Sialia currucoides*	X			X	X
Townsend's solitaire	*Myadestes townsendi*	X		X	X	X
Swainson's thrush	*Catharus ustulatus*	X	X	X		X
Hermit thrush	*Catharus guttatus*	X	X	X	X	X
American robin	*Turdus migratorius*	X	X	X	X	X
Varied thrush	*Ixoreus naevius*	X		X		X
American pipit (water pipit)	*Anthus spinoletta*	X			X	X
Solitary vireo	*Vireo solitarius*		X	X		X
Orange-crowned warbler	*Vermivora celata*	X				X

Table 11 (con't).

Common Name	Scientific Name	HABITAT TYPES USED: Open	Small Tree	Large Tree	Parklands	Riparian/Special
Yellow-rumped warbler	*Dendroica coronata*	X	X	X	X	X
Townsend's warbler	*Dendroica townsendi*			X	X	X
Hermit warbler	*Dendroica occidentalis*			X		X
Wilson's warbler	*Wilsonia pusilla*					X
Western tanager	*Piranga ludoviciana*		X	X		X
Chipping sparrow	*Spizella passerina*	X	X			X
Savannah sparrow	*Passerculus sandwichensis*	X				X
Fox sparrow	*Passerella iliaca*	X			X	X
Lincoln's sparrow	*Melospiza lincolnii*	X				X
White-crowned sparrow	*Zonotrichia leucophrys*	X			X	X
Dark-eyed junco	*Junco hyemalis*	X	X	X	X	X
Snow bunting	*Plectrophenax nivalis*	X			X	X
Brown-headed cowbird	*Molothrus ater*	X	X			X
Rosy finch	*Leucosticte arctoa*	X			X	X
Pine grosbeak	*Pinicola enucleator*				X	X
Cassin's finch	*Carpodacus cassinii*	X	X	X	X	X
Red crossbill	*Loxia curvirostra*			X	X	X
White-winged crossbill	*Loxia leucoptera*			X	X	X
Pine siskin	*Carduelis pinus*	X	X	X	X	X
Evening grosbeak	*Coccothraustes vespertinus*	X	X	X	X	X
MAMMALS						
Masked shrew	*Sorex cinereus*					X
Vagrant shrew	*Sorex vagrans*	X				X
Baird's shrew	*Sorex bairdii*	X		X	X	X
Dusky shrew	*Sorex monticolus*	X	X	X	X	X
Water shrew	*Sorex palustris*					X
Coast mole	*Scapanus orarius*	X	X	X		X
Little brown myotis	*Myotis lucifugus*	X		X	X	X
Long-eared myotis	*Myotis evotis*	X	X	X	X	X
Fringed myotis	*Myotis thysanodes*	X		X		X

Table 11 (con't).

		HABITAT TYPES USED				
Common Name	Scientific Name	Open	Small Tree	Large Tree	Parklands	Riparian/Special
Long-legged myotis	*Myotis volans*	X	X	X	X	X
California myotis	*Myotis californicus*	X		X	X	X
Silver-haired bat	*Lasionycteris noctivagans*	X			X	X
Big brown bat	*Eptesicus fuscus*	X				X
Hoary bat	*Lasiurus cinereus*	X		X	X	X
Pika	*Ochotona princeps*	X			X	X
Snowshoe hare	*Lepus americanus*	X			X	X
Yellow-pine chipmunk	*Tamias amoenus*	X			X	X
Townsend's chipmunk	*Tamias townsendii*			X	X	X
Yellow-bellied marmot	*Marmota flaviventris*	X			X	X
Hoary marmot	*Marmota caligata*	X			X	X
Golden-mantled ground squirrel	*Spermophilus lateralis*	X	X	X	X	X
Cascade golden-mantled ground squirrel	*Spermophilus saturatus*	X	X	X	X	X
Douglas' squirrel	*Tamiasciurus douglasii*		X	X		X
Northern flying squirrel	*Glaucomys sabrinus*			X		X
Northern pocket gopher	*Thomomys talpoides*	X				X
Western pocket gopher	*Thomomys mazama*	X			X	X
Beaver	*Castor canadensis*					X
Forest (long-tailed) deer mouse	*Peromyscus oreas*	X	X	X		X
Deer mouse	*Peromyscus maniculatus*	X			X	X
Southern red-backed vole	*Clethrionomys gapperi*	X	X	X	X	X
Western red-backed vole	*Clethrionomys californicus*	X	X	X	X	X
Heather vole	*Phenacomys intermedius*	X			X	X
Long-tailed vole	*Microtus longicaudus*	X			X	X
Creeping vole	*Microtus oregoni*	X			X	X
Water vole	*Microtus richardsoni*					X
Gray wolf	*Canis lupus*	X	X	X		X
Red fox	*Vulpes vulpes*	X			X	X
Black bear	*Ursus americanus*	X	X	X		X

Table 11 (con't).

		HABITAT TYPES USED				
Common Name	Scientific Name	Open	Small Tree	Large Tree	Parklands	Riparian/Special
Grizzly bear	*Ursus arctos*	X	X	X	X	X
Marten	*Martes americana*			X		X
Fisher	*Martes pennanti*			X		X
Ermine	*Mustela erminea*	X	X	X	X	X
Long-tailed weasel	*Mustela frenata*	X			X	X
Mink	*Mustela vison*	X			X	X
Wolverine	*Gulo gulo*			X	X	X
Mountain lion	*Felis concolor*	X	X	X	X	X
Lynx	*Felis lynx*	X	X	X	X	X
Bobcat	*Felis rufus*	X			X	X
Elk	*Cervus elaphus*	X	X	X	X	X
Black-tailed & mule deer	*Odocoileus hemionus*	X	X	X	X	X
Mountain goat	*Oreamnos americanus*	X		X	X	X
REPTILES						
Northern alligator lizard	*Elgaria coerulea*	X			X	X
Western skink	*Eumeces skiltonianus*	X				X
Rubber boa	*Charina bottae*	X				X
Common garter snake	*Thamnophis sirtalis*	X			X	X

[1] These species are restricted to lower elevation sites in the Mountain Hemlock zone, generally below about 4,000 feet.

PLANT ASSOCIATION DESCRIPTIONS

KEYING OUT PLANT ASSOCIATIONS

The keys that follow are intended to be used in relatively undisturbed, mature forest stands. Stands with sufficient ground disturbance to alter species composition, and stands younger than about 40 years will be difficult to key. Such sites are not at "potential", but rather in an earlier successional stage. (Early successional keys are currently available only for the Pacific Silver Fir Zone, and can be obtained by contacting the Area Ecologist). When keying out a site, forest edges (adjacent to openings) should be avoided. As a rule, a good size of an area to key out is a circle with a radius of 40 to 50 feet.

When evaluating a plot for species composition, the percent cover of each species is determined independently. Appendix 2 contains a visual representation of various levels of percent cover to aid in estimation. Some stands may be so dense that the understory is not well-developed; in this case, use relative dominance rather than absolute percent cover when working through the key.

The keying process begins with a determination of Forest Zone (see keys below). Plant associations for the Mountain Hemlock Zone are found in this publication; consult the publications listed in the Forest Zone Key for plant associations in other zones.

Always begin at the first pair of couplets in the key! Entering the key part way through will yield an incorrect answer. Always evaluate your answer by comparing your site with the narrative description of species composition, and if necessary, compare to the cover/constancy tables found in Appendix 1.

Note: The key is not the classification! The plant associations are much more complex than can easily be represented in a dichotomous key, therefore before accepting the results of keying, the description should be read and used to verify the determination.

KEYS TO FOREST ZONES

The following keys are used to determine which Forest Zone a site falls within. A Forest Zone is the area within which a particular tree species is projected to be the "climax", or potential natural community, dominant over time. Because of disturbance regimes, climax stands are infrequently found within the study area, and mixtures of early and late successional species are the rule. The Forest Zone concept is important because it reflects a fundamental ecological stratification of environments, related primarily to macroclimate. The keys for Oregon and Washington are slightly different; be sure to use the appropriate key for the State you are in (this will affect primarily east-side areas). **Note: In the keys below, overstory trees are >12' tall; understory trees are <=12' tall.**

Key to Forest Zones, Gifford Pinchot National Forest (Washington)

1a Subalpine fir (understory) >=2% and Subalpine fir (overstory) >=10%; or Mountain hemlock (understory) >=2% or Mountain hemlock (overstory) >=10% . . .**Mountain Hemlock Zone**
1b Not as above . . . **2**

2a Pacific silver fir (understory) >=2% or Pacific silver fir (overstory) >=10% . . . **Pacific Silver Fir Zone** (see Brockway and others, 1983)
2b Not as above . . . **3**

3a Western hemlock (understory) >=2% or Western hemlock (overstory) >=10% . . . **Western Hemlock Zone** (see Topik and others, 1986)
3b Not as above . . . **4**

4a Grand fir (understory) >=2% or Grand fir (understory) >=10% . . . **5**
4b Not as above . . . **6**

5a West of Cascade crest, on alluvial terrace . . . **Western Hemlock Zone** (see Topik and others, 1986)
5b East of Cascade crest, or dry upland site on Wind R. RD . . . **Grand Fir Zone** (see Topik and others, 1989)

6a Douglas-fir (understory) >=2% or Douglas-fir (overstory) >=10% . . .**Douglas-Fir Zone** (see Topik and others, 1989)
6b Not as above, not part of a coniferous forest series

Key to Forest Zones, Mt. Hood National Forest (Oregon)

1a Subalpine fir (understory) >=2% and Subalpine fir (overstory) >=10%; or Mountain hemlock (understory) >=2% or Mountain hemlock (overstory) >=10% . . .**Mountain Hemlock Zone**
1b Not as above . . . **2**

2a Pacific silver fir (understory) >=2% or Pacific silver fir (overstory) >=10% . . . **Pacific Silver Fir Zone** (see Hemstrom and others, 1982)
2b Not as above . . . **3**

3a Grand fir (understory) >=2% or Grand fir (understory) >=10% (key eastside types dominated by Western redcedar here) . . . **4**

4a West of Cascade crest . . . **Western Hemlock Zone** (see Halverson and others, 1986)
4b East of Cascade crest . . . **Grand Fir Zone** (see Topik and others, 1988)

3b Not as above . . . **5**

5a Western hemlock (understory) >=2% or Western hemlock (overstory) >=10% . . . **Western Hemlock Zone** (see Halverson and others, 1986)
5b Not as above . . . **6**

6a Douglas-fir (understory) >=2% or Douglas-fir (overstory) >=10% . . . **Douglas-Fir Zone** (see Topik and others, 1988)
6b Not as above . . . 7

7a Ponderosa pine (understory) >=2% and Ponderosa pine (overstory) >=10% . . . **Ponderosa Pine Zone** (see Topik and others, 1988)

Key to Mountain Hemlock Zone Plant Associations

1a. Overstory tree cover ≥ 10% 2

1b. Overstory tree cover < 10% . . . . non-forest, not included

2a. Mountain hemlock (TSME) + subalpine fir (ALBA2) + white bark pine (PIAL) + lodgepole pine (PICO) ≥ 10% 3

2b. Not as above. . . . . Not included in this guide; either alpine area with krumholtz or subalpine

3a. Mountain juniper (JUCO4) cover ≥ 2% . . . . **TSME-ABLA2/JUCO4**, p. 47 **CAS411**

3b. Not as above 4

4a. Green fescue (FEVI) cover ≥ 10%. . . . . **TSME-ABLA2/FEVI**, p. 43 **CAG211**

4b. Not as above 5

5a.. Newberry's fleeceflower (PONE4) cover ≥ 2% . . . . **TSME-ABLA2/PONE4**, p. 51 **CAF211**

5b. Not as above 6

6a. Cascade aster (ASLE2) cover ≥ 5% . . . . **TSME-ABLA2/ASLE2,** p. 39 **CAF311**

6b. Not as above 7

7a. Red heather (PHEM) + delicious blueberry (VADE)cover > 5%. . . . . **TSME/PHEM-VADE**, p. 63 **CAS211**

7b. Not as above 8

8a. Hitchcock's woodrush (LUHI) cover ≥2%. 9

- 9a. White bark pine cover ≥ 2% . . . . **TSME-PIAL/LUHI**, p. 67 **CAG312**

- 9b.. White bark pine (PIAL) cover < 2%. . . . . **TSME/LUHI**, p. 55 **CAG311**

8b. Hitchcock's woodrush cover < 2% 10

10a. Cascade azalea (RHAL) cover ≥ 5% . . . . **TSME/RHAL**, p. 71 **CMS223**

10b. Not as above 11

11a Fool's huckleberry (MEFE) cover ≥ 5% .... **TSME/MEFE**, p. 59
CMS221

11b.. Not as above 12

12a. Grouse huckleberry (VASC) cover ≥ 5%. .... **TSME/VASC**, p. 93
CMS114

12b. Not as above 13

13a. Rhododendron (RHMA) cover ≥ 5% .... **TSME/RHMA, p. 77**
CMS612

13b. Not as above 14

14a. Big huckleberry (VAME) cover ≥ 5% 15

15a. Beargrass (XETE) cover ≥ 5% .... **TSME/VAME/XETE**, p. 87
CMS216

15b. Beargrass (XETE) cover < 5%. .... **TSME/VAME/CLUN**, p. 81
CMS218

14b. Go back to #`1, use lower plant cover totals to make your decisions. IF THAT DOES NOT WORK, YOU ARE IN AN UNUSUAL AREA, OR A DIFFERENT ZONE.

Table 12. Scientific name, common name and PLANTS Database (USDA-NRCS, 1997) acronym of common Mountain Hemlock Zone plant species. Nomenclature conforms to Hitchcock and Cronquist, 1973.

Scientific Name	**Common Name**	**Acronym**
TREES:		
Abies amabilis	Pacific silver fir	ABAM
Abies grandis	Grand fir	ABGR
Abies lasiocarpa	Subalpine fir	ABLA2
Abies procera	Noble fir	ABPR
Castanopsis chrysophylla	Golden chinkapin	CACH
Chamaecyparis nootkatensis	Alaska yellow-cedar	CHNO
Larix occidentalis	Western larch	LAOC
Picea engelmannii	Engelmann spruce	PIEN
Pinus albicaulis	Whitebark pine	PIAL
Pinus contorta	Lodgepole pine	PICO
Pinus monticola	Western white pine	PIMO
Pseudotsuga menziesii	Douglas-fir	PSME
Thuja plicata	Western redcedar	THPL
Tsuga heterophylla	Western hemlock	TSHE
Tsuga mertensiana	Mountain hemlock	TSME
SHRUBS:		
Acer circinatum	Vine maple	ACCI
Amelanchier alnifolia	Saskatoon serviceberry	AMAL
Arctostaphylos nevadensis	Pinemat manzanita	ARNE
Berberis nervosa	Oregon grape	BENE
Cassiope mertensiana	White mountain heather	CAME

Scientific Name	**Common Name**	**Acronym**
Chimaphila menziesii	Little prince's pine	CHME
Chimaphila umbellata	Prince's pine	CHUM
Gaultheria ovatifolia	Slender wintergreen	GAOV
Holodiscus discolor	Oceanspray	HODI
Juniperus communis	Mountain juniper	JUCO4
Linnaea borealis	Twinflower	LIBO2
Lonicera involucrata	Black twinberry	LOIN
Menziesia ferruginea	Fools huckleberry	MEFE
Pachistima myrsinites	Mountain boxwood	PAMY
Phyllodoce empetriformis	Red mountain heather	PHEM
Rhododendron albiflorum	Cascades azalea	RHAL
Rhododendron macrophyllum	Western rhododendron	RHMA
Ribes lacustre	Prickly currant	RILA
Rosa gymnocarpa	Baldhip rose	ROGY
Rubus lasiococcus	Dwarf bramble	RULA
Rubus parviflorus	Thimbleberry	RUPA
Rubus pedatus	Trailing blackberry	RUPE
Sorbus sitchensis	Sitka mountain ash	SOSI
Spiraea densiflora	Subalpine spiraea	SPDE
Symphoricarpos mollis	Trailing snowberry	SYMO
Vaccinium alaskaense	Alaska huckleberry	VAAL
Vaccinium caespitosum	Dwarf huckleberry	VACA
Vaccinium deliciosum	Blueleaf huckleberry	VADE
Vaccinium membranaceum	Big huckleberry	VAME
Vaccinium ovalifolium	Oval-leaf huckleberry	VAOV

Scientific Name	Common Name	Acronym
Vaccinium parvifolium	Red huckleberry	VAPA
Vaccinium scoparium	Grouse huckleberry	VASC
FORBS:		
Achillea millefolium	Western yarrow	ACMI
Achlys triphylla	Vanilla leaf	ACTR
Anaphalis margaritacea	Pearly everlasting	ANMA
Anemone deltoidea	Threeleaf anemone	ANDE
Anemone lyallii	Lyall's anemone	ANLY2
Anemone occidentalis	Western pasqueflower	ANOC
Anemone oregana	Oregon anemone	ANOR
Antennaria lanata	Woolly pussytoes	ANLA
Arenaria macrophylla	Big-leaved sandwort	ARMA3
Arnica cordifolia	Heart-leaf arnica	ARCO
Arnica latifolia	Mountain arnica	ARLA
Aster alpigenus	Alpine aster	ASAL
Aster ledophyllus	Cascades aster	ASLE2
Aster spp.	Aster	ASTER
Calochortus subalpinus	Mountain mariposa	CASU6
Calypso bulbosa	Calypso orchid	CABU2
Campanula scouleri	Scouler's harebell	CASC2
Castilleja hispida	Harsh Indian paintbrush	CAHI2
Clintonia uniflora	Queencup beadlily	CLUN
Cornus canadensis	Bunchberry dogwood	COCA
Corallorhiza mertensiana	Merten's coralroot	COME
Epilobium alpinum	Alpine willow-weed	EPAL

Scientific Name	**Common Name**	**Acronym**
Epilobium minutum	Small-flowered willowherb	EPMI
Erigeron peregrinus	Subalpine daisy	ERPE
Erythronium montanum	Avalanche lily	ERMO
Fragaria spp.	Wild strawberry	FRAGA
Goodyera oblongifolia	Rattlesnake plantain	GOOB
Hieracium albiflorum	White-flowered hawkweed	HIAL
Hieracium gracile	Slender hawkweed	HIGR
Hypopitys monotropa	Common pinesap	HYMO
Ligusticum grayi	Gray's lovage	LIGR
Listera caurina	Western twayblade	LICA3
Listera cordata	Northern listera	LICO3
Lomatium martindalei	Biscuit root	LOMA2
Luetkea pectinata	Partridge foot	LUPE
Lupinus latifolius	Broadleaf lupine	LULA
Lupinus lepidus	Prairie lupine	LULE2
Lupinus polyphyllus	Bigleaf lupine	LUPO
Lupinus spp.	Lupine	LUPIN
Mitella breweri	Brewer's miterwort	MIBR
Nothochelone nemorosa	Woodland beard-tongue	NONE
Osmorhiza chilensis	Sweet cicely	OSCH
Osmorhiza purpurea	Purple sweetroot	OSPU
Pedicularis groenlandica	Elephant's head	PEGR
Pedicularis racemosa	Parrot's beak	PERA
Phlox diffusa	Spreading phlox	PHDI
Polemonium pulcherrimum	Skunkleaf polemonium	POPU

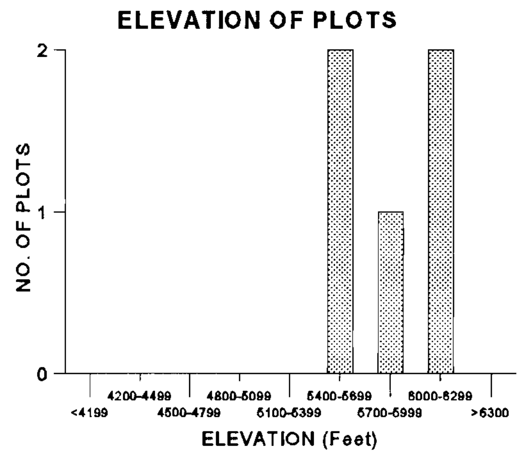
Scientific Name	Common Name	Acronym
Polygonum bistortoides	American bistort	POBI
Polygonum newberryi	Newberry's knotweed	PONE4
Potentilla flabellifolia	Fan-leaved cinquefoil	POFL2
Pteridium aquilinum	Bracken fern	PTAQ
Pyrola asarifolia	Large pyrola	PYAS
Pyrola picta	White vein pyrola	PYPI
Pyrola secunda	Sidebells pyrola	PYSE
Senecio bolanderi	Bolander's groundsel	SEBO
Senecio triangularis	Arrow-leaf groundsel	SETR
Smilacina racemosa	False solomonplume	SMRA
Smilacina stellata	Starry solomonplume	SMST
Spraguea umbellata	Pussypaws	SPUM
Streptopus roseus	Rosy twistedstalk	STRO
Tiarella trifoliata unifoliata	Coolwort foamflower	TITRU
Trillium ovatum	Western trillium	TROV
Valeriana sitchensis	Sitka valerian	VASI
Vancouveria hexandra	Insideout flower	VAHE
Veratrum californicum	False hellebore	VECA
Veratrum viride	False hellebore	VEVI
Vicia spp.	Vetch	VICIA
Viola orbiculata	Darkwoods violet	VIOR2
Viola sempervirens	Evergreen violet	VISE
Xerophyllum tenax	Beargrass	XETE
GRASSES/GRASSLIKES:		
Bromus spp.	Brome	BROMU

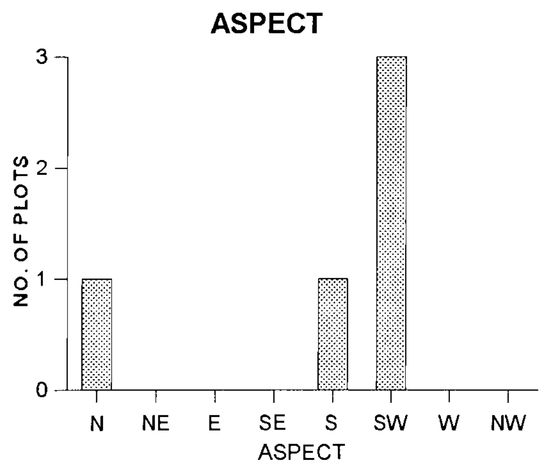
Scientific Name	**Common Name**	**Acronym**
Carex geyeri	Elk sedge	CAGE
Carex nigricans	Black alpine sedge	CANI2
Carex pachystachya	Thick-headed sedge	CAPA
Carex pensylvanica	Long-stolon sedge	CAPE5
Carex spectabilis	Showy sedge	CASP
Carex spp.	Sedge	CAREX
Deschampsia atropurpurea	Mountain hairgrass	DEAT
Festuca viridula	Green fescue	FEVI
Juncus drummondii	Drummond's rush	JUDR
Luzula campestris	Field woodrush	LUCA2
Luzula hitchcockii	Hitchcock's woodrush	LUHI
Luzula parviflora	Small-flowered woodrush	LUPA
Poa spp.	Bluegrass species	POA

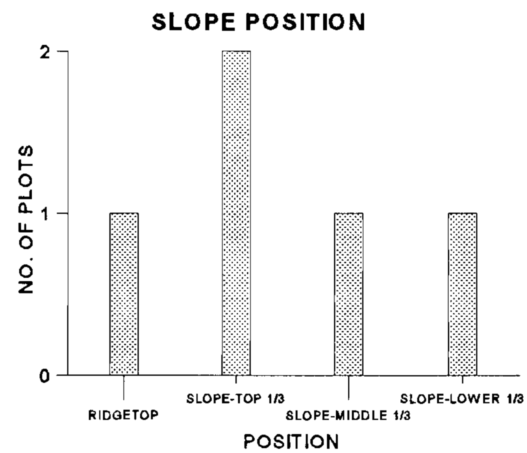
Mountain Hemlock-Subalpine Fir/Cascade Aster
Tsuga mertensiana-Abies lasiocarpa/Aster ledophyllus
TSME-ABLA2/ASLE2 CAF311
No. Plots = 6

Environment and Location

The TSME-ABLA2/ASLE2 association represents cold, moist subalpine environments. These open forests have severe winters, cool summers, deep winter snowpacks and late snowmelt. In this sample, the TSME-ABLA2/ASLE2 association was found between 5600 and 6200 feet in elevation on moderate to steep, south to southwest-facing slopes (occasionally northwest). Most sites were on high elevation benches or plateaus, or on the middle to upper-half of high ridges. The samples from which this type is described were located in the Goat Rocks Wilderness, on Mt. Adams, and in the vicinity of Mt. Hood.







Vegetation Composition, Structure, and Diversity

The TSME-ABLA2/ASLE2 association typically occurs as open-canopy tree islands or ribbons within the subalpine zone. Shrubs are sparse, but the herbaceous layer is usually well-developed. Mature mountain hemlock (TSME) and subalpine fir (ABLA2) dominate the canopy, and Pacific silver fir (ABAM) is often present in low to moderate amounts. Scattered white bark pine (PIAL) may also occur. Mountain hemlock dominates the regeneration layer. The shrub layer is depauperate; dwarf bramble (RULA) and Sitka mountain ash (SOSI) may occur in small amounts.

Herbaceous cover is very well-developed; in the Mountain Hemlock Zone only the TSME-ABLA2/FEVI association has higher herbaceous cover. Cascade aster (ASLE2), skunk-leaved polemonium (POPU), broadleaf lupine (LULA), and Hitchcock's woodrush (LUHI) are dominant. Other species that may be present include parrot's beak (PERA), green fescue (FEVI), false hellebore (VEVI), and mountain hairgrass (DEAT).

The TSME-ABLA2/ASLE2 association consists primarily of pole (5-11" dbh) and small-diameter (11-21" dbh) stands with an relatively open canopy (mature tree canopy cover ranged between 5 and 60% among plots in this association). A variety of age classes were represented in this sample. The oldest were between 150 and 200 years old. Mountain hemlock generally was the oldest species present. The younger age classes (50-100 years) were generally subalpine fir and white bark pine. Tree heights were generally less than 100 feet, and the tallest trees were mountain hemlock. Live basal area averaged 217 ft^2 /ac in this sample, a low value compared the Mountain Hemlock Zone as a whole, reflecting the open structure of this type.

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies amabilis	ABAM	14	50
Abies lasiocarpa	ABLA2	15	67
Pinus albicaulis	PIAL	5	50
Tsuga mertensiana	TSME	12	83
Reprod. Trees			
Abies amabilis	ABAM	3	33
Abies lasiocarpa	ABLA2	4	50
Tsuga mertensiana	TSME	2	83
Shrubs			
Rubus lasiococcus	RULA	1	50
Sorbus sitchensis	SOSI	2	67
Forbs			
Aster ledophyllus	ASLE2	13	100
Lupinus latifolius	LULA	15	100
Phlox diffusa	PHDI	7	50
Polemon. pulcherr.	POPU	22	83
Grasses, grasslikes			
Deschampsia atrop.	DEAT	2	50
Luzula hitchcockii	LUHI	5	83

COV. = Average % foliar cover
CONS. = the % of plots on which species occurred

There was an average of 20.0 vascular plant species per plot in this sample of the TSME-ABLA2/ASLE2 association, with an average of 6.5 dominant species. These are average values compared to the Mountain Hemlock Zone overall.

Fire Ecology

The TSME-ABLA2/ASLE2 association falls within Fire Group 10 (Evers and others, 1996). Because the subalpine environment is generally cold and moist, stand replacement fires tend to occur infrequently (at least 200-300 years apart). The concept of stand replacement fire frequency does not apply well to this Fire Group, because most fires are spotty and involve only a few trees scattered among clumps. Crown fires are most likely to occur during periods of drought where high winds cause lower elevation fires to burn up into the subalpine zone.

Fuel loadings in natural mature stands generally consist of sparse fine fuels in combination with moderate to heavy amounts of larger fuels, mostly as a result of wind damage, snow breakage and insect activity. In all but the driest years, high fuel moisture and cool temperatures result in low fire hazard.

Wildlife Habitat Relationships

This association has a low diversity of conifers. The presence of white bark pine on many sites provides an important conifer seed source for those birds and mammals exploiting that resource. Trees are somewhat stunted but still provide small tree habitat and structure.

Shrub cover is very low. The occasional heather or huckleberry plant provides some cover for ground nesting birds.

Marmots often create burrows with entrances near rocks and boulders. Gophers burrow in the ashy/sandy soils. These mammals feed on forbs and grasses.

These open, parkland sites provide habitat for several high elevation specialists, such as the rosy finch, white-tailed ptarmigan, American pipit, and marmots. The birds nest in open areas near rocks, boulders, or tufts of grass. The finch and ptarmigan feed on leaves, flowers, and seeds of grasses and forbs. Lupine is common on these sites and provides seeds for these birds and other birds and mammals. Lupine flowers also provide nectar for hummingbirds.

Productivity and Management

Plant growth in sites with the TSME-ABLA2/ASLE2 association is limited by cold temperatures, deep snowpacks and short growing season. These are not sites where typical forest management through tree harvest would be carried out; tree productivity is limited, and stand recovery from treatment is likely to be lengthy. Single-tree or small-group selection are likely to be the best choices where stand regeneration is an objective. Site index on our samples in this type averaged 50 (base age 100) for subalpine fir and 49 (base age 100) for mountain hemlock. Stocking is lower than in typical non-parkland forested sites. These are sites that are difficult to reforest once the canopy is removed, and difficult to revegetate after ground disturbance, due to the short, severe growing season with the risk of nightly frost. Soil nutrients may be limited, especially if the forest floor is disturbed. Because of cold temperatures, soil biological activity is limited, and site nutrients tend to concentrate in the forest floor layers rather than becoming incorporated into the mineral soil.

Recreation values are very high in this type, due to the attractions of the subalpine environment for hiking, camping and hunting. Wildflower openings are common. Although only one soil description is available for this type, the species present indicate the soils are likely to be silty to sandy and adequately-drained, and have abundant moisture for plant growth. In areas of finer-textured, moist soils, there may be a risk of compaction, rutting, root exposure and erosion where human traffic is concentrated. This type often occurs in areas managed for nordic or alpine skiing; sites that are cleared for ski runs are likely to be very difficult to revegetate, due to the extreme climate and nutrient-poor soils.

Down wood data are not available for this association. Due to small tree diameters, large woody debris is likely to be limited.

Soils

Only one plot in this association has a soil description, from a cirque basin in the headwaters of the Cispus River. The soil is moderately deep volcanic ash and pumice deposited over basalt. The effective depth is low and no duff layer was present.

Number of soil descriptions:	1
Average soil depth:	70 cm
Average rooting depth:	70 cm
Average effective depth:	30 cm
Average duff thickness:	0 cm
Parent materials:	Volcanic ash, pumice/andesite, glacial drift

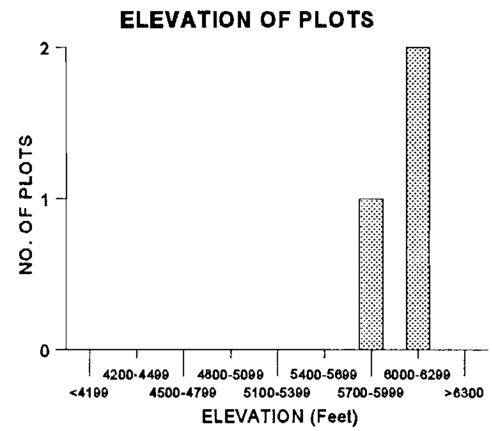
Comparisons

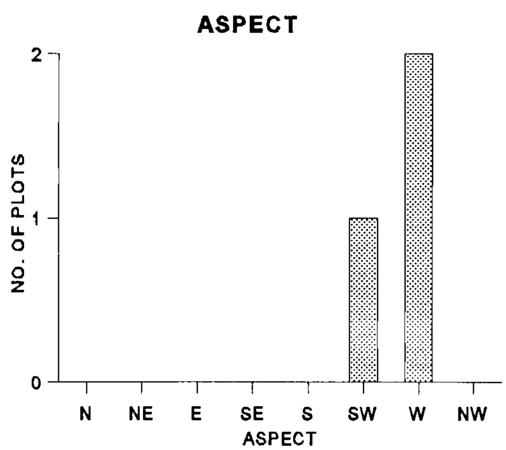
This type has not been described elsewhere in USDA Forest Service Pacific Northwest Region plant association classifications.

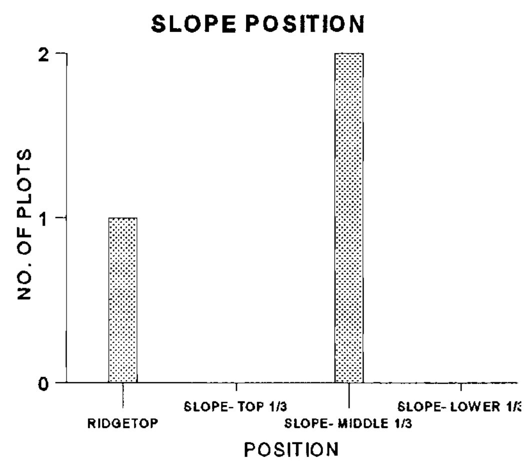
Mountain Hemlock-Subalpine Fir/Green Fescue
Tsuga mertensiana-Abies lasiocarpa/Festuca viridula
TSME-ABLA2/FEVI CAG211
No. Plots = 3

Environment and Location

The TSME-ABLA2/FEVI association is found at high elevations in cold, mesic sites at the upper limit of tree growth. These open subalpine forests have severe winters, cool summers, and deep winter snowpacks. The average elevation for this sample was 5916 feet. Slopes were flat to moderate, and orientation tended to be to the southwest or west. The plots in this sample occurred on ridgetops and mid-slopes. This type is described from a small number of samples located in subalpine parkland on the southern flanks of Mt. Hood and Mt. Adams.







Vegetation Composition, Structure, and Diversity

The TSME-ABLA2/FEVI association typically occurs as small tree islands or ribbons in subalpine parkland. Shrubs are sparse, but the herbaceous layer is generally well-developed, at 83% cover in this sample, the highest herb abundance of any Mountain Hemlock Zone association. The tree overstory and regeneration layers are dominated by subalpine fir (ABLA2) and mountain hemlock (TSME). Small amounts of mature and regenerating white bark pine (PIAL) may be found. The following herbs are common and typically comprise 10-25% of the cover: green fescue (FEVI), Hitchcock's woodrush (LUHI), broadleaf lupine (LULA), and Cascade aster (ASLE2). Other herbs include black alpine sedge (CANI2), mountain arnica (ARLA), and chamisso sedge (CAPA).

This association consists primarily of pole (5-11" dbh) stands with a relatively open canopy (5 to 40% in this sample). Stands tended to be uneven aged, with the older trees in this sample averaging between 90 and 120 years old. Live basal area averaged 130 ft^2/acre, by far the lowest value for all Mountain Hemlock Zone associations. Tree height averaged between 50 and 100 feet.

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies lasiocarpa	ABLA2	17	100
Tsuga mertensiana	TSME	12	100
Reprod. Trees			
Abies lasiocarpa	ABLA2	6	100
Tsuga mertensiana	TSME	6	100
Forbs			
Arnica latifolia	ARLA	1	67
Aster ledophyllus	ASLE2	9	100
Lupinus latifolius	LULA	23	100
Polemon. pulcherr.	POPU	11	67
Grasses, grasslikes			
Carex nigricans	CANI2	3	67
Carex pachystachya	CAPA	2	100
Deschampsia atrop.	DEAT	1	67
Festuca viridula	FEVI	20	100
Luzula hitchcockii	LUHI	21	100

COV. = Average % foliar cover
CONS. = the % of plots on which species occurred

There was an average of 19.7 vascular plant species per plot in this sample of the TSME-ABLA2/FEVI association, with an average of 7.5 dominant species. These are average values for the Mountain Hemlock Zone as a whole.

Fire Ecology

The TSME-ABLA2/FEVI association falls within Fire Group 10 (Evers and others, 1996). Because the subalpine environment is generally cold and moist, stand replacement fires tend to occur infreqently (at least 200-300 years apart). The concept of stand replacement fire frequency does not apply well to this Fire Group, because most fires are spotty and involve only a few trees scattered among clumps. Crown fires are most likely to occur during periods of drought where high winds cause lower elevation fires to burn up into the subalpine zone.

Fuel loadings in mature natural stands generally consist of sparse fine fuels in combination with moderate to heavy amounts of larger fuels, mostly as a result of wind damage, snow breakage and insect activity. In all but the dryest years, high fuel moisture and cool temperatures result in low fire hazard.

Wildlife Habitat Relationships

This association has a low diversity of conifers. The presence of white-bark pine on some sites provides an important conifer seed source for those birds and mammals exploiting that resource. Tree sizes are quite small, almost providing a "shrubby" structure for wildlife habitat.

Shrub cover is very low. The occasional heather or huckleberry plant provides some cover for ground nesting birds.

These open, parkland sites provide habitat for several high elevation specialists, such as the rosy finch, white-tailed ptarmigan, American pipit, and marmots. The birds nest in open areas near rocks, boulders or tufts of grass. The finch and ptarmigan feed on leaves, flowers and seeds of grasses and forbs. Lupine and fescue are common on these sites and provide seeds for these birds and other birds and mammals. Lupine flowers also provide nectar for hummingbirds.

Marmots often create burrows with entrances near rocks and boulders. Gophers burrow in the ashy/sandy soils. These mammals feed on forbs and grasses.

Productivity and Management

Plant growth in sites with the TSME-ABLA2/FEVI association is limited by the cold temperatures, deep snowpacks and short growing season. These are not sites where typical forest management through tree harvest would be carried out; tree productivity is limited, and stand recovery from treatment is likely to be lengthy. Single-tree or small-group selection are likely to be the best choices for stand management. Only a small number of samples (5) of tree productivity are available; site index on these samples averaged 72 (base age 100) for subalpine fir and 66 (base age 100) for mountain hemlock. In addition, stocking is lower than in typical non-parkland forested sites. These are sites that are difficult to reforest once the canopy is removed, and difficult to revegetate after ground disturbance, due to the short, severe growing season with the risk of nightly frost. Soil nutrients may be limited, especially if the forest floor is disturbed. Because of cold temperatures, soil biological activity is limited, and site nutrients tend to concentrate in the forest floor layers rather than becoming incorporated into the mineral soil.

Recreation values are very high in this type, due to the attractions of the subalpine environment for hiking, camping and hunting. Although soil descriptions are not available for this type, the species present indicate the soils are likely to be relatively fine-textured and have adequate moisture throughout the growing season. The finer-textured, moist soils may be susceptible to compaction, rutting, root exposure and erosion where human traffic is concentrated. This type often occurs in areas managed for nordic or alpine skiing; sites that are cleared for ski runs are likely to be very difficult to revegetate, due to the extreme climate and nutrient-poor soils.

Down wood data are not available for this association. Due to small tree diameters, large woody debris is unlikely to be present.

Soils

Soil descriptions are not available for this association.

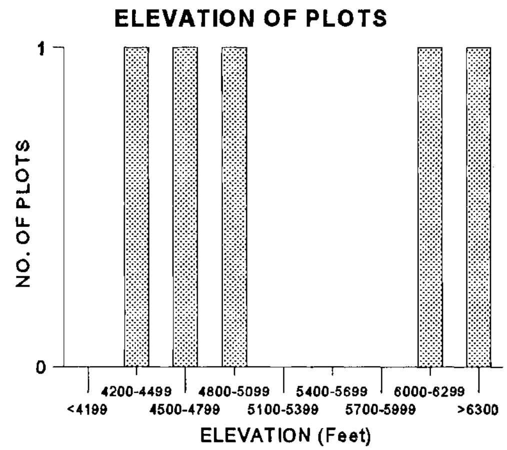
Comparisons

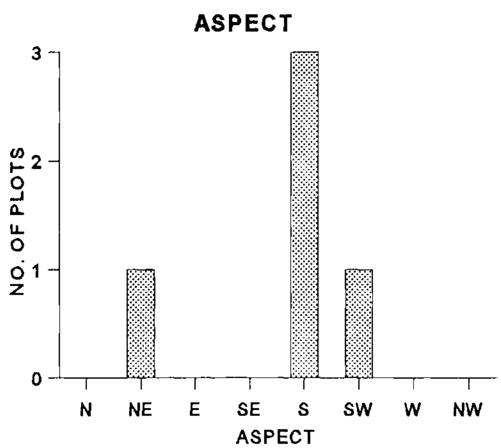
This type has not been described elsewhere in USDA Forest Service Pacific Northwest Region plant association classifications.

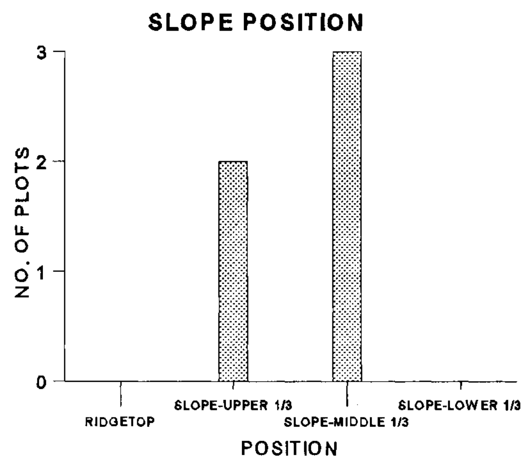
Mountain Hemlock-Subalpine Fir/Mountain Juniper
Tsuga mertensiana-Abies lasiocarpa/Juniperus communis
TSME-ABLA2/JUCO4 CAS411
No. Plots - 4

Environment and Location

The TSME-ABLA2/JUCO4 association represents severely cold, dry subalpine timberline environments. These open, parkland forests have extremely cold winters, cool summers and deep winter snowpacks. The sites in this sample ranged between 4720 feet and 6600 feet in elevation. Slopes were moderate to very steep, and often oriented to the south. Upper and mid-slopes were the most common plot locations. This type is described from a small number of samples on Mt. Hood.







Vegetation Composition, Structure, and Diversity

The TSME-ABLA2/JUCO4 association typically occurs as small tree islands in subalpine parkland. The overstory and regeneration layers are composed of mountain hemlock (TSME), subalpine fir (ABLA2), and white bark pine (PIAL). White bark pine dominates; of the parkland associations this one has the smallest amounts of mountain hemlock and subalpine fir. Common juniper (JUCO4), a low shrub, was found in all sample plots and averaged 24% cover. Very small amounts of herbs are present, including fleeceflower (PONE4), Hitchcock's woodrush (LUHI), skunk-leaved polemonium (POPU), and bromes (*Bromus* spp.).

This association consists primarily of pole (5-11" dbh) stands with a very open canopy. Tree ages in this sample were extremely variable; trees in all age classes are likely to be present, even trees as old as 200-300 years. Tree stature is usually quite low (<50 ft.), but scattered individuals as tall as 100 ft. may occasionally be present. Live basal area in this sample averaged 227 ft^2/acre, a moderate value for parkland types.

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies lasiocarpa	ABLA2	5	50
Pinus albicaulis	PIAL	10	75
Tsuga mertensiana	TSME	8	75
Reprod. Trees			
Abies lasiocarpa	ABLA2	6	50
Pinus albicaulis	PIAL	6	50
Tsuga mertensiana	TSME	1	75
Shrubs			
Arctostaph. nevaden.	ARNE	3	50
Juniperus communis	JUCO4	24	100
Forbs			
Achillea millefolium	ACMI	1	100
Aster spp.	ASTER	1	50
Phlox diffusa	PHDI	2	50
Polemon. pulcherr.	POPU	9	50
Grasses, grasslikes			
Luzula hitchcockii	LUHI	8	50

COV. = Average % foliar cover
CONS. = the % of plots on which species occurred

This association as a whole has many plant species present but each comprises only a small amount of cover. On the average there were 22.5 vascular plant species per plot, with an average of 6.1 dominant species. This is the highest species richness for Mountain Hemlock Zone associations overall.

Fire Ecology

The TSME-ABLA2/JUCO4 association falls within Fire Group 10 (Evers and others, 1996). Because the subalpine environment is generally cold and moist, stand replacement fires tend to occur infrequently (at least 200-300 years apart). The concept of stand replacement fire frequency does not apply well to this Fire Group, because most fires are spotty and involve only a few trees scattered among clumps. Crown fires are most likely to occur during periods of drought where high winds cause lower elevation fires to burn up into the subalpine zone.

Fuel loadings in mature natural generally consist of sparse fine fuels in combination with moderate to heavy amounts of larger fuels, mostly as a result of wind damage, snow breakage and insect activity. In all but the driest years, high fuel moisture and cool temperatures result in low fire hazard.

Wildlife Habitat Relationships

This association has a fairly low diversity of conifers. The presence of white-bark pine on most sites provides an important conifer seed source for those birds and mammals exploiting that resource. Tree sizes are quite small, almost providing a "shrubby" structure for wildlife habitat. Low shrubs provide cover for ground-nesting birds.

These open, parkland sites provide habitat for several high elevation specialists, such as the rosy finch, white-tailed ptarmigan, American pipit, mountain goats and marmots. The birds nest near rocks or boulders. The finch and ptarmigan feed on leaves, flowers and seeds of grasses and forbs. The pipit is insectivorous. Marmots often create burrows with entrances near rocks and boulders. These mammals also feed on forbs and grasses. The steep slopes and numerous boulders may provide fall/spring range for mountain goats.

Productivity and Management

Plant growth in the TSME-ABLA2/JUCO4 association is limited by cold temperatures, deep snowpacks, short growing season and coarse/dry soils. These are not sites where typical forest management through timber harvest would be carried out; tree productivity is limited, and stand recovery from treatment is likely to be lengthy. Single tree or small group selection are likely to be the best choices for stand management. Only a small number (5) of tree productivity estimates are available; site index on these samples was recorded as 68 (base age 100) for subalpine fir and 41 (base age 100) for mountain hemlock. In addition, stocking is lower than in a typical non-parkland forest. These sites are extremely difficult to reforest once the canopy is removed, and difficult to revegetate after ground disturbance. The short severe growing season with its nightly risk of frost, and the coarse, dry soils impede vegetation re-establishment. The forest floor tends to be patchy and thin, indicating soil nutrients and biological activity are severely restricted.

Recreation values are very high in this association, due to the attractiveness of the subalpine environment for hiking, camping and hunting. The presence of rocks and boulders on the soil surface may affect camping use. High amounts of bare soil result in a very high hazard of soil displacement, especially where there is damage to sparse, low-growing vegetation, and traffic is heavy or dispersed over a wide area. This type often occurs in areas managed for nordic or alpine skiing; sites that are cleared for ski runs are likely to be very difficult to revegetate, due to the extreme climate and nutrient-poor soils.

Down wood data are not available for this association. Due to small tree diameters, large woody debris is likely to be extremely limited.

Soils

There were only two soil descriptions recorded for this association. The soil surfaces on these plots have duff layers under the tree islands but considerable bare soil elsewhere. The surface layers of these soils are sandy in texture. One profile has an eluviated horizon. Ten to twenty percent of the surface of these plots is covered by boulders.

Number of soil descriptions:	2	
Average soil depth:	100 cm	
Average rooting depth:	93 cm	Range 85-100 cm
Average effective depth:	64 cm	Range 42-86 cm

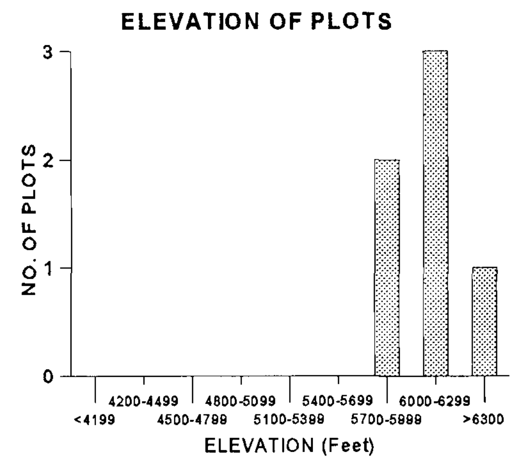
Average duff thickness:	2.25 cm	Range 0.5-4 cm
Parent materials:	Volcanic ash/andesite, glacial drift	

Comparisons

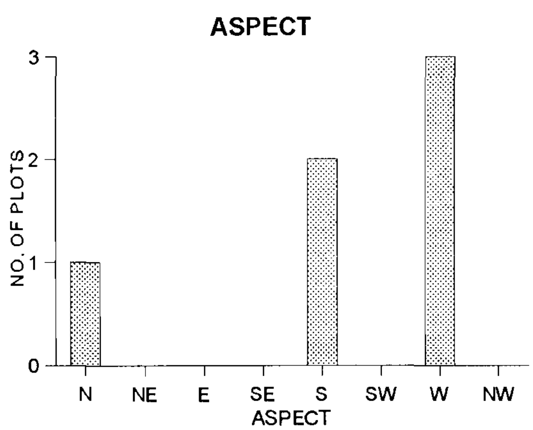
This type is not described elsewhere in USDA Forest Service Pacific Northwest Region plant association classifications.

Mountain Hemlock-Subalpine Fir/Newberry's Knotweed
Tsuga mertensiana-Abies lasiocarpa/Polygonum newberryi
TSME-ABLA2/PONE4 CAF211
No. Plots = 4

Environment and Location



The TSME-ABLA2/PONE4 association represents severely cold and dry subalpine parkland environments at the upper elevation of tree growth. In this sample elevations ranged between 5900 and 6400 feet. These sites are cold in winter, cool in summer, and have deep snow accumulations and late snowmelt. Soils are coarse and dry, and there is considerable bare soil and rock. Slopes tended to be flat to moderate and were oriented primarily to the west. Most plots occurred on the middle to upper half of high ridges. This type is described from a small number of samples located on the south side of Mt. Adams, and on Mt. Hood.



Vegetation Composition, Structure, and Diversity

The TSME-ABLA2/PONE4 typically occurs as tree islands or ribbons in subalpine parkland. The overstory is dominated by mountain hemlock (TSME) with lower amounts of subalpine fir (ABLA2) and white bark pine (PIAL). Lodgepole pine (PICO) may be present as well. Regeneration is predominantly mountain hemlock. Shrubs are sparse; Sitka mountain ash (SOSI) and little prince's pine (CHME) occur in very small amounts. The low herb cover consists almost entirely of Newberry knotweed (PONE4), although lupine and smallflowered woodrush (LUPA) may be present.

This association consists primarily of pole (5-11" dbh) stands with a very open canopy (20-30% mature tree canopy cover). A variety of age classes is typically represented in the tree layer. The oldest trees tend to be mountain hemlock, and an abundance of trees in the 200-300 year age class may be present. Tree stature is generally less than 100 feet, and significant numbers of old, very small trees (<12' tall) are common. Live basal area averaged 204 ft^2/acre in this sample, the second-lowest value for the Mountain Hemlock Zone.

There was an average of 14.3 vascular plant species per plot in this sample of the TSME-ABLA2/PONE4 association, with an average of 7.5 dominants. This represents very low species richness compared to the Mountain Hemlock Zone as a whole.

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies lasiocarpa	ABLA2	5	75
Pinus albicaulis	PIAL	4	75
Tsuga mertensiana	TSME	10	100
Reprod. Trees			
Pinus albicaulis	PIAL	2	75
Tsuga mertensiana	TSME	8	75
Forbs			
Lupinus latifolius	LULA	6	50
Lupinus spp.	LUPIN	2	75
Polygonum newberryi	PONE4	3	100

COV. = Average % foliar cover
CONS. = the % of plots on which species occurred

Wildlife Habitat Relationships

This association has a fairly low diversity of conifers. The presence of white-bark pine and lodgepole pine provides an important source of conifer seed for those birds and mammals exploiting that resource. Tree sizes are quite small, almost providing a "shrubby" structure for wildlife habitat.

These open, park-like sites provide habitat for several high elevation specialists, such as the rosy finch, white-tailed ptarmigan, American pipit, and marmots. The birds nest in open areas near rocks, boulders, or tufts of grass. The finch and ptarmigan feed on leaves, flowers, and seeds of grasses and forbs. Lupine is common on these sites and provides seeds for these birds and other birds and mammals. Lupine flowers also provide nectar for hummingbirds.

Marmots often create burrows with entrances near rocks and boulders. Gophers burrow in the ash/pumice soils. These mammals feed on forbs and grasses.

Fire Ecology

The TSME-ABLA2/PONE4 association falls within Fire Group 10 (Evers and others, 1996). Because the subalpine environment is generally cold and moist, stand replacement fires tend to occur infrequently (at least 200-300 years apart). The concept of stand replacement fire frequency does not apply well to this Fire Group, because most fires are spotty and involve only a few trees scattered among clumps. Crown fires are most likely to occur during periods of drought where high winds cause lower elevation fires to burn up into the subalpine zone.

Fuel loadings in mature natural stands generally consist of sparse fine fuels in combination with moderate to heavy amounts of larger fuels, mostly as a result of wind damage, snow breakage and insect activity. In all but the driest years, high fuel moisture and cool temperatures result in low fire hazard.

Productivity and Management

Plant growth in the TSME-ABLA2/PONE4 association is limited by cold temperatures, deep snowpacks, short growing season and coarse/dry soils. These are not sites where typical forest management through timber harvest would be carried out; tree productivity is limited, and stand recovery from treatment is likely to be lengthy. Single tree or small group selection are likely to be the best choices for stand management. Site index on our samples in this type averaged 61 (base age 100) for subalpine fir and 47 (base age 100) for mountain hemlock. Stocking is lower than in a typical non-parkland forest. These sites are extremely difficult to reforest once the canopy is removed, and difficult to revegetate after ground disturbance. The short severe growing season with its nightly risk of frost, and the coarse, dry soils impede vegetation re-establishment. The forest floor tends to be patchy and thin, indicating soil nutrients and biological activity are severely restricted.

Recreation values are very high in this association, due to the attractiveness of the subalpine environment for hiking, camping and hunting. The presence of rocks and boulders on the soil surface may affect camping use. High amounts of bare soil result in a very high risk of soil displacement, especially where traffic is heavy. Human use may become very dispersed and impactful in this type, as there are few natural barriers to off-trail traffic. As a result damage to fragile subalpine vegetation may be considerable. This type often occurs in areas managed for nordic or alpine skiing; sites that are cleared for ski runs are likely to be very difficult to revegetate, due to the extreme climate and nutrient-poor soils.

Down wood data are not available for this association. Due to small tree diameters, large woody debris is extremely limited.

Soils

Four plots in this association had soil profile descriptions. The soils were characterized by very thin duff layers, shallow rooting and low effective depths. The soils consisted of thin layers of volcanic ash and pumice deposited over glacial materials with high rock content. One plot had soil with an eluviated surface horizon.

Number of soil descriptions:	4	
Average soil depth:	75 cm	Range 35-100 cm
Average rooting depth:	54 cm	Range 15-75 cm

Average effective depth:	40 cm	Range 14-73 cm
Average duff thickness:	0.68 cm	Range 0-1.4 cm
Parent material:	Volcanic ash, some pumice/andesite, glacial drift	

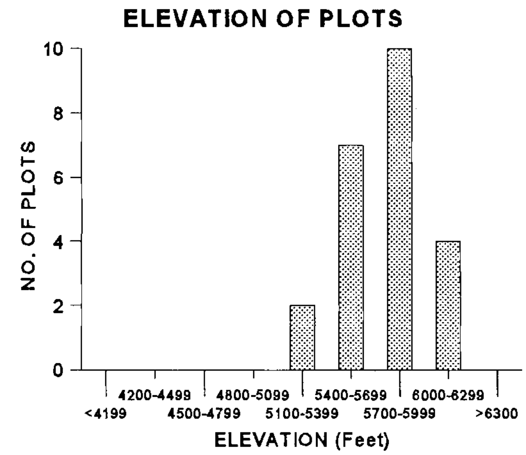
Comparisons

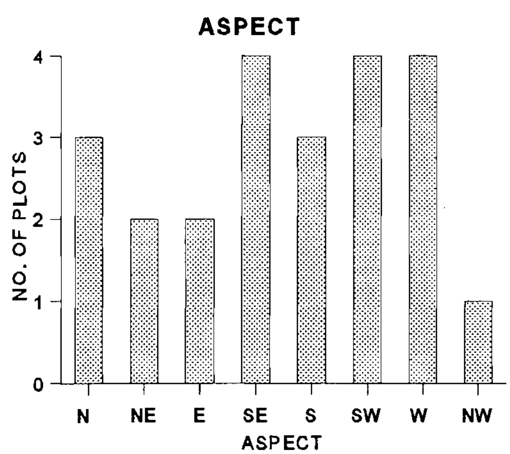
This type has not been described elsewhere in plant association classifications for the USDA Forest Service Pacific Northwest Region.

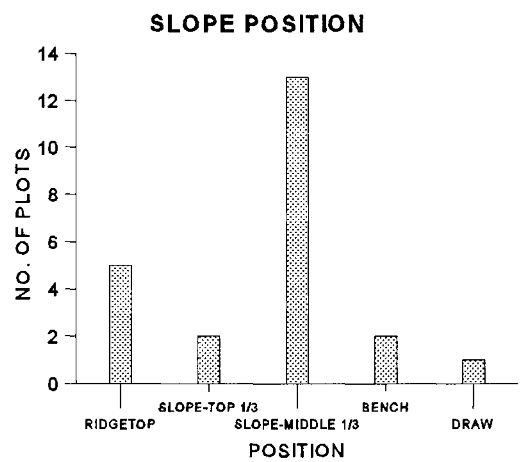
Mountain hemlock/Hitchcock's Woodrush
Tsuga mertensiana/Luzula hitchcockii
TSME/LUHI CAG311
No. Plots = 22

Environment and Location

The TSME/LUHI association represents cold, mesic sites in the transition zone between continuous forest and subalpine parkland. These sites have severe winters, cool summers and deep winter snowpacks. Snowmelt generally occurs late in the season; the lichen line averaged 15 feet above the ground in this sample. Our plots ranged between 5210 and 6200 feet in elevation, averaging 5739 feet. Most plots were on ridgetops or upper slopes. Slope steepness and aspect were variable. This type is described from a variety of locations throughout the study area; it is a common upper elevation Mountain Hemlock Zone type.







Vegetation Composition, Structure, and Diversity

The TSME/LUHI association takes a variety of forms, from small tree islands within the subalpine parkland to closed canopy forest at the upper edge of the continuous forest zone. The shrub layer is variable, and the herbaceous layer is typically well-developed. The overstory is predominantly mountain hemlock (TSME) with an average cover of 19%. Subalpine fir (ABLA2) and Pacific silver fir are often present, in smaller amounts. In the shrub layer, low to moderate amounts of big huckleberry (VAME), Sitka mountain ash (SOSI) and dwarf bramble (RULA) are often present. In the herbaceous layer, Hitchcock's woodrush (LUHI) is dominant, and is frequently associated with green fescue (FEVI), mitrewort (MIBR), Sitka valerian (VASI), skunk-leaved polemonium (POPU), mountain arnica (ARLA), and broadleaf lupine (LULA).

This association consists mostly of small- (11-21" dbh) and large-diameter (>21" dbh) stands with a relatively open canopy (average mature tree canopy cover = 36%, range 15-70%). The oldest trees in sampled stands were mountain hemlock and subalpine fir trees in the 200-300 year age class. Sampled trees represented a wide range of ages, with trees over 100 years old commonly found. Tree stature was typically between 50 and 100 feet tall; trees over 100 feet were rare. Live basal area averaged 315 ft^2 per acre. This is average stocking for continuous forest types within the Mountain Hemlock Zone.

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies amabilis	ABAM	6	41
Abies lasiocarpa	ABLA2	21	64
Tsuga mertensiana	TSME	19	100
Reprod. Trees			
Abies lasiocarpa	ABLA2	6	50
Tsuga mertensiana	TSME	5	86
Shrubs			
Rubus lasiococcus	RULA	5	59
Sorbus sitchensis	SOSI	2	59
Vaccinium membran.	VAME	6	59
Forbs			
Arnica latifolia	ARLA	5	77
Lupinus latifolius	LULA	9	82
Mitella breweri	MIBR	6	45
Polemon. pulcherr.	POPU	2	64
Senecio triangularis	SETR	2	55
Valeriana sitchensis	VASI	8	59
Grasses, grasslikes			
Luzula hitchcockii	LUHI	19	100

COV. = Average % foliar cover
CONS. = the % of plots on which species occurred

There was an average of 18.5 vascular plant species per plot in this sample of the TSME/LUHI association, with an average of 6.3 dominant species. These are somewhat low values compared to the Mountain Hemlock Zone as a whole.

Fire Ecology

The TSME/LUHI association falls within Fire Group 10 (Evers and others, 1996). Because the subalpine environment is generally cold and moist, stand replacement fires tend to occur infrequently (at least 200-300 years apart). The concept of stand replacement fire frequency does not typically apply well to this Fire Group, because most fires are spotty and involve only a few trees scattered among clumps. Crown fires are most likely to occur during periods of drought where high winds cause lower elevation fires to burn up into the subalpine zone.

Fuel loadings in mature natural stands generally consist of sparse fine fuels in combination with moderate to heavy amounts of larger fuels, mostly as a result of wind damage, snow breakage and insect activity. In all but the driest years, high fuel moisture and cool temperatures result in low fire hazard.

Wildlife Habitat Relationships

True firs and mountain hemlock dominate this association. Except for the occasional white pine or Engelmann spruce this type does not have the diverse cone crop that attracts seed eating birds. The closed canopy stands provide thermal cover in summer range for deer and elk.

The sparse shrub layer often contains big huckleberry and/or Sitka mountain ash. These shrubs provide limited nest sites and cover. Both shrubs produce berries consumed by a variety of wildlife species. Lupine is common on these sites and provides an important seed source for birds and mammals. Lupine flowers also provide nectar for hummingbirds.

The combination of open parkland sites, plentiful herbs, and ashy soils makes good habitat for burrowing mammals such as pocket gophers and ground squirrels. The soil is easy to burrow and the forbs provide forage.

Productivity and Management

Plant growth in sites with the TSME/LUHI association is limited by cold temperatures, deep snowpacks and short growing season. These are not sites where typical forest management through timber harvest is often carried out; tree productivity is limited, and stand recovery from treatment is likely to be lengthy. Single-tree or small-group selection are likely to be the best choices for stand management. Site index on our samples in this type averaged 57 (base age 100) for subalpine fir and 57 (base age 100) for mountain hemlock. Since this type is transitional between continuous forest and subalpine parkland, stockability is significantly higher than in the parkland types. These are sites that are likely to be difficult to reforest once the canopy is removed, and difficult to revegetate after ground disturbance, due to the short, severe growing season with the risk of nightly frost. Soil nutrients may be limited, especially if the forest floor is disturbed. Because of cold temperatures, soil biological activity is limited, and site nutrients tend to concentrate in the forest floor layers rather than becoming incorporated into the mineral soil. Sites with deep ashy soils and a well-developed herbaceous cover are likely to experience a significant increase in pocket gopher populations if the tree overstory is removed through clearcutting.

Recreation values in this type are those characteristic of upper elevation forests. Scattered openings with wildflowers may be present. The finer-textured, moist volcanic ash soils are likely to be susceptible to compaction, rutting, root exposure, loss of soil organic matter, and erosion where human traffic is concentrated. This type often occurs in areas managed for nordic or alpine skiing; sites that are cleared for ski runs are likely to be very difficult to revegetate, due to the extreme climate and nutrient-poor soils.

Down wood data are not available for this association. Large woody debris is likely to be present, but the quantities have not been estimated.

Soils

Thirteen soil profiles were described in this sample of the TSME/LUHI association. Most plots had fairly thin duff layers. Effective depths were, on the average, higher than in any other Mountain Hemlock Zone association. On the Gifford Pinchot National Forest some of these sites have fairly thick layers of volcanic ash and pumice from the 1980 eruption of Mt. St. Helens. On the Mt. Hood National Forest these soils all have highly leached, eluvial surface layers and three of them have spodic subsurface layers.

Number of soil descriptions:	13	
Average soil depth:	99 cm	Range 84-100 cm
Average rooting depth:	89 cm	Range 55-100 cm
Average effective depth:	76 cm	Range 29-98 cm
Average duff thickness:	2.49 cm	Range 0-6 cm
Parent materials:	Volcanic ash, pumice/andesite, glacial drift	

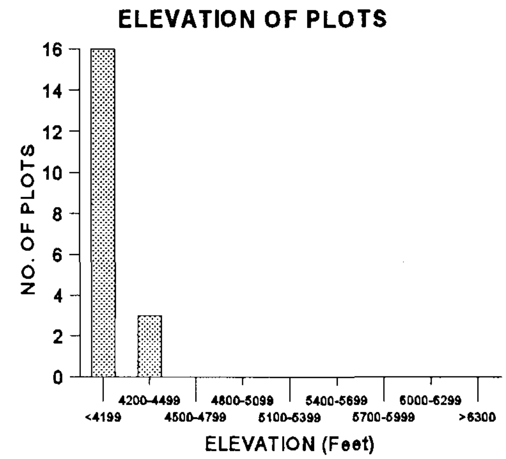
Comparisons

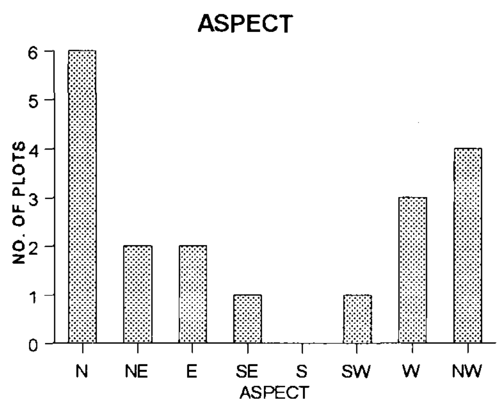
This association has also been described in the High Cascades on the Willamette National Forest (Hemstrom and others, 1987), and on the Wenatchee National Forest (Lillybridge and others, 1996).

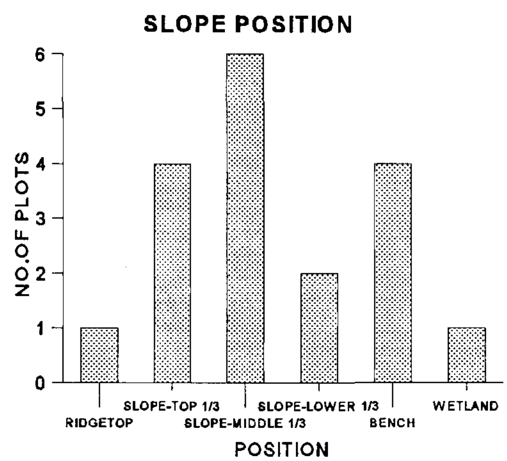
Mountain Hemlock/Fool's Huckleberry
Tsuga mertensiana/Menziesia ferruginea
TSME/MEFE CMS221
No. Plots = 18

Environment and Location

The TSME/MEFE association is typical of moist to wet sites in the lower to mid portions of the Mountain Hemlock Zone. These are upper elevation sites where frequent frost, heavy snowpacks and short growing seasons are common. Plots in this sample were located on gentle north to west-facing mountain slopes and benches at an average elevation of 4028 feet. This type is widespread throughout the Mountain Hemlock Zone within the study area.







Vegetation: Composition, Structure, and Diversity

The TSME/MEFE association is a closed forest type with a well-developed shrub layer, and variable herbaceous component. The overstory consists primarily of Pacific silver fir (ABAM) and mountain hemlock (TSME), with both species reproducing in the understory. Significant amounts of Douglas-fir (PSME), and western hemlock (TSHE) may also be present. This association is characterized by a fairly dense shrub layer, consisting predominantly of fool's huckleberry (MEFE), big huckleberry (VAME), and oval-leaf huckleberry (VAOV). Smaller amounts of dwarf bramble (RULA), five-leaved bramble (RUPE), and Sitka mountain ash (SOSI) are often present. Variable amounts of beargrass (XETE) may occur, along with small quantities of moist-site herbs, including queencup beadlily (CLUN), bunchberry dogwood (COCA), rosy twisted-stalk (STRO), and Sitka valerian (VASI).

Most of the stands in this sample of the TSME/MEFE association were in mid-seral to near climax successional stages. Stands tended to be even-aged, although a few multi-aged examples were found. The oldest well-represented age class was between 200 and 300 years old; very few trees older than this were found. Most stands were within the large diameter (>21" dbh) or old growth structural classes. Canopies averaged 100-150 feet in height. Live basal area averaged 292 ft^2/acre, a somewhat low value compared to closed-canopy Mountain Hemlock Zone forests as a whole.

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies amabilis	ABAM	26	100
Pseudotsuga menz.	PSME	16	44
Tsuga heterophylla	TSHE	10	72
Tsuga mertensiana	TSME	14	100
Reprod. Trees			
Abies amabilis	ABAM	21	100
Tsuga heterophylla	TSHE	3	56
Tsuga mertensiana	TSME	6	56
Shrubs			
Menziesia ferruginea	MEFE	23	100
Rubus lasiococcus	RULA	5	94
Vaccinium membran.	VAME	24	100
Vaccinium ovalifolium	VAOV	15	83
Forbs			
Clintonia uniflora	CLUN	4	61
Cornus canadensis	COCA	7	56
Xerophyllum tenax	XETE	16	94

COV. = Ave. % foliar cover
CONS. = % of plots on which species occurred

There was an average of 20.3 vascular plant species per plot in this sample of the TSME/MEFE association, with an average of 8.2 dominant species. These are high values compared to closed forest types in the Mountain Hemlock Zone overall.

Fire Ecology

The TSME/MEFE association falls within Fire Group 6 (Evers and others, 1996). This Fire Group represents cool, moist upper elevation sites with a regime of infrequent (one to several centuries apart) stand replacement fires. Low intensity ground fires are probably rare. Stand replacement fires probably occur under a combination of drought and strong wind conditions. The crowns of these stands are typically dense and have a high proportion of aerial fuels such as mosses and lichens, aiding the spread of the fire through the canopy.

Ground fuels in natural stands are most commonly in the >3" diameter class; smaller fuels decay rapidly in these high elevation sites. Because the stands are dense, fuel loadings may be relatively high. The abundance of shrubs may function as a heat sink under normal weather conditions, reducing fire spread, but during prolonged drought may significantly add to fuel loading.

Wildlife Habitat Relationships

This association occurs at lower elevations and on more productive sites than most of the Mountain Hemlock types. As a result, trees are larger and canopy cover is relatively high. Wildlife species typically associated with lower elevation late-successional forests are more likely to occur on these sites than most other Mountain Hemlock types. Occasionally white pine, lodgepole pine, and Engelmann spruce occur, increasing the diversity of conifer seeds available for seed eating birds and mammals. Black-backed woodpeckers use these tree species for foraging and nesting. This woodpecker has been identified as a "Protection Buffer" species in the Northwest Forest Plan (USDA Forest Service, 1994).

The dense shrub layer provides nest sites and cover for birds and hiding cover for a variety of wildlife species. Fool's huckleberry and huckleberries dominate the shrub layer producing high quality browse for deer and elk. A variety of birds and mammals consume the berries. The well-developed herb layer provides additional forage. The combination of hiding cover, forage and gentle topography makes these sites excellent summer range for deer and elk.

The thick duff layers provide habitat for invertebrates consumed by a variety of insectivorous wildlife including amphibians, shrews, thrushes and sparrows.

The sandy and ashy soils provide good substrate for burrowing mammals such as ground squirrels and moles. Most of the mature stands are probably not open enough to support pocket gophers, but gophers can be expected to increase in early successional openings.

Productivity and Management

This association is one of the more productive types within the Mountain Hemlock Zone, although it is quite low compared to forest types at lower elevations. Site index averaged 75 feet for Pacific silver fir, 107 for noble fir, 82 for Douglas-fir, 83 for western hemlock and 69 for mountain hemlock (all base age 100) in this sample.

This type is similar in management implications to the TSME/RHAL association, but the TSME/MEFE sites are probably not as cold. Frost during the growing season and an increase in shrub cover are likely to occur with canopy removal through clearcutting. Frost tolerant species such as western white pine (PIMO), western larch (LAOC) and Engelmann spruce (PIEN) are good candidates for plantation management. Douglas-fir and noble fir are more likely to suffer frost damage when planted in this type (Brockway and others, 1983). Shelterwood harvest or small group selection may be used successfully to mitigate growing season frost problems, as well as providing a seed source; Brockway and others (1983) recommended leaving 100 to 200 ft^2/acre in shelterwoods in this type. Pocket gopher populations may expand into plantations where the soils are deep and fine-textured.

The TSME/MEFE association indicates high soil moisture, and use of heavy equipment should be minimized; the risk of compaction and displacement are high. Disturbance of the subsurface spodic horizon may lead to accelerated nutrient losses through leaching. Falling to lead, cable yarding with maximum possible suspension, pre-planned skidding patterns, and minimal fuel treatment and site preparation activities will help to maintain soil productivity.

Recreation values are typical of upper elevation forests. Location of heavy human traffic or campsites in this type carries a risk of compaction and erosion, root exposure and rutting, due to the relatively fine soil textures and high soil moisture. Rehabilitation of disturbed areas should not be difficult unless soil damage is severe.

Down wood data are not available for this association. The large-diameter stand structures suggest large woody debris would be abundant in natural stands, but the quantities have not been estimated. A similar type, TSME/RHAL, had an average of 58 logs (8.4 tons) per acre in size class 12 and 5 logs (1.7 tons) per acre in size class 20 (see p. 22 for size class definitions).

Soils

The sample of this association had ten plots with soil profile descriptions. Nine of these had surface eluvial horizons and eight had subsurface spodic horizons. Duff layers were quite thick. These characteristics indicate a cold, wet environment which results in soils that have low fertility.

Number of soil descriptions:	10	
Average soil depth:	86 cm	Range 53-100 cm
Average rooting depth:	77 cm	Range 53-95 cm
Average effective depth:	58 cm	Range 15-95 cm
Average duff thickness:	5.55 cm	Range 0.25- 13 cm
Parent materials:	Volcanic ash and pumice/andesite, glacial drift	

Comparisons

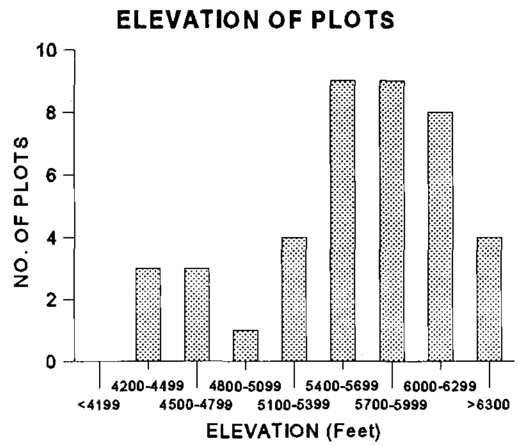
This association was described previously for the Gifford Pinchot National Forest by Brockway and others (1983). The type description has been updated to include additional plots for this publication.

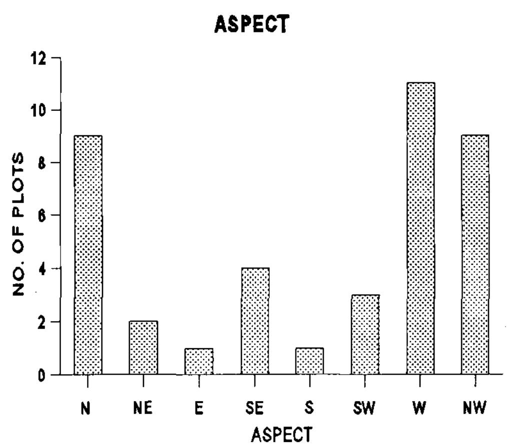
The TSME/MEFE association is similar to the Pacific Silver Fir/Fool's Huckleberry habitat type/plant association described for southern Washington (Franklin and Dyrness, 1973), for Mt. Rainier National Park (Franklin and others, 1979), for the Mt. Hood and Willamette National Forests (Hemstrom and others, 1982), and for the Gifford Pinchot National Forest (Brockway and others, 1983). The Pacific Silver Fir Zone version represents warmer sites but is similar in other respects to the Mountain Hemlock/Fool's Huckleberry association.

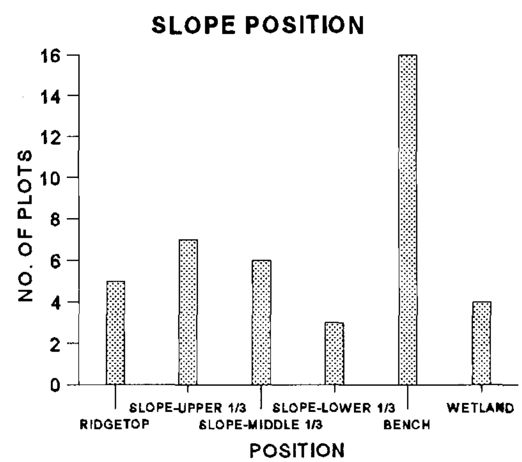
Mountain Hemlock/Red Heather-Delicious Blueberry
Tsuga mertensiana/Phyllodoce empetriformis-Vaccinium deliciosum
TSME/PHEM-VADE CAS211
No. Plots = 41

Environment and Location

The TSME/PHEM-VADE association represents cold, moist subalpine parkland sites. These open forests have severe winters, cool summers, deep winter snowpack and late snowmelt. The lichen line in this sample averaged 13 feet above ground level. The average elevation was 5600 feet, with a range of 4260 to 6660 feet. Slopes tended to be flat to moderately steep, and north, northwest and west aspects were most common. Often this association is found on a bench or adjacent to a wetland. This type is described from a variety of sites scattered throughout the subalpine portions of the study area, and is our most common subalpine association.







Vegetation Composition, Structure, and Diversity

The TSME/PHEM-VADE association typically occurs as a meadow-forest mosaic within the subalpine zone. The overstory is dominated by mountain hemlock (TSME) and subalpine fir (ABLA2), with mature or regenerating Pacific silver fir (ABAM) frequently present. The shrub layer is well-developed. Low shrubs dominate with red heather (PHEM) and delicious blueberry (VADE) together making up at least 5% foliar cover. Big huckleberry (VAME) is common, while grouse huckleberry (VASC), white heather (CAME), dwarf bramble (RULA), and Sitka mountain ash (SOSI) are often present. Herb cover averages 40% and commonly consists of Hitchcock's woodrush (LUHI), lupine, and purple lovage (LIGR). Other herbs that may be present include beargrass (XETE), Sitka valerian (VASI), false hellebore (VEVI), mountain arnica (ARLA), and avalanche fawn lily (ERMO).

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies amabilis	ABAM	9	37
Abies lasiocarpa	ABLA2	16	85
Tsuga mertensiana	TSME	17	83
Reprod. Trees			
Abies amabilis	ABAM	6	46
Abies lasiocarpa	ABLA2	9	90
Tsuga mertensiana	TSME	6	78
Shrubs			
Phyllodoce empetri.	PHEM	12	76
Vaccinium deliciosum	VADE	23	90
Vaccinium membran.	VAME	10	49
Vaccinium scoparium	VASC	4	32
Forbs			
Erythronium montanum	ERMO	4	41
Ligusticum grayi	LIGR	2	76
Luetkea pectinata	LUPE	10	71
Valeriana sitchensis	VASI	4	54
Veratrum viride	VEVI	2	37
Xerophyllum tenax	XETE	7	44

COV. = Average % foliar cover
CONS. = the % of plots on which species occurred

The TSME/PHEM-VADE association is represented by a variety of stand structural types. Most common were small-diameter (11-21" dbh) or pole (5-11" dbh) stands, but large-diameter (>21") and old growth structural types occurred in this sample as well. Canopies tended to be open, rarely exceeding 40%. Our plots in this type contained a variety of age classes, with the 100-150 year and 200-300 year age classes being most common. The oldest trees in stands tend to be mountain hemlock; it dominates the 200-300 year age class. While subalpine fir also occur in this older age class, it dominates the 100-150 year age class. These stands tend to be older than other parkland types. Sampled stands generally averaged between 50 and 100 feet in height. Live basal area averaged 254 ft^2/acre, the highest value for any of the true parkland types.

An average of 19.9 vascular plant species per plot was found in this sample of the TSME/PHEM-VADE association, with an average of 6.5 dominant species. These are average values for the Mountain Hemlock Zone as a whole.

Fire Ecology

The TSME-PHEM-VADE association falls within Fire Group 10 (Evers and others, 1996). Because the subalpine environment is generally cold and moist, stand replacement fires tend to occur infrequently (at least 200-300 years apart). The concept of stand replacement fire frequency does not apply well to this Fire Group, because most fires are spotty and involve only a few trees scattered among clumps. Crown fires are most likely to occur during periods of drought where high winds cause lower elevation fires to burn up into the subalpine zone.

Fuel loadings in mature natural stands generally consist of sparse fine fuels in combination with moderate to heavy amounts of larger fuels, mostly as a result of wind damage, snow breakage and insect activity. In all but the driest years, high fuel moisture and cool temperatures result in low fire hazard.

Wildlife Habitat Relationships

These sites support a moderate diversity of conifer trees. The addition of white pine, lodgepole pine, larch, and Engelmann spruce to some of these sites provides a variety of seed for several high elevation bird species that rely on conifer seeds. Black-backed woodpeckers use these trees for foraging and nesting. Even though the trees are short the dbh is large enough to provide nesting habitat. This woodpecker is identified as a "Protection Buffer" species in the Northwest Forest Plan (USDA Forest Service, 1994).

The low shrub layer provides nest sites for small birds and hiding cover for a variety of wildlife. Huckleberry, boxwood and Sitka mountain ash provide quality browse for deer and elk. Huckleberry and Sitka mountain ash also produce fruit consumed by a variety of birds and mammals. Beargrass and other forbs provide quality forage for deer and elk. The available forage and flat topography combine to make these sites good summer range for deer and elk.

These open parkland sites are frequently adjacent to meadows and wetlands. The edge between forest and mountain wetlands/meadows attracts species such as grouse, hares, warblers and a number of wetland associated species. Lincoln's sparrow and Cascades frog are found only in high elevation wetlands.

In open areas, the occasional rock provides nesting cover for rosy finch, white-tailed ptarmigan, and American pipit. The finch and ptarmigan feed on leaves, flowers and seeds of grasses and forbs. Lupine is common on these sites and provides seeds for these birds and other birds and mammals. Lupine flowers also provide nectar for hummingbirds.

The ashy soils provide good burrowing substrate for gophers and ground squirrels. Herbs and grasses are available for food. Wet soils may limit gopher habitat in some areas.

Productivity and Management

Plant growth in sites with the TSME/PHEM-VADE association is likely to be severely limited by cold temperatures, deep snowpacks and short growing season. These are not sites where typical forest management through timber harvest would be carried out; tree productivity is limited, and stand recovery from treatment is likely to be lengthy. Single-tree or small-group selection are likely to be the best choices for stand management. Site index on our samples in this type averaged 54 (base age 100) for subalpine fir, 51 (base age 100) for mountain hemlock, and 61 (base age 100) for Pacific silver fir. In addition, stocking is lower than in typical non-parkland forested sites. These are sites that are difficult to reforest once the canopy is removed, and difficult to revegetate after ground disturbance, due to the short, severe growing season with the risk of nightly frost. Soils may be particularly susceptible to compaction and displacement; pockets of peaty organic soils, an indication of true wetland conditions, may also occur. Soil nutrients may be limited, especially if the forest floor is disturbed. Because of cold temperatures, soil biological activity is limited, and site nutrients tend to concentrate in the forest floor layers rather than becoming incorporated into the mineral soil.

Recreation values are very high in this type, due to the attractions of the subalpine environment for hiking, camping and hunting. Wildflower openings are common, and huckleberry-picking is prime; delicious huckleberry lives up to its name, and is probably the tastiest huckleberry in our area. Because of the abundant soil moisture where this type is found, there is a significant risk of compaction, rutting, root exposure and erosion where human traffic is concentrated. The vegetation is very susceptible to trampling; red heather cover can be severely reduced because it recovers very slowly from breakage. This type often occurs in areas managed for nordic or alpine skiing; sites that are cleared for ski runs may be difficult to revegetate, due to the extreme climate, but probably not as difficult as the other parkland types in more severe sites.

Down wood data are not available for this association. Large woody debris is likely to be present, but the amounts have not been estimated.

Soils

Thirty-one plots in this association have soil profile descriptions. These plots are typically in timbered stringers adjacent to wetlands; therefore, many of the soils display characteristics of wetness such as peaty layers and mottles within a meter of the soil surface. Many areas in this association have considerable surface rock.

Number of soil descriptions:	31	
Average soil depth:	78 cm	Range 36-100 cm
Average rooting depth:	67 cm	Range 29-100 cm
Average effective depth:	56 cm	Range 25-96 cm
Average duff thickness:	3.65 cm	Range 0-11 cm
Parent materials:	Volcanic ash, some pumice/andesite, glacial drift	

Comparisons

This association is also described on the Mt. Baker-Snoqualmie National Forest (Henderson and others, 1990) and the Wenatchee National Forest (Lillybridge and others, 1996). A similar type - the TSME-ABLA2/VADE association (Henderson and others, 1989) - occurs in the Olympic National Park.

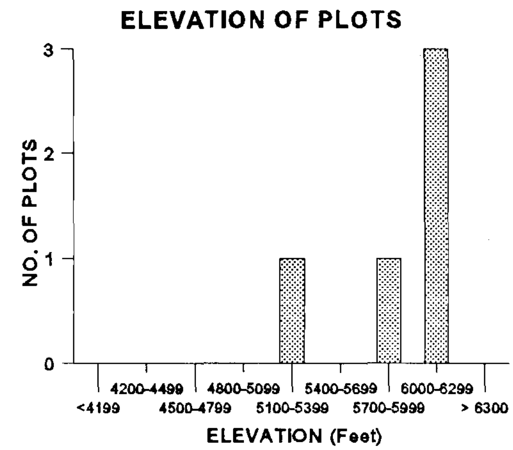
Mountain Hemlock-White Bark Pine/Hitchcock's Woodrush

Tsuga mertensiana-Pinus albicaulis/Luzula hitchcockii

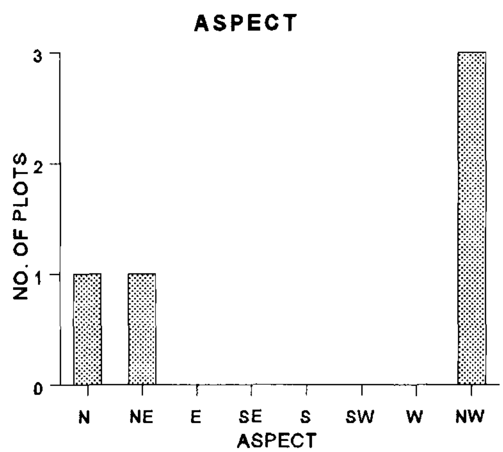
TSME-PIAL/LUHI CAG312

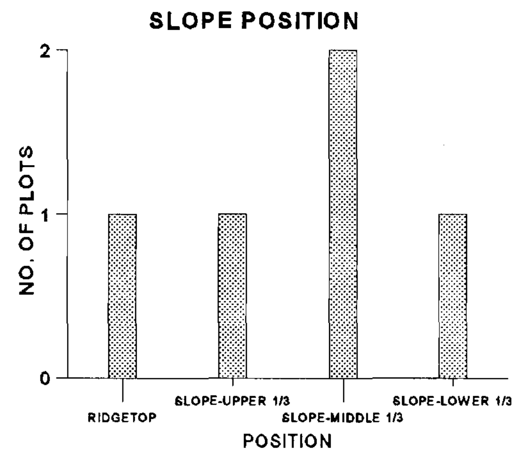
No. Plots = 5

Environment and Location



The TSME-PIAL/LUHI association occurs at very high elevations in harsh conditions. These open, subalpine forests have severe winters, cool summers, and deep winter snowpacks. These sites are some of the last to become snow-free; the lichen line averaged 14 feet above the ground surface on our plots. Four of the five plots in this sample were on a ridgetops or upper slopes at an average elevation of 5944 feet. The slope steepness varied from 10 to 68 percent; all 5 plots were oriented to the north, northeast, or northwest. The plots from which this type is described occurred on the southeast flank of Mt. Hood and the north side of Mt. Adams.





Vegetation Composition, Structure, and Diversity

The TSME-PIAL/LUHI association typically occurs as open canopy tree islands or ribbons within the subalpine zone. Of the parkland associations in the Mountain Hemlock Zone, this association generally has the highest tree cover. The shrub layer is very sparse, and the herbaceous layer is usually quite well-developed with a combination of forbs and grasslike species. The overstory is predominantly mountain hemlock (TSME) and white bark pine, with smaller amounts of Pacific silver fir (ABAM) and subalpine fir (ABLA2). In the shrub layer, big huckleberry (VAME) and Sitka mountain ash (SOSI) may occur in very small amounts. In the herbaceous layer, Hitchcock's woodrush is always present, and is often associated with mountain arnica (ARLA), broadleaf lupine (LULA), partridgefoot (LUPE) and skunk-leaved polemonium (POPU).

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies lasiocarpa	ABLA2	10	60
Pinus albicaulis	PIAL	6	100
Tsuga mertensiana	TSME	21	80
Reprod. Trees			
Abies lasiocarpa	ABLA2	5	60
Pinus albicaulis	PIAL	2	60
Tsuga mertensiana	TSME	5	80
Shrubs			
Sorbus sitchensis	SOSI	2	60
Forbs			
Arnica latifolia	ARLA	5	80
Lupinus latifolius	LULA	14	80
Luetkea pectinata	LUPE	4	80
Polemonium pulcherr.	POPU	2	60
Grasses, grasslikes			
Luzula hitchcockii	LUHI	14	100

COV. = Average % foliar cover
CONS. = the % of plots on which species occurred

This association consists of pole (5-ll" dbh) and small diameter (11-21" dbh) parkland stands with an open canopy (generally 20-40%). Mountain hemlock and whitebark pine tended to be the oldest trees in this sample, averaging 175 and 135 years old, respectively. Subalpine fir tended to be younger, generally less than 100 years old. Live tree basal area in this sample averaged 250 ft^2/acre; this is a moderate value compared to parkland types overall. In general, tree stature is small, with most individuals less than 50 feet tall.

There was an average of 16.8 vascular plant species per plot in this sample of the TSME-PIAL/LUHI association, with an average of 6.0 dominant species. These are somewhat low values compared to the Mountain Hemlock Zone as a whole.

Fire Ecology

The TSME-PIAL/LUHI association falls within Fire Group 10 (Evers and others, 1996). Because the subalpine environment is generally cold and moist, stand replacement fires tend to occur infreqently (at least 200-300 years apart). The concept of stand replacement fire frequency does not apply well to this Fire Group, because most fires are spotty and involve only a few trees scattered among clumps. Crown fires are most likely to occur during periods of drought where high winds cause lower elevation fires to burn up into the subalpine zone.

Fuel loadings in mature natural stands generally consist of sparse fine fuels in combination with moderate to heavy amounts of larger fuels, mostly as a result of wind damage, snow breakage and insect activity. In all but the dryest years, high fuel moisture and cool temperatures result in low fire hazard.

Wildlife Habitat Relationships

This association has a fairly low diversity of conifers. The presence of white-bark pine provides an important conifer seed source for those birds and mammals exploiting that resource.

Big huckleberry and/or Sitka mountain ash are the primary species in the sparse shrub layer. These shrubs provide limited nest sites and cover for birds and small mammals. Both shrubs produce berries consumed by a variety of wildlife species.

These open, parkland sites provide habitat for several high elevation specialists, such as the rosy finch, white-tailed ptarmigan, American pipit and marmots. The birds nest near rocks, boulders, or tufts of grass and sedge. The finch and ptarmigan feed on leaves, flowers and seeds of grasses and forbs. The pipit is insectivorous. Marmots often create burrows with entrances near rocks and boulders, and feed on forbs and grasses. Lupine is common on these sites and provides seeds for birds and mammals. The flowers also provide nectar for hummingbirds.

The thick duff layers provide habitat for invertebrates consumed by a variety of ground-foraging, insectivorous species. These species include amphibians, shrews, thrushes, and sparrows. The combination of ashy soils and open areas provides habitat for burrowing mammals such as gophers and moles.

Productivity and Management

Productivity on sites with the TSME-PIAL/LUHI association tends to be limited by the cold temperatures, deep snowpacks and short growing season. These are not sites where typical forest management through timber harvest would be carried out; tree productivity is limited, and stand recovery from treatment is likely to be lengthy. If stand regeneration is an objective, single-tree or small group selection are likely to be the best choices. Site index averaged 43 feet (base age 100) for mountain hemlock, 64 feet (base age 100) for Pacific silver fir, and 67 feet (base age 100) for subalpine fir. In addition, stocking tends to be lower than in typical non-parkland forested stands.

These are sites that are difficult to reforest once the canopy is removed, and difficult to revegetate if the ground is disturbed. Growing-season frost, along with insufficient soil moisture and nutrients, contribute to the lengthening of the recovery process after a disturbance. Protection of the forest floor during management activities will enhance site recovery. The thick duff layers indicate soil biological activity is impeded by cold or drouth, and thus site nutrients tend to concentrate in the forest floor.

Recreation values are very high in this type, due to the attractiveness of the subalpine environment for hiking, camping and hunting. These soils generally have very thick duff layers which make them more resilient to traffic (for example, in campgrounds) than other areas. Care must be taken to conserve these duff layers as most of the site's nutrient capital is located here. These areas have heavy snowpacks which result in high soil moisture content well into the summer months. The presence of this moisture makes the mineral soils quite susceptible to compaction and rutting. This type often occurs in areas managed for nordic or alpine skiing; sites that are cleared for ski runs are likely to be very difficult to revegetate, due to the extreme climate and nutrient-poor soils.

Down wood data were unavailable for this association. Due to small tree diameters, large woody debris is extremely limited.

Soils

Five soil profiles were described in this sample of the TSME-PIAL/LUHI association. In general, effective depth and duff thickness were greater than average for the subalpine parkland zone.

Number of soil descriptions:	5	
Average soil depth:	92 cm	Range 62-100 cm
Average rooting depth:	84 cm	Range 58-100 cm
Average effective depth:	65 cm	Range 6-96 cm
Average duff thickness:	5.6 cm	Range 0.9-12.5 cm
Parent materials:	Volcanic ash/andesite/glacial drift	

Comparisons

This type has not been described elsewhere in USDA Forest Service Pacific Northwest Region plant association classifications. It is similar to the TSME/LUHI type described both in this guide and for the Wenatchee National Forest, but differs from it in having whitebark pine as a major component, and occurring at higher elevations in more extreme climates.

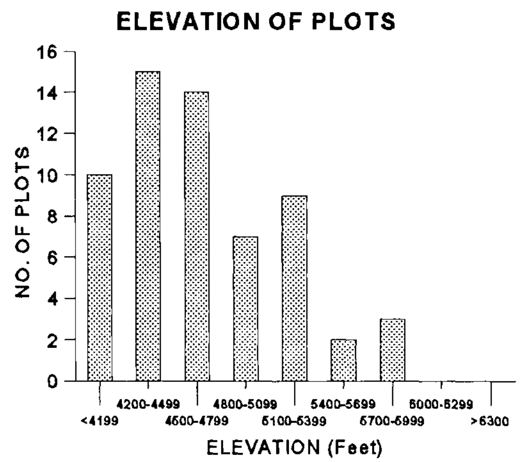
Mountain Hemlock/Cascade Azalea

Tsuga mertensiana/Rhododendron albiflorum

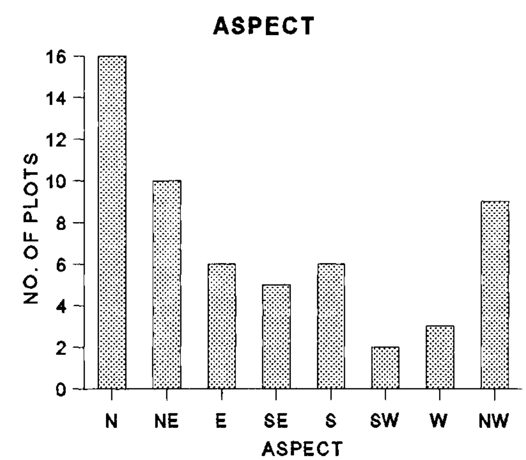
TSME/RHAL CMS223

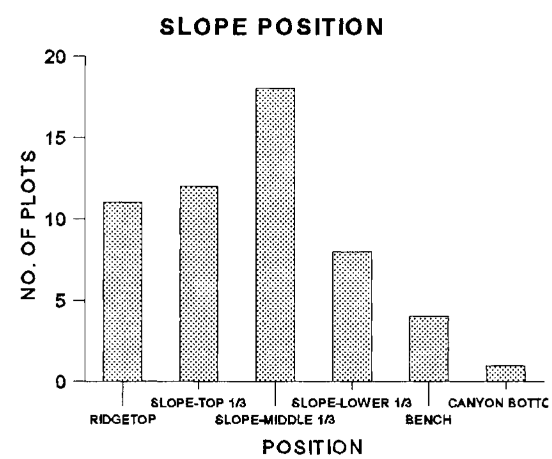
No. Plots = 55

Environment and Location



The TSME/RHAL association represents cool, wet, high elevation sites. Sites with this association have heavy snowpacks, short growing seasons, and relatively cool temperatures throughout the growing season. Soils tend to be saturated year-round. The elevations in this sample ranges from 3700 feet to 5700 feet, with an average of 4628 feet. Slopes tended to be gentle and oriented to the north. The TSME/RHAL association was found on a variety of slope positions. It is very widespread, and was found throughout the study area.





Vegetation: Composition, Structure, and Diversity

The TSME/RHAL association is a closed canopy forest type with well-developed shrub and herbaceous layers. Pacific silver fir (ABAM) and mountain hemlock (TSME) dominate the overstory, sometimes in combination with western hemlock (TSHE), western white pine (PIMO), subalpine fir (ABLA2), Douglas-fir (PSME), and Engelmann spruce (PIEN). Both mountain hemlock and Pacific silver fir reproduce in the understory. Alaska yellow cedar (CHNO) is more likely to occur in this association than in any other within the Mountain Hemlock Zone. The shrub layer is usually dense, consisting of Cascade azalea (RHAL) and big huckleberry (VAME), and sometimes fool's huckleberry (MEFE), oval-leaf huckleberry (VAOV), and traces of Sitka mountain ash (SOSI). Dwarf bramble (RULA) is common in small amounts. The herb component is usually composed of small to moderate quantities of moist-site herbs such as queencup beadlily (CLUN), vanillaleaf (ACTR), heart-leaf arnica (ARCO), avalanche fawn-lily (ERMO), mitrewort (MIBR), and rosy twisted-stalk (STRO). Beargrass is common, and probably represents slightly drier microsites.

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies amabilis	ABAM	93	26
Picea engelmannii	PIEN	24	5
Pseudotsuga menzies.	PSME	33	10
Tsuga mertensiana	TSME	93	21
Reprod. Trees			
Abies amabilis	ABAM	94	22
Tsuga mertensiana	TSME	56	3
Shrubs			
Menziesia ferruginea	MEFE	40	18
Rhodod. albiflorum	RHAL	93	21
Rubus lasiococcus	RULA	93	6
Sorbus sitchensis	SOSI	51	3
Vaccinium membran.	VAME	87	22
Vaccinium ovalifolium	VAOV	45	8
Forbs			
Clintonia uniflora	CLUN	44	6
Erythronium montan.	ERMO	27	11
Pyrola secunda	PYSE	51	3
Xerophyllum tenax	XETE	76	15

COV. = Average % foliar cover
CONS. = the % of plots on which species occurred

Our sample in this association included a range of successional stages and structural classes. Successional stages ranged from early seral to near climax, and stand structures included pole (5-11" dbh), small diameter (11-21" dbh), large diameter (>21" dbh) and old growth classes. The majority of older stands were in the large diameter and old growth structural classes. The stands tended to be fairly even-aged, and most commonly fell within the 150-200 and 200-300 year age classes. Trees rarely exceeded 150 feet in height, but frequently were between 100 and 150 feet tall. Live basal area averaged 345 ft^2, a high value compared to closed forest types within the Mountain Hemlock Zone overall.

There was an average of 17.0 vascular plant species per plot in this sample of the TSME/RHAL association, with an average of 7.4 dominant species. Species richness is slightly below average for the Mountain Hemlock Zone as a whole.

Fire Ecology

The TSME/RHAL association falls within Fire Group 6 (Evers and others, 1996). This Fire Group represents cool, moist upper elevation sites with a regime of infrequent (one to several centuries apart) stand replacement fires. Low intensity ground fires are probably rare. Stand replacement fires are most likely to occur under a combination of drought and strong wind conditions. The crowns of these stands are typically dense and have a high proportion of aerial fuels such as mosses and lichens, aiding the spread of the fire through the canopy.

Ground fuels in mature, natural stands are most commonly in the >3" diameter class; smaller fuels decay rapidly in these warmer high elevation sites. Because these stands are relatively dense, fuel loadings may be relatively high. The abundance of shrubs may function as a heat sink under normal weather conditions, reducing fire spread, but during prolonged drought may significantly add to fuel loading.

Wildlife Habitat Relationships

This association occurs at lower elevations and on more productive sites relative to most of the Mountain Hemlock Zone. As a result, trees are larger and canopy cover is relatively high. These sites support a diverse mix of conifer trees. The addition of white pine, lodgepole pine, larch, and Englemann spruce to some of these sites provides a variety of seed for several high elevation bird species that rely on conifer seeds. Black-backed woodpeckers use these tree species for foraging and nesting. This woodpecker has been identified as a "Protection Buffer" species in the Northwest Forest Plan (USDA Forest Service, 1994).

The well-developed shrub layer of both tall and low shrubs provides nest sites and cover for birds and hiding cover for a variety of wildlife species. Fool's huckleberry, huckleberries, and Sitka mountain ash occur in the shrub layer and produce high quality browse for deer and elk and berries for a variety of birds and mammals. The well-developed herb layer provides additional forage. The combination of hiding cover, forage and gentle topography makes these sites excellent summer range for deer and elk.

The thick duff layers provide habitat for invertebrates consumed by a variety of insectivorous wildlife including amphibians, shrews, thrushes and sparrows.

Productivity and Management

The TSME/RHAL association represents some of the most productive sites within the Mountain Hemlock Zone, although productivity is less than in lower-elevation sites with a longer growing season. Site index in this sample averaged 73 feet for Pacific silver fir, 98 for noble fir, 87 for Engelmann spruce, 86 for Douglas-fir, 92 for western hemlock, and 68 for mountain hemlock (all base age 100).

Management implications are similar to those for the TSME/MEFE association, but the TSME/RHAL association probably represents slightly colder sites. Frost during the growing season and an increase in shrub cover are likely to occur with canopy removal. Frost tolerant species such as western white pine (PIMO), western larch (LAOC) and Engelmann spruce (PIEN) are good candidates for plantation establishment along with mountain hemlock and Pacific silver fir. Alaska yellow cedar is most likely to occur in this type, and its presence contributes to diversity in the tree layer. Douglas-fir and noble fir are more vulnerable to frost damage when planted in openings within this type (Brockway and others, 1983). Noble fir is likely to produce the highest volume per acre of any tree species. Shelterwood harvest or small group selection may be used successfully to mitigate growing season frost problems, as well as providing a seed source; Brockway and others (1983) recommended leaving 100 to 120 ft^2/acre in shelterwoods in this type.

The TSME/RHAL association indicates high soil moisture, and use of heavy equipment should be minimized; the risk of compaction and displacement are high. Disturbance of the subsurface spodic horizon may lead to accelerated nutrient losses through leaching.

Maintaining the duff layers intact is not as critical in these soils as in others with thin duff layers. A cool spring burn that reduces the duff thickness by half or less should not result in loss of site productivity. Removing some litter may result in a more favorable carbon-to-nitrogen level in these nitrogen-poor soils. It is important that some duff be left intact, especially the nutrient-rich bottom layers. Yarding and skidding operations should be carefully planned and executed to avoid compaction, displacement, and erosion of the ashy surface soils.

Recreation values are typical of upper elevation forests. Location of heavy human traffic or campsites in this type carries a risk of compaction and erosion, root exposure and rutting, due to the relatively fine soil textures and high soil moisture. Rehabilitation of disturbed areas should not be difficult unless soil damage is severe.

In this sample of the TSME/RHAL association, there was an average of 58 logs (8.4 tons) per acre in size class 12 and 5 logs (1.7 tons) per acre in size class 20. The larger logs tended to be in less-decayed condition (condition classes 1 and 2), while most of the smaller logs were well-decayed (condition class 3; see p. 22 for size and condition class definitions). The number of logs in size class 20 is close to the average for the Mountain Hemlock Zone as a whole, but the number in size class 12 is approximately 1.5 times the average, reflecting the dense stocking of stands in this association.

Soils

Eighteen plots had soil profile descriptions in this sample of the TSME/RHAL association. Nine of these had eluvial surface layers but only two had spodic subsurface layers. The soils in this association have the greatest average duff thickness in the Mountain Hemlock Zone.

Number of plot descriptions:	18	
Average soil depth:	90 cm	Range 52-100 cm
Average rooting depth:	82 cm	Range 52-100 cm
Average effective depth:	53 cm	Range 13-88 cm
Average duff thickness:	6.7 cm	Range 0.5- 17 cm
Parent materials:	Volcanic ash/andesite, glacial drift	

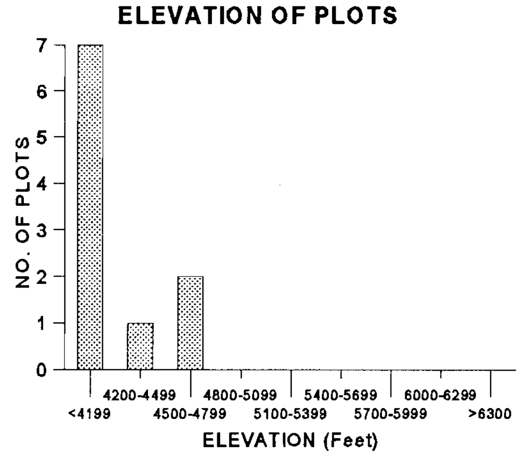
Comparisons

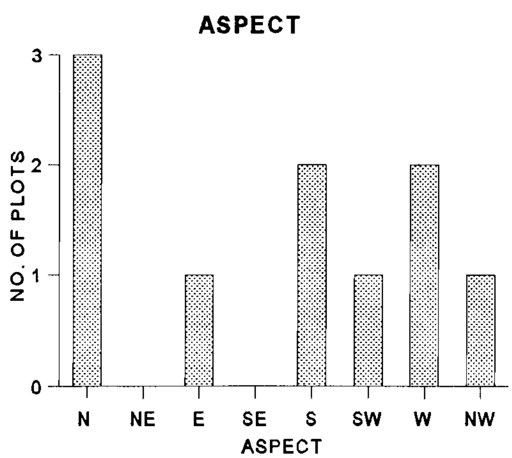
This association was previously described by Brockway and others (1983); the description and management implications have been updated with additional data for this guide. A similar type, the Mountain Hemlock/Cascade Azalea-Big Huckleberry association, occurs on the Mt. Baker-Snoqualmie National Forest (Henderson and others, 1990) and on the Wenatchee National Forest (Lillybridge and others, 1996). On the Olympic National Forest a Pacific Silver Fir-Mountain Hemlock/White Rhododendron has been described (Henderson and others, 1989). Franklin's (1973) Alaska Yellow Cedar/Cascade Azalea habitat type is similar although probably wetter; the climax species is Alaska yellow cedar instead of mountain hemlock. Franklin and others (1979) described a Pacific Silver Fir/Cascade Azalea type at Mt. Rainier that is probably similar, although Alaska yellow cedar is a major constituent in it, and it completely lacks western hemlock.

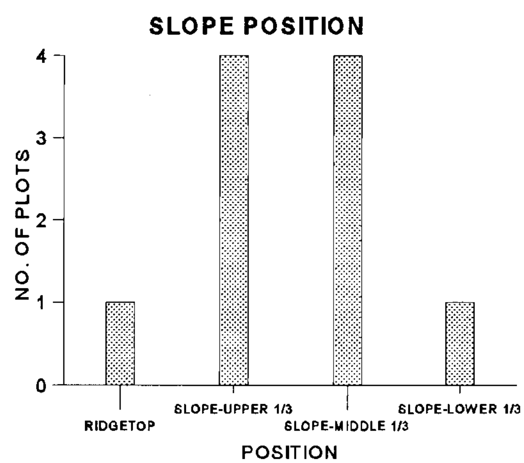
Mountain Hemlock/Rhododendron
Tsuga mertensiana/Rhododendron macrophyllum
TSME/RHMA CMS612
No. Plots = 11

Environment and Location

The TSME/RHMA association represents the warm, dry end of the Mountain Hemlock Zone, although compared to forested types overall, these are cool, upper elevation environments. While winters are cold and deep snowpacks accumulate, this is one of the earliest portions of the Mountain Hemlock Zone to experience snowmelt, and the growing season is considerably longer than in other Mountain Hemlock Zone types. Even so, frost can occur any time during the growing season on clear, cold nights.







The plots in this sample ranged between 3500 and 4500 feet in elevation, on moderately steep mid- to upper slopes at a variety of aspects. This type is described from the Mt. Hood National Forest, and is most widespread near the crest of the Cascades south of Mt. Hood; it has not been found in Washington.

Vegetation Composition, Structure, and Diversity

The TSME/RHMA association is a closed forest type with a well-developed shrub layer, and a rather species-poor herbaceous component. Mountain hemlock (TSME), Pacific silver fir (ABAM), western hemlock (TSHE), and Douglas-fir (PSME) dominate the overstory. Noble fir (ABPR) may be present. Stands often contain small amounts of western red cedar (THPL), western white pine (PIMO), and western larch (LAOC). The well-developed shrub layer includes rhododendron (RHMA) as a dominant, along with small amounts of dwarf Oregongrape (BENE), prince's pine (CHUM), big huckleberry (VAME), Sitka mountain ash (SOSI), Oregon boxwood (PAMY), and Oregon wintergreen (GAOV). Few species are represented in the herb layer. Beargrass is common; avalanche fawn lily, twinflower (LIBO2), rattlesnake plantain (GOOB), and white vein pyrola (PYPI) are often present in small amounts as well.

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies amabilis	ABAM	15	92
Abies procera	ABPR	18	42
Pseudotsuga menz.	PSME	21	100
Tsuga heterophylla	TSHE	21	67
Tsuga mertensiana	TSME	20	100
Reprod. Trees			
Abies amabilis	ABAM	14	100
Tsuga heterophylla	TSHE	6	67
Tsuga mertensiana	TSME	5	83
Shrubs			
Berberis nervosa	BENE	7	42
Chimaphila umbellata	CHUM	6	50
Gautheria ovatifolia	GAOV	3	67
Rhododendron macro.	RHMA	52	100
Vaccinium membrana.	VAME	7	50
Forbs			
Goodyera oblongifolia	GOOB	4	42
Xerophyllum tenax	XETE	28	92

COV. = Ave. % foliar cover
CONS. = % of plots on which species occurred

Mid- to late seral stands predominated in our sample of the TSME/RHMA association, mostly in the large-diameter (>21" dbh) structural class. The canopy height did not typically exceed 100 feet. Stands were densely stocked; live basal area averaged 368 ft^2/acre, the highest value of any of the Mountain Hemlock Zone associations.

There was an average of 12.8 vascular plant species per plot in this sample of the TSME/RHMA association, with an average of 5.6 dominant species. These are low values compared to the Mountain Hemlock Zone as a whole.

Fire Ecology

The TSME/RHMA association falls within Fire Group 6 (Evers and others, 1996). This Fire Group represents cool, moist upper elevation sites with a regime of infrequent (one to several centuries apart) stand replacement fires. Low intensity ground fires are probably rare. Stand replacement fires probably occur under a combination of drought and strong wind conditions. The crowns of these stands are typically dense and have a high proportion of aerial fuels such as mosses and lichens, aiding the spread of the fire through the canopy.

In natural, mature stands, ground fuels are most commonly in the >3" diameter class; smaller fuels decay rapidly in these warmer high elevation sites. Because the stands are dense, fuel loadings may be relatively high. The abundance of shrubs may function as a heat sink under normal weather conditions, reducing fire spread, but during prolonged drought may significantly add to fuel loading.

Wildlife Habitat Relationships

This association occurs at lower elevations and on more productive sites than most of the Mountain Hemlock types. As a result, trees are larger and canopy cover is greater. Wildlife species typically associated with lower elevation late-successional forests are more likely to occur on these sites than most other Mountain Hemlock types. On those sites with western white pine and larch, black-backed woodpeckers may be present. This woodpecker is identified as a "Protection Buffer" species in the Northwest Forest Plan (USDA Forest Service, 1994).

Small amounts of browse and forage occur on some plots, with dwarf Oregon grape and beargrass being the most common. Elk may use these sites earlier in the spring than other higher elevation sites. Dwarf Oregon grape and big huckleberry provide berries for birds and mammals.

Productivity and Management

Although this type represents the warm end of the Mountain Hemlock Zone, tree growth is still limited by the cold climate, short growing season, shallow, stony soils and possibly by low available soil nitrogen. Site index in our sample averaged 62 for Pacific silver fir, 77 for noble fir, 76 for Douglas-fir, 70 for western hemlock and 63 for mountain hemlock (all base age 100). These are moderate values compared to the Mountain Hemlock Zone as a whole. Stand development after a disturbance is likely to be inhibited by frost during the growing season. Where timber harvest is an objective, shelterwood or small group harvest would help mitigate frost problems. Sites with abundant rhododendron may be deficient in soil nitrogen. For that reason, these sites may be candidates for fertilization as a silvicultural treatment. After a fire, snowbrush ceanothus (CEVE), a nitrogen-fixer, is often abundant; it is sometimes viewed as being in competition with trees for growing space in plantations, but its nitrogen-fixing abilities may be of significant benefit to the site. Because soil organic matter is concentrated in the forest floor, the duff layer should be protected during all ground-disturbing activities. The shallow, stony soils may make tree planting difficult in some sites.

Recreation values in this type are those characteristic of upper elevation forests. These are relatively favorable sites for development of camping facilities because the soils tend to be quite resilient to traffic. Cultivation of rhododendron can help screen campsites and channel traffic to desired areas.

Down wood data are not available for this association. Given the stand structures present, down woody debris is likely to be relatively abundant. Similar associations in the Pacific Silver Fir Zone averaged 3 to 4 large (>20" in diameter) logs per acre in undisturbed stands.

Soils

No soil profiles were described for this type on the Mt. Hood or Gifford Pinchot National Forests. On the Willamette National Forests, soils in this association are usually shallow and stony or skeletal, often derived from glacial till. Total soil depth averaged 40 inches and effective rooting depth averaged only 24 inches in Willamette NF sample soil pits. Soil nitrogen is often low.

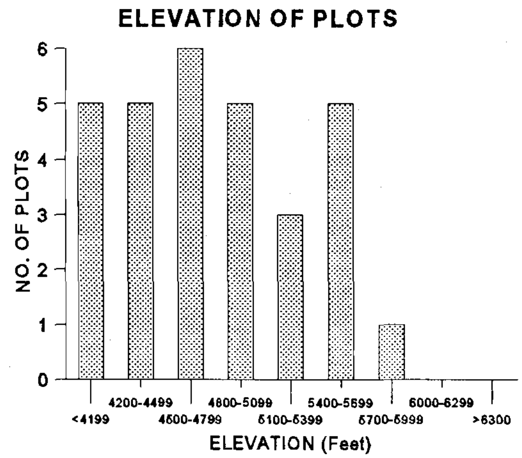
Comparisons

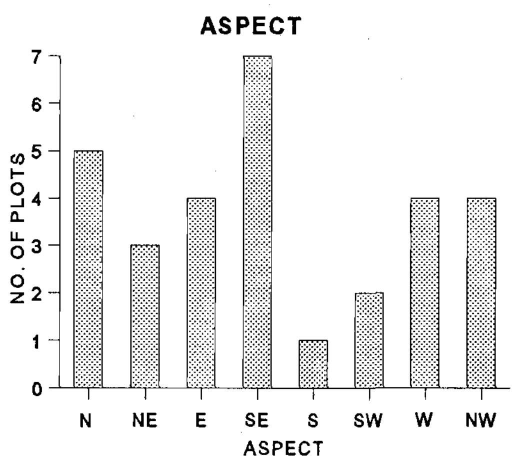
This association is also described for the Willamette National Forest, farther south in the Cascades (Hemstrom and others, 1987).

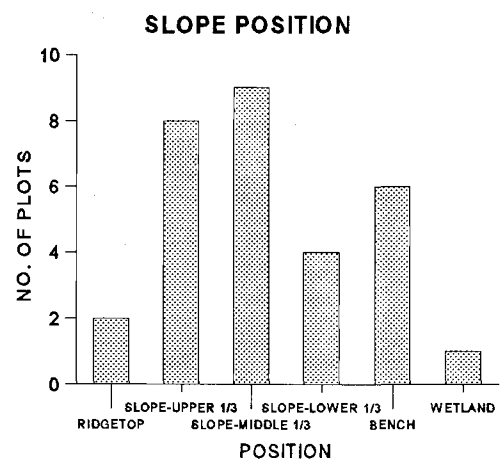
Mountain Hemlock/Big Huckleberry/Queencup Beadlily
Tsuga mertensiana/Vaccinium membranaceum/Clintonia uniflora
TSME/VAME/CLUN CMS218
No. Plots = 40

Environment and Location

The TSME/VAME/CLUN association represents cool, mesic, relatively productive sites within the Mountain Hemlock Zone. These are sites with long winters, deep snowpacks and a short, cool growing season. In this sample it occurred in a broad range of elevations, from 3300 feet to 5800 feet, on gentle to somewhat steep mid- to upper slopes and benches. All aspects were represented, but north and east were most common. The TSME/VAME/CLUN association occurs widely throughout the study area.







Vegetation: Composition, Structure, and Diversity

The TSME/VAME/CLUN association is a closed canopy forest type with well-developed shrub and herbaceous layers. The overstory layer is commonly dominated by mountain hemlock (TSME) and Pacific silver fir (ABAM), with smaller amounts of noble fir (ABPR), Douglas-fir (PSME), Engelmann spruce (PIEN), and subalpine fir (ABLA2). Big huckleberry (VAME) is the dominant shrub, commonly associated with small amounts of dwarf bramble (RULA). Prince's pine (CHUM) and Sitka mountain ash (SOSI) are common. The herbaceous layer typically consists of small amounts of moist-site herbs, including queencup beadlily (CLUN), mitrewort (MIBR), sidebells pyrola (PYSE), vanillaleaf (ACTR), and mountain arnica (ARLA).

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies amabilis	ABAM	24	95
Abies procera	ABPR	21	35
Pseudotsuga menz.	PSME	22	33
Tsuga mertensiana	TSME	17	93
Reprod. Trees			
Abies amabilis	ABAM	20	95
Tsuga mertensiana	TSME	4	60
Shrubs			
Rubus lasiococcus	RULA	6	75
Sorbus sitchensis	SOSI	1	43
Vaccinium membr.	VAME	22	95
Forbs			
Achlys triphylla	ACTR	6	50
Arnica latifolia	ARLA	5	50
Clintonia uniflora	CLUN	4	55
Pyrola secunda	PYSE	2	65
Valeriana sitchensis	VASI	3	38
Xerophyllum tenax	XETE	3	48

COV. = Ave. % foliar cover
CONS. = % of plots on which species occurred

The stands in this sample were primarily mid- to late seral, with a predominance the oldest trees in the 150-200 and 200-300 year age classes. Small diameter (11-21" dbh) and large diameter (>21") structural classes were most prevalent. This association had a greater percentage of trees >150 feet tall than any other Mountain Hemlock Zone association. The tallest individuals in stands were generally noble fir, Douglas-fir and mountain hemlock. Live basal area averaged 337 ft^2/acre, considerably higher than the average for closed canopy forests within the Mountain Hemlock Zone.

There was an average of 19.0 vascular plant species in this sample of the TSME/VAME/CLUN association, with an average of 5.9 species. This reflects average species richness compared to the Mountain Hemlock Zone overall.

Fire Ecology

The TSME/VAME/CLUN association falls within Fire Group 7 (Evers and others, 1996). This Fire Group represents cool, mesic to dry environments with a fire regime of stand replacement fires 1-3 centuries apart, and with occasional low to moderate intensity fires. This Fire Group is often found on flat plateaus near the Cascade crest, an area in which very large lightening fires have occurred in the past, and which currently has a very high occurrence of lightening. Lodgepole pine is an extremely common pioneer species following a fire in this Fire Group, and fire-initiated stands dominated by lodgepole pine are quite common within the study area, as a result of several large, severe fires that occurred near the turn of the century. Burning by native Americans for management of huckleberry fields has been a common occurrence in this Fire Group as well.

Although Fire Group 7 as a whole tends to have lower-than-average fuel loadings in natural stands, the TSME/VAME/CLUN association is an exception, because it is more productive than other associations within this Fire Group (see down wood discussion in Productivity and Management section). The risk of high-intensity fire increases in stands where later seral species are becoming established under lodgepole pine and ladder fuels are most abundant, and where suppression mortality has added to ground fuels. Age 60-80 is commonly when fuel build-up begins to be significant.

The risk of a severe fire is probably higher in Fire Group 7 than any other Mountain Hemlock Zone type, due to the combination of high lightening frequency, heavy recreation use, inaccessibility of large areas, and fuel conditions.

Wildlife Habitat Relationships

These sites support a diverse mix of conifer trees. The addition of white pine, lodgepole pine, larch, and Englemann spruce to some of these sites provides a variety of seed for several high elevation bird species that rely on conifer seeds. These trees also attract black-backed woodpeckers to a stand. This woodpecker has been identified as a "Protection Buffer" species in the Northwest Forest Plan (USDA Forest Service, 1994).

The larger trees and older ages common to these sites provide late-successional forest habitat. At lower elevation sites, species such as spotted owl and pileated woodpecker may occur.

The shrubby understory provides nest sites for a number of small birds and hiding cover for a variety of wildlife. Big huckleberry provides high quality browse. Vine maple, dwarf Oregon grape, and Sitka mountain ash commonly add to available browse. These species also produce fruits and seeds consumed by a variety of birds and mammals. Those sites with gentle slopes make quality summer range for deer and elk.

Productivity and Management

The TSME/VAME/CLUN association represents sites of high productivity relative to the Mountain Hemlock Zone as a whole, although productivity is less than in lower-elevation sites with a longer growing season. Site index in this sample averaged 76 for Pacific silver fir, 101 for noble fir, 89 for Engelmann spruce, 104 for Douglas-fir and 75 for mountain hemlock (all base age 100).

Frost during the growing season is likely to occur where this association is found, especially on flatter slopes (<15%) and at higher elevations. Shelterwood harvest or small group selection can mitigate frost damage during cold, clear summer nights. Brockway and others (1983) recommended leaving 100-120 ft^2/acre in shelterwood harvest units with this type. Frost tolerant species such as western white pine, Engelmann spruce and western larch are good candidates for plantation management, along with noble fir, mountain hemlock and Pacific silver fir. Noble fir is likely to produce the highest volume per acre of any conifer on these sites. Where soils are deep and ashy, pocket gopher populations may expand into plantations and interfere with reforestation efforts.

In these cool sites the forest floor organic matter tends to decompose and become incorporated into the mineral soil very slowly. Although in some sites the duff layer may be quite thick, in general protection of the forest floor is necessary for conservation of site nutrients.

Recreation values in the TSME/VAME/CLUN association are typical of those associated with high elevation forests. Huckleberries are likely to be abundant in openings, and this association is second only to the TSME/VAME/XETE association in the opportunities it affords for huckleberry management through prescribed fire or stand manipulation. Where the soil has a high proportion of fine-textured volcanic ash, compaction, erosion, rutting and root exposure are likely to result from heavy traffic. Rehabilitation of disturbed areas should not be difficult unless soil damage is severe. This type is likely to occur in areas managed for nordic or alpine skiing. Where vegetation is removed to create ski runs, protection of the organic material and upper soil layers will enhance the success of revegetation efforts. Subsoils are likely to be infertile and difficult to revegetate.

In this sample of the TSME/VAME/CLUN association, these was an average of 54.8 logs (10.3 tons) per acre in size class 12 and 7.0 logs (3.4 tons) per acre in size class 20. The preponderance of the down wood was in the most decayed condition class (condition class 3; see p. 22 for size and condition class definitions). These are high values compared to the Mountain Hemlock Zone as a whole.

Soils

Soils were described on twelve plots in this association. These soils had fairly thick duff layers but effective depths were low. Most of these soils had eluvial surface horizons but only three had spodic subsurface layers.

A number of soils in this association consist of multiple layers of volcanic ash and pumice. Humified, buried forest floors are commonly present between these deposits. Roots are concentrated in these layers as they contain far more nutrients and hold more available moisture than the volcanic materials. Deep disturbance of the soil may disrupt this arrangement and fertility losses could occur. Minimizing disturbance is essential to avoidance of excessive compaction and erosion, and to retention of nutrients on the site.

Number of soil descriptions:	12	
Average soil depth:	86 cm	Range 49-100 cm
Average rooting depth:	83 cm	Range 49-100 cm
Average effective depth:	46 cm	Range 17-100 cm
Average duff thickness:	4.55 cm	Range 1.1- 10 cm
Parent materials:	Volcanic ash/andesite, glacial drift	

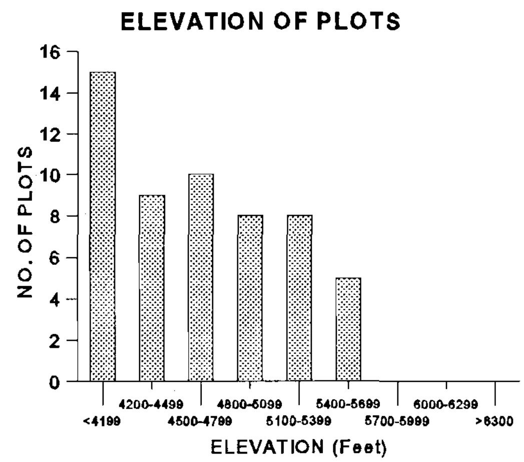
Comparisons

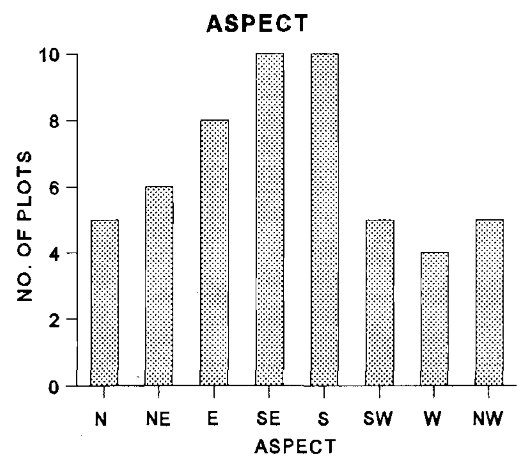
On the Gifford Pinchot National Forest, this association was originally combined with the TSME/VAME/XETE association in the TSME/VAME type (Brockway and others, 1983). Subsequent analysis suggested that the TSME/VAME type should be split. The TSME/VAME/CLUN association is similar to the ABAM/VAME/CLUN association of Hemstrom and others (1982), but occupies colder sites. It is somewhat similar to the TSME/VAME/STRO association described by Henderson and others (1992) farther north in the Cascades on the Mt. Baker-Snoqualmie National Forest, but lacks rosy twisted-stalk, a characteristic indicator of the northern type.

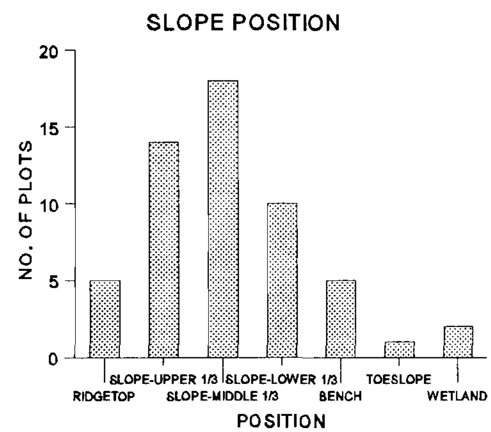
Mountain Hemlock/Big Huckleberry/Beargrass
Tsuga mertensiana/Xerophyllum tenax
TSME/VAME/XETE CMS216
No. Plots = 70

Environment and Location

The TSME/VAME/XETE association occurs in dry, cold forested environments. It occupies areas of short, cool summers subject to frequent frost, and long winters with deep snowpack. Soils are often effectively dry, and soil nutrients may be limited due to slow decomposition of organic matter. Elevations in this sample ranged from 3700 feet to 5800 feet with a mean of 4728 feet. Slopes are usually gentle to moderate. Many stands with this association occur on high elevation plateaus or benches, or on the middle to upper one-third of high ridges. This is by far the most widespread, common association within the Mountain Hemlock Zone, and is found throughout the study area, as well as farther north and south in the Cascades.







Vegetation: Composition, Structure, and Diversity

The TSME/VAME/XETE association is a closed canopy forest type with a relatively well-developed shrub layer and a species-poor herbaceous layer. Older stands typically have a tree layer dominated by mountain hemlock (TSME), usually in combination with Pacific silver fir (ABAM). Reproduction of both species in the understory is common. Occasionally other tree species are present in addition, including noble fir (ABPR), Douglas-fir (PSME), lodgepole pine (PICO), subalpine fir (ABLA2), and western hemlock (TSHE). In younger, fire-initiated stands, the canopy is often dominated by lodgepole pine, which is eventually replaced by other more shade-tolerant species, such as mountain hemlock and Pacific silver fir. Young lodgepole pine stands often have high initial stocking, and often become stagnated and subject to snow breakage, windthrow, and insect infestations. The dominant shrub is big huckleberry (VAME), often accompanied by moderate amounts of dwarf bramble (RULA). The herbaceous component is almost exclusively beargrass (XETE), although small amounts of queencup beadlily (CLUN) and sidebells pyrola (PYSE) are sometimes present.

Our sample reflected the presence of a fairly wide range of stand structures and successional stages. Pole (5-11" dbh), small diameter (11-21" dbh) and large diameter (>21") structural classes were all represented. Canopy height rarely exceeded 150 feet, and was usually less than 100 feet. In general, in stands with a mix of tree species, mountain hemlock and Douglas-fir were the largest individual trees. Stands ranged from early- to late- successional stages and were sometimes multi-aged, but more often even-aged. The oldest trees were commonly in the 200-300 year age class. Live basal area averaged 314 ft^2/acre, an average value for the Mountain Hemlock Zone as a whole.

These was an average of 15.1 vascular plant species per acre in this sample of the TSME/VAME/XETE association, with an average of 6.2 dominant species. This is low species diversity compared to the Mountain Hemlock Zone overall.

Fire Ecology

The TSME/VAME/XETE association falls within two Fire Groups, 5 and 7 (Evers and others, 1996). Both Fire Group represents cool, mesic to dry environments with a fire regime of stand replacement fires 1-3 centuries apart, and with occasional low to moderate intensity fires. They differ slightly in location, but are otherwise similar with regard to fire ecology. Fire Group 5 occupies lower subalpine areas just east of the Cascade Crest. Fire Group 7 occurs on flat plateaus near the Cascade crest, an area in which very large lightening fires have occurred in the past. Both groups have high occurrence of lightening. Lodgepole pine is an extremely common pioneer species following a fire. Fire-initiated stands dominated by lodgepole pine are quite common within the study area, as a result of several large, severe fires that occurred near the turn of the century. Burning by native Americans for management of huckleberry fields has been a common occurrence as well.

As a whole, Fire Groups 5 and 7 tend to have lower-than-average fuel loadings in mature natural stands. However, in this association, higher-than-average amounts of large down logs were found (see down wood discussion in Productivity and Management section for down wood data). Possibly this is due to the relatively recent turn-of-the-century series of large fires, which have temporarily increased the large fuel levels above the norm for this environment. The risk of high-intensity fire increases in stands where later seral species are becoming established under lodgepole pine and ladder fuels are most abundant, and where suppression mortality has added to ground fuels. Age 60-80 is commonly when fuel build-up begins to be significant.

The risk of a severe fire is probably higher in Fire Groups 5 and 7 than any other Mountain Hemlock Zone type, due to the combination of high lightening frequency, heavy recreation use, inaccessibility of large areas, and fuel conditions.

Wildlife Habitat Relationships

These sites support a diverse mix of conifer trees. The addition of white pine, lodgepole pine, and Englemann spruce to some of these sites provides a variety of seed for several high elevation bird species that rely on conifer seeds. These species also attract black-backed woodpeckers to a stand. This woodpecker has been identified as a "Protection Buffer" species in the Northwest Forest Plan (USDA Forest Service, 1994).

The shrubby understory provides nest sites for a number of small birds and hiding cover for a variety of wildlife. Big huckleberry provides high quality browse. Vine maple, dwarf Oregon grape, and Sitka mountain ash commonly add to available browse. These species also produce fruits and seeds consumed by a variety of birds and mammals. Bear grass provides quality forage for elk. The moderate slopes and flats in addition to the available forage provide for quality summer range for deer and elk.

The ash and pumice soil makes good substrate for burrowing mammals. In mature forests, ground squirrels and moles are likely to be found. Gophers may increase in early successional openings.

Productivity and Management

The TSME/VAME/XETE association presents some significant challenges to commercial forest management. Due to the combination of short growing season, limited soil moisture and nutrients, cold rooting zone and frequency of growing season frost, conditions for tree establishment, survival and growth are harsh. Site index in this sample averaged 71 for Pacific silver fir, 88 for noble fir, 69 for lodgepole pine, 92 for western white pine, 80 for Douglas-fir and 65 for mountain hemlock (all base age 100). These are average values for the Mountain Hemlock Zone as a whole, but low compared to lower-elevation forests with a longer growing season.

Shelterwood harvest and small group selection can help mitigate growing season frost problems. Frost tolerant species such as western white pine, mountain hemlock, Pacific silver fir and lodgepole pine may be most successful in clearcut plantations. Use of fire for fuel reduction after logging may stimulate the proliferation of beargrass and long-stolon sedge (CAPE5), especially if the residual forest floor organic matter is destroyed. Duff layers should be protected as they are critical for moderating soil temperatures, conserving soil moisture, and supplying nutrients; soil biological activity is limited in these sites and nutrients tend to concentrate in the duff. These ash and pumice soils are very susceptible to compaction over a wide range of moisture conditions.

Deep displacement can occur especially when the soil is dry. Populations of pocket gophers may expand considerably into plantations, especially in fine-textured, ashy soils.

Recreation values in the TSME/VAME/XETE association are typical of those associated with high elevation forests. Huckleberries are likely to be abundant in openings, and this association is affords substantial opportunities for huckleberry management through prescribed fire or stand manipulation. Where the soil has a high proportion of fine-textured volcanic ash, compaction, erosion, rutting and root exposure are likely to result from heavy traffic. Rehabilitation of disturbed areas should not be difficult unless soil damage is severe.

In this sample of the TSME/VAME/XETE association, these was an average of 27.1 logs (3.6 tons) per acre in size class 12 and 10 logs (2.03 tons) per acre in size class 20. The largest percentage was in the most decayed condition class (condition class 3; see p. 22 for size and condition class definitions). This represents lower-than-average values for smaller logs, but almost double the average for larger logs. Since most large logs are extremely decayed, the high numbers may be related to the widespread occurrence of severe fires near the turn of the century, which probably occurred in this association more than any other in the Cascades.

Soils

Twenty-four plots in this association had soil profile descriptions. Both duff thickness and effective depth were near average for soils in the Mountain Hemlock Zone. On the Mt. Hood National Forest, eight soil samples had eluvial surface layers and four of these had spodic subsurface layers.

Number of soil descriptions:	24	
Average soil depth:	87 cm	Range 34-100 cm
Average rooting depth:	71 cm	Range 32-100 cm
Average effective depth:	55 cm	Range 13-100 cm
Average duff thickness:	3.7 cm	Range 0.4-10 cm
Parent material:	Volcanic ash/andesite, glacial drift	

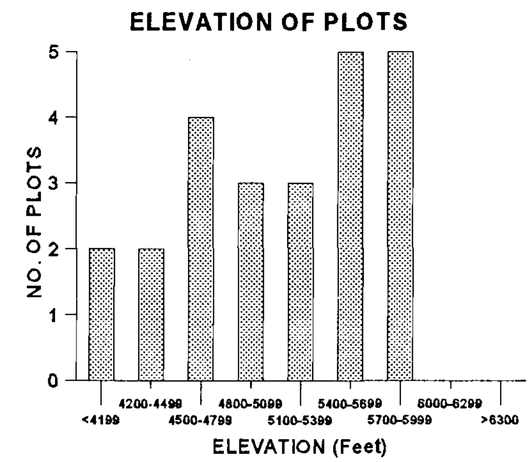
Comparisons

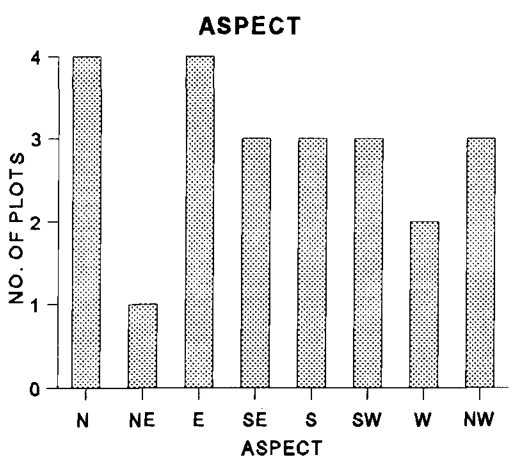
The TSME/VAME/XETE association was originally described for this area by Hemstrom and others (1982 - Oregon) and Brockway and others (1983 - Washington). This association is similar to the ABAM/VAME/XETE association (Hemstrom and others, 1982; Brockway and others, 1983), but occurs on colder sites. It occurs farther north in the Cascades of Washington (Henderson and others, 1992) and south in the Cascades of Oregon on the Willamette National Forest (Hemstrom et al. 1987). It is essentially the same as the TSME/XETE association described for the Warm Springs Indian Reservation (Marsh and others, 1987). A TSME/XETE association also occurs on the Wenatchee National Forest (Williams and Smith, 1981), but it appears to have less big huckleberry. Franklin (1966) originally described this association as a component of the Pacific Silver Fir-Mountain Hemlock/Big Huckleberry association in southern Washington and the northern Oregon Cascades.

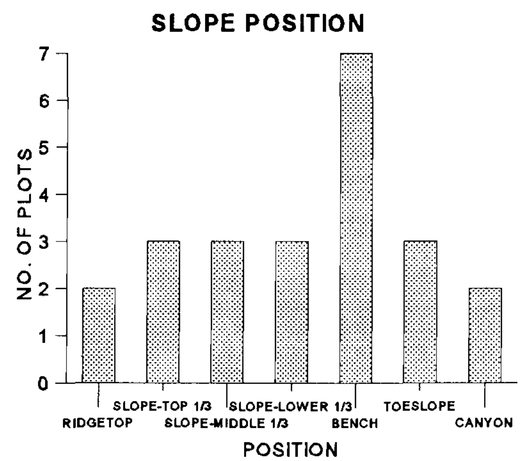
Mountain Hemlock/Grouse Huckleberry
Tsuga mertensiana/Vaccinium scoparium
TSME/VASC CMS114
No. Plots = 23

Environment and Location

The TSME/VASC association occupies the coldest, driest portions of the Mountain Hemlock Zone; these are among the harshest sites that support closed forest vegetation in the study area. Winter snow accumulations are deep, and snowmelt occurs late, resulting in a short growing season. In this sample, it occurred between 4000 feet and 5700 feet, most often on flat to gently-sloping benches or mountain slopes. Soils are often rocky and have low nutrients levels and effective moisture. The TSME/VASC association was widespread throughout the Mountain Hemlock Zone on both the Mt. Hood and Gifford Pinchot National Forests.







Vegetation: Composition, Structure, and Diversity

The TSME/VASC association is a closed to open canopy (range = 20-65% cover of mature trees) forest type with variable shrub and herbaceous layers. The development of the understory is generally greater when the canopy is more open. The overstory is dominated by a mixture of Pacific silver fir (ABAM) and mountain hemlock (TSME), with subalpine fir (ABLA2) in addition in many stands. This association is the most likely of any in the Mountain Hemlock Zone to have lodgepole pine (PICO) in significant amounts, especially in stands recovering from fire.

Lodgepole pine is an early successional, and relatively short-lived, species in this association. Both Pacific silver fir and mountain hemlock are found as regeneration in older stands. The understory is typically low in species richness and often depauperate. Big huckleberry (VAME) and grouse huckleberry (VASC) are the dominant shrubs, and sometimes small amounts of dwarf bramble (RULA) are present. Beargrass (XETE) is often the only herb present and may reach fairly high cover (40-50%). Other herbs that may be present in trace amounts include lupine (LULA), parrot's beak (PERA), sidebells pyrola (PYSE), and Sitka valerian (VASI).

SPECIES	CODE	COV.	CONS.
Mature Trees			
Abies amabilis	ABAM	13	48
Abies lasiocarpa	ABLA2	14	61
Pinus contorta	PICO	9	67
Tsuga mertansiana	TSME	17	87
Reprod. Trees			
Abies amabilis	ABAM	11	57
Abies lasiocarpa	ABLA2	5	65
Pinus contorta	PICO	4	52
Tsuga mertensiana	TSME	7	87
Shrubs			
Vaccinium membr.	VAME	17	83
Vaccinium scoparium	VASC	9	100
Forbs			
Lupinus latifolia	LULA	3	35
Pyrola secunda	PYSE	1	30
Xerophyllum tenax	XETE	27	83

COV. = Ave. % foliar cover
CONS. = % of plots on which species occurred

The stands in this sample were primarily in the pole (5-11" dbh) and small diameter (11-21" dbh) structural classes. A few stands reached the large diameter (>21" dbh) class. Canopy height rarely exceeded 100 feet. These stands tended to be relatively young compared to other Mountain Hemlock Zone associations, with the 50-100 and 100-150 age classes predominating. This may be a reflection of the recent fire history of sites where this type occurs. Mountain hemlock, lodgepole pine and Pacific silver fir tended to be older than subalpine fir. Live basal area averaged 255 ft^2/acre, the lowest of any closed forest type in the Mountain Hemlock Zone, but considerably higher than the parkland types.

There was an average of 15.1 vascular plant species per plot in this sample of the TSME/VASC association, with an average of 6.4 dominant species. These are low values compared to the Mountain Hemlock Zone as a whole.

Fire Ecology

The TSME/VASC association falls within two Fire Groups, 5 and 7 (Evers and others, 1996). Both Fire Group represents cool, mesic to dry environments with a fire regime of stand replacement fires 1-3 centuries apart, and with occasional low to moderate intensity fires. They differ slightly in location, but are otherwise similar with regard to fire ecology. Fire Group 5 occupies lower subalpine areas just east of the Cascade Crest. Fire Group 7 occurs on flat plateaus near the Cascade crest, an area in which very large lightening fires have occurred in the past. Both groups have high occurrence of lightening. Lodgepole pine is an extremely common pioneer species following a fire. Fire-initiated stands dominated by lodgepole pine are quite common within the study area, as a result of several large, severe fires that occurred near the turn of the century. Burning by native Americans for management of huckleberry fields has been a common occurrence as well.

As a whole, Fire Groups 5 and 7 tend to have lower-than-average fuel loadings in mature natural stands. The risk of high-intensity fire increases in stands where later seral species are becoming established under lodgepole pine and ladder fuels are most abundant, and where suppression mortality has added to ground fuels. Age 60-80 is commonly when fuel build-up begins to be significant.

The risk of a severe fire is probably higher in Fire Groups 5 and 7 than any other Mountain Hemlock Zone type, due to the combination of high lightening frequency, heavy recreation use, inaccessibility of large areas, and fuel conditions.

Wildlife Habitat Relationships

These sites support a diverse mix of conifer trees. The addition of white pine, lodgepole pine, larch, and Englemann spruce to some of these sites provides a variety of seed for several high elevation bird species that rely on conifer seeds. Trees in this association tend to be small and thus those species requiring large trees will not be common on these sites. Because lodgepole pine is often present, the black-backed woodpecker is likely to forage in these stands. Small tree size probably limits nesting habitat. This woodpecker is identified as a "Protection Buffer" species in the Northwest Forest Plan (USDA Forest Service, 1994).

Even though the shrub layer is species poor, big huckleberry is almost always present. Big huckleberry provides browse for deer and elk and berries for many birds and mammals. Beargrass provides forage for elk. Sitka valerian and lupine provide additional forage on some sites. The combination of food and the moderate to flat topography would make these sites good summer range for deer and elk, especially when hiding cover is nearby.

The lack of a high shrub component limits hiding cover for wildlife and nesting sites for shrub-nesting birds. The low shrubs provide cover for ground nesting birds.

Productivity and Management

Sites with the TSME/VASC association are generally marginal in terms of commercial forest management, due to low productivity and reforestation problems. Contributing factors are the short growing season, cold soils, limited soil moisture and nutrients, high soil rock content and frequent growing-season frost. Site index in this sample averaged 75 for subalpine fir, 75 for lodgepole pine, 83 for Engelmann spruce, and 58 for mountain hemlock. These are low values compared to closed canopy Mountain Hemlock Zone forests, but are somewhat higher than the values for the parkland types.

These are not typically sites where intensive forest management would occur. Where slopes are less than 15%, frost pockets are likely to develop in openings. Regeneration is most likely to be successful with application of the shelterwood or small group selection systems. Fuels reduction through burning may result in proliferation of beargrass or long-stolon sedge (CAPE5), especially if the duff layer is removed. Where deep ash soils occur, populations of pocket gophers may expand rapidly. Rocky soils may make tree planting difficult. Frost-tolerant species such as lodgepole pine, mountain hemlock and western white pine are likely to be easiest to establish. In moist microsites, Engelmann spruce may do well.

These are sites where soil biological activity is inhibited by the cold, dry conditions. The usually thin duff layers, important to conservation of site nutrients and protection of soils from moisture loss, need protection during ground-disturbing activities.

Recreation values are typical of those associated with upper-elevation forests, and uses such as camping, hiking and hunting are likely to be significant. The coarse, rocky soils may be less susceptible to compaction and erosion than the ashy soils that are typical of other portions of the Mountain Hemlock Zone. However, once the organic layer is disturbed, site rehabilitation may be difficult due to low nutrients (as well as rockiness). This type is likely to be found in areas managed for alpine or nordic skiing, and areas cleared for ski runs are likely to be extremely difficult to revegetate, especially where the forest floor and upper soil layers are disrupted. Although big huckleberry may be present, it is not as common in this association as in TSME/VAME/CLUN or TSME/VAME/XETE types, and opportunities for huckleberry management are correspondingly less. Grouse huckleberry is not usually sought after by berry pickers.

In this sample of the TSME/VASC association there was an average of 5.3 logs (2.3 tons) per acre in size class 12 and 0.3 logs (0.13 tons) per acre in size class 20. Most of the logs tallied were in the less-decayed classes (condition classes 1 and 2; see p. 22 for size and condition class definitions). These are extremely low values compared to the Mountain Hemlock Zone as a whole, and reflect both the rather low stocking and small tree sizes present in this type.

Soils

This association has thirteen plots with soil profile descriptions. These soils were moderately deep to shallow and had considerable rock content in the soil and on the surface. Duff layers were thin.

Number of soil descriptions:	13	
Average soil depth:	74 cm	Range 29-100 cm
Average rooting depth:	70 cm	Range 55-100 cm
Average effective depth:	43 cm	Range 9-94 cm
Average duff thickness:	2.65 cm	Range 0.5-7 cm
Parent material:	Thin volcanic ash/andesite, glacial drift	

Comparisons

This type was originally described for the Mt. Hood and Willamette National Forests by Hemstrom and others (1982). It was also described by Franklin (1973) near timberline in the eastern parts of the Mt. Adams Province of southwestern Washington. Franklin states that a similar community, often without Pacific silver fir, is very common in the southern Oregon Cascade Range. The TSME-PICO/VASC association described for the Warm Springs Indian Reservation by Marsh and others (1987) is very similar. A Mountain Hemlock/Grouse Huckleberry association is described at elevations above 5700 feet on the Klamath Ranger District of the Winema National Forest (Hopkins 1979); it differs from this type in often having Shasta red fir as a stand component.

REFERENCES

Brockway, D.G., C. Topik, M.A. Hemstrom and W.H. Emmingham. 1983. Plant Association and Management Guide for the Pacific Silver Fir Zone, Gifford Pinchot National Forest. USDA Forest Service, Pacific Northwest Region, R6-ECOL-130a-1983.

Cole, D.N., 1982. Wilderness Campsite Impacts: Effect of Amount of Use. USDA Forest Service Research Paper INT-284. Intermountain Forest and Range Experiment Station, Ogden, UT.

Evers, L., H. Hubbs, R. Crump, J. Colby and R. Dobson. 1996. Fire Ecology of the Mid-Columbia Region. USDA Forest Service, Pacific Northwest Region, Mt. Hood National Forest.

Franklin, J.F. and C.T. Dyrness. 1973. Natural Vegetation of Oregon and Washington. USDA Forest Service General Technical Report PNW-8. Pacific Northwest Research Station.

Franklin, J.F., W.H. Moir, M.A. Hemstrom and S. Greene. 1979. Forest ecosystems of Mount Rainier National Park. USDA Forest Service, unpublished report, Pacific Northwest Research Station.

Froehlich, H.A., 1979. The Effect of Soil Compaction by Logging on Forest Productivity. Final Report to USDI Bureau of Land Management, Contract 53500-CT4-5(N). Oregon State Univerisity, Corvallis, OR.

Grier, C.C., K.A. Vogt, K.M. Lee & R.O. Teskey, 1984. Factors Affecting Root Production in Subalpine Forests of the Northwestern U.S.. in: IUFRO High Altitude Forests Workshop.

Hall, F.C. 1983. Growth basal area: a field method for appraising forest site potential for stockability. *Canadian Journal of Forest Research*, 13(1): 70-77.

Halverson, N.M., C. Topik and R. Van Vickle. 1986. Plant Association and Management Guide for the Western Hemlock Zone, Mt. Hood National Forest. USDA Forest Service, Pacific Northwest Region, R6-ECOL-232a-1986.

Harris, L.D. 1984. The fragmented forest. Univ. of Chicago Press. Chicago. 211 pp.

Hemstrom, Miles, W.H. Emmingham, N.M. Halverson, S.E. Logan and C. Topik. 1982. Plant Association and Management Guide for the Pacific Silver Fir Zone, Mt. Hood and Willamette National Forests. USDA Forest Service, Pacific Northwest Region, R6-ECOL-100-1982a.

Hemstrom, M.A., S.E. Logan and W. Pavlat. 1987. Plant Association and Management Guide, Willamette National Forest. USDA Forest Service, Pacific Northwest Region, R6-ECOL-257b-86.

Henderson, J., R.D. Lesher, D.H. Peter and D.C. Shaw. 1989. Forested Plant Associations of the Olympic National Forest. USDA Forest Service, Pacific Northwest Region, R6-ECOL-TP-001-88.

Henderson, J., R.D. Lesher, D.H. Peter and D.C. Shaw. 1992. Field Guide to the Forested Plant Associations of the Mt. Baker-Snoqualmie National Forest. USDA Forest Service, Pacific Northwest Region, R6-ECOL-TP-028-91.

High, T., 1989. Soil Survey of The Dalles Watershed, Mt.Hood National Forest. Unpublished.

Hill, M.O. 1979. TWINSPAN - A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Section of Ecology and Systematics, Cornell University, Ithaca, NY.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle.

Hopkins, W.E. 1979. Plant Associations of South Chiloquin and Klamath Ranger Districts, Winema National Forest. USDA Forest Service, Pacific Northwest Region, R6-ECOL-79-005.

Larsen, M.J., A.E. Harvey & M.F. Jurgensen, 1979. Residue Decay Processes and Associated Environmental Functions in Rocky Mountain Forests. in: Environmental Consequences of Timber Harvesting in Rocky Mountain Coniferous Forests. USDA Forest Service Gen. Tech. Rep. INT-90; Intermountain Forest and Range Experiment Station, Missoula, MT.

Lillybridge, T. R., B.L. Kovalchik, C.K. Williams and B.G. Smith. 1995. Field Guide for Forested Plant Associations of the Wenatchee National Forest. USDA Forest Service General Technical Report PNW-GTR-359, Pacific Northwest Research Station.

Marsh, F., R. Helliwell and J. Rodgers. 1987. Plant Association Guide for the Commercial Forest of the Warm Springs Indian Reservation. USDI-BIA, unpublished report.

Maser, C. And J.M. Trappe (tech eds.). 1984. The seen and unseen world of the fallen tree. USDA Forest Service General Technical Report PNW-164. Pacific Northwest Research Station, Portland, OR.

Meador, N.C. 1982. Reforestation in the Cascades Pacific Silver Fir Zone. USDA Forest Service, Pacific Northwest Region, R6-ECOL-091-1982.

Minore, D. 1979. Comparative autecological characteristics of Northwestern tree species: A literature review. USDA Forest Service General Technical Report PNW-87, Pacific Northwest Research Station, Portland, OR.

Mueller-Dombois, D. And H. Ellenbert. 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons, New York.

Radwan, M.A. & J.S. Shumway, 1985. Response of Douglas-fir Seedlings to Nitrogen, Sulphur and Potassium Fertilization. USDA Forest Service Research Paper PNW-346; Pacific Northwest Research Station, Portland, OR.

Soil Survey Staff, 1975. Soil Taxonomy. USDA Agricultural Handbook No. 436.

Topik, Christopher, N.M. Halverson and D.G. Brockway. 1986. Plant Association and Management Guide for the Western Hemlock Zone, Gifford Pinchot National Forest. USDA Forest Service, Pacific Northwest Region, R6-ECOL-230a-1986.

Topik, C., N.M. Halverson and C.T. High. 1988. Plant Association and Management Guide for the Ponderosa Pine, Douglas-Fir and Grand Fir Zones, Mt. Hood National Forest. USDA Forest Service, Pacific Northwest Region, R6-ECOL-TP-004-88.

Topik, Christopher. 1989. Plant Association and management Guide for the Grand Fir Zone, Gifford Pinchot National Forest. USDA Forest Service, Pacific Northwest Region, R6-ECOL-TP-006-88.

Ugolini, F.C., 1981. Soil Development in the Abies Amabalis Zone of the Central Cascades of Washington. in: C.D. Oliver & R.M. Kennedy (eds.) Proceedings of the Biology and Management of True Fir in the Pacific Northwest Symposium, pp 165-176. College of Forest Resources, University of Washington, Seattle, WA.

USDA Forest Service, 1994. Record of Decision for Amendments to Forest Service and Bureau of Land management Planning Documents within the Range of the Northern Spotted Owl *and* Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl. USDA Forest Service and USDI BLM..

USDA-NRCS, 1977. The PLANTS Database, National Plant Data Center, Baton Rouge LA.

Vogt, K.A. & C.C. Grier, 1981. Root Growth and Mycorrhizae in True Firs. in: C.D. Oliver & R.M. Kennedy (eds.) Proceedings of the Biology and Management of True Fir in the Pacific Northwest Symposium. College of Forest Resources, University of Washington, Seattle, WA.

APPENDICES

APPENDIX 1. ASSOCIATION TABLES

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS
CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred
% COV = average % foliar cover of species in type

	TSME-ABLA2/ASLE2		TSME-ABLA2/FEVI		TSME-ABLA2/JUCO4		TSME-ABLA2/PONE4		TSME-PIAL/LUHI		TSME/LUHI	
	6 Plots		3 Plots		4 Plots		4 Plots		5 Plots		22 Plots	
Species	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV
MATURE TREES												
Abies amabilis	50	14	.	.	.	.	.	.	40	13	41	6
Abies grandis	.	.	.	.	.	.	.	.	.	.	5	3
Abies lasiocarpa	67	15	100	17	50	5	75	5	60	10	64	21
Abies procera	.	.	.	.	25	5	.	.	.	.	5	30
Chamaecyparis nootkatensis	.	.	.	.	.	.	.	.	.	.	.	.
Larix occidentalis	.	.	.	.	.	.	.	.	.	.	.	.
Pinus albicaulis	50	5	33	1	75	10	75	4	100	6	5	2
Pinus contorta	.	.	.	.	.	.	25	5	.	.	.	.
Picea engelmannii	.	.	.	.	.	.	.	.	.	.	9	6
Pinus monticola	.	.	.	.	.	.	.	.	.	.	.	.
Pseudotsuga menziesii	.	.	.	.	25	25	.	.	.	.	.	.
Thuja plicata	.	.	.	.	.	.	.	.	.	.	.	.
Tsuga heterophylla	.	.	.	.	.	.	.	.	.	.	.	.
Tsuga mertensiana	83	12	100	12	75	8	100	10	80	21	100	19
REGEN TREES												
Abies amabilis	33	3	.	.	.	.	.	.	40	7	64	4
Abies grandis	.	.	.	.	.	.	.	.	.	.	.	.
Abies lasiocarpa	50	4	100	6	50	6	25	3	60	5	50	6
Abies procera	.	.	.	.	25	4	.	.	.	.	.	.
Chamaecyparis nootkatensis	.	.	.	.	.	.	.	.	.	.	.	.
Pinus albicaulis	17	1	33	1	50	6	75	2	60	2	32	1
Pinus contorta	.	.	.	.	.	.	25	2	.	.	.	.
Picea engelmannii	.	.	.	.	.	.	.	.	.	.	5	1
Pinus monticola	.	.	.	.	.	.	.	.	.	.	.	.
Pseudotsuga menziesii	.	.	.	.	25	1	.	.	.	.	.	.
Thuja plicata	.	.	.	.	.	.	.	.	.	.	.	.
Tsuga heterophylla	.	.	.	.	.	.	.	.	.	.	.	.
Tsuga mertensiana	83	2	100	6	75	1	75	8	80	5	86	5
SHRUBS												
Acer circinatum	.	.	.	.	.	.	.	.	.	.	.	.
Amelanchier alnifolia	.	.	.	.	.	.	.	.	.	.	.	.
Arctostaphylos nevadensis	.	.	.	.	50	3	.	.	.	.	.	.
Berberis nervosa	.	.	.	.	.	.	.	.	.	.	.	.
Castanopsis chrysophylla	.	.	.	.	.	.	.	.	.	.	.	.
Cassiope mertensiana	.	.	.	.	.	.	.	.	.	.	5	1
Chimaphila menziesii	.	.	.	.	.	.	25	1	.	.	.	.
Chimaphila umbellata	.	.	.	.	25	7	.	.	.	.	.	.
Gaultheria ovatifolia	.	.	.	.	.	.	.	.	.	.	.	.
Holodiscus discolor	.	.	.	.	25	2	.	.	.	.	.	.
Juniperus communis	.	.	.	.	100	24	.	.	.	.	5	1
Linnaea borealis	.	.	.	.	.	.	.	.	.	.	.	.
Lonicera involucrata	.	.	.	.	25	2	.	.	.	.	5	1

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS

CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred

% COV = average % foliar cover of species in type

	TSME-ABLA2/ASLE2		TSME-ABLA2/FEVI		TSME-ABLA2/JUCO4		TSME-ABLA2/PONE4		TSME-PIAL/LUHI		TSME/LUHI	
	6 Plots		3 Plots		4 Plots		4 Plots		5 Plots		22 Plots	
Species	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV
Menziesia ferruginea	.	.	.	.	.	.	.	.	.	.	.	.
Pachistima myrsinites	.	.	.	.	50	21	.	.	.	.	.	.
Phyllodoce empetriformis	17	1	33	1	.	.	.	.	.	.	.	.
Rhododendron albiflorum	.	.	.	.	.	.	.	.	.	.	.	.
Rhododendron macrophyllum	.	.	.	.	.	.	.	.	.	.	.	.
Ribes lacustre	.	.	.	.	.	.	.	.	.	.	5	1
Rosa gymnocarpa	.	.	.	.	.	.	.	.	.	.	.	.
Rubus lasiococcus	50	1	.	.	25	1	.	.	.	.	59	5
Rubus parviflorus	.	.	.	.	.	.	.	.	.	.	.	.
Rubus pedatus	.	.	.	.	.	.	.	.	.	.	.	.
Sorbus sitchensis	67	2	33	1	25	1	50	1	60	2	59	2
Spiraea densiflora	.	.	.	.	.	.	.	.	.	.	.	.
Symphoricarpos mollis	.	.	.	.	.	.	.	.	.	.	.	.
Vaccinium alaskaense	.	.	.	.	.	.	.	.	.	.	.	.
Vaccinium caespitosum	.	.	.	.	.	.	.	.	.	.	.	.
Vaccinium deliciosum	17	1	.	.	.	.	.	.	.	.	9	2
Vaccinium membranaceum	17	1	33	2	25	2	.	.	20	2	59	6
Vaccinium ovalifolium	.	.	.	.	.	.	.	.	.	.	.	.
Vaccinium parvifolium	.	.	.	.	.	.	.	.	.	.	.	.
Vaccinium scoparium	17	10	.	.	.	.	25	3	20	1	23	4
FORBS												
Achillea millefolium	33	7	.	.	100	1	.	.	20	5	.	.
Achlys triphylla	.	.	.	.	.	.	.	.	.	.	.	.
Anemone deltoidea	.	.	.	.	.	.	.	.	.	.	.	.
Antennaria lanata	17	1	.	.	.	.	50	3	.	.	5	1
Anemone lyallii	.	.	.	.	.	.	.	.	.	.	.	.
Anaphalis margaritacea	.	.	.	.	.	.	.	.	.	.	5	1
Anemone occidentalis	17	1	.	.	.	.	.	.	.	.	.	.
Anemone oregana	.	.	.	.	.	.	.	.	.	.	.	.
Arnica cordifolia	.	.	.	.	.	.	.	.	.	.	.	.
Arnica latifolia	33	2	67	1	.	.	50	1	80	5	77	5
Arenaria macrophylla	.	.	.	.	25	2	.	.	.	.	.	.
Aster alpigenus	.	.	.	.	.	.	25	1	.	.	.	.
Aster ledophyllus	100	13	100	9	.	.	.	.	20	1	36	2
Aster spp.	.	.	.	.	50	1	.	.	.	.	.	.
Calypso bulbosa	.	.	.	.	.	.	.	.	.	.	.	.
Castilleja hispida	.	.	33	1	25	1	.	.	.	.	.	.
Campanula scouleri	.	.	.	.	.	.	.	.	.	.	.	.
Calochortus subalpinus	17	1	.	.	.	.	.	.	20	1	14	1
Clintonia uniflora	.	.	.	.	.	.	.	.	.	.	.	.
Cornus canadensis	.	.	.	.	.	.	.	.	.	.	.	.
Corallorhiza mertensiana	.	.	.	.	.	.	.	.	.	.	.	.
Epilobium alpinum	.	.	.	.	.	.	.	.	.	.	9	1
Epilobium minutum	17	1	.	.	25	1	.	.	.	.	9	1

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS
CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred
% COV = average % foliar cover of species in type

	TSME-ABLA2/ASLE2		TSME-ABLA2/FEVI		TSME-ABLA2/JUCO4		TSME-ABLA2/PONE4		TSME-PIAL/LUHI		TSME/LUHI	
	6 Plots		3 Plots		4 Plots		4 Plots		5 Plots		22 Plots	
Species	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV
Erythronium montanum	.	.	.	.	.	.	.	.	20	1	9	1
Erigeron peregrinus	17	1	33	1	.	.	.	.	20	1	27	2
Fragaria spp.	.	.	.	.	.	.	.	.	.	.	.	.
Goodyera oblongifolia	17	1	.	.	25	1	.	.	.	.	5	1
Hieracium albiflorum	33	1	.	.	25	1	.	.	.	.	5	1
Hieracium gracile	17	1	33	1	25	1	25	2	20	1	27	1
Hypopitys monotropa	.	.	.	.	.	.	.	.	.	.	5	1
Listera caurina	.	.	.	.	.	.	.	.	20	1	5	1
Listera cordata	.	.	.	.	.	.	.	.	.	.	.	.
Ligusticum grayi	17	1	33	1	.	.	25	2	40	1	23	1
Lomatium martindalei	17	1	33	1	25	1	.	.	40	1	14	1
Lupinus latifolius	100	15	100	23	25	3	50	6	80	14	82	9
Lupinus lepidus	.	.	33	1	.	.	.	.	20	10	.	.
Luetkea pectinata	.	.	33	2	.	.	25	10	80	4	41	9
Lupinus spp.	.	.	.	.	25	1	75	2	.	.	.	.
Lupinus polyphyllus	.	.	.	.	.	.	.	.	.	.	.	.
Lupinus wyethii	.	.	.	.	50	4	.	.	.	.	.	.
Mitella breweri	17	1	.	.	.	.	.	.	20	1	45	6
Nothochelone nemorosa	.	.	.	.	25	1	.	.	.	.	9	1
Osmorhiza chilensis	17	1	.	.	.	.	.	.	.	.	14	1
Osmorhiza purpurea	17	1	.	.	.	.	.	.	.	.	14	1
Pedicularis groenlandica	.	.	.	.	.	.	50	1	.	.	.	.
Pedicularis racemosa	33	1	33	1	.	.	25	2	20	1	41	2
Phlox diffusa	50	7	33	3	50	2	25	3	.	.	5	1
Polygonum bistortoides	17	1	.	.	.	.	.	.	.	.	14	1
Potentilla flabellifolia	17	1	33	1	.	.	.	.	.	.	23	1
Polygonum newberryi	17	1	33	2	50	2	100	3	20	1	.	.
Polemonium pulcherrimum	83	22	67	11	50	9	50	2	60	2	64	2
Pteridium aquilinum	.	.	.	.	.	.	.	.	.	.	.	.
Pyrola asarifolia	.	.	.	.	.	.	.	.	.	.	.	.
Pyrola picta	17	1	.	.	.	.	.	.	.	.	5	1
Pyrola secunda	.	.	.	.	25	1	.	.	.	.	23	1
Senecio bolanderi	.	.	.	.	.	.	.	.	.	.	.	.
Senecio triangularis	33	1	.	.	.	.	.	.	20	1	55	2
Smilacina racemosa	.	.	.	.	25	1	.	.	.	.	.	.
Smilacina stellata	.	.	.	.	25	1	.	.	.	.	.	.
Spraguea umbellata	.	.	33	1	.	.	25	1	20	1	.	.
Streptopus roseus	.	.	.	.	.	.	.	.	.	.	.	.
Tiarella trifoliata unifoliata	.	.	.	.	.	.	.	.	.	.	.	.
Trillium ovatum	.	.	.	.	.	.	.	.	.	.	.	.
Vancouveria hexandra	.	.	.	.	.	.	.	.	.	.	.	.
Valeriana sitchensis	.	.	33	2	.	.	25	1	40	1	59	8
Veratrum californicum	.	.	.	.	.	.	.	.	.	.	5	1
Veratrum viride	33	2	33	1	.	.	.	.	20	3	41	6
Vicia spp.	.	.	.	.	.	.	.	.	.	.	.	.

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS
CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred
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Species	TSME-ABLA2/ASLE2		TSME-ABLA2/FEVI		TSME-ABLA2/JUCO4		TSME-ABLA2/PONE4		TSME-PIAL/LUHI		TSME/LUHI	
	6 Plots		3 Plots		4 Plots		4 Plots		5 Plots		22 Plots	
	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV
Viola orbiculata	.	.	.	.	.	.	.	.	.	.	.	.
Viola sempervirens	17	1	.	.	.	.	.	.	.	.	5	2
Xerophyllum tenax	17	5	.	.	25	15	.	.	.	.	27	2
GRASSES/GRASSLIKES												
Bromus spp.	17	2	.	.	25	4	.	.	20	1	.	.
Carex geyeri	.	.	.	.	25	1	.	.	.	.	.	.
Carex nigricans	.	.	67	3	.	.	.	.	.	.	5	3
Carex pachystachya	17	1	100	2	.	.	.	.	.	.	9	1
Carex pensylvanica	33	13	33	1	25	3	.	.	.	.	5	1
Carex spp.	.	.	.	.	.	.	.	.	.	.	18	1
Carex spectabilis	17	1	.	.	.	.	.	.	20	50	18	13
Deschampsia atropurpurea	50	2	67	1	.	.	.	.	20	1	18	1
Festuca viridula	33	2	100	20	.	.	.	.	40	3	41	3
Juncus drummondii	17	1	67	2	25	1	.	.	.	.	14	1
Luzula campestris	.	.	.	.	.	.	.	.	.	.	.	.
Luzula hitchcockii	83	5	100	21	50	8	25	2	100	14	100	19
Luzula parviflora	.	.	.	.	.	.	50	3	.	.	.	.
Poa spp.	.	.	.	.	.	.	50	1	.	.	.	.

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS
CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred
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Species	TSME/MEFE 18 Plots CON	% COV	TSME/PHEM-VADE 41 Plots CON	% COV	TSME/RHAL 55 Plots CON	% COV	TSME/RHMA 12 Plots CON	% COV	TSME/VAME/CLUN 40 Plots CON	% COV	TSME/VAME/XETE 70 Plots CON	% COV
MATURE TREES												
Abies amabilis	100	26	37	9	95	26	92	15	95	24	80	22
Abies grandis	.	.	.	.	.	.	.	.	3	5	3	11
Abies lasiocarpa	6	1	85	16	20	9	.	.	23	5	33	12
Abies procera	11	1	2	5	9	10	42	18	35	21	29	13
Chamaecyparis nootkatensis	.	.	.	.	18	8	.	.	3	2	4	10
Larix occidentalis	.	.	.	.	7	6	8	1	5	6	1	3
Pinus albicaulis	.	.	15	2	.	.	.	.	5	6	.	.
Pinus contorta	6	5	5	2	11	2	.	.	.	.	11	14
Picea engelmannii	22	3	2	5	24	5	.	.	28	4	10	4
Pinus monticola	6	2	.	.	18	4	25	1	13	1	9	5
Pseudotsuga menziesii	44	16	.	.	33	10	100	21	33	22	49	14
Thuja plicata	17	7	2	1	4	7	8	1	.	.	3	3
Tsuga heterophylla	72	10	.	.	22	7	67	21	13	7	29	18
Tsuga mertensiana	100	14	83	17	98	21	100	20	93	17	96	20
REGEN TREES												
Abies amabilis	100	21	46	6	91	22	100	14	95	20	91	20
Abies grandis	.	.	.	.	.	.	17	1	3	1	3	1
Abies lasiocarpa	6	1	90	9	7	9	.	.	15	5	21	5
Abies procera	.	.	.	.	.	.	.	.	5	13	3	7
Chamaecyparis nootkatensis	.	.	12	1	16	6	.	.	3	2	4	6
Pinus albicaulis	.	.	20	1	.	.	.	.	.	.	.	.
Pinus contorta	.	.	5	2	.	.	.	.	.	.	9	3
Picea engelmannii	11	1	2	3	7	2	.	.	8	1	1	2
Pinus monticola	.	.	5	1	9	3	25	2	5	2	10	2
Pseudotsuga menziesii	.	.	.	.	2	3	.	.	3	4	3	2
Thuja plicata	6	3	2	2	.	.	.	.	3	1	4	2
Tsuga heterophylla	56	3	.	.	20	3	67	6	15	3	23	5
Tsuga mertensiana	56	6	78	6	55	5	83	5	60	4	71	4
SHRUBS												
Acer circinatum	.	.	.	.	2	1	25	15	10	22	1	1
Amelanchier alnifolia	.	.	.	.	2	2	8	2	10	2	3	2
Arctostaphylos nevadensis	.	.	.	.	.	.	8	1	5	1	6	7
Berberis nervosa	.	.	.	.	7	2	42	7	10	11	19	3
Castanopsis chrysophylla	.	.	.	.	.	.	25	6	.	.	13	2
Cassiope mertensiana	.	.	34	8	.	.	.	.	.	.	.	.
Chimaphila menziesii	6	1	.	.	13	1	33	2	20	1	11	1
Chimaphila umbellata	17	1	.	.	18	3	50	6	25	2	37	2
Gaultheria ovatifolia	44	5	2	1	20	4	67	3	5	2	17	2
Holodiscus discolor	6	25	.	.	.	.	.	.	8	2	.	.
Juniperus communis	.	.	.	.	.	.	.	.	3	2	.	.
Linnaea borealis	28	3	.	.	15	9	50	3	8	2	13	3
Lonicera involucrata	.	.	.	.	.	.	.	.	.	.	.	.

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS
CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred
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	TSME/MEFE		TSME/PHEM-VADE		TSME/RHAL		TSME/RHMA		TSME/VAME/CLUN		TSME/VAME/XETE	
	18 Plots		41 Plots		55 Plots		12 Plots		40 Plots		70 Plots	
Species	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV
Menziesia ferruginea	100	23	2	15	40	13	.	.	5	2	6	4
Pachistima myrsinites	6	1	.	.	7	8	25	1	13	3	21	3
Phyllodoce empetriformis	.	.	76	12	5	8	.	.	.	.	1	2
Rhododendron albiflorum	17	3	12	4	93	21	.	.	8	1	3	13
Rhododendron macrophyllum	33	19	.	.	7	6	100	52	.	.	6	3
Ribes lacustre	11	1	.	.	.	.	.	.	8	1	.	.
Rosa gymnocarpa	.	.	.	.	7	3	17	3	18	3	7	3
Rubus lasiococcus	94	5	46	4	93	6	17	5	75	6	67	5
Rubus parviflorus	.	.	.	.	2	3	.	.	10	3	1	1
Rubus pedatus	56	3	10	6	33	6	.	.	8	4	.	.
Sorbus sitchensis	72	2	56	3	51	3	33	2	43	1	36	2
Spiraea densiflora	.	.	7	3	2	5	.	.	.	.	1	1
Symphoricarpos mollis	.	.	.	.	2	10	.	.	13	3	1	2
Vaccinium alaskaense	22	11	.	.	9	8	25	25	.	.	1	60
Vaccinium caespitosum	.	.	.	.	.	.	.	.	.	.	.	.
Vaccinium deliciosum	.	.	90	23	2	2	.	.	.	.	1	2
Vaccinium membranaceum	100	24	49	10	87	22	50	7	95	22	93	20
Vaccinium ovalifolium	83	15	5	7	45	8	.	.	25	4	11	3
Vaccinium parvifolium	.	.	.	.	2	4	17	2	3	1	4	1
Vaccinium scoparium	.	.	32	4	15	4	8	1	3	2	16	2
FORBS												
Achillea millefolium	.	.	.	.	.	.	.	.	3	1	.	.
Achlys triphylla	33	3	.	.	29	6	.	.	50	6	23	4
Anemone deltoidea	6	3	.	.	16	3	8	2	23	2	13	3
Antennaria lanata	.	.	22	2	.	.	.	.	.	.	.	.
Anemone lyallii	.	.	.	.	4	2	.	.	8	1	3	2
Anaphalis margaritacea	.	.	.	.	.	.	.	.	.	.	1	2
Anemone occidentalis	.	.	5	1	.	.	.	.	.	.	.	.
Anemone oregana	.	.	.	.	2	1	.	.	18	1	7	2
Arnica cordifolia	.	.	.	.	2	2	.	.	8	1	1	10
Arnica latifolia	6	2	39	2	18	12	.	.	50	5	13	2
Arenaria macrophylla	.	.	.	.	.	.	.	.	10	1	1	1
Aster alpigenus	.	.	7	3	.	.	.	.	.	.	1	2
Aster ledophyllus	.	.	7	1	.	.	.	.	.	.	1	1
Aster spp.	.	.	5	2	.	.	.	.	.	.	1	2
Calypso bulbosa	.	.	.	.	2	1	.	.	.	.	.	.
Castilleja hispida	.	.	.	.	.	.	.	.	.	.	.	.
Campanula scouleri	.	.	.	.	7	2	.	.	13	2	4	1
Calochortus subalpinus	.	.	5	1	.	.	.	.	.	.	.	.
Clintonia uniflora	61	4	2	2	44	6	8	4	55	4	39	3
Cornus canadensis	56	7	2	1	11	8	8	1	10	7	9	5
Corallorhiza mertensiana	6	1	.	.	2	2	8	1	3	2	.	.
Epilobium alpinum	.	.	5	1	.	.	.	.	.	.	1	1
Epilobium minutum	.	.	5	2	.	.	.	.	.	.	.	.

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS
CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred
% COV = average % foliar cover of species in type

	TSME/MEFE		TSME/PHEM-VADE		TSME/RHAL		TSME/RHMA		TSME/VAME/CLUN		TSME/VAME/XETE	
	18 Plots		41 Plots		55 Plots		12 Plots		40 Plots		70 Plots	
Species	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV	CON	% COV
Viola orbiculata	33	2	7	2	24	2	33	2	15	3	29	2
Viola sempervirens	6	1	.	.	15	2	.	.	38	1	19	1
Xerophyllum tenax	94	16	44	7	76	15	92	28	48	3	97	20
GRASSES/GRASSLIKES												
Bromus spp.	.	.	2	1	.	.	.	.	8	10	3	2
Carex geyeri	.	.	2	2	.	.	.	.	.	.	.	.
Carex nigricans	.	.	22	2	.	.	.	.	.	.	.	.
Carex pachystachya	.	.	5	1	.	.	.	.	.	.	1	1
Carex pensylvanica	.	.	.	.	.	.	.	.	.	.	3	26
Carex spp.	.	.	15	2	.	.	.	.	3	1	6	21
Carex spectabilis	.	.	2	1	.	.	.	.	.	.	.	.
Deschampsia atropurpurea	.	.	41	1	.	.	.	.	.	.	1	1
Festuca viridula	.	.	10	1	.	.	.	.	.	.	.	.
Juncus drummondii	.	.	12	2	.	.	.	.	.	.	.	.
Luzula campestris	.	.	.	.	.	.	.	.	.	.	1	1
Luzula hitchcockii	.	.	59	11	4	1	.	.	.	.	3	3
Luzula parviflora	.	.	17	6	.	.	.	.	.	.	4	24
Poa spp.	.	.	17	6	5	1	.	.	.	.	3	9

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS

CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred

% COV = average % foliar cover of species in type

Species	TSME/MEFE 18 Plots CON	% COV	TSME/PHEM-VADE 41 Plots CON	% COV	TSME/RHAL 55 Plots CON	% COV	TSME/RHMA 12 Plots CON	% COV	TSME/VAME/CLUN 40 Plots CON	% COV	TSME/VAME/XETE 70 Plots CON	% COV
Erythronium montanum	17	20	41	4	27	11	17	2	5	1	4	9
Erigeron peregrinus	.	.	29	2	.	.	.	.	.	.	.	.
Fragaria spp.	6	1	.	.	2	1	.	.	3	5	4	2
Goodyera oblongifolia	11	2	2	1	18	1	42	4	38	1	34	2
Hieracium albiflorum	6	1	.	.	5	3	.	.	13	2	14	2
Hieracium gracile	.	.	34	1	.	.	.	.	.	.	1	1
Hypopitys monotropa	17	1	2	1	9	1	8	2	5	1	10	1
Listera caurina	6	1	2	1	9	1	.	.	18	1	7	1
Listera cordata	.	.	.	.	5	1	.	.	3	1	1	2
Ligusticum grayi	.	.	76	2	4	1	.	.	5	1	1	1
Lomatium martindalei	.	.	2	1	.	.	.	.	.	.	3	1
Lupinus latifolius	11	1	44	10	15	3	.	.	18	2	14	4
Lupinus lepidus	.	.	.	.	.	.	.	.	.	.	.	.
Luetkea pectinata	.	.	71	10	5	5	.	.	.	.	.	.
Lupinus spp.	6	1	12	12	.	.	.	.	10	2	17	3
Lupinus polyphyllus	.	.	12	5	.	.	.	.	.	.	.	.
Lupinus wyethii	.	.	.	.	.	.	.	.	.	.	.	.
Mitella breweri	11	2	41	1	16	3	.	.	35	4	7	5
Nothochelone nemorosa	.	.	.	.	4	1	.	.	10	2	7	2
Osmorhiza chilensis	.	.	2	5	.	.	.	.	13	1	3	1
Osmorhiza purpurea	.	.	2	1	2	1	.	.	3	1	1	2
Pedicularis groenlandica	.	.	10	2	.	.	.	.	5	2	.	.
Pedicularis racemosa	6	3	15	2	13	2	.	.	15	5	20	2
Phlox diffusa	.	.	2	5	.	.	.	.	.	.	1	2
Polygonum bistortoides	.	.	17	2	.	.	.	.	.	.	1	2
Potentilla flabellifolia	.	.	24	4	.	.	.	.	.	.	.	.
Polygonum newberryi	.	.	2	3	.	.	.	.	.	.	1	3
Polemonium pulcherrimum	.	.	15	2	.	.	.	.	8	1	1	2
Pteridium aquilinum	6	1	.	.	4	10	8	2	8	9	6	2
Pyrola asarifolia	11	2	.	.	11	2	8	1	5	2	4	3
Pyrola picta	.	.	.	.	.	.	33	2	18	1	14	1
Pyrola secunda	44	3	5	1	51	3	17	3	65	2	54	2
Senecio bolanderi	.	.	.	.	.	.	.	.	5	4	1	1
Senecio triangularis	.	.	10	3	4	1	.	.	13	1	1	5
Smilacina racemosa	.	.	.	.	4	2	.	.	15	1	1	1
Smilacina stellata	22	2	2	1	5	3	.	.	28	2	6	2
Spraguea umbellata	.	.	2	2	.	.	.	.	.	.	.	.
Streptopus roseus	33	3	.	.	27	3	.	.	20	1	6	2
Tiarella trifoliata unifoliata	22	2	.	.	22	4	.	.	23	6	6	2
Trillium ovatum	28	1	.	.	25	2	17	2	38	1	13	1
Vancouveria hexandra	11	2	.	.	.	.	8	1	5	2	1	3
Valeriana sitchensis	39	2	54	4	24	4	.	.	38	3	20	2
Veratrum californicum	11	1	.	.	13	2	.	.	5	1	9	1
Veratrum viride	6	1	37	2	13	1	.	.	20	1	6	1
Vicia spp.	.	.	.	.	.	.	.	.	5	1	1	1

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS
CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred
% COV = average % foliar cover of species in type

	TSME/VASC 23 Plots	
Species	CON	% COV
MATURE TREES		
Abies amabilis	48	13
Abies grandis	4	5
Abies lasiocarpa	61	14
Abies procera	13	2
Chamaecyparis nootkatensis	.	.
Larix occidentalis	9	10
Pinus albicaulis	.	.
Pinus contorta	65	9
Picea engelmannii	17	10
Pinus monticola	30	3
Pseudotsuga menziesii	17	7
Thuja plicata	.	.
Tsuga heterophylla	4	15
Tsuga mertensiana	87	17
REGEN TREES		
Abies amabilis	57	11
Abies grandis	9	2
Abies lasiocarpa	65	5
Abies procera	9	6
Chamaecyparis nootkatensis	.	.
Pinus albicaulis	13	1
Pinus contorta	52	4
Picea engelmannii	9	2
Pinus monticola	26	2
Pseudotsuga menziesii	9	4
Thuja plicata	.	.
Tsuga heterophylla	9	3
Tsuga mertensiana	87	7
SHRUBS		
Acer circinatum	.	.
Amelanchier alnifolia	.	.
Arctostaphylos nevadensis	13	2
Berberis nervosa	4	3
Castanopsis chrysophylla	4	5
Cassiope mertensiana	.	.
Chimaphila menziesii	.	.
Chimaphila umbellata	9	2
Gaultheria ovatifolia	9	6
Holodiscus discolor	.	.
Juniperus communis	.	.
Linnaea borealis	.	.
Lonicera involucrata	4	1

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS
CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred
% COV = average % foliar cover of species in type

	TSME/VASC 23 Plots	
Species	CON	% COV
Menziesia ferruginea	4	2
Pachistima myrsinites	9	5
Phyllodoce empetriformis	17	2
Rhododendron albiflorum	4	2
Rhododendron macrophyllum	4	60
Ribes lacustre	.	.
Rosa gymnocarpa	.	.
Rubus lasiococcus	35	8
Rubus parviflorus	.	.
Rubus pedatus	4	2
Sorbus sitchensis	26	1
Spiraea densiflora	4	20
Symphoricarpos mollis	.	.
Vaccinium alaskaense	.	.
Vaccinium caespitosum	9	34
Vaccinium deliciosum	9	1
Vaccinium membranaceum	83	17
Vaccinium ovalifolium	.	.
Vaccinium parvifolium	4	1
Vaccinium scoparium	100	9
FORBS		
Achillea millefolium	4	2
Achlys triphylla	.	.
Anemone deltoidea	4	4
Antennaria lanata	.	.
Anemone lyallii	4	2
Anaphalis margaritacea	9	3
Anemone occidentalis	.	.
Anemone oregana	9	3
Arnica cordifolia	9	3
Arnica latifolia	22	1
Arenaria macrophylla	.	.
Aster alpigenus	.	.
Aster ledophyllus	.	.
Aster spp.	4	1
Calypso bulbosa	.	.
Castilleja hispida	.	.
Campanula scouleri	.	.
Calochortus subalpinus	.	.
Clintonia uniflora	13	2
Cornus canadensis	4	3
Corallorhiza mertensiana	.	.
Epilobium alpinum	.	.
Epilobium minutum	.	.

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS
CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred
% COV = average % foliar cover of species in type

	TSME/VASC 23 Plots	
Species	CON	% COV
Erythronium montanum	.	.
Erigeron peregrinus	.	.
Fragaria spp.	13	2
Goodyera oblongifolia	4	1
Hieracium albiflorum	13	3
Hieracium gracile	9	1
Hypopitys monotropa	.	.
Listera caurina	.	.
Listera cordata	.	.
Ligusticum grayi	17	1
Lomatium martindalei	.	.
Lupinus latifolius	35	3
Lupinus lepidus	.	.
Luetkea pectinata	4	2
Lupinus spp.	.	.
Lupinus polyphyllus	9	6
Lupinus wyethii	.	.
Mitella breweri	4	1
Nothochelone nemorosa	4	1
Osmorhiza chilensis	.	.
Osmorhiza purpurea	.	.
Pedicularis groenlandica	.	.
Pedicularis racemosa	26	2
Phlox diffusa	4	4
Polygonum bistortoides	4	1
Potentilla flabellifolia	.	.
Polygonum newberryi	.	.
Polemonium pulcherrimum	.	.
Pteridium aquilinum	.	.
Pyrola asarifolia	.	.
Pyrola picta	4	1
Pyrola secunda	30	1
Senecio bolanderi	.	.
Senecio triangularis	.	.
Smilacina racemosa	.	.
Smilacina stellata	.	.
Spraguea umbellata	.	.
Streptopus roseus	.	.
Tiarella trifoliata unifoliata	.	.
Trillium ovatum	.	.
Vancouveria hexandra	.	.
Valeriana sitchensis	26	2
Veratrum californicum	.	.
Veratrum viride	9	1
Vicia spp.	.	.

MOUNTAIN HEMLOCK ZONE PLANT ASSOCIATIONS
CONSTANCY AND PERCENT COVER OF VASCULAR PLANTS

CON = Constancy = % of plots in type on which species occurred
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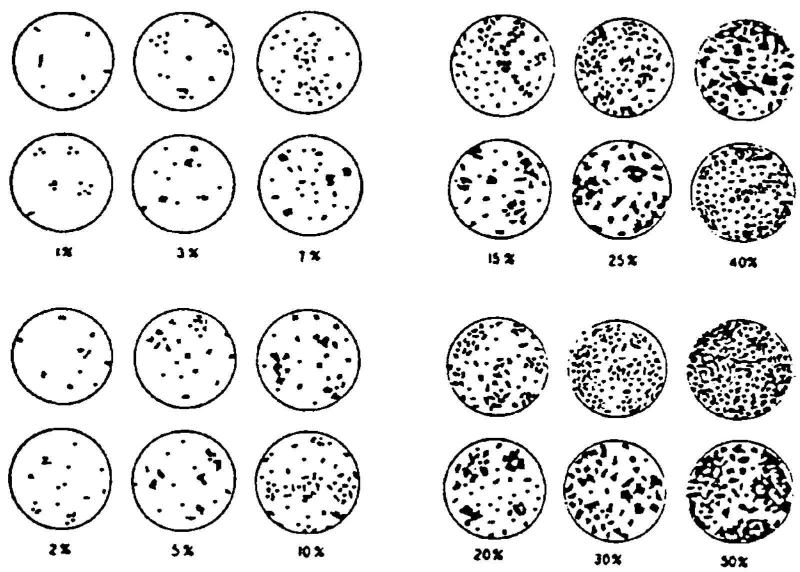
	TSME/VASC 23 Plots	
Species	CON	% COV
Viola orbiculata	17	2
Viola sempervirens	13	1
Xerophyllum tenax	83	27
GRASSES/GRASSLIKES		
Bromus spp.	.	.
Carex geyeri	9	10
Carex nigricans	4	1
Carex pachystachya	.	.
Carex pensylvanica	4	1
Carex spp.	.	.
Carex spectabilis	.	.
Deschampsia atropurpurea	.	.
Festuca viridula	.	.
Juncus drummondii	.	.
Luzula campestris	.	.
Luzula hitchcockii	13	1
Luzula parviflora	9	4
Poa spp.	13	3

APPENDIX 2. PERCENT COVER ESTIMATION

COMPARISON CHARTS FOR VISUAL
ESTIMATION OF FOLIAGE COVER



On a 500 m^2 plot, 1% = 7 ft. x 7 ft.
On a 5 x 10 m. plot, 1% = 1m. x 0.5 m.

Source: Terry, Richard D. and George V. Chilingar, 1955. Journal of Sedimentary Petrology, vol. 25, no. 3, pp. 229-234.

APPENDIX 3. SITE INDEX REFERENCES

Site indices were calculated from equations obtained from John Teply, Regional Biometrician, based on the following sources. These equations are used by both the Current Vegetation Survey and the Timber Stand Exam programs in the Pacific Northwest Region.

Barrett, J.W. 1978. Height growth and site index curves for managed even-aged stands of ponderosa pine in the Pacific Northwest. USDA Forest Service, Pacific Northwest Research Station, Research Paper PNW-232. **Used for Ponderosa pine**. 100-year base.

Brickell, J.E. 1970. Equations and computer subroutines for estimating site quality of eight Rocky Mountain species. USDA Forest Service, Intermountain Research Station, Research Paper INT-75. **Used for Engelmann spruce** (base age 50) **and western white pine** (base age 50, converted to base age 100).

Cochran, P.H. 1979. Site index and height growth curves for managed, even-aged stands of white or grand fir east of the Cascades in Oregon and Washington. USDA Forest Service, Pacific Northwest Research Station, Research Paper PNW-252. **Used for grand fir**. 50-year base.

Cochran, P.H. 1985. Site index, height growth, normal yields and stocking curves for larch in Oregon. USDA Forest Service, Pacific Northwest Research Station, Research Paper PNW-424. **Used for western larch**. 50-year base.

Curtis, R.O., F.R. Herman, and D.J. DeMars. 1974. Height growth and site index for Douglas-fir in high elevation forests of the Oregon-Washington Cascades. *Forest Science* 20:307-316. **Used for Douglas-fir**. 100-year base.

Dahms, W.G. 1975. Gross yield of central Oregon lodgepole pine. In: Baumgartner, D.M. (ed.), management of lodgepole pine ecosystems: Proceedings of a symposium. Pullman, WA; vol. 1, pp. 208-232. **Used for lodgepole pine**. 90-year base.

Herman, F.R., R.O. Curtis and D.J. DeMars. 1978. Height growth and site index estimates for noble fir in high elevation forests of the Oregon-Washington Cascades. USDA Forest Service, Pacific Northwest Research Station, Research Paper PNW-243. **Used for Pacific silver fir, subalpine fir, noble fir.** 100-year base.

Means, J.E., M.H. Campbell, and G.P. Johnson, 1986. Preliminary height growth and site index curves for mountain hemlock. FIR Report, Vol. 10, No. 1. Oregon State University, Corvallis, OR. **Used for mountain hemlock.** 100-year base.

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