AN ABSTRACT OF THE THESIS OF

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Title: THE LOCATION, COMPOSITION, AND STRUCTURE OF OLD-GROWTH FORESTS OF THE OREGON COAST RANGE

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The objectives of this study were to: (1) locate and note patterns of old-growth occurrence, (2) classify old-growth communities, and (3) determine old-growth structural attributes in order to determine important controlling factors.

Maps of major historical burns of the Coast Range; old-growth, climax, and mature forests of western Oregon; and four vegetation zones are presented. In the Valley-Margin Zone (VMZ), located in the foothills and lower slopes east of the Coast Range crest, old-growth occurs in cool moist topographic locations of reduced drought and fire frequency, except along the western margin of the zone where it becomes more widespread. In the Western Hemlock Zone (WHZ), which occupies low and moderate elevations coastward of the VMZ and inland from the coastal fog belt, large mass fires have produced a greater likelihood of finding old-growth in fire protected pockets and stringers than elsewhere. Old-growth, however, can occur broadly across the landscape. The True Fir Zone (TFZ) is found on isolated higher Coast Range peaks which receive a

regular winter snowpack. Only a handful of these relict stands have escaped windthrow, fire, and climatic change. Old-growth in the coastal lowland Sitka Spruce Zone (SSZ) is found in wind-protected sites, especially stands dominated by Picea sitchensis. Inland stands containing Pseudotsuga menziesii are broadly distributed.

Several new communities are defined. The most widespread new VMZ type is the Pseudotsuga menziesii-Acer macrophyllum/Corylus cornuta var. californica/Adenocaulon bicolor association. The Tsuga heterophylla/Vaccinium ovatum/Polystichum munitum association is a new WHZ type. A widespread new TFZ type is the Abies procera/Oxalis oregana association which lacks a true climax tree species. A new SSZ association, the Tsuga heterophylla-Pseudotsuga menziesii-Picea sitchensis/Polystichum munitum-Eurynchium oreganum-Oxalis oregana-Plagiothecium undulatum type, exhibits a complex pattern of conifer dominance.

Data on tree stratum structure from 15 x 25 M plots were found to be unsatisfactory. Full hectare tallies of all trees $>$5 cm d.b.h. were taken. VMZ old-growth stands supported from 75 to 200 Pseudotsuga per hectare, from 73.5 to 99.1 M^2/HA tree basal area, about 986 metric tons per hectare total above ground live biomass, and an average leaf area index of 27 M^2/M^2. VMZ plots had the highest tree, shrub, and herb species richness. WHZ old-growth had 36 to 45 Pseudotsuga and from 165 to 362 Tsuga per hectare, from 71.6 to 96.8 M^2/HA tree basal area, 1121.1 metric tons per hectare biomass, and an average 39.0 M^2/M^2 leaf area index. WHZ plots have the oldest dominant trees of all zones, averaging 422 years.

TFZ basal area averaged 79.3 M^2/HA, leaf area index 31.6 M^2/M^2. SSZ stands on coastal headlands supported from 37 to 48 _Picea_ and from 134 to 164 _Tsuga_ per hectare. Biomass averaged 1093.9 metric tons per hectare, leaf area index 37.1 M^2/M^2, and basal area 86.1 M^2/HA. Herb species diversity and cover were low, and bryophyte cover high.

Except for inland types, SSZ old-growth is well protected. Planning decisions hold the key to the fate of most TFZ and VMZ old-growth. If current trends continue, there will be practically no WHZ old-growth left in the Oregon Coast Range.

THE LOCATION, COMPOSITION, AND STRUCTURE OF OLD-GROWTH FORESTS OF THE OREGON COAST RANGE

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This thesis is dedicated to her.

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THE LOCATION, COMPOSITION AND STRUCTURE OF OLD-GROWTH FORESTS OF THE OREGON COAST RANGE

INTRODUCTION

Foresters and ecologists working in the Pacific Northwest have long recognized an entity called old-growth, especially in forest stands west of the Cascade crest. This entity has, at times, been poorly or incompletely characterized. In the context of this study old-growth forests are stands two hundred years old or older, usually dominated by trees larger than one hundred centimeters in diameter at breast height. These large trees are characterized by ragged, flat-topped crowns with relatively few large diameter upper limbs, and shaggy or flaking bark.

Because of the large volumes of standing timber in old-growth stands, the generally clear grained nature of the lumber, and zero or negative stand growth, management plans for public and especially private forest lands have concentrated on eliminating old-growth. Further, the Coast Range has been the scene of several large and intense forest fires. The cumulative effect of these past events and current practices has been to reduce old-growth in the Oregon Coast Range to scattered small stands or to eliminate it entirely over large areas.

The objective of this study was to make use of the current old-growth resource of the Coast Range by sampling as wide a variety of old-growth stands and types as possible. Since old-growth is rapidly disappearing, an investigation now will have a greater potential data base than at any time in the foreseeable future. Specifically, this study was designed to

(1) locate old-growth using a combination of remote sensing imagery and ground checking in order to devise a sampling strategy and to note patterns of occurrence, (2) classify old-growth forest communities based upon species composition and abundances, and (3) determine structural attributes of old-growth especially as related to inferences about controlling environmental factor complexes.

The study included an area from the Columbia River on the north to the Middle Fork of the Coquille River on the south (State Highway 42) and from the Pacific Ocean on the west to the edge of the Willamette Valley, or, below Eugene, Interstate Highway Five on the east. Excluded were forests developed on a loose sand substrate (except for special cases as noted), alluvial bottomland stands, and Oregon white oak (*Quercus garryana* Dougl.) forests.

Taxonomic nomenclature for most vascular plants follows the five volumes of Hitchcock *et al*. (1955, 1959, 1961, 1964, 1969). The reference for certain more southerly species not covered in their work is Munz (1959). Appendix 1 lists the species encountered in this study along with four letter abbreviation codes developed for field and computer handling of all species and used in presenting data for common trees and shrubs.

CONCEPTS AND TERMINOLOGY

Plant ecology is characterized by a lack of standardization in methods and a lack of common agreement about the fundamental organizational nature of plant assemblages. Although some may view this diversity as an indication of a vigorous and emerging science, it does require an investigator to provide a background of his perspectives and certain definitions to enable readers to properly evaluate his work. The following are the major perspectives, assumptions, and terms I have used in this study.

1. Important nodes on environmental gradients can confront plants with major environmental limitations which may effectively displace entire groups and allow or even favor the occurrence of others. To the degree that these environmental discontinuities can occur over relatively short distances and appear in various places in a landscape, more or less recognizable and recurring plant assemblages develop. Succession offers the opportunity for some species to blur the distinctiveness of community boundaries through release from competitive exclusion or the sudden availability of new open habitats suitable for germination. This phenomenon is countered to some degree by the high incidence in many Coast Range ecosystems of plant species persisting through

disturbances by vegetative reproduction from residual organs.

2. Old-growth is the physical expression at one point of the overlapping niches of its component plant species. Consequently old-growth stands are powerful fine-scale indicators of particular physical environments. Further, old-growth stands can reveal the nature of steady-state biotic interactions within the limits of a dynamic equilibrium. Because this study is restricted to old-growth, inferences can be drawn that are increasingly less applicable to correspondingly younger and more disturbed vegetation.

3. It is important to consider scale when looking for patterns of plant community organization. What may be an appropriate scale at which to look for homogeneity in the tree stratum, for example, may encompass too much variation in the physical environment to allow for homogeneity in shrub or herb strata.

4. The landscape of the Coast Range is a mosaic of different frequencies of experiencing major disturbances, such as fire, wind, and earth movement. In some cases modern man has greatly changed the nature

of the occurrence of these. Only in areas relatively free from physical disturbances did succession proceed to a "climax" ecosystem. In other areas, however, succession did result in a "terminal" product.

5. The individualistic view (Gleason, 1926) and the gradient perspective (Whittaker, 1970; Curtis, 1959) of the organizational nature of plant communities provide some valuable insights, but overlook many factors which operate to form species co-occurrences. A large dominant tree may define niches for many subordinate species which are co-adapted to live under its influence. Species may have mutualistic relationships or be favored by community processes such as nutrient cycling. The species themselves may cause important changes in the physical environment that may select for or against others (e.g. allelopathy). Perhaps the most serious flaw, however, is the over-idealization of gradients of gradual environmental change when often sharp environmental discontinuities can be demonstrated in nature. Gradual changes in vegetation may simply be messy data that do not reflect fundamental organization so much as a secondary disturbance along community edges, an explanation typically ignored in the individualistic or gradient concepts. On the other

hand, the community package approach (Daubenmire, 1966) does falter in areas with truly gradual changes in environments, since "mixed" sampling plots can be encountered. Both approaches could be strengthened by investigating the environmental optima of subspecific taxonomic entities and the closer investigation of the variation of subtle environmental factors at a fine scale. I used the community package approach because it more closely fit my objectives and seemed less of an idealization in my study area.

A community is any interacting group of organisms in close proximity.

A stand is a particular real example of an old-growth community.

A pocket of old-growth is a stand of limited extent found in a particularly favorable topographic location and surrounded by more recently disturbed communities.

Climax means a self-perpetuating community fluctuating within a dynamic equilibrium that can occupy a site indefinitely in the absence of major disturbance.

Constancy is the number of stands in a sample of a community that a species occurs in, and is expressed as a percentage.

Differential species are those that distinguish two different communities or associations under comparison by having high presence or constancy in one and low presence or being absent in the other.

A plant species has high fidelity when it occurs in a particular association or group of associations with high constancy and does not occur in others.

An association is a fully developed old-growth or climax community which may be distinguished by differential and/or high fidelity species of high constancy.

THE STUDY AREA

Geology and Physiography

The geologic features of the Coast Range exert a fundamental level of control over its ecosystems' origin, development, and expression. These features include the sequence and position of sedimentary formations, the location of igneous activity, the chemical composition of bedrock soil parent materials, and the history of deformation uplift and incision that has resulted in the modern physiography.

The oldest formations present in the Coast Range are early Eocene in age. The area occupied by the present Coast Range was a synclinal basin embayment extending 640 km between the Klamath Mountains and western Washington (Snavely and Wagner, 1963; Snavely, MacLeod, and Rau, 1969). The area was at or near the margin of the then tectonically active Pacific and North American plates. Major sources of sediment were the Cenozoic Klamath uplands and huge amounts of submarine flows, breccias, and tuffaceous sediments produced from igneous activity at the plate boundary. Along the eastern margin, flows from the early Cascades made a contribution (Baldwin, 1964).

In the early to mid Eocene, local centers of igneous activity poured out pillow basalts and breccias in the central to north Coast Range. These rocks were low-potassium tholeiitic basalts identical in chemical composition to ocean ridge basalts (Snavely, MacLeod, and Wagner, 1968). As subduction was probably occurring at the same, time thicknesses up to 3000 M collected. If flows and breccias were successful in emerging above sea level, flows and ash would accumulate. The Siletz River Volcanics (Snavely and Baldwin, 1948) represent this sequence in the north to central Coast Range, and the Umpqua Formation (Diller, 1898) in the south.

The basalt rocks of the upper Siletz River Volcanics are different both chemically and in genesis from the lower tholeiitic basalts. They were erupted in shallower water and differentiated from the earlier magmatic source. They are predominantly alkali basalts, feldspar-phyric basalt, ankaramite, and picrite. Where islands formed, sub-aerial basalt accumulated (Snavely, MacLeod, and Wagner, 1968). MacLeod and Snavely (1973) suggest that these areas were later truncated by erosion, down-warped (forming a seamount), and buried by sedimentary facies. Present-day seamounts show similar ranges of alkaline basalt composition.

During the mid Eocene, volcanism subsided, but uplift of the Klamath Mountain province initiated a gradual aggradation from the southern portion of the basin to the north. Sedimentation built deltas and a coastal sediment margin. When the critical angle of repose was exceeded, turbidity currents were released. Coarse sand settled at the base of the continental slope first, followed by the silts of the turbidity flow. Baldwin (1964) describes the Tyee Formation as a rhythmically bedded micaceous arkosic (unaltered feldspar) sandstone and sandy siltstone. He points out that the base of each sandstone bed is sharply defined. The sandstone (making up most of the bed) grades upward rapidly into fine grained sandstone and siltstone, commonly cut on its surface by small scour channels. Common fossils are small reeds which he suggests are salt marsh plants. Consistent also with this model of genesis is the fact that the Tyee Formation gradually thins out from 1800 M in the south to approximately 300 M at Ball Mountain where it overlies a seamount of the Siletz River Volcanics (MacLeod and Snavely, 1973).

The early to late Eocene Yamhill Formation named by Baldwin, Brown, Gair and Pease (1955) is a variant of and interfingers with the Tyee Formation. It is distinguished by only faintly bedded shale-mudstone and siltstone sedimentary rocks with some lime cemented sandstone. Baldwin (1964) suggests that it was probably deposited in quieter water than the Tyee further from a sediment source.

MacLeod and Snavely (1973) propose that in the upper Eocene volcanics were erupted from a complexly differentiated magma to form the headlands between Yachats and Heceta Head (basalt and basaltic andesite-quartz normative, high in alkali and alumina), Cascade Head (nepheline normative-quartz undersaturated) and Table Mountain (nepheline syenite). This upsurge of volcanic activity in the late Eocene contributed much ejecta typically as tuffaceous material that formed the siltstones and claystones typical of the Nestucca Formation. Baldwin (1964) suggests that volcanic activity may have occurred into the lowermost Oligocene.

MacLeod and Snavely (1973) report that the widespread high ash content of mid-Oligocene tuffaceous siltstones (siltstone of Alsea) was probably due to rapid alluvial transport or direct fall into the marine environment of ash from the ancestral Cascades. Mid Oligocene sills and dikes of basalt and iron-rich granophyric gabbro cap high peaks along the axis of the Coast Range including Mary's Peak.

Snavely, MacLeod, and Wagner (1973) have identified two periods of middle and late Miocene volcanic activity that complete this discussion of north Coast Range orogeny. Through chemical analyses they propose that during the earlier period, which formed the Depoe Bay Basalt, and the second, which formed the Cape Foulweather Basalt, these formations were co-magmatic with the extensive Yakima Basalt (Columbia River Basalt fissure flows). The Depoe Bay Basalt is the more extensive and makes up Cape Lookout, Cape Mears, Cape Falcon, Tillamook Head, Mount Hebo, and Mount Gauldy.

The Cape Foulweather Basalt is most abundant at Cape Foulweather but also underlies Yaquina Head.

Snavely and Wagner (1963) proposed a shrunken synclinal basin in the early Miocene restricted to the northwestern Coast Range. With the intrusion of gabbroic sills and considerable uplift accompanying the gentle deformation of all these Tertiary formations, the cycle of incision and erosion by rivers and streams began to form the modern Coast Range. Baldwin (1952) describes the geology of Saddle Mountain as the interfluve erosion remnant of undercutting of softer sedimentary beds overlain by basalt. Saddle Mountain is one of a series of such small high peaks trending northeast to southwest across the far northwest Coast Range.

This geologic setting has produced the modern physiography which together with overall patterns of atmospheric circulation results in the climate of the Coast Range. All these factors in turn provide the physical environment for ecosystem development.

The Tyee Formation with sharp breaks between sandstone-siltstone rhymites has a marked tendency, when lubricated by water flowing along bedding planes and when tilted, to slump or undergo rotational block failure. The resulting benches and headwalls are very common over large areas of the Coast Range. Such large scale earthslides have formed dams across streams resulting in Loon and Triangle Lakes, an ancient lake at Sitkum (now filled in), and recently, the largest historically recorded earthslide in the Coast Range (probably aggravated by roadbuilding and clearcutting) at Drift Creek near Table Mountain. Erosion exposed bedding plane contacts often seep moisture that in some cases flows down steep slopes between the solum and regolith before collecting in streams.

In the South Coast Range the Tyee Formation (the most widespread formation in the Coast Range) has a higher sand to silt ratio (Baldwin, 1964) and thicker accumulations have produced more massive, less friable sandstone. Erosion has often carved the underlying siltstone first causing steep walled canyons and large blocky boulders less easily weathered than sandstones of the central Coast Range.

The mid Oligocene basalt or gabbro sills and dikes have been much more erosion-resistant than the Tyee Formation they were injected into. These have formed peaks, including Grass Mountain, Mary's Peak, Prairie Mountain, Flat Mountain, and Monmouth Peak, which are an effective topographic barrier for moisture-laden westerly winds. This creates a very high annual precipitation (260+ cm) on the windward side and the "rain shadow" climate of warming downslope air masses leeward. Together with the Siletz River Volcanics of the Mill Creek-Rickreall Ridge uplands and the Tillamook uplands (usually 950+ M), these peaks appear to have been glaciated at the highest elevations. Evidence encountered in the course of this study includes unsorted glacial till, cirques, morainal lakes, glacially scoured bedrock surfaces, and U-shaped valleys. These uplands still receive a considerable winter snowpack that often persists into late spring or early summer.

The upper Eocene basalt and basaltic andesite headlands at Cascade Head and from Cape Perpetua to Heceta Head and the late Miocene Depoe Bay Basalt headlands (Capes Lookout, Mears, and Falcon, and Tillamook Head) form a unit directly fronting the Pacific Ocean. These headlands block summer fog and cool temperatures from inland penetration except along major lowlands or river valleys.

Biogeography and Climate

Franklin and Dyrness (1973) recognize three major vegetation zones in the Coast Range, the *Picea sitchensis* Zone, the *Tsuga heterophylla* Zone, and the Willamette-Umpqua Valleys. Frenkel (1974) recognizes a coastal Sitka Spruce type, a Western Hemlock type, and a Willamette Prairie-Forest type.

Figure 3 presents the four zones recognized in the course of this study. Climatically all are under the influence of the North Pacific High which blocks summer storms and produces a marked summer drought.

The Sitka Spruce Zone (SSZ) is distributed along that portion of the coastal region under the influence of air masses moving directly in from the ocean, primarily coastal river valleys and mountain slopes with no major topographic barrier to the ocean. During the summer because of oceanic upwelling these air masses are often saturated, cool, and very stable. Being stable they localize their effects by not escaping major drainage basins. Figure 1 illustrates the pattern of a summer marine air mass intrusion in the erosion-dissected upper Eocene volcanics at Cascade Head. During the winter repeated low pressure storm centers accompanied by high winds move inland producing extended periods of high rainfall and mild temperatures. Relatively warm air is drawn up from the southwest in advance of the low center followed, if the front passes completely, by cool moist unstable air.

The major effects of this coastal climatic pattern as compared to inland regions include the reduction of maximum summer daytime temperature and the increase of minimum summer relative humidity. This reduces maximum seasonal and daily transpirational demand of the vegetation. Differences between summer and winter average temperatures are minimized. Because frosts and freezes are rare and of short duration primary production can occur all year.

The resulting boundary of the Sitka Spruce Zone shows intrusions farthest inland along major river valleys. Some Coast Range rivers

Figure 1. Coastal Low Stratus Bathing Windward Slope Near Cascade Head (405T-408T) And Dissipating or Blocked from Penetrating on Leeward Slope

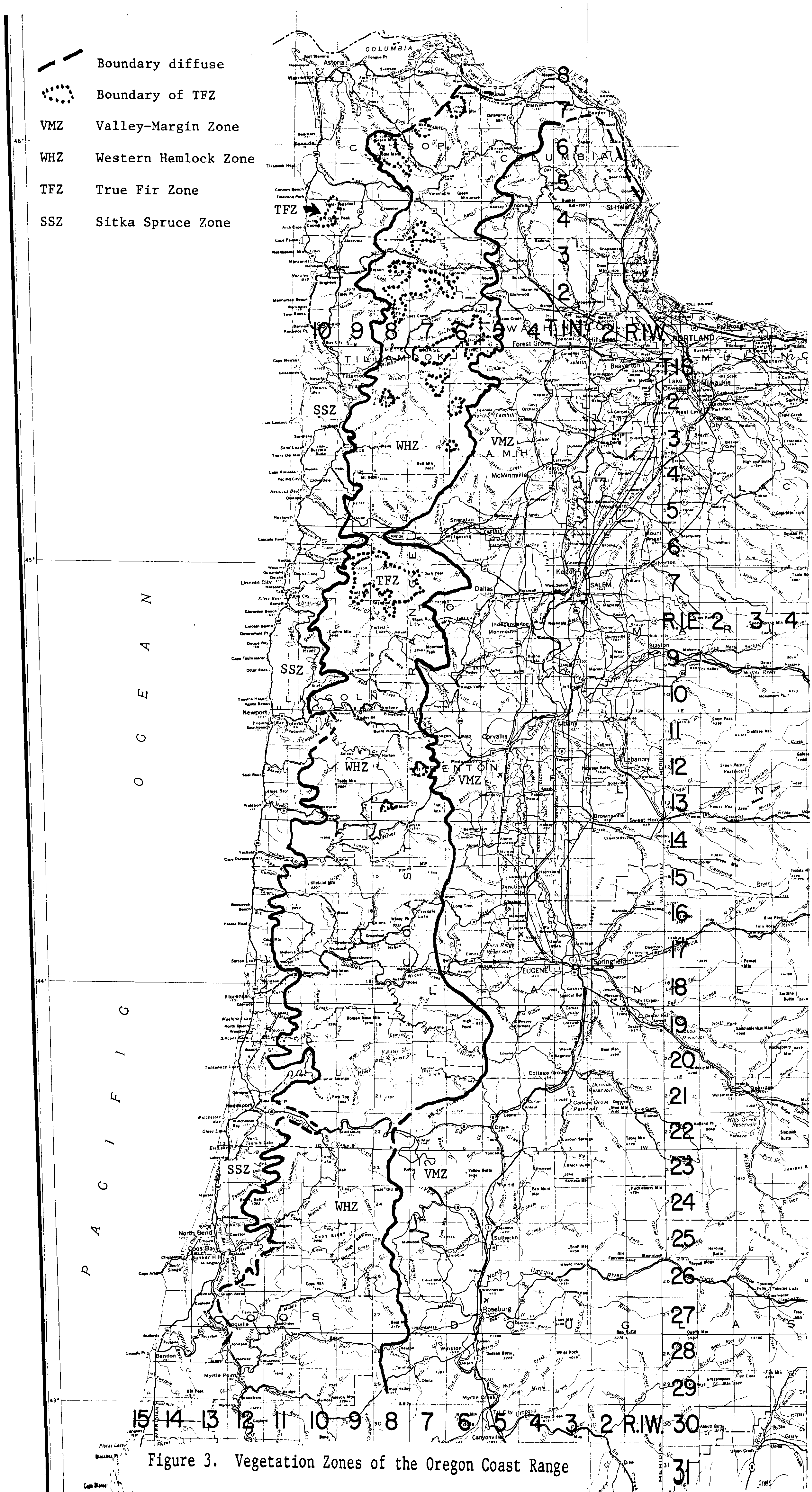


Figure 3. Vegetation Zones of the Oregon Coast Range

connect to interior valleys, such as the Umpqua and the Columbia, or to low passes such as the Yaquina, the South Fork Coos, and the North Fork Coquille. In these areas the boundary becomes diffuse because there are no barriers to separate air masses, resulting in gradual climatic and vegetational gradients. The Zone widens gradually to the north, a fact noted by Hines (1971). It is in the north that major low pressure centers dropping down from the Gulf of Alaska first encounter the mainland, especially the first storms of the late summer and the last storms of the late spring. These storms are effective in alleviating cumulative or incipient summer drought respectively. Also, strong northwest winds associated with oceanic upwelling in the summer, drive cool air in from the northwest which penetrates effectively along the Columbia and Tillamook lowlands.

Table 1 presents representative climatic data for the Sitka Spruce Zone. Annual precipitation is often higher several kilometers inland than that on the coastline itself. Southern stations tend to reach their maximum winter precipitation and highest summer temperatures somewhat later than northern areas. Summer precipitation is higher in the north than in the south and is on the average higher than that for any other area of western Oregon. Snowfall and freezing weather are very rare. Mean annual temperature is low due mostly to low average summer maxima, since average winter minima are quite mild.

The distribution and performance of several species can be correlated with the Sitka Spruce Zone boundaries. The distribution of Picea sitchensis roughly defines the zone except for its absence from active

Table 1. Representative Climatic Data from Stations within Sitka Spruce Zone
In A Gradient From South to North
Source: U.S. Weather Bureau (1965)

Station	Average Annual Precipitation (cm)	Month with Highest Precipitation	June-August Average Precipitation (cm)	Average Annual No. Days With Precip. > .25 cm.	June-August No. Days With Precip. > .25 cm.	Average Annual Snowfall (cm)	Mean Annual Temperature (°C)	Mean July Maximum Temperature.(°C)	Mean January Minimum Temperature (°C)	Mean No. Days with Temperature > 32.2°C	Month with Highest Mean Maximum Temperature	Station Elevation (M)	Station Latitude N.	Station Longitude W.
Bandon	142	Jan.	5.8	100	6	--	10.8	17.9	3.3	0	Aug.= Sept.	2.5	43 07	124 45
N. Bend FAA AP	157	Jan.	6.7	107	7	1.8	11.3	19.1	3.6	fract.	Aug.	3	43 25	124 15
Reedsport	194	Jan.	9.3	128	9	--	11.3	20.7	2.9	fract.	Aug.	29	43 42	124 08
Florence 3 NNW	165	Jan.	8.2	--	--	--	--	--	--	--		15	44 00	124 07
Newport	168	Dec.	10.5	134	14	--	10.5	17.7	3.2	fract.	Aug.	41	44 38	124 04
Otis 2 NE	250	Jan.	16.3	151	16	--	10.3	20.9	2.2	1	Aug.	45	45 02	123 56
Cloverdale 1 NW	214	Dec.	15.4	145	17	--	10.9	21.7	2.1	--	July	6	45 13	123 54
Tillamook	227	Dec.	15.0	147	15	--	10.3	20.2	1.8	1	Aug.	10	45 27	123 49
Nehalem	213	Jan.	16.0	--	--	--	--	--	--	--		23	45 43	123 55
Jewell Guard Sta.	181	Dec.	10.0	--	--	--	--	--	--	--		150	45 56	123 30
Astoria WB AP	197	Jan.	14.0	145	19	--	10.6	20.6	2.1	fract.	Aug.	61	46 11	123 50

coastal dunes and its erratic presence along the southern and inland portion of the zone. The spruce weevil (Pissodes strobi Peck), which reduces the competitiveness of Picea sitchensis through damage to the terminal shoots, requires the greater accumulated heat sums of these latter areas for the development of its broods (McMullen, 1976). Pseudotsuga menziesii is virtually absent along the immediate central and northern coast, and occurs abundantly only on warm, dry sites in the southern portion of the Zone. On extremely steep south and west facing slopes with thin soils in the far southern portion of the Zone some Abies grandis and even Arbutus menziesii occur. However, in the north there is less site differentiation by aspect and slope.

Rubus spectabilis and Blechnum spicant are widely distributed on upland sites in the Zone, but often confined to particularly moist micro-sites elsewhere. Two species found in the Cascades and the Sitka Spruce Zone but not the intervening lowlands are Menziesia ferruginea and Maianthemum dilatatum.

The True Fir Zone (TFZ) is found on the upper slopes and summits of the taller Eocene Siletz River Volcanics, the mid-Oligocene basaltic or gabbroic mountains (usually above 1000 M), and the far northwestern Miocene basaltics where there is a regular winter snowpack. Although some snow occurs all winter beginning in November, maximum mean snow depth is usually reached in April (USDA, 1958-1966). In March of 1976, for example, the summit of Mary's Peak was snowless, yet later received a snowpack that persisted well into May. Total precipitation is often quite high since these mountains are a major topographic barrier forcing orographic uplift at or near the crest of the Coast Range.

Since the distribution of the True Fir Zone in the Coast Range is a group of small, isolated, and uninhabited areas, no regular climatic data are available.

Several plant species in the Coast Range True Fir Zone are relicts, disjuncts, or endemics (Chambers, 1973; Detling, 1954). The Zone derives its name from the two characteristic and dominant trees, Abies procera and Abies amabilis. Several areas appear to be truncated ecosystems when compared to similar but more extensive and species-rich upper slope Cascade ecosystems. Characteristic species include Clintonia uniflora, Viola adunca, and Senecio triangularis.

Pinus monticola is reported in four locations in the Coast Range True Fir Zone (Little, 1971). However after extensive searches I have come to the conclusion that it does not occur in the Mary's Peak or Saddleback Mountain areas. Lost Prairie, near Saddleback Mountain, is fringed with old Pseudotsuga menziesii bearing flagged limbs, perhaps due to the unique soil conditions there. This may have led to the report of Pinus monticola. In a quick search I failed to find any Pinus monticola on Edwards Butte. I do have an unconfirmed report of Pinus monticola on Boulder Creek in T 7S R 7W Sec 27 Willamette Meridian.

Merkle (1951) and Nieland (1958) do not report Abies amabilis in Abies procera stands. Hines (1971) defined a community including A. procera and reported an A. amabilis variant from sampling on Saddleback

Mountain. I have found that A. procera and amabilis do co-occur on Saddleback Mountain. The intriguing question is what controls A. amabilis distribution? Kotar (1976) notes that pre-dawn moisture stress measured on Tsuga heterophylla through xylem pressure potential was significantly higher just below the lower elevational limits of Abies amabilis. Hines (1971) and Schmidt (1957) believe that the "heavy seeded" thin barked Abies amabilis is restricted to very cool moist environments where elimination by fire is least likely since recolonization may require many centuries.

The Valley-Margin Zone (VMZ) is found eastward from the lower slopes of the crest of the Coast Range, where westerly air masses are descending, warming, and drying. Summer drought is pronounced and the Zone is made up of a complex mosaic of plant communities that typically segregate on the basis of slope-aspect exposure or fire pattern history. This Zone has the greatest growing season sum of heat units of all Coast Range vegetation zones. However, summer drought dormancy is common in herbaceous communities.

The summer pattern is typically a cloudless, dry stagnant air mass confined to the interior valleys experiencing nighttime inversions. Occasionally a marine air mass overtops the Coast Range crest and spills inland, cooling temperatures and sometimes forming a low cloud layer. Infrequently an upper level low pressure center will come ashore to produce slight amounts of summer rainfall.

During the winter, repeated offshore low pressure centers draw up moisture-laden winds from the southwest, producing persistently cloudy, rainy winters. In the early spring, the low pressure centers weaken and draw up warm air from the southwest less effectively, resulting in lower freezing levels. Snowfalls accompany such events as well as rare outbreaks of cold continental polar air from the east.

Table 2 presents climatic data for the Valley-Margin Zone. The south to north gradient shows increasing summer rainfall, number of days with rain, amount of snowfall, and decreasing summer maximum and winter minimum temperatures. Total precipitation is lower and maximum summer temperature higher than for the other zones.

The Valley-Margin Zone is so named because no one vegetation type of major tree species exclusively characterizes it. Its mosaic includes different physiognomic types that intergrade from interior valley floors westward twenty kilometers or more into the Coast Range. However *Corylus cornuta* and *Adenocaulon bicolor* show high fidelity to most forest stands in the Zone. In the southern portion of the Zone *Calocedrus decurrens* and even *Pinus ponderosa* appear. In the north and at the edge of the Western Hemlock Zone, *Thuja plicata* appears in ponded areas, near springs, or along streams. Some limited numbers of *Tsuga heterophylla* may occur, but on the whole a good way to characterize the Valley-Margin Zone is that portion of the east slope of the Coast Range where *Tsuga heterophylla* cannot grow.

Table 2. Representative Climatic Data from Stations within or near the Valley-Margin Zone In A Gradient From South to North
Source: U.S. Weather Bureau (1965)

Station	Average Annual Precipitation (cm)	Month with Highest Precipitation	June-August Average Precipitation (cm)	Average Annual No. Days With Precip. > .25 cm.	June-August No. Days with Precipitation > .25 cm.	Average Annual Snowfall (cm)	Mean Annual Temperature (°C)	Mean July Maximum Temperature (°C)	Mean January Minimum Temperature (°C)	Mean No. Days with Temperature > 32.2°C	Month with Highest Mean Maximum Temperature	Station Elevation (M)	Station Latitude N.	Station Longitude W.
Reston	136	Jan.**	3.1	95	6	--	--	--	--	--	--	260	43 08	123 38
Roseburg WB AP	83	Dec.	4.7	74	4	17	12.1	28.0	1.6	21	July+	153	43 14	123 22
Bellfountain 1 SW	110	Jan.	3.6	--	--	--	--	--	--	--	--	98	44 21	123 23
Corvallis State Col.	100	Dec.	4.9	91	6	--	11.3	27.3	.6	13	July	62	44 38	123 12
Falls City *	185	Dec.	6.2	116	6	--	10.6	26.9	-.4	11	July+	183	44 51	123 27
Haskins Dam *	190	Dec.	6.4	121	9	--	--	--	--	--	--	256	45 19	123 21
Cherry Grove 2 S	137	Dec.	7.4	112	9	85	10.4	25.9	-.8	11	July	238	45 25	123 15
Forest Grove	116	Dec.	5.9	99	8	--	11.0	27.9	-.6	15	Aug.	53	45 32	123 06

* Transition to Western Hemlock Zone
** four years out of the recorded five
\+ less than .3°F difference between July and August

The Western Hemlock Zone (WHZ) is perhaps best characterized as the portion of the Coast Range inland from the Sitka Spruce Zone, coastward of the Valley-Margin Zone, and lower in elevation than the True Fir Zone. The climate is wet, mild, and still under considerable maritime influence. Extending over the widest range in elevation and from near the coast to near the interior valleys, the Western Hemlock Zone has the greatest variation in climate of the Coast Range vegetation zones (Franklin and Dyrness, 1973). The Zone is, however, under the same general patterns of atmospheric circulation as described previously for the other zones.

Table 3 presents specific climatic data for the Western Hemlock Zone. Total precipitation can be seen to be related to both latitude and elevation (actually proximity to the Coast Range crest). Summer precipitation, total and number of days, more clearly increases from south to north. As in the Sitka Spruce and Valley-Margin Zones winter temperatures are mild and snowfalls light.

There are uniquely distinctive major tree species over the whole Western Hemlock Zone. Rather, the Zone has been conceived of as a great area over which, given enough time, Tsuga heterophylla and/or Thuja plicata would replace other trees through succession (Küchler, 1964; Munger, 1940; Weaver and Clements, 1938). This may be problematical, and I favor the more pragmatic view of the role of disturbance as presented in CONCEPTS AND TERMINOLOGY.

Table 3. Representative Climatic Data from Stations within or near the Western Hemlock Zone In A Gradient From South to North
Source: U.S. Weather Bureau (1965)

Station	Average Annual Precipitation (cm)	Month with Highest Precipitation	June-August Average Precipitation (cm)	Average Annual No. Days With Precip. > .25 cm.	June-August No. Days With Precip. > .25 cm.	Average Annual Snowfall (cm)	Mean Annual Temperature (°C)	Mean July Maximum Temperature (°C)	Mean January Minimum Temperature (°C)	Mean No. Days with Temperature > 32.2°C	Month with Highest Mean Maximum Temperature	Station Elevation (M)	Station Latitude N.	Station Longitude W.
Sitkum 2 SW	203	Dec.	8.2	119	8	45.0	11.1	25.1	.8	7	July=Aug.	173	43 08	123 53
Allegany	225	Jan.	8.1	--	--	--	--	--	--	--	--	15	43 25	124 02
Elkton 3 SW *	134	Dec.	5.4	99	7	14.2	12.3	28.9	1.3	20	July	35	43 36	123 35
Drain 1 NNE *	116	Dec.	5.5	97	7	--	11.8	28.7	1.2	23	July	92	43 41	123 18
Alsea Fish Hatchery	247	Dec.	8.6	134	9	--	11.8	--	--	--	--	70	44 24	123 45
Corvallis WB *	172	Jan.	6.3	107	5	--	--	--	--	--	--	180	44 31	123 27
Valsetz	321	Dec.	14.4	137	10	37.6⊕	9.9	25.6	-.7	12	July	346	44 50	123 40
Lees Camp	274	Jan.	12.6	--	--	--	--	--	--	--	--	181	45 36	123 32
Timber	156	Dec.	7.1	--	--	--	--	--	--	--	--	293	45 43	123 18
Clatskanie 3 W	147	Dec.	9.0	131	13	--	10.4	23.2	.1	4	July	24	46 06	123 17

⊕ In the period 1951-1960 only one snowfall year was greater than a trace
* Transition to Valley Margin Zone

Vaccinium parvifolium has relatively high fidelity to the Zone, at least in old-growth. In the far south (below the Umpqua River) *Umbellularia californica* and *Chamaecyparis lawsoniana* appear as conspicuous indicators of a contingent of species more common in the Siskiyou Mountains.

METHODS

Location

The three aspects of this study involved different research methods. The first, the location of old-growth, began in the summer of 1973 with a reconnaissance of the central Coast Range. I counted growth rings on stumps in clearcuts adjacent to mature timber in order to be able to extrapolate age-size relationships. I then entered various stands and noted the characteristics of older (larger) trees, their general distribution, and the species composition of the shrub and herb understory.

In the fall and winter of 1973-74, I gathered U.S. Forest Service and Bureau of Land Management Forest type maps, U.S. Forest Service Wildlife habitat ortho-photos (for Northern Spotted Owl [*Strix occidentalis caurina*] habitat), and 1:15,840 and 1:2,000 black and white and true color air photos. With these supporting materials I located several old-growth stands throughout the Coast Range. I then assembled an uncontrolled mosaic of eight NASA Landsat frames providing coverage of all of Oregon west of the Cascade crest. Each frame is a composite series of scanning images of reflected radiant energy taken from an elevation of approximately 907 km. These scenes were color reconstitutions of bands four (.5 to .6μ), five (.6 to .7μ), and seven (.8 to 1.1μ).

For more finely detailed color infrared imagery, I consulted NASA U-2 high altitude (19,812 M) aerial photography in two formats. The 22.9 x 22.9 cm (9 x 9 in.) format is a contact scale for features at mean sea level of approximately 1:130,000. The 22.9 x 45.7 cm (9 x 18 in.) format would likewise be 1:32,500 scale.

Using the Landsat mosaic (each frame 74 x 74 cm, approximate scale 1:250,000) as a base map, I noted the image signature (tone, pattern, texture, color, and intensity) for known old-growth stands as "training fields." Old-growth stands were delineated by black ink shading on a mylar overlay of the mosaic. I extrapolated the image characteristics of old-growth to other areas of the scene, checking with the high altitude aerial photography wherever coverage was available, and performing spot checks with closer scale maps, photographs, or field knowledge.

Since fire has had a major influence in eliminating old-growth (conversely allowing it to remain in unburned areas) and in shaping the characteristics of remnant stands, a map of major fires in the Coast Range proved to be instructive in studying old-growth location. In producing my fire map I consulted the Oregon State Forestry Department for the boundaries of the Tillamook, Vincent Creek, Smith River, and Ox-bow burns. Jerry Phillips of Coos Bay was particularly helpful by providing his map of the Coos Fire of 1868. It is based upon his careful observations over many years of timber types, reproduction patterns and fire scars. For the extent of the Nestucca Fire, I used Munger's (1944) written description, BLM forest type maps, and my own field observations. Morris (1934) presented a map of the extent of other major early Coast Range burns which I modified slightly based upon my field work.

Two areas that were the subjects of special studies, MacDonald Forest and Cape Lookout, were mapped to show the relationship of old-growth to local landscapes (Juday, 1975a, 1975b).

Composition

Once I had located the population of old-growth stands reasonably well, I began field sampling. From the late summer of 1974, to the early summer of 1976, I took 94 sampling plots over the Coast Range. Figure 2 shows their location. In order to develop a representative sample of old-growth I used a hierarchy of criteria in choosing stands to sample.

An overall criterion was that the final group of plots should reflect in its sub-totals the relative abundances of old-growth stands among the four zones. Sample plots were taken in stands on a variety of geological formations (soil parent materials) also in approximately the abundances that old-growth occurs. Within each zone I attempted to include a plot or plots at the far north and far south in order to detect latitudinal gradients of change. Plots were geographically widely spaced over the whole Coast Range to avoid concentrating plots into a few stands. Four plots were the most I took in any one stand, and it was extensive and somewhat variable. Some stands were partially or totally destroyed after my source maps were made or imagery taken, and obviously could not be sampled. I rejected a few stands upon inspection as either too young and only partially displaying the characteristics of old-growth or as having been partially disturbed (by natural forces) and being now too "thin" or poorly stocked with old-growth trees. The latter was the

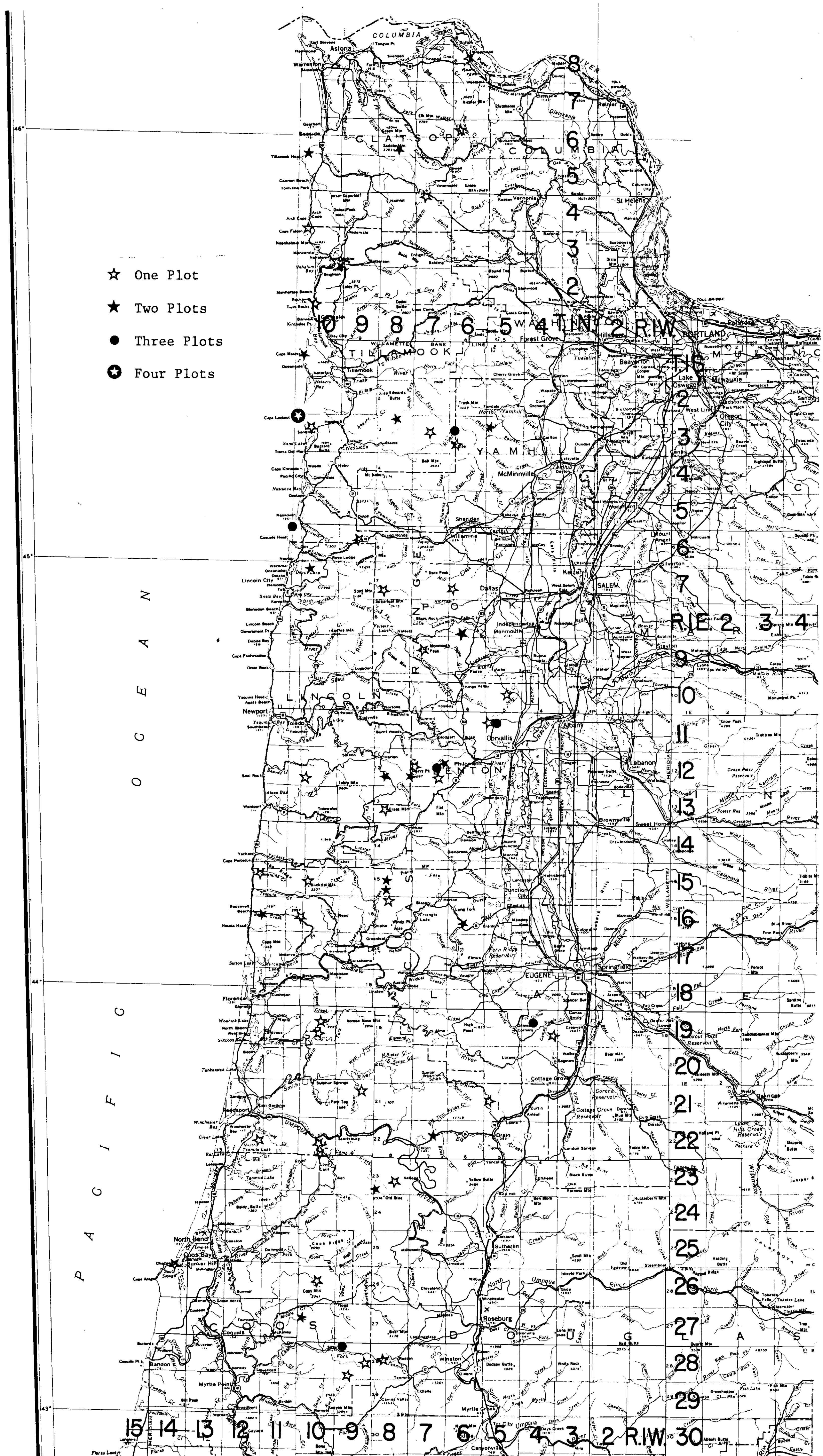


Figure 2. Location of 15 X 25 M Sampling Plots Of Old-Growth Forest in the Coast Range

most common basis of rejection although it was sometimes possible to find a suitably dense portion of the stand to sample. In many stands the density of stocking was a continuum, and my biasing toward dense pockets of old-growth had implications for my structural data.

Once I had walked through most of a contiguous area of old-growth I chose the placement of a plot or plots. Plots were chosen to (1) be in the relatively most homogeneous portion of a stand, (2) contain at least one large old-growth tree, (3) be free from light penetration along edges that had been clear cut or experienced windthrow or that were of another forest type, (4) be free from excessive soil disturbance such as from extraordinary concentrations of deer or elk, and (5) represent the average densest canopy for the old-growth stand. Macroplots were 15 x 25 M, oriented with the long axis parallel to slope contours, unless some major soil discontinuity required a different orientation. To maximize field efficiency I used the following sequence of data collection. At each chosen plot corner I took a tree basal area horizontal point sample with a metric ten factor wedge prism. While moving from corner to corner I measured the diameter of all trees, took at least four widely separated measurements of organic litter depth, and made a first estimate of shrub cover. I next estimated tree cover and percent of the plot surface under the influence of light penetrating from the canopy, and measured the slope and aspect. Finally I took thirty 2 x 5 dm microplots to record herb cover. At each microplot I recorded a sun-shade index number, zero being full shade; one, partial illumination; two, a deciduous canopy; and three, full sunlight. At every third microplot I took a count over one square meter of shrub stems 2 dm above the litter surface. Any adjustments of initial estimates were made after the microplots were finished. I recorded the canopy coverage to the nearest five percent by species and the diameter individually for woody plants with a central stem greater than 5 cm at 1.5 M above the forest floor as the tree stratum. For the shrub stratum canopy coverage classes by species of woody or partially woody plants greater than 7.5 dm in height (but less than 5 cm d.b.h.) were recorded. The herb stratum included all plants of the forest floor (including logs) below 7.5 dm, for which canopy coverage classes also were recorded by species. The cover class limits are given in Daubenmire (1959), along with the general rationale for the shape and size of the plot and the use of canopy coverage as a measure of species abundance.

The system I used is basically similar to Daubenmire's, but was modified to allow the plots to be taken more rapidly. I used only thirty 2 x 5 dm microplots to sample the herb stratum instead of the forty Daubenmire (1959) suggested. However, his own species-area curves show that the "plateau" on such curves is reached within thirty microplots. I placed the microplots in a stratified random manner, aiming for sampling over the whole macroplot with roughly equal spacing of all microplots. Daubenmire (1968) suggested systematically placing fifty microplots at equal spacing along two central belt transects. However, Daubenmire (1959) noted, "Resolution of the random versus systematic argument seems purely a matter of opinion..."

The most significant difference is that I recorded species coverage by strata and Daubenmire (1968) recorded by species specific growth forms (low shrubs, perennial forbs, etc.). I also made a separate overall cover class estimate for the shrub stratum instead of relying solely on values derived from microplots. I assigned species that met the criteria for more than one stratum the appropriate amount of cover in each.

MacArthur and MacArthur (1961) demonstrated that the number of strata and the proportion of foliage in each is related to the diversity of bird species. Cantlon (1953) found that some plant species, when they reach a certain size and structure, create significant changes in local microclimate. Lindsey (1970) used a stratum ranking system of dominance as a basis for comparing various forest types. By recognizing that physical differences in size and stature define strata one helps insure that structure and not the species itself is seen to be an expression of a plant's niche.

A further advantage of my system is that, in the field, it frees the sampler from making time-consuming and often imprecise vertical projections above the 2 x 5 dm microplot frame to certain large shrubs or small trees.

Structure

Early analysis of the tree stratum data from the 15 x 25 M macroplots indicated serious problems with extrapolation to per hectare values for biomass, density, and basal area. In the spring and early summer of 1976 I took eleven full hectare tallies of trees greater than 5 cm d.b.h. (3,654 trees total). In the first three tallies I recorded only by quarter hectares (50 x 50 M). In all others I recorded diameters by quarter quarter hectare (25 x 25 M). If possible I tallied four quarter hectares to make a 100 x 100 M block. Some stands were too narrow so I tallied a 200 x 50 M strip of quarter hectares. For the smallest or most discontinuous stands I tallied two separate 100 x 50 M sets of two quarter hectares, or finally, for the most irregular, other odd shapes as necessary. Contiguity of quarter hectares was maintained when possible. If separation was necessary, the second set of quarter hectares was placed in a portion of the stand with similar structure to the first set. For slopes greater than ten degrees boundaries were topographically corrected.

Analysis

Plots and quarter hectare tallies were assigned numbers based upon their initial field classification into zones. Numbers above one hundred but below two hundred represent the Valley-Margin Zone (VMZ). In a similar manner two hundred series are the Western Hemlock Zone (WHZ), three hundreds are the True Fir Zone (TFZ), and four hundreds indicate the Sitka Spruce Zone (SSZ). A "T" after the number indicates a quarter hectare tally; a number alone represents a plot. The first 84 plots were numbered by zones starting from the south (e.g. 101 is the southernmost VMZ plot, etc.). However, eight supplemental plots taken in 1976 were mostly in the south Coast Range, yet numbered in the order they were taken starting after the previously highest (northernmost) number. Appendix 2 lists the public land survey location and site characteristics of plots and Appendix 3 lists quarter hectare tally locations.

For the analysis of composition I generated computer cards in the format appropriate for the Phyto-Caphy programs. Phyto and Caphy are community classifications programs based upon Braun-Blaunquet principles (Moore, 1970). The user can emphasize either dominance or presence-absence for a computer selected classification, specify differential species for a classification, or dictate the order of plots and/or species. I entered each 2 x 5 dm microplot of the herb stratum as a "plot" for the computer analysis. Since a maximum of 150 "plots" could be entered in the program version available on the Oregon State University CDC Cyber computer, I analyzed a maximum of four macroplots' data (thirty 2 x 5 dm microplots each) at a time. I attempted to first determine important character species for similar macroplots and then compare these in computer runs with dissimilar macroplots to determine important differential species. If necessary I would specify these or other species in the differential species option for further verification.

I next used a computer program to sum data from 2 x 5 dm microplots into average plot values. Based upon both field experience and Phyto-Caphy analysis, I chose sixty tree, shrub, and herb stratum species' plot cover values for similarity ordination. These are listed in Table 4. The SIMORD program (Dick-Peddie and Moir, 1971) calculates two axis coordinate values which represent degrees of similarity of a given plot to either computer chosen or user specified endstands. The algorithm is:

$$SIM(i,j) = \frac{1}{n} \sum_{k=1}^{60} \frac{2 \min (a_{ik}, a_{jk})}{a_{ik} + a_{jk}}$$

where, SIM(i,j) is the similarity between plots i and j, a_{ik} is the cover value of species k in plot i, a_{jk} is the cover value of species k in plot j, and min represents the minimum value.

I performed SIMORD runs with both specified and computer chosen endstands. For specified endstands I chose a plot from each zone that was a typical representative of the modal community for that zone. The computer chooses the stand most dissimilar to all other stands as the left end of the X-axis and the stand most dissimilar to it as the right end of the X-axis. The Y-axis endstands are chosen from a group of stands two to twelve units from the middle of the X-axis (dissimilar to both X-axis endstands). The stand in this group most dissimilar to both X-axis endstands is chosen as the bottom endstand of the Y-axis, and the stand most dissimilar to it is the top endstand of the Y-axis.

Finally, I constructed manual-visual tables to produce community classifications. I concentrated on important character and differential species (as revealed from Phyto-Caphy analysis) and important dominant tree and shrub species to produce trial classifications of high cover, constancy, and fidelity species. These were then compared with other

Table 4. Sixty Tree, Shrub, and Herb Species of High Indicator Value Used in Similarity Ordination

TREE STRATUM

Pseudotsuga menziesii
Abies grandis
Acer macrophyllum
Cornus nuttallii
Calocedrus decurrens
Pinus ponderosa
Arbutus menziesii
Thuja plicata
Tsuga heterophylla
Chamaecyparis lawsoniana
Abies procera
Picea sitchensis

SHRUB STRATUM

Corylus cornuta
Holodiscus discolor
Rosa gymnocarpa
Rhus diversiloba
Acer circinatum
Vaccinium parvifolium
Tsuga heterophylla
Rhododendron macrophyllum
Vaccinium ovatum
Vaccinium membranaceum
Menziesia ferruginea
Vaccinium alaskaense
Rubus spectabilis
Sambucus racemosa

HERB STRATUM

Blechnum spicant
Adenocaulon bicolor
Bromus vulgaris
Madia gracilis
Osmorhiza chilensis
Ligusticum apiifolium
Thalictrum occidentale
Linnaea borealis
Achlys triphylla
Berberis nervosa
Gaultheria shallon
Disporum smithii
Coptis laciniata
Goodyera oblongifolia
Asarum caudatum
Smilacina racemosa
Smilacina stellata
Hieracium albiflorum
Polystichum munitum
Oxalis oregana
Viola sempervirens
Xerophyllum tenax
Chimaphila menziesii
Trisetum cernuum
Maianthemum dilatatum
Clintonia uniflora
Abies amabilis
Viola adunca
Listera cordata
Luzula parviflora
Plagiothecium undulatum
Eurynchium oreganum
Tiarella trifoliata
Picea sitchensis

communities reported in the literature and examined on the SIMORD graph for geographic affinities. The final community classification incorporated revisions suggested by the literature and SIMORD data.

The major calculations in structural analysis were biomass and leaf area index from tree diameters. Appendix 4 lists the biomass regressions and authors, and Appendix 5, the leaf area regressions and authors. It is important to note that leaf area index, as used in this thesis, refers to total leaf area (all surfaces). Gholz _et_. _al_. (1976) describe the techniques for developing coefficients, including a correction for the three-dimensional nature of conifer needles, to convert foliage biomass to surface area.

RESULTS AND DISCUSSION

Location

Role of Fire, Subsequent History, and Management

In the earliest phase of this study, that of locating old-growth, it became obvious that wildfires were of major importance in explaining both the characteristics and location of old-growth. Fires have eliminated old-growth over large areas and partially burned some stands to produce either restricted pockets or areas of scattered light stocking of old-growth. Figure 4 is a map of major historical burns of the Coast Range. Morris (1934) cites three independent accounts or recollections pointing to a fire in the period 1845-49, probably the year 1849, burning "500,000 or more acres of forest between the Siuslaw and Siletz rivers." Although there is some evidence that it represents the coalescence of at least two major fires which were re-burns in part, the most reliable reports indicate that the fire may have begun near Florence on the Siuslaw River, south of Heceta Head. For this reason I have called it the Florence Fire. The pattern of old-growth remnants indicate that this fire burned to the crest of the Coast Range before reducing in intensity sufficiently to leave scattered old-growth stands.

By the year 1868, there were numerous settlers and newspapers to note and record fires. The nuisance of smoke in the Willamette Valley was the greatest concern. The year 1868 was marked by large persistent fires over much of western Washington, Oregon, and southwestern British Columbia. Morris (1934) notes, "The Coast Range in Oregon was afire in

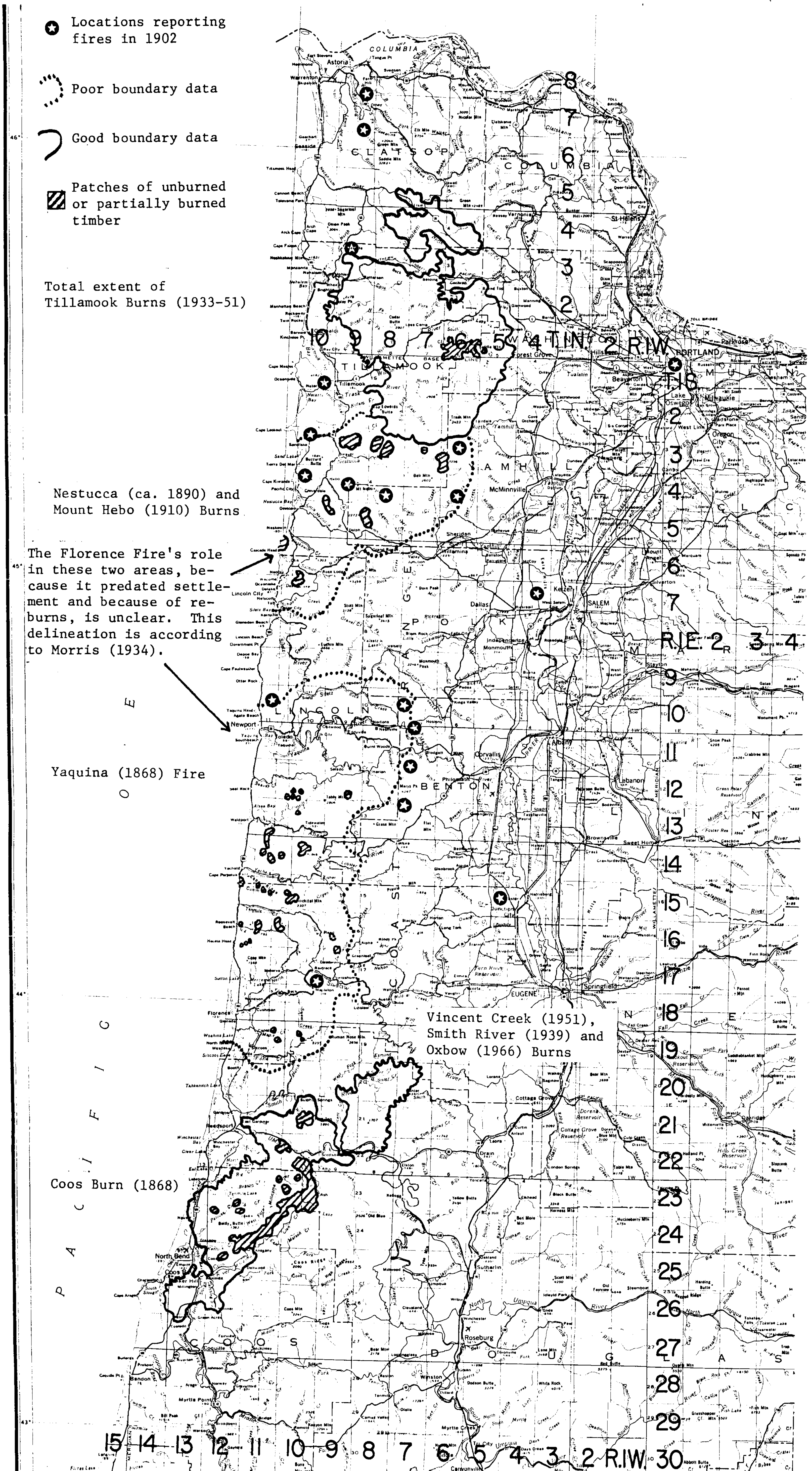


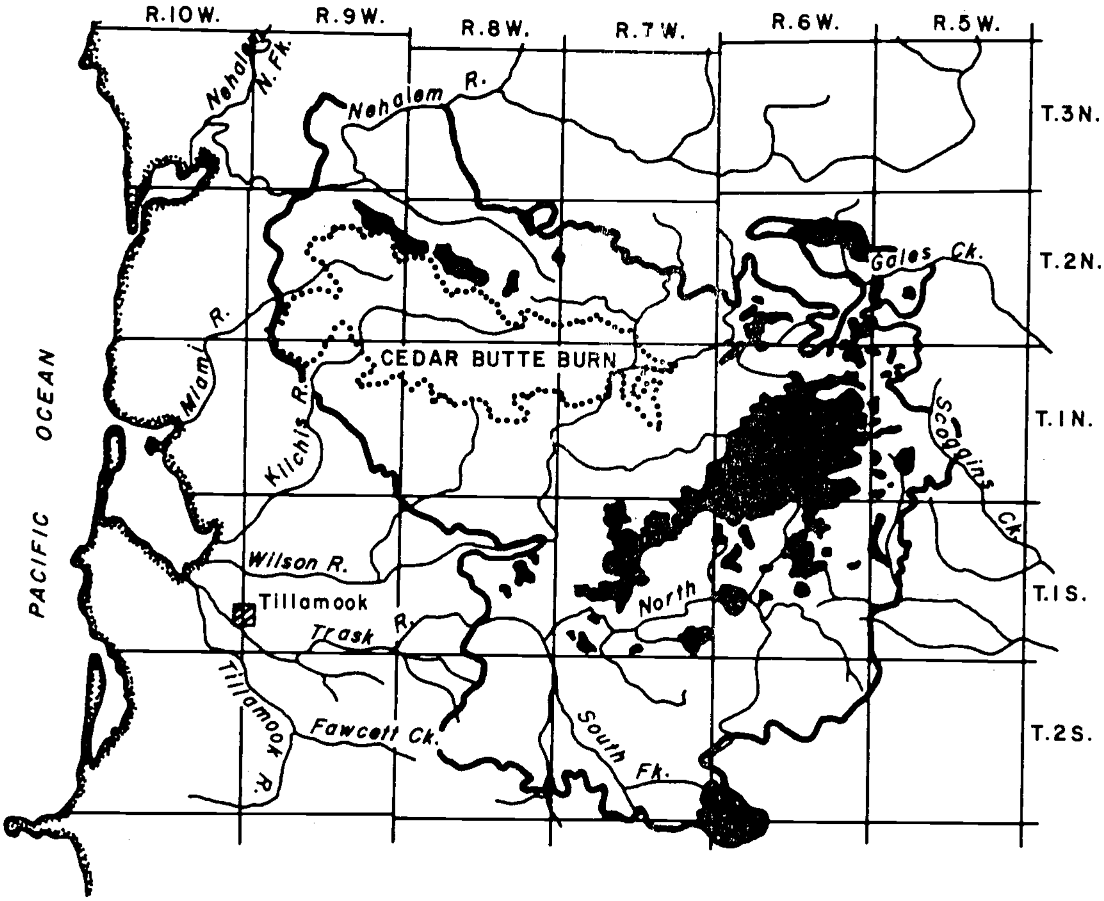
Figure 4. Major Historical Burns of the Coast Range

several places about September 1, especially around Yaquina Bay." Tree ring counts indicate a widespread fire at this date (which I have called the Yaquina Fire) at places interacting with the effects of the Florence Fire.

A separate fire, the Coos Burn of 1868, burned from Coos Bay northward to the Umpqua River, continuing north for some distance. Again, an extensive margin of partially burned timber forms the eastern boundary. There is some evidence that this boundary area had been burned in the 1840's and, further eastward, there may have been a large burn about 1775.

An extensive fire around 1890 covered an area from the coast to the southern edge of the Tillamook Burn (along the Nestucca watershed divide) on eastward to the upper Nestucca drainage where it became discontinuous along the steep Nestucca River canyon. Repeated settlers' land clearing fires were likely responsible (Munger, 1944). A reburn occurred in 1902, a bad fire year in which many small fires were reported in what was becoming by then a burned-over landscape.

A consistent theme seems to have been unburned or partially burned blocks of timber along the margin of the main fire. Figure 5 shows an extensive area of such timber within the boundaries of the first (1933) Tillamook Burn. These seem to be located particularly (1) along major rivers or at stream junctions, (2) in cool, moist upper elevation (TFZ) habitats, and (3) along the margins of the fire or where a previous burn had occurred.



Exterior boundary of first Tillamook burn (1933)

Patches of unburned timber (1933)

Cedar Butte burn of 1918

SOURCE: W.G. Morris, USFS PNW For. Exp. Sta. Res. note 18, 1936

Figure 5. The Pattern of the First Tillamook Burn (1933)

The phenomenon of repeated burns after an initial major burn seems to recur also. Three more fires at six year intervals burned in the Tillamook region. Figure 6 shows that even after these there was still an extensive "Green Island" of unburned old-growth in cool, moist, or topographically isolated portions of the landscape. Figure 7 shows an area of repeated burns between the Smith and Umpqua Rivers in the southern Coast Range.

Many of my plots give evidence that the initial fire may have set off a wave of subsequent mortality over the next several decades by scorching foliage, providing entry for insect attack, exposing trees to new wind stresses, etc. I often encountered downed trees of the same size class as the old-growth, and with the same charred bark, that had fallen anywhere from the year of observation to forty or more years before. Some plots contained two or even three size classes of old-growth, which could be interpreted to represent double or triple "disaster veterans." A model for the origin of such stands, consistent with the observations of fire and old-growth interaction previously discussed, would be (1) an initial fire leaving residual trees (which become the largest size class) followed by (2) one or several more fires which leave most or all of the original stand and which generate one or more cohorts of trees that mature into old-growth themselves.

Subsequent to 1900, management became an important factor in determining old-growth remnants. Timber was cut at first for local construction and firewood near the coastal strip of settlement and near the

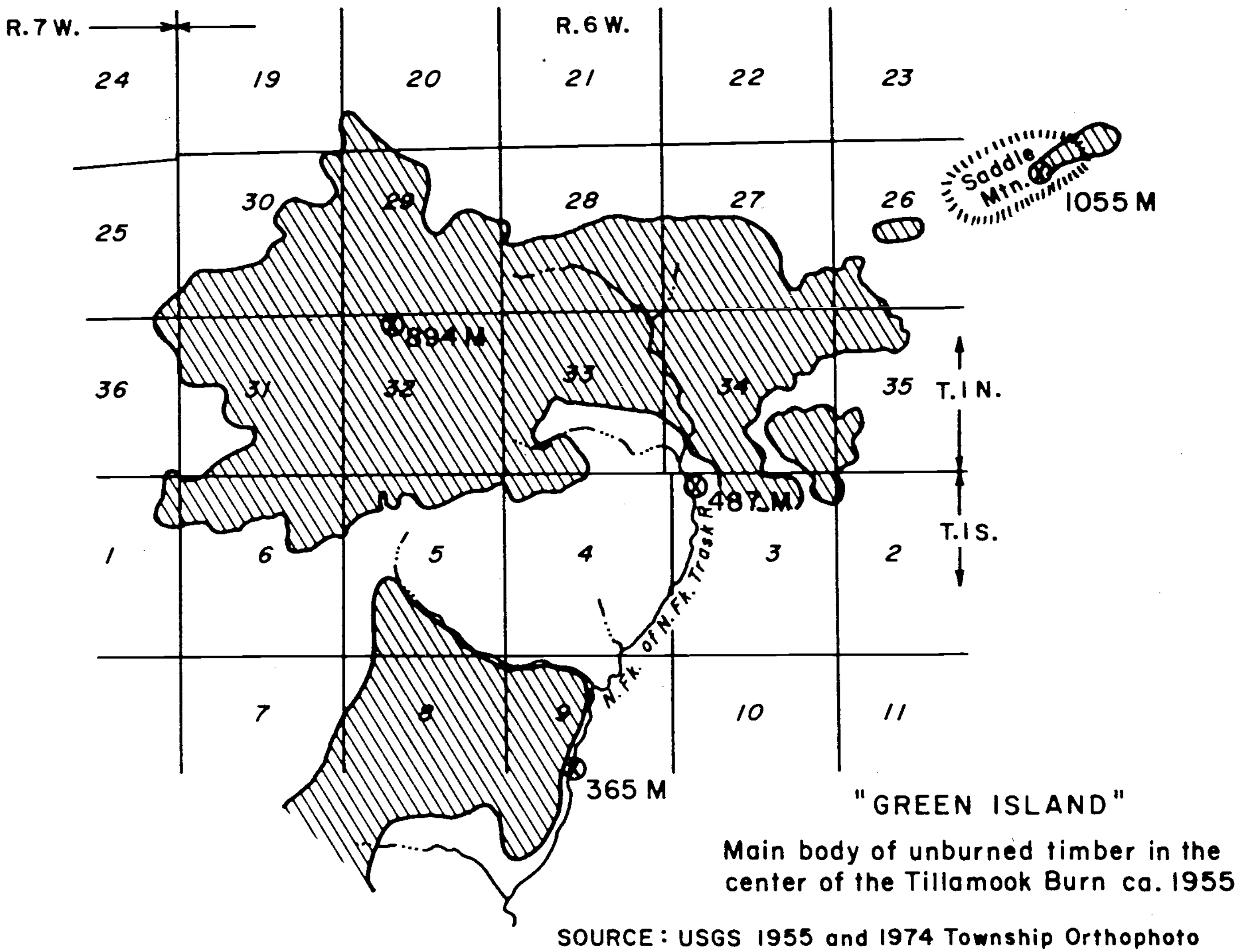


Figure 6. The "Green Island" After the Last Tillamook Burn

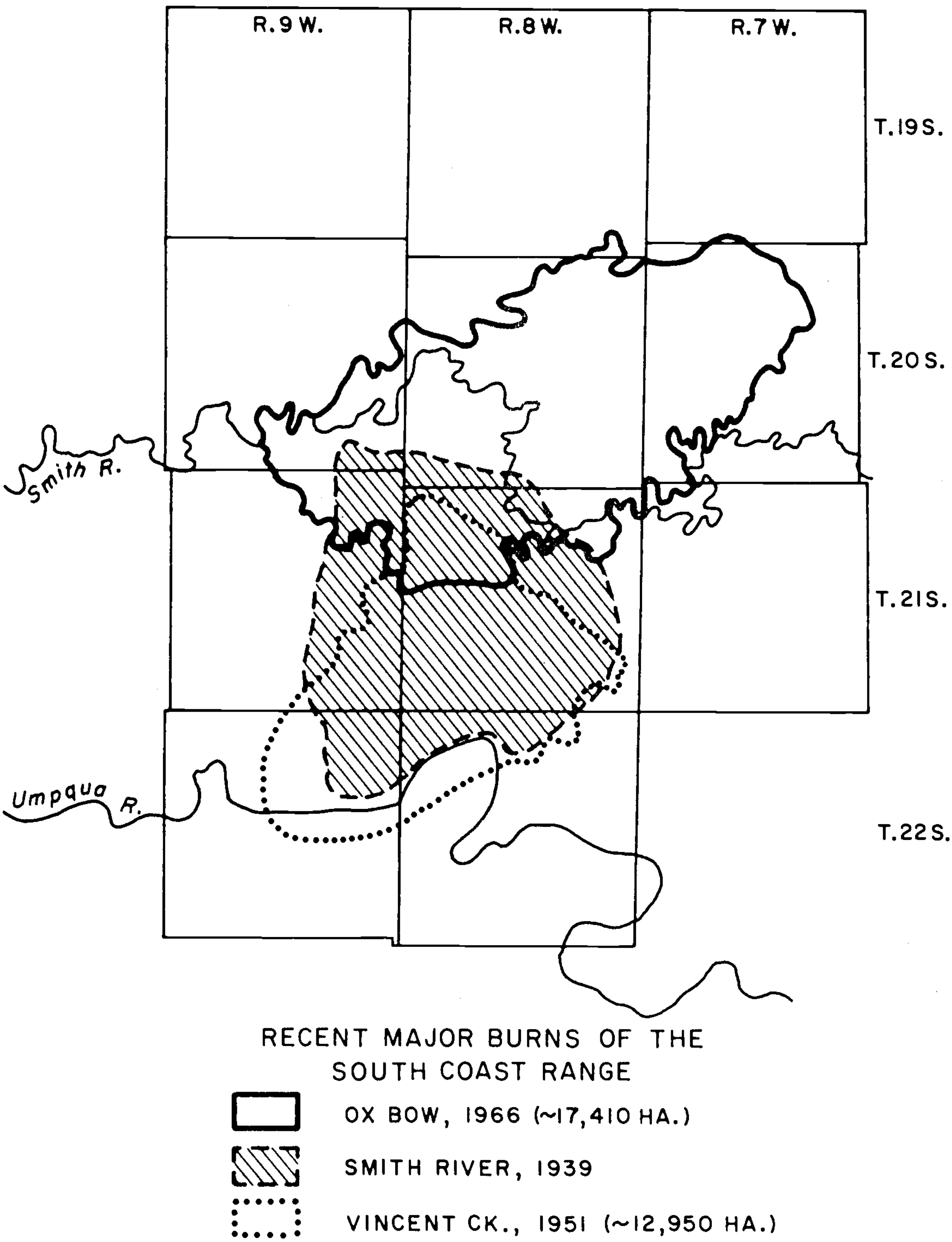


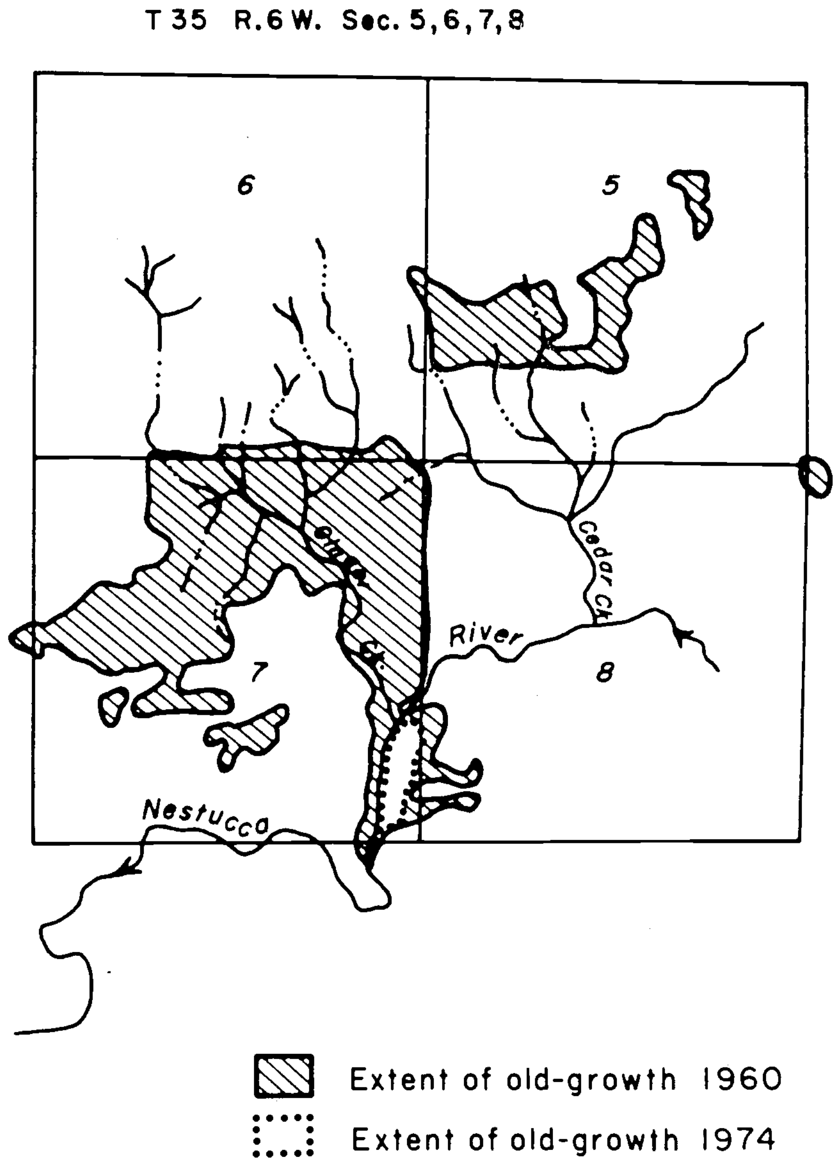
Figure 7. The Pattern of Repeated Burns in the South Coast Range

interior valleys. After the First World War, which produced a demand for Sitka Spruce, commercial logging began in earnest. It began along easily accessible (by water) lowlands, particularly the lower Columbia River and Coos Bay. The Tillamook region was being logged by railroad extensively up to the Depression, and it was logging activity that started the Tillamook Burn. After the Second World War, greatly increased demand and exhaustion of the nation's other stores of virgin timber induced widespread cutting on the Siuslaw National Forest and Bureau of Land Management resource lands. Large private forest land-owners began a program of old-growth liquidation which is now practically complete. The public lands until now have been cut more slowly in "staggered settings" of clearcuts.

Figure 8 shows a typical pattern. The private sections six and eight had been cut by 1960. The publicly-owned BLM sections five and seven were cut, except for a small river buffer, by 1974. Of the old-growth shown in Figure 6 the only remnant left on this private land today (1976) is about forty hectares along the steepest part of the river canyon in sections 34 and 35.

Relationships to Topography

The Western Hemlock Zone has been more affected by the previously discussed fires than the other vegetation zones of the Coast Range. Two other zones show consistent patterns of old-growth occurrence not directly related solely to crown fires.



SOURCE : Field notes and US BLM forest type maps 7-1-60 and Nov. 1974

Figure 8. The Impact of Harvesting
On the Rate of Disappearance and Extent of Old-Growth
In a North Coast Range Stand

In the Valley-Margin Zone old-growth is practically absent from the interior valleys themselves, occurring infrequently in cool north and east facing slopes in the foothills, along streams and topographic breaks, finally becoming relatively widespread at the Western Hemlock Zone boundary. Figure 9 shows the upper portion of a mountain which contains some old-growth. If moisture availability is a controlling factor one would expect old-growth to be limited to that portion of the landscape with the least direct radiation (which would cause high evaporative stress), the north and northeast facing slopes. Figure 10 shows that this is exactly the case. Juday (1975b) reported soil moisture data from this area that are also consistent with this explanation. From May 27 to June 3, 1970, soil in a grass bald increased from 5 to 15 atmospheres soil moisture tension while an adjacent north facing forest ridge increased in the same period from a fraction to 2 atmospheres. By June 25, the forest soil was 5 atmospheres while the grass bald had increased to 25 atmospheres.

Other environmental factors such as soil temperature and vegetation surface temperature are higher in the grass bald while relative humidity is lower, which indicates that there is likely a complex operational control. Fire is a key element in any explanation of old-growth distribution in the Valley-Margin Zone. Juday (1975b) notes that grass balds appear to have been maintained by frequent fires and have experienced forest encroachment in recent years. Forests of *Pseudotsuga menziesii* and *Quercus garryana* intermediate between the grass bald and old-growth forest appears to have been burned less often than the grass balds.

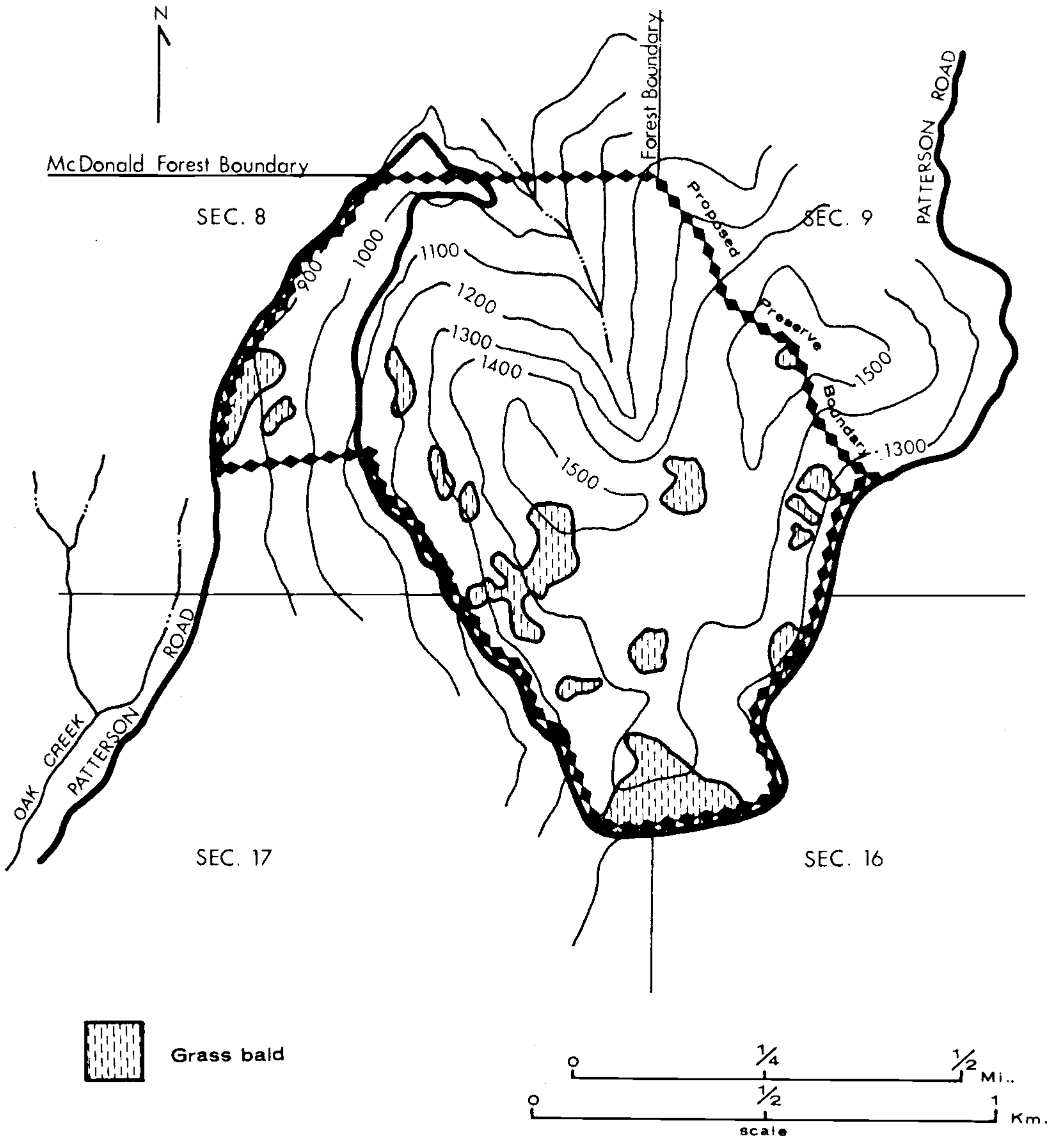


Figure 9. The Topography of a MacDonald Forest Mountain

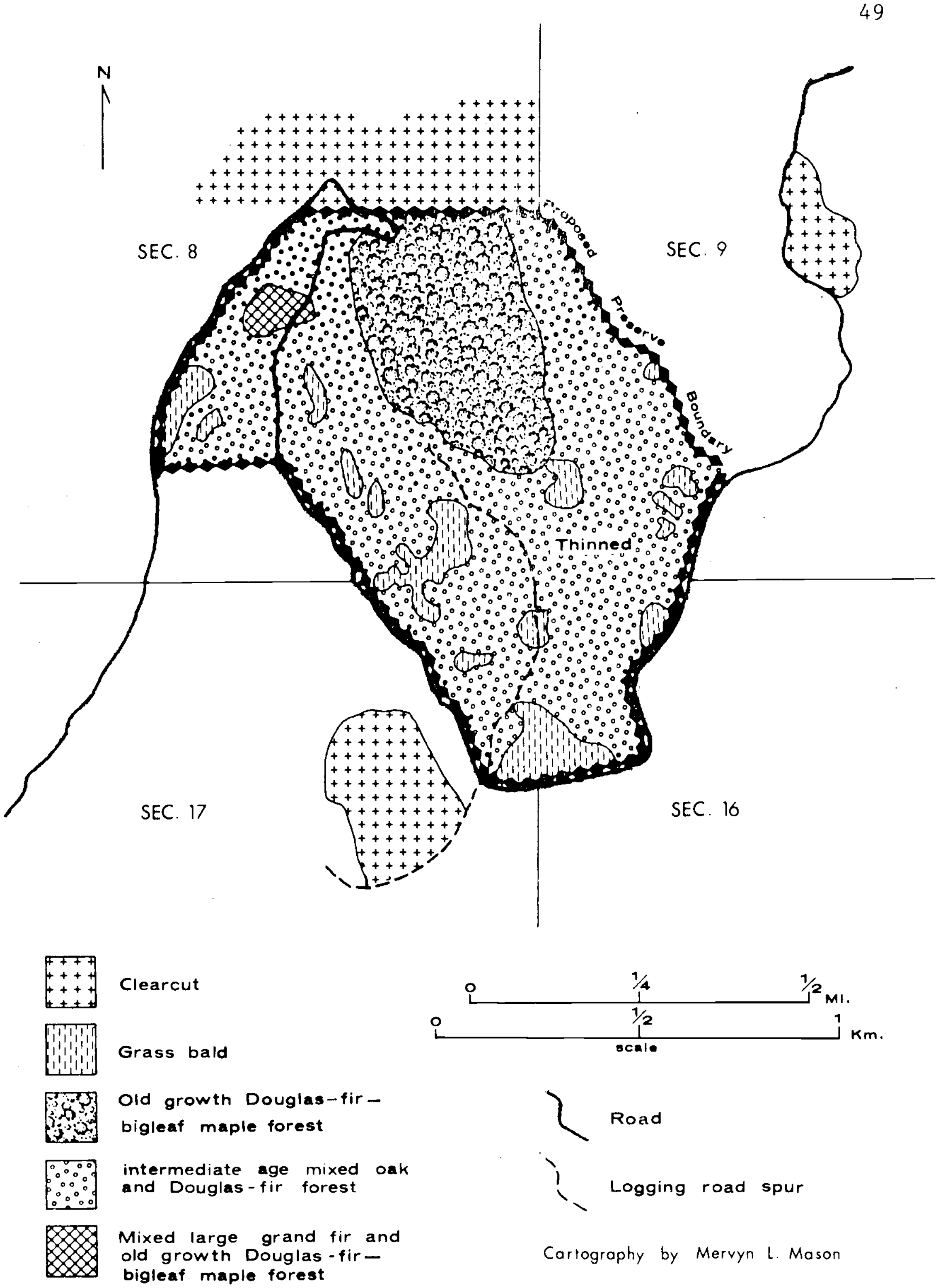


Figure 10. A Pocket of Old-Growth in MacDonald Forest
(Compare to Fig. 9. for Relationship to Topography)

A model for the occurrence of old-growth in such situations would be a landscape mosaic of different parcels each on its own burning schedule ranging from nearly every year for grass balds to the least frequently in old-growth environments. Recurring ground fires in such old-growth stands would kill weakened or severely scarred trees, produce a new group of fire scarred trees, leave large healthy thick-barked trees unharmed, periodically eliminate seedlings, yet partially open up the canopy for new tree growing space.

By contrast, the Sitka Spruce Zone shows the least evidence of fire. Along the immediate central and north coast, characterized by the presence (in the branches of larger trees) of the Licorice Fern, Polypodium scouleri, are stands which appear to have been affected by few post-settlement burns or none at all.

At Cape Lookout and several other headlands there is, however, a recurring pattern of old-growth stands ranging from poor to full stocking occupying ravines, slopes, and pockets which appear to be the most wind-sheltered local environments. Figure 11 presents a map of the Cape Lookout area.

Current Distribution of Old-Growth

Figure 12 shows the previously discussed model of fire-originated old-growth stand development. Figure 13 shows two examples of the results of that process, old-growth pockets in favorable fire-resistant landscape segments.

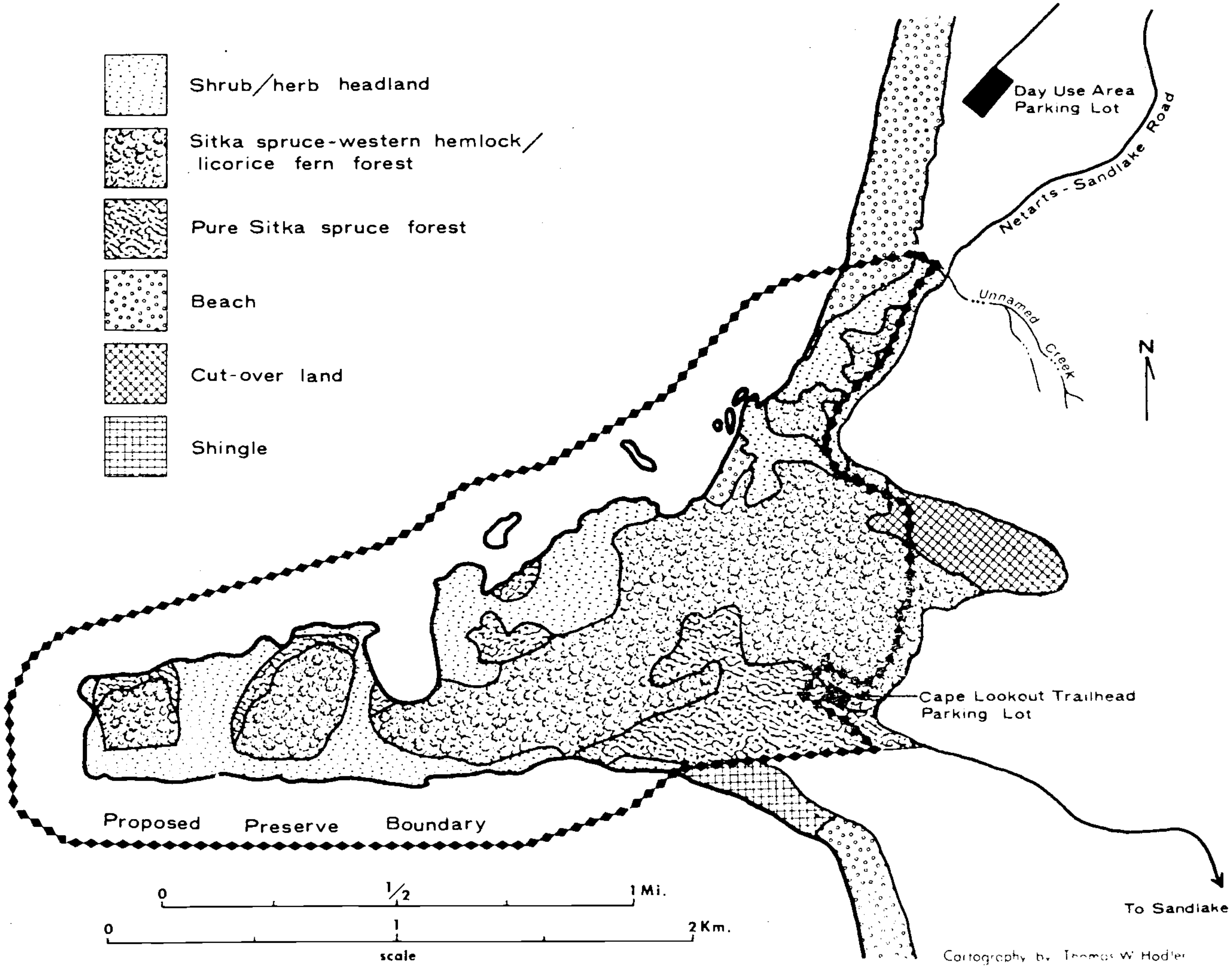


Figure 11. Old-Growth Sitka Spruce-Western Hemlock/Licorice Fern Forest in Wind Protected Slopes, Ravines and Pockets

Figure 12. Complete Mortality in the Oxbow Burn
Near the Coast Range Crest (above)
And Good Survival in a Partially Burned Grove
At the Edge of the Oxbow Burn (below)

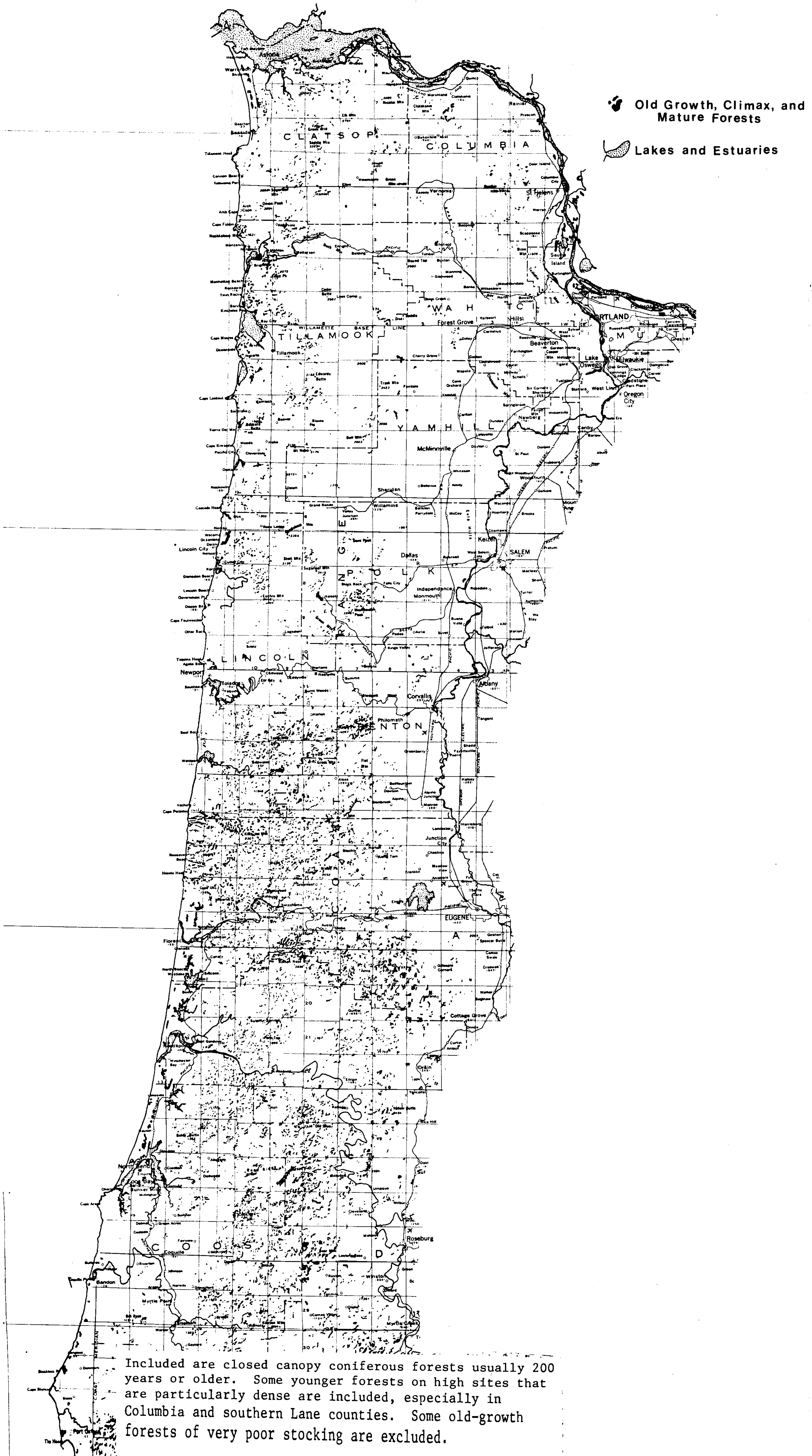
Figure 13. Pockets of Old-Growth
Surrounded by Successional Forest (above)
And at the Junction of Two Streams, Plot 226 (below)

All the previous discussion of old-growth patterns is helpful in interpreting Figure 14, a map of the entire stock of mature and old-growth forests of the Coast Range. The map shows the north Coast Range nearly devoid of old-growth. In spite of extensive cutting, the Siuslaw National Forest exhibits considerable mature timber including some old-growth in many pockets and streamside stringers. The Mary's Peak watershed and the north facing slope of Prairie Mountain are particularly noticeable. South of Fern Ridge reservoir the checkerboard pattern of alternate BLM-owned sections is plainly visible. Along the Coast Range crest south of the Umpqua River on BLM land are the most extensive areas of undisturbed true old-growth. Cutting has been increased there over the years and current plans are to liquidate most of this old-growth.

Composition

Introduction

This study did not produce a comprehensive community classification of Coast Range forests. I had exacting standards about what kind of stands I would sample; I rejected several of Hines' (1971), Anderson's (1967), and Corliss' and Dyrness' (1965) stands as too young. Old-growth is not found in convenient sampling locations in the Coast Range and is absent from some places which ideally should be sampled. I did sample some strategically located stands that were just beginning to display old-growth characteristics. In two plots, 236 (Bradwood Cliffs) and 410 (Sand Lake Sand), I sampled forests on a loose sand substrate for specific comparative purposes.



Included are closed canopy coniferous forests usually 200 years or older. Some younger forests on high sites that are particularly dense are included, especially in Columbia and southern Lane counties. Some old-growth forests of very poor stocking are excluded.

Table 5 presents the results of my community classification procedures. The communities are arranged within each zone in an inferred effective moisture gradient from dry to mesic. All communities with four or more plots, since they are old-growth or climax are named associations and their data are presented in Tables 6 through 15. All those with fewer than four representative plots are, for the purposes of this paper, presented as communities in Appendices 6 through 8. In some cases other authors have identified very similar stands as associations.

A slash is used to separate community descriptor species in different strata starting with the tree stratum. In order to be consistent with other classifications I have placed *Polystichum munitum*, when it appears in a community descriptor, as an herb stratum species even though by my methods the canopy coverage may have been greater in the shrub stratum. A hyphen is used to separate species in the same stratum in community descriptors, and parentheses identify tree species of presumed major importance that are not present or dominant in the current tree stratum.

Pseudotsuga menziesii-Acer macrophyllum/Corylus cornuta var. *californica/Adenocaulon bicolor* Association

The Psme-Acma/Coco/Adbi association is the most widespread and abundant of all the communities (general sense) found in the Valley-Margin Zone. Table 6 presents constancy and cover data for the association. All descriptor species have 100% constancy, but *Adenocaulon*

Table 5. Communities Defined, Species Abbreviation Codes, and Plots Assigned to Each

Community Name	Community Descriptor	Plot Numbers
VALLEY-MARGIN ZONE		
Pinus ponderosa--Pseudotsuga menziesii--Calocedrus decurrens/Rhus diversiloba	Pipo-Psme-Cade/Rhdi	105
Pseudotsuga menziesii--Calocedrus decurrens/Corylus cornuta v. californica/ Lathyrus polyphyllus	Psme-Cade/Coco/Lapo	104,122,123
Pseudotsuga menziesii--Acer macrophyllum/Corylus cornuta v. californica/ Bromus vulgaris	Psme-Acma/Coco/Brvu	113
Pseudotsuga menziesii--Acer macrophyllum/Corylus cornuta v. californica/ Adenocaulon bicolor	Psme-Acma/Coco/Adbi	102,103,106,107 109,112,114,115 116,117,118
Pseudotsuga menziesii/Holodiscus discolor	Psme/Hodi	108,119
Pseudotsuga menziesii (Tsuga heterophylla)/Corylus cornuta v. californica [Transition Community]	Psme (Tshe)/Coco	110,111,236
Pseudotsuga menziesii--Thuja plicata/Gaultheria shallon/Linnaea borealis	Psme-Thpl/Gash/Libo	101,120,121
WESTERN HEMLOCK ZONE		
(Pseudotsuga menziesii, since it plays a major seral role in all Western Hemlock Zone communities, is included as a community descriptor only in the Tshe-Psme/Acci/Pomu community where Tshe appears less capable of displacing it.)		
Tsuga heterophylla/Rhododendron macrophyllum--Gaultheria shallon	Tshe/Rhma-Gash	205.214
Tsuga heterophylla/Acer circinatum--Gaultheria shallon	Tshe/Acci-Gash	222,225,239
Tsuga heterophylla--Chamaecyparis lawsoniana/Rhododendron macrophyllum-- Gaultheria shallon	Tshe-Chla/Rhma-Gash	203
Tsuga heterophylla--Pseudotsuga menziesii/Acer circinatum/Polystichum munitum	Tshe-Psme/Acci/Pomu	208,224,228 237,238
Tsuga heterophylla/Polystichum munitum	Tshe/Pomu	215,218,227,229 230,231,233
Tsuga heterophylla/Vaccinium ovatum/Polystichum munitum	Tshe/Vaov/Pomu	206,207,211,213 219,220,240
Tsuga heterophylla/Chamaecyparis lawsoniana/Polystichum munitum--Oxalis oregana	Tshe/Chla/Pomu-Oxor	201,202,204
Tsuga heterophylla/Polystichum munitum--Oxalis oregana	Tshe/Pomu-Oxor	209,210,212,216 217,223,226,232 235,241

Community Name	Community Descriptor	Plot Numbers
	TRUE FIR ZONE	
Abies procera/Oxalis oregana	Abpr/Oxor	301,302,303 304,305
Tsuga heterophylla (Abies amabilis)/Vaccinium alaskaense	Tshe (Abam)/Vaal	306,307
	SITKA SPRUCE ZONE	
Tsuga heterophylla--Pseudotsuga menziesii (Picea sitchensis)/ Gaultheria shallon/Eurynchium oreganum--Plagiothecium undulatum [Transition Community]	Tshe-Psme (Pisi)/Gash/Euor-Plun	221,234,410,418
Tsuga heterophylla--Pseudotsuga menziesii--Picea sitchensis/Polystichum munitum-- Eurynchium oreganum--Oxalis oregana--Plagiothecium undulatum	Tshe-Psme-Pisi/Pomu-Euor-Oxor-Plun	402,405,406,423
Tsuga heterophylla--Pseudotsuga menziesii--Chamaecyparis lawsoniana-- Picea sitchensis/Polystichum munitum--Eurynchium oreganum-- Oxalis oregana--Plagiothecium undulatum	Tshe-Psme-Chla-Pisi/Pomu-Euor-Oxor-Plun	401
Picea stichensis--Tsuga heterophylla/Gaultheria shallon/Blechnum spicant	Pisi-Tshe/Gash/Blsp	403,404,408,413 414,415,416,419 421,422
Picea sitchensis--Tsuga heterophylla/Polystichum munitum--Blechnum spicant	Pisi-Tshe/Pomu--Blsp	407,409,411,412
Elsie Mixed		420
Rockaway Swamp		417

Table 6. Constancy and Cover Values for Psme-Acma/Coco/Adbi Association

Stratum & Species	Av. % Cover	Av. % Const.	102	103	106	107	109	112	114	115	116	117	118
TREE													
Pseudotsuga menziesii	74.1	100	65	55	65	70	95	90	80	75	70	65	85
Acer macrophyllum	15.5	100	10	20	10	10	10	25	15	5	30	25	10
Cornus nuttallii	7.7	82	10	–	10	20	5	15	5	–	5	5	10
Abies grandis	10.9	64	–	15	40	–	–	15	20	5	10	–	15
Acer circinatum	4.1	18	–	–	15	–	–	–	–	30	–	–	–
Arbutus menziesii	1.8	9	–	–	–	–	–	–	–	20	–	–	–
Alnus rubra	.9	9	–	–	–	–	–	–	–	–	–	10	–
Amelanchier alnifolia	.5	9	5	–	–	–	–	–	–	–	–	–	–
Taxus brevifolia	.5	9	–	–	5	–	–	–	–	–	–	–	–
SHRUB													
Polystichum munitum	24.5	100	15	15	15	40	5	15	65	5	15	40	40
Corylus cornuta	10.9	100	15	5	5	5	5	5	40	15	5	15	5
Abies grandis	5.0	82	5	5	5	–	–	5	15	5	5	5	5
Berberis nervosa	19.1	73	15	65	5	–	15	15	–	15	–	40	40
Rosa gymnocarpa	4.5	73	5	5	–	5	5	*	15	5	5	5	*
Holodiscus discolor	7.3	64	40	5	–	15	5	–	–	–	5	5	5
Acer macrophyllum	4.5	55	–	15	–	5	5	–	15	*	5	5	*
Gaultheria shallon	20.0	45	100	–	5	–	85	–	–	–	–	15	15
Symphoricarpos mollis	3.2	45	5	*	–	5	–	*	15	*	5	5	*
Acer circinatum	16.4	36	–	15	65	–	–	–	–	85	15	–	–
Cornus nuttallii	1.8	36	5	–	–	–	5	–	–	–	–	5	5
Rhus diversiloba	6.4	27	15	40	–	–	15	–	–	*	*	–	–
Rubus parviflorus	2.3	27	–	–	–	5	–	15	5	–	–	–	–
Pteridium aquilinum	1.4	27	5	*	–	5	–	–	–	*	–	5	–
Rhamnus purshiana	.9	18	–	5	–	–	–	–	–	–	–	5	–

Stratum & Species	Av. % Cover	Av. % Const.	102	103	106	107	109	112	114	115	116	117	118
Vaccinium parvifolium	.9	18	-	-	-	-	-	-	-	-	-	5	5
Athyrium filix-femina	.5	9	-	-	-	-	-	-	5	-	-	-	-
Castanopsis chrysophylla	.5	9	-	-	-	-	5	-	-	-	-	-	-
Philadelphus lewisii	.5	9	-	-	-	-	-	-	-	-	-	-	5
Pseudotsuga menziesii	.5	9	5	*	-	-	-	-	-	-	-	*	-
HERB													
Mosses	26.7	100	40.3	26.3	47.5	14.7	23.1	12.1	23.8	29.1	20.8	31.1	24.9
Polystichum munitum	7.6	100	.7	2.6	5.3	31.6	.5	10.3	2.3	.5	12.1	4.5	13.2
Adenocaulon bicolor	2.8	100	.5	1.0	.1	4.9	.2	.7	6.7	3.8	8.8	1.8	2.8
Bromus vulgaris	2.4	100	1.2	1.6	.3	.3	.3	4.0	4.8	4.8	4.6	3.4	1.2
Disporum smithii	2.9	91	.4	.1	-	9.0	.1	4.0	5.5	4.5	7.5	.6	.7
Galium trifidum	1.7	91	.4	.8	2.7	1.3	-	1.5	1.8	1.1	5.9	1.6	1.5
Trientalis latifolia	3.3	82	2.3	6.5	-	.8	-	2.0	4.3	11.8	3.0	2.7	2.8
Rubus ursinus	2.3	82	.8	.3	1.0	.3	-	2.5	9.2	6.5	4.3	.8	-
Trillium ovatum	.9	82	.1	.1	1.3	1.0	-	2.3	-	.5	2.6	.6	1.3
Vancouveria hexandra	1.8	73	3.3	.2	-	4.7	-	2.0	1.5	.6	7.0	-	.5
Rosa gymnocarpa	.8	73	.6	1.0	-	-	-	1.0	1.8	1.7	.6	.6	1.3
Cardamine purcherrima		73	-	**	**	**	-	**	**	-	**	**	**
Berberis nervosa	5.7	64	.9	15.8	-	-	3.0	7.8	-	3.1	-	11.9	20.3
Achlys triphylla	3.7	64	1.2	-	-	-	1.8	10.9	4.2	-	14.3	3.8	4.5
Symphoricarpos mollis	1.6	64	1.0	1.0	-	4.0	-	4.8	3.4	2.1	.5	.5	.5
Montia sibirica	1.4	64	-	-	2.0	1.3	-	6.3	-	.4	3.7	.3	.9
Anemone deltoidea	.7	64	-	.1	.5	.1	.1	-	-	1.1	2.8	3.1	-
Calypso bulbosa		64	**	**	-	**	-	**	-	**	**	**	-
Osmorhiza chilensis	1.4	55	1.8	.6	-	-	-	-	1.9	8.1	.9	-	2.3
Smilacina stellata	.7	55	-	.1	-	2.8	-	-	.5	.2	-	3.3	.5
Viola glabella	.6	55	-	-	-	3.8	-	1.1	.8	-	.3	.1	.1
Rhus diversiloba	2.2	45	2.3	10.8	-	-	7.4	-	-	2.3	1.4	-	-
Synthyris reniformis	.3	45	.3	2.6	.2	-	-	-	.2	-	-	.3	-

Stratum & Species	Av. % Cover	Av. % Const.	102	103	106	107	109	112	114	115	116	117	118
Goodyera oblongifolia	.2	45	-	-	-	-	.6	-	-	.7	.1	.3	.1
Thalictrum occidentale	1.2	36	-	-	-	-	-	3.3	-	-	3.0	5.3	2.1
Asarum caudatum	.6	36	-	-	-	-	-	-	1.8	1.8	-	.6	2.3
Nemophila pedunculata	.4	36	-	-	.5	.6	-	-	-	-	2.8	-	.6
Acer macrophyllum	.2	36	-	.2	-	-	-	-	1.4	-	.2	-	.1
Corylus cornuta	.1	36	-	-	-	-	-	1.3	.1	.1	-	.1	-
Fragaria vesca	.1	36	.1	-	-	.1	-	-	.5	.5	-	-	-
Arenaria macrophylla	.7	27	-	.5	-	-	-	-	5.6	1.7	-	-	-
Acer circinatum	.3	27	-	.7	.7	-	-	-	-	1.6	-	-	-
Pteridium aquilinum	.3	27	-	.5	-	1.1	-	-	-	1.8	-	-	-
Veratrum californicum	.2	27	-	-	-	-	-	1.0	.1	-	-	1.3	-
Smilacina racemosa	.1	27	-	-	-	.5	-	.5	-	-	-	.2	-
Rubus parviflorus	1.4	18	-	-	-	-	-	9.3	6.1	-	-	-	-
Carex spp.	.2	18	-	-	-	-	-	.1	-	-	2.0	-	-
Ligusticum apiifolium	.2	18	-	-	-	-	-	-	.2	1.8	-	-	-
Linnaea borealis	.2	18	.8	-	-	-	-	-	-	-	-	1.8	-
Poa spp.	.1	18	-	-	-	-	-	-	1.3	.2	-	-	-
Corallorhiza mertensiana	TR	18	-	-	-	.1	-	-	-	-	-	.1	-
Dicentra formosa	TR	18	-	-	.5	-	-	-	-	.5	-	-	-
Hieracium albiflorum	TR	18	.2	-	-	-	-	-	-	-	-	.1	-
Iris tenax	TR	18	-	.5	-	-	-	-	.5	-	-	-	-
Pseudotsuga menziesii	TR	18	-	.1	-	-	-	-	-	-	-	.1	-
Osmaronia cerasiformis	.2	9	-	-	-	-	-	-	-	2.3	-	-	-
Sedum spathulifolium	.2	9	2.6	-	-	-	-	-	-	-	-	-	-
Actea rubra	.1	9	-	-	-	-	-	1.6	-	-	-	-	-
Athyrium filix-femina	.1	9	-	-	-	-	-	-	1.3	-	-	-	-
Cynoglossum grande	.1	9	-	1.3	-	-	-	-	-	-	-	-	-
Hierochloe occidentalis	.1	9	1.2	-	-	-	-	-	-	-	-	-	-
Heuchera micrantha	.1	9	1.4	-	-	-	-	-	-	-	-	-	-
Lobaria pulmonaria	.1	9	-	-	1.5	-	-	-	-	-	-	-	-
Streptopus amplexifolius	.1	9	-	-	1.3	-	-	-	-	-	-	-	-

Stratum & Species	Av. % Cover	Av. % Const.	102	103	106	107	109	112	114	115	116	117	118
Viola sempervirens	.1	9	1.5	-	-	-	-	-	-	-	-	-	-
Abies grandis	TR	9	-	-	-	-	-	-	.1	-	-	-	-
Cornus nuttallii	TR	9	-	-	-	-	-	-	-	-	-	.2	-
Festuca rubra	TR	9	1.0	-	-	-	-	-	-	-	-	-	-
Lotus crassifolius	TR	9	.1	-	-	-	-	-	-	-	-	-	-
Luzula spp.	TR	9	.1	-	-	-	-	-	-	-	-	-	-
Madia gracilis	TR	9	-	.1	-	-	-	-	-	-	-	-	-
Mitella spp.	TR	9	.8	-	-	-	-	-	-	-	-	-	-
Rhamnus purshiana	TR	9	-	-	-	-	-	-	-	-	-	.1	-
Vaccinium parvifolium	TR	9	-	-	-	-	-	-	-	-	-	.6	-

* = species occurs in a lower stratum.
** = species present in macroplot but not encountered in sub-sampling for herbs.
TR = trace (species presence is less than .1% cover).

varies from high to low cover. In the tree stratum, Cornus nuttallii did not achieve 100% constancy primarily because of its slightly erratic distribution. Abies grandis was important also, yet occurred in fewer stands. This species was present in 82% of the shrub strata yet only nine percent of the herb strata.

Total tree canopy cover in the Psme-Acma/Coco/Adbi association is either low or is distributed among several species, allowing for double canopy coverage in some places and openings in others. Pseudotsuga, the major tree dominant, had an average tree canopy cover of 74.1% and represented 89.04% of tree basal area.

This association has not been previously described in the literature. All but two of the eleven plots were taken at or below 300 M elevation. Such low elevation sites, not part of a large continuous body of public land, have not been the subject of extensive studies; smaller scale studies in the area have either dealt with more mesic communities or, where this association occurs, specialized research problems not involving classification.

Four of the eleven plots occurred on steep north slopes at the edge of the Coast Range. Four others occurred on southwest slopes near rivers, incipient streams, or canyons. These features provided protection for these stands from recurring ground fires sweeping in from the interior valleys to the east. Three of the plots were located on gentle or moderate south and west slopes at the Western Hemlock Zone transition.

Other Valley-Margin Zone Communities

Appendix 6 presents data on the remaining plots which have been classified into six communities. Three are new and three are closely related (if not the same) as previously reported communities.

The *Pinus ponderosa-Pseudotsuga menziesii-Calocedrus decurrens/Rhus diversiloba* community has not been previously described, although Franklin and Dyrness (1973) allude to it in a discussion of Willamette Valley conifer forests including a picture in the general vicinity of plot 105. The community is found on warm dry ridge tops. Windthrown trees show a shallow, sharply-defined rooting depth related to a soil pan. *Pinus ponderosa* is at the northern limit of its range in the Coast Range *per se* here along with *Quercus kelloggii*. This community should be seen as an outlier related to low elevation Western Cascade and Siskiyou Mountain forest types.

The *Pseudotsuga menziesii-Calocedrus decurrens/Corylus cornuta* var. *californica/Lathyrus polyphyllus* community is also unreported in the literature. It too appears to be related to southern Western Cascade and northern Siskiyou forest types. All three plots representing this type were found just below the crest of the Coast Range at low elevations on exposed south and west slopes south of Eugene. Some distinctive species, such as *Oxalis suksdorfii*, set it off from all other plots. There is evidence of a complicated fire history. Figure 15 shows an example of this community and the Psme-Acma/Coco/Adbi association.

Figure 15. Mesic, Herb-Rich Understory in Plot 112, Psme-Acma/Coco/Adbi Association (left) And Large *Calocedrus decurrens* (120 cm. d.b.h.) in Plot 123, Psme-Cade/Coco/Lapo Association (right)

The other unreported community, Pseudotsuga menziesii-Thuja plicata/ Gaultheria shallon/Linnaea borealis, was represented by the northernmost and southernmost Valley-Margin Zone plots. It appears in the bed of incipient streams, at springs, or along flowing streams near the Western Hemlock Zone transition. It appears to be strictly correlated with a supplemental ground water supply. The macroclimate for this community is the same as for most other VMZ plots. However, since a particular stand can include areas under the influence of the supplemental moisture as well as free from it, the composition of this community is similar to the Psme-Acma/Coco/Adbi association, but with more mesic species added. Gaultheria shallon and Berberis nervosa have a very high cover in the shrub stratum. Oxalis oregana, absent from all other VMZ plots, is found in two of the three stands representing this community.

The Pseudotsuga menziesii-Acer macrophyllum/Corylus cornuta var. californica/Bromus vulgaris community was defined by Anderson (1967) in the Mary's Peak watershed. Plot 113, my sample of this community was located near the crest of the northeast facing slope containing the old-growth pocket in Figure 10. As in Anderson's plots the Bromus under-story in my plot was dense and tall. Woody tall shrubs are reduced in numbers of species and abundance of stems from the numbers found in the Psme-Acma/Coco/Adbi association further downslope. This community appears to be part of a former Pseudotsuga savanna complex, since large trees in the plot have old, now dead limbs to the ground.

The Pseudotsuga menziesii/Holodiscus discolor community is quite similar to those reported by Franklin and Dyrness (1973), and Dyrness, Franklin, and Moir (1974). Their data show some plots with no Gaultheria shallon and some with up to 50% canopy coverage of the species. I assigned two plots to this community, 108 and 119; one had no Gaultheria and the other had it abundantly. Corliss and Dyrness (1965), Bailey (1966), and Anderson (1967) all recognize a separate Holodiscus discolor-Gaultheria shallon community. The separation is probably justified, although the continuity of other species may indicate some factor operating to control Gaultheria alone.

Dyrness, Franklin, and Moir (1974) include the Psme/Hodi community at the dry end of the spectrum of their Tsuga heterophylla zone. Their data place it on extreme sites (low elevation, dry, steep) within that zone where, indeed, one would expect to find outliers of the Valley-Margin Zone. My representatives have, as theirs, a relatively open tree canopy (70%). Plot 119 occurs as a steep (21°), dry, southwest slope at the edge of the Western Hemlock Zone. I would characterize the Psme/Hodi community as the last upland (no supplemental moisture) VMZ community before encountering stands with some Tsuga heterophylla.

The Pseudotsuga menziesii-(Tsuga heterophylla)/Corylus cornuta var. californica community is a transition type. It is represented by plots 110 and 111 (which are nested within quarter hectare tallies 101T-104T--103T contains one Tsuga) and 236. Plot 236, Bradwood Cliffs, was taken on a loose sand substrate to determine whether a site well within the WHZ would show VMZ affinities if it were located on a droughty sand. It did, to a convincing degree. Plots 110 and 111 are within one kilometer of the WHZ border.

High constancy shrubs of the Psme-(Tshe)/Coco community include, in addition to Corylus cornuta var. californica, Berberis nervosa, Gaultheria shallon, and Rosa gymnocarpa. Galium trifidum and Bromus vulgaris are characteristic herbs. Dyrness, Franklin, and Moir (1974) report the same community in the Western Cascades. There, as in my plots, Tsuga heterophylla does not reach 100% constancy in the tree stratum. However, because the species has a potential to occupy further sites and increase its dominance with time (in the absence of disturbance) I have included it as a community descriptor within parentheses.

Tsuga heterophylla-Pseudotsuga menziesii/
Acer circinatum/Polystichum munitum Association

The Tshe-Psme/Acci/Pomu association is typically found near the drier eastern edge of the WHZ on low elevation (average, 329 M), very steep (average, 25°) slopes along or on either side of the Coast Range crest. In the south, stands of this association are found on north aspects, but gradually orient to the south in the central and north Coast Range. Soils are often very gravelly. Large specimens of Tsuga are not often encountered and there is a good deal of sunlight penetration through the tree canopy.

Other authors (Dyrness, Franklin, Moir, 1973; Hines, 1971; Anderson, 1967) report virtually the same association. However, in my Coast Range plots of this community Oxalis oregana has 100% constancy with 14.7% average cover as seen in Table 7. This could indicate that either the Coast Range norm is more mesic than the Cascades, or that unlike else-

Table 7. Constancy and Cover Values
For Tshe-Psme/Acci/Pomu Association

Stratum & Species	Av. % Cover	Av. % Const.	208	224	228	237	238
TREE							
Pseudotsuga menziesii	75.0	100	90	90	90	60	45
Tsuga heterophylla	18.0	100	10	5	20	20	35
Acer circinatum	14.0	100	5	5	25	30	5
Acer macrophyllum	2.0	40	-	5	-	5	-
Thuja plicata	2.0	20	-	10	-	-	-
Castanopsis chrysophylla	1.0	20	-	-	-	-	5
Taxus brevifolia	1.0	20	-	-	-	-	5
SHRUB							
Polystichum munitum	67.0	100	85	65	85	85	15
Acer circinatum	39.0	100	15	15	40	85	40
Vaccinium parvifolium	5.0	100	5	5	5	5	5
Tsuga heterophylla	4.0	60	-	-	5	5	15
Berberis nervosa	4.0	40	-	15	-	-	5
Corylus cornuta	2.0	40	-	5	-	5	-
Gaultheria shallon	2.0	40	-	5	-	-	5
Abies grandis	1.0	20	-	5	-	-	-
Castanopsis chrysophylla	1.0	20	-	-	-	-	5
Holodiscus discolor	1.0	20	-	5	-	-	-
Oplopanax horridum	1.0	20	-	-	5	-	-
Rosa gymnocarpa	1.0	20	-	5	-	-	-
HERB							
Mosses	14.6	100	27.3	13.3	23.4	3.0	5.8
Oxalis oregana	14.6	100	38.4	11.9	11.3	7.5	3.7
Polystichum munitum	10.6	100	6.3	14.9	17.4	8.4	6.1
Acer circinatum	1.1	100	.1	1.1	3.4	.3	.5
Trillium ovatum	1.1	100	.5	1.2	2.3	1.3	.2
Lobaria pulmonaria	.7	100	1.5	.5	.5	1.0	.2
Eurynchium oreganum	12.6	80	9.8	5.6	-	36.1	11.4
Montia sibirica	.7	80	1.3	-	.8	1.2	.1
Asarum caudatum	.6	60	-	-	.1	3.0	**
Galium trifidum	.5	60	-	.6	1.4	.3	-
Plagiothecium undulatum	.5	60	1.3	-	1.3	**	-
Disporum smithii	.3	60	1.0	.1	-	.6	-
Vaccinium parvifolium	TR	60	.1	-	.1	-	.2
Galium oreganum	.5	40	2.3	-	-	-	.1
Trientalis latifolia	.3	40	1.1	.2	-	-	-
Gaultheria shallon	.2	40	-	.2	-	-	.8

Stratum & Species	Av. % Cover	Av. % Const.	208	224	228	237	238
Smilacina racemosa	.2	40	-	.5	.5	-	-
Tiarella trifoliata	.2	40	.5	-	-	-	.3
Actea rubra	.1	40	-	-	-	.5	**
Anemone deltoidea	.1	40	-	.2	-	.5	-
Listera cordata	TR	40	-	-	.1	-	.1
Tsuga heterophylla	TR	40	-	-	.2	-	.1
Trisetum cernuum		40	**	-	-	**	-
Cardamine purcherrima	1.1	20	-	-	-	5.5	-
Thalictrum occidentale	.7	20	-	-	-	3.3	-
Adiantum pedatum	.5	20	-	-	-	2.4	-
Vancouveria hexandra	.5	20	-	-	-	2.3	-
Dicentra formosa	.4	20	2.2	-	-	-	-
Athyrium filix-femina	.3	20	-	1.3	-	-	-
Berberis nervosa	.3	20	-	-	-	-	1.6
Campanula scouleri	.3	20	-	1.3	-	-	-
Coptis laciniata	.3	20	-	-	-	-	1.3
Stachys mexicana	.3	20	1.3	-	-	-	-
Carex spp.	.2	20	1.2	-	-	-	-
Hieracium albiflorum	.2	20	1.0	-	-	-	-
Luzula parviflora	.2	20	.9	-	-	-	-
Adenocaulon bicolor	.1	20	-	.5	-	-	-
Linnaea borealis	.1	20	-	-	-	-	.5
Oplopanax horridum	.1	20	-	-	.5	-	-
Rubus ursinus	.1	20	-	.6	-	-	-
Smilacina stellata	.1	20	-	-	-	.5	-
Viola sempervirens	.1	20	-	-	-	-	.7
Whipplea modesta	.1	20	.5	-	-	-	-
Luzula campestris	TR	20	-	.3	-	-	-
Maianthemum dilatatum	TR	20	-	-	-	-	.1
Rosa gymnocarpa	TR	20	-	.1	-	-	-
Rubus spectabilis	TR	20	-	-	-	-	.1
Umbellularia californica	TR	20	.1	-	-	-	-
Viola glabella	TR	20	-	.2	-	-	-
Petasites frigidus	-	20	-	-	-	-	**
Pyrola secunda	-	20	-	-	-	-	**
Synthyris reniformis	-	20	-	-	-	**	-

** = species present in macroplot but not encountered in sub-sampling for herbs.
TR = trace (species presence is less than .1% cover).

where Coast Range representatives of this type are transient. Evidence from other aspects of my study convince me of the former.

Tsuga heterophylla/Polystichum munitum Association

Another widely agreed upon association is Tshe/Pomu. All of my stands of this type occurred in the central and north Coast Range. The Tshe/Pomu association is found on moderate slopes of an average (excluding one 34° plot) of 17°. There are no consistent aspect patterns.

Table 8 shows that the association is not particularly species rich although it is well-defined. Tsuga reproduction in the shrub and herb layers is excellent. The total tree canopy is high, allowing little light on the forest floor. The lichen, Lobaria pulmonaria, characteristic of the large diameter upper limbs of large Pseudotsuga, is produced abundantly and is consistently found on the forest floor. This association generates the classic large old-growth Pseudotsuga of the popular image.

Tsuga heterophylla/Vaccinium ovatum/ Polystichum munitum Association

This is a new association, although Franklin and Dyrness (1973) present a picture taken near plot 206 and call it a Tshe/Pomu association "with the shrub layer dominated by Vaccinium ovatum." All plots of this type occurred in the central to south Coast Range. Plots were taken on both gentle smooth slopes with moderately deep soils and on rocky ridges of massive sandstone boulders more characteristic of the south Coast

Table 8. Constancy and Cover Values for Tshe/Pomu Association

Stratum & Species	Av. % Cover	Av. % Const.	215	218	227	229	230	231	233
TREE									
Pseudotsuga menziesii	85.7	100	80	70	85	90	95	85	95
Tsuga heterophylla	41.4	100	35	50	25	35	30	45	70
Thuja plicata	2.9	29	-	-	-	15	-	-	5
SHRUB									
Polystichum munitum	26.4	100	65	15	40	5	5	15	40
Vaccinium parvifolium	6.4	100	5	15	5	5	5	5	5
Tsuga heterophylla	10.7	86	5	40	15	*	5	5	5
Berberis nervosa	8.6	86	5	-	15	5	5	15	15
Gaultheria shallon	3.6	71	5	5	5	5	-	-	5
Acer circinatum	2.9	57	5	5	-	5	-	-	5
Pteridium aquilinum	.7	14	-	-	5	-	-	-	-
Vaccinium ovatum	.7	14	5	-	-	-	-	-	-
HERB									
Mosses	35.7	100	10.5	23.9	12.7	72.8	76.7	44.8	8.8
Polystichum munitum	3.2	100	9.3	.6	3.8	.2	.1	.8	7.4
Tsuga heterophylla	1.7	100	.3	7.8	**	2.9	.3	.3	.1
Vaccinium parvifolium	1.5	100	3.3	2.3	1.5	.3	1.4	1.0	1.0
Lobaria pulmonaria	.7	100	2.0	.3	.3	1.6	.3	.4	.1
Viola sempervirens	1.0	86	.8	-	.6	.1	.7	3.3	1.5
Trillium ovatum	.6	86	1.5	.5	.8	.6	-	.3	.5
Plagiothecium undulatum	2.5	71	2.2	12.1	1.9	-	-	.5	.5
Berberis nervosa	.8	71	1.7	-	.8	-	.1	1.5	1.5

Stratum & Species	Av. % Cover	Av. % Const.	215	218	227	229	230	231	233
Eurynchium oreganum	16.0	57	29.8	13.4	41.1	-	-	-	27.6
Gaultheria shallon	.4	57	1.3	1.3	.2	.3	-	-	-
Trientalis latifolia	.4	57	-	-	-	.6	.3	.9	1.2
Tiarella trifoliata	.2	57	-	.1	.1	-	.6	.3	-
Montia sibirica	.5	43	1.3	-	-	-	.1	1.9	-
Achlys triphylla	.2	43	-	-	-	.1	-	.2	1.3
Luzula parviflora	.2	43	.5	-	-	-	.1	.6	-
Oxalis oregana	.6	29	1.8	-	-	-	-	2.2	-
Disporum smithii	.5	29	1.8	-	1.6	-	-	-	-
Acer circinatum	.2	29	1.1	-	-	.6	-	-	-
Galium trifidum	.2	29	-	-	-	-	-	.3	1.3
Osmorhiza chilensis	.2	29	-	-	-	-	-	.1	1.3
Rosa gymnocarpa	.2	29	-	-	.6	-	-	-	1.0
Chimaphila menziesii	.1	29	-	-	-	.3	.5	-	-
Corallorhiza mertensiana	TR	29	-	-	-	.1	.2	-	-
Pseudotsuga menziesii	TR	29	.2	.3	-	-	-	-	-
Blechnum spicant	.5	14	3.8	-	-	-	-	-	-
Rubus spectabilis	.3	14	1.8	-	-	-	-	-	-
Rubus ursinus	.1	14	-	-	.8	-	-	-	-
Anemone deltoidea	TR	14	-	-	-	-	-	.2	-
Asarum caudatum	TR	14	-	-	-	-	-	.1	-
Campanula scouleri	TR	14	.3	-	-	-	-	-	-
Galium oreganum	TR	14	.6	-	-	-	-	-	-
Hieracium albiflorum	TR	14	-	-	-	.1	-	-	-
Listera cordata	TR	14	-	-	-	-	.1	-	-
Melica subulata	TR	14	-	-	-	-	-	.1	-
Smilacina stellata	TR	14	-	-	-	.2	-	-	-
Trisetum cernuum	TR	14	.6	-	-	-	-	-	-
Rhamnus purshiana	-	14	-	-	**	-	-	-	-

* = species occurs in a lower stratum.
** = species present in macroplot but not encountered in sub-sampling for herbs.
TR = trace (species presence is less than .1% cover).

Range. The rocky open nature of several plots reduced the total tree cover and allowed many shrub and herb species special growth opportunities as can be seen from Table 9.

The many boulders (and the open canopy) of this type may have reduced the intensities of fires or stopped them altogether. Thuja plicata has a constancy, in the tree stratum, of 57%. The grass Hierochloe occidentalis was more common in this association than any other. Viola sempervirens, Berberis nervosa, and Trillium ovatum occurred in the herb stratum with high constancy and cover.

Tsuga heterophylla/Polystichum munitum-
Oxalis oregana Association

Table 10 presents constancy and cover data for the modal Coast Range Western Hemlock Zone old-growth type, the Tshe/Pomu-Oxor association. Nearly every author who has studied forest types of western Oregon has found a Tshe/Pomu-Oxor type (Bailey, 1966; Anderson, 1967; Corliss and Dyrness, 1965; Franklin and Dyrness, 1973; Dyrness, Franklin, and Moir, 1974). Franklin and Dyrness (1973) propose the Tshe/Pomu association as the mode. However, considering the variation in slope, aspect, elevation, and latitude within which my Tshe/Pomu-Oxor association occurs and the relative abundances of Coast Range old-growth available for sampling, the Tshe/Pomu-Oxor type seems to me to be a better choice. This again emphasizes that forest sites in the Coast Range are more generally mesic than in the western Cascades.

Table 9. Constancy and Cover Values for Tshe/Vaov/Pomu Association

Stratum & Species	Av. % Cover	Av. % Const.	206	207	211	213	219	220	240
TREE									
Pseudotsuga menziesii	68.6	100	70	65	85	80	70	70	45
Tsuga heterophylla	22.9	100	10	10	65	5	20	15	35
Thuja plicata	7.8	57	15	-	-	-	5	10	25
Acer macrophyllum	2.9	29	-	-	-	-	10	-	10
Cornus nuttallii	2.1	29	-	10	-	-	5	*	-
Taxus brevifolia	2.1	29	-	*	-	-	10	5	-
Alnus rubra	.7	14	-	-	-	5	-	-	-
Umbellularia californica	.7	14	-	-	5	-	-	-	-
SHRUB									
Polystichum munitum	56.4	100	85	40	40	65	40	40	85
Vaccinium ovatum	17.1	100	15	15	40	15	15	5	15
Vaccinium parvifolium	5.0	100	5	5	5	5	5	5	5
Tsuga heterophylla	3.6	71	5	*	5	-	5	5	5
Berberis nervosa	2.9	57	5	5	*	-	5	5	*
Acer circinatum	15.7	43	-	-	-	80	15	15	-
Taxus brevifolia	2.9	43	-	5	-	-	5	15	-
Gaultheria shallon	2.1	43	-	5	-	-	5	5	-
Corylus cornuta	1.4	29	-	-	-	-	-	5	5
Rosa gymnocarpa	1.4	29	-	5	-	-	5	-	-
Cornus nuttallii	.7	14	-	-	-	-	-	5	-
Lithocarpus densiflorus	.7	14	-	5	-	-	-	-	-
Pteridium aquilinum	.7	14	-	-	-	-	-	-	5
Rhus diversiloba	.7	14	-	5	-	-	-	-	-
Thuja plicata	.7	14	-	-	-	-	-	5	-
Umbellularia californica	.7	14	-	-	5	-	-	-	-

Stratum & Species	Av. % Cover	Av. % Const.	206	207	211	213	219	220	240
HERB									
Mosses	24.0	100	36.9	49.9	13.3	7.3	16.8	31.4	12.6
Polystichum munitum	6.6	100	4.9	4.3	11.3	7.3	3.2	4.6	10.8
Lobaria pulmonaria	1.1	100	1.0	2.2	.8	.1	1.2	1.5	.6
Viola sempervirens	.9	86	.8	.8	.5	-	2.2	1.7	.2
Trillium ovatum	.8	86	.1	.6	-	1.3	1.1	.5	1.8
Vaccinium parvifolium	.6	86	.1	-	1.0	.5	.6	1.2	1.3
Berberis nervosa	.4	86	.2	.5	**	-	1.1	.7	.1
Galium trifidum	.3	86	1.0	.2	.1	-	.1	.1	.3
Oxalis oregana	15.5	71	29.1	16.2	**	21.5	-	-	19.8
Eurynchium oreganum	14.3	71	-	-	24.8	.6	36.1	9.4	29.3
Plagiothecium undulatum	1.3	71	2.3	-	4.4	1.2	-	1.1	.1
Vaccinium ovatum	.8	57	-	-	2.5	1.3	1.5	.5	-
Trientalis latifolia	.6	57	-	.5	**	-	.4	3.3	-
Tsuga heterophylla	.2	57	-	.1	-	-	.6	.5	.1
Smilacina stellata	.8	43	-	1.3	-	-	.5	4.0	-
Vancouveria hexandra	.6	43	-	.6	-	-	-	3.3	.5
Rubus ursinus	.1	43	-	.5	.1	-	.1	-	-
Hierochloe occidentalis	.6	29	-	3.3	-	-	-	.6	-
Asarum caudatum	.5	29	-	-	-	2.8	-	-	.7
Dryopteris austriaca	.5	29	-	-	1.6	-	-	-	1.9
Adiantum pedatum	.4	29	-	-	-	-	-	1.8	1.3
Disporum smithii	.4	29	1.3	-	-	1.2	-	-	-
Maianthemum dilatatum	.3	29	-	-	-	1.3	-	.6	-
Luzula parviflora	.2	29	.6	-	-	-	-	-	.6
Acer circinatum	TR	29	-	-	-	.1	.1	-	-
Festuca occidentalis	TR	29	-	.1	-	-	-	.1	-
Goodyera oblongifolia	TR	29	.1	.1	-	-	-	-	-
Montia sibirica	TR	29	-	-	-	.2	-	-	.1
Monotropa uniflora	TR	29	-	-	-	-	.5	.1	-
Osmorhiza chilensis	TR	29	-	.1	-	-	.5	-	-

Stratum & Species	Av. % Cover	Av. % Const.	206	207	211	213	219	220	240
Linnaea borealis	1.5	14	-	-	-	-	-	10.2	-
Montia diffusa	.8	14	-	5.7	-	-	-	-	-
Achlys triphylla	.3	14	-	1.8	-	-	-	-	-
Adenocaulon bicolor	.3	14	-	2.1	-	-	-	-	-
Whipplea modesta	.3	14	-	2.3	-	-	-	-	-
Blechnum spicant	.2	14	-	-	-	-	-	-	1.3
Tellima grandiflora	.2	14	-	1.3	-	-	-	-	-
Gaultheria shallon	.1	14	-	-	-	-	1.0	-	-
Anemone deltoidea	TR	14	-	-	-	-	-	-	.5
Campanula scouleri	TR	14	-	-	-	-	-	-	.1
Hieracium albiflorum	TR	14	-	-	-	-	.6	-	-
Pseudotsuga menziesii	TR	14	-	-	-	-	.1	-	-
Rosa gymnocarpa	TR	14	-	-	-	-	.5	-	-
Taxus brevifolia	TR	14	-	-	-	-	.1	-	-
Thuja plicata	TR	14	-	-	-	-	-	.2	-
Trisetum cernuum	TR	14	-	-	.3	-	-	-	-
Umbellularia californica	TR	14	-	-	.1	-	-	-	-

* = species occurs in a lower stratum.
** = species present in macroplot but not encountered in sub-sampling for herbs.
TR = trace (species presence is less than .1% cover).

Table 10. Constancy and Cover Values for Tshe/Pomu-Oxor Association

Stratum & Species	Av. % Cover	Av. % Const.	209	210	212	216	217	223	226	232	235	241
TREE												
Pseudotsuga menziesii	82.5	100	95	85	70	90	75	75	90	85	80	80
Tsuga heterophylla	38.0	100	45	60	10	45	55	10	30	65	40	20
Thuja plicata	5.0	40	10	–	20	–	–	5	–	–	–	15
Acer macrophyllum	3.0	20	–	–	10	–	–	–	–	–	20	–
Taxus brevifolia	1.0	20	5	–	–	–	–	5	–	–	–	–
Cornus nuttallii	.5	10	–	–	5	–	–	*	–	–	–	–
Acer circinatum	.5	10	–	–	*	–	*	5	*	*	–	*
SHRUB												
Polystichum munitum	61.5	100	65	40	85	40	65	40	65	65	65	85
Vaccinium parvifolium	6.0	100	5	5	5	15	5	5	5	5	5	5
Berberis nervosa	10.5	80	5	15	*	5	–	40	5	15	15	5
Tsuga heterophylla	10.5	80	15	40	*	15	5	5	*	15	5	5
Acer circinatum	8.5	60	–	–	15	–	5	5	15	5	–	40
Gaultheria shallon	4.5	20	–	–	–	40	–	5	–	–	–	–
Oplopanax horridum	1.0	20	–	–	–	–	–	–	5	–	5	–
Vaccinium ovatum	.6	20	1	–	–	5	–	–	–	–	–	–
Pteridium aquilinum	1.5	10	–	–	–	–	–	–	15	–	–	–
Vaccinium membranaceum	.5	10	–	–	–	–	–	–	5	–	–	–
Menziesia ferruginea	.5	10	–	–	–	–	–	–	–	5	–	–
Corylus cornuta	.5	10	–	–	–	–	–	–	–	–	–	5
Pseudotsuga menziesii	.5	10	–	5	–	–	–	–	–	–	–	–

Stratum & Species	Av. % Cover	Av. % Const.	209	210	212	216	217	223	226	232	235	241
HERB												
Oxalis oregana	27.4	100	49.8	10.8	21.8	19.0	37.5	27.1	46.6	23.9	11.3	26.1
Mosses	19.3	100	6.0	11.7	43.7	9.9	9.6	46.4	27.1	11.5	17.2	10.2
Polystichum munitum	5.1	100	3.9	5.1	5.6	1.7	6.6	6.4	2.8	3.8	8.3	6.6
Vaccinium parvifolium	.7	100	.5	.1	.5	.8	.8	.1	.2	2.8	.7	.5
Eurynchium oreganum	13.5	90	7.1	12.6	1.3	22.8	6.5	–	9.8	42.5	11.3	21.4
Plagiothecium undulatum	3.1	90	.8	.2	2.8	4.7	2.8	–	6.2	6.3	5.6	1.8
Tsuga heterophylla	1.3	90	1.3	.8	.6	.8	.3	–	.8	3.4	1.1	3.9
Lobaria pulmonaria	.8	90	.5	.3	1.6	1.4	1.3	1.2	.3	.3	–	1.5
Trillium ovatum	.9	80	1.0	.5	–	1.3	.5	.1	–	3.1	1.1	1.5
Tiarella trifoliata	1.4	70	8.3	1.0	–	.5	.1	–	.9	1.5	1.7	–
Disporum smithii	1.1	70	.8	.5	–	2.6	.1	–	4.7	–	.1	1.8
Berberis nervosa	1.2	60	1.1	.8	.1	–	–	5.6	–	2.0	–	2.1
Galium trifidum	1.0	60	.8	–	5.8	–	–	–	.1	1.4	1.6	.5
Trientalis latifolia	.3	60	.1	.3	.5	.6	–	–	–	.6	–	1.1
Luzula parviflora	.5	50	1.0	.6	–	–	.5	–	.6	–	2.3	–
Trisetum cernuum	.2	50	.5	.3	–	–	.6	–	–	–	.3	.1
Blechnum spicant	1.2	40	–	–	3.6	6.8	1.0	–	–	–	–	.5
Viola sempervirens	.6	40	1.0	2.3	1.9	.6	–	–	–	–	–	–
Montia sibirica	.5	40	–	–	2.3	–	1.1	–	–	–	1.4	.1
Vancouveria hexandra	.4	40	1.0	–	.6	–	–	–	–	–	1.5	1.3
Asarum caudatum	.4	30	.5	–	.5	–	–	–	–	–	–	2.6
Dicentra formosa	.1	30	**	–	–	–	–	–	1.3	–	–	**
Vaccinium ovatum	TR	30	.1	**	–	.6	–	–	–	–	–	–
Gaultheria shallon	.5	20	–	–	–	3.6	–	1.5	–	–	–	–
Bromus vulgaris	.4	20	–	–	2.6	–	–	1.0	–	–	–	–
Rubus ursinus	.2	20	–	–	–	1.2	–	–	1.0	–	–	–
Athyrium filix-femina	.1	20	–	–	.1	–	–	–	–	–	1.2	–
Osmorhiza chilensis	.1	20	–	–	1.1	–	–	–	–	–	–	.1
Smilacina stellata	.1	20	–	–	–	.5	–	–	–	–	–	.5

Stratum & Species	Av. % Cover	Av. % Const.	209	210	212	216	217	223	226	232	235	241
Acer circinatum	TR	20	-	-	-	-	-	.2	-	-	-	.2
Adenocaulon bicolor	TR	20	-	-	.5	-	-	-	-	-	-	**
Anemone deltoidea	TR	20	-	.1	-	-	-	-	-	-	-	.5
Campanula scouleri	TR	20	-	.5	-	-	-	.1	-	-	-	-
Chimaphila menziesii	TR	20	-	.3	-	-	-	-	-	-	.1	-
Goodyera oblongifolia	TR	20	.1	-	-	-	-	-	-	-	.5	-
Hieracium albiflorum	TR	20	.5	**	-	-	-	-	-	-	-	-
Melica geyeri	TR	20	-	-	-	.1	-	-	-	-	.1	-
Achlys triphylla	.3	10	2.8	-	-	-	-	-	-	-	-	-
Asplenium trichomanes	.2	10	-	-	1.8	-	-	-	-	-	-	-
Stachys spp.	.2	10	-	-	-	-	-	-	-	-	-	1.8
Whipplea modesta	.2	10	-	1.6	-	-	-	-	-	-	-	-
Adiantum pedatum	.1	10	-	-	-	-	-	-	-	-	-	1.3
Cryptogramma crispa	.1	10	-	-	-	-	1.0	-	-	-	-	-
Lotus crassifolius	.1	10	1.0	-	-	-	-	-	-	-	-	-
Clintonia uniflora	TR	10	-	-	-	-	-	-	.1	-	-	-
Corallorhiza mertensiana	TR	10	-	-	-	-	-	-	-	.1	-	-
Cornus nuttallii	TR	10	-	-	-	-	-	.1	-	-	-	-
Festuca occidentalis	TR	10	-	-	.1	-	-	-	-	-	-	-
Linnaea borealis	TR	10	-	-	.1	-	-	-	-	-	-	-
Pteridium aquilinum	TR	10	-	-	-	-	-	-	.5	-	-	-
Pyrola secunda	TR	10	-	.5	-	-	-	-	-	-	-	-
Rubus nivalis	TR	10	-	-	-	-	-	-	-	-	.1	-
Rubus spectabilis	TR	10	-	-	-	-	.2	-	-	-	-	-
Synthyris reniformis	TR	10	-	-	-	-	-	.3	-	-	-	-
Areraria macrophylla	-	10	**	-	-	-	-	-	-	-	-	-
Hydrophyllum tenuipes	-	10	-	-	-	-	-	-	-	-	**	-

* = species occurs in a lower stratum.
** = species present in macroplot but not encountered in sub-sampling for herbs.
TR = trace (species presence is less than .1% cover).

This association includes both high constancy-cover herbs and a group of "list extenders" from plots including influences from the many different surrounding habitats. For example, plot 212 was taken on a north slope in a seep exuding from Tyee sandstone bedding planes and was just across a stream from Plot 102, a VMZ plot. Tree canopy density can be very high. However, succession can so easily proceed to Tsuga that openings from Pseudotsuga mortality can thin a stand considerably.

Polystichum munitum overwhelmingly dominates the shrub stratum (100% constancy, 61.5% cover) and Oxalis the herb stratum (100% constancy, 27.4% cover). A luxuriant moss carpet is characteristic as well as abundant Tsuga reproduction in both the herb and shrub strata. Trillium ovatum, Tiarella trifoliata, and Disporum smithii are other important high constancy herbs. Blechnum spicant and Viola sempervirens are occasionally important, the latter especially in the south Coast Range.

Other Western Hemlock Zone Communities

Appendix 6 lists other WHZ communities. The Tsuga heterophylla/ Rhododendron macrophyllum-Gaultheria shallon community is found exclusively in the south Coast Range. It is at the highest average elevation of all WHZ communities and both plots representing it are on south slopes. The shrub stratum is particularly dense. The tree stratum is sufficiently open to allow Xerophyllum tenax to appear. Polystichum munitum is absent from plot 205, one of the very few such instances in the Coast Range. Dyrness, Franklin, and Moir (1974) report the same community in the western Cascades.

Hawk (personal communication) reports two variants of previously discussed communities distinguished by the presence of Chamaecyparis lawsoniana. I also encountered these and they are listed in Appendix 6 as the Tsuga heterophylla-Chamaecyparis lawsoniana/Rhododendron macrophyllum-Gaultheria shallon and the Tsuga heterophylla-Chamaecyparis lawsoniana/Polystichum munitum-Oxalis oregana communities. The Tshe-Chla/Rhma-Gash type is basically the same as above, but includes a few more species indicating it is perhaps more mesic and it is also distinctively more open. The Tshe-Chla/Pomu-Oxor is virtually the same as the association without Chamaecyparis except for the appearance of Festuca occidentalis and Chamaecyparis in all strata. Figure 16 shows this community and the Tshe-(Psme)/Acci/Pomu association.

The Tsuga heterophylla/Acer circinatum-Gaultheria shallon community is reported by Dyrness, Franklin, and Moir (1974), and is represented by plots 222, 225, and 239. All were taken on Mary's Peak and Monmouth Peak. Monmouth Peak does not support a TFZ island on its summit, but plot 225 showed affinities for other TFZ plots. In all plots' shrub strata Berberis nervosa was more abundant than Polystichum munitum. I have found Berberis to be more closely correlated with localized gravel, colluvium, or loose soil than the overall environment and for that reason have not used it as a community descriptor. Recurring partial burns may

Figure 16. Lightspot Illuminating *Acer circinatum* on a Steep Slope In Plot 237, Tshe/Acci/Pomu Association (left) And Open Understory on Level Bench in Plot 202, Tshe-Chla/Pomu-Oxor Association (right)

be important in maintaining this type. All plots showed evidence of burning effects, and Acer circinatum in particular responded favorably.

Abies procera/Oxalis oregana Association

Table 11 presents constancy-cover data for the Abpr/Oxor association. This association has been mentioned by Merkle (1951), but not widely or specifically recognized. With the exception of reported enormous amount of Cryptogramma crispa in his plots, Hines' (1971) Tsuga heterophylla-Abies procera/Vaccinium membranaceum/Cryptogramma crispa community is quite similar.

All plots of this association were located above 880 M on Mary's Peak, Grass Mountain, or Sheridan Peak. Figure 17 illustrates the general nature of the association. Abies seedlings and saplings are not able to survive in the dense shade of an old-growth canopy. They occur in patchy openings characteristic of the old-growth stands. Otherwise the shrub stratum is very poorly developed.

Some herbs which occur in the VMZ and are nearly absent in the WHZ such as Adenocaulon bicolor and Thalictrum occidentale reappear in this association. The herb stratum is relatively species rich and Oxalis can have a phenomenonally high cover (up to 72%)

Table 11. Constancy and Cover Values
For Abpr/Oxor Association

Stratum & Species	Av. % Cover	Av. % Const.	301	302	303	304	305
TREE							
Abies procera	76	100	85	95	80	45	75
Tsuga heterophylla	17	40	20	-	-	65	-
Pseudotsuga menziesii	3	20	-	-	-	-	15
SHRUB							
Abies procera	4	80	5	5	5	*	5
Tsuga heterophylla	3	10	15	-	-	*	-
Polystichum munitum	3	10	*	-	-	-	15
Rosa gymnocarpa	1	10	-	-	-	-	5
Vaccinium parvifolium	1	10	-	-	-	*	5
HERB							
Oxalis oregana	45.6	100	31.3	65.3	72.1	15.3	43.8
Montia sibirica	2.2	100	1.8	1.4	4.3	.7	2.6
Clintonia uniflora	1.8	100	2.6	.5	1.3	1.0	3.5
Abies procera	.2	100	.2	.3	.3	.1	.2
Viola adunca	4.2	80	3.7	4.8	10.3	-	2.3
Coptis laciniata	3.8	80	4.4	-	8.4	1.7	4.4
Tiarella trifoliata	2.7	80	-	2.1	4.3	.7	6.6
Disporum smithii	2.2	80	1.3	1.8	-	.2	7.5
Smilacina stellata	5.2	60	2.4	-	.5	-	23.3
Thalictrum occidentale	1.6	60	2.2	1.2	4.7	-	-
Trillium ovatum	.3	60	-	.5	.1	.7	-
Mosses	2.4	40	-	-	-	5.7	6.2
Achlys triphylla	1.9	40	8.3	-	-	-	1.1
Dicentra formosa	1.6	40	-	6.1	2.1	-	-
Bromus spp.	1.5	40	5.6	-	-	-	1.9
Campanula scouleri	1.0	40	-	-	1.1	-	4.0
Senecio triangularis	1.0	40	-	2.3	2.8	-	-
Galium oreganum	.8	40	.7	-	-	-	3.3
Whipplea modesta	.8	40	-	-	.2	-	3.9
Carex mertensii	.7	40	-	.6	3.0	-	-
Dryopteris austriaca	.6	40	.5	2.6	-	-	-
Trisetum cernuum	.5	40	-	-	2.2	-	.1
Viola sempervirens	.4	40	-	-	-	.9	1.1
Maianthemum dilatatum	.3	40	-	-	-	.6	.8
Polystichum munitum	.3	40	.5	-	-	-	.8
Adenocaulon bicolor	TR	40	-	-	.5	-	.1

Stratum & Species	Av. % Cover	Av. % Const.	301	302	303	304	305
Tsuga heterophylla	TR	40	.1	-	-	.1	-
Eurynchium oreganum	2.6	20	13.2	-	-	-	-
Vancouveria hexandra	2.1	20	-	-	-	-	10.6
Mimulus guttatus	.8	20	-	4.0	-	-	-
Symphoricarpos mollis	.8	20	-	-	-	-	3.8
Asarum caudatum	.3	20	-	-	-	-	1.3
Blechnum spicant	.3	20	-	1.3	-	-	-
Scrophularia spp.	.3	20	-	1.6	-	-	-
Smilacina racemosa	.3	20	-	-	1.3	-	-
Luzula parviflora	.2	20	-	-	-	-	1.0
Trientalis latifolia	.2	20	-	-	-	-	1.2
Osmorhiza chilensis	.1	20	-	-	-	-	.7
Peltigera cannina	.1	20	.5	-	-	-	-
Berberis nervosa	TR	20	-	-	-	-	.2
Listera cordata	TR	20	-	-	.5	-	-
Lobaria pulmonaria	TR	20	-	-	-	.2	-
Pyrola secunda	TR	20	-	-	-	.5	-
Rubus nivalis	TR	20	-	-	-	-	.2
Vaccinium parvifolium		20	-	-	-	**	-

* = species occurs in a lower stratum.
** = species present in macroplot but not encountered in sub-sampling for herbs.
TR = trace (species presence is less than .1% cover).

Figure 17. Clear Bole and Large Diameter Upper Limbs On an Old <u>Abies procera</u> (above) And Open Shrubless Understory in Plot 301 A Fire Remnant Pocket, Abpr/Oxor Association (below)

Tsuga heterophylla-Pseudotsuga menziesii-(Picea sitchensis)/Gaultheria shallon/Eurynchium oreganum-Plagiothecium undulatum Association

The Tshe-Psme-(Pisi)/Gash/Euor-Plun association, previously unreported, is a WHZ-SSZ transition community with half its plots from each zone. Pseudotsuga is included in the community descriptor since its absence in other SSZ associations is significant. As Table 12 shows, Gaultheria and the moss Eurynchium have an extremely high cover. Plot 410, Sand Lake Sand, was taken on a loose sand substrate within three kilometers of the ocean to determine whether a sandy soil would produce a characteristic WHZ forest type. That was very nearly the outcome. Certainly plot 410 is very different from nearby forests on residual soil.

There was evidence of some burning in all four plots and they all had some edaphic or topographic factor that distinguished them as relatively dry. Picea appears capable of appearing as a minor tree species in this type though its distribution is so irregular it does not occur in all plots. The species composition of most SSZ stands is very similar. Associations are differentiated on the basis of dominance and the presence or absence of certain diagnostic species. This necessitates long association names. In the regional context of SSZ plots I have put high diagnostic value on Gaultheria.

Table 12. Constancy and Cover Values
For Tshe-Psme (Pisi)/Gash/Euor-Plun Association

Stratum & Species	Av. % Cover	Av. % Const.	221	234	410	418
TREE						
Pseudotsuga menziesii	78.8	100	95	85	75	60
Tsuga heterophylla	40.0	100	60	35	35	30
Picea sitchensis	5.0	25	*	*	–	20
Thuja plicata	2.5	25	10	–	–	–
SHRUB						
Gaultheria shallon	62.5	100	15	85	65	85
Vaccinium parvifolium	15.0	100	15	15	15	15
Tsuga heterophylla	12.5	100	15	15	15	5
Polystichum munitum	36.3	75	40	–	65	40
Menziesia ferruginea	3.8	75	5	5	–	5
Pteridium aquilinum	2.5	50	–	5	5	–
Vaccinium membranaceum	2.5	50	–	5	–	5
Vaccinium ovatum	3.8	25	–	–	15	–
Acer circinatum	1.3	25	–	–	–	5
Berberis nervosa	1.3	25	5	–	–	–
Rhamnus purshiana	1.3	25	–	–	5	–
HERB						
Eurynchium oreganum	36.5	100	29.9	58.5	34.4	23.2
Gaultheria shallon	6.5	100	1.8	13.2	1.4	9.7
Plagiothecium undulatum	5.5	100	1.9	7.8	7.5	4.8
Mosses	4.9	100	6.5	5.8	2.3	5.1
Vaccinium parvifolium	2.1	100	2.8	3.4	1.9	.1
Blechnum spicant	1.9	100	1.8	.5	3.2	2.0
Polystichum munitum	1.9	75	4.4	–	.5	2.8
Trillium ovatum	.6	75	1.7	–	.5	.1
Menziesia ferruginea	.3	75	.6	.2	–	.2
Picea sitchensis	.2	75	**	.5	–	.1
Disporum smithii	.3	50	.5	–	–	.5
Luzula parviflora	.2	50	**	–	–	.7
Tiarella trifoliata	.2	50	**	–	–	.6
Lobaria pulmonaria	.1	50	.2	–	.2	–
Maianthemum dilatatum	.7	25	–	–	–	2.8
Vaccinium ovatum	.4	25	–	–	1.4	–
Viola sempervirens	.4	25	1.6	–	–	–
Rubus nivalis	.3	25	1.1	–	–	–
Streptopus amplexifolius	.3	25	–	–	1.3	–

Stratum & Species	Av. % Cover	Av. % Const.	221	234	410	418
Montia sibirica	.2	25	.6	-	-	-
Peltigera cannina	.2	25	.6	-	-	-
Cryptogramma crispa	.1	25	.5	-	-	-
Monotropa uniflora	.1	25	-	-	.5	-
Athyrium filix-femina	TR	25	-	-	-	.1
Berberis nervosa	TR	25	.1	-	-	-
Bromus spp.	TR	25	.1	-	-	-
Hieracium albiflorum	TR	25	-	.1	-	-
Vaccinium membranaceum	TR	25	-	.1	-	-

* = species occurs in a lower stratum.
** = species present in macroplot but not encountered in sub-sampling for herbs.
TR = trace (species presence is less than .1% cover).

Tsuga heterophylla-Pseudotsuga menziesii-Picea sitchensis/Polystichum munitum-Eurynchium oreganum-Oxalis oregana-Plagiothecium undulatum Association

The Tshe-Psme-Pisi/Pomu-Euor-Oxor-Plun association is found in the southern and central coast region, somewhat inland, where Pseudotsuga can play a major role in tree canopy dominance. Picea appears to be restricted to favorable microsites such as springs or incipient drainages. All plots contain very large old Pseudotsuga that exhibit fire scars. All Picea trees are in the smaller size classes and appear to have originated after the major post-settlement burns.

There is a considerable thickness of organic litter on the forest floor carpeted with mosses. Polystichum has a very high (75%) average cover. Typical coastal species such as Maianthemum dilatatum, Rubus spectabilis and Menziesia ferruginea are present. In other respects, however, one could look at this type to be the coastal fog belt phase of the Tshe/Pomu-Oxor association. Table 13 presents constancy-cover data for the association. An interesting feature is the addition of Umbellularia californica south of the Umpqua River.

Although the association is previously unreported in the literature it does appear to be somewhat like Hines' (1971) Tsuga heterophylla-Picea sitchensis/Oplopanax horridum/Athyrium filix-femina community. His data appear to reflect the influence of more wet or ponded areas in his plots.

Table 13. Constancy and Cover Values
For Tshe-Psme-Pisi/Pomu-Euor-Oxor-Plun Association

Stratum & Species	Av. % Cover	Av. % Const.	402	405	406	423
TREE						
Pseudotsuga menziesii	65.0	100	50	75	60	75
Tsuga heterophylla	23.8	100	25	35	30	5
Picea sitchensis	10.0	100	25	5	5	5
Thuja plicata	5.0	50	-	-	10	10
Acer circinatum	2.5	25	-	-	-	5
Acer macrophyllum	2.5	25	-	-	-	5
SHRUB						
Polystichum munitum	75.0	100	65	65	85	85
Tsuga heterophylla	8.8	75	*	15	15	5
Vaccinium parvifolium	6.3	75	-	15	5	5
Vaccinium ovatum	7.5	50	15	-	-	15
Athyrium filix-femina	2.5	50	-	5	5	-
Menziesia ferruginea	2.5	50	5	5	*	-
Rubus spectabilis	2.5	50	5	-	-	5
Vaccinium membranaceum	2.5	50	5	5	-	-
Acer circinatum	10.0	25	-	-	-	40
Gaultheria shallon	1.3	25	*	5	*	*
Rhamnus purshiana	TR	25	-	-	-	1
HERB						
Oxalis oregana	20.8	100	8.4	29.5	35.0	10.1
Eurynchium oreganum	18.6	100	10.2	20.4	28.8	14.8
Mosses	10.1	100	14.5	6.0	9.2	10.5
Polystichum munitum	5.4	100	2.7	5.5	4.7	8.6
Blechnum spicant	4.8	100	7.2	3.7	7.0	1.1
Plagiothecium undulatum	4.1	100	2.0	5.5	1.2	7.8
Gaultheria shallon	.6	100	.5	1.5	.1	.2
Trillium ovatum	1.3	75	-	2.3	2.3	.7
Maianthemum dilatatum	.9	75	2.7	.6	.1	-
Menziesia ferruginea	.5	75	.6	.6	.7	-
Vaccinium parvifolium	.3	75	-	.1	.7	.2
Montia sibirica	1.3	50	-	-	4.0	1.3
Tiarella trifoliata	.8	50	-	2.6	-	.7
Galium trifidum	.6	50	-	-	1.7	.8
Luzula parviflora	.4	50	-	-	1.1	.6
Tsuga heterophylla	.3	50	.5	.7	-	-
Vaccinium ovatum	.3	50	.7	-	-	.3
Disporum smithii	.2	50	.2	-	-	.5
Smilacina stellata	.4	25	-	1.5	-	-

Stratum & Species	Av. % Cover	Av. % Const.	402	405	406	423
Acer circinatum	.3	25	-	-	-	1.1
Smilacina racemosa	.2	25	-	-	.6	-
Viola sempervirens	.2	25	.8	-	-	-
Stachys mexicana	.1	25	-	-	.5	-
Umbellularia californica	.1	25	-	-	-	.5
Athyrium filix-femina	TR	25	-	-	.1	-
Berberis nervosa	TR	25	-	-	-	.3
Chimaphila menziesii	TR	25	-	.1	-	-
Dryopteris austriaca	TR	25	-	-	-	.1
Lobaria pulmonaria	TR	25	-	-	.1	-
Melica subulata	TR	25	.1	-	-	-
Rubus spectabilis	TR	25	.1	-	-	-
Vaccinium membranaceum	TR	25	.1	-	-	-
Trienlalis latifolia		25	-	-	-	**

* = species occurs in a lower stratum.
** = species present in macroplot but not encountered in sub-sampling for herbs.
TR = trace (species presence is less than .1% cover).

Picea sitchensis-Tsuga heterophylla/Gaultheria shallon/Blechnum spicant Association

The Pisi-Tshe/Gash/Blsp association is found on the basalt and basalt andesitic headlands of the coast from Heceta Head to Tillamook Head, a north-south distance of over 212 km. Over that distance stands of this association are remarkably similar. The oceanic influence overwhelms other climatic factors. Few other old-growth communities segregate from this association where it occurs. The overall impression one gets from working with this type is that of uniformity and redundancy.

Table 14 presents constancy-cover data for the association. Even with ten plots representing it, the species total is not very great. Ferns, mosses, liverworts, and lichens are particularly well represented.

Although the tree canopy cover is high there are many shrubs normally thought of as successional, such as Rubus spectabilis, scattered throughout with high cover. Stands of this association are typically broken up and contain quite open areas. I placed my plots in dense stands but that did not totally avoid the influence of these openings.

Hines (1971) defined the same community from more restricted sampling along the north coast. However, he reported that Tsuga dominated the tree canopy in all his representative plots and Picea was present in only half the plots. Kratz (1975) reported three similar

Table 14. Constancy and Cover Values for Pisi-Tshe/Gash/Blsp Association

Stratum & Species	Av. % Cover	Av. % Const.	403	404	408	413	414	415	416	419	421	422
TREE												
Picea sitchensis	69.0	100	5	80	70	70	95	90	80	70	70	60
Tsuga heterophylla	32.0	100	25	45	45	30	10	25	20	45	35	40
Thuja plicata	7.0	10	70	-	-	-	-	-	-	-	-	-
SHRUB												
Polystichum munitum	51.5	100	85	65	65	85	15	15	65	40	15	65
Gaultheria shallon	18.5	100	5	40	15	5	5	40	40	15	5	15
Rubus spectabilis	18.5	80	15	15	15	65	15	15	40	5	-	-
Menziesia ferruginea	7.0	80	5	*	15	5	15	*	15	5	5	5
Vaccinium parvifolium	6.0	60	-	-	-	5	-	5	15	5	15	15
Vaccinium membranaceum	3.5	30	15	5	15	-	-	-	-	-	-	-
Tsuga heterophylla	1.5	30	-	5	*	*	-	-	-	*	5	5
Vaccinium ovatum	4.5	20	-	40	-	-	-	-	5	-	-	-
Sambucus racemosa	1.5	10	-	-	-	15	-	-	-	-	-	-
Athyrium filix-femina	.5	10	5	*	*	*	*	-	-	*	*	*
Picea sitchensis	.5	10	-	-	-	-	-	-	-	-	-	5
Pteridium aquilinum	.5	10	-	-	-	-	-	5	*	-	-	-
HERB												
Eurynchium oreganum	17.9	100	16.6	5.3	12.5	4.9	18.4	36.8	23.5	20.5	30.9	9.4
Mosses	12.1	100	17.7	5.5	14.3	11.3	11.1	8.9	11.9	15.3	13.4	12.0
Blechnum spicant	5.9	100	13.3	8.5	2.7	3.3	7.8	2.3	7.8	.8	3.9	8.3
Plagiothecium undulatum	5.5	100	5.7	3.0	2.6	3.7	8.4	9.8	2.0	8.8	5.1	6.1
Polystichum munitum	5.0	100	5.2	1.4	2.8	17.6	1.7	2.2	8.3	2.1	3.0	5.3

Stratum & Species	Av. % Cover	Av. % Const.	403	404	408	413	414	415	416	419	421	422
Maianthemum dilatatum	3.4	90	5.0	1.8	–	.8	2.9	8.3	4.6	3.4	4.4	2.3
Gaultheria shallon	2.6	90	3.8	1.6	4.9	2.9	–	3.2	4.5	3.5	.1	1.3
Athyrium filix-femina	.6	80	1.6	.5	1.3	.8	1.3	–	–	.1	.1	.5
Oxalis oregana	6.9	70	1.4	1.8	–	2.5	6.5	–	4.3	–	15.6	37.2
Montia sibirica	2.2	70	6.5	2.0	1.1	.4	6.5	–	–	–	.8	5.0
Trillium ovatum	1.1	70	.5	–	3.8	.1	.1	1.1	4.7	–	.6	–
Menziesia ferruginea	.7	70	1.8	.3	1.7	–	–	.1	–	1.7	.1	1.1
Tsuga heterophylla	.5	60	–	.2	.3	.2	–	–	–	.1	.2	.5
Vaccinium parvifolium	.4	60	–	–	–	.5	–	.5	.6	.9	.5	.5
Luzula parviflora	.2	50	–	–	–	–	–	.5	**	.2	.5	1.1
Tiarella trifoliata	.2	50	–	–	–	–	–	.6	.6	.3	.3	.1
Vaccinium membranaceum	.6	30	2.9	1.2	1.8	–	–	–	–	–	–	–
Peltigera cannina	.4	30	–	–	–	.1	2.9	–	–	1.0	–	–
Disporum smithii	.3	30	–	–	1.3	–	–	1.0	.5	–	–	–
Galium trifidum	.2	30	–	–	1.5	.1	–	–	–	–	–	.1
Melica subulata	.2	30	.7	.5	.5	–	–	–	–	–	–	–
Streptopus amplexifolius	.1	30	.1	–	.5	.5	–	–	–	–	–	–
Vaccinium ovatum	.3	20	–	1.0	–	–	–	–	1.8	–	–	–
Cardamine angulata	.1	20	–	–	–	.5	.6	–	–	–	–	–
Rubus spectabilis	.1	20	–	.5	–	.5	–	–	–	–	–	–
Picea sitchensis	TR	20	–	–	.1	–	–	–	–	.1	–	–
Asarum caudatum	.3	10	–	–	2.5	–	–	–	–	–	–	–
Pteridium aquilinum	.2	10	–	–	–	–	–	–	1.5	–	–	–
Lysichitum americanum	.1	10	–	–	–	–	1.3	–	–	–	–	–
Chimaphila menziesii	TR	10	–	–	–	–	–	–	–	–	.8	–
Clintonia uniflora	TR	10	–	–	–	–	.1	–	–	–	–	–
Listera cordata	TR	10	–	–	–	–	–	–	–	–	.1	–
Lobaria pulmonaria	TR	10	–	–	–	–	–	.1	–	–	–	–
Pseudotsuga menziesii	TR	10	.2	–	–	–	–	–	–	–	–	–
Viola sempervirens	TR	10	.5	–	–	–	–	–	–	–	–	–

* = species occurs in a lower stratum.
** = species present in macroplot but not encountered in sub-sampling for herbs.
TR = trace (species presence is less than .1% cover).

communities from coastal Washington headlands, Picea sitchensis/ Gaultheria shallon, Picea sitchensis/Polystichum munitum and Tsuga heterophylla-Picea sitchensis/Polystichum munitum. His Picea/Gaultheria community was very near the coast and exposed to storm winds from the ocean. It contained mostly Picea seedlings and trees in the 31-61 cm d.b.h. size class; there were only an average of four trees larger than 123 cm per hectare, all Picea. This would indicate he sampled mostly younger forests which were mot as broken up by winds as mine. Kratz's Picea/Polystichum community was "...usually protected from ocean winds by a line of young trees." His Tsuga-Picea/Polystichum community was found on "...older surfaces behind the sea cliffs." It contained fewer Picea, much more Tsuga, and had a higher total basal area (182 M^2/HA) than the other two. One could interpret Hines' community as a combination of Krantz's ocean-facing, ocean-sheltered, and inland communities. My Pisi-Tshe/Gash/Blsp association is similar to Hines' in being mature or old-growth but dissimilar in having more Picea as in Krantz's Picea/Gaultheria type.

Picea sitchensis-Tsuga heterophylla/Polystichum munitum-Blechnum spicant Association

The Pisi-Tshe/Pomu-Blsp and Pisi-Tshe/Gash/Blsp associations are found together on coastal headlands. The absence of Gaultheria, the presence of Oplopanax horridum, and an increase in average cover of Polystichum (from 51.5% to 68.8%) in this type differentiates it from the Pisi-Tshe/Gash/Blsp type. Table 15 contains the constancy and cover data for the association.

Table 15. Constancy and Cover Values
For Pisi-Tshe/Pomu-Blsp Association

Stratum & Species	Av. % Cover	Av. % Const.	407	409	411	412
TREE						
Picea sitchensis	78.8	100	90	90	60	75
Tsuga heterophylla	33.8	100	30	35	40	30
SHRUB						
Polystichum munitum	68.8	100	85	40	65	85
Menziesia ferruginea	23.8	75	65	15	15	-
Rubus spectabilis	11.3	75	-	15	15	15
Athyrium filix-femina	2.5	75	-	5	5	5
Tsuga heterophylla	2.5	50	*	5	5	-
Vaccinium parvifolium	2.5	50	5	-	5	-
Oplopanax horridum	1.3	25	5	-	-	-
Sambucus racemosa	1.3	25	-	5	-	-
Vaccinium membranaceum	1.3	25	5	*	-	-
HERB						
Oxalis oregana	17.1	100	14.7	39.8	12.5	1.3
Eurynchium oreganum	9.9	100	17.8	8.8	9.8	3.0
Mosses	8.3	100	6.3	19.0	4.5	3.4
Polystichum munitum	5.6	100	3.6	2.7	3.6	12.6
Blechnum spicant	4.9	100	9.1	3.6	2.7	4.3
Plagiothecium undulatum	4.1	100	1.5	1.8	4.7	8.5
Montia sibirica	4.1	75	-	5.8	8.1	2.3
Galium trifidum	3.1	75	11.8	.6	-	.1
Stachys mexicana	.9	75	2.0	1.2	-	.5
Asarum caudatum	2.2	50	1.9	6.9	-	-
Disporum smithii	1.3	50	2.8	2.3	-	-
Menziesia ferruginea	1.3	50	1.7	3.6	-	-
Maianthemum dilatatum	1.1	50	-	3.3	-	1.0
Bromus spp.	1.0	50	.5	3.3	-	-
Cardamine angulata	.5	50	-	-	.6	1.2
Trillium ovatum	.4	50	1.1	.5	-	-
Tsuga heterophylla	.4	50	.8	.8	-	-
Picea sitchensis	.2	50	.1	.6	-	-
Vaccinium membranaceum	.2	50	.1	.7	-	-
Thalictrum occidentale	.7	25	-	2.8	-	-
Tiarella trifoliata	.5	25	-	1.9	-	-
Athyrium filix-femina	.3	25	-	-	1.2	-
Lysichitum americanum	.3	25	-	-	1.3	-

Stratum & Species	Av. % Cover	Av. % Const.	407	409	411	412
Rubus spectabilis	.2	25	-	.6	-	-
Anthoceros spp.	.1	25	-	-	.5	-
Listera cordata	.1	25	.5	-	-	-
Peltigera cannina	.1	25	-	-	.5	-
Rubus ursinus	.1	25	.5	-	-	-
Gaultheria shallon	TR	25	.1	-	-	-
Hydrophyllum tenuipes	TR	25	-	-	-	.1

* = species occurs in a lower stratum.
TR = trace (species presence is less than .1% cover).

Kratz's (1975) Picea/Polystichum and Tsuga-Picea/Polystichum are the most similar previously described communities.

Figures 18 and 19 show examples of typical large old-growth from various SSZ communities.

Other Sitka Spruce Zone and
True Fir Zone Communities

Appendix 8 presents data on other SSZ and TFZ communities. The Tsuga heterophylla-(Abies amabilis)/Vaccinium alaskaense community is a truncated relict TFZ community found at the summit of Saddle Mountain. Abies amabilis is present in the herb and shrub strata and could be expected to increase in importance with time. However the elevation (920 M) is low enough that there is some question as to whether Abies will come to express the same dominance in the tree stratum here as it does in similar communities elsewhere. This type is not quite comparable to any of the Abies amabilis containing communities that Hines (1971) reported from the north coastal region. The community is relatively species rich, but fails to compare very well with any of Dyrness, Franklin, and Moir's (1974) communities.

The Tsuga heterophylla-Pseudotsuga menziesii-Chamaecyparis lawsoniana-Picea sitchensis/Polystichum munitum-Eurynchium oreganum-Oxalis oregana-Plagiothecium undulatum community is near Charleston on Coos Bay. As in the case of the Tshe-Chla/Pomu-Oxor type, this community is like a widespread association, differing by the addition of Chamaecyparis and a few other south Coast Range species. The stand did

Figure 18. Large Thuja plicata (230 cm. above butt swell) in Plot 403 (left)
And Large Picea sitchensis (210 cm. d.b.h.) in Plot 404 (right)
Survey Pin on Tree is Divided into 2.54 cm. Segments

Figure 19. Large Pseudotsuga menziesii (165 cm. d.b.h.) With Charred Bark from the Florence Fire, Plot 402 Survey Pin on Tree is Divided into 2.54 cm. Segments

not strictly qualify as old-growth; it appeared to be about 100 years old. However, it was the oldest, least disturbed sample of the type I could find.

Another plot not strictly old-growth was plot 420, Elsie mixed. The oldest age class was 125 years (1975). I took this sample because it was an intriguing mixture, near three zone boundaries, of SSZ, TFZ, and WHZ elements. Its strongest affinities are with the SSZ zone. It appears to have experienced some partial burning in the past few decades and this may help explain its mixed nature.

Plot 417, Rockaway Swamp, occurred in a large coastal _Thuja_-_Tsuga_-_Picea_ swamp. It contains the classic candelabra growth form _Thuja_, and a very deep uneven organic litter accumulation. It would fit nicely into the Pisi-Tshe/Pomu-Blsp association except that _Polystichum_ is absent.

SIMORD Analysis

Figures 20 and 21 present SIMORD computer runs with endstands specified and computer chosen respectively. In both figures endstand plots are numbered.

In Figure 20 the distribution of plots on the coordinate axes crowds up toward the top and right endstands. Plot 217, assigned to the Tshe/Pomu-Oxor association and even though representative of the Western Hemlock Zone, provided poor spread or differentiation of all plots as an endstand. This indicates that WHZ and SSZ have close affinities but are relatively distinct from VMZ and TFZ communities.

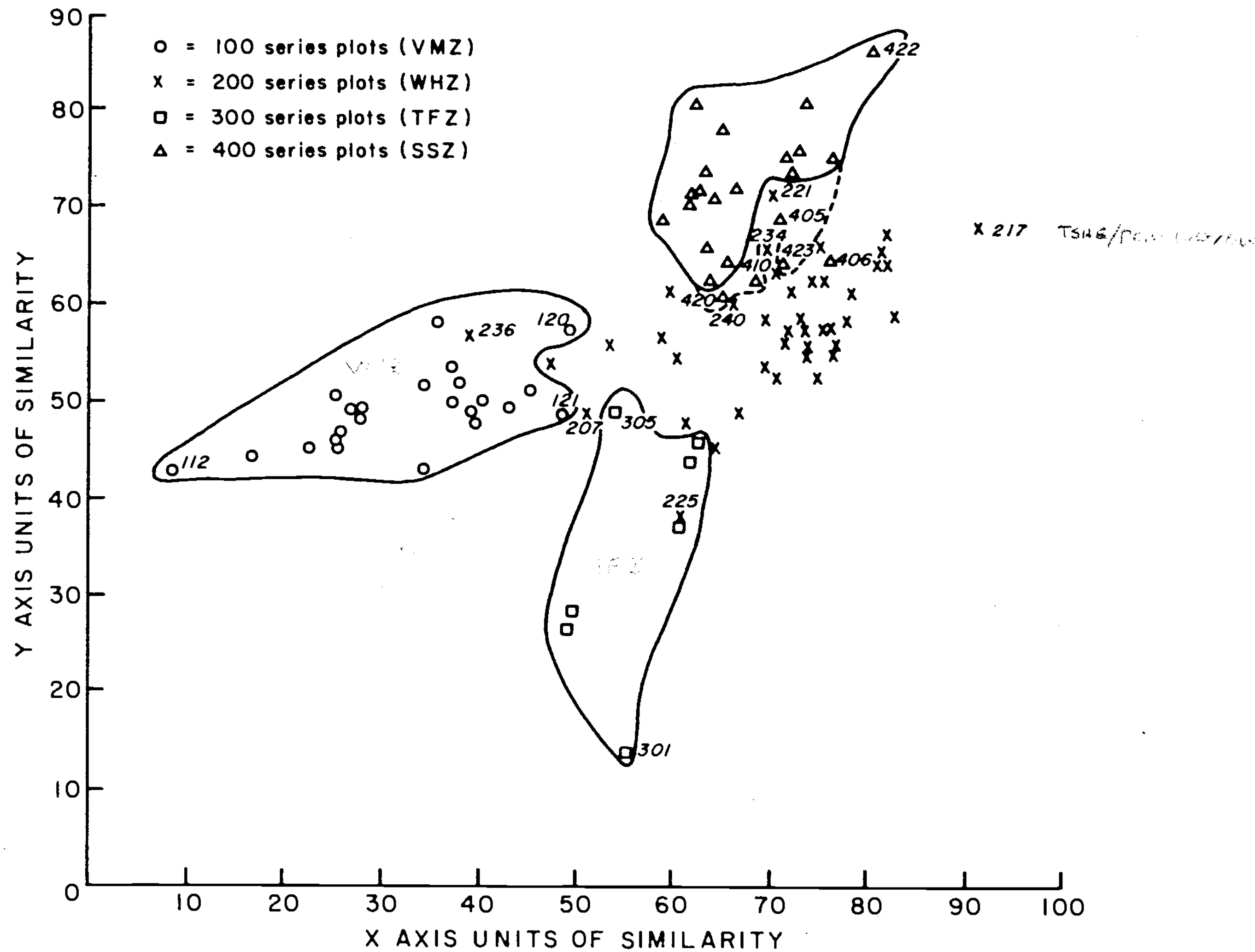


Figure 20. Similarity Ordination of 94 Old-Growth Stands Based upon Canopy Coverage of 60 Trees, Shrubs, and Herbs with Endstands Specified.

Also in Figure 20 there are several interesting patterns (locations) of transition plots. Plots 221, 234, and 410, assigned to the Tshe-Psme-(Pisi)/Gash/Euor-Plun association, occupy an area between the main body of WHZ and SSZ plots. Plots 405, 406, and 423, representative of the Tshe-Psme-Pisi/Pomu-Euor-Oxor-Plun association, are in a similar position but more to the upper right of the gradient field. In both cases a line drawn to encircle all 400 series (SSZ) plots is either too serpentine to be clear or will exclude some plots (dashed line Figure 20). Likewise, the line around all 300 series (TFZ) plots includes plot 225, which was located high on Monmouth Peak.

In Figure 21, by contrast, the computer chosen endstands have produced maximum spread of the plots on the gradient field. Lines drawn to enclose the main body of 100, 200, 300, and 400 series plots are distinct with the adjustments for transition plots noted previously. However, two endstands, 105 and 109, are from the same zone. This emphasizes the distinctiveness of plots from the far southern Valley-Margin Zone which include species characteristic of the Siskiyou mountains. A generalized environmental interpretation can be made of this pattern also. There are four basic characterizations which correspond to the four zones. The Valley-Margin Zone portion of the field is warm and dry; the True Fir Zone, cold; the Sitka Spruce Zone, wet; and the Western Hemlock Zone occupies intermediate positions (environments).

The next logical question is, do the communities and associations occupy distinct portions of the field? One would expect them to if they

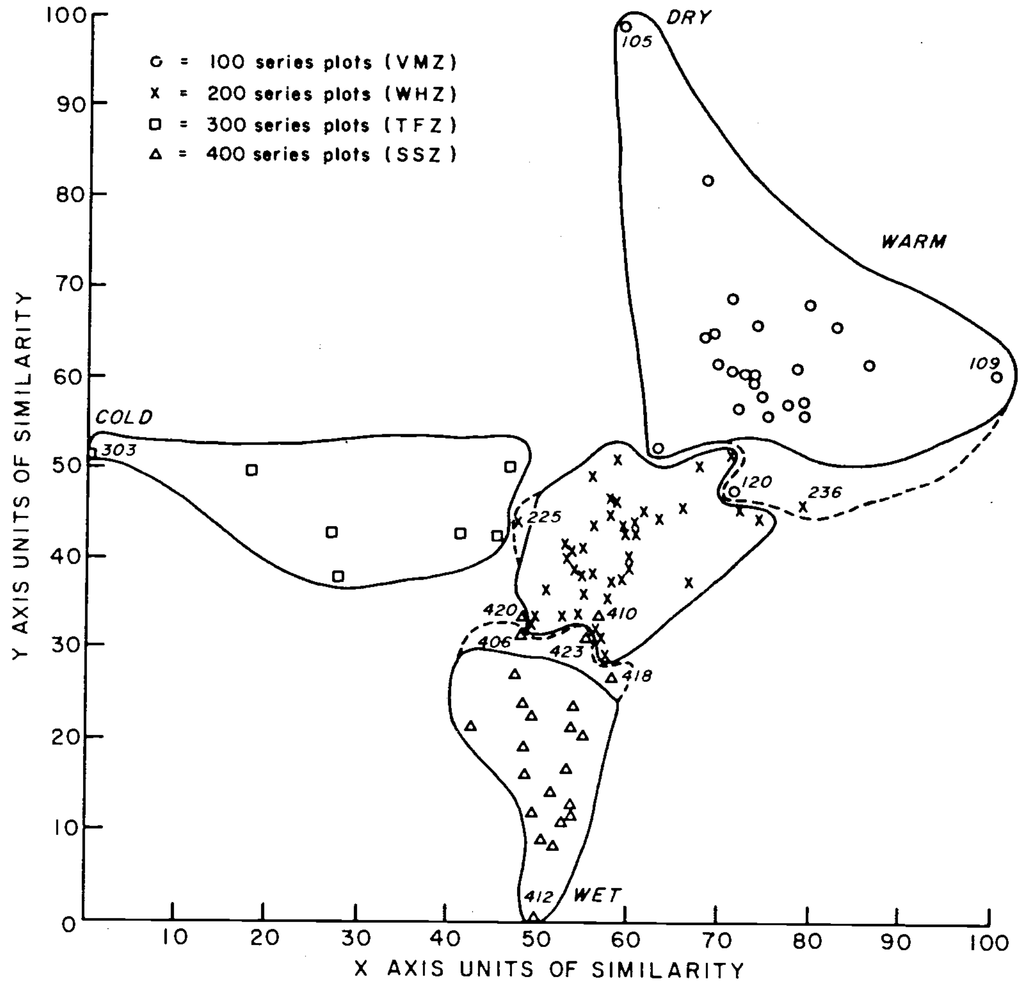


Figure 21. Similarity Ordination of 94 Old-Growth Stands Based upon Canopy Coverage of 60 Trees, Shrubs, and Herbs with Endstands Computer Chosen.

indeed are compositionally and structurally identifiable. Figures 22, 23, and 24 demonstrate that the communities are notably distinct, particularly considering that the SIMORD technique was designed to emphasize the continuous nature of change from plot to plot. In Figure 22 the same endstands (user specified) as in Figure 20 form the scatter plot; the run allows clear differentiation of VMZ and TFZ communities. In Figure 23 the run using computer chosen endstands clearly differentiates the SSZ and TFZ communities. In neither case were WHZ communities unambiguously assignable to distinct portions of the field. A separate run with endstands specified was needed as seen in Figure 24. Despite a separate run for WHZ plots and the specification of quite different endstands, the plots remain relatively closely grouped, illustrating the affinities of WHZ plots for one another. All plots assigned to the Western Hemlock Zone are labeled; the bottom plots which are associated with endstand 418 were assigned to the Sitka Spruce Zone. Only in the case of the Tshe/Rhma-Gash and Tshe/Acci-Gash communities are plots divided by an intervening community. Plot 224 has been singled out to show its affinities with the VMZ-transition Psme-(Tshe)/Coco type. It was actually a seepage moist pocket in the Valley-Margin Zone very near the WHZ border. The plot was oriented such that it included a portion of the non-subirrigated upland.

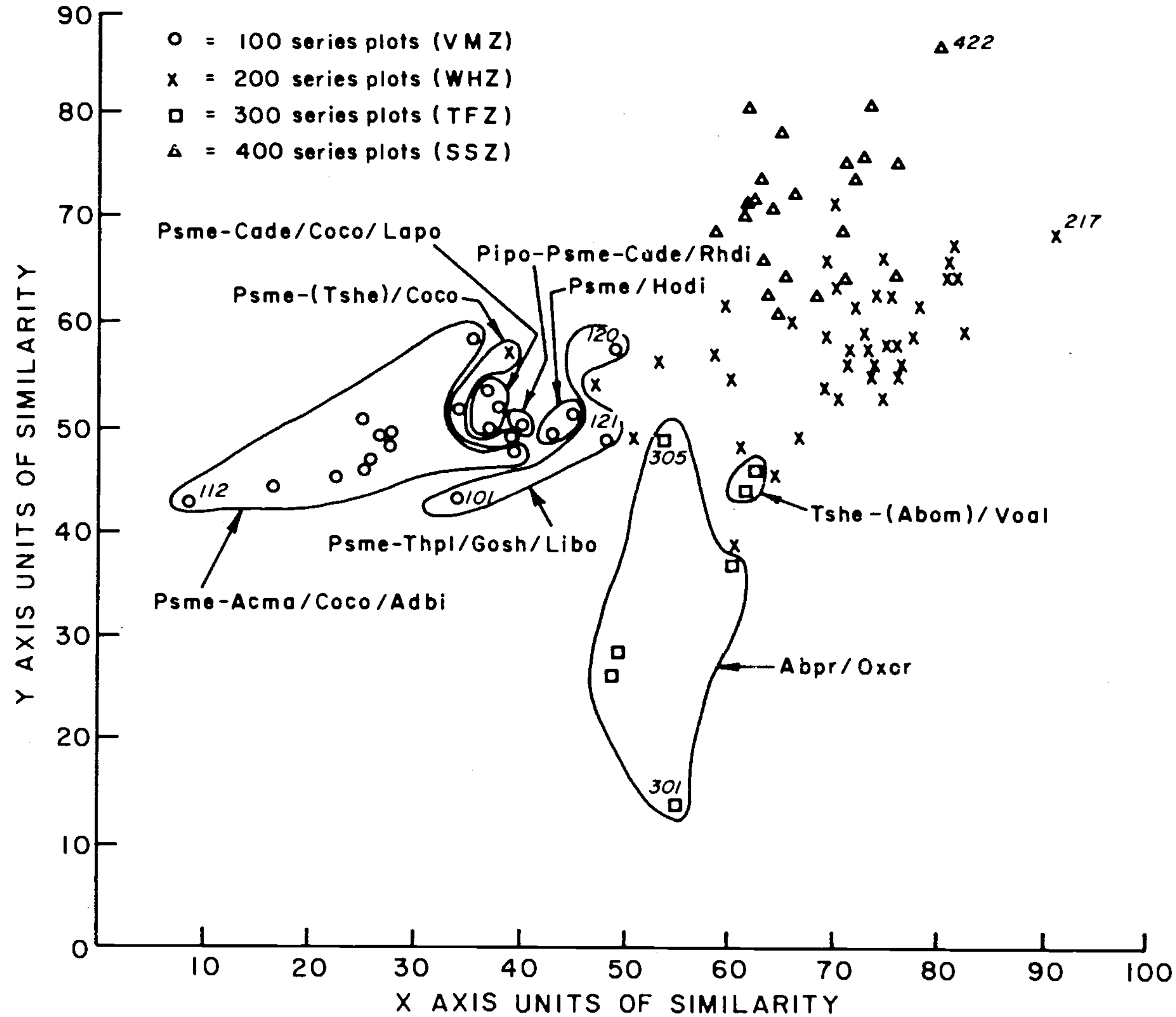


Figure 22. Similarity Ordination as in Figure 20 with VMZ and TFZ Communities Identified.

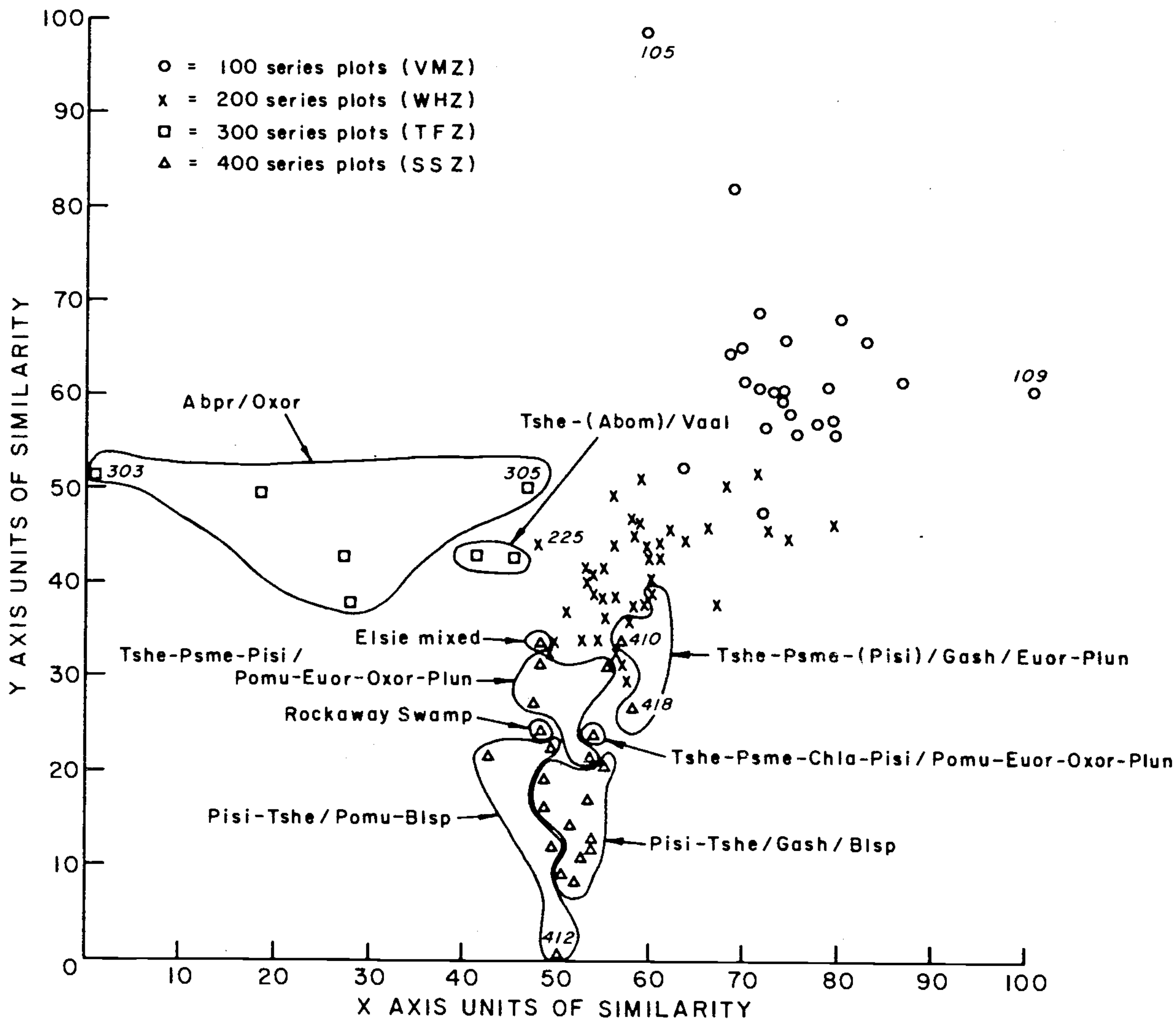


Figure 23. Similarity Ordination as in Figure 21 with SSZ and TFZ Communities Identified.

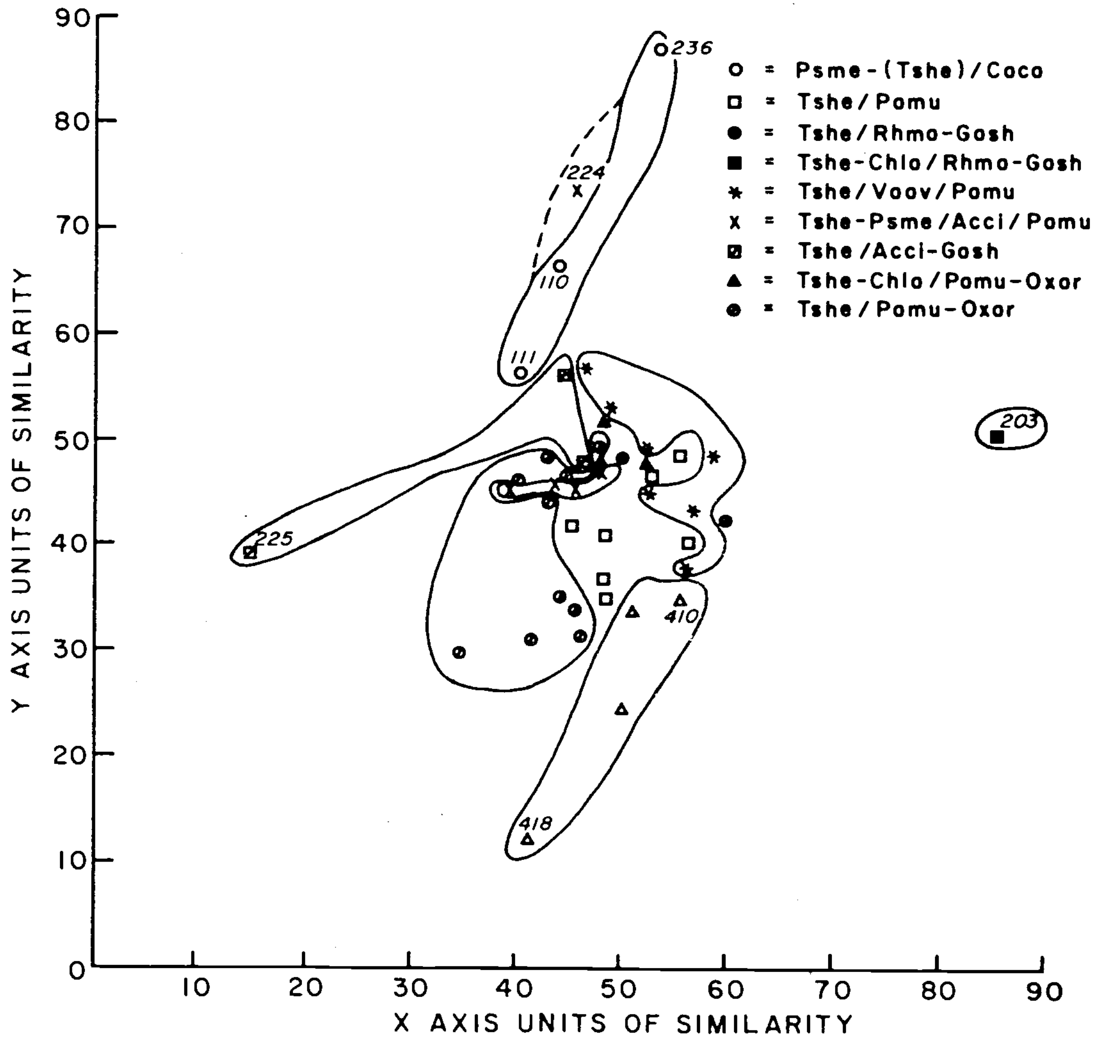


Figure 24. Similarity Ordination of 45 WHZ and Transition Stands with Endstands Specified and Communities Identified.

Structure

Differences in Species Richness, Cover, Stocking and Basal Area Among the Zones

Table 16 presents data by stratum on species richness, cover, and density for major associations representative of the four zones. All values are derived from 15 x 25 M plot data. Several interesting patterns are present.

Tree species richness is highest in the Psme-Acma/Coco/Adbi association and lowest in the Abpr/Oxor and Pisi-Tshe/Gash/Blsp associations. All three are homogeneous types representative of their respective zones. Within the Western Hemlock Zone richness is low in the Tshe/Pomu but high in the Tshe-Psme/Acci/Pomu type. Both are, again, homogeneous. However, richness increases greatly in the Tshe/Vaov-Pomu type, which is often found on rocky open spur ridges in the south Coast Range, and in the Tshe/Pomu-Oxor type, which can be very irregularly distributed because of the spotty effects of seepage areas. Average species per plot show no departures from these trends.

Tree cover values show that the VMZ, SSZ, and TFZ types have less canopy closure than the Tshe/Pomu and Tshe/Pomu-Oxor associations. The Tshe/Vaov/Pomu type is less completely closed due to the effects of large boulders in some plots; the Tshe-Psme/Acci-Pomu type is less closed than other WHZ types because of a greater mean inter-tree distance correlated with its occurrence on steep gravelly slopes.

Table 16. Species Richness, Cover, and Density by Stratum for Major Associations, 15 X 25 M Plot Data

Association	Number of plots sampled	Tree Stratum: Total species/assoc.	Tree Stratum: Average species/plot	Tree Stratum: Average actual % cover	Tree Stratum: No. trees (>5 cm)/HA	Tree Stratum: No. trees (>5 cm)/HA excluding "shrub growth form" species	Shrub Stratum: Total vascular species/association	Shrub Stratum: Average species/plot	Shrub Stratum: Average accumulative shrub cover/plot	Shrub Stratum: Average accumulative shrub cover/plot excluding Pomu	Shrub Stratum: Number shrub stems/M^2	Shrub Stratum: Number shrub stems/M^2 excluding Pomu	Herb Stratum: Total vascular species/association	Herb Stratum: Average species/plot#	Herb Stratum: Average accumulative herb cover/plot	Herb Stratum: Average accumulative lichen-bryophyte cover/plot	Herb Stratum: Average species/plot*#
VALLEY-MARGIN ZONE																	
Psme-Acma/ Coco/Adbi	11	9	4.0	116.0	458.2	385.5	20	8.6	131.1	106.6	7.95	3.78	62	23.4	52.5	26.7	29.1
WESTERN HEMLOCK ZONE																	
Tshe-Psme/ Acci/Pomu	5	7	4.0	113.0	624.0	384.0	12	5.8	128.0	61.0	7.94	0.82	48	20.2	38.3	28.4	24.0
Tshe/Pomu	7	3	2.3	130.0	438.1	438.1	8	5.3	60.0	33.6	5.36	1.40	34	15.9	16.1	54.9	18.0
Tshe/Vaov/ Pomu	7	8	3.7	107.8	419.0	419.0	16	7.0	112.7	56.3	8.51	1.40	43	18.3	35.9	39.6	24.0
Tshe/Pomu- Oxor	10	7	3.0	130.5	336.0	333.3	13	5.3	106.6	45.1	9.29	1.34	52	19.2	46.9	36.7	22.3
TRUE FIR ZONE																	
Abpr/Oxor	5	3	1.6	96.0	216.3	216.3	5	1.6	12.0	9.0	0.02	0.02	41	19.0	86.2	5.1	19.6
SITKA SPRUCE ZONE																	
Pisi-Tshe/ Gash/Blsp	10	3	2.1	108.0	241.3	241.3	12	5.4	114.0	62.5	9.23	1.54	30	16.0	32.2	35.9	18.5

* Species counted only once per plot even if present in all strata.
\# Includes mosses, lichens, and liverworts listed in Appendix 1.

Tree density values show that the Abpr/Oxor and Pisi-Tshe/Gash/Blsp associations have relatively low numbers of trees per hectare. The Psme-Acma/Coco/Adbi and Tshe-Psme/Acci/Pomu types have high numbers when "shrub" growth form species are counted but only moderate numbers otherwise. The Tshe/Pomu-Oxor type has moderately low numbers due to its often undisturbed condition. The high values of the Tshe/Pomu and Tshe/Vaov/Pomu types reflect great amounts of Tsuga reproduction.

In the shrub stratum the Psme-Acma/Coco/Adbi and Tshe/Vaov/Pomu associations clearly have the largest numbers of shrubs and shrubs per plot. Interestingly the Pisi-Tshe/Gash/Blsp association reverses its tree stratum trend toward low numbers and exhibits moderately high numbers of shrubs. Otherwise the trends noted for the tree stratum apply.

Shrub cover and density values are reported with and without Polystichum. The high shrub cover and density of the Psme-Acma/Coco/Adbi association is unrivaled as is the low cover and density of the Abpr/Oxor association. The apparently high values of the Tshe/Pomu and Tshe/Pomu-Oxor types evaporate when the contribution of Polystichum is removed. The former would be lower yet, but for the contribution of Tsuga reproduction. The shrub cover values without Polystichum of the Tshe-Psme/Acci/Pomu association are still high even though the shrub density values are low. This can be explained by the shading effects of large Acer circinatum which have few but large stems. The values without Polystichum of the Tshe/Vaov/Pomu type are not due to the effects of Tsuga reproduction, which can be quite low there, but the great number of different shrub species mentioned previously.

In the herb stratum the Psme-Acma/Coco/Adbi type has, again, far and away the highest total number of herbs and herbs per plot with a moderately high herb cover but moderately low lichen-bryophyte cover. The Pisi-Tshe/Gash/Blsp association, by contrast, has the lowest herb species total and species per plot, and a low herb cover. However its lichen-bryophyte cover is high. Also notable is the reversal of the tree and shrub strata trends for the Abpr/Oxor association. Herb cover is very high even though lichen-bryophyte cover is low, and herb numbers and herbs per plot are relatively high. This is due to the reappearance of several VMZ herbs, absent in WHZ plots, in this association. The heterogeneous nature of Tshe/Pomu-Oxor plots is again responsible for high herb numbers and cover. The extremely dense shading of many Tshe/Pomu plots is responsible for the very low herb cover; this is partially offset by the highest lichen-bryophyte cover value.

Table 17 shows the tree stocking and basal area levels derived from 15 x 25 M plot data. Basal area values are expressed as a percent of the plot in tree surface, which is 1/100 of the square meter per hectare value. It is important to note that these numbers have comparative value only because they represent the old-growth condition when the highest basal area and lowest tree stocking will occur. There are obviously a virtually unlimited number of lower basal area and higher stocking values possible in a stand depending upon its degree of disturbance or length of time since origin if it is not old-growth.

Table 17. Average Stocking and Basal Area of Trees (>5 cm d.b.h.), 15 X 25 M Plot Data

Zone and Community	No. of Plots	% of Plot in Basal Area (M^2/HA x 10^{-2})	No. Psme/HA	No. Tshe/HA	No. Abpr/HA	No. Pisi/HA
VALLEY-MARGIN ZONE						
Psme-Acma/Coco/Adbi	11	1.366	113.9	–	–	–
Psme-Cade/Coco/Lapo	3	1.953	257.8			
Psme (Tshe)/Coco	3	1.761	133.3	26.7	–	–
WESTERN HEMLOCK ZONE						
Tshe-Psme/Acci/Pomu	5	2.161	85.3	86.7*	–	–
Tshe/Pomu	7	2.446	110.5	304.8	–	–
Tshe/Vaov/Pomu	7	1.743	87.6	217.1	–	–
Tshe/Pomu-Oxor	10	2.331	74.7	210.7	–	–
Tshe-Chla/Pomu-Oxor	3	3.942	88.9	266.7	–	–
TRUE FIR ZONE						
Abpr/Oxor	5	1.393	10.7	90.7	245.3	–
SITKA SPRUCE ZONE						
Tshe-Psme (Pisi)/ Gash/Euor-Plun	4	1.874	93.3	233.3	–	13.3
Tshe-Psme-Pisi/Pomu- Euor-Oxor-Plun	4	2.046	80.0	146.7	–	26.7
Pisi-Tshe/Gash/Blsp	10	2.021	–	234.7	–	53.3
Pisi-Tshe/Pomu-Blsp	4	1.475	–	220.0	–	86.7

*excluding one atypical plot burned within the last 45 years.

The TFZ and VMZ plots can be seen to have low basal area values. SSZ plots have higher values but WHZ plots have the highest basal areas.

The density of *Pseudotsuga* is highest in VMZ communities. It is barely present in the Abpr/Oxor association and absent altogether from the *Picea* dominated SSZ associations. Moderate values, usually just below 100 per hectare have been calculated for *Pseudotsuga* in WHZ and inland SSZ associations. *Tsuga* densities can be seen to be low in the transitional Psme (Tshe)/Coco type, and increase somewhat in the Tshe-Psme/Acci/Pomu association. Values for other WHZ and SSZ associations are mostly between two and three hundred per hectare. *Picea sitchensis* numbers are comparable to WHZ *Pseudotsuga* values.

A model of a typical stand structure, characteristic of each zone, emerges from an integrated synthesis of these structural data. VMZ stands are species rich in all strata but particularly in the herb and shrub strata. Tree cover is relatively low, but tree density is relatively high. Shrub cover and density are both exceptionally high. Herb cover is high but lichen-bryophyte cover is moderately low. WHZ stands are low in tree, shrub, and herb richness except for the drier Tshe-Psme/Acci/Pomu type or associations with diverse microsites. Tree cover is very high except in the Tshe/Vaov/Pomu type where stands are sometimes associated with bouldery spur ridges. Shrub cover is moderate, often made up mostly of *Polystichum* and *Tsuga* reproduction. Lichen-bryophyte cover is moderate to very high, inversely proportional to herb cover. Herb species richness is great only when there are diverse microsites. TFZ stands have low tree species richness, cover, and density. The shrub stratum is poorly developed especially in the Abpr/Oxor type. Other communities of this zone may differ in this characteristic somewhat. Herb richness and cover are high, with some VMZ species present. SSZ stands have high tree basal area, low density and richness. Shrub richness, density, and cover are relatively high. Herb richness is low and herb cover exceeded by lichens and bryophytes.

A pertinent question at this point would be, how close are the tree data from plot samples, extrapolated to per hectare values, to what one would find on an actual hectare? The basal area values indicate a problem. Anderson (1967) reported a basal area of 92.13 square meters per hectare for his Corylus-Bromus (a VMZ type), and 85.54 for his Polystichum-Oxalis type. Even allowing for somewhat higher basal area for plots taken in true old-growth only, my values are too high. There is wide disagreement in the literature on tree density values for the same association. For example, Anderson (1967) reports 217 Pseudotsuga and 118 Tsuga per hectare; Bailey (1966) 112 and 1811, respectively; and Hines (1971) 40 and 372, respectively, all from the Tsuga/Polystichum-Oxalis community.

Tables 18, 21, 24, and 26 present stocking level values for full hectare tallies done in each of the zones, and Tables 19, 20, 22, 23, 25, and 27-29, the basal area values. A somewhat different picture than in Tables 16 and 17 emerges from these data. In the Valley-Margin Zone, the MacDonald Forest and Little Sink tallies were taken in similar portions of the two stands, areas of the Psme-Acma/Coco/Adbi association. The totals of Pseudotsuga in Table 18 can be seen to vary widely from quarter hectare to quarter hectare. The values of Acer macrophyllum in the two stands are more stable and comparable. "Shrub" growth form species can make a very large contribution in some quarter hectares. The total number of trees is very much lower in the MacDonald Forest tally than in the 15 x 25 M plot data for the association. Little Sink had extremely high numbers of Cornus nuttallii.

The basal area values in Tables 19 and 20 total 73.48 and 80.48 square meters per hectare while the 15 x 25 M plot figure is nearly twice as high, 136.6 square meters per hectare. Interestingly, the plot data previously reported (in the section on Composition) that Pseudotsuga represented 89.04% of tree basal area; the figure for MacDonald Forest and Little Sink hectare tallies is 88.72%. Acer macrophyllum represents a steady six to ten percent of basal area in the quarter hectares.

The Mary's Peak Watershed hectare tally, taken in the Psme (Tshe)/ Coco association shows, in Table 18, steady numbers of Pseudotsuga in the quarter hectares. No other species of tree comes close to the numbers of Pseudotsuga present, although large Acer circinatum can be locally abundant. The basal area figures in Table 19 are high, totaling nearly 100 square meters per hectare. Pseudotsuga is a steady and overwhelming 98% of the total.

Table 21 presents stocking level data for three superlative old-growth WHZ stands. The 15 x 25 M plot data for all WHZ associations

Table 18. Stocking Density of Trees (> 5 cm. d.b.h.) For Valley-Margin Zone Quarter Hectare Tallies

		Mary's Peak Watershed					MacDonald Forest					Little Sink RNA				
	Species	101T	102T	103T	104T	Σ	105T	106T	107T	108T	Σ	109T	110T	111T	112T	Σ
"Tree" Growth Form Species	Psme	54	42	59	57	212	16	13	15	30	74	71	42	33	21	167
	Acma	2	–	–	–	2	15	17	6	16	54	17	21	15	8	61
	Abgr	9	3	5	1	18	9	1	10	24	44	18	8	2	1	29
	Conu	–	11	5	–	16	–	–	3	5	8	23	30	46	23	122
	Alru	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
	Tabr	1	1	–	3	5	–	–	–	–	–	3	2	13	19	37
	Arme	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
	Cach	1	1	1	1	4	–	–	–	–	–	–	–	–	–	–
	Tshe	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–
	Quga	–	–	–	–	–	–	–	–	2	2	–	–	–	–	–
Total Tree Growth Form		67	58	71	62	258	40	31	34	77	182	133	103	109	73	418
"Shrub" Growth Form Species	Hodi	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
	Acci	15	32	43	15	105	–	–	–	–	–	–	–	–	–	–
	Amal	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2
	Coco	–	–	1	–	1	1	4	7	56	68	1	–	1	–	2
TOTAL		82	90	115	77	364	41	35	41	133	250	134	103	113	73	423

Table 19. Basal Area (sq.M./Ha.) and Percent of Total Basal Area By Species in 1/4 Hectare Tallies

Valley Margin Zone--Mary's Peak Watershed

	101T		102T		103T		104T	
Species	Basal Area	%	Basal Area	%	Basal Area	%	Basal Area	%
Psme	113.65	98.72	91.25	97.84	117.91	98.85	67.95	98.66
Acma	.03	.02						
Abgr	.70	.61	.64	.69	.12	.10	.06	.08
Conu		.43	.46	.34	.29			
Acci	.41	.36	.71	.76	.66	.55	.20	.29
Tabr	.11	.09	.09	.10			.56	.82
Coco					.01	.01		
Cach	.22	.20	.14	.15	.05	.04	.10	.15
Tshe					.19	.16		
Sum	115.12	100.00	93.26	100.00	119.28	100.00	68.87	100.00
Mean Basal Area for all four plots: $\bar{x}$ = 99.13								

Valley Margin Zone--MacDonald Forest

	105T		106T		107T		108T	
Species	Basal Area	%	Basal Area	%	Basal Area	%	Basal Area	%
Psme	71.17	89.95	72.77	89.27	45.03	91.29	97.62	87.20
Acma	6.98	8.82	8.66	10.63	2.69	5.46	7.40	6.61
Abgr	.96	1.22	.06	.07	1.16	2.34	5.86	5.23
Conu					.34	.69	.09	.09
Coco	.01	.01	.02	.03	.11	.22	.74	.66
Quga							.23	.21
Sum	79.12	100.00	81.51	100.00	49.33	100.00	111.94	100.00
Mean Basal Area for all four plots: $\bar{x}$ = 80.48								

Table 20. Basal Area (sq.M./Ha.) and Percent of Total Basal Area By Species in 1/4 Hectare Tallies

Valley Margin Zone--Little Sink Research Natural Area

	109T		110T		111T		112T	
Species	Basal Area	%	Basal Area	%	Basal Area	%	Basal Area	%
Psme	64.03	87.75	73.78	90.61	63.00	86.78	58.14	86.89
Acma	7.26	9.94	6.42	7.88	6.04	8.32	4.44	6.64
Abgr	.42	.58	.17	.21	.05	.07	.01	.01
Conu	.88	1.21	1.01	1.24	2.01	2.77	1.79	2.68
Tabr	.11	.16	.05	.06	1.24	1.71	2.31	3.45
Coco	.01	.01			.01	.01		
Hodi					.01	.01		
Arme	.26	.35						
Amal					.24	.33		
Alru							.22	.33
Sum	72.97	100.00	81.43	100.00	72.60	100.00	66.91	100.00
Mean Basal Area for all four plots: $\bar{x}$ = 73.48								

Table 21. Stocking Density of Trees (>5 cm. d.b.h.)
For Western Hemlock Zone Quarter Hectare Tallies

		Upper Camp Creek					Taylor Butte					Elliott State Forest Bench				
	Species	201T	202T	203T	204T	Σ	205T	206T	207T	208T	Σ	209T	210T	211T	212T	Σ
"Tree" Growth Form Species	Psme	5	13	10	8	36	7	13	5	12	37	12	7	14	12	45
	Tshe	45	93	104	120	362	44	30	45	46	165	93	51	35	33	212
	Thpl	-	-	-	-	-	-	-	2	-	2	5	2	1	1	9
	Alru	-	-	-	-	-	-	-	-	-	-	7	-	2	4	13
	Acma	-	-	-	-	-	-	-	-	-	-	-	3	1	-	4
Total Tree Growth Form		50	106	114	128	398	51	43	52	58	204	117	63	53	50	283
"Shrub" Growth Form Species	Rhma	-	5	65	46	116	-	-	-	-	-	1	11	4	-	16
	Acci	-	-	-	-	-	-	4	5	3	12	1	21	22	34	78
	Coco	-	-	-	-	-	-	-	-	-	-	9	-	7	-	16
	Vaov	-	-	-	-	-	-	-	-	-	-	4	2	1	-	7
	Rhpu	-	-	-	-	-	-	-	-	-	-	2	1	3	-	6
TOTAL		50	111	179	174	514	51	47	57	61	216	134	98	90	84	406

total above 300 trees per hectare. Taylor Butte and Elliott Forest Bench (excluding "shrub" growth form species) have fewer than 300. Plot data in Table 17 indicate more than 75 Pseudotsuga per hectare in all associations; all three hectare tallies have under 50 Pseudotsuga per hectare. Tsuga reproduction can be very dense and the plot and tally values are roughly comparable.

Tables 22 and 23 show that WHZ basal area totals are often near 100 square meters per hectare; if the whole hectare is below 100 it is due to certain quarter hectares falling far short and within which Tsuga basal area begins to approach that of Pseudotsuga. The 15 x 25 M plot data had values above 200 square meters per hectare for all but one association.

Table 24 contains stocking data for Mary's Peak Summit, representative of the Abpr/Oxor association, and Saddleback Mountain, an Abies amabilis-Tsuga heterophylla stand. In the Mary's Peak Summit tally Abies procera overwhelmingly dominates; on Saddleback Mountain Abies amabilis and Tsuga heterophylla trade dominance in different quarter hectares. Table 25 shows that this is the case for basal area values also. The basal area totals are comparable to VMZ values, and nearly half the value of the 15 x 25 M plot extrapolations.

Table 26 represents the stocking densities at Cascade Head and Cape Lookout, both in the Pisi-Tshe/Gash/Blsp association, and at Schofield Ridge in the Tshe-Psme-Pisi/Pomu-Euor-Oxor-Plun type. Picea sitchensis has under 50 trees per hectare, irregularly distributed among quarter

Table 22. Basal Area (sq.M./Ha.) and Percent of Total Basal Area By Species in 1/4 Hectare Tallies

Western Hemlock Zone--Upper Camp Creek

	201T		202T		203T		204T	
Species	Basal Area	%	Basal Area	%	Basal Area	%	Basal Area	%
Psme	25.33	46.09	69.59	67.40	45.80	67.85	39.70	65.19
Tshe	29.63	53.91	33.56	32.51	21.00	31.11	20.70	33.99
Rhma			.09	.09	.70	1.04	.50	.82
Sum	54.96	100.00	103.24	100.00	67.50	100.00	60.90	100.00
Mean Basal Area for all four plots: $\bar{x}$ = 71.65								

Western Hemlock Zone--Taylor Butte

	205T		206T		207T		208T	
Species	Basal Area	%	Basal Area	%	Basal Area	%	Basal Area	%
Psme	37.39	46.45	105.49	79.34	31.25	49.46	76.94	69.54
Tshe	43.09	53.55	27.37	20.59	29.24	46.27	33.64	30.40
Acci			.09	.07	.12	.19	.07	.06
Thpl					2.58	4.08		
Sum	80.48	100.00	132.95	100.00	63.19	100.00	110.65	100.00
Mean Basal Area for all four plots: $\bar{x}$ = 96.82								

Table 23. Basal Area (sq.M./Ha.) and Percent of Total Basal Area By Species in 1/4 Hectare Tallies

Western Hemlock Zone--Elliott State Forest Bench

	209T		210T		211T		212T	
Species	Basal Area	%	Basal Area	%	Basal Area	%	Basal Area	%
Psme	46.30	49.66	51.20	63.59	65.50	66.50	71.30	66.32
Tshe	38.30	41.07	21.00	26.08	28.80	29.24	21.40	19.91
Acma			2.15	2.67	1.06	1.08		
Acci	.04	.04	.48	.60	.40	.40	1.22	1.12
Coco	.12	.13			.08	.08		
Alru	2.00	2.14			.52	.53	3.85	3.53
Thpl	6.40	6.86	5.40	6.71	2.01	2.04	9.84	9.12
Rhma	.02	.02	.23	.29	.07	.07		
Vaov	.04	.04	.02	.02	.01	.01		
Rhpu	.04	.04	.03	.04	.05	.05		
Sum	93.26	100.00	80.51	100.00	98.50	100.00	107.59	100.00
Mean Basal Area for all four plots: $\bar{x}$ = 94.97								

Table 24. Stocking Density of Trees ($>$ 5 cm. d.b.h.) For True Fir Zone Quarter Hectare Tallies

	Mary's Peak Summit					Saddleback Mountain				
Species	301T	302T	303T	304T	Σ	305T	306T	307T	308T	Σ
Abpr	100	51	57	43	251	-	-	-	-	-
Tshe	3	1	1	-	5	66	40	39	41	186
Abam	-	-	-	-	-	19	82	29	85	215
TOTAL	103	52	58	43	256	85	122	68	126	401

Table 25. Basal Area (sq.M./Ha.) and Percent of Total Basal Area By Species in 1/4 Hectare Tallies

True Fir Zone

Mary's Peak Summit

	301T		302T		303T		304T	
Species	Basal Area	%	Basal Area	%	Basal Area	%	Basal Area	%
Abpr	81.85	98.38	78.02	98.96	90.70	99.34	77.10	100.00
Tshe	1.35	1.62	.82	1.04	.60	.66		
Sum	83.20	100.00	78.84	100.00	91.30	100.00	77.10	100.00

Mean Basal Area for all four plots: $\bar{x}$ = 82.61

Saddleback Mountain

	305T		306T		307T		308T	
Species	Basal Area	%	Basal Area	%	Basal Area	%	Basal Area	%
Tshe	37.90	52.10	49.50	64.60	22.60	27.40	43.20	60.30
Abam	34.80	47.90	27.10	35.40	60.00	72.60	28.50	39.70
Sum	72.70	100.00	76.60	100.00	82.60	100.00	71.70	100.00

Mean Basal Area for all four plots: $\bar{x}$ = 75.90

Table 26. Stocking Density of Trees (> 5 cm. d.b.h.) for Sitka Spruce Zone Quarter Hectare Tallies

		Schofield Ridge					Cascade Head					Cape Lookout				
	Species	401T	402T	403T	404T	Σ	405T	406T	407T	408T	Σ	409T	410T	411T	412T	Σ
"Tree" Growth Form Species	Pisi	1	6	4	1	12	9	16	8	15	48	7	22	6	2	37
	Tshe	5	7	7	4	23	39	38	31	26	134	38	29	52	45	164
	Psme	25	17	15	12	69	–	–	–	–	–	–	–	–	–	–
	Thpl	16	20	18	20	74	–	–	–	–	–	–	–	–	–	–
	Alru	9	–	–	–	9	–	1	3	–	4	–	1	3	–	4
	Umca	10	5	1	4	20	–	–	–	–	–	–	–	–	–	–
	Acma	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–
Total Tree Growth Form		66	55	46	41	208	48	55	42	41	186	45	52	61	47	205
"Shrub" Growth Form Species	Acci	23	29	59	9	120	–	–	–	–	–	–	–	–	–	–
	Vaov	4	–	5	–	9	–	–	–	–	–	–	–	–	–	–
	Rhpu	3	1	–	–	4	–	–	–	–	–	–	–	–	–	–
	Samb	–	–	2	–	2	1	1	11	15	28	7	9	10	1	27
	Hodi	–	–	5	–	5	–	–	–	–	–	–	–	–	–	–
	Vapa	–	–	–	2	2	–	–	–	–	–	1	1	1	–	3
	Mefe	–	–	–	–	–	3	2	3	–	8	4	14	1	1	20
	Rhma	9	–	–	–	9	–	–	–	–	–	–	–	–	–	–
	Rusp	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–
TOTAL		96	85	117	52	350	52	58	57	56	223	57	76	73	49	255

hectares. Total trees per hectare (excluding "shrub" growth form species) number around 200. The Picea numbers per hectare were significantly higher in the 15 x 25 M plot data. Tables 27-29 show that as in the WHZ tallies total basal area is near 100 square meters per hectare, except when some quarter hectares fall far short to bring the total down.

Size Class Distributions and an Explanation for 15 X 25 M Plot and Hectare Tally Differences

In addition to the numbers of trees per unit area (stocking) and their total size (basal area), the size class distribution of trees by species is an important structural attribute. Because a very approximate relationship exists between size and age, size class distributions give a crude picture of stand dynamics (Auclair and Goff, 1974). I encountered several basic patterns of size class curves. The "reproductive tail" of highest numbers of trees in the smallest size class (logarithmic) is well known and characteristic of shade tolerant trees. The normal distribution of an intolerant tree species is widely recognized also. I interpreted flattened curves or those with a "reproduction bulge" of highest numbers in intermediate size classes as indicative of mid-successional species or those undergoing gap replacement (reproducing in openings only).

Figure 25 shows the difference in size and dynamics of *Pseudotsuga menziesii* between the Valley-Margin Zone and the Western Hemlock Zone. Both curves are based upon tree measurements within the total number of 15 x 25 M plots assigned to each zone (All size class frequency polygons are based upon 10 cm size classes). The VMZ curve is considerably

Table 27. Basal Area (sq.M./Ha.) and Percent of Total Basal Area By Species in 1/4 Hectare Tallies

Sitka Spruce Zone--Schofield Ridge

Species	401T		402T		403T		404T	
	Basal Area	%	Basal Area	%	Basal Area	%	Basal Area	%
Tshe	3.26	2.59	2.73	2.25	8.10	6.79	2.20	1.92
Pisi	.23	.18	16.42	13.53	11.80	9.90	2.10	1.83
Psme	113.24	89.79	80.26	66.14	89.90	75.41	71.60	62.39
Thpl	5.51	4.37	18.72	15.43	7.30	6.12	38.10	33.20
Samb					.02	.02		
Acci	.38	.30	.72	.59	1.40	1.17	.22	.18
Umca	3.20	2.54	2.05	1.69	.09	.08	.53	.46
Rhma	.13	.10						
Vaov	.05	.04			.07	.06		
Rhpu	.11	.09	.45	.37				
Acma					.50	.42		
Hodi					.04	.03		
Vapa							.02	.02
Sum	126.11	100.00	121.35	100.00	119.22	100.00	114.77	100.00

Mean Basal Area for all four plots: $\bar{x}$ = 120.36

Table 28. Basal Area (sq.M./Ha.) and Percent of Total Basal Area By Species in 1/4 Hectare Tallies

Sitka Spruce Zone--Cascade Head

	405T		406T		407T		408T	
Species	Basal Area	%	Basal Area	%	Basal Area	%	Basal Area	%
Tshe	27.20	33.83	28.00	34.41	26.30	23.54	13.10	12.48
Pisi	53.20	66.14	53.00	65.13	83.30	74.55	91.40	87.10
Samb	.01	.01	.03	.04	.29	.26	.44	.42
Mefe	.02	.02	.02	.03	.03	.03		
Alru			.32	.39	1.80	1.61		
Rusp					.01	.01		
Sum	80.43	100.00	81.37	100.00	111.73	100.00	104.94	100.00
Mean Basal Area for all four plots: $\bar{x}$ = 94.62								

Table 29. Basal Area (sq.M./Ha.) and Percent of Total Basal Area By Species in 1/4 Hectare Tallies

Sitka Spruce Zone--Cape Lookout

	409T		410T		411T		412T	
Species	Basal Area	%	Basal Area	%	Basal Area	%	Basal Area	%
Tshe	49.40	53.00	18.00	19.94	50.00	72.27	51.20	83.18
Pisi	43.60	46.78	71.70	79.42	14.20	21.66	10.30	16.74
Samb	.16	.17	.37	.41	.62	.95	.02	.03
Vapa	.01	.01	.01	.01	.01	.01		
Mefe	.04	.04	.18	.20	.02	.03	.03	.05
Alru			.02	.02	.71	1.08		
Sum	93.21	100.00	90.28	100.00	65.56	100.00	61.55	100.00
Mean Basal Area for all four plots: $\bar{x} = 77.65$								

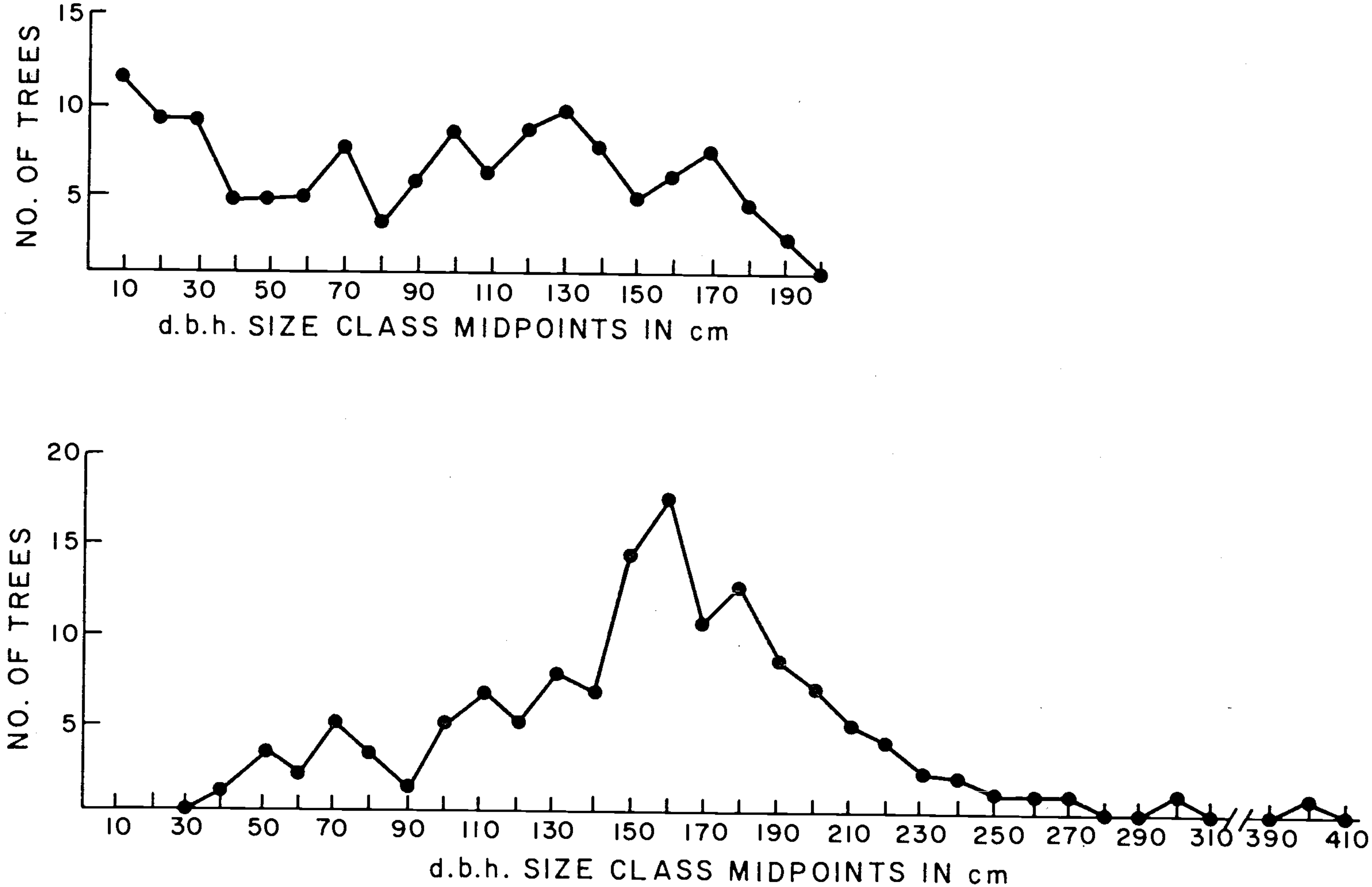


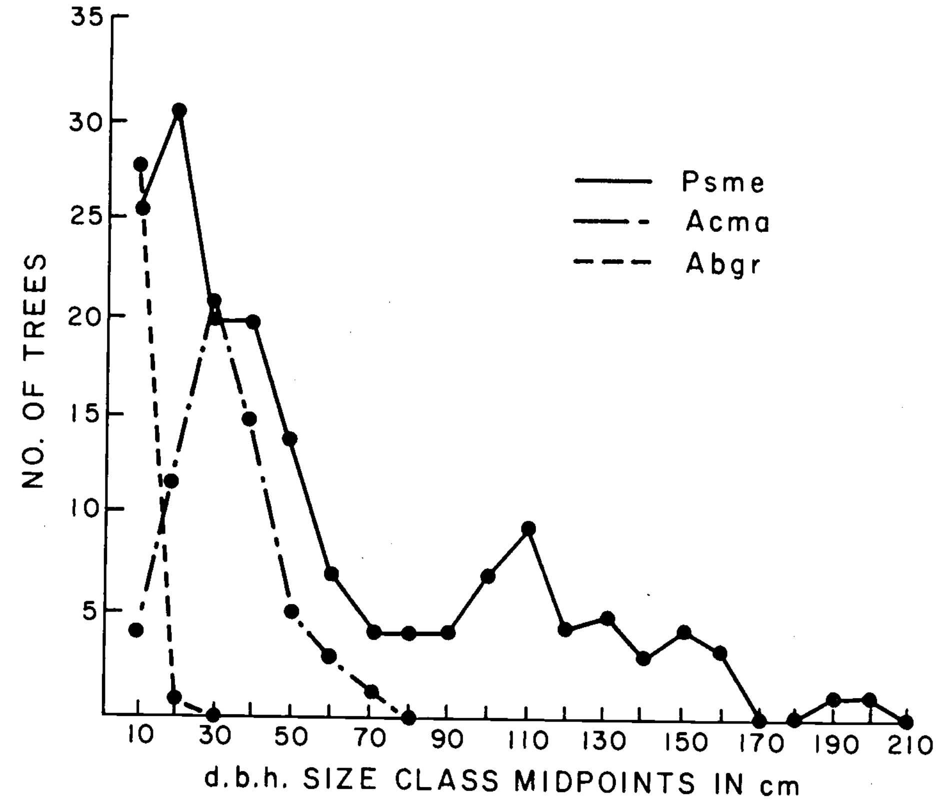
Figure 25. Size Class Frequency Polygon for Pseudotsuga menziesii
All Valley-Margin Zone (top) and Western Hemlock Zone (bottom) 15 X 25 M Plots

flattened especially when compared to the very nearly normal distribution of the Western Hemlock Zone. The latter has a modal diameter of 160 cm, the Valley-Margin Zone 130 cm (for larger trees). These curves indicate that there is some self-replacement by Pseudotsuga in VMZ stands, the trees in the old-growth condition reaching smaller size than in the Western Hemlock Zone, where virtually no self-replacement occurs in old-growth.

Full Hectare Tally Data

The curves of Figure 25 are instructive for general comparative purposes but do not supply values for a convenient unit area and do not apply to any one particular stand. In addition, the bias toward higher stocking and basal area in 15 x 25 M plots versus measurements over one hectare as noted previously should caution against the direct acceptance of those curves.

Figures 26 and 27 are size class frequency polygons for three full hectare tallies taken in the Valley-Margin Zone. Figure 26 represents two stands of the Psme-Acma/Coco/Adbi association. It can be seen that in both stands, Abies grandis displays a steeply declining log pattern, Acer macrophyllum shows a bulge in the intermediate size classes, and Pseudotsuga menziesii has a modal diameter (for larger trees) of 100 to 110 cm. However Little Sink (top) shows a reproductive bulge for Pseudotsuga while MacDonald Forest (bottom) does not; also Little Sink has fewer large Pseudotsuga (> 100 cm), and does not have a few very large Abies grandis as MacDonald Forest does. This could be interpreted



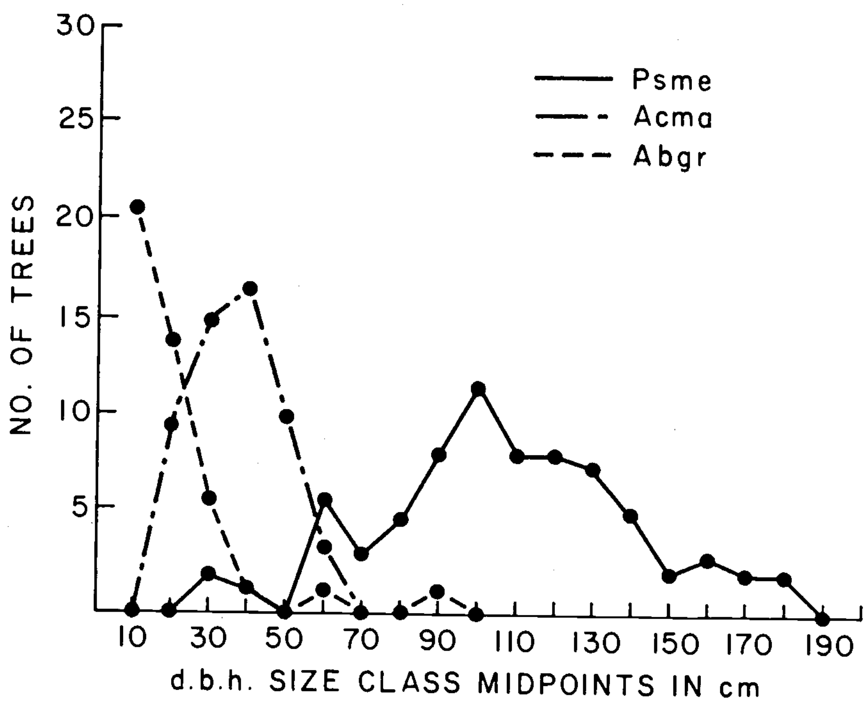


Figure 26. Size Class Frequency Polygon for Major Trees At Little Sink (109T-112T) [top] and MacDonald Forest (105T-108T) [bottom]

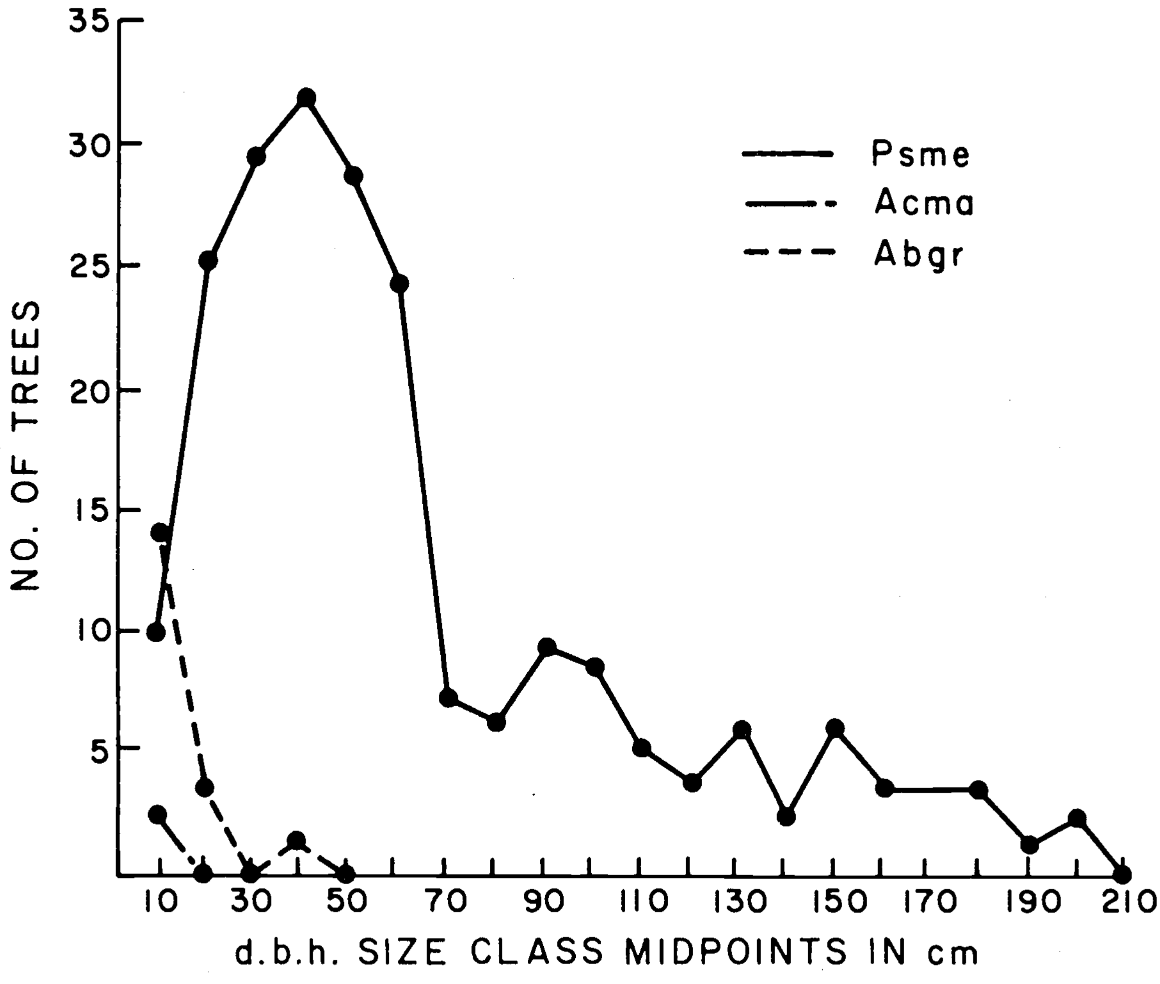


Figure 27. Size Class Frequency Polygon for Major Trees In the Mary's Peak Watershed (101T-104T)

as being the result of freedom from disturbance in MacDonald Forest and a not too distant partial disturbance, such as a ground fire, in Little Sink.

The gap between the log phase and the very few large trees in the curve of A. grandis in MacDonald Forest is significant. If there were higher numbers of intermediate and large sized A. grandis one could tentatively assign it a climax dominant role. However, both the curve and field observations reveal that large A. grandis trees are afflicted with a high mortality. Furthermore Juday (1975b) reported that one of the largest A. grandis (79 cm d.b.h.) originated in 1895 ± five years along with many of the small trees which have simply been greatly suppressed. It is by no means clear that A. grandis has the potential to greatly increase its dominance in VMZ old-growth stands over what it now exhibits.

Figure 27 shows that the lower Mary's Peak Watershed also exhibits a reproductive bulge in Pseudotsuga, possibly due to the effects of the widespread 1902 fires. However, this stand, which is representative of the Psme (Tshe)/Coco community has only token amounts of Acer macrophyllum and Abies grandis. It seems probably that periodic light ground fires (as described in section, Location) would have allowed the development of Pseudotsuga reproduction more than ample for self-replacement.

Figures 28, 29, and 30 are size class frequency polygons for three full hectare tallies taken in the Western Hemlock Zone. Figure 28,

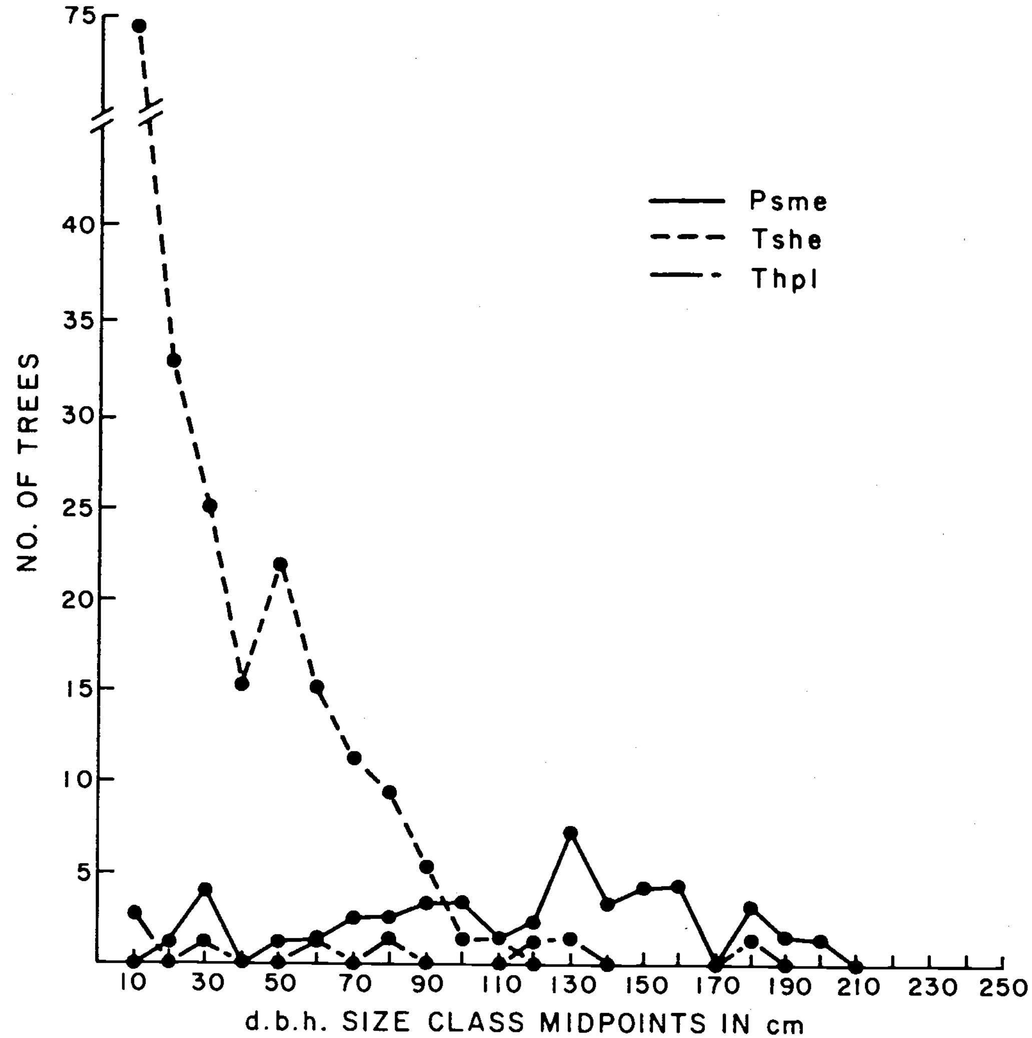


Figure 28. Size Class Frequency Polygon for Major Trees in Elliott State Forest Bench (209T-212T)

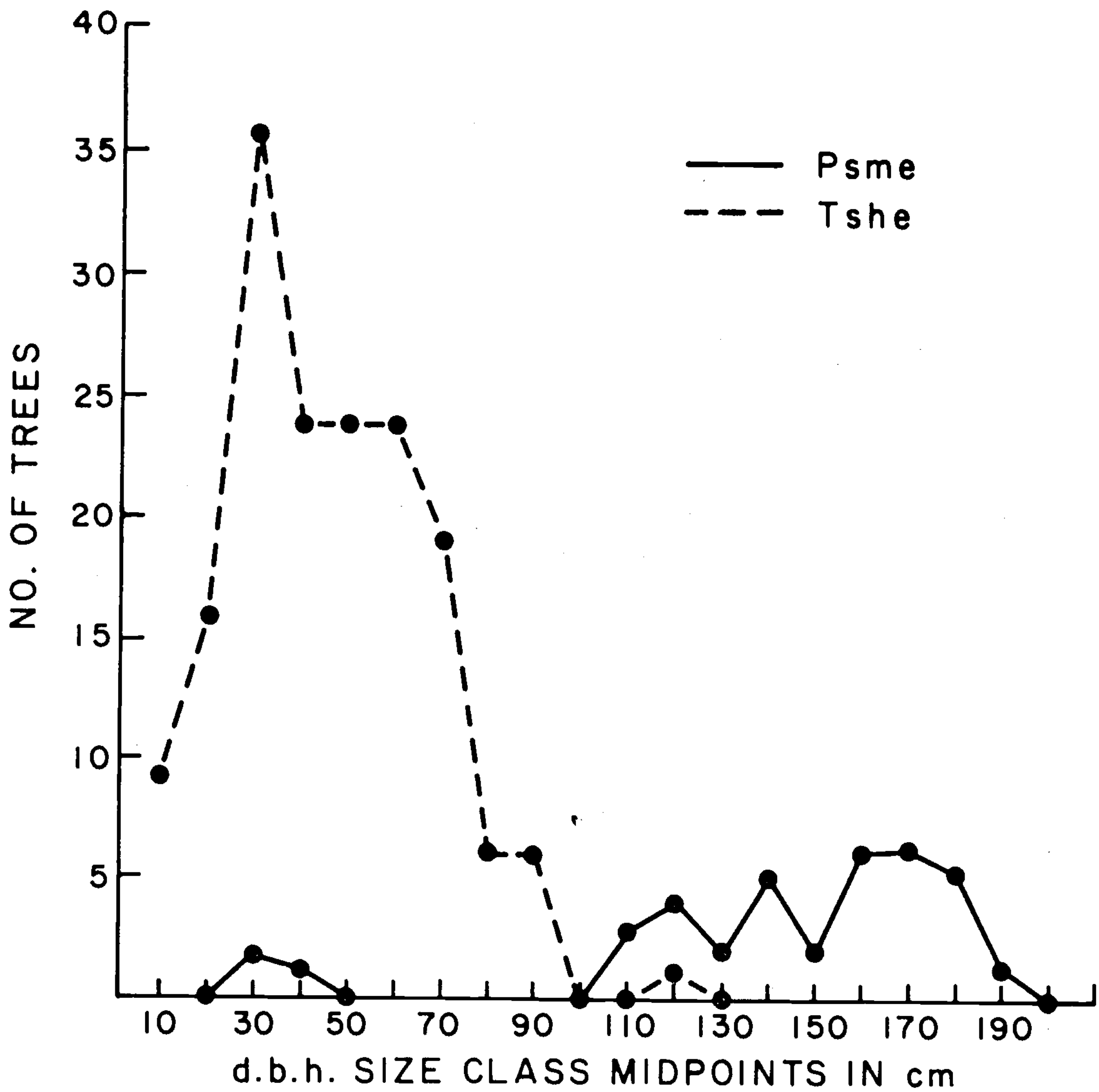


Figure 29. Size Class Frequency Polygon for Major Trees At Taylor Butte (205T-208T)

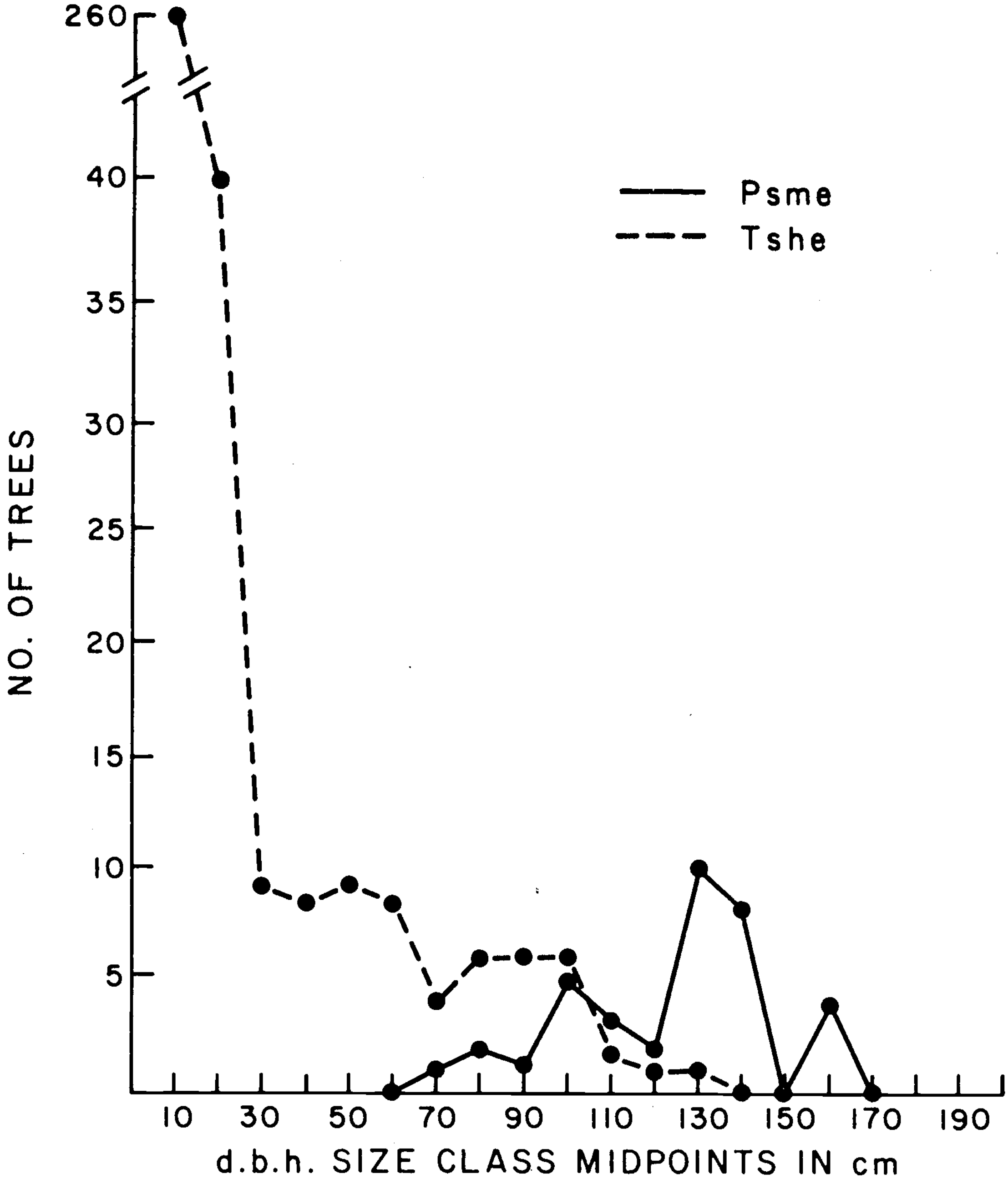


Figure 30. Size Class Frequency Polygon for Major Trees At Upper Camp Creek (201T-204T)

representing Elliott Forest Bench was taken in a stand at the edge of the Coos Burn exhibiting the Tshe/Vaov/Pomu, Tshe/Pomu, and Tshe/Rhma/Bene associations (Dyrness, et al, 1974). There are some trees of post-burn origin in the tally. Figure 29, Taylor Butte, was a stand on a large debris bench which, except for a small light pocket was virtually undisturbed. It contains both the Tshe/Pomu and Tshe/Pomu-Oxor associations. It was at least 406 years old (origin, approximately 1569 ± five years). The Camp Creek stand, seen in Figure 30, contained *Pseudotsuga* of the 417, 203, and 151 and *Tsuga* of the 201 year age classes, which may partially explain the three minor peaks on the *Pseudotsuga* curve.

Elliott Forest and Camp Creek show the log distribution of *Tsuga heterophylla* which illustrates its climax (replacement) potential in the Western Hemlock Zone. The Camp Creek stand is quite far along in this process. Taylor Butte however, has an actual decline in the numbers of smallest *Tsuga*. This may be due to a canopy too dense to allow *Tsuga* reproduction in any great amounts. The *Pseudotsuga* curves in all stands are erratic normal distributions, especially those of Camp Creek and Elliott Forest where there may have been some partial disturbance over the past two centuries. The curve for Taylor Butte is smoother; there is no evidence of disturbance beyond the one light spot in this stand. *Thuja plicata* in Elliott Forest, Figure 28, appears as a few scattered trees of all sizes.

Figure 31 presents the size class distributions of two TFZ stands, Mary's Peak Summit and Saddleback Mountain. Mary's Peak Summit is a truncated relict forest of nearly pure *Abies procera*. There are two

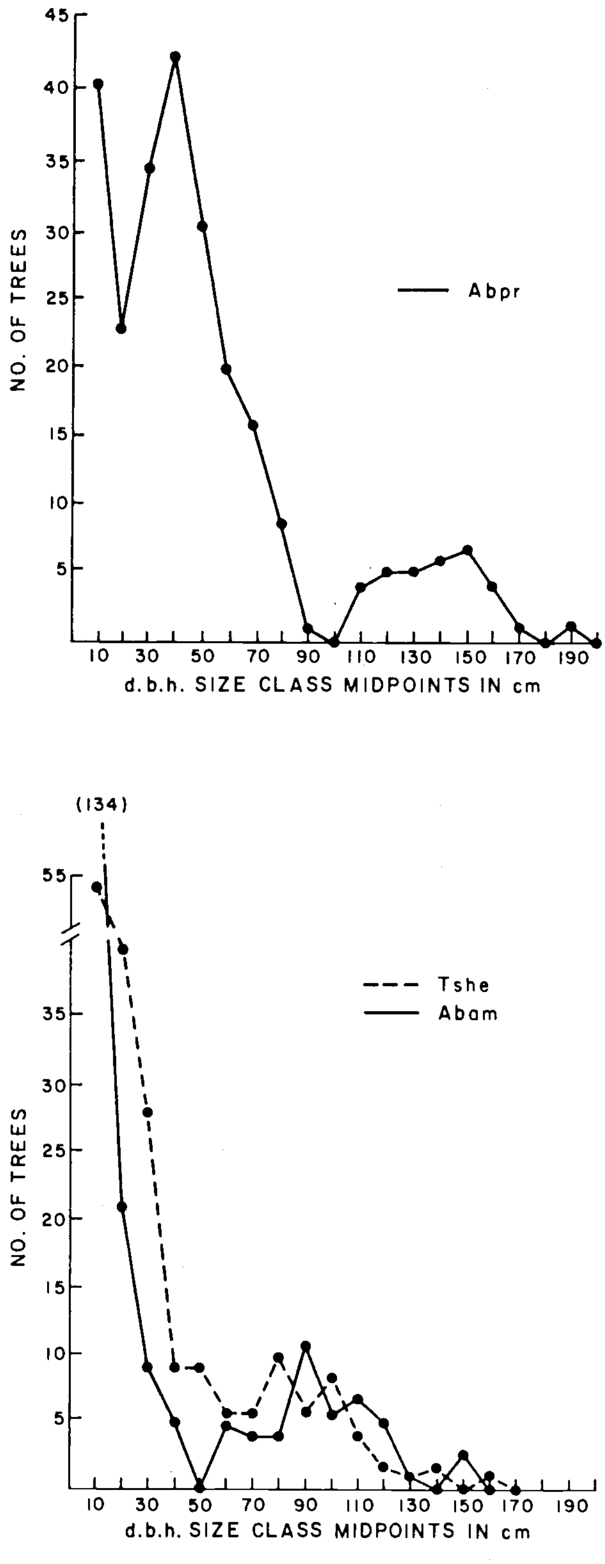


Figure 31. Size Class Frequency Polygon for Major Trees at Marys Peak Summit (301T-304T) [top] and Saddleback Mountain (305T-308T) [bottom].

distinct populations of trees in the stand. The large old-growth trees approach a normal distribution with a modal size of about 150 cm d.b.h. The portion of the curve representing poles and saplings, however, fluctuates between high and moderate numbers of trees. This is due to scattered pockets of these trees crowded into light spots. Abies procera is generally acknowledged to be a shade-intolerant species. Since there are no other tree species on Mary's Peak with the capability of displacing A. procera, these stands are maintained by reproduction in pockets of overstory mortality.

The curves for Saddleback Mountain, however, represent two competing climax species, Tsuga heterophylla and Abies amabilis. Ring counts on a Pseudotsuga in an adjacent clear cut indicated that the stand has been essentially free from disturbance for about 670 years (since approximately 1300 A.D.). Some Tsuga were upwards of 400 years old. The curves of the two species tend to mirror each other; when one outnumbers the other in a given size class it will often decline to lesser numbers in the next.

Figure 32 is the size class distribution plot for the Schofield Ridge stand, representing the Tshe-Psme-Pisi/Pomu-Euor-Oxor-Plun association. It exhibits one of the most interesting and complex patterns of Pacific confier dominance of any Coast Range old-growth stand. Picea sitchensis displays a low flat curve, being widely scattered in small amounts in all size classes. The Pseudotsuga curve indicates some minor peaks of possible disturbance origin. Two very interesting features are the very low numbers of Tsuga and the relatively great abundance of

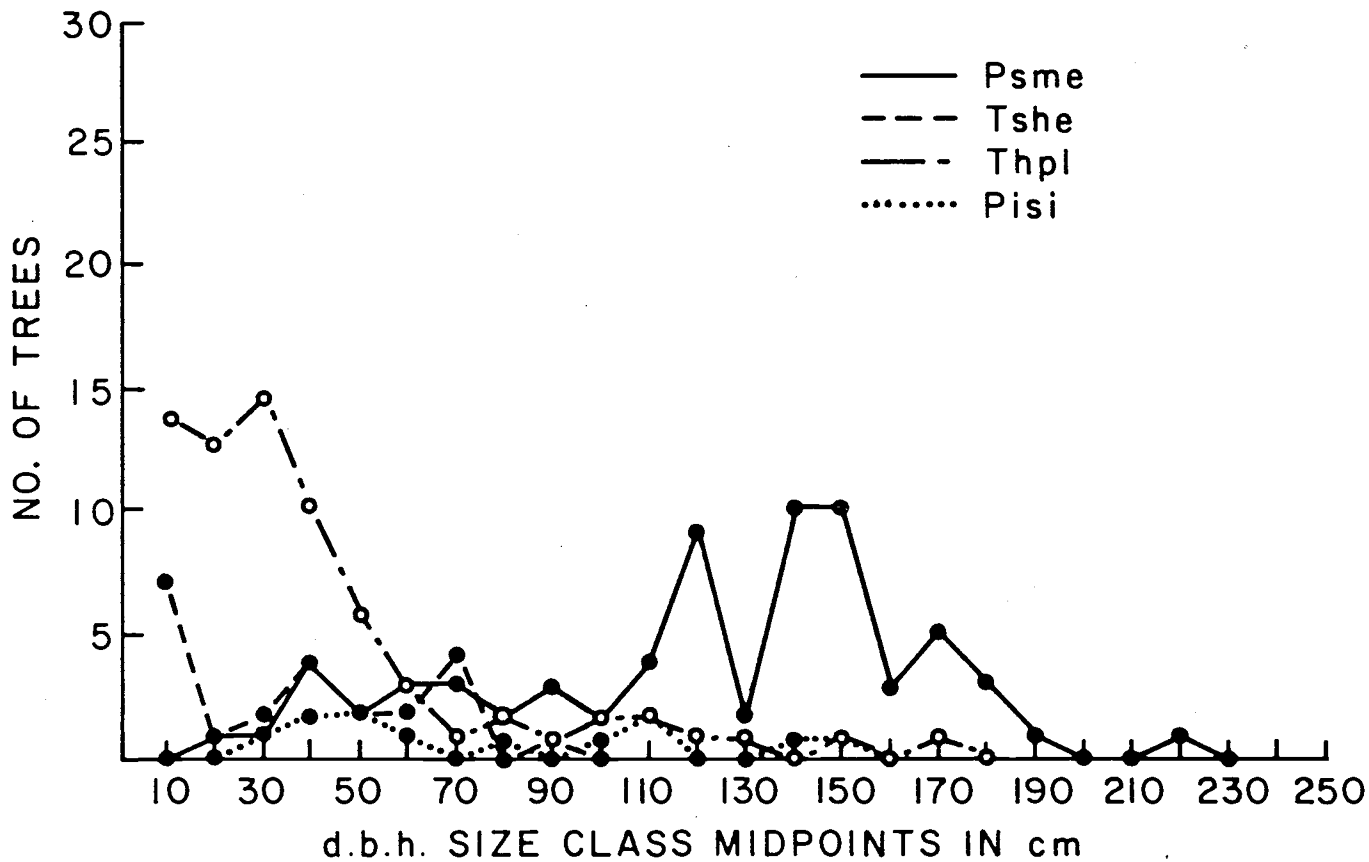


Figure 32. Size Class Frequency Polygon for Major Trees at Schofield Ridge (401T-404T)

Thuja plicata. The stand is on a very steep slope of Tyee sandstone-siltstone: The *Thuja* is correlated with seeps and incipient drainages.

Figure 33 represents the size distributions of *Tsuga* and *Picea* at Cascade Head and Cape Lookout. In these stands *Picea* again has a long, low, flat curve. There is, however, some indication of successful reproduction as evidenced by an upturn in the curves when working back toward the smallest size class. *Tsuga*, by contrast, has higher numbers in the smallest size class but certainly nothing like the large numbers exhibited in the True Fir Zone or Western Hemlock Zone. There are relatively few *Tsuga* greater than 100 cm d.b.h. The erratic numbers of these smaller size class trees reflect openings crowded with *Tsuga*. Both of these tallies were taken in the Pisi-Tshe/Gash/Blsp and Pisi-Tshe/Pomu-Blsp associations. A model which would explain these observations is *Tsuga* reproducing on the forest floor in partial shade but with reduced vigor because of some factor of the immediate coastal environment (possibly salt in the precipitation). After growing to about 80 cm d.b.h. these trees are greatly affected by some mortality factor and survive as small groups or individuals. The humid coastal environment allows the growth of many fungi which can take advantage of any entry point. High winds can then snap off weakened stems or uproot tall trees. *Picea* is able to reproduce on the forest floor in these openings and grow rapidly to reach the upper canopy before full closure. It then grows even larger and seemingly resists rots, wind-pruning, and salt spray more effectively than *Tsuga*.

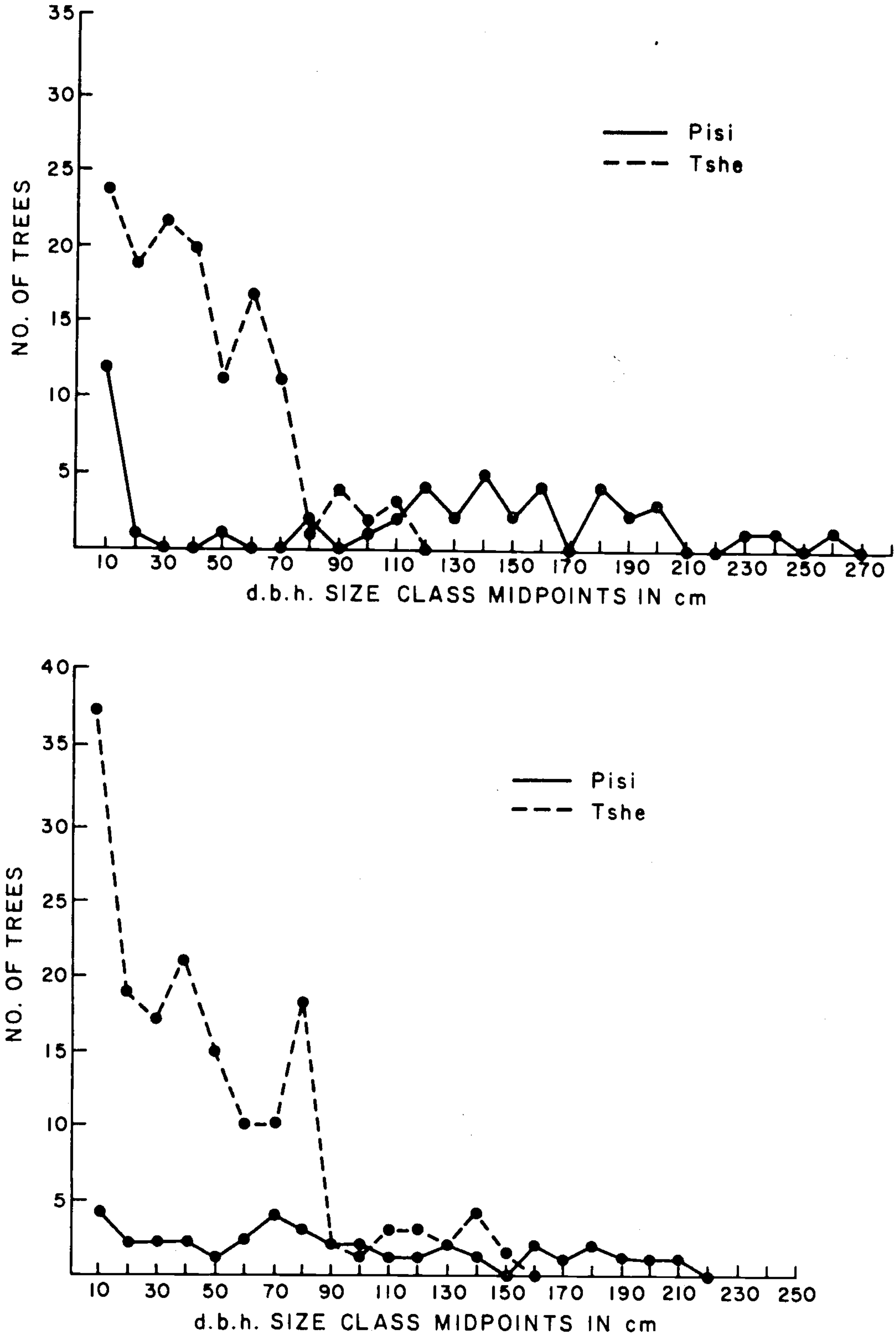


Figure 33. Size Class Frequency Polygon for Major Trees at Cascade Head (405T-408T) [top] and Cape Lookout (409T-412T) [bottom].

Having now compared the structure of stands from both 15 x 25 M plot and full hectare tally data, a logical question is why did the plots give a distorted estimate of per hectare values? Figures 34 and 35 help explain the situation. Large old-growth trees are not uniformly distributed over a hectare or even within a quarter hectare. When sampling old-growth with 15 x 25 M plots, I placed plots where the trees were (densely stocked pockets) and not where the trees weren't (poorly stocked areas or gaps of no trees). Unless 15 x 25 M plots are strictly randomly placed there will be distortions in extrapolating to larger unit area values. However, if I had followed random placement I would have been studying the composition and structure of old-growth stands through some plots that had no old-growth. Figure 36 illustrates such openings in TFZ and SSZ stands. Clearly a larger sampling unit was required. Since I was extrapolating to per hectare values, I decided to measure all trees in a hectare by quarter hectares. Whenever possible, I aligned the hectare to include one or more 15 x 25 M plots taken previously. The results of this comparison for one Valley-Margin Zone stand can be seen at the top of Figure 34. The basal area totals here and elsewhere indicated that some quarter hectares are very close to the average, some slightly above, but some far below. These latter quarter hectares also have low numbers of large trees. It appears that stocking and size of large old-growth trees reach an average maximum level; any number of smaller areas within a stand can lose many or all old-growth trees. I then recorded by quarter quarter hectare (25 x 25 M). As can be seen at the bottom of Figure 34 and in Figure 35

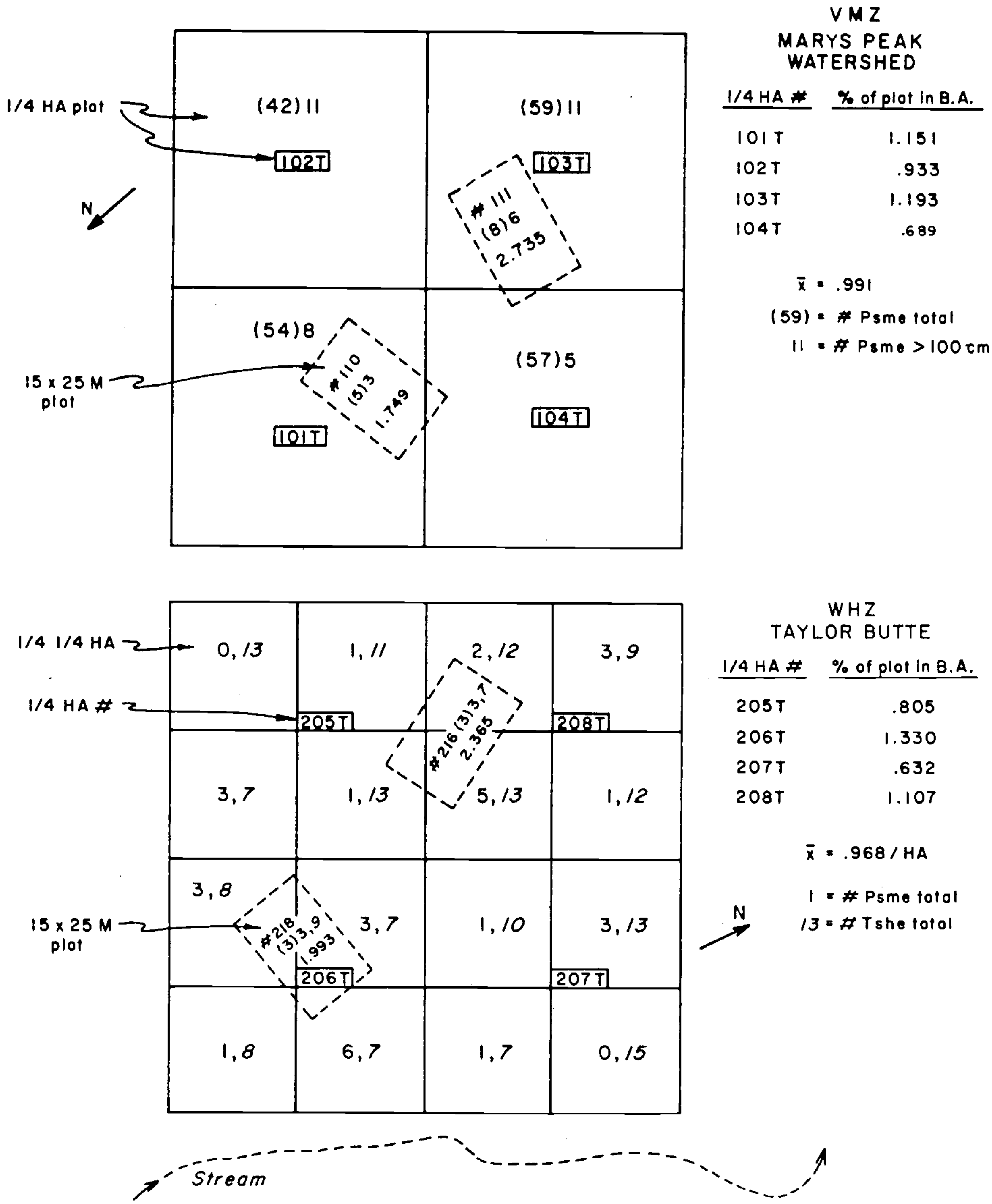


Figure 34. Stocking Level and Basal Area of Trees >5 cm in 15 x 25 M Plots Compared to 1/4 HA Tallies, VMZ and WHZ.

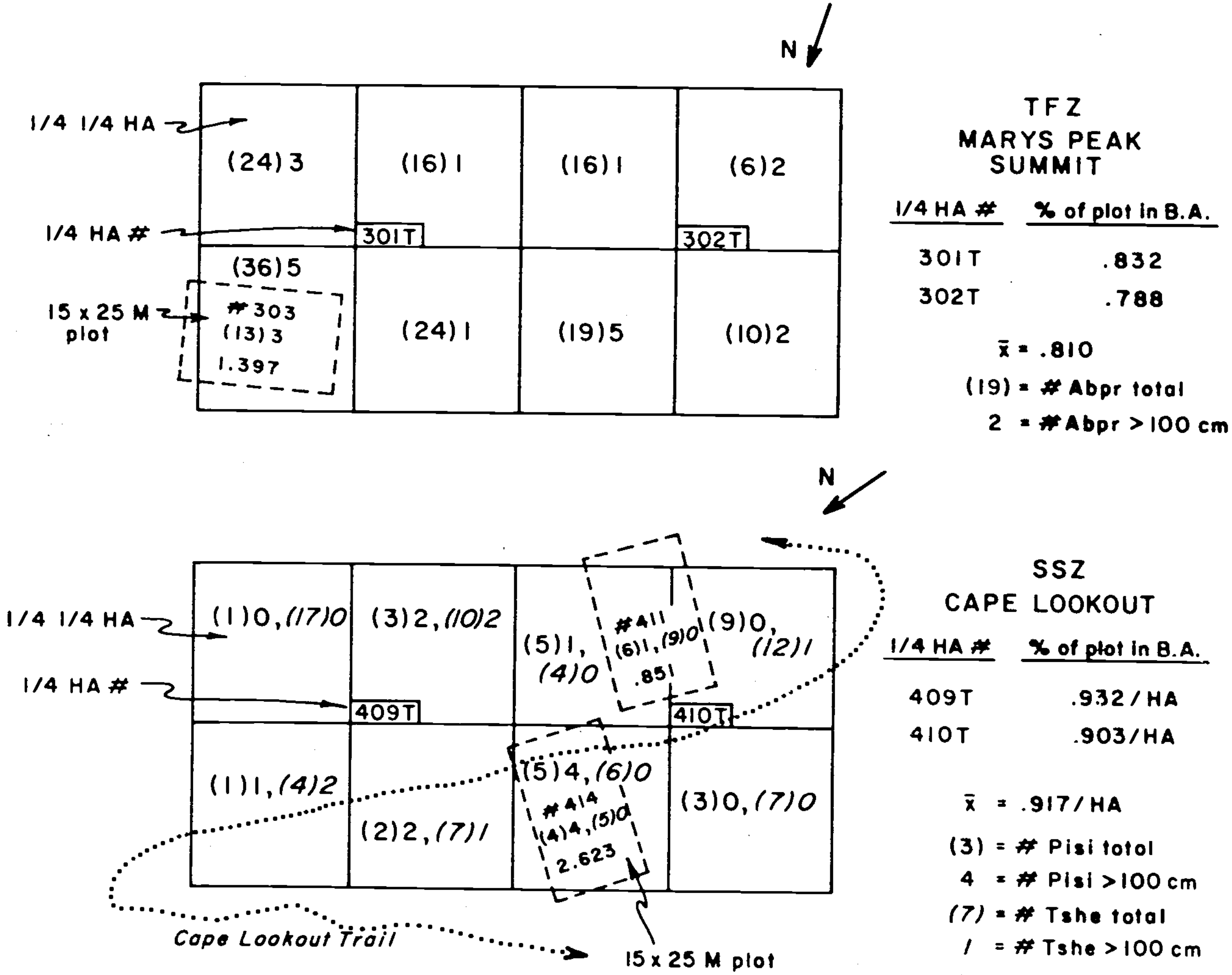


Figure 35. Stocking Level and Basal Area of Trees >5 cm in 15 x 25 M Plots Compared to 1/4 HA Tallies, TFZ and SSZ.

nearly all 15 x 25 M plots were taken in particularly dense concentrations of large trees, exactly where one would sample in order to minimize the influence of disturbance edges. The problem is that trees rooted within 15 x 25 M plots, especially large trees, are likely to be drawing upon resources (light, rooting space, etc.) outside the plot. Nearly any 15 x 25 M plot which avoids completely unstocked areas faces this problem.

Age

Table 30 presents the approximate average age of oldest old-growth dominants for all stands where clearcut stumps of the same size class were available. All were counted in the field and the values reported are the stump ring counts; counting error and growth to stump height must be considered.

Except for an occasional streamside tree most VMZ old-growth trees evidently do not reach ages greater than 300 years; none exceeds 400. WHZ trees usually do not begin to fully display the characteristics of old-growth until they are 250-300 years old. Trees greater than 400 years old are relatively common in old-growth stands and 500 and 600 year age classes can be found. Pseudotsuga older than this have been known from the Coast Range but seem to have been nearly depleted in modern times.

Not enough counts were available from the True Fir Zone to compile meaningful data. The Sitka Spruce Zone counts were divided between

Table 30. Approximate Average Age (in 1975) of Oldest Dominant Trees For 15 X 25 M Plots by Zone

VALLEY-MARGIN ZONE		WESTERN HEMLOCK ZONE		SITKA SPRUCE ZONE	
Plot No.	Age	Plot No.	Age	Plot No.	Age
Psme		Psme		Psme	
101	185	201	600+	403	350
102	255	202	330	405	370
103	337	205	407	418	374
106	225	206	600+	423	208
107	285	209	383		
109	237	210	403	$\bar{X}$ = 325.5	
110	300	211	520		
112	290	216	328		
115	230	217	364	Pisi	
117	350	221	401		
119	215	225	239	404	300
120	383	226	350	406	240
122	230	228	432	409	270
		232	488	411	250
$\bar{X}$ = 273.2		234	374	413	300
		235	350	415	248
		237	287	421	280
		238	298		
		240	290	$\bar{X}$ = 269.7	
		241	379		
		$\bar{X}$ = 391.2			

Picea sitchensis-dominated and *Pseudotsuga*-dominated stands. The average of the latter was lower than for the Western Hemlock Zone. The average stump ring count for *Picea* in *Picea*-dominated stands was very nearly the same as the Valley-Margin Zone average.

Figure 36 shows openings in both TFZ and SSZ stands which indicate that there is a process of death and renewal within stands. This may be contributing to the lower average age of dominants.

Figure 37 shows the crown and root structure of individual old-growth trees. At the top, an old-growth *Pseudotsuga* displays a broken, flat-topped crown. Flanking it are younger trees beginning to experience top die-back; regrowth of lateral branches broadens the top of the crown. Large diameter upper limbs and flat-topped crowns are characteristic of old-growth. The lower picture shows a windthrow root mound in the Sitka Spruce Zone. Large roots have penetrated fracture joints in the easily weathered sedimentary soil parent material.

Figure 38 illustrates the rate of growth of a typical WHZ *Pseudotsuga*. Early growth is rapid, usually for most of a century. Competition from then on may either totally suppress a tree eventually or allow it to experience a mid- or late-life growth spurt through the occupation of vacant growing space from dead canopy neighbors. Understory *Tsuga* appear capable of causing stagnation also.

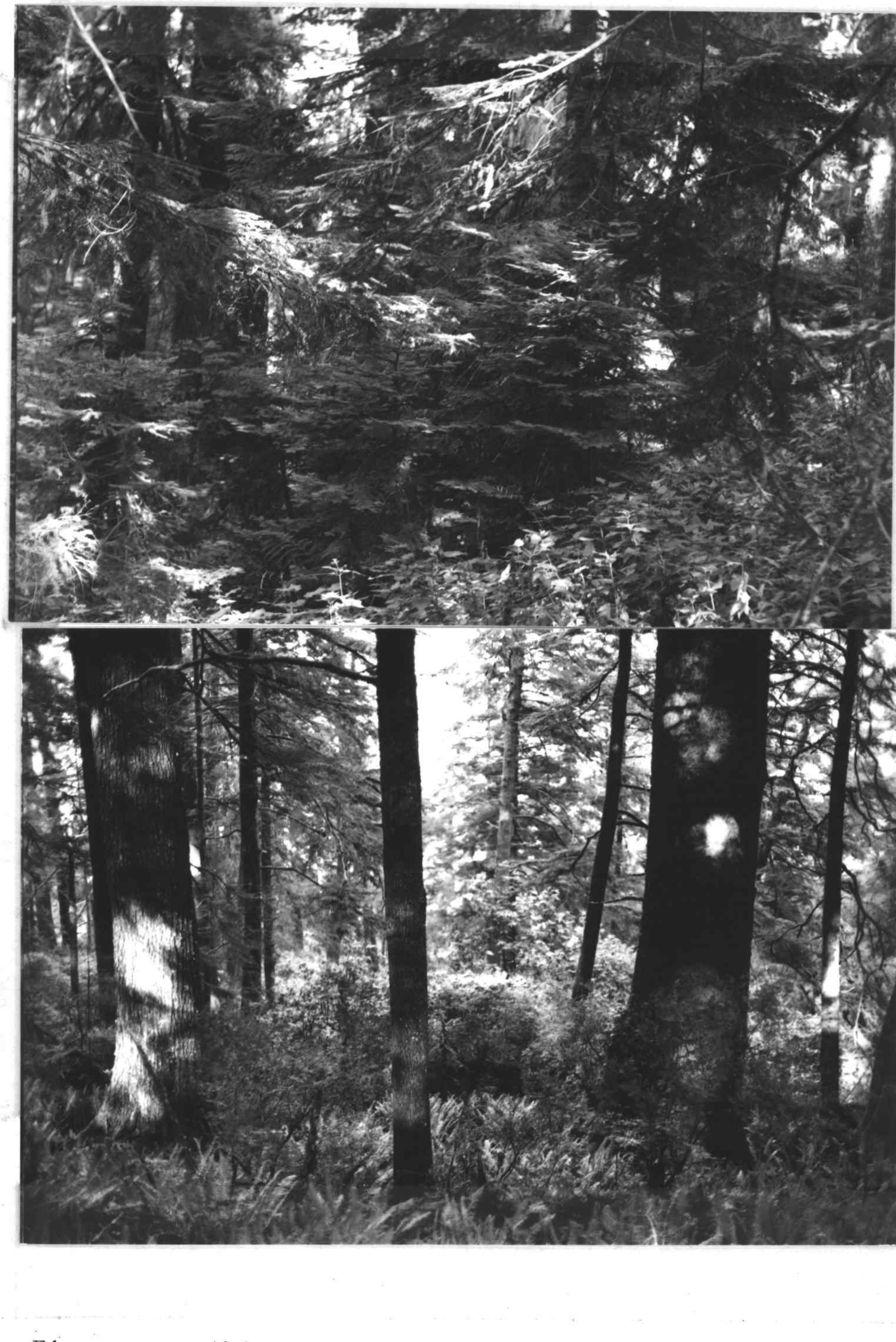


Figure 36. *Abies procera* Saplings and *Senecio triangularis* Crowded into a Well-Lighted Opening in 301T (above). Light Penetrating through Wind-Broken Trees in 409T (below).

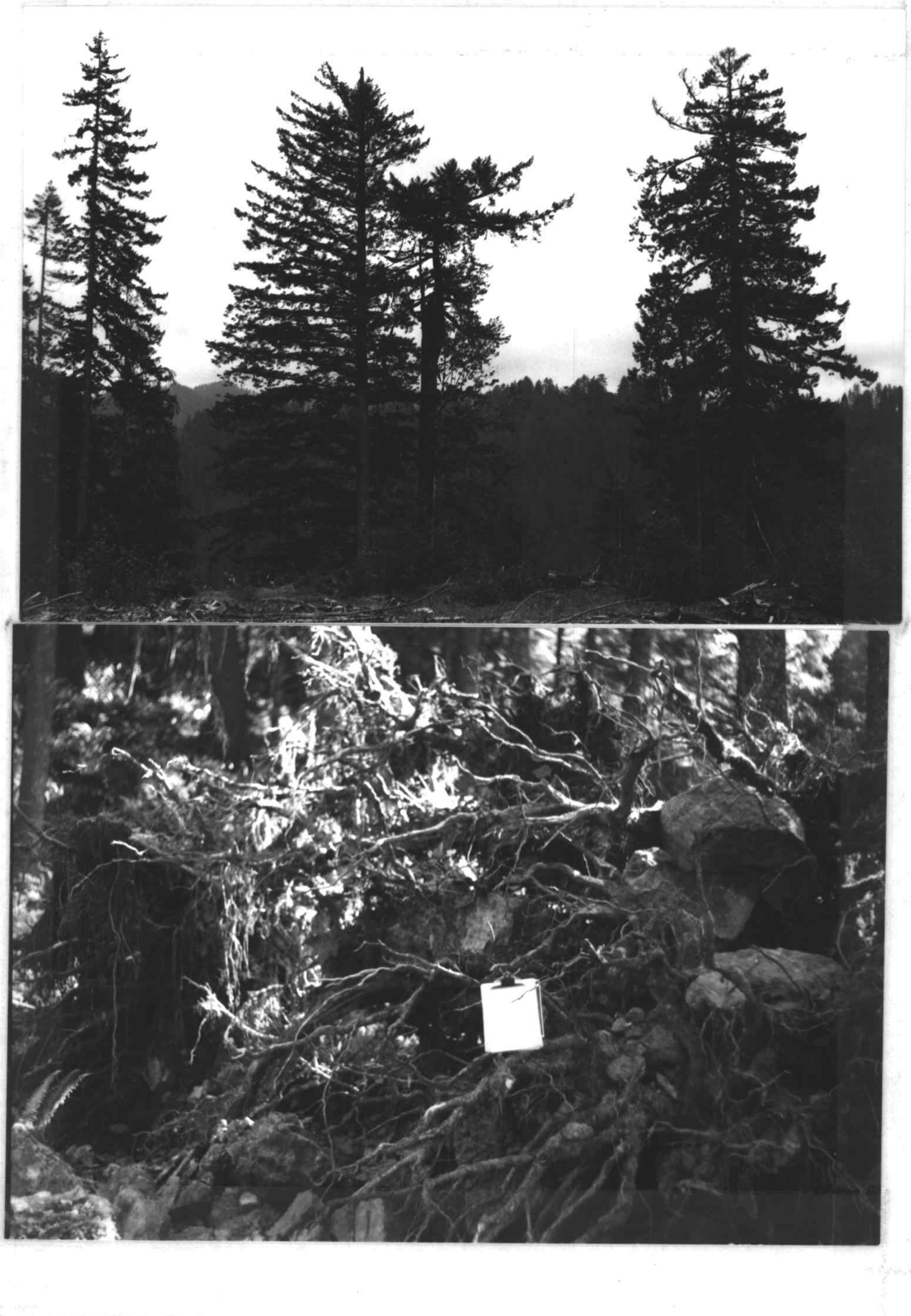


Figure 37. Crown and Root Structure of Old Growth. Flat-topped Crown of Old _Pseudotsuga menziesii_ in Center Surrounded by Post-Coos Fire Trees, near Plot 240 (above). Large Roots of _Tsuga heterophylla_ Probing Fracture Joints in Bedrock Exposed in a Windthrow Root Mound, near 405T (below).

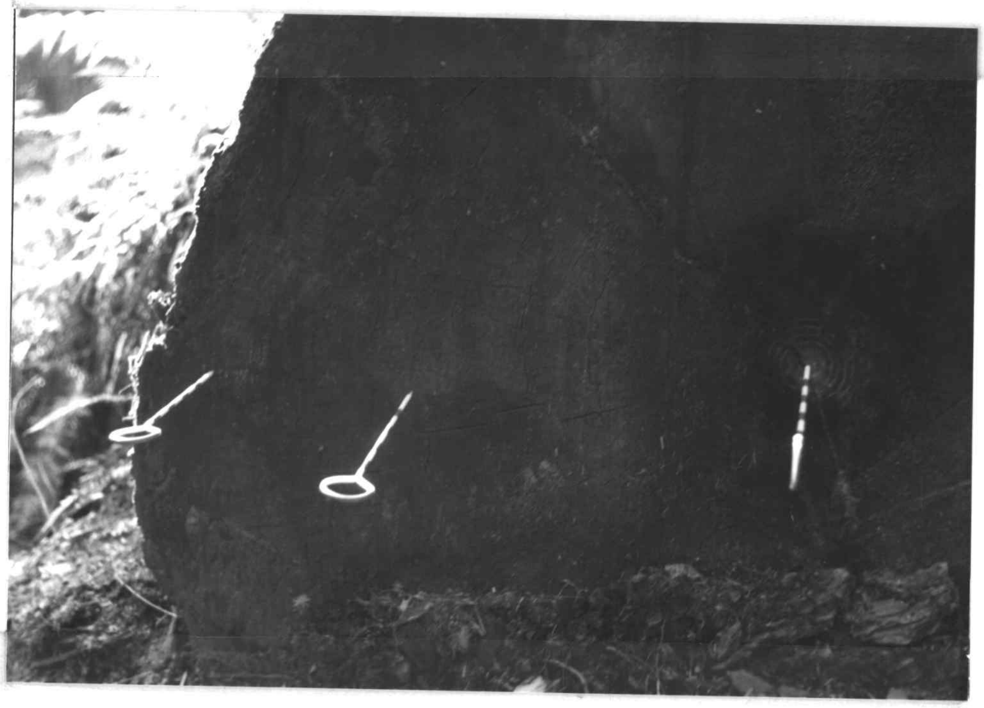


Figure 38. One Hundred Year Growth Intervals
Marked by Survey Pins (divided into 2.54 cm. segments)
On a 250 Year Old <u>Pseudotsuga</u> <u>menziesii</u>

Biomass and Leaf Area Index

Appendices 9-12 present computer printouts of biomass (kg/HA) and leaf area index (M^2/M^2) based upon quarter hectare tallies in each of the four zones. Since these projections are based upon allometric regression equations using diameter, the results parallel the trends of basal area. This discussion will be based upon averages of quarter hectare tallies by zone since stocking density has a great effect on the biomass at any one given point, or as Grier and Logan (1976) said, "Tree biomass was inversely proportional to fallen log biomass."

Average total biomass in the Valley-Margin Zone was 1095.2 metric tons per hectare. In the Western Hemlock Zone the average was 1057.0. Since component values were missing for certain species there are no average True Fir Zone values. The Sitka Spruce Zone average was 1093.9, if Schofield Ridge (a mixed Pseudotsuga stand) is excluded. These values are in close accord with Grier and Logan's (1976) report of a range of 605.8 to 1184.6 metric tons per hectare from 400-500 year old Pseudotsuga in Western Hemlock Zone old-growth of the Western Cascades. Fujimori (1971) reported 192.7 metric tons per hectare of above ground biomass in a 19-32 year old Tsuga heterophylla stand in the Sitka Spruce Zone, which is basically a logical value for a stand of that age if the old-growth figures are correct. Hanley (1976) reported an average 492.5 metric tons per hectare in unmanaged stands of the Abies grandis/ Pachistima myrsinites, Thuja plicata/Pachistima and Tsuga heterophylla/ Pachistima habitat types in northern Idaho.

However, if the WHZ-VMZ transition hectare, Mary's Peak Watershed, is taken out of the VMZ average and added to the Western Hemlock Zone average, the values become 986.1 and 1121.1 respectively. This is more in line with basal area value trends and my observational assessments of accumulated biomass. A further adjustment may also be necessary, because WHZ regressions probably produce estimates that are slightly high for VMZ trees. These values appear to be upper limits for the accumulation of biomass over a relatively large sampling area in Coast Range old-growth. Some quarter hectares do have much larger values and it is conceivable but not likely that such stocking could hold up over a whole hectare. The highest such value was 1868.5 metric tons per hectare in plot 206T, in the Taylor Butte stand. The Sitka Spruce Zone biomass would be higher, but windthrown tree patches cannot be avoided in contiguous sampling areas taken within a few kilometers of the ocean.

These biomass values are among the highest in the world for any ecosystem type, exceeding even tropical rainforest values (Olsen, 1975; Rodin et. al., 1975). The reasons for this marked tendency to accrete organic matter are not fully known.

Leaf area index values (M^2/M^2) average 26.6 for the Valley-Margin Zone, 39.0 for the Western Hemlock Zone, 31.6 for the True Fir Zone, and 38.2 for the Sitka Spruce Zone. The corresponding sun index values derived from my ranking system for 15 x 25 M plots are 34.1, 16.7, 17.0, and 23.5 respectively. This confirms the openness of VMZ stands and the very tight, dense nature of WHZ and TFZ canopies. The two data for

Sitka Spruce Zone stands are not in agreement. The leaf area index value reflects the very high productivity of Sitka Spruce Zone stands; it could have been the highest of all zones were it not for extensive windthrow. The sun index value reflects the fact that sunlight does penetrate the canopy in windthrow openings.

Management Implications

Despite the enormous temptations of great economic gain from the sale of all old-growth timber, resource managers must always remember that old-growth is a phenomenon which pre-dates them and the human species. It comes into being for some very compelling reasons, exists as one small exception to entropy, and then either persists in transmuted form or disassembles only to re-appear elsewhere. It functions according to rules that the human species must understand if we are truly serious about managing forest ecosystems on a long term basis. The policy of completely liquidating old-growth is shortsighted.

Rotation ages of tree crops are increasingly becoming shorter and shorter; in this situation old-growth stands have key roles to play as gene pool reserves, buffers of soil stability, refugia for species slow to reinvade disturbed sites, and perhaps most important, as habitats for old-growth dependent canopy organisms. Old-growth associations as indicators of habitat types are the logical stratification unit for management purposes. Regeneration response, kinds of competing vegetation, thinning intensities and schedules, wildlife habitat value, soil engineering properties, all could be expected to vary according to habitat type. Old-growth stands can be of irreplaceable value to the perceptive recreationist and amateur naturalist. These stands can serve as training sites for future land managers, scientists, and educators, as basic research facilities, and as storehouses of future knowledge.

The location, composition, and structure of Valley-Margin Zone stands all indicate that perturbation of these stands by clearcutting can have serious consequences. Many species of shrubs are abundant and able to provide effective competition to young Pseudotsuga menziesii, which can be a terminal species in the zone. In the lower elevation portions of the zone, old-growth stands evidently do not have the potential to occupy the whole landscape; management aimed at developing full stocking calculated from "normal" stands should be seriously questioned. Hardwood tree species are a major component of some VMZ communities in their terminal stages of development. It is not at all clear that it is either possible or desirable to eliminate these hardwoods from VMZ commercial forest stands. Size class distribution inferences of ages indicate that VMZ Pseudotsuga old-growth stands have some tendency to be all-aged.

Post-fire stands of Pseudotsuga in the Western Hemlock Zone developed from old-growth remnant pockets, stringers, or individual trees. These conditions can be simulated by the shelterwood, seed tree, or clearcutting silvicultural systems. In the case of repeated burns killing early reproduction, scattered old-growth Pseudotsuga must have been important in maintaining local genetic integrity. Extensive mass soil movement and soil creep has churned most of the soils of the zone and kept them immature. Clearcut harvesting can raise the water table, lubricate the bedding planes of the extensive Tyee Formation, and increase erosion hazard. This can be particularly serious when accompanied by road construction or other soil disturbance. Leaving substantial mature forest cover on critical headwalls and slippage lines should be evaluated as a technique for reducing erosion hazard.

Remaining old-growth True Fir Zone stands are few and of limited extent and commercial significance. However their research and educational values are great. The biogeography of these stands can offer clues to post-Pleistocene climates. Their spotty distribution can be compared to island biogeography, offering many research opportunities. The very few Pseudotsuga that become established in these stands may persist for more than six centuries; these trees offer the opportunity for establishing a long-term tree growth ring chronology.

The location, the presence of intolerant species, and the gaps revealed by structural analysis all indicate that Sitka Spruce Zone old-growth is greatly affected by wind. If stands are opened too much there is a good chance that wind will remove many remaining trees. If stands are clearcut, shrubs may occupy valuable growing space in what would otherwise be sites producing very large amounts of wood.

Appendix 2 gives a ranking of the status of the ninety-four 15 x 25 M plots. Secure (S) indicates that the current ownership or management is committed to maintaining the stand. Not secure (NS) indicates that modification is likely. Potentially secure (PS) indicates that a management decision including a preservation option is pending. VMZ plots are 34.8% NS, 21.7% S, and 43.5% PS. The values of old-growth have been recognized, but many decisions are pending which will determine the fate of most of the old-growth in the zone. WHZ plots, by contrast are 80.5% NS, 12.2% PS, and only 7.3% S. This zone is the productive heart of the Coast Range. In spite of nearly complete liquidation in the north and central Coast Range, old-growth values are basically being ignored. Extinction of old-growth dependent organisms and the irretrievable loss of a valuable research resource are likely if this ratio holds. TFZ plots are 28.6% NS, 42.8% PS, and 28.6% S. Considering that economic values are somewhat lower here, an acceptable balance for this zone seems likely in the future. SSZ plots are 39.1% NS, 8.7% PS, and 52.2% S. This is a reflection of the many coastal state parks. With the protection of more inland stands and types, the basic integrity of this zone would not be seriously threatened.

Adding two stands that included full hectare tallies but no 15 x 25 M plots, and assigning, as an estimate, half of the PS plots to NS and half to S, gives a figure for all zones of 66.1% NS and 33.9%S. It is by no means certain that this will be an adequate effort to maintain the integrity of the ecological systems of which Coast Range old-growth types are a part.

SUMMARY AND CONCLUSIONS

This study was undertaken to (1) locate and note the patterns of occurrence of old-growth, (2) classify old-growth into communities based upon species abundances and composition, and (3) determine the structure of old-growth. Ninety-four 15 x 25 M sampling plots and eleven full hectare tallies were taken over the Oregon Coast Range.

The geology of the area is uniform, mostly Tertiary sedimentaries and basalts. Erosion-resistant intrusive masses form higher peaks. Unmodified marine air mass intrusions characterize coastal lowlands. Higher peaks receive a regular winter snowpack. Interior valley foothills experience regular summer drought. All areas are under the influence of an overall maritime climate, although inland portions somewhat less so.

The area can be characterized by four vegetation zones which are practically defined by the ranges of major tree species. The Sitka Spruce Zone (SSZ) is defined by the presence of (or potential for) *Picea sitchensis* and is found along the coastal fog belt. The True Fir Zone (TFZ) is found on the higher Coast Range peaks that receive a winter snowpack where *Abies amabilis* and/or *Abies procera* grow. The Western Hemlock Zone (WHZ) is found inland from the Sitka Spruce Zone and below the True Fir Zone; *Tsuga heterophylla* is a potential climax dominant. Further inland, on the lower east slopes of the Coast Range and where *Tsuga* cannot survive, the Valley-Margin Zone (VMZ) is found.

The Valley-Margin Zone is made up of several associations, the most inland of which were found only behind topographic firebreaks or on cool north and east slopes. With the cessation of periodic fires in post-settlement times there has been general forest encroachment into former hill prairie and savanna. Other communities of the zone are found more generally distributed topographically near the edge of the Western Hemlock Zone.

Valley-Margin Zone stands are the most species rich in trees, shrubs, and herbs of all Coast Range old-growth types. Most widespread is the Pseudotsuga menziesii-Acer macrophyllum/Corylus cornuta var. californica/Adenocaulon bicolor association. The abundances and kinds of species found in the understory of this and other associations of the zone are correlated with relatively low leaf area index values and high sun index values. The presence of small amounts of species otherwise found only in savanna or hill prairie indicate that stands were more open previously, probably due to periodic light ground fires. In addition, tree canopies do not appear to be able to close as tightly as in all other zones. There are from 75 to 200 Pseudotsuga trees (>5 cm d.b.h.) per hectare in the zone, many more than typically found in the adjacent Western Hemlock Zone. The total stand basal area ranges from just under 75 to just under 100 M^2/HA in superlative stands. Two Psme-Acma/Coco/Adbi association stands support an average total biomass of 986 metric tons/HA; when transition communities are included the average is 1095. The average leaf area index is about 27 M^2/M^2. Largest old-growth Pseudotsuga are smaller and younger in this zone than in others; trees seldom exceed 180 cm d.b.h. and 300 years. Woody shrubs are numerous.

The Western Hemlock Zone has an equable climate which allows the growth of Pseudotsuga of enormous size (up to 415 cm d.b.h.). More old-growth communities and associations were encountered in the Western Hemlock Zone than in the other zones. The most frequently encountered associations were the Tsuga heterophylla/Polystichum munitum-Oxalis oregana, the Tsuga/Polystichum, both previously defined, and the Tsuga/Vaccinium ovatum/Polystichum, newly defined. The distribution of the latter was correlated with bouldery ridges in the south Coast Range. South of the Umpqua River a Chamaecyparis lawsoniana variant of the Tsuga/Polystichum-Oxalis association was encountered. The Tsuga-Pseudotsuga/Acer circinatum/Polystichum association was found on steep gravelly slopes, especially just west of the crest of the Coast Range. Communities displaying an abundance of Rhododendron macrophyllum were mostly found in the south Coast Range.

Mass fires evidently ranged widely over the Western Hemlock Zone in times past leaving pockets, stringers, blocks, and scattered individual old-growth stands. These remnants were mostly along streams, shaded slopes, headwalls, stream junctions, and near the perimeter of the major burns. In recent years clearcutting has targeted old-growth for early harvest. These two factors explain much of the current distribution of old-growth.

Near the heart of the Western Hemlock Zone, the *Tsuga*/*Polystichum-Oxalis* association is relatively floristically simple; the species list for the association becomes extended because of stands near the edge of the zone which contain diverse microsites not under the influence of some compensating factor favoring the association. The *Tsuga-Pseudotsuga*/*Acer*/*Polystichum* association contains some of the species and many of the structural attributes of Valley-Margin Zone stands.

Two undisturbed hectares contained 36 and 37 *Pseudotsuga* per hectare; a partially disturbed hectare contained 45. True old-growth *Pseudotsuga* were usually greater than 150 cm d.b.h. The mean value for *Pseudotsuga* (which approaches a normal distribution in the zone) is in the 160 cm d.b.h. size class. Numbers of *Tsuga* per hectare ranged from 165 to 362. Basal area measured over a whole hectare ranged between 71.6 and 96.8 M^2/HA. Values fell short of 100 M^2/HA because of mortality pockets where succession to *Tsuga* was advanced. Individual quarter hectares often exceeded 100 M^2/HA (maximum was 132.9 M^2/HA). Total above ground living biomass averaged 1057.0 metric tons per hectare for twelve quarter hectares; when a transition zone *Pseudotsuga* (*Tsuga*)/*Corylus cornuta* var. *californica* hectare is included the average is 1121.1 metric tons per hectare. One quarter hectare supports 1868.5 metric tons per hectare. The average leaf area index value for the zone is 39.0 M^2/M^2. The average age of oldest dominant trees (all *Pseudotsuga*) was 422 years for stands sampled in the zone. The highest ring count on a stump was 520 years, although *Pseudotsuga* estimated to be 600 or more years old were encountered.

True Fir Zone old-growth stands are isolated truncated relict communities on the highest Coast Range peaks which experience a regular winter snowpack. The only remaining old-growth stands of any extent representing the zone are on Saddle Mountain (Clatsop County), Saddleback Mountain (Lincoln County), "The Green Island" (near Saddle Mountain in Tillamook and Washington Counties), Mary's Peak and Grass Mountain (Benton County). Of these stands, Abies amabilis occurs only on Saddleback and Saddle (Clatsop County) Mountains, which are in the highest precipitation zone of Oregon.

Shrubs are conspicuously absent from the Abies procera/Oxalis oregana association. The Tsuga heterophylla (Abies amabilis)/Vaccinium alaskaense community appears to be shrubbier. Herb species richness is moderate in the zone. Bryophyte cover is very much lower than in the other zones.

Full hectare tallies on Saddleback Mountain and Mary's Peak totaled 75.9 and 82.6 M^2/HA tree basal area respectively. Abies procera totals 251 trees (>5 cm d.b.h.) per hectare on Mary's Peak. Abies amabilis and Tsuga heterophylla share dominance on Saddleback Mountain, totaling 215 and 186 trees per hectare respectively (grand total, 401 trees per hectare). Leaf area index values average 31.6 M^2/M^2.

The Sitka Spruce Zone is found along the coastal fog belt and inland along low elevation valleys under the direct influence of marine air. In the south Coast Range there are no Picea sitchensis dominated communities. In the central Coast Range Picea and Tsuga heterophylla dominate stands within a few kilometers of the coast to the near exclusion of Pseudotsuga. This belt widens in the north Coast Range. The Picea-Tsuga/Gaultheria shallon/Blechnum spicant association is the most widespread association on coastal headlands. Slightly more inland or sheltered areas support the Picea-Tsuga/Polystichum-Blechnum association. Species richness and herb cover are low, and bryophyte cover very high in these two associations. Some species, such as Menziesia ferruginea and Maianthemum dilatatum, which occur in the Cascades and Coast Range True Fir Zone also occur in the Sitka Spruce Zone but not the intervening lowlands. Successional species, including Alnus rubra and many shrubs, appear in ever present openings in old-growth stands of these two associations.

Two hectares representing these associations contained 48 and 37 Picea per hectare and 134 and 164 Tsuga per hectare. Shrub growth form species (>5 cm d.b.h.) contributed significant numbers. Basal area totals 94.6 and 77.6 M^2/HA, with individual quarter hectares as high as 111.7 or as low as 61.5 M^2/HA. Picea of over 200 cm d.b.h. are not at all uncommon. Picea dominants, however, averaged only 270 years old in 15 x 25 M plots. Biomass in these associations averages 1093.9 metric tons per hectare, leaf area index 37.1 M^2/M^2. This suggests enormous primary productivity, seriously reduced by wind mortality.

A series of associations further inland forms a transition in composition and structure to Western Hemlock Zone types. They are less wind-affected than coastward types. The average age of Pseudotsuga dominants in 15 x 25 M plots is 325 years, in between the value for the rest of the Sitka Spruce Zone and the Western Hemlock Zone. A complex pattern of conifer dominance including Picea, Tsuga, Pseudotsuga, Chamaecyparis lawsoniana and Thuja plicata occurs. A full hectare tally of trees in a southern example of the Tsuga-Pseudotsuga-Picea/Polystichum-Eurynchium oreganum-Oxalis oregana-Plagiothecium undulatum association had 208 trees per hectare (350 including shrub growth form species greater than 5 cm d.b.h.) and 120.4 M^2/HA tree basal area. Live above ground biomass was 1565.2 metric tons per hectare and the leaf area index 40.2 M^2/M^2.

Because of gaps and great crown spread, 15 x 25 M plots are not satisfactory for measuring old-growth stand structure. A plot size adequate for such sampling is 50 x 50 M, a quarter hectare.

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APPENDICES

APPENDIX 1

CHECKLIST OF VASCULAR PLANTS AND IMPORTANT MOSSES AND LIVERWORTS OCCURRING WITHIN OLD-GROWTH FOREST PLOTS

Species Name	*	Abbreviation Code
Abies amabilis (Dougl.) Forbes		Abam
Abies grandis (Dougl.) Lindl.		Abgr
Abies procera Rehd.		Abpr
Acer circinatum Pursh		Acci
Acer macrophyllum Pursh		Acma
Achlys triphylla (Smith) DC.		Actr
Actea rubra (Ait.) Willd.		Acru
Adenocaulon bicolor Hook.		Adbi
Adiantum pedatum L.		Adpe
Aira praecox		Arpr
Alnus rubra Bong.		Alru
Amelanchier alnifolia Nutt.		Amal
Anemone deltoidea Hook.		Ande
Anthoceros spp.	L	Anth
Arbutus menziesii Pursh		Arme
Arenaria macrophylla Hook.		Arma
Asarum caudatum Lindl.		Asca
Asplenium trichomanes L.	F	Astr
Athyrium filix-femina (L.) Roth	F	Atfi
Berberis nervosa Pursh		Bene
Blechnum spicant (L.) With	F	Blsp
Bromus spp.		Brom
Bromus vulgaris (Hook.) Shear		Brvu
Calocedrus decurrens (Torr.) Florin.		Cade
Calochortus tolmiei H. & A.		Cato
Calypso bulbosa (L.) Oakes		Cabu
Campanula scouleri Hook.		Case
Cardamine angulata Hook.		Caan
Cardamine oligosperma Nutt.		Caol
Cardamine pulcherrima (Robins.) Greene var. tenella (Pursh) C.L. Hitchc.		Capu

* LN = Lichen
L = Liverwort
F = Fern
M = Moss

Species Name	*	Abbreviation Code
Carex mertensii Prescott		Came
Carex spp.		Casp
Castanopsis chrysophylla (Dougl.) A.DC.		Cach
Chamaecyparis lawsoniana (A. Murr.) Parl.		Chla
Chimaphila menziesii (R.Br.) Spreng.		Chme
Clintonia uniflora (Schult.) Kunth		Clun
Coptis laciniata Gray		Cola
Corallorhiza mertensiana Bong.		Come
Cornus nuttallii Aud. ex T. & G.		Conu
Corylus cornuta Marsh. var. californica (DC.) Sharp		Coco
Cryptogramma crispa (L.) R.Br. ex Hook.	F	Crcr
Cynoglossum grande Dougl.		Cygr
Cynosurus echinatus L.		Cyec
Dicentra formosa (Andr.) Walp.		Difo
Disporum smithii (Hook.) Piper		Dism
Dryopteris austriaca (Jacq.) Woynar ex Schinz & Thell.	F	Drdi
Eriophyllum lanatum (Pursh) Forbes		Erla
Eurynchium oreganum (Sull.) Jaeg & Souerb.	M	Euor
Festuca occidentalis Hook.		Feoc
Festuca rubra L.		Feru
Fragaria vesca L. var. bracteata (Heller) Davis		Frve
Galium oreganum Britt.		Gaor
Galium trifidum L.		Gatr
Gaultheria shallon Pursh		Gash
Glecoma hederaceae L.		Glhe
Goodyera oblongifolia Raf.		Goob
Heuchera micrantha Dougl.		Humi
Hieracium albiflorum Hook.		Hial
Hierochloe occidentalis Buckley		Hioc
Holodiscus discolor (Pursh) Maxim.		Hodi
Hydrophyllum tenuipes Heller		Hyte

* LN = Lichen
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Species Name	*	Abbreviation Code
Hypericum perforatum L.		Hype
Iris tenax Dougl.		Irte
Lathyrus polyphyllus Nutt. ex T. & G.		Lapo
Ligusticum apiifolium (Nutt.) Gray		Liap
Lilium columbianum Hanson		Licl
Linnaea borealis L.		Libo
Listera cordata (L.) R. Br.		Lico
Lithocarpus densiflorus (Hook. & Arn.) Rehd.		Lide
Lobaria pulmonaria (L.) Hoffm.	LN	Loba
Lotus crassifolius (Benth.) Greene		Locr
Luzula campestris (L.) DC.		Luca
Luzula parviflora (Ehrh.) Desv.		Lupa
Luzula spp.		Lusp
Lysichitum americanum Hult. & St. John		Lyam
Madia gracilis (Smith) Keck		Magr
Maianthemum dilatatum (Wood) Nels. & Macbr.		Midi
Melica geyeri Munro		Megi
Melica subulata (Griseb.) Scribn.		Mesu
Menziesia ferruginea Smith		Mefe
Microsteris gracilis (Hook.) Greene		Migr
Mimulus guttatus DC.		Migu
Mitella spp.		Mitl
Monotropa uniflora L.		Moun
Montia diffusa (Nutt.) Greene		Modi
Montia sibirica (L.) How.		Mosi
Mosses	M	Moss
Myrica californica Cham.		Myca
Nemophila pedunculata Dougl.		Nepe
Oplopanax horridum (J.E. Smith) Miq.		Opho
Osmaronia cerasiformis (T. & G.) Greene		Osce
Osmorhiza chilensis H. & A.		Osch
Oxalis oregana Nutt. ex T. & G.		Oxor
Oxalis suksdorfii Trel.		Oxsu

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Species Name	*	Abbreviation Code
Peltigera cannina (L.) Willd.	LN	Pelt
Petasites frigidus (L.) Fries		Pefr
Philadelphus lewisii Pursh		Phle
Picea sitchensis (Bong.) Carr.		Pisi
Pinus ponderosa Dougl.		Pipo
Plagiothecium undulatum (Hedw.) BSG.	M	Plun
Poa spp.		Poas
Polystichum munitum (Kaulf.) Presl	F	Pomu
Pseudotsuga menziesii (Mirb.) Franco		Psme
Pteridium aquilinum (L.) Kuhn	F	Ptaq
Pyrola secunda L.		Pyse
Quercus garryana Dougl.		Quga
Quercus kelloggii Newberry		Quke
Rhamnus purshiana DC.		Rhpu
Rhododendron macrophyllum G. Don		Rhma
Rhus diversiloba T. & G.		Rhdi
Ribes spp.		Ribe
Rosa gymnocarpa Nutt.		Rogy
Rubus nivalis Dougl. ex Hook.		Runi
Rubus parviflorus Nutt.		Rupa
Rubus spectabilis Pursh		Rusp
Rubus ursinus Cham. & Schlecht.		Ruur
Sambucus racemosa L. var. arborescens (T. & G.) Gray		Samb
Sanicula crassicaulis Poepp.		Sacr
Satureja douglasii (Benth.) Briq.		Sado
Scrophularia spp.		Scro
Sedum spathulifolium Hook.		Sesp
Senecio triangularis Hook.		Setr
Smilacina racemosa (L.) Desf.		Smra
Smilacina stellata (L.) Desf.		Smst
Stachys mexicana Benth.		Stme
Stachys spp.		Stsp
Streptopus amplexifolius (L.) DC. var. americanus Schult.		Stam
Symphoricarpos mollis Nutt. var. hesperius (G.N. Jones) Cronq.		Symo

* LN = Lichen
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Species Name	*	Abbreviation Code
Synthyris reniformis (Dougl.) Benth.		Syre
Taxus brevifolia Nutt.		Tabr
Tellima grandiflora (Pursh) Dougl.		Tegr
Thalictrum occidentale Gray		Thoc
Thuja plicata Donn		Thpl
Tiarella trifoliata L.		Titr
Tiarella unifoliata Hook.		Tiun
Trientalis latifolia Hook.		Trla
Trillium ovatum Pursh		Trov
Trisetum cernuum Trin.		Trce
Tsuga heterophylla (Raf.) Sarg.		Tshe
Umbellularia californica (Hook. & Arn.) Nutt.		Umca
Vaccinium alaskaense How.		Vaal
Vaccinium membranaceum Dougl. ex Hook.		Vame
Vaccinium ovatum Pursh		Vaov
Vaccinium parvifolium Smith		Vapa
Vancouveria hexandra (Hook.) Morr. & Dec.		Vahe
Veratrum californicum Durand		Veca
Viola adunca Smith		Viad
Viola glabella Nutt.		Vigl
Viola sempervirens Greene		Vise
Viola spp.		Visp
Whipplea modesta Torr.		Whmo
Xerophyllum tenax (Pursh) Nutt.		Xete

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L = Liverwort
F = Fern
M = Moss

APPENDIX 2

LOCATION AND GENERAL CHARACTERISTICS OF 15x25M PLOTS

Plot No.	Location	Aspect	Elev (M)	Slope (°)	Status *	Est. Tree Canopy Density (%±5)
101	T28S R8W Sec16 SE1/4 NW1/4	NNE	580	14	PS	70
102	T22S R7W Sec15 SW1/4 NE1/4 SE1/4	SSW	50	28	S	55
103	T19S R4W Sec9 SW1/4 SE1/4 SE1/4	SSW	185	31	PS	50
104	T19S R4W Sec9 NW1/4 SE1/4 SE1/4	S	200	27	PS	70
105	T19S R4W Sec9 SE1/4 NE1/4	SSE	245	15	PS	50
106	T19S R4W Sec25 NE1/4 SW1/4	NNW	275	0	PS	70
107	T16S R6W Sec28 SE1/4 NW1/4	W	135	35	S	70
108	T16S R6W Sec28 SE1/4 NW1/4	SW	115	16	S	55
109	T12S R7W Sec25 NE1/4 SE1/4	SE	365	19	NS	75
110	T12S R7W Sec13 NE1/4 SE1/4	W	255	0	PS	70
111	T12S R7W Sec13 SE1/2 SE1/4	W	260	11	PS	70
112	T11S R5W Sec8 NW1/4 SE1/4	N	290	10	PS	80
113	T11S R5W Sec8 SE1/4 SE1/4	NNE	350	27	PS	75
114	T11S R5W Sec8 NW1/4 SE1/4	SW	335	26	PS	75
115	T11S R5W Sec7 NE1/4 SE1/4	SW	300	7	NS	80
116	T10S R5W Sec22 NW1/4 SE1/4	NW	250	25	NS	65
117	T8S R6W Sec33 W1/2 NW1/4	W	225	0	S	65
118	T8S R6W Sec33 W1/2 NW1/4	NNE	180	14	S	70
119	T7S R6W Sec29 NW1/4 NW1/4 SW1/4	SW	625	21	NS	70
120	T3S R5W Sec7 NW1/4 SE1/4	SW	285	5	NS	85
121	T3S R5W Sec7 NW1/4 SE1/4	SE	280	6	NS	80
122	T23S R8W Sec27 SE1/4 NE1/4	SW	500	32	NS	70
123	T21S R5W Sec19 N1/2 NE1/4	ESE	135	17	NS	65
201	T28S R9W Sec5 NE1/4 NW1/4	SE	370	25	NS	95
202	T28S R9W Sec33 NE1/4 SW1/4	WSW	640	3	NS	80
203	T28S R9W Sec5 NE1/4 NW1/4	SW	390	31	NS	70
204	T28S R7W Sec5 NE1/4 NW1/4	WNW	370	40	NS	90
205	T27S R9W Sec24 NE1/4 SW1/4	S	762	2	NS	80
206	T27S R10W Sec18 NW1/4 SW1/4	NW	310	35	S	85
207	T27S R10W Sec18 NW1/4 NW1/4 SW1/4	SW	280	33	S	70
208	T26S R10W Sec16 NE1/4 NW1/4 NW1/4	N	275	27	NS	85
209	T23S R8W Sec31 SE1/4 SE1/4 NW1/4	SW	590	34	NS	85
210	T23S R8W Sec31 SE1/4 SE1/4 NW1/4	SW	585	29	NS	70
211	T23S R10W Sec2 SW1/4 NW1/4 NW1/4	NNE	230	9	NS	95
212	T22S R7W Sec15 SE1/4 NW1/4 SE1/4	N	50	18	S	60
213	T19S R10W Sec28 NW1/4 NW1/4	WSW	290	45	NS	65
214	T19S R10W Sec15 W1/2 SW1/4	S	430	26	NS	95
215	T16S R11W Sec24 SW1/4 NW1/4	NW	245	26	NS	70

Plot No.	Location	Aspect	Elev (M)	Slope (°)	Status *	Est. Tree Canopy Density (%+5)
216	T15S R8W Sec17 SE1/4 NW1/4	NNE	495	32	NS	95
217	T15S R10W Sec29 NW1/4 NW1/4	NW	411	14	NS	90
218	T15S R8W Sec17 SE1/4 NW1/4	SW	495	11	NS	95
219	T15S R8W Sec32 SE1/4 NE1/4	S	280	32	NS	90
220	T15S R8W Sec32 SE1/4 NE1/4	W	265	47	NS	60
221	T12S R10W Sec29 SE1/4 NW1/4	SSW	355	32	PS	90
222	T12S R7W Sec23 SE1/4 NE1/4 NE1/4	ESE	255	3	NS	55
223	T12S R7W Sec23 SW1/4 NE1/4 NE1/4	ESE	270	5	NS	85
224	T12S R7W Sec14 SE1/4 NE1/4	NNW	295	37	PS	60
225	T9S R7W Sec9 SW1/4 SE1/4 SW1/4	S	870	14	NS	80
226	T7S R8W Sec30 NE1/4 NE1/4 NW1/4	SE	335	18	PS	70
227	T6S R9W Sec14 SW1/4 NE1/4 NE1/4	SSE	190	14	PS	95
228	T3S R7W Sec17 NW1/4 SE1/4 SE1/4	SE	340	3	NS	65
229	T3S R6W Sec7 E1/2 SE1/4 SE1/4	WSW	480	16	NS	95
230	T3S R6W Sec7 E1/2 SE1/4 SE1/4	W	485	10	NS	95
231	T3S R6W Sec7 E1/2 SE1/4 SE1/4	W	485	26	NS	90
232	T3S R8W Sec3 NW1/4 SW1/4	SE	425	20	NS	90
233	T3S R8W Sec3 NW1/4 SW1/4	SE	365	34	NS	95
234	T2N R10W Sec1 SE1/4 NW1/4	E	95	22	NS	65
235	T6N R6W Sec7 SE1/4 SW1/4 NE1/4	NW	280	17	NS	65
236	T8N R6W Sec9 SE1/4 SW1/4	NNE	75	43	NS	50
237	T16S R8W Sec4 SW1/4 NE1/4 NW1/4	W	260	38	NS	65
238	T12S R7W Sec29 NW1/4 NW1/4 SE1/4	SW	475	22	NS	85
239	T12S R7W Sec29 NW1/4 NW1/4 SE1/4	SE	470	16	NS	85
240	T22S R10W Sec22 NE1/4 SW1/4 SE1/4	NNE	130	30	PS	80
241	T21S R9W Sec10 SE1/4 NW1/4 SE1/4	SSW	145	20	NS	85
301	T13S R8W Sec21 SW1/4 SW1/4	NW	990	32	NS	70
302	T12S R7W Sec20 SE1/4 SE1/4	W	1160	17	PS	80
303	T12S R7W Sec20 SE1/4 SE1/4	NW	1110	16	PS	70
304	T12S R7W Sec21 W1/2 SW1/4 NW1/4	W	1160	15	PS	95
305	T3S R6W Sec29 SW1/4 NE1/4	N	880	24	NS	85
306	T6N R8W Sec34 SW1/4 NE1/4	S	920	45	S	80
307	T6N R8W Sec34 NE1/4 SW1/4	NE	915	37	S	95
401	T26S R14W Sec2 E1/2 NW1/4	ESE	10	27	PS	90
402	T16S R12W Sec24 NW1/4 NW1/4	W	120	38	NS	65
403	T16S R12W Sec24 NW1/4 NW1/4	W	115	27	NS	60
404	T15S R12W Sec11 NW1/4 NW1/4	NNW	90	29	NS	55
405	T7S R10W Sec8 NE1/4 NW1/4	SSE	175	5	NS	95
406	T7S R10W Sec8 NE1/4 NW1/4	ESE	170	27	NS	90
407	T6S R11W Sec11 SE1/4 NW1/4	SSE	140	26	S	60
408	T6S R11W Sec11 SW1/4 NW1/4	S	135	29	S	60
409	T6S R11W Sec2 NW1/4 SW1/4	W	150	9	S	75
410	T3S R10W Sec7 SE1/4 SE1/4	WNW	75	32	NS	90

Plot No.	Location	Aspect	Elev (M)	Slope (°)	Status *	Est. Tree Canopy Density (%±5)
411	T3S R11W Sec1 NW1/4 NE1/4	ESE	245	12	S	75
412	T3S R11W Sec1 SW1/4 NW1/4	NNW	200	28	S	90
413	T3S R11W Sec1 SW1/4 NW1/4	NNW	205	20	S	65
414	T3S R11W Sec1 NW1/4 NE1/4	E	240	29	S	70
415	T1S R11W Sec13 SW1/4 NE1/4	S	120	11	S	85
416	T1S R11W Sec13 NW1/4 SE1/4	E	115	16	S	60
417	T1N R10W Sec5 SE1/4 SW1/4 NW1/4	SE	10	0	NS	75
418	T2N R10W Sec1 SE1/4 NW1/4	NE	100	11	NS	60
419	T3N R10W Sec7 SE1/4 NE1/4 SW1/4	ENE	65	6	S	70
420	T5N R7W Sec32 SW1/4 SE1/4	N	175	4	NS	80
421	T5N R10W Sec6 SE1/4 NW1/4 NW1/4	SE	290	24	S	85
422	T5N R10W Sec6 SE1/4 NW1/4 NW1/4	SE	265	24	S	75
423	T22S R12W Sec24 SW1/4 SE1/4	SSW	180	32	PS	80

* Status: S = Secure; ownership status (park, etc.) or management committed to preservation.

PS = Potentially secure; unofficial preservation or management decision including preservation option pending.

NS = Not secure; modification decided upon or likely.

APPENDIX 3

LOCATION AND CHARACTERISTICS OF FULL HECTARE TALLIES BY QUARTER HECTARE PLOTS

Plot No.	Location	Name	Shape[1]	Status[2]
101T 102T 103T 104T	T12S R7W Sec13 NE1/4 SE1/4	Mary's Peak Watershed	Block	PS
105T 106T 107T 108T	T11S R5W Sec8 SE1/4 SE1/4 T11S R5W Sec8 NW1/4 SE1/4	MacDonald Forest	105T & 106T adjacent 107T & 108T adjacent	PS
109T 110T 111T 112T	T8S R6W Sec33 W1/2 NW1/4	Little Sink RNA	Strip	S
201T 202T 203T 204T	T23S R8W Sec32 NW1/4 SE1/4	Upper Camp Creek	Strip	NS
205T 206T 207T 208T	T15S R8W Sec17 SE1/4 NW1/4	Taylor Butte	Block	NS

Plot No.	Location	Name	Shape[1]	Status[2]
209T 210T 211T 212T	T22S R10W Sec22 NE1/4 SW1/4 SE1/4	Elliott State Forest Bench	Block	PS
301T 302T 303T 304T	T12S R7W Sec20 SE1/4 SE1/4	Mary's Peak Summit	Strip	PS
305T 306T 307T 308T	T7S R9W Sec3 SE1/4 NW1/4	Saddleback Mountain	Block	NS
401T 402T 403T 404T	T22S R12W Sec24 SW1/4 SE1/4	Schofield Ridge	401T, 402T, 403T Strip 404T = 25Mx100M adjacent to 402T & 403T	NS
405T 406T 407T 408T	T6S R11W Sec2 SW1/4 & SE1/4 of NW1/4	Cascade Head	Strip	S

Plot No.	Location	Name	Shape[1]	Status[2]
409T 410T	T3S R11W Sec1 NW1/4 NE1/4	Cape Lookout	409T & 410T adjacent	S
411T 412T	T3S R11W Sec1 SW1/4 NW1/4		411T & 412T adjacent	

[1]Shape: Strip = Four 50x50M 1/4 ha. plots in a 50x200M rectangle.
Block = Four 50x50M 1/4 ha. plots in a 100x100M square.
Others (except 401T-404T) = Two 50x50M 1/4 ha. plots in a 50x100M rectangle; two (non-contiguous) rectangles = 1 ha.

[2]Status: S = Secure; ownership status (park, etc.) or management committed to preservation.

PS = Potentially secure; unofficial preservation or management decision including preservation option pending.

NS = Not secure; modification decided upon or likely.

APPENDIX 4

BIOMASS EQUATIONS AND SOURCES

Species Encountered In This Study	Species Equation Developed For	Biomass Regression (in Fortran IV)**	Author
Psme Abgr Pisi	Psme	SW=EXP(2.530*ALOG(DOB)-2.656) SB=EXP(2.390*ALOG(DOB)-4.108) BL=EXP(2.389*ALOG(DOB)-4.786) BD=EXP(1.400*ALOG(DOB)-2.455) FN=EXP(1.899*ALOG(DOB)-4.962) FT=EXP(1.982*ALOG(DOB)-4.151)	Grier and Logan, in press
Tshe Tabr	Tshe	SW=EXP(2.257*ALOG(DOB)-2.172) SB=EXP(2.258*ALOG(DOB)-4.373) BL=EXP(2.778*ALOG(DOB)-5.149) BD=EXP(1.313*ALOG(DOB)-2.409) FN=EXP(2.124*ALOG(DOB)-5.379) FT=EXP(2.128*ALOG(DOB)-4.130)	Grier and Logan, in press
Arme Alru Acci Cach Umca Rhma	Cach	SW=EXP(2.658*ALOG(DOB)-3.708) SB=EXP(2.989*ALOG(DOB)-5.923) BL=EXP(2.576*ALOG(DOB)-4.579) BD=EXP(2.883*ALOG(DOB)-7.124) FN=EXP(1.535*ALOG(DOB)-4.365) FT=EXP(1.693*ALOG(DOB)-3.123)	Grier and Logan, in press
Acma	Acma	SW=EXP(2.723*ALOG(DOB)-3.493) SB=EXP(2.574*ALOG(DOB)-4.574) BL=EXP(2.430*ALOG(DOB)-4.236) BD=EXP(1.092*ALOG(DOB)-2.116) FT=EXP(1.617*ALOG(DOB)-3.765)	Grier and Logan, in press

Species Encountered In This Study	Species Equation Developed For	Biomass Regression (in Fortran IV)**	Author
Thpl	*Thuja occidentalis*	SW=10.0**(2.3665*ALOG10(DOB)+2.7147)/1000.0 SB=10.0**(1.9492*ALOG10(DOB)+2.0166)/1000.0 BRATOT=10.0**(2.3307*ALOG10(DOB)+2.1000)/1000.0 FT=10.0**(1.915*ALOG10(DOB)+2.0977)/1000.0	Reiners, 1972
Abam Abpr	Abam	FT=EXP(2.0877*ALOG(DOB)-4.5)	Grier, personal communication
Conu	*Cornus florida*	TB=10.0**(2.371+2.414*ALOG10(DOB))/1000.0	Thomas, 1969
Coco	*Corylus cornuta* (Minnesota)	FT=39.4+0.015*BA*ACF)/ACF TB=(-683.3+1850.3*BA*ACF)/ACF	Tappeiner and John, 1973

** All biomass values in Kg/Ha.
SW = Stemwood
SB = Stembark
BL = Live Branches
BD = Dead Branches
FN = New Foliage
FT = Total Foliage
BRATOT = Branch Total Biomass
DOB = Diameter Outside Bark in cm.
ACF = Area Conversion Factor--from Biomass/Plot to Biomass/Hectare
BA = Ground Level Basal Area in M^2

APPENDIX 5

LEAF AREA EQUATIONS AND SOURCES

Species Encountered In This Study	Species Equation Developed For	Leaf Area Regression (in Fortran IV)**	Author
Psme,Abgr	Psme	FA=FN*204.3/10.0+FO*161.7/10.0	Gholz et.al., 1976
Abpr	Abpr	FA=FT*131.9/10.0	Gholz et.al., 1976
Tshe	Tshe	FA=FN*210.0/10.0+FO*197.0/10.0	Gholz et.al., 1976
Thpl	Thpl	FA=FT*176.7/10.0	Gholz et.al., 1976
Arme	Rhma	FA=FT*261.2/10.0	Gholz, personal communication
Pisi	Pisi	FA=FT*140.0/10.0	Kruger and Ruth, 1969
Abam	Abam	FA=FT*152.0/10.0	Gholz et.al., 1976
Cach	Cach	FA=FT*140.4/10.0	Gholz et.al., 1976
Tabr	Tabr	FA=FT*155.7/10.0	Gholz et.al., 1976
Conu,Alru,Acci	estimate	FA=FT*250.0/10.0	J. Means, personal communication
Coco	estimate	FA=FT*200.0/10.0	J. Means, personal communication

** FA = Foliage Area (M^2/tree)
FT = Foliage Total (Kg/Ha)
FO = Old Foliage (Kg/Ha)
FN = New Foliage (Kg/Ha)

APPENDIX 6

CONSTANCY AND COVER VALUES FOR VALLEY-MARGIN ZONE COMMUNITIES
WITH FEW REPRESENTATIVE PLOTS

Stratum & Species	Pipo-Psme-Cade/Rhdi	Psme-Cade/Coco/Lapo					Psme-Acma/Coco/Brvu	Psme/Hodi			Psme (Tshe)/Coco					Psme-Thpl/Gash/Libo				
	Av. % Cover 105	Av. % Cover	Av. % Const.	104	122	123	Av. % Cover 113	Av. % Cover	108	119	Av. % Cover	Av. % Const.	110	111	236	Av. % Cover	Av. % Const.	101	120	121
TREE																				
Pseudotsuga menziesii	15	63.3	100	40	85	65	90	75	60	90	80	100	85	95	60	75	100	80	65	80
Pinus ponderosa	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calocedrus decurrens	15	30.0	100	55	15	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arbutus menziesii	-	8.3	100	10	5	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercus kelloggii	-	1.7	33.3	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercus garryana	*	-	-	-	-	-	-	2.5	5	-	1.7	33.3	5	-	-	-	-	-	-	-
Acer macrophyllum	-	1.7	33.3	*	-	5	20	-	-	-	10	33.3	-	-	30	8.3	66.7	*	10	15
Cornus nuttallii	-	1.7	33.3	-	-	5	-	2.5	5	-	-	-	-	-	-	1.7	33.3	-	-	5
Abies grandis	-	-	-	-	-	-	5	5.0	10	-	1.7	33.3	*	5	-	15.0	66.7	25	20	*
Tsuga heterophylla	-	-	-	-	-	-	-	-	-	-	1.7	33.3	-	-	5	-	-	-	-	-
Thuja plicata	-	-	-	-	-	-	-	-	-	-	*	*	-	-	*	11.7	100	10	15	10
Castanopsis chrysophylla	-	-	-	-	-	-	-	*	*	-	-	-	-	-	-	1.7	33.3	5	-	-
Taxus brevifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7	33.3	-	5	-
SHRUB																				
Corylus cornuta	5	15.0	100	15	15	15	5	10.0	15	5	8.3	100	5	5	15	3.3	66.7	5	-	5
Polystichum munitum	5	8.3	100	5	5	15	15	7.5	15	-	35.0	100	15	5	85	8.3	100	5	15	5
Symphoricarpos mollis	5	5.0	100	5	5	5	*	7.5	15	*	1.7	33.3	*	5	-	6.7	66.7	15	-	5
Quercus garryana	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinus ponderosa	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhus diversiloba	65	15.0	66.7	40	-	5	-	*	*	-	-	-	-	-	-	-	-	-	-	-
Arbutus menziesii	5	3.3	66.7	5	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudotsuga menziesii	15	3.3	66.7	5	-	5	-	2.5	5	-	-	-	-	-	-	-	-	-	-	-
Rubus parviflorus	-	1.7	33.3	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Holodiscus discolor	-	23.3	100	15	40	15	-	52.5	65	40	10.0	66.7	15	-	15	-	-	-	-	-
Rosa gymnocarpa	*	5.0	100	5	5	5	-	15.0	15	15	8.3	100	5	15	5	3.3	66.7	5	*	5
Gaultheria shallon	-	6.7	66.7	-	15	5	-	50	-	100	31.7	100	40	40	15	70	100	85	85	40
Berberis nervosa	-	43.3	100	5	85	40	-	2.5	-	5	15.0	100	15	15	15	28.3	100	40	40	5
Pteridium aquilinum	-	1.7	33.3	-	-	5	5	7.5	15	-	6.7	66.7	5	15	-	1.7	33.3	-	-	5
Acer macrophyllum	-	*	*	*	-	-	5	-	-	-	5.0	33.3	-	-	15	*	*	*	-	-
Abies grandis	-	-	-	-	-	-	5	2.5	5	-	3.3	66.7	5	5	-	16.7	100	40	5	5
Cornus nuttallii	-	-	-	-	-	-	-	2.5	5	-	*	*	-	*	-	-	-	-	-	-
Acer circinatum	-	*	*	-	-	*	-	10.0	5	15	26.7	66.7	65	15	-	3.3	66.7	-	5	5
Osmaronia cerasiformis	-	-	-	-	-	-	-	7.5	15	-	-	-	-	-	-	-	-	-	-	-
Castanopsis chrysophylla	-	-	-	-	-	-	-	2.5	5	-	5.0	33.3	-	15	-	-	-	-	-	-
Vaccinium parvifolium	-	-	-	-	-	-	-	5.0	5	5	1.7	33.3	-	5	-	3.3	66.7	-	5	5
Thuja plicata	-	-	-	-	-	-	-	-	-	-	1.7	33.3	-	-	5	1.7	33.3	5	-	-
Rhamnus purshiana	-	-	-	-	-	-	-	-	-	-	-	-	*	*	-	1.7	33.3	-	-	5

Stratum & Species	Pipo-Psme-Cade/Rhdi Av. % Cover 105	Psme-Cade/Coco/Lapo Av. % Cover	Psme-Cade/Coco/Lapo Av. % Const.	Psme-Cade/Coco/Lapo 104	Psme-Cade/Coco/Lapo 122	Psme-Cade/Coco/Lapo 123	Psme-Acma/Coco/Brvu Av. % Cover 113	Psme/Hodi Av. % Cover	Psme/Hodi 108	Psme/Hodi 119	Psme (Tshe)/Coco Av. % Cover	Psme (Tshe)/Coco Av. % Const.	Psme (Tshe)/Coco 110	Psme (Tshe)/Coco 111	Psme (Tshe)/Coco 236	Psme-Thpl/Gash/Libo Av. % Cover	Psme-Thpl/Gash/Libo Av. % Const.	Psme-Thpl/Gash/Libo 101	Psme-Thpl/Gash/Libo 120	Psme-Thpl/Gash/Libo 121
HERB																				
Mosses	26.8	17.6	100	31.3	13.6	8.0	9.0	28.9	49.1	8.6	32.4	100	41.7	54.3	1.1	22.6	100	27.9	23.5	16.4
Xerophyllum tenax	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quercus garryana	6.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aira praecox	5.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cynosurus echinatus	2.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardamine oligosperma	.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Festuca rubra	.5	1.0	66.7	.3	-	2.8	-	-	-	-	.3	33.3	-	.9	-	-	-	-	-	-
Hypericum perforatum	.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microsteris gracilis	.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chimaphila menziesii	-	-	-	-	**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubus parviflorus	-	-	-	-	-	**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lathyrus pol yphyllus	1.5	3.5	100	.3	9.6	.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Madia gracilis	1.4	1.5	100	1.6	2.5	.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eriophyllum lanatum	2.6	TR	33.3	-	-	.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cynoglossum grande	-	1.8	66.7	5.3	-	.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Satureja douglasii	2.7	.7	100	.3	.1	1.6	-	.6	1.1	-	-	-	-	-	-	-	-	-	-	-
Whipplea modesta	.9	1.4	66.7	-	3.1	1.1	-	.1	.2	-	-	-	-	-	-	-	-	-	-	-
Rhus diversiloba	12.3	8.0	66.7	13.7	-	10.3	-	1.1	2.1	-	-	-	-	-	-	-	-	-	-	-
Pseudotsuga menziesii	.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	TR	33.3	.1	-	-
Dicentra formosa	.7	-	-	-	-	-	-	TR	.1	-	-	-	-	-	-	-	-	-	-	-
Fragaria vesca	.4	.5	66.7	.8	.8	-	-	.6	1.1	-	-	-	-	-	-	-	-	-	-	-
Iris tenax	.3	1.6	100	3.8	.7	.3	-	-	-	-	-	-	-	-	-	.2	33.3	.5	-	-
Polystichum munitum	.5	.2	66.7	-	.1	.5	5.3	6.2	12.3	-	6.2	100	5.0	**	13.5	1.3	100	.1	2.6	1.3
Adenocaulon bicolor	3.4	3.2	100	6.5	2.6	.5	9.1	.2	.3	-	1.6	100	1.3	3.6	**	1.7	100	4.6	.1	.5
Galium trifidum	3.3	.7	100	.6	.1	1.3	.8	.7	1.4	-	1.6	100	3.9	.8	**	1.2	100	.5	2.1	1.0
Synthyris reniformis	3.4	2.3	100	.3	4.0	2.6	-	1.0	1.9	-	2.4	66.7	2.8	4.3	-	-	-	-	-	-
Osmorhiza chilensis	6.0	2.0	100	3.4	1.1	1.6	1.5	-	-	-	.1	33.3	.3	-	-	.8	66.7	1.3	-	1.0
Bromus vulgaris	2.0	1.6	66.7	3.8	-	.9	9.8	.3	.5	-	.7	100	1.3	.8	**	TR	33.3	-	.1	-
Trientalis latifolia	1.8	1.4	100	1.0	.3	2.8	1.3	1.8	3.5	-	.2	100	.6	.1	**	4.0	100	6.8	4.4	.8
Symphoricarpos mollis	1.6	1.3	100	1.1	.8	1.9	2.3	4.2	6.8	1.8	3.9	66.7	2.1	9.7	-	.9	33.3	2.7	-	-
Rosa gymnocarpa	.2	1.4	100	3.3	.3	.7	.5	2.7	3.0	2.3	.1	33.3	.3	-	-	.6	66.7	.5	1.3	-
Berberis nervosa	-	5.4	100	**	8.8	7.3	-	1.7	-	3.3	2.6	100	3.6	1.2	2.9	2.3	100	2.1	1.3	3.5
Gaultheria shallon	-	1.2	66.7	-	2.7	.9	-	20.4	-	40.8	9.5	100	8.8	17.2	2.4	3.8	100	4.3	1.4	5.7
Vancouveria hexandra	-	.5	66.7	-	1.5	.1	14.3	.4	.7	-	1.5	66.7	1.3	3.1	-	2.4	66.7	.5	-	6.4
Achlys triphylla	-	.2	33.3	-	.5	-	1.8	8.1	-	16.2	.2	33.3	-	.5	-	1.4	100	3.2	.6	.5
Disporum smithii	-	.3	66.7	-	.7	.2	3.3	.3	.5	-	.2	33.3	-	.7	-	1.0	66.7	1.8	-	1.3
Viola glabella	-	.9	100	.2	1.0	.5	5.1	TR	.1	-	.2	66.7	.3	.3	-	-	-	-	-	-
Oxalis suksdorfii	-	.8	66.7	-	1.0	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromus spp.	-	.2	33.3	-	.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petasites frigidus	-	TR	33.3	-	.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardamine purcherrima	-	.2	100	**	**	.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calochortus tolmiei	-	.2	33.3	-	-	.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Festuca occidentalis	-	1.5	66.7	-	3.8	.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eurynchium oreganum	-	9.2	66.7	-	20.8	6.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sanicula crassicaulis	-	.7	66.7	-	2.1	**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corylus cornuta	-	TR	66.7	-	.1	.1	-	.3	.5	-	-	-	-	-	-	-	-	-	-	-
Luzula campestris	.3	TR	66.7	.1	-	.1	-	-	-	-	.3	33.3	-	.9	-	-	-	-	-	-

	Pipo-Psme-Cade/Rhdi	Psme-Cade/Coco/Lapo					Psme-Acma/Coco/Brvu	Psme/Hodi			Psme (Tshe)/Coco					Psme-Thpl/Gash/Libo				
Stratum & Species	Av. % Cover 105	Av. % Cover	Av. % Const.	104	122	123	Av. % Cover 113	Av. % Cover	108	119	Av. % Cover	Av. % Const.	110	111	236	Av. % Cover	Av. % Const.	101	120	121
HERB																				
Calypso bulbosa	**	-	-	**	**	**	**	TR	.1	-	-	-	-	-	-	-	-	-	-	-
Campanula scouleri	-	.4	33.3	1.3	-	-	-	-	-	-	2.7	66.7	1.8	6.3	-	.4	66.7	.8	.5	-
Anemone deltoidea	-	.2	100	.5	.1	.1	-	-	-	-	.9	66.7	.7	2.0	-	TR	33.3	-	.2	-
Goodyera oblongifolia	-	.2	100	.5	**	.2	-	.4	.7	-	.4	66.7	1.1	.1	-	.5	100	.6	.3	.6
Viola sempervirens	-	.1	33.3	-	-	.3	-	-	-	-	-	-	-	-	-	1.8	66.7	5.0	.4	-
Acer macrophyllum	-	TR	33.3	.1	-	-	-	-	-	-	-	-	-	-	-	TR	33.3	.2	-	-
Hierochloe occidentalis	-	.4	33.3	-	1.3	-	-	-	-	-	-	-	-	-	-	2.0	33.3	6.1	-	-
Lilium columbianum	-	.2	33.3	-	.5	-	-	-	-	-	TR	33.3	-	.1	-	-	-	-	-	-
Acer circinatum	-	.1	33.3	-	-	.3	-	-	-	-	.7	66.7	.4	1.8	-	.4	66.7	-	.1	1.0
Hieracium albiflorum	-	TR	33.3	-	-	.1	-	-	-	-	TR	33.3	.1	-	-	-	-	-	-	-
Montia sibirica	-	TR	33.3	-	-	.1	-	-	-	-	TR	33.3	-	-	.2	-	-	-	-	-
Nemophila pedunculata	-	.1	33.3	.3	-	-	-	-	-	-	.2	33.3	-	.5	-	-	-	-	-	-
Arenaria macrophylla	.1	-	-	-	-	-	7.4	.2	.4	-	1.3	66.7	.7	3.3	-	-	-	-	-	-
Trillium ovatum	-	-	-	-	-	-	1.0	.4	.7	-	.2	66.7	.5	.1	-	.9	100	1.3	.7	.6
Pteridium aquilinum	-	-	-	-	-	-	.7	.1	.2	-	.7	66.7	.6	1.4	-	-	-	-	-	-
Smilacina racemosa	-	-	-	-	-	-	.1	1.2	2.3	-	.4	33.3	-	1.3	-	-	-	-	-	-
Smilacina stellata	-	-	-	-	-	-	-	11.9	23.7	-	.4	66.7	1.1	.1	-	TR	33.3	-	.1	-
Rubus ursinus	-	-	-	-	-	-	-	5.1	9.4	.7	.6	66.7	.8	-	1.1	1.7	66.7	-	.7	4.3
Ligusticum apiifolium	-	-	-	-	-	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-
Actea rubra	-	-	-	-	-	-	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Stachys spp.	-	-	-	-	-	-	-	.6	1.1	-	-	-	-	-	-	-	-	-	-	-
Osmaronia cerasiformis	-	-	-	-	-	-	-	TR	.1	-	-	-	-	-	-	-	-	-	-	-
Vaccinium parvifolium	-	-	-	-	-	-	-	TR	-	.1	-	-	-	-	-	-	-	-	-	-
Cornus nuttallii	-	-	-	-	-	-	-	-	-	-	.2	33.3	-	.5	-	TR	33.3	-	.1	-
Abies grandis	-	-	-	-	-	-	-	-	-	-	TR	33.3	-	.1	-	.1	66.7	-	.2	.1
Tiarella unifoliata	-	-	-	-	-	-	-	-	-	-	TR	33.3	-	-	.1	.3	33.3	.8	-	-
Rhamnus purshiana	-	-	-	-	-	-	-	-	-	-	TR	66.7	.2	.1	-	-	-	-	-	-
Castanopsis chrysophylla	-	-	-	-	-	-	-	-	-	-	.2	33.3	-	.5	-	-	-	-	-	-
Plagiothecium undulatum	-	-	-	-	-	-	-	-	-	-	.3	33.3	-	-	1.0	-	-	-	-	-
Melica subulata	-	-	-	-	-	-	-	-	-	-	.2	33.3	-	-	.7	-	-	-	-	-
Galium oreganum	-	-	-	-	-	-	-	-	-	-	.2	33.3	-	-	.5	-	-	-	-	-
Lobaria pulmonaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.4	100	.1	.5	.5
Oxalis oregana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.8	66.7	-	2.2	15.3
Asarum caudatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.6	66.7	-	1.3	.5
Coptis laciniata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.8	33.3	2.3	-	-
Asplenium trichomanes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.7	33.3	-	-	2.1
Lotus crassifolius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.2	33.3	.7	-	-
Tellima grandiflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.2	33.3	.5	-	-
Thuja plicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	TR	33.3	-	-	.2
Maianthemum dilatatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	TR	33.3	-	-	.1

* = species occurs in a lower stratum.
** = species present in macroplot but not encountered in sub-sampling for herbs.
TR = trace (species presence is less than .1% cover).

APPENDIX 7

CONSTANCY AND COVER VALUES FOR WESTERN HEMLOCK ZONE COMMUNITIES WITH FEW REPRESENTATIVE PLOTS

Stratum & Species	Tshe/Rhma-Gash Av. % Cover	Tshe/Rhma-Gash 205	Tshe/Rhma-Gash 214	Tshe-Chla/ Rhma-Gash Av. % Cover 203	Tshe/Acci-Gash Av. % Cover	Tshe/Acci-Gash Av. % Const.	Tshe/Acci-Gash 222	Tshe/Acci-Gash 225	Tshe/Acci-Gash 239	Tshe/Chla/Pomu-Oxor Av. % Cover	Tshe/Chla/Pomu-Oxor Av. % Const.	Tshe/Chla/Pomu-Oxor 201	Tshe/Chla/Pomu-Oxor 202	Tshe/Chla/Pomu-Oxor 204
TREE														
Pseudotsuga menziesii	70.0	65	75	45	75.0	100	85	75	65	76.7	100	70	65	95
Tsuga heterophylla	42.5	30	55	5	16.7	100	**	10	40	16.7	100	30	10	10
Lithocarpus densiflorus	2.5	5	-	-	-	-	-	-	-	-	-	-	-	-
Rhododendron macrophyllum	2.5	5	*	*	-	-	-	-	-	-	-	-	-	-
Chamaecyparis lawsoniana	-	-	-	45	-	-	-	-	-	23.3	100	35	20	15
Alnus rubra	-	-	-	5	1.7	33.3	-	-	5	-	-	-	-	-
Acer circinatum	-	-	-	-	3.3	100	*	5	5	-	-	-	-	-
Thuja plicata	-	-	-	-	1.7	33.3	5	-	-	-	-	-	-	-
Cornus nuttallii	-	-	-	-	1.7	33.3	5	-	-	-	-	-	-	-
Taxus brevifolia	-	-	-	-	1.7	33.3	-	-	5	-	-	-	-	-
SHRUB														
Polystichum munitum	20.0	-	40	5	5.0	100	5	5	5	40.0	100	40	40	40
Berberis nervosa	15.0	15	15	15	20.0	100	40	10	10	13.3	100	15	15	10
Tsuga heterophylla	10.0	15	5	15	5.0	33.3	-	-	15	16.7	100	40	5	5
Vaccinium parvifolium	5.0	5	5	15	5.0	100	5	5	5	5.0	100	5	5	5
Rhododendron macrophyllum	50.0	85	15	15	-	-	-	-	-	-	-	-	-	-
Vaccinium ovatum	2.5	-	5	15	-	-	-	-	-	-	-	-	-	-
Acer circinatum	-	-	-	-	48.3	100	85	40	20	-	-	-	-	-
Pseudotsuga menziesii	-	*	-	-	*	*	*	*	-	-	-	-	-	-
Castanopsis chrysophylla	-	-	-	5	-	-	*	-	*	-	-	-	-	-
Pteridium aquilinum	-	-	-	-	5.0	33.3	-	15	*	-	-	-	-	-
Holodiscus discolor	-	-	-	-	1.7	33.3	-	-	5	-	-	-	-	-
Chamaecyparis lawsoniana	-	-	-	15	-	-	-	-	-	3.3	66.7	5	-	5
Gaultheria shallon	22.5	40	5	5	48.3	100	40	85	20	1.7	33.3	5	-	-

Stratum & Species	Tshe/Rhma-Gash Av. % Cover	205	214	Tshe-Chla/ Rhma-Gash Av. % Cover 203	Tshe/Acci-Gash Av. % Cover	Av. % Const.	222	225	239	Tshe/Chla/Pomu-Oxor Av. % Cover	Av. % Const.	201	202	204
HERB														
Mosses	9.2	9.8	8.5	16.1	24.8	100	63.0	5.8	5.5	11.9	100	11.3	8.9	15.4
Xerophyllum tenax	2.1	4.1	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium hexandra	.7	-	1.4	-	-	-	-	-	-	-	-	-	-	-
Rubus nivalis	.3	.5	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium ovatum	.4	.8	-	-	-	-	-	-	-	-	-	-	-	-
Galium oreganum	.2	-	.3	-	-	-	-	-	-	-	-	-	-	-
Lithocarpus densiflorus	TR	.1	-	-	-	-	-	-	-	-	-	-	-	-
Berberis nervosa	4.4	7.1	1.7	.6	1.2	100	2.2	.7	.7	2.7	100	4.7	2.3	1.2
Polystichum munitum	1.7	-	3.3	.6	.6	100	.3	.2	1.1	3.4	100	2.3	1.3	6.5
Plagiothecium undulatum	2.0	2.1	1.8	.1	TR	33.3	-	-	.1	1.4	66.7	2.1	-	2.1
Viola sempervirens	1.5	-	3.0	3.9	1.6	100	1.0	3.0	.7	.7	100	1.0	.8	.3
Vaccinium parvifolium	2.0	2.6	1.3	.4	.6	100	.1	1.5	.1	.3	100	.1	.3	.5
Disporum smithii	.5	-	1.0	.6	.7	33.3	-	2.0	-	.8	100	.7	1.5	.2
Oxalis oregana	1.7	-	3.4	-	12.0	66.7	-	33.6	2.3	29.8	100	29.3	40.0	20.1
Lobaria pulmonaria	.2	-	.3	.2	1.1	66.7	1.4	1.8	-	1.3	100	2.6	.6	.7
Trillium ovatum	TR	-	.1	.5	.7	100	.3	1.2	.7	1.3	66.7	1.0	-	3.0
Trientalis latifolia	.2	-	.3	7.1	.2	100	.1	.6	**	.6	100	1.1	.5	.2
Eurynchium oreganum	8.1	5.3	10.9	-	9.4	66.7	-	17.0	11.3	-	-	-	-	-
Gaultheria shallon	1.9	3.5	.2	.1	5.5	100	3.8	9.4	3.3	-	-	-	-	-
Pseudotsuga menziesii	TR	.1	-	.2	.1	66.7	.1	.2	-	-	-	-	-	-
Rhododendron macrophyllum	.4	.8	-	.2	-	-	-	-	-	-	-	-	-	-
Trisetum cernuum	.2	-	.3	-	.2	33.3	-	.5	-	-	-	-	-	-
Chimaphila menziesii	.5	.7	.3	.2	-	-	-	-	-	-	-	-	-	-
Tsuga heterophylla	1.4	.8	2.0	2.8	-	-	-	-	-	.7	33.3	2.1	-	-
Blechnum spicant	.3	-	.5	-	-	-	-	-	-	.7	33.3	-	-	2.1
Linnaea borealis	-	-	-	8.2	-	-	-	-	-	-	-	-	-	-
Whipplea modesta	-	-	-	1.3	-	-	-	-	-	-	-	-	-	-
Hieracium albiflorum	-	**	-	.6	-	-	-	-	-	-	-	-	-	-
Luzula spp.	-	-	-	.6	-	-	-	-	-	-	-	-	-	-
Corallorhiza mertensiana	-	-	-	.1	-	-	-	-	-	TR	33.3	-	.1	-
Campanula scouleri	-	-	-	.5	.1	100	.1	.1	.1	-	-	-	-	-

Stratum & Species	Tshe/Rhma-Gash Av. % Cover	205	214	Tshe-Chla/ Rhma-Gash Av. % Cover 203	Tshe/Acci-Gash Av. % Cover	Av. % Const.	222	225	239	Tshe/Chal/Pomu-Oxor Av. % Cover	Av. % Const.	201	202	204
Goodyera oblongifolia	-	-	-	3.0	.2	33.3	.6	-	-	TR	33.3	.1	-	-
Festuca occidentalis	-	-	-	1.8	-	-	-	-	-	.2	66.7	.1	.5	-
Chamaecyparis lawsoniana	-	-	-	.2	-	-	-	-	-	.2	33.3	.5	-	-
Achlys triphylla	-	-	-	.5	1.9	33.3	-	5.7	-	5.8	66.7	.5	16.9	-
Galium trifidum	-	-	-	.8	.2	66.7	.1	.6	-	.1	66.7	.3	-	.1
Acer circinatum	-	-	-	-	.4	100	.3	.3	.5	-	-	-	-	-
Castanopsis chrysophylla	-	-	-	-	.5	66.7	1.3	-	.1	-	-	-	-	-
Anemone deltoidea	-	-	-	-	.1	33.3	.3	-	-	-	-	-	-	-
Melica subulata	-	-	-	-	.2	33.3	-	.6	-	-	-	-	-	-
Clintonia uniflora	-	-	-	-	1.3	33.3	-	3.8	-	-	-	-	-	-
Tiarella trifoliata	-	-	-	-	1.1	66.7	-	3.3	.1	-	-	-	-	-
Cryptogramma crispa	-	-	-	-	-	33.3	-	-	**	-	-	-	-	-
Pyrola secunda	-	-	-	-	-	33.3	-	-	**	-	-	-	-	-
Dicentra formosa	-	-	-	-	-	33.3	-	-	**	-	-	-	-	-
Rosa gymnocarpa	-	-	-	-	-	33.3	-	**	-	-	-	-	-	-
Smilacina stellata	-	-	-	-	.8	33.3	-	2.5	-	-	-	-	-	-
Pteridium aquilinum	-	-	-	-	.2	33.3	-	-	.5	-	-	-	-	-
Smilacina racemosa	-	-	-	-	TR	33.3	-	-	.1	-	-	-	-	-
Montia sibirica	-	-	-	-	TR	33.3	-	.1	-	.9	66.7	-	.1	2.5
Coptis laciniata	-	-	-	-	.6	66.7	-	1.8	.1	1.0	66.7	-	2.8	.1
Rubus ursinus	-	-	-	-	TR	33.3	.1	-	-	.2	33.3	.7	-	-
Maianthemum dilatatum	-	-	-	-	.8	33.3	-	2.4	-	TR	33.3	-	-	.1
Asarum caudatum	-	-	-	-	TR	33.3	-	-	.2	.2	33.3	.5	-	-
Tiarella unifoliata	-	-	-	-	-	-	-	-	-	.6	66.7	-	1.7	.1
Luzula parviflora	-	-	-	-	-	-	-	-	-	TR	66.7	-	.1	.1
Adenocaulon bicolor	-	-	-	-	-	-	-	-	-	.7	33.3	-	2.2	-
Streptopus amplexifolius	-	-	-	-	-	-	-	-	-	TR	33.3	-	-	.1
Osmorhiza chilensis	-	-	-	-	-	-	-	-	-	TR	33.3	-	-	.1

* = species occurs in a lower stratum.
** = species present in macroplot but not encountered in sub-sampling for herbs.
TR = trace (species presence is less than .1% cover).

APPENDIX 8

COVER VALUES FOR TRUE FIR ZONE AND SITKA SPRUCE ZONE COMMUNITIES WITH FEW REPRESENTATIVE PLOTS

Stratum & Species	Tshe (Abam)/Vaal			Tshe-Psme-Chla-Pisi/ Pomu-Euor-Oxor-Plun	Rockaway Swamp	Elsie Mixed
	Av. % Cover	306	307	Av. % Cover 401	Av. % Cover 417	Av. % Cover 420
TREE						
Tsuga heterophylla	92.5	90	95	30	35	20
Picea sitchensis	–	–	–	20	20	5
Chamaecyparis lawsoniana	–	–	–	30	–	–
Myrica californica	–	–	–	5	–	–
Pseudotsuga menziesii	–	–	–	25	–	65
Thuja plicata	–	–	–	–	50	–
Acer circinatum	–	–	–	–	–	5
Alnus rubra	–	–	–	–	–	20
Abies amabilis	–	*	*	–	–	5
SHRUB						
Vaccinium alaskaense	27.5	40	15	–	–	–
Berberis nervosa	10.0	15	5	–	–	–
Abies amabilis	2.5	5	*	–	–	–
Ribes spp.	2.5	5	–	–	–	–
Menziesia ferruginea	2.5	5	–	–	5	–
Vaccinium parvifolium	7.5	15	*	5	15	*
Tsuga heterophylla	10.0	15	5	5	5	–
Polystichum munitum	15.0	15	15	40	–	40
Oplopanax horridum	5.0	5	5	–	–	5
Myrica californica	–	–	–	5	–	–
Pteridium aquilinum	–	–	–	5	–	–

Stratum & Species	Tshe (Abam)/Vaal Av. % Cover	Tshe (Abam)/Vaal 306	Tshe (Abam)/Vaal 307	Tshe-Psme-Chla-Pisi/ Pomu-Euor-Oxor-Plun Av. % Cover 401	Rockaway Swamp Av. % Cover 417	Elsie Mixed Av. % Cover 420
Gaultheria shallon	-	-	-	5	65	-
Vaccinium ovatum	-	-	-	15	15	-
Vaccinium membranaceum	-	-	-		5	-
Rubus spectabilis	-	-	-	-	15	5
Acer circinatum	-	-	-	-	-	15
Sanicula crassicaulis	-	-	-	-	-	5
Athyrium filix-femina	-	-	-	-	-	5
HERB						
Oxalis oregana	35.6	43.1	28.0	1.3	4.1	20.0
Mosses	23.2	28.7	17.7	8.2	9.0	19.5
Eurynchium oreganum	.7	1.3		48.7	41.8	9.0
Vancouveria hexandra	8.4	4.5	12.3	-	-	-
Smilacina stellata	5.0	5.3	4.6	-	-	-
Achlys triphylla	4.2	3.8	4.6	-	-	-
Clintonia uniflora	.8	1.0	.6	-	-	-
Abies amabilis	.4	.2	.5	-	-	-
Sanicula crassicaulis	.3	.6	-	-	-	-
Vaccinium alaskaense	2.9	4.1	1.7	-	-	-
Trisetum cernuum	1.7	3.3	-	-	-	.1
Berberis nervosa	1.4	2.8	-	-	-	-
Campanula scouleri	.7	1.3	-	-	-	-
Tsuga heterophylla	.7	1.3	-	.1	1.8	-
Dryopteris austriaca	-	-	-	.5	-	-
Rhamnus purshiana	-	-	-	.3	-	-
Plagiothecium undulatum	-	-	-	9.3	8.4	**
Blechnum spicant	-	-	-	6.9	11.8	-
Gaultheria shallon	-	-	-	1.4	3.3	-

Stratum & Species	Tshe (Abam)/Vaal Av. % Cover	306	307	Tshe-Psme-Chla-Pisi/ Pomu-Euor-Oxor-Plun Av. % Cover 401	Rockaway Swamp Av. % Cover 417	Elsie Mixed Av. % Cover 420
Vaccinium ovatum	-	-	-	.8	2.8	-
Tiarella trifoliata	3.1	4.3	1.9	.2	2.4	.7
Vaccinium parvifolium	.7	1.2	.1	1.9	3.4	1.1
Polystichum munitum	1.1	.7	1.4	2.3	-	5.4
Trillium ovatum	.6	.6	.5	1.0	-	3.0
Maianthemum dilatatum	3.6	3.3	3.8	1.0	-	1.1
Viola sempervirens	2.6	4.3	.8	.1	-	1.2
Luzula parviflora	1.1	1.4	.7	-	-	1.2
Disporum smithii	.8	.6	1.0	-	-	.1
Montia sibirica	.7	-	1.3	-	-	1.8
Lobaria pulmonaria	.3	-	.5	-	-	.7
Osmorhiza chilensis	.4	.6	.1	-	-	.1
Melica subulata	1.3	2.5	-	-	-	.8
Hieracium albiflorum	.6	1.2	-	-	-	.1
Dicentra formosa	.3	.5	-	-	-	.2
Goodyera oblongifolia	.1	.2	-	-	-	.1
Rubus nivalis	-	-	-	.1	-	.2
Athyrium filix-femina	-	-	-	-	.6	.1
Rubus spectabilis	-	-	-	-	.5	-
Streptopus amplexifolius	-	-	-	-	.5	-
Lysichitum americanum	-	-	-	-	**	-
Asarum caudatum	-	-	-	-	-	4.7
Galium trifidum	-	-	-	-	-	2.2
Adenocaulon bicolor	-	-	-	-	-	1.0
Actea rubra	-	-	-	-	-	.6
Acer circinatum	-	-	-	-	-	.1
Trientalis latifolia	-	-	-	-	-	**

* = species occurs in a lower stratum

** = species present in macroplot but not encountered in sub-sampling for herbs.

APPENDIX 9

BIOMASS PROJECTIONS IN Kg/HA FOR VALLEY-MARGIN ZONE 1/4 HECTARE TALLIES
(LAI = leaf area index; PCTBA = percent of plot in basal area; LEAF CONV = foliage biomass to leaf area equation used)

PLOT NUMBER 101T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
7	CACH	1	CACH	595.2	192.2	190.4	40.9	7.8	37.4	45.2	1064.0	.002	CACH	634.3	.06
13	TABR	1	TSHE	330.2	36.7	76.9	16.5	9.1	22.9	32.0	492.4	.001	TABR	493.0	.05
6	ACMA	2	ACMA	16.0	4.2	4.5	3.7	0	0	1.7	30.2	.000	ACMA	43.3	.00
19	ABGR	9	PSME	2997.3	463.0	234.3	137.5	46.8	87.1	133.9	3965.1	.007	PSME	2364.0	.24
23	ACCI	15	CACH	577.1	134.2	200.3	31.7	23.4	92.4	115.8	1059.2	.004	FUDG	2316.7	.23
2	PSME	54	PSME	1369385.2	160297.1	80971.1	7213.6	6218.8	14666.6	20385.3	1639752.3	1.136	PSME	364207.9	36.42
PLOT TOTALS:		82		1373901.1	161127.4	81577.5	7444.1	6305.9	14906.5	21214.0	1645364.1	1.151		370064.7	37.01

PLOT NUMBER 102T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
14	CONU	11	COFL	0	0	0	0	0	0	0	1835.1	.004	FUDG	0	0
7	CACH	1	CACH	320.7	95.9	104.5	20.9	5.4	25.1	30.5	572.6	.001	CACH	428.2	.04
13	TABR	1	TSHE	272.8	30.3	60.8	14.8	7.6	19.1	26.7	405.5	.001	TABR	416.0	.04
19	ABGR	3	PSME	3540.8	511.2	258.6	92.7	40.5	80.4	121.0	4524.4	.006	PSME	2129.0	.21
23	ACCI	32	CACH	938.2	212.5	327.9	50.6	42.1	163.0	205.1	1734.3	.007	FUDG	4101.7	.41
2	PSME	42	PSME	1013249.0	121477.0	61372.0	6111.5	5055.1	11751.7	16806.8	1219016.3	.912	PSME	293301.4	29.33
PLOT TOTALS:		90		1018321.6	122327.0	62123.9	6290.5	5150.8	12039.3	17190.1	1228088.2	.932		300376.3	30.04

PLOT NUMBER 103T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
4	TSHE	1	TSHE	622.5	69.1	167.9	24.0	16.5	41.7	58.2	941.6	.002	TSHE	1167.0	.12
24	COCO	1	COCO	0	0	0	0	0	0	39.4		.000	GUES	985.0	.10
14	CONU	5	COFL	0	0	0	0	0	0	0	983.0	.002	FUDG	0	0
7	CACH	1	CACH	72.5	18.0	24.7	4.2	2.3	9.5	11.8	131.2	.000	CACH	165.0	.02
19	ABGR	5	PSME	341.1	58.3	29.8	35.6	8.6	14.6	23.2	488.5	.001	PSME	411.1	.04
23	ACCI	43	CACH	788.6	168.5	279.6	40.9	43.2	161.5	204.7	1482.3	.007	FUDG	4094.9	.41
2	PSME	59	PSME	1314525.7	157115.4	79375.7	8051.4	6542.3	15179.5	21721.7	1580790.0	1.179	PSME	379110.6	37.91
PLOT TOTALS:		115		1316350.3	157429.8	79877.8	8156.0	6612.9	15406.8	22059.0	1584207.2	1.192		385934.5	38.59

PLOT NUMBER 104T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
7	CACH	1	CACH	212.9	60.5	70.3	13.4	4.3	19.2	23.5	380.6	.001	CACH	329.3	.03
13	TABR	3	TSHE	1907.6	211.9	546.5	58.0	49.8	126.2	176.0	2910.3	.006	TABR	2740.1	.27
19	ABGR	1	PSME	184.9	30.2	15.3	12.5	3.7	6.5	10.2	253.2	.001	PSME	179.0	.02
23	ACCI	15	CACH	215.6	44.3	77.2	10.3	13.3	48.8	62.1	410.0	.002	FUDG	1241.5	.12
2	PSME	57	PSME	652165.3	80893.1	40878.8	5593.2	3886.7	8634.9	12531.6	792112.1	.679	PSME	220002.0	22.00
PLOT TOTALS:		77		654686.2	81240.0	41588.1	5698.3	3957.8	8895.6	12853.3	796066.5	.689		224493.5	22.45

PLOT NUMBER 105T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
24	COCO	1	COCO	0	0	0	0	0	0	39.4		.000	GUES	985.0	.10
19	ABGR	9	PSME	5133.3	768.5	788.9	184.4	69.7	133.5	213.2	6678.3	.011	PSME	3583.1	.36
6	ACMA	15	ACMA	42459.4	8138.7	6581.2	362.3	0	0	437.7	59039.3	.070	ACMA	12192.1	1.22
2	PSME	16	PSME	846441.9	99859.5	50444.0	4251.4	3880.4	9131.8	13072.2	1014367.0	.712	PSME	227907.8	22.79
PLOT TOTALS:		41		894044.6	108765.7	57414.0	4798.1	3950.1	9725.3	13832.5	1078175.2	.792		[illegible]	24.47

PLOT NUMBER 106T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
24	COCO	1	COCO	0	0	0	0	0	0	39.4		.001	GUES	985.0	.10
19	ABGR	1	PSME	203.4	33.1	16.7	13.1	3.9	7.0	11.0	277.3	.001	PSME	193.9	.02
6	ACMA	17	ACMA	52583.6	10084.9	8159.9	442.9	0	0	603.2	71874.4	.087	ACMA	15079.1	1.51
2	PSME	13	PSME	914519.1	106364.1	53724.8	4075.5	3926.3	9417.7	13343.9	1092027.5	.728	PSME	232497.4	23.25
PLOT TOTALS:		32		967306.1	116482.1	61901.5	4531.5	3930.2	9424.7	13997.5	1163643.9	.816		248755.5	24.88

PLOT NUMBER 107T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
14	CONU	3	COFL	0	0	0	0	0	0	0	1596.5	.003	FUOG	0	0
24	COCO	1	COCO	0	0	0	0	0	0	39.4	130.8	.004	GUES	985.2	.10
19	ABGR	10	PSME	5822.7	859.2	434.7	191.4	74.5	144.2	218.7	7526.8	.012	PSME	3854.4	.39
6	ACMA	6	ACMA	15188.6	2961.4	2433.5	148.5	0	0	134.4	20926.4	.027	ACMA	4859.4	.49
2	PSME	15	PSME	539652.7	65135.2	32903.7	3247.3	2739.5	6367.7	9107.2	650051.1	.494	PSME	158933.4	15.89
PLOT TOTALS:		35		560664.0	68955.9	35776.9	3587.2	2814.0	6511.9	9559.7	690221.6	.541		168632.4	16.86

PLOT NUMBER 108T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
14	CONU	5	COFL	0	0	0	0	0	0	0	389.6	.001	FUOG	0	0
24	COCO	1	COCO	0	0	0	0	0	0	39.4	4793.6	.030	GUES	986.1	.10
19	ABGR	24	PSME	43549.7	5767.2	2915.8	682.0	353.6	742.3	1095.9	54010.7	.059	PSME	19227.2	1.92
6	ACMA	16	ACMA	42022.3	8178.0	6709.1	404.3	0	0	531.9	57845.6	.074	ACMA	13296.3	1.33
2	PSME	30	PSME	1044700.6	126817.6	64075.5	6510.8	5426.2	12566.3	17992.5	1268897.0	.976	PSME	314054.3	31.41
PLOT TOTALS:		76		1130272.6	140762.9	73700.4	7597.1	5779.8	13308.6	19659.7	1377136.4	1.139		347563.9	34.76

PLOT NUMBER 109T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
17	ARME	1	CACH	722.2	238.9	229.7	50.4	8.7	42.4	51.1	1292.4	.003	RHMA	1335.9	.13
13	TABR	3	TSHE	308.1	34.2	55.9	24.8	9.0	22.8	31.8	454.8	.001	TABR	495.3	.05
14	CONU	23	COFL	0	0	0	0	0	0	0	3826.2	.009	FUOG	0	0
24	COCO	1	COCO	0	0	0	3	0	0	39.4	56.8	.004	GUES	985.1	.10
19	ABGR	18	PSME	1304.9	219.7	111.2	120.4	30.1	51.7	81.7	1837.9	.004	PSME	1449.9	.14
6	ACMA	17	ACMA	45065.8	8585.4	6908.2	381.4	0	0	506.8	61447.6	.073	ACMA	12670.0	1.27
2	PSME	71	PSME	646421.0	79135.8	39986.6	5110.2	3634.7	8212.5	11847.3	782500.1	.640	PSME	287054.4	28.71
PLOT TOTALS:		134		693822.1	88213.2	47291.6	5687.3	3682.5	8329.4	12558.2	851415.8	.734		223990.3	22.40

PLOT NUMBER 110T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
13	TABR	2	TSHE	123.1	13.7	20.2	12.1	3.7	9.3	13.0	182.0	.000	TABR	203.0	.02
14	CONU	30	COFL	0	0	0	0	0	0	0	4327.1	.010	FUOG	0	0
19	ABGR	8	PSME	482.7	83.2	42.1	51.3	12.2	20.6	32.8	692.1	.002	PSME	582.4	.06
6	ACMA	21	ACMA	32437.5	6467.3	5430.6	409.9	0	0	491.6	45236.7	.064	ACMA	12289.4	1.23
2	PSME	42	PSME	765388.8	93497.5	47242.5	5324.9	4142.9	9487.1	13630.0	925583.7	.738	PSME	238044.9	23.30
PLOT TOTALS:		103		798932.1	100061.6	52735.3	5798.2	4158.8	9517.9	14157.4	976021.6	.815		251119.9	25.11

PLOT NUMBER 111T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
13	TABR	13	TSHE	4079.1	453.0	1142.9	176.7	108.1	273.5	381.6	6233.4	.012	TABR	~~5941.4~~	~~.59~~
14	CONU	46	COFL	0	0	0	0	0	0	0	9346.3	.021	FUDG	0	0
24	COCO	1	COCO	0	0	0	0	0	0	39.4		.001	GUES	985.0	.10
19	ABGR	2	PSME	145.8	25.1	12.7	14.9	3.5	6.2	9.8	209.3	.001	PSME	174.1	.02
6	ACMA	15	ACMA	33961.2	6621.4	5442.8	341.7	0	0	439.3	46806.5	.060	ACMA	10983.2	1.10
2	PSME	33	PSME	757690.6	88836.7	44874.6	3976.5	3447.5	8136.7	11584.2	906952.7	.630	PSME	202003.3	20.20
PLOT TOTALS:		110		795876.8	95936.3	51473.1	4509.9	3559.2	8416.4	12454.3	963021.9	.726		220087.0	22.01

PLOT NUMBER 112T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
16	ALRU	1	CACH	595.2	192.2	190.4	40.9	7.8	37.4	45.2	1064.0	.002	FUDG	904.4	.09
13	TABR	19	TSHE	7627.2	847.0	2105.3	312.2	201.7	510.7	712.4	11604.2	.023	TABR	11092.5	1.11
14	CONU	23	COFL	0	0	0	0	0	0	0	8293.4	.018	FUDG	0	0
19	ABGR	1	PSME	32.0	5.8	2.9	4.7	1.0	1.6	2.6	48.0	.000	PSME	45.8	.00
6	ACMA	8	ACMA	28989.5	5465.7	4355.3	215.6	0	0	331.5	39327.6	.044	ACMA	7538.7	.75
2	PSME	21	PSME	661413.1	78843.7	39831.3	3737.1	3203.4	7496.3	10699.7	794524.9	.581	PSME	196660.8	18.67
PLOT TOTALS:		73		698657.0	85354.3	46485.2	4310.5	3413.9	8046.1	11761.5	854867.0	.669		206242.1	20.62

APPENDIX 10

BIOMASS PROJECTIONS IN Kg/HA FOR WESTERN HEMLOCK ZONE 1/4 HECTARE TALLIES
(LAI = leaf area index; PCTBA = percent of plot in basal area; LEAF CONV = foliage biomass to leaf area equation used)

PLOT NUMBER 201T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
2	PSME	5	PSME	305988.1	35969.7	18169.8	1476.2	1376.1	3273.6	4649.8	366253.5	.253	PSME	81048.9	8.10
4	TSHE	45	TSHE	131905.1	14665.2	67890.5	1867.9	2983.1	7601.5	10584.6	226913.2	.296	TSHE	212394.0	21.24
PLOT TOTALS:		50		437893.2	50634.8	86060.3	3344.1	4359.2	10875.1	15234.3	593166.8	.550		293442.9	29.34

PLOT NUMBER 202T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
7	RHMA	5	CACH	105.4	22.9	37.2	5.5	5.5	20.6	26.1	197.0	.001	CACH	366.4	.04
2	PSME	13	PSME	835626.0	98445.8	49729.7	4048.4	3782.4	8993.7	12776.1	1000625.0	.696	PSME	222702.8	22.27
4	TSHE	93	TSHE	147137.4	16357.8	73701.7	2301.0	3352.4	8539.9	11892.4	251390.3	.336	TSHE	238637.5	23.86
PLOT TOTALS:		111		982868.7	114826.4	123468.7	6355.0	7140.3	17554.3	24694.6	1252213.4	1.032		461706.7	46.17

PLOT NUMBER 203T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
7	RHMA	65	CACH	745.5	149.3	268.6	37.0	50.6	182.1	232.6	1432.9	.007	CACH	3266.1	.33
2	PSME	10	PSME	525383.8	62648.6	31649.5	2797.3	2509.0	5907.5	8416.5	630895.6	.458	PSME	146783.1	14.68
4	TSHE	104	TSHE	88703.3	9860.4	43336.3	1741.1	2054.9	5230.2	7284.9	150925.1	.210	TSHE	146184.2	14.62
PLOT TOTALS:		179		614832.6	72658.3	75254.4	4575.4	4614.4	11319.7	15934.0	783254.7	.675		296233.3	29.62

PLOT NUMBER 204T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
7	RHMA	46	CACH	514.1	102.6	185.4	25.4	35.2	126.6	161.9	989.4	.005	CACH	2272.3	.23
2	PSME	8	PSME	470367.0	55581.7	28077.6	2352.2	2162.7	5125.2	7288.0	563666.4	.397	PSME	127059.5	12.71
4	TSHE	120	TSHE	84953.4	9442.4	38530.3	1318.2	1999.6	5086.5	7086.1	141830.4	.207	TSHE	142196.4	14.22
PLOT TOTALS:		174		555834.5	65126.7	66793.3	4195.8	4197.6	10338.4	14536.0	706486.2	.609		271528.3	27.15

PLOT NUMBER 205T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
2	PSME	7	PSME	477410.5	55304.7	27933.8	2055.7	2010.1	4840.0	6850.1	569554.7	.374	PSME	119328.5	11.93
4	TSHE	44	TSHE	180817.2	20098.2	80428.1	2960.0	4221.9	10744.3	14966.0	299269.5	.431	TSHE	300319.3	30.03
PLOT TOTALS:		51		658227.7	75402.9	108361.9	5015.6	6231.9	15584.3	21816.1	868824.1	.805		419647.8	41.96

PLOT NUMBER 206T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
23	ACCI	4	CACH	125.5	29.1	43.6	6.9	5.3	20.8	26.2	231.3	.001	FUDG	523.1	.05
2	PSME	13	PSME	1407085.9	161253.7	31440.9	5436.0	5618.4	13677.8	19296.2	1674512.8	1.055	PSME	335954.3	33.60
4	TSHE	30	TSHE	116151.8	12911.1	53295.0	1857.9	2695.1	6860.6	9555.7	193771.5	.274	TSHE	191751.7	19.18
PLOT TOTALS:		47		1523363.2	174194.0	134779.5	7300.8	8318.9	20559.2	28878.1	1868515.6	1.329		528229.2	52.82

PLOT NUMBER 207T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
8	THPL	2	THOC	9320.6	444.5	0	0	0	0	476.7	12241.7	.026	THPL	8423.6	.84
23	ACCI	5	CACH	157.7	36.0	55.0	8.6	6.9	26.8	33.7	291.0	.001	FUDG	674.3	.07
2	PSME	5	PSME	391941.5	45639.8	23052.9	1733.4	1684.7	4044.0	5728.7	468096.3	.312	PSME	99809.9	9.98
4	TSHE	45	TSHE	122104.4	13571.4	53342.7	2178.0	2871.9	7306.2	10178.0	201374.6	.295	TSHE	204240.5	20.42
PLOT TOTALS:		57		523524.2	59691.8	76450.7	3919.9	4563.4	11377.0	16417.2	682003.5	.635		313148.3	31.31

PLOT NUMBER 208T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
23	ACCI	3	CACH	86.6	19.4	30.3	4.6	4.0	15.4	19.4	160.4	.001	FUDG	387.7	.04
2	PSME	12	PSME	990616.7	114535.6	57849.7	4158.6	4125.1	9963.8	14091.9	1181252.5	.769	PSME	245452.5	24.55
4	TSHE	46	TSHE	138634.8	15408.6	60737.0	2491.9	3264.4	8304.6	11569.0	223841.3	.336	TSHE	232153.9	23.22
PLOT TOTALS:		61		1129338.1	129963.6	118617.1	6655.1	7396.5	18283.8	25630.4	1410254.3	1.106		477994.1	47.80

PLOT NUMBER 209T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
24	COCO	1	COCO	0	0	0	0	0	0	39.4	204.8	.000	GUES	985.2	.10
16	ALRU	7	CACH	6278.7	2227.7	1964.3	459.2	63.1	315.1	378.2	11308.1	.020	FUDG	7564.1	.76
8	THPL	5	THOC	25424.8	1097.3	0	0	0	0	1157.8	33096.3	.054	THPL	20635.3	2.06
23	ACCI	1	CACH	57.5	13.9	19.8	3.2	2.0	8.2	10.2	104.6	.000	FUDG	204.1	.02
7	RHMA	1	CACH	20.8	4.4	7.4	1.1	1.1	4.2	5.3	39.0	.000	CACH	74.9	.01
2	PSME	12	PSME	597543.5	68864.0	34781.3	2596.8	2488.8	5987.7	8476.4	712262.0	.463	PSME	147665.7	14.77
4	TSHE	93	TSHE	156813.0	17428.7	68019.7	3023.1	3705.5	9425.5	13131.1	258414.6	.383	TSHE	263500.2	26.35
PLOT TOTALS:		120		786138.3	89636.1	104791.5	6083.4	6260.7	15740.6	23208.5	1015429.5	.931		440623.5	44.06

PLOT NUMBER 210T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
6	ACMA	3	ACMA	16702.0	3036.1	2335.0	86.8	0	0	133.6	22293.6	.021	ACMA	3340.2	.33
8	THPL	2	THOC	23448.5	910.2	0	0	0	0	959.2	30263.3	.054	THPL	16949.6	1.69
7	RHMA	11	CACH	310.3	70.7	108.3	16.8	13.9	53.7	67.5	573.7	.002	CACH	948.3	.09
2	PSME	7	PSME	695855.5	79303.0	40050.3	2610.1	2718.9	6640.3	9359.2	827178.1	.512	PSME	162920.7	16.29
4	TSHE	51	TSHE	86343.3	9597.2	37594.9	1603.7	2034.1	5174.7	7208.8	142352.8	.210	TSHE	144658.7	14.47
23	ACCI	21	CACH	651.1	150.6	226.5	35.6	28.0	108.7	136.7	1200.4	.005	FUDG	2733.8	.27
PLOT TOTALS:		95		823315.7	93067.8	80314.9	4353.0	4794.9	11977.4	17865.1	1023862.0	.804		331551.3	33.16

PLOT NUMBER 211T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
6	ACMA	1	ACMA	7707.0	1427.8	1115.6	40.6	0	0	65.8	10356.8	.011	ACMA	1645.7	.16
24	COCO	1	COCO	0	0	0	0	0	0	39.4		.000	GUES	985.1	.10
16	ALRU	2	CACH	1490.4	495.9	473.3	104.4	17.7	86.4	104.0	2668.1	.005	FUDG	2080.8	.21
8	THPL	1	THOC	7284.2	346.0	0	0	0	0	370.6	9564.1	.020	THPL	6548.7	.65
23	ACCI	22	CACH	585.2	134.2	204.1	31.5	26.2	101.1	127.3	1082.6	.004	FUDG	2545.9	.25
7	RHMA	4	CACH	86.7	19.1	30.5	4.6	4.4	16.5	20.9	161.8	.001	CACH	293.4	.03
2	PSME	14	PSME	785063.0	92429.5	46690.5	3880.6	3567.3	8453.9	12031.2	940094.8	.655	PSME	209741.3	20.97
4	TSHE	35	TSHE	124416.1	13830.7	59416.0	1906.5	2861.8	7287.6	10149.5	209718.8	.288	TSHE	203665.2	20.37
PLOT TOTALS:		80		926632.6	108683.1	107930.1	5968.5	6477.4	15955.5	22918.8	1173555.7	.985		427506.1	42.75

PLOT NUMBER 212T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
16	ALRU	4	CACH	17049.6	7081.1	5125.9	1388.7	96.0	531.3	627.2	31272.5	.038	FUDG	12544.3	1.25
8	THPL	1	THOC	47703.4	1626.7	0	0	0	0	1695.8	50976.9	.098	THPL	29964.6	3.00
23	ACCI	34	CACH	1942.8	502.5	658.0	114.5	60.1	246.0	306.1	3523.9	.012	FUDG	6122.1	.61
2	PSME	12	PSME	892790.3	104001.1	52531.8	3977.3	3847.6	9229.3	13076.9	1066377.4	.713	PSME	227845.1	22.78
4	TSHE	33	TSHE	87860.7	9765.1	37743.5	1605.1	2074.7	5277.5	7352.3	144326.7	.214	TSHE	147537.1	14.75
PLOT TOTALS:		84		1047346.8	122976.5	96059.2	7085.6	6078.4	15284.1	23058.3	1306477.4	1.076		424013.2	42.40

BIOMASS PROJECTIONS IN Kg/HA FOR TRUE FIR ZONE 1/4 HECTARE TALLIES
(LAI = leaf area index; PCTBA = percent of plot in basal area; LEAF CONV = foliage biomass to leaf area equation used)

PLOT NUMBER 301T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
4	TSHE	3	TSHE	5672.9	630.6	2529.7	93.1	132.2	336.4	468.6	9334.8	.013	TSHE	9403.5	.94
1	ABPR	100	ABPR	0	0	0	0	0	0	17229.6	17229.6	.819	ABPR	227258.0	22.73
PLOT TOTALS:		103		5672.9	630.6	2529.7	93.1	132.2	336.4	17698.2	26624.3	.832		236661.5	23.67

PLOT NUMBER 302T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
4	TSHE	1	TSHE	3256.6	361.9	1286.8	62.8	78.1	198.6	276.8	5244.8	.008	TSHE	5554.1	.56
1	ABPR	51	ABPR	0	0	0	0	0	0	17081.7	17081.7	.800	ABPR	225307.5	22.53
PLOT TOTALS:		52		3256.6	361.9	1286.8	62.8	78.1	198.6	17358.5	22326.5	.808		230861.6	23.09

PLOT NUMBER 303T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
4	TSHE	1	TSHE	2101.1	233.4	750.4	48.7	51.7	131.4	183.1	3316.7	.006	TSHE	3674.4	.37
1	ABPR	57	ABPR	0	0	0	0	0	0	19111.1	19111.1	.907	ABPR	252076.0	25.21
PLOT TOTALS:		58		2101.1	233.4	750.4	48.7	51.7	131.4	19294.2	22427.8	.913		255750.4	25.58

PLOT NUMBER 304T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
1	ABPR	43	ABPR	0	0	0	0	0	0	16316.8	16316.8	.771	ABPR	215218.5	21.52
PLOT TOTALS:		43		0	0	0	0	0	0	16316.8	16316.8	.771		215218.5	21.52

PLOT NUMBER 305T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
3	ABAM	19	ABAM	0	0	0	0	0	0	7317.5	7317.5	.348	ABAM	111225.6	11.12
4	TSHE	66	TSHE	161253.3	17925.0	76183.8	2695.5	3731.9	9500.6	13232.5	271290.1	.379	TSHE	265532.5	26.55
PLOT TOTALS:		85		161253.3	17925.0	76183.8	2695.5	3731.9	9500.6	20550.0	278607.6	.727		376758.1	37.68

PLOT NUMBER 306T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
3	ABAM	82	ABAM	0	0	0	0	0	0	5626.6	5626.6	.271	ABAM	95524.9	9.55
4	TSHE	40	TSHE	234589.7	26087.8	135834.9	2585.9	5138.0	13110.6	18248.5	417346.8	.495	TSHE	356175.2	35.62
PLOT TOTALS:		122		234589.7	26087.8	135834.9	2585.9	5138.1	13110.6	23875.2	422973.5	.766		451700.1	45.17

PLOT NUMBER 307T

SPNO	SPP	COUNT	BIOMA EONS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
3	ABAM	29	ABAM	0	0	0	0	0	0	12714.6	12714.6	.600	ABAM	193261.4	19.33
4	TSHE	39	TSHE	95350.1	10598.9	44244.0	1600.2	2213.1	5633.5	7846.6	159639.8	.225	TSHE	157455.0	15.75
PLOT TOTALS:		68		95350.1	10598.9	44244.0	1600.2	2213.1	5633.5	20561.2	172354.4	.826		350716.5	35.07 .

PLOT NUMBER 308T

SPNO	SPP	COUNT	BIOMA EONS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
4	TSHE	41	TSHE	203242.6	22601.2	115987.1	2313.7	4467.7	11398.5	15866.2	360010.8	.432	TSHE	318372.2	31.84
3	ABAM	85	ABAM	0	0	0	0	0	0	6037.8	6037.8	.285	ABAM	91774.8	9.18
PLOT TOTALS:		126		203242.6	22601.2	115987.1	2313.7	4467.7	11398.5	21904.0	366048.6	.717		410146.9	41.01 .

APPENDIX 12

BIOMASS PROJECTIONS IN Kg/HA FOR SITKA SPRUCE ZONE 1/4 HECTARE TALLIES
(LAI = leaf area index; PCTBA = percent of plot in basal area; LEAF CONV = foliage biomass to leaf area equation used)

PLOT NUMBER 401T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
2	PSME	25	PSME	1363002.3	160284.9	80966.8	6683.1	6160.5	14630.5	20791.0	1631723.0	1.132	PSME	352434.9	36.24
5	PISI	1	PSME	1174.7	173.4	87.7	34.7	14.6	28.6	43.3	1513.7	.002	PISI	605.9	.06
4	TSHE	5	TSHE	13506.3	1501.2	5848.5	234.1	317.4	807.6	1125.1	22215.2	.033	TSHE	22576.3	2.26
7	RHMA	9	CACH	149.4	32.2	52.9	7.8	8.3	30.9	39.2	281.5	.001	CACH	550.0	.05
17	UMCA	10	CACH	10478.2	3751.8	3269.2	771.4	99.6	503.5	603.1	18873.7	.032	RHMA	15753.9	1.58
23	ACCI	23	CACH	445.9	95.3	158.1	23.1	24.2	90.6	114.7	837.1	.004	FUDG	2294.5	.23
8	THPL	16	THOC	15507.0	983.2	0	0	0	0	1079.3	23978.7	.055	THPL	19070.8	1.91
PLOT TOTALS:		89		1404263.8	166821.8	90383.3	7754.1	6624.7	16091.7	23735.7	1536427.9	1.259		423286.3	42.33

PLOT NUMBER 402T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
2	PSME	17	PSME	1022712.0	119883.6	60556.9	4849.8	4546.5	10835.6	15382.2	1223384.4	.838	PSME	268097.6	26.81
5	PISI	6	PSME	179236.7	21603.8	10914.9	1100.5	911.2	2113.7	3025.0	215833.3	.154	PISI	42349.5	4.23
4	TSHE	7	TSHE	11179.6	1242.5	4859.5	214.7	263.9	571.3	835.1	18431.4	.027	TSHE	18765.4	1.88
17	UMCA	5	CACH	7562.6	2887.9	2323.0	581.5	59.0	307.2	366.2	13721.2	.020	RHMA	9564.2	.96
23	ACCI	29	CACH	1008.9	237.4	349.6	55.3	41.1	161.2	212.3	1854.0	.007	FUDG	4046.3	.40
8	THPL	20	THOC	67897.4	3229.6	0	0	0	0	3466.0	89145.4	.197	THPL	61245.1	6.12
PLOT TOTALS:		84		1289597.2	149084.7	79003.9	6802.3	5821.7	14089.0	23376.8	1562417.2	1.244		404068.0	40.41

PLOT NUMBER 403T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
2	PSME	15	PSME	1154466.8	133570.7	67464.3	4889.4	4828.5	11644.5	16473.1	1376854.2	.899	PSME	286939.1	28.69
5	PISI	4	PSME	133599.0	15958.8	8062.4	761.3	651.4	1523.1	2174.5	160555.0	.118	PISI	30443.2	3.04
4	TSHE	7	TSHE	34674.9	3854.5	16106.6	519.3	800.1	2037.2	2837.3	57932.7	.081	TSHE	55935.3	5.59
6	ACMA	1	ACMA	2707.7	531.2	438.7	26.7	0	0	35.4	3739.6	.005	ACMA	0	0
24	HODI	1	COCO	0	0	0	0	0	0	39.4		.000	GUFS	985.1	.10
17	UMCA	1	CACH	182.9	51.0	60.7	11.4	3.9	17.4	21.3	327.3	.001	RHMA	557.6	.06
23	ACCI	59	CACH	1954.2	471.9	673.4	109.9	76.2	301.7	378.6	3588.0	.014	FUDG	7571.3	.76
8	THPL	18	THOC	21921.9	1297.8	0	0	0	0	1417.4	29426.2	.073	THPL	25045.9	2.50
PLOT TOTALS:		106		1349507.4	155735.9	92806.1	6318.0	6360.9	15523.9	23377.0	1632106.8	1.191		406477.0	40.95

PLOT NUMBER 404T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
2	PSME	12	PSME	944473.5	108374.0	54734.8	3825.4	3827.4	9272.9	13100.3	1124508.0	.716	PSME	228136.1	22.81
5	PISI	1	PSME	19824.5	2502.1	1264.5	165.5	122.0	274.0	396.0	24152.7	.021	PISI	5544.7	.55
4	TSHE	4	TSHE	8572.4	952.5	3189.6	190.6	209.3	531.7	741.0	13646.1	.022	TSHE	14869.3	1.49
17	UMCA	4	CACH	1407.3	453.2	450.9	96.4	19.5	32.6	112.2	2520.1	.005	RHMA	2930.6	.29
23	ACCI	9	CACH	343.1	83.0	118.1	19.3	13.0	51.4	64.4	627.9	.002	FUDG	1287.8	.13
8	THPL	20	THOC	157810.7	6444.6	0	0	0	0	6327.7	204473.4	.231	THPL	120646.1	12.06
PLOT TOTALS:		50		1132431.6	118809.5	59757.9	4297.3	4191.3	19222.5	21241.6	1309934.2	1.148		373414.1	37.34

PLOT NUMBER 405T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
5	PISI	9	PSME	779759.0	86391.7	43625.1	2523.3	2792.5	6917.0	9709.5	913007.7	.532	PISI	135432.8	13.59
4	TSHE	39	TSHE	114521.2	12729.7	52521.9	1927.5	2664.5	6781.8	9446.4	191246.7	.272	TSHE	[illegible]	18.96
PLOT TOTALS:		48		885279.2	99121.4	96247.1	4450.9	5457.0	[illegible]	19155.9	[illegible]	.804		325490.3	32.55

PLOT NUMBER 406T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
16	ALRU	1	CACH	982.6	337.8	309.5	70.4	10.4	51.8	62.2	1762.5	.003	FUDG	1244.5	.12
5	PISI	16	PSME	682138.1	78825.4	39813.1	2906.1	2846.0	6861.4	9707.5	813330.2	.530	PISI	135904.8	13.59
4	TSHE	38	TSHE	116601.5	12960.2	51432.2	1991.4	2731.9	6951.4	9683.3	192668.6	.280	TSHE	194312.8	19.43
PLOT TOTALS:		55		799722.3	92123.3	91554.8	4967.8	5588.3	13864.7	19453.0	1007821.3	.813		331462.1	33.15

PLOT NUMBER 407T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
16	ALRU	3	CACH	6863.6	2642.1	2102.7	530.9	50.0	265.3	315.3	12454.7	.018	FUDG	6306.8	.63
5	PISI	8	PSME	1244191.4	138205.6	69795.2	3861.0	4353.5	10840.3	15193.8	1471237.0	.833	PISI	212713.7	21.27
4	TSHE	31	TSHE	114806.9	12763.1	56294.6	1701.7	2625.1	6686.5	9311.6	194877.9	.263	TSHE	186851.0	18.69
PLOT TOTALS:		42		1365862.0	153610.8	128192.5	6093.5	7028.7	17792.1	24820.8	1678569.6	1.115		405871.5	40.59

PLOT NUMBER 408T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
5	PISI	15	PSME	1188686.1	136987.0	69188.0	4915.3	4895.9	11835.2	16731.1	1416507.6	.914	PISI	234235.3	23.42
4	TSHE	26	TSHE	54038.9	6006.3	24044.7	1005.0	1270.8	3232.9	4503.6	89598.6	.131	TSHE	90373.9	9.04
PLOT TOTALS:		41		1242725.0	142993.3	93232.7	5920.4	6166.7	15068.0	21234.7	1506106.2	1.045		324609.1	32.46

PLOT NUMBER 409T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
5	PISI	7	PSME	588750.3	67145.7	33910.8	2270.4	2320.7	5651.6	7972.3	700049.5	.436	PISI	111612.8	11.16
4	TSHE	38	TSHE	228640.3	25423.8	126952.5	2769.6	5071.0	12932.5	18003.6	401789.9	.494	TSHE	361263.8	36.13
PLOT TOTALS:		45		817390.6	92569.6	160863.3	5040.0	7391.7	18584.3	25976.0	1101839.4	.930		472876.6	47.29

PLOT NUMBER 410T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
16	ALRU	1	CACH	17.3	3.6	6.2	.9	1.0	3.7	4.7	32.7	.000	FUDG	95.0	.01
5	PISI	22	PSME	891940.7	103690.0	52374.3	4270.0	3894.9	9273.2	13168.1	1065443.1	.717	PISI	184352.8	18.44
4	TSHE	29	TSHE	75415.7	8382.7	34333.3	1311.6	1760.6	4480.4	6240.9	125684.2	.180	TSHE	125234.6	12.52
PLOT TOTALS:		52		967373.8	112076.2	86713.8	5582.5	5656.4	13757.3	19413.7	1191160.0	.898		309682.3	30.97

PLOT NUMBER 411T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
16	ALRU	3	CACH	2299.1	828.9	716.9	169.9	22.9	113.7	136.6	4151.4	.007	FUDG	2731.8	.27
5	PISI	6	PSME	175096.5	20467.7	10338.7	835.1	772.0	1840.7	2612.3	209350.3	.142	PISI	36572.7	3.66
4	TSHE	52	TSHE	226012.9	25129.5	120009.1	2956.3	5069.9	12923.9	17993.9	392102.2	.500	TSHE	361069.6	36.11
PLOT TOTALS:		61		403408.5	46426.0	131064.7	3961.3	5864.0	14877.9	20742.8	605603.9	.649		400374.3	40.04

PLOT NUMBER 412T

SPNO	SPP	COUNT	BIOMA EQNS	STEMWOOD	STEMBARK	LIVEBRAN	DEADBRAN	NEWFOLIG	OLDFOLIG	TOTFOLIG	TOTBIOMA	PCTBA	LEAF CONV	LEAFSURF	LAI
5	PISI	2	PSME	121207.2	14379.0	7263.9	614.1	564.4	1335.7	1900.1	145354.7	.103	PISI	26601.3	2.66
4	TSHE	45	TSHE	234915.7	26120.9	127715.7	2398.6	5231.7	13340.3	18571.9	410222.8	.512	TSHE	372665.1	37.27
PLOT TOTALS:		47		356122.9	40499.8	134979.6	3512.8	5796.0	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]