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INTRODUCTION

Intensive management of National Forest lands requires accurate evaluation of resource condition, capability and response to management. How can different forest types be distinguished? How do they respond to manipulation? How productive are they? Complete knowledge--acre by acre--of species populations, growth rates, biomass, soils, and environment cannot be compiled at present. A reasonable alternative is to let the vegetation and soils of a site indicate potential species composition, productivity and response to management.

Plant populations that have developed on a site over a long period have come into balance with, and are useful indicators of, their environment. A classification of long-term, stable plant communities (or associations)--combined with soils information--can be the basis of resources evaluation, project planning, and land management planning (U.S. Department of Agriculture--Forest Service 1986).

Classification of plant associations allows us to:

1. Plan management strategies--evaluate resource condition, productivity, and responses to manipulation.

2. Communicate--record successes or failures of management actions, provide common descriptions of resource conditions and responses for various disciplines.

3. Apply research--provide a direct link between research results and management practices.

OBJECTIVES

The objective of this project is to provide a vegetative basis for land stratification on the Willamette National Forest which can be used for project level and land management planning. Three major tasks were involved:

1. Describe plant associations on the Willamette National Forest and provide a means for field identification.

2. Compile environmental profiles and management implications for these associations from field measurements, research results, and management experience.

3. Sample tree growth, wildlife habitat, and soils for each plant association and provide estimates of site capability.

Our sampling in the Wilderness Areas was not sufficient to develop plant association descriptions for subalpine parkland communities. We sampled non-forest communities at a reconnaissance level. Tentative descriptions of non-forest plant communities are included in the guide. These areas will be sampled more completely and an addendum to this guide will be published.

Classification of the Willamette National Forest lands is part of a larger project to classify all lands in the Pacific Northwest Region. The ecology program has been involved in this project for several years and the Regional Forester has set a deadline of 1987 for finishing all classification work.

CLASSIFICATION CONCEPTS

Plant communities are useful indicators of environment. Temperature, moisture, light and nutrient availability filter from the large pool of available plant species those which can most effectively occupy a site. After a relatively long disturbance-free period, only those plants which can grow and reproduce in competition with their neighbors remain. This long-term stable collection is the plant association. Different plant associations develop in different environments. For the sake of practical application, plant associations are defined as more or less discrete, recurring collections of plant species which maintain stable populations over a long time period. This concept is similar to habitat type (Daubenmire 1968, Franklin 1966, Pfister et al. 1977).

Climax forests rarely occur in the Pacific Northwest. Although catastrophic natural disturbances are relatively infrequent (Hemstrom 1979, Henderson et al. 1981, Burke 1979, Morrison 1984), pioneer conifer species can be very long lived. The important pioneer conifer species frequently live over 500 years under natural conditions (Franklin and Hemstrom 1981). Climax forest species composition and structure can develop only after these species have died out of the stand. Under some conditions, climax species are the only pioneers. In these rare instances, climax forests of western hemlock, grand fir, incense cedar, western redcedar, Pacific silver fir, or mountain hemlock, develop in a relatively short time. The use of potential natural vegetation (i.e., plant association) to describe a landscape does not mean that stands must be in climax status, or even that we will ever see climax conditions. Instead, the concept relates to the environmental conditions where groups of species would be climax.

The classification of forested associations presented in this guide is based on over 1600 reconnaissance and 275 intensive sample plots from throughout the Willamette National Forest. Plots were sorted into groups using a variety of computer and manual techniques (Volland and Connelly 1978, Gauch 1981). The resulting groups

of plots represent different plant associations and are named after the species which would dominate at climax.

The split between series is based on the physically largest species which would dominate at climax. There are 5 major coniferous series and several others dominated by grasses or shrubs. Several shade tolerant species, in addition to the dominant, would normally be present or common in climax stands. Series names are kept to one or two species for simplicity.

Classification of non-forested communities is based on a combination of floristics, physiognomy, and site physical characteristics. Non-forest types vary from small openings in a forest matrix to rock cliffs, avalanche chutes, and extensive alpine and subalpine parklands. In general, stable non-forest communities indicate extreme environmental conditions: extremely rocky substrates, extremely dry or wet areas, extremely severe winter conditions, etc. Some non-forest openings are the result of disturbance in otherwise forested conditions. In these cases, down logs, abundant charred wood or other signs of the previously existing forest are usually present. Some openings may be the result of heavy domestic livestock grazing.

The non-forest types described in this guide are, for the most part, based on plots taken in areas where succession to forested condition was not obviously occurring. Because each non-forest area tends to have unique environmental conditions and species composition, the classification is based on site physical characteristics and broad floristic patterns, e.g., dominance by moisture-indicating species on talus.

THE STUDY AREA

VEGETATION AND CLIMATE

Four major conifer series occur on the Willamette National Forest. The series are distributed across the Forest according to species autecology (Table 1) and environment. Annual precipitation ranges from about 60 inches in local rain shadows to over 130 inches on some high ridges (Figure 1, U.S. Weather Bureau 1964). Precipitation patterns are heavily influenced by topography. Precipitation peaks occur at the head of the Little North Santiam River, on the Detroit Ranger District, and near Wildcat Mountain, on the Blue River Ranger District. Local rainshadows are present in the Breitenbush area and south of the McKenzie River. The south half of the Willamette National Forest is considerably drier than the north half--an important factor in vegetation distribution. Most precipitation falls as snow at upper-elevations.

The Douglas-fir series occurs on warm, relatively dry sites across the Willamette National Forest. This series is a northern extension of the Sierran mixed conifer forests common in the southwestern Oregon Cascades, Siskiyou Mountains, and Sierra Nevada Range (Franklin and Dyrness 1973). The Douglas-fir series is rare north of the McKenzie River, occurring only on steep, south-facing slopes with thin, rocky soils (Means 1980). South of the McKenzie River, climax Douglas-fir sites are relatively common at lower elevations on southerly exposures, especially on the Rigdon Ranger District. The major climax tree species include incense cedar and grand fir, but Douglas-fir generally dominates both the canopy and regeneration layers. Western hemlock is scarce or absent. Important species include: Douglas-fir, incense cedar, sugar pine, ponderosa pine, bigleaf maple, oceanspray, poison oak, tall Oregon grape, dwarf Oregon grape, salal, whipple vine, grasses, snow queen, yerba buena, baby blue eyes, Alaska habenaria, and others typical of Southwestern Oregon.

The Douglas-fir series occupies the driest enviroments capable of supporting closed forests on the Willamette National Forest (see Means 1980 for a more extensive discussion). Predawn plant moisture stress, a measure of the ability of plants to replenish water supplies from the soil at night (Waring and Cleary 1967), often exceeds 15 bars during August and early September (Means 1980, Figure 2). High summer temperatures increase environmental stress (Figure 3). Precipitation is relatively low (Oakridge Ranger Station, Figure 4). Winter snow is usually transient. These factors add up to a long, dry, warm growing season. On the driest sites, conifer canopies give way to open woodlands of Douglas-fir, Oregon white oak, pines and grasses.

On slightly more moist sites, the Douglas-fir series melds into the western hemlock series. Grand fir is at least co-climax on many of these sites, especially south of the McKenzie River. Franklin and Dyrness (1973) did not consider grand fir climax types separately from the rest of the mixed conifer zone in Southwestern Oregon. Several grand fir plant associations were separated from the Douglas-fir and western hemlock series because grand fir appears to be the dominant climax species on some sites. Grand fir series have often been described in Southwestern Oregon (Atzet and Wheeler 1984) and east of the Cascade crest (Johnson and Simon 1986). Climatic information generally has not been available for this series, but conditions should be intermediate between the Douglas-fir and western hemlock series.

The grand fir series most frequently occurs on relatively dry, southerly-facing slopes and

Table 1. Comparative autecological characteristics of important conifer species (Minore 1979).

Species	Shade Tolerance	Frost Tolerance	Drought Tolerance	Snow Damage Resistance	Fire Resistance	Root rot Resistance	Seed Crop Frequency
Pacific silver fir	H[1]	M	L	M	L *	L	M
Subalpine fir	H	M	M	H	L	M	M
Grand fir	H	M	M	M	M	L	M
Noble fir	L	M *	L *	M	M	M *	M *
Incense cedar	L	M	H	M *	H *	M	**
Alaska cedar	M	M *	L *	H *	L *	H *	**
Engelmann spruce	L	H	M	H *	L	M	M
White bark pine	L *	H *	**	H *	M *	**	**
Lodgepole pine	L	H	H	M *	L	M	M
Sugar pine	M	M	M	L	M	**	**
Western white pine	M	H	M	M	M	M	H
Douglas-fir	L	L	M	L	H	L	M
Western redcedar	H	L	M	M *	L	H	M
Western hemlock	H	L	L	H	L	M	M
Mountain hemlock	H	H	L	H	M	L	M

[1]H - high, M - moderate, L - low.

* Not listed in Minore (1979), estimated from field observations and species similarities.

** No estimates available.

excessively well-drained river terraces. It extends into upper elevations south of the McKenzie River, where it mixes with the Pacific silver fir series. Important species include a mixture of those from the Douglas-fir series, the western hemlock series, and the Pacific silver fir series.

The bulk of lower elevation forests fall into the western hemlock series. The western hemlock series extends along the Pacific coast from British Columbia south to the Klamath Mountains and along a narrow coastal strip farther south (Franklin and Dyrness 1973). In the Cascades, the western hemlock series extends from British Columbia south to the divide between the North and South Umpqua Rivers (Franklin and Dyrness 1973). Important species include: Douglas-fir, western hemlock, western redcedar, bigleaf maple, vine maple, dwarf Oregon grape, salal, rhododendron, swordfern, vanilla leaf, Oregon oxalis, twinflower, and redwoods violet.

Climatic conditions in the western hemlock zone are relatively mild. Temperatures range from sightly below freezing in winter to 90 to 100 degrees F in summer (Figs. 5 and 6). Precipitation amounts vary from about 60 to over 100 inches per year, mostly falling as rain or snow in the winter (Figs. 7 and 8). Winter snowpacks are not usually deep nor long lasting. Plant moisture stress seldom exceeds 15 bars during the growing season (Means 1980, Zobel et al. 1976, Figure 2).

The Pacific silver fir series occurs on the western slopes of the Cascade Range from British Columbia to near the southern end of the Willamette National Forest (Franklin and Dyrness 1973). Smaller areas of the Pacific silver fir zone are found in the Olympic Mountains, in cool, wet sites in the Cascades east of the Crest, in isolated areas of the northern Oregon Coast Range, and south to about 43 degrees North latitude. The Pacific silver fir series dominates upper-slopes, from 3000 to 5500 feet elevation, on the Willamette National Forest. Important species include: Douglas-fir, noble fir, Pacific silver fir, mountain hemlock, western hemlock, lodgepole pine, vine maple, dwarf Oregon grape, big

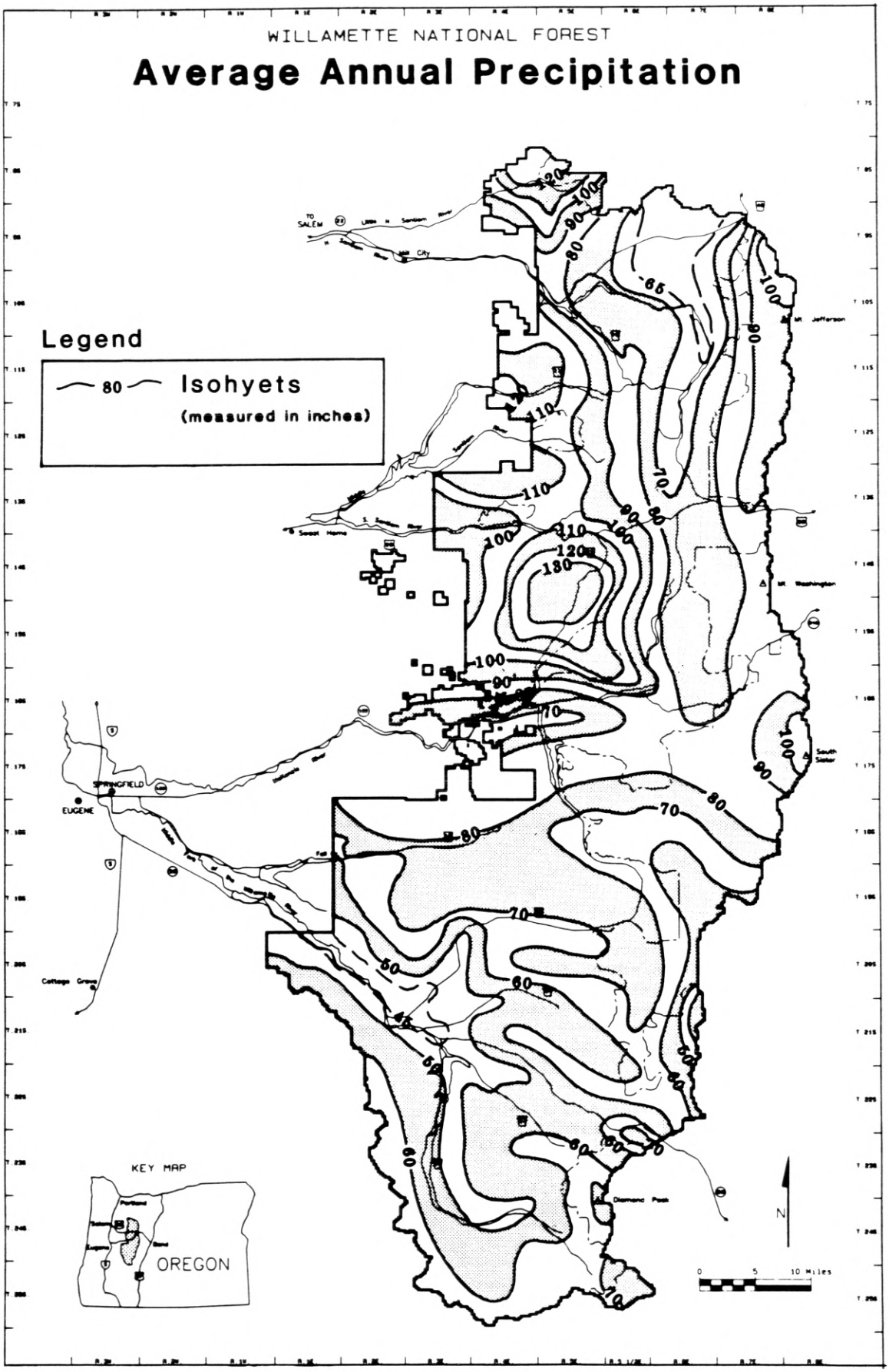


Figure 1. Generalized total annual precipitation map of the Willamette National Forest (U.S. Weather Bureau 1964).

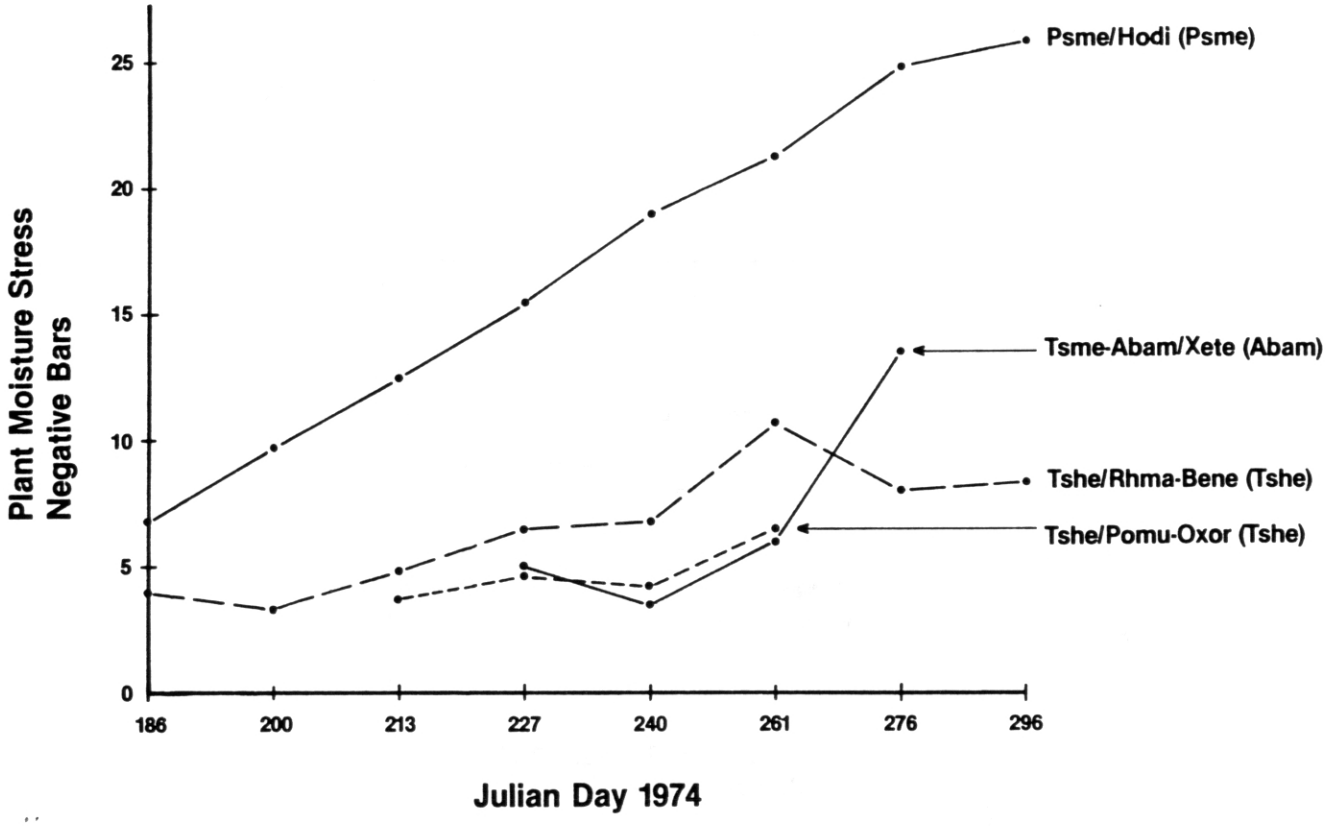


Figure 2. Predawn plant moisture stress for representative plant associations on the Willamette National Forest.

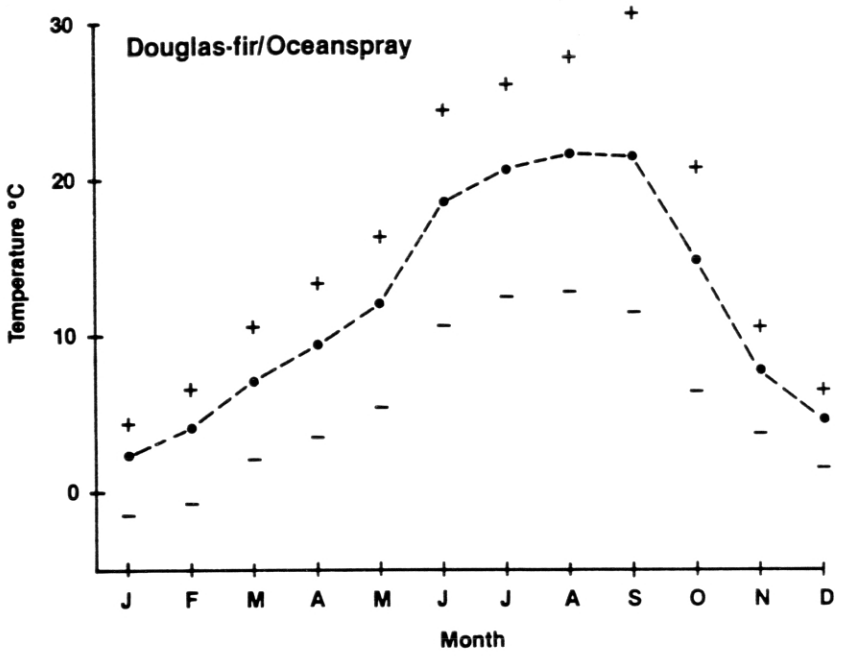


Figure 3. Mean maximum (+), mean, and mean minimum (-) monthly temperatures, Douglas-fir/oceanspray association. (Emmingham and Lundberg 1977).

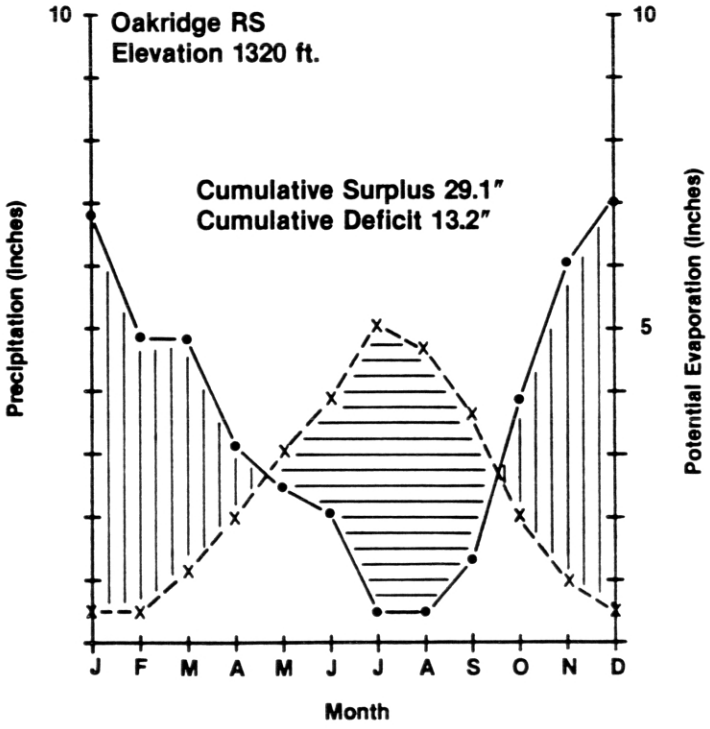


Figure 4. Precipitation and potential evapotranspiration, Oakridge Ranger Station, Oregon (Johnsgard 1963).

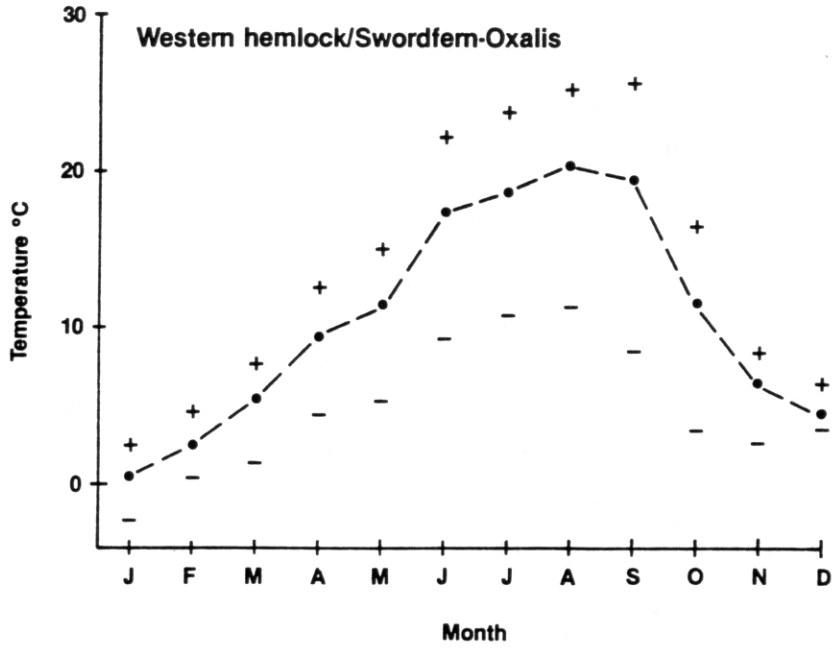


Figure 5. Mean maximum (+), mean, and mean minimum (-) monthly temperatures, western hemlock/Oregon oxalis association (Emmingham and Lundberg 1977).

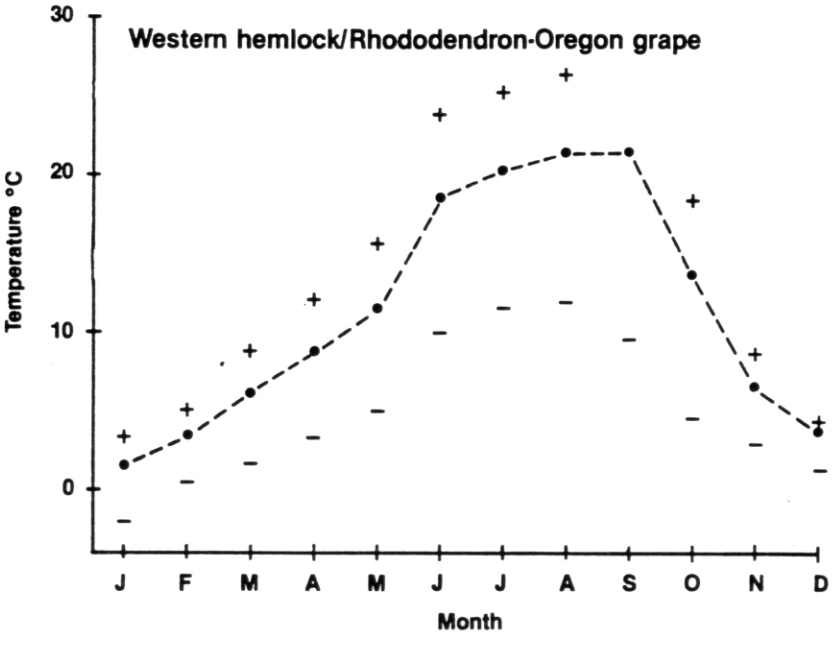


Figure 6. Mean maximum (+), mean, and mean minimum (-) monthly temperatures, western hemlock/rhododendron-dwarf Oregon grape association (Emmingham and Lundberg 1977).

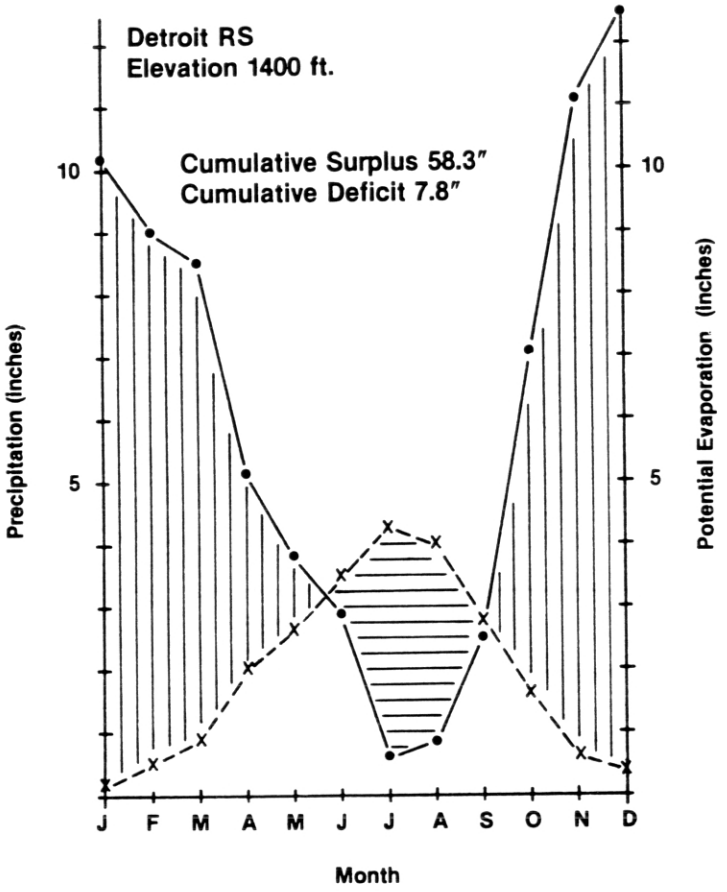


Figure 7. Precipitation and potential evapotranspiration, Detroit Ranger Station, Oregon (Johnsgard 1963).

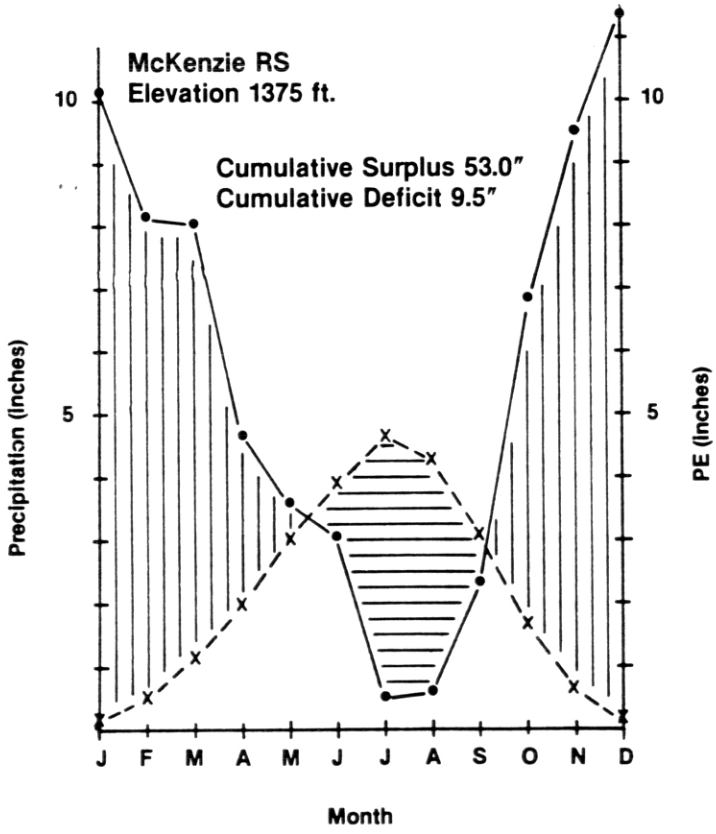


Figure 8. Precipitation and potential evapotranspiration, McKenzie Ranger Station, Oregon (Johnsgard 1963).

huckleberry, Alaska huckleberry, rhododendron, grouse huckleberry, Cascades azalea, coolwort foamflower, false solomonseal, queencup beadlily, dogwood bunchberry, sidebells pyrola, and beargrass.

Most of the annual precipitation in the Pacific silver fir and mountain hemlock series falls in winter and accumulates as a deep snowpack at upper elevations (Figure 9). Mean maximum air temperatures usually occur in August and range from about 75 degrees F to about 63 degrees F at the transition to the mountain hemlock series (Figure 10). Growing seasons are short at upper-elevations and summer frost frequently occurs in openings, particularly on gentle topography (Halverson and Emmingham 1982). Predawn plant moisture stress usually reaches only 6 to 8 bars in mid-summer (Figure 2, Emmingham and Lundberg 1977); a level which can slow growth but is not usually fatal to conifer seedlings. Moisture stress can be higher in seedlings planted in cold soils because root growth and function are impeded (Halverson and Emmingham 1982).

At least 16 conifer species are locally common in the Willamette National Forest, including: Pacific silver fir, subalpine fir, grand fir, noble fir, incense cedar, Alaska cedar, Engelmann spruce, whitebark pine, lodgepole pine, sugar pine, western white pine, ponderosa pine, Douglas-fir, western redcedar, western hemlock, and mountain hemlock. For simplicity, the genetic intermediates between noble fir and Shasta red fir (Franklin and Greathouse 1968a and 1968b, Zavarin et al. 1978) and grand fir and white fir (Zobel 1973, 1974, and 1975) that occur on the Willamette National Forest will be called noble fir and grand fir, respectively. Autecological characteristics of these 16 species vary tremendously (Table 1). Several species are climax dominants on very cold or very dry sites but seral on moderate sites where more shade-tolerant species are competitive. Species composition at the north end of the Forest is typical of the rest of the Washington and northern Oregon Cascades (Figures 11 and 12). At the south end of the Forest, species representative of the Sierran mixed conifer zone (Franklin and Dyrness 1973) become common (Figures 13 and 14).

Shrub and herb distributions also change from north to south. Fool's huckleberry and Cascades azalea are uncommon south of the North Santiam River and rare south of the McKenzie River. Devil's club is not widespread south of the McKenzie River (except in the Little Fall Creek drainage on the Lowell Ranger District) but is relatively common on the Detroit and Sweet Home Ranger Districts. Species characteristic of dry sites in the Douglas-fir series are locally common on the Rigdon and Oakridge Ranger Districts but rare farther north. Most notable among these are ponderosa pine, sugar pine, incense cedar, tall Oregon grape, poison oak, and whipple vine.

Most of these species shifts relate to precipitation and temperature patterns. The vegetation of the Oakridge and Rigdon Ranger Districts reflects significantly drier climatic conditions than those farther north. The Pacific silver fir series is not as widespread on these Ranger Districts and, on south-facing slopes, is often replaced by the grand fir and Douglas-fir series.

GEOLOGY AND SOILS

The Oregon Cascade Range is divided into two major geologic provinces (Franklin and Dyrness 1973, Legard and Meyer 1973). The geologically older Western Cascades are largely composed of Oligocene and Miocene volcanic and pyroclastic formations, particularly the Little Butte Volcanic Series and the Sardine Formation (Figure 15). Tuffs and breccias, which dominate the Little Butte Series, weather relatively rapidly and completely to deep, fine textured soils which can be very unstable. Flows of basalt and andesite, most abundant in the Sardine Formation, weather slowly, often producing well-drained, coarse, stony soils. These soils are much less subject to mass movement (Legard and Meyer 1973).

A long history of glacial and stream erosion has produced highly dissected topography, especially on the west-facing half of the Western Cascades. Ridge tops are typically about 5000 feet elevation with only a few peaks reaching 6000 feet.

Soils in the Western Cascades can be divided into two major groups; those derived from pyroclastic parent materials (tuffs and breccias) and those derived from basic igneous rocks (basalt and andesite) (Franklin and Dyrness 1973). Soils forming from pyroclastic parent materials on gentle slopes are often deep, fine textured Haploxerults which are poorly drained and subject to soil mass movements (Franklin and Dyrness 1973). Those which develop on steeper slopes are usually less well-developed, stony or gravelly clay loams. They are generally classified as Haplumbrepts or Xerumbrepts (Franklin and Dryness 1973).

Basalt and andesite bedrocks weather more slowly and produce more well-drained, stonier and coarser textured soils than pyroclastic parent materials. On steep slopes, these soils are poorly developed and, especially at higher elevations, often contain significant amounts of volcanic ash and pumice (Franklin and Dyrness 1973). Well-developed soils are usually classified as Argixerolls or Haplohumults and poorly developed soils are usually Xerumbrepts (Franklin and Dyrness 1973).

The High Cascades province consists of rolling uplands and plateaus punctuated by high volcanoes. The broad, relatively flat plateau ranges from about 4500 feet to 5500 feet elevation with some deep, glaciated valleys. Volcanic peaks rise 150 feet to over 5300 feet above the surrounding plateau. Most of the surface rocks are geologically recent volcanic deposits. These andesite and basalt lavas and pyroclastic rocks are overlain in many places by extensive ash, cinder and pumice deposits. Mazama ash is common

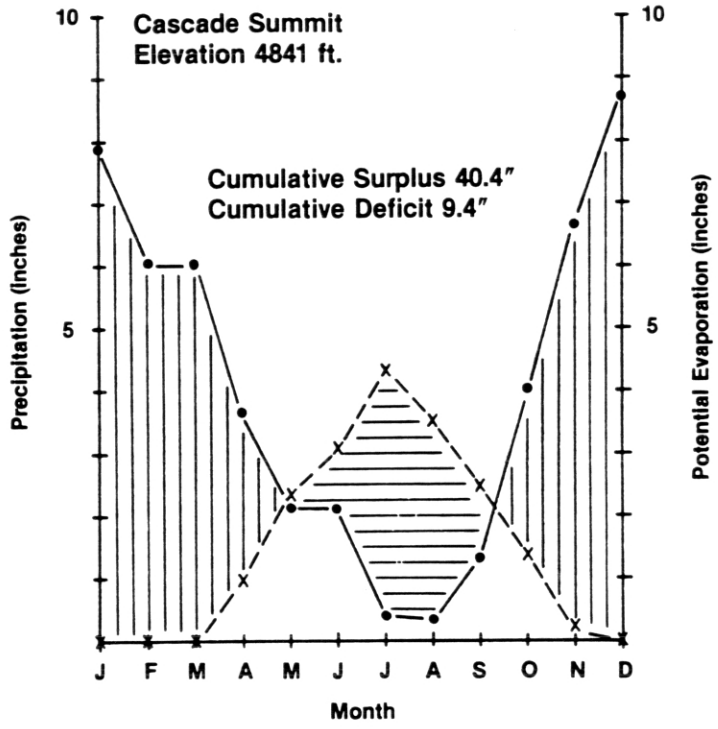


Figure 9. Precipitation and potential evapotranspiration, Cascade Summit, Oregon (Johnsgard 1963).

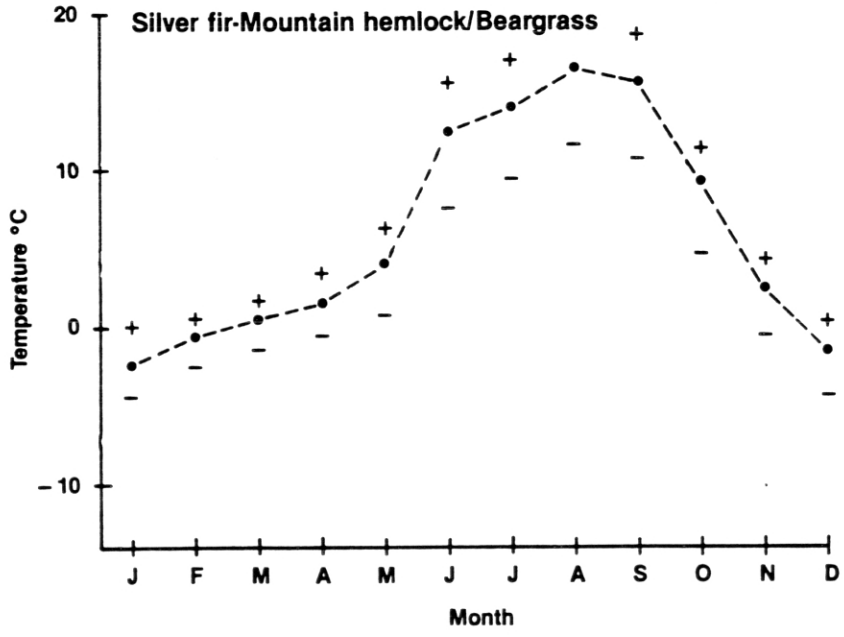


Figure 10. Mean maximum (+), mean, and mean minimum (-) monthly temperatures, Pacific silver fir-mountain hemlock/ beargrass association (Emmingham and Lundberg 1977).

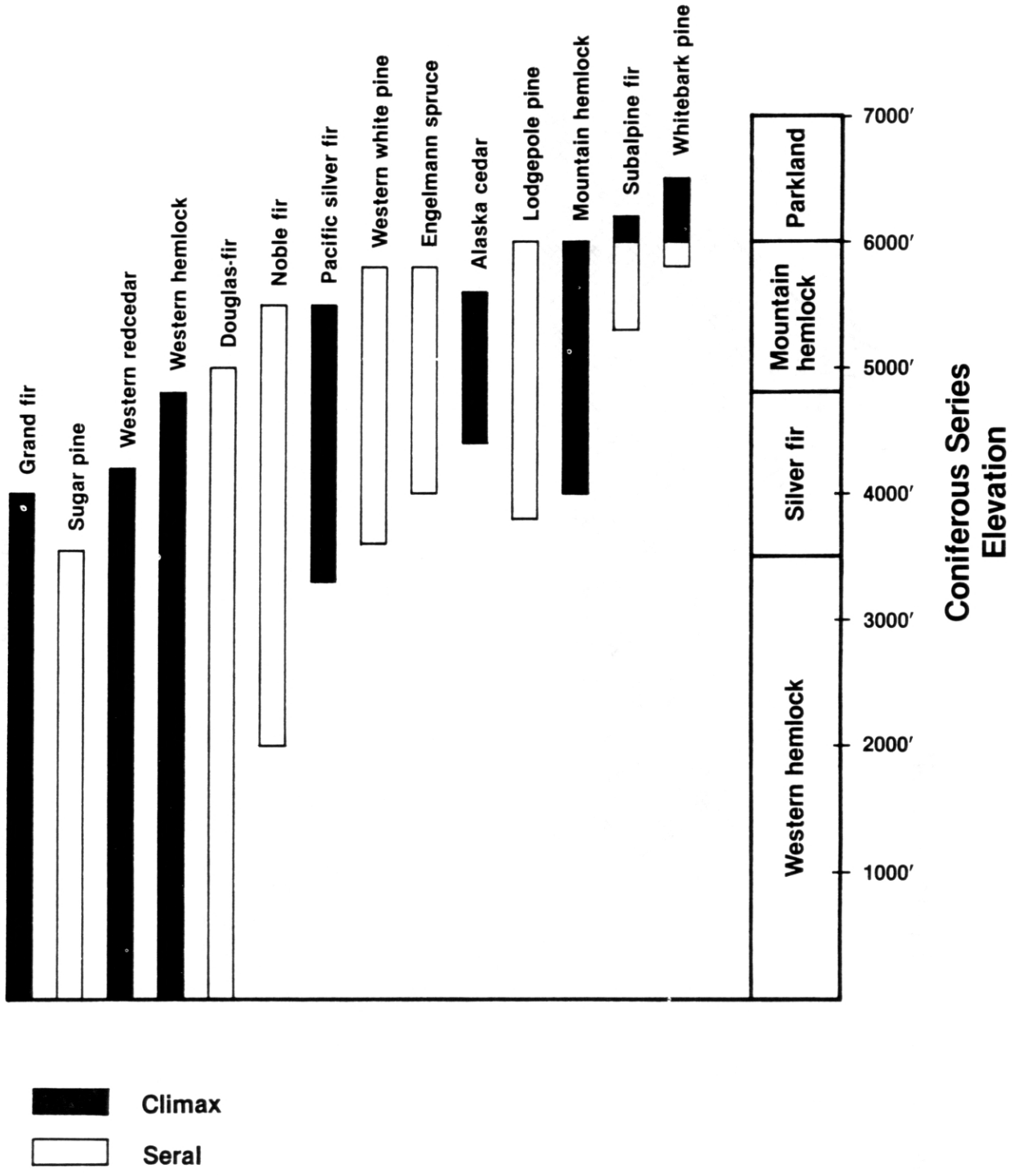


Figure 11. Successional status of important conifers, north half of the Willamette National Forest.

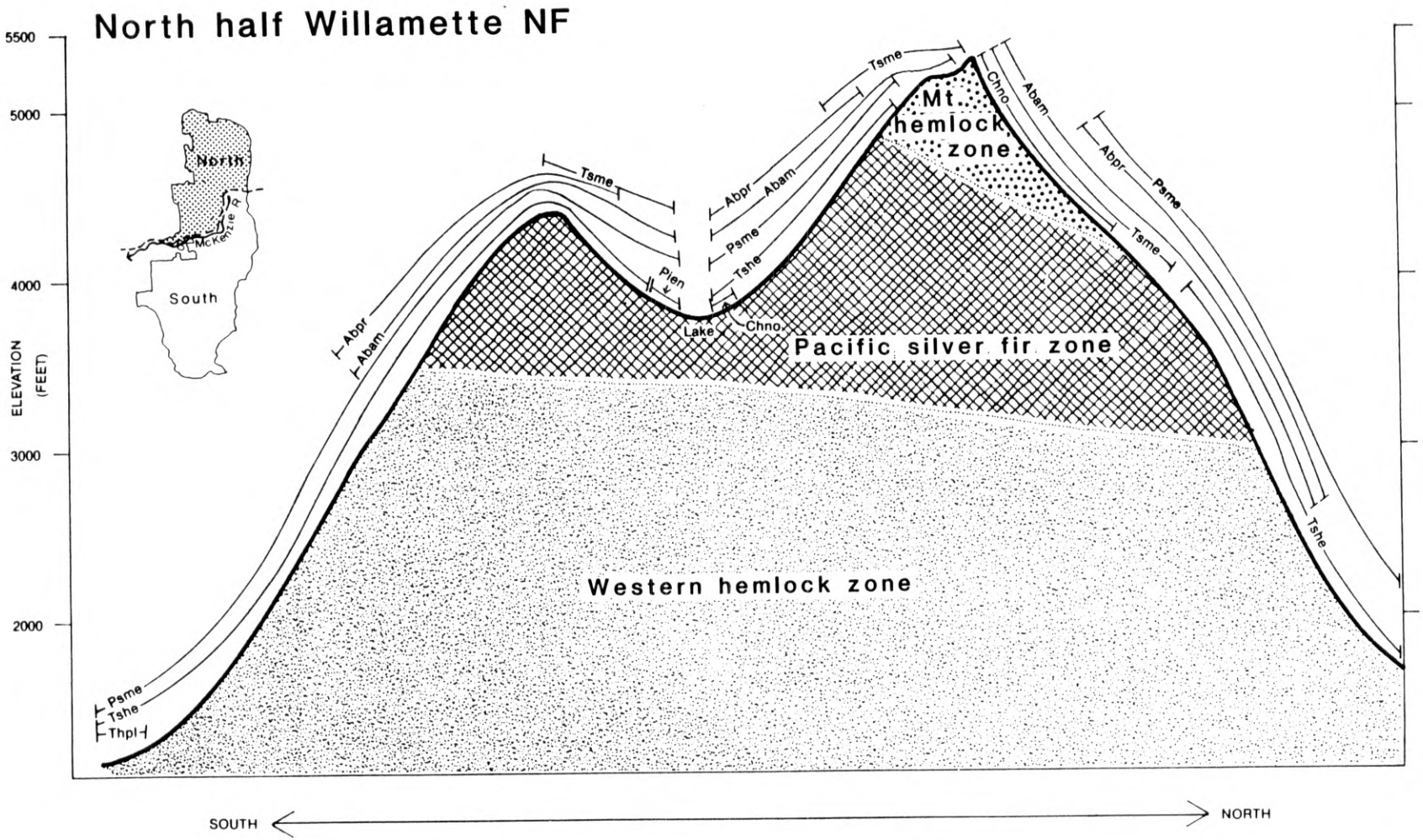


Figure 12. Distribution of important conifer species on south-facing and north-facing slopes at different elevations, north half of the Willamette National Forest.

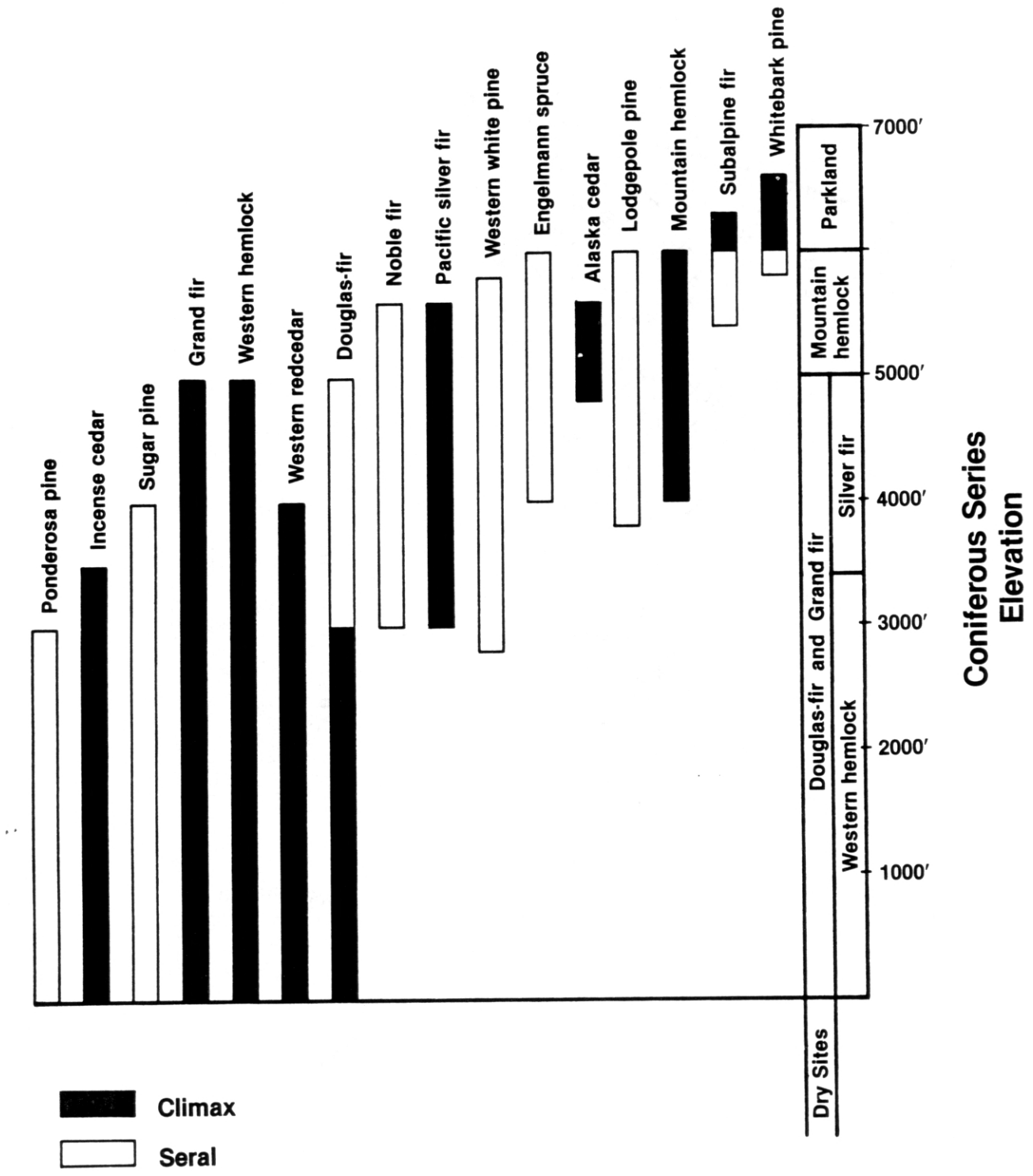


Figure 13. Successional status of important conifers, south half of the Willamette National Forest.

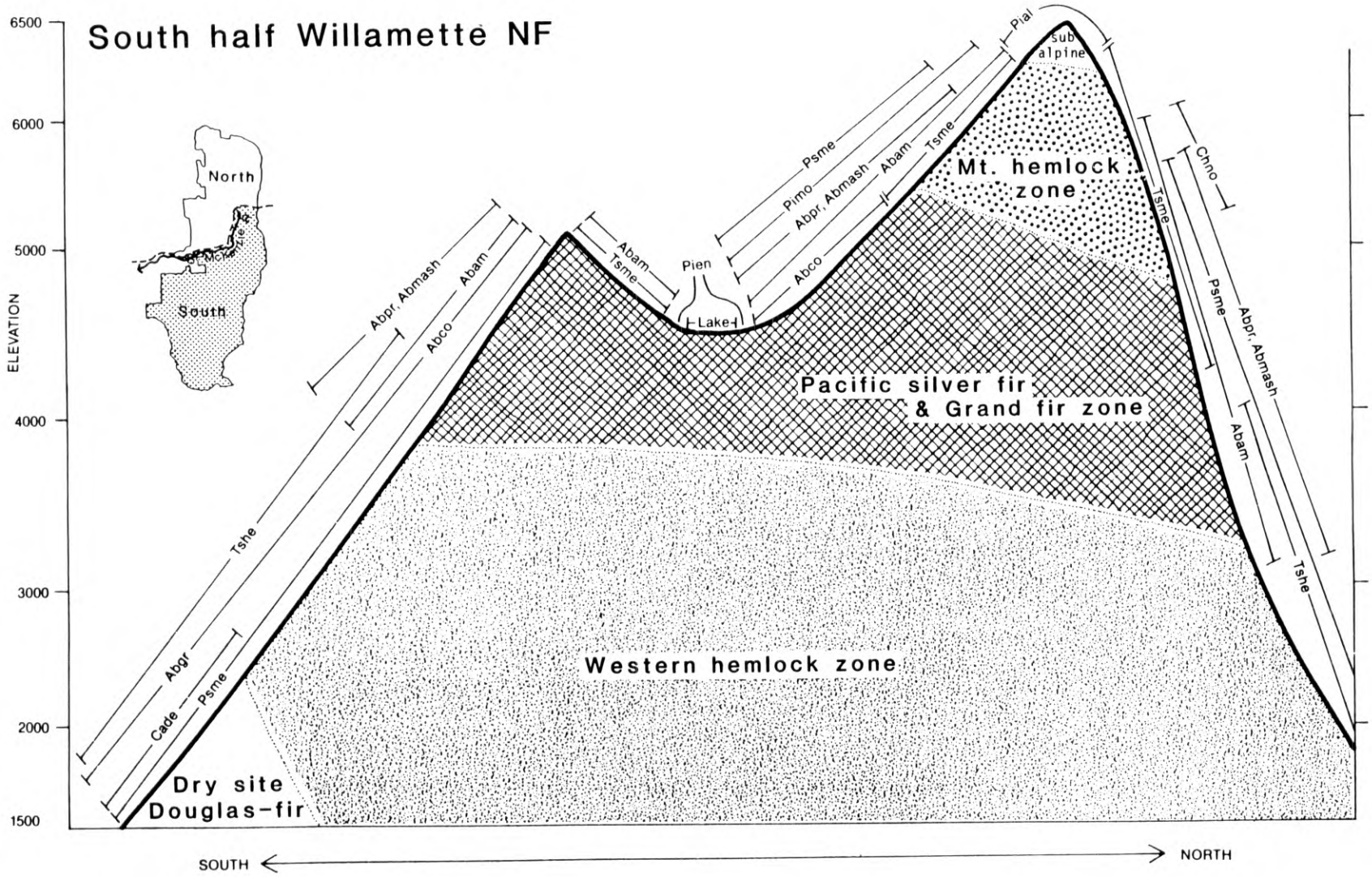


Figure 14. Distribution of important conifer species on south-facing and north-facing slopes at different elevations, south half of the Willamette National Forest

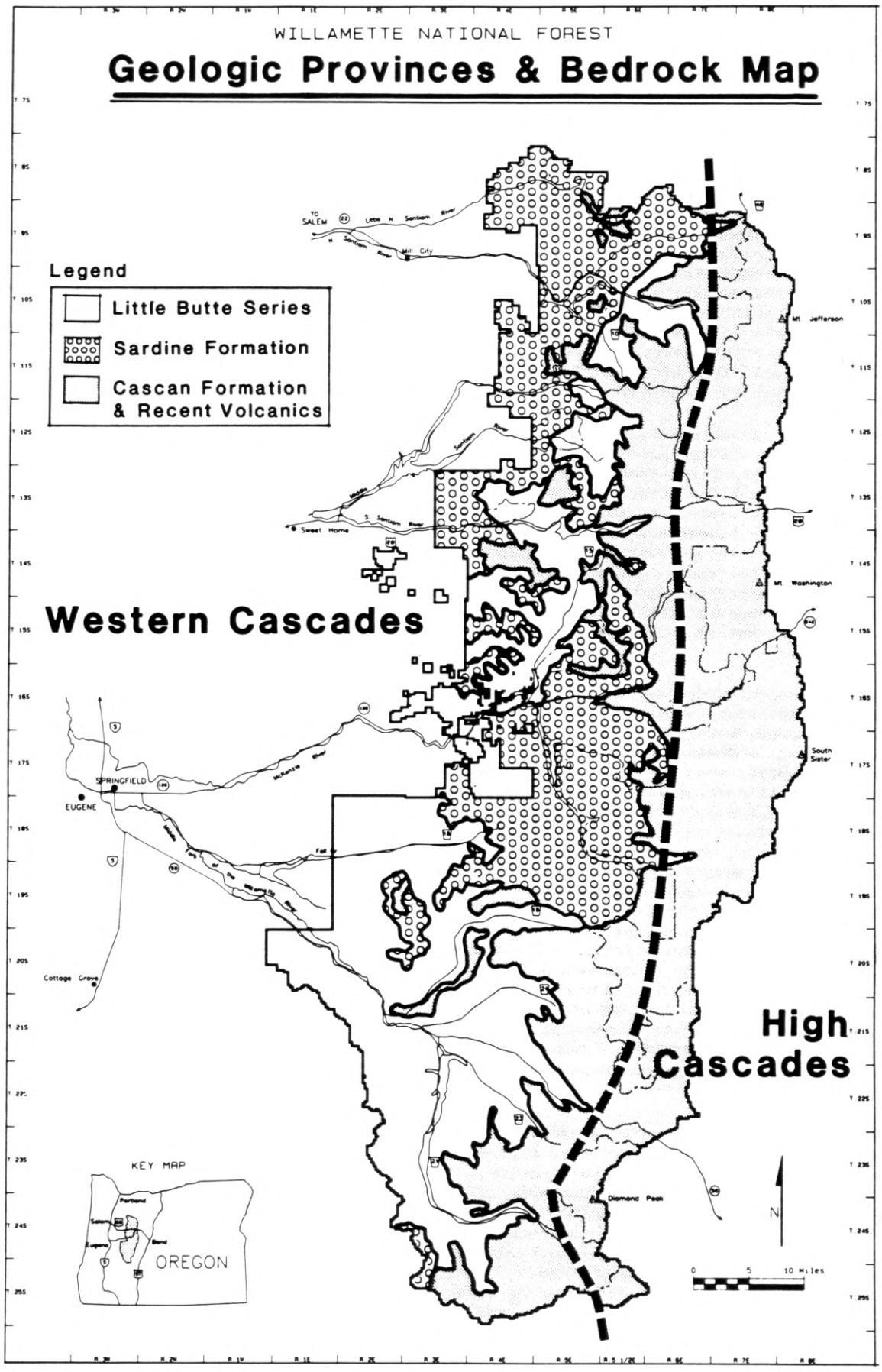


Figure 15. Geologic provinces and bedrock types, Willamette National Forest (Legard and Meyer 1973).

at the south end of the Forest. Glacial deposits are locally abundant adjacent to the higher peaks.

High Cascades soils are usually immature and developed in volcanic ejecta or glacial till (Franklin and Dyrness 1973). Soils developed in glacial till typically have stony or gravelly loam subsoils overlain by loam or gravelly loam surface layers which may show weak A2 horizon development. These are generally classified as Cryorthods, Haplorthods, or Cryumbrepts. Soils derived from volcanic ejecta cover extensive portions of the high plateau. These poorly developed soils are usually classified as Vitrandepts (Franklin and Dyrness 1973). Valuable soil data which should be used in conjunction with plant association information, has been compiled in the Willamette National Forest Soil Resource Inventory (SRI, Legard and Meyer 1973).

We collected soil descriptions at about 670 plot locations across the Forest. Most of these were in the Pacific silver fir and mountain hemlock zones during an earlier effort (Hemstrom et al. 1982). Soil descriptions from this earlier effort do not include Soil Resource Inventory mapping unit. We also collected approximately 100 soil descriptions in Douglas-fir, grand fir and western hemlock types during intensive ecology plot sampling in the summer of 1986. These include full soil descriptions and SRI map unit for each soil described.

The most evident feature of an analysis of soils by plant association is the lack of clear patterns in both SRI mapping unit (Table 2) and total soil depth (Table 3). Individual plant associations occur across various soil conditions in response to changes in climate or soil factors other than effective rooting depth and texture. This is particularly evident in some of the Douglas-fir series associations. The Douglas-fir/ oceanspray/grass association, for example, occurs on shallow, skeletal soils or deep clays, both of which can be very droughty (Table 2). By the same token, SRI types often span many plant associations and productivity levels. SRI mapping unit 61, shallow and stony, is common in the dry Douglas-fir series, several of the western hemlock associations and into the Pacific silver fir series. In fact, both plant association and soils characteristics should be used to develop accurate predictions of productivity and response to management.

The Douglas-fir series occurs on droughty sites. At the south end of the Forest, some fairly deep soils, particularly clays, can be droughty. Farther north, sites dry enough to support Douglas-fir types are mostly limited to steep sites with shallow, rocky soils on south aspects. As a consequence, SRI types which are shallow and rocky (21, 31, 61) and deeper clays (23, 25, 33, 35) are common in the Douglas-fir series (Table 2). Total and effective rooting depth (total depth minus percent coarse fragments) vary in a similar fashion (Table 3).

Grand fir associations, except grand fir/bearberry, seem to occur on moderately deep soils, often with fairly high coarse fragment contents. The relatively uncommon grand fir/bearberry association is found on thin soils over lava or bedrock. Other grand fir associations are wide-spread at the south end of the Forest, but become increasingly restricted to glacial outwash, coarse alluvial deposits, or similar soils to the north.

Soils in the western hemlock zone are highly variable. Most soils are relatively deep, often with abundant coarse fragments. SRI types 21, 31, and 61 (shallow and rocky) are not common. The rhododendron dominated associations often occur on soils which are relatively high in coarse fragments. The driest, least productive western hemlock zone association, western hemlock/ rhododendron/beargrass, generally occurs on thin soils on rocky ridges. The SRI types for this association may be misleading since the association often occurs as patches in a mosaic of more productive, deeper soils. Western hemlock/Oregon oxalis associations, which are among the most productive, generally occur on deep soils.

While we don't have information on SRI types in the Pacific silver fir and mountain hemlock zones, soils at upper elevations are substantially higher in coarse fragments than those at lower elevations. Over 30 percent of the total soil volume in many Pacific silver fir associations is comprised of coarse fragments, compared to 25 percent or less for most western hemlock associations. Soils in the mountain hemlock zone are even more stony, often averaging over 40 percent coarse fragments. Increased coarse fragment content at upper-elevations does not necessarily mean increased moisture stress. Increased precipitation, decreased temperatures, and persistent snowpacks reduce total evaporative demand. Stony soils often indicate poor nutrient status and difficult planting conditions.

Combinations of soil and plant association information can be very helpful in decisions about the use of fire, fertilizers, and other site treatments. Fire probably becomes more harmful to site productivity, through increased erosion and nitrogen loss, as the soils become thinner and stonier, as nitrogen fixing plants become less important in early succession, and as available nitrogen decreases. Several combinations of plant association and SRI would seem to be particularly sensitive to fire, including: Douglas-fir associations on SRI types 21, 31, and 61, western hemlock/rhododendron associations on SRI types 21, 31, and 61, western hemlock/salal on SRI types 21, 31, and 61, Pacific silver fir/rhododendron associations on most soils, Pacific silver fir/big huckleberry/ beargrass associations on most soils, and all of the mountain hemlock zone. Sensitivity varies with fire intensity.

We have not examined the potential of using plant associations and SRI types to estimate fertilizer effects. It seems reasonable that available nitrogen and stand growth following fertilization should tie well to plant association and SRI type. The rhododendron associations, in

Table 2. Soil Resource Inventory mapping units by plant association for the Willamette National Forest.

Association	Number of Pits	Soil Resource Inventory Mapping Units (Number of Pits)
WESTERN HEMLOCK SERIES		
Western hemlock/Alaska huckleberry/dogwood bunchberry	5	15 (2), 3 (1), 63 (1), 66 (1)
Western hemlock/ dwarf Oregon grape	22	13 (1), 15 (4), 16 (4), 21 (1), 23 (6) 25 (1) 33 (2), 61 (2), 64 (1)
Western hemlock/dwarf Oregon grape/ Oregon oxalis	11	15 (2) 16 (2) 23 (5) 25 (1), 33 (1)
Western hemlock/dwarf Oregon grape-salal	13	14 (2), 16 (3), 21 (2), 23 (2), 25 (1), 35 (1), 235 (1)
Western hemlock/dwarf Oregon grape/vanilla leaf	9	16 (3), 21 (1), 23 (1), 25 (1), 64 (1), 66 (2)
Western hemlock/devil's club	3	15 (2), 25 (1)
Western hemlock/Oregon oxalis	9	8 (1), 13 (1), 15 (1), 16 (2), 23 (1), 25 (1), 33 (1)
Western hemlock/rhododendron-Alaska huckleberry/dogwood bunchberry	4	13 (1), 16 (2), 25 (1)
Western hemlock/rhododendron/ beargrass	16	16 (2), 23 (2), 25 (1), 33 (1), 35 (1), 61 (2), 64 (1)
Western hemlock/rhododendron-dwarf Oregon grape	15	16 (3), 23 (4), 33 (2), 56 (1), 61 (3), 63 (1), 66 (1)
Western hemlock/rhododendron/ Oregon oxalis	5	16 (1), 33 (2), 35 (1), 61 (1)
Western hemlock/rhododendron-salal	16	13 (1), 15 (1), 16 (5), 23 (5), 33 (1), 35 (1), 61 (2),
Western hemlock/rhododendron/ twinflower	3	16 (2), 23 (1)
Western hemlock/salal	12	13 (1), 14 (1), 15 (2), 21 (2), 23 (1), 25 (2), 35 (1), 61 (1)
Western hemlock/swordfern	4	16 (1), 23 (1), 31 (1), 33 (1)
Western hemlock/twinflower	5	15 (1), 16 (1), 33 (1), 64 (1), 66 (1)
Western hemlock/vanilla leaf	7	14 (1), 15 (2), 23 (1), 33 (2), 66 (1)

Table 2. (continued)

Association	Number of Pits	Soil Resource Inventory Mapping Units (Number of Pits)
DOUGLAS-FIR SERIES		
Douglas-fir/oceanspray-dwarf Oregon grape	3	3 (1), 9 (1), 33 (1), 61 (1)
Douglas-fir/oceanspray/grass	5	14 (1), 33 (3), 61 (1)
Douglas-fir/oceanspray-whipple vine	4	23 (1), 61 (3)
Douglas-fir/snowberry	2	23 (1), 33 (1)
Douglas-fir-western hemlock/dwarf Oregon grape	3	23 (1), 35 (1), 66 (1)
Douglas-fir-western hemlock/salal	6	16 (1), 31 (1), 35 (1), 61 (1), 66 (1)
Douglas-fir-western hemlock/rhododendron	1	33 (1)
GRAND FIR SERIES		
Grand fir/bearberry	2	16 (1), 33 (1)
Grand fir/dwarf Oregon grape	5	15 (1), 16 (1), 21 (1), 61 (1), 63 (1)
Grand fir/prince's pine	6	5 (1), 15 (1), 16 (1), 57 (1), 62 (1), 66 (1)
Pacific silver fir-grand fir/false solomonseal	33	3 (1), 15 (1), 16 (1), 21 (1), 25 (1), 44 (3), 55 (2), 61 (6), 66 (4), 67 (1), 73 (1), 74 (4), 82 (1), 92 (1)

Table 3. Total Depth and Effective Rooting Depth for Soils of the Willamette National Forest.

Association	Number of Pits	Total Depth (Inches)		Total Depth (Inches)	Effective Rooting Depth (Inches)		Effective Rooting Depth (Inches)
		Mean	SE[1]	Range	Mean	SE	Range
DOUGLAS-FIR SERIES							
Douglas-fir/oceanspray-dwarf Oregon grape	3	30	3	21-40	25	3	15-32
Douglas-fir/oceanspray/grass	5	35	2	24-47	31	2	18-39
Douglas-fir/oceanspray-whipple vine	4	41	6	21-60	31	4	14-46
Douglas-fir/snowberry	2	26	6	16-35	19	5	12-26
Douglas-fir-western hemlock/dwarf Oregon grape	3	52	4	37-60	48	7	25-60
Douglas-fir-western hemlock/salal	6	34	1	24-41	23	1	18-30
Douglas-fir-western hemlock/rhododendron	1	57			52		
GRAND FIR SERIES							
Grand fir/bearberry	2	25	6	16-33	18	7	8-28
Grand fir/dwarf Oregon grape	5	36	3	18-60	28	2	10-46
Grand fir/prince's pine	6	44	2	38-60	34	2	26-58
MOUNTAIN HEMLOCK SERIES							
Mountain hemlock/big huckleberry/beargrass	42	47	1	16-98	29	1	5-69
Mountain hemlock/grouse huckleberry	14	42	1	26-60	29	1	9-51
Mountain hemlock/luzula	-	-	-	-	-	-	-
Mountain hemlock/rhododendron beargrass	21	40	1	9-82	24	1	5-65

[1] Standard error.

Table 3. (continued)

Association	Number of Pits	Total Depth (Inches)		Total Depth (Inches)	Effective Rooting Depth (Inches)		Effective Rooting Depth (Inches)
		Mean	SE	Range	Mean	SE	Range
PACIFIC SILVER FIR SERIES							
Pacific silver fir-grand fir false Solomon's seal	33	50	1	16-99	28	1	3-57
Pacific silver fir/Alaska huckleberry/dogwood bunchberry	14	49	1	18-75	40	1	4-64
Pacific silver fir/Alaska huckleberry-salal	3	59	12	37-99	30	6	11-47
Pacific silver fir/big huckleberry/beargrass	31	43	1	18-73	28	1	7-51
Pacific silver fir/big huckleberry/queencup beadlily	30	49	1	21-72	29	1	12-65
Pacific silver fir/Cascades azalea/beargrass	2	33	8	22-44	23	4	17-29
Pacific silver fir/Cascades azalea/queencup beadlily	5	50	3	33-60	36	3	16-55
Pacific silver fir/coolwort foamflower	68	52	1	19-96	35	1	5-86
Pacific silver fir/Devil's club	22	52	1	24-68	35	1	8-65
Pacific silver fir/dwarf Oregon grape	60	49	1	15-95	31	1	6-54
Pacific silver fir/fool's huckleberry	8	37	2	17-61	24	2	8-57
Pacific silver fir/Oregon oxalis	18	55	1	18-96	38	1	11-77
Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry	18	40	1	16-60	25	1	6-48
Pacific silver fir/rhododendron/beargrass	47	46	1	8-118	30	1	3-99
Pacific silver fir/rhododendron/dwarf Oregon grape	13	46	1	30-70	28	1	17-55
Pacific silver fir/vine maple/coolwort foamflower	25	50	1	12-70	33	1	9-60
Pacific silver fir-western hemlock/rhododendron-salal	5	43	3	18-60	18	2	5-31

Table 3. (continued)

Association	Number of Pits	Total Depth (Inches)		Total Depth (Inches)	Effective Rooting Depth (Inches)		Effective Rooting Depth (Inches)
		Mean	SE[1]	Range	Mean	SE	Range
WESTERN HEMLOCK SERIES							
Western hemlock/Alaska huckleberry/dogwood bunchberry	5	38	3	29-60	31	1	23-36
Western hemlock/ dwarf Oregon grape	22	43	1	5-60	34	1	6-58
Western hemlock/dwarf Oregon grape/ Oregon oxalis	11	49	1	30-70	42	1	6-66
Western hemlock/dwarf Oregon grape-salal	13	45	1	24-65	37	1	9-60
Western hemlock/dwarf Oregon grape/vanilla leaf	9	42	2	8-66	35	2	5-59
Western hemlock/devil's club	3	35	7	21-58	29	4	21-43
Western hemlock/Oregon oxalis	9	47	2	20-78	30	1	15-49
Western hemlock/rhododendron-Alaska huckleberry/dogwood bunchberry	4	48	3	30-60	35	3	24-48
Western hemlock/rhododendron/ beargrass	10	48	1	36-65	36	2	18-64
Western hemlock/rhododendron-dwarf Oregon grape	15	41	1	20-60	29	1	10-55
Western hemlock/rhododendron/ Oregon oxalis	5	55	2	36-65	48	3	22-65
Western hemlock/rhododendron-salal	16	43	1	18-60	35	1	18-60
Western hemlock/rhododendron/ twinflower	3	42	7	17-60	31	6	10-48
Western hemlock/salal	12	34	1	6-60	25	1	4-57
Western hemlock/swordfern	4	44	1	38-52	36	2	25-38
Western hemlock/twinflower	5	23	3	8-45	20	3	5-43
Western hemlock/vanilla leaf	7	54	1	35-60	47	2	25-58

[1] Standard error.

particular, seem to occur on sites with significant nitrogen limitations. In these types, fertilization and the proper management of nitrogen fixing species, such as Ceanothus species, could significantly increase tree growth and benefit long term site productivity. Economic analysis should be used to see where returns would be greatest. Careful maps of plant association and SRI types should be kept for all field fertilizer applications so we can begin to build predictive models of response.

Natural Disturbance and Succession

Fire has been the most pervasive natural distrubance in the central portion of the Oregon Cascades. Catastrophic fires occur infrequently over much of the Cascade Range from the Willamette National Forest northward (Hemstrom and Franklin 1982). The forests of Mt. Rainier National Park, for example, experience major, stand replacing fires every 400 or more years (Hemstrom 1979).

The tendency for periodic smaller fires and underburning seems to increase in the southern Cascades Range. Morrison (1984) found that while parts of his study area, (just north of the McKenzie River) had not burned in several centuries, other areas had fire return intervals of 15 to 20 years. Stuart (1984) also found in his study area on the Sweet Home Ranger District that relatively frequent small burns produced a patchwork of stand ages and compositions. The drier sites in the Douglas-fir series experience relatively infrequent underburns (on the order of once every 100 years) and rarer catastrophic fires (Means 1980). Mountain hemlock forests in the Waldo Lake vicinity have also burned in a patchy fashion over the last several centuries. Stand ages range from 60 years to over 700 years (Dickman 1984).

Winds of hurricane force (over 74 miles per hour) strike the Oregon Coast several times each winter (Badura et al. 1974). Blowdown resulting from these storms can be substantial. The Columbus Day storm (on October 12, 1962) blew down 11 billion board feet of timber in Oregon and Washington, 98 percent of which was west of the Cascade Crest. Other major windstorms in Oregon and Washington occurred in November 1953, April 1957, February 1958, March 1963, January 1921, and January 1880 (Lynott and Cramer 1966). Other major windstorms have occurred since 1966. Those before 1950 are not well documented.

The effects of windstorms do not seem to be as pronounced in the Cascades Range as in the Oregon Coast Range. Many of the larger blowdown events in the Cascades Range seem to come with east winds during the winter. In general, windstorms speed successional development by opening the canopy and releasing suppressed understory climax species (Dale et al. 1986). Local windthrows increase the opportunity for tree seedling establishment, resulting in higher stand structural and species diversity (Stuart 1984).

Pathogens occasionally cause substantial tree mortality. Dickman (1984) studied the extent, history, and rate of spread of Phellinus weirii in the vicinity of Waldo Lake. He found that some infection centers are over 1000 years old and rates of spread varied substantially from patch to patch. Hardwood species are immune to Phellinus weirii infection and a rotation of these species or a resistant conifer species (e.g., lodgepole pine) may substantially slow the rate of patch spread.

Insects, particularly bark beetles, cause chronic low-level conifer mortality over most of the Willamette National Forest. More extensive outbreaks may occur west of the Cascade Crest but they have not been documented as well as those east of the Cascade Crest.

Long-term natural stand development depends on several factors including: disturbance type and intensity, disturbance frequency, seed source availability, and local environmental conditions. A typical sequence following an intense fire would be (1) herbaceous phase (0 to 5 years), (2) shrub phase (5 to 15 years), (3) Douglas-fir phase (15 to 750 years), (4) climax conifer. Succession modeling indicates that Douglas-fir continues to dominate stand structure as long as it survives (Dale et al. 1986). After Douglas-fir density drops below 1 to 3 trees per acre, the stand goes through a rapid period of adjustment to climax composition and structure. Douglas-fir is not the primary seral species in the mountain hemlock zone. Lodgepole pine establishes over a period of several decades and becomes senescent at 100 to 200 years of age. Mountain hemlock and Pacific silver fir, which become established under the shelter of the lodgepole pine canopy, will dominate stands 200 to 300 years after burning (Dickman 1984).

Stand structure is an important result of successional development. Successional sequences lasting more than 200 years in conifer stands allow large accumulations of standing live and standing and down dead trees. Large live and dead boles fulfill many important ecosystem functions including: wildlife habitat, long-term nutrient storage, sites for nitrogen fixation, and sources for large woody debris in streams, providing important energy bases and channel stability (Franklin et al. 1981, Maser et al. 1981).

Live trees can grow to old-growth dimensions (e.g., 30 inches diameter breast height) quickly on high quality sites, but large dead woody debris accumulates more slowly. Hardwood dominated stands do not produce large amounts of decay-resistant woody debris, unless they are replaced by shade tolerant conifers in late succession. Likewise, managed stands do not develop large standing and down dead wood accumulations, unless management practices are designed to produce large dead wood.

Management actions substantially change successional paths by reducing or eliminating the shrub phase, influencing tree species composition and density, and determining the number of years until the next stand-replacing event.

METHODS

Data presented in this guide come from two kinds of sample plots. Reconnaissance plots are designed for quick measurement of site physical factors, conifer productivity, stand structure, wildlife use, forage, and plant species composition and dominance. The intent of reconnaissance sampling was to develop a very large information base on plant community composition, site environment, and general productivity across the Forest.

Intensive samples were installed in a subset of reconnaissance plot locations after the preliminary plant association classification was completed. The purpose of intensive sampling was to more carefully characterize stand volume, volume increment, snags (sizes, numbers and use), down woody debris (condition and amounts), and productive potential by plant association.

Reconnaissance sampling of the western hemlock, Douglas-fir, and grand fir series was completed in three field seasons and resulted in a data base of over 900 plots. Reconnaissance samples for the Pacific silver fir and mountain hemlock series were collected in an earlier effort (Hemstrom et al. 1982) using similar methods. The Forest was sampled drainage by drainage from south to north. Relatively undisturbed, natural stands over 70 years old (with a few exceptions) with uniform vegetative composition were sampled as they were encountered. The samples are not a systematic representation of forested plant communities on a per acre basis. Measurements taken on each plot included:

1) Site physical factors - elevation, aspect, slope, landform, slope position, and total cover of canopy, shrubs and herbs.

2) Wildlife habitat features - snag tally with a 40 factor prism, presence of cavities in snags, presence of game trails, presence of elk and deer pellet groups, evidence of browse by species, evidence of use by other wildlife species (e.g., mountain beaver burrows).

3) Age, height (measured with a tape and clinometer), diameter breast height, current diameter growth rate for at least one dominant conifer (Douglas-fir if possible), and total stand basal area.

4) Percent canopy cover estimates for all trees, shrubs and herbs present on a 0.1235 acre circular plot.

Plots were grouped into plant associations using a set of multivariate stastical analysis, association table analysis, and ecological data analysis computer programs.

Intensive plots were far more time consuming to install. Due to budget and time restrictions,

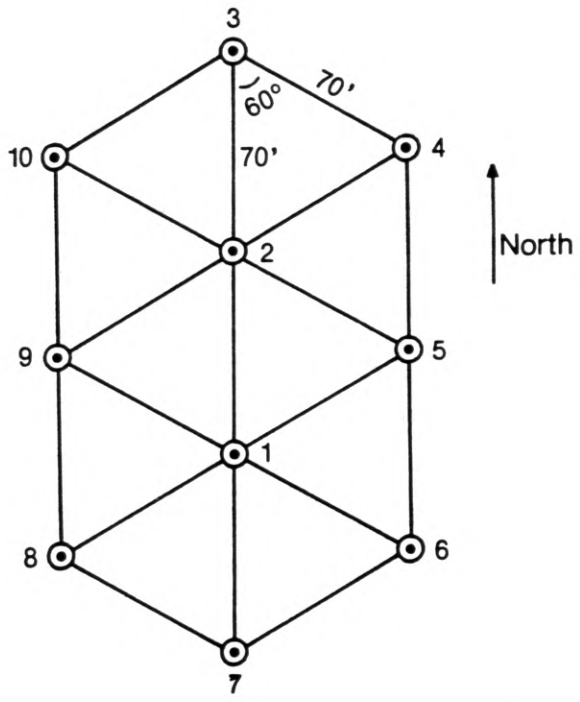


Figure 16. Intensive plot design, adapted from U. S. Department of Agriculture--Forest Service (1985).

intensive sampling of the western hemlock, grand fir and Douglas-fir series was limited to one six month field season (275 plots). Each intensive plot consisted of measurements collected on a series of points in a single stand and plant association, usually in the same general location as a previously sampled reconnaissance plot. The points were arranged in a grid (Figure 16) with each point 70 feet and 60 degrees from the previous point. The basic sample design and measurement techniques follow the guidelines prescribed for formal Vegetative Resource Inventory Plots (U.S. Department of Agriculture-Forest Service 1985). In addition to reconnaissance plot information, the following data were collected:

1) Live tree measurements (collected at each point)

   - total height, diameter breast height (DBH) to the nearest 0.1 inch, total age at breast height from an increment core, crown ratio, and sapwood thickness for the first dominant tree of each species encountered

   - species and DBH to the nearest 0.1 inch for each live tally tree in a 40 basal area factor (BAF) prism plot

2) Snag measurements (collected at each point)

   - DBH estimated to the nearest 5 inches, height estimated to the nearest 5 feet, decay class (Neitro et al. 1985), presence of small (0 to 2 inches), medium (2 to 5 inches), and large (over 5 inches) cavities, and presence of feeding use for each snag encountered as "in" with a 20 BAF prism swung at point center

3) Down woody debris characteristics (collected at the first, third, and fifth points)

   - the total length estimated to the nearest 5 feet, diameter at each end estimated to the nearest 2 inches, and decay class (Bartels et al. 1985) for all pieces of down, dead wood contained within the slope corrected boundaries of a 0.247 acre circular plot

4) Soil description (collected at the second point)
   - description according to U.S.Department of Agriculture-Soil Conservation Service standards and classification by Soil Resource Inventory land types (Legard and Meyer 1973) on a subset of 100 intensive plots

Intensive sampling of the Pacific silver fir and mountain hemlock series was completed as part of an earlier effort (Hemstrom et al. 1982). Soil descriptions were taken from many of the 600 reconnaissance plots collected in this effort.

MANAGEMENT CONSIDERATIONS

WILDLIFE HABITAT

Plant communities play an obvious role in animal habitat. Plant species composition and abundance determine the kinds and quality of food and shelter available for wildlife. Seral communities vary from grasses and forbs (0 to 5 years following disturbance) to old-growth forests (200 to 700 years following disturbance). The pattern of plant species composition during succession varies substantially among plant associations, resulting in different kinds and amounts of forage and cover. Many important animal habitat features, such as stand structure, are more closely related to disturbance history than to plant association. The rates at which an ecosystem acquires biomass and structure, however, are related to site productivity, and can be estimated from plant association.

Snags are used by 100 wildlife species in western Oregon and Washington. At least 53 species (39 birds and 14 mammals) are cavity dependent (Neitro et al. 1985). Most of the variation in numbers of snags per acre among plant associations (Table 4) is a function of fire history and early stand establishment conditions. In general, snags are most abundant in the most moist, productive plant associations. Plant associations in the Douglas-fir and grand fir series have relatively few snags over 20 inches in diameter (Table 4). This is due both to frequent fires in the past, which consumed snags, and to patchy, open stands where competition related mortality is less important.

The highest levels of snags are in the western hemlock/Alaska huckleberry/dogwood bunchberry, western hemlock/rhododendron/Oregon oxalis, western hemlock/dwarf Oregon grape/Oregon oxalis, western hemlock/devil's club, and western hemlock/swordfern plant associations. These types are highly productive, typically old-growth stands, and are often in or near riparian zones. These associations should be focal points for snag management plans. On the other hand, it is not reasonable to plan for high levels of snags in the Douglas-fir series unless stands are managed for snags from the outset. We do not have adequate information to characterize snags or down wood in the Pacific silver fir or mountain hemlock zones.

We measured approximately 2600 snags during the course of intensive sampling. Several important characteristics of the snag population in mature, natural stands emerge when all the snags are analyzed as a group without regard to plant association.

Decay condition (snag decay condition according to Neitro et al. 1985, Table 5) is strongly related to wildlife use in our sample. Decay classes 2, 3 and 4 snags are most common (Table 6). Decay class 1 snags are not as common and are not heavily used for either feeding or cavity excavation. Many class 1 snags are relatively small, resulting from suppression-related mortality. The heaviest amount of wildlife use occurs in decay classes 3 and 4 snags. These are most often large, remnant Douglas-fir snags which provide stable habitat and food sources. Large Douglas-fir trees generally reach decay class 3 twenty years after mortality and may persist in decay classes 3 and 4 for an additional 100 years (Neitro et al. 1985). Decay class 5 snags are nearly always large and past the stage of optimum habitat for most cavity nesting animals. Most class 1 snags are over 50 feet tall, while class 5 snags are usually less than 10 feet tall.

Snag diameter is also strongly related to wildlife use (Table 7). Cavity presence increases as a function of snag diameter. The incidence of cavities in snags over 20 inches diameter is higher than in smaller snags. Cavities are even more common in snags over 30 inches. Large cavities are most common in snags over 40 inches. Snag height is not strongly related to diameter.

Down wood provides primary or secondary habitat for 150 terrestrial wildlife species (Bartels et al. 1985). In addition, down wood plays an important role in nutrient cycling processes in forest ecosystems (Bartels et al. 1985). Most of the variation in woody debris reflects fire

Table 4. Number of snags over 20 inches DBH per acre by decay class and plant association from intensive ecology plots on the Willamette National Forest.

Association	Number of Samples	Snags Over 20 Inches DBH Per Acre — Decay Class 1	2	3	4	5	Total
		Mean/Standard Error					
Douglas-fir/oceanspray-dwarf Oregon grape	5	0.5/0.5	0.0/0.0	1.9/1.1	0.8/0.8	0.0/0.0	3.2/1.3
Douglas-fir/oceanspray/grass	13	1.1/0.6	0.7/0.3	1.1/0.5	1.2/0.9	0.2/0.2	4.3/1.2
Douglas-fir/oceanspray-whipple vine	5	0.4/0.4	1.7/1.5	0.2/0.2	1.3/0.8	0.9/0.9	4.6/1.2
Douglas-fir/snowberry	5	0.2/0.2	0.0/0.0	1.1/0.9	0.0/0.0	0.0/0.0	1.2/0.8
Douglas-fir-western hemlock/ dwarf Oregon grape	7	0.0/0.0	0.0/0.0	1.4/0.9	0.8/0.4	0.0/0.0	2.1/1.0
Douglas-fir-western hemlock/ salal	12	0.5/0.3	1.2/1.1	2.4/1.2	2.9/1.0	0.6/0.5	7.5/1.8
Douglas-fir-western hemlock/ rhododendron	5	0.3/0.3	0.6/0.5	1.1/0.6	0.9/0.6	0.3/0.2	3.2/1.5
Grand fir/bearberry	3	0.0/0.0	0.3/0.3	0.3/0.3	0.0/0.0	0.3/0.3	1.0/0.6
Grand fir/dwarf Oregon grape	11	0.8/0.5	0.9/0.4	4.1/1.8	1.0/0.9	0.0/0.0	6.7/2.1
Grand fir/prince's pine	9	1.5/1.0	1.2/0.6	2.2/1.0	1.2/0.9	0.4/0.3	6.4/2.6
Pacific silver fir - Grand fir/false solomonseal	3	0.7/0.7	0.9 0.9	5.6/5.6	1.1/1.1	0.0/0.0	8.2/6.1
Western hemlock/Alaska huckle-berry/dogwood bunchberry	7	1.7/1.7	4.3/1.7	2.7/1.2	8.5/5.3	1.3/0.7	18.6/4.
Western hemlock/ dwarf Oregon grape	19	0.2/0.2	1.1/0.5	2.1/0.7	1.6/0.5	1.1/0.4	6.1/1.0
Western hemlock/dwarf Oregon grape/ Oregon oxalis	12	1.2/0.7	1.9/0.8	8.1/3.8	3.0/1.1	0.1/0.1	14.2/4.6
Western hemlock/dwarf Oregon grape-salal	12	0.7/0.5	1.6/0.8	1.6/0.8	3.9/1.6	0.8/0.3	8.5/2.3

Table 4. (continued)

Association	Number of Samples	Snags Over 20 Inches DBH Per Acre — Decay Class 1	2	3	4	5	Total
		Mean/Standard Error					
Western hemlock/devil's club	7	0.5/0.3	4.0/2.5	5.0/1.5	2.7/1.2	0.1/0.1	12.3/3.4
Western hemlock/dwarf Oregon grape/vanilla leaf	11	0.2/0.2	1.7/0.9	4.4/2.2	2.4/0.9	1.0/0.6	9.7/2.7
Western hemlock/Oregon oxalis	17	0.5/0.3	1.2/0.5	3.0/0.8	3.2/0.9	1.1/0.3	8.9/1.5
Western hemlock/rhododendron-Alaska huckleberry/dogwood bunchberry	6	1.1/0.5	2.4/0.5	2.0/0.9	0.8/0.5	0.0/0.0	6.2/1.4
Western hemlock/rhododendron/beargrass	8	0.2/0.2	0.8/0.4	2.5/1.3	0.2/0.2	0.0/0.0	3.6/1.4
Western hemlock/rhododendron-dwarf Oregon grape	20	0.5/0.4	2.4/0.7	3.9/0.8	3.7/0.8	0.7/0.5	11.3/1.4
Western hemlock/rhododendron/Oregon oxalis	6	0.0/0.0	2.9/0.9	7.7/2.9	4.2/2.4	1.3/1.3	16.1/5.1
Western hemlock/rhododendron-salal	11	0.8/0.7	0.4/0.3	2.0/0.9	2.7/1.6	0.5/0.4	6.4/2.4
Western hemlock/rhododendron/twinflower	6	0.9/0.6	0.0/0.0	1.5/0.5	0.0/0.0	0.0/0.0	2.3/0.9
Western hemlock/salal	14	0.1/0.1	0.2/0.2	1.2/1.0	4.0/2.1	1.0/0.7	6.5/3.0
Western hemlock/swordfern	12	0.0/0.0	0.7/0.6	3.2/1.1	8.0/3.4	0.4/0.3	12.4/4.5
Western hemlock/twinflower	7	0.0/0.0	0.8/0.8	0.9/0.4	0.7/0.3	0.6/0.6	3.1/1.3
Western hemlock/vanilla leaf	8	0.0/0.0	2.8/1.5	3.9/2.6	2.9/2.6	0.0/0.0	9.6/4.9
All Associations Combined	256	0.5/0.1	1.3/0.2	2.9/0.3	2.6/0.3	0.5/0.1	7.9/0.6

history, which is loosely related to plant association (Table 8). A large part, generally between 20 and 40 tons per acre, of the down wood in a stand falls in decay classes 2, 3 and 4 (decay condition according to Bartels et al. 1985, Table 9). On average, less than 1 ton per acre is freshly dead wood (Decay class 1). About 2 tons per acre are in decay class 5 and have nearly disappeared into the forest floor. Our estimates of decay class 5 down wood mass may be underestimates since it is often difficult to see class 5 logs in shrubby stands.

The total amount of down wood ranges between 5 and 105 tons per acre by plant association. Down wood is least abundant in the Douglas-fir types, due to a combination of high natural fire frequency and relatively low productivity. A couple of plots in the western hemlock/devil's club association had very high levels of down wood. Moist, productive associations had the highest average down wood loads. These associations, in general, also provide abundant, important wildlife habitat.

Management for specific structural characteristics should consider:

1. The potential of sites to produce structures of a given size within a specified time e.g.,trees over 30 inches diameter in 50 years,

2. The number of structures at the start of the management period to allow for a sufficient number at the end of the period (allow for some loss),

3. The rate at which the structure decays. A Douglas-fir tree will grow to 30 inches diameter faster in the western hemlock/swordfern plant association than in the western hemlock/ rhododendron/beargrass association but will require at least 20 years following mortality to reach decay class 3 in both associations.

Plant associations vary substantially in the amount of forage and cover available for deer and elk. We measured forage (green weight, pounds per acre), thermal and hiding cover (canopy and tall shrub cover), and evidence of use (frequency of trails and pellets) in all plant associations (Table 10). Herb forage is the biomass of all foliage and stems for all species combined. This figure is heavily influenced by swordfern, the largest and most abundant herb on most sites. Shrub forage is reported by species and represents the weight of foliage and new twigs up to 5 feet above the ground surface for each species in our plots. The most common shrubs are included in Table 10, many others in our data set could be summarized in the same fashion. Trail and pellet frequency is based on presence or absence in each reconnaissance plot.

Overall, abundance of forage does not seem to be correlated well with deer and elk use as indicated by trail and pellet frequency. In fact, the heaviest amounts of use are in the Douglas-fir types and in the mountain hemlock zone. The Douglas-fir series occurs on warm, low-elevation sites where winter conditions are relatively mild. Snow is not usually persistent. Forage is available both in the stands and in adjacent openings. If trail frequency is a good measure, all of the Douglas-fir types are more heavily used than all but one or two of the western hemlock types. The Douglas-fir series should be a focus of deer and elk winter range habitat management. Areas with abundant Douglas-fir types may have the highest carrying capacities for deer and elk. Plantations in these areas may also incur high rates of browse damage.

Portions of the Forest where Douglas-fir associations are in close proximity to the mountain hemlock zone are also likely to support high populations of deer and elk. The South Fork of the Middle fork of the Willamette River is a good example.

Patterns of elk and deer use in the western hemlock zone are not as clear. Abundance of herbage in stands correlates moderately well with deer and elk use, as indicated by trail and pellet frequency. Western hemlock/devil's club, western hemlock/Oregon oxalis, western hemlock/rhododendron/Oregon oxalis, western hemlock/dwarf Oregon grape/Oregon oxalis, western hemlock/vanilla leaf, and western hemlock/dwarf Oregon grape/vanilla leaf are the most heavily used by deer and elk, as indicated by pellet and trail frequencies (Table 10). Western hemlock/rhododendron associations, with their dense evergreen shrub layer, may be used for hiding cover in some places.

Deer and elk use of the Pacific silver fir zone is generally higher than in the western hemlock zone. Elk use, as indicated by pellet presence, is highest in the Pacific silver fir/Oregon oxalis, Pacific silver fir-grand fir/false solomonseal, Pacific silver fir/vine maple/ coolwort foamflower, Pacific silver fir/big huckleberry/queencup beadlily, and Pacific silver fir/coolwort foamflower associations, all of which are herb-rich (Table 10). None of these types are as heavily used as those in the Douglas-fir series. Deer use is more common than elk use. Wildlife trails occur at moderate levels in nearly all types. The Pacific silver fir/devil's club association is not heavily used by either deer or elk in spite of abundant forage.

Deer and elk use appears to be high in the mountain hemlock zone. Mountain hemlock types are undoubtedly important summer range. Stands may not contain much forage (Table 10), but adjacent openings often do. Many stands are probably used for thermal cover during frosty summer nights or for hiding cover. Amounts of deer and elk use in the two most common mountain hemlock types, mountain hemlock/big huckleberry/beargrass and mountain hemlock/grouse huckleberry, are similar to those in the most herb-rich western hemlock types and the Douglas-fir associations. Areas of mountain hemlock types intermingled with non-forest communities, particularly moist communities like blueberry-alpine spirea/grass, are likely to provide ideal summer range.

Table 5. Physical characteristics of Douglas-fir snags by deterioration stage, Western Oregon (from Neitro et al. 1985).

Attribute	Decay Class 1	2	3	4	5
Limbs and branches	All present	Few limbs, no fine branches	Limb stubs only	Few or no stubs	None
Top	Pointed	Broken			
Diameter, top	- - - - - - - - - - - - - - - Increasing at decreasing rate - - - - - - - - - - - - - - -				
Height	- - - - - - - - - - - - - - - Decreasing at decreasing rate - - - - - - - - - - - - - - -				
Bark remaining	100% - - - - - - - - - - - - - - - - - - Variable -				20%
Sapwood pres.	Intact - - - - - - - - - - - - - - - - Sloughing -				Gone
Sapwood cond.	Sound, incipient decay, hard, original color	Advanced decay, fibrous, firm to soft, light brown	Fibrous, soft, light to reddish brown	Cubical, soft, reddish to dark brown	
Heartwood	Sound, hard, original color	Sound at base, incipient decay in outer edge of upper bole, hard, light to reddish brown	Incipient decay at base, advanced decay throughout upper bole, fibrous, hard to firm, reddish brown	Advanced decay at base. Sloughing from upper bole, fibrous to cubical, soft, dark reddish brown	Sloughing, cubical soft, dark brown; or, fibrous, very soft dark reddish brown encased in hardened shell

Table 6. Snags per acre by diameter and decay class (Neitro et al. 1985) from 256 intensive ecology plots in the western hemlock, grand fir and Douglas-fir series across the Willamette National Forest.

Diameter Class	Decay Class 1	2	3	4	5	Total
	mean/standard deviation					
0 - 10 inches	36.3/44.3	58.1/96.3	68.9/134.0	45.1/100.1	9.8/5.7	218
11 - 20 inches	4.6/ 2.1	8.8/10.2	7.5/ 6.0	5.3/ 3.6	4.4/2.7	30
21 - 30 inches	1.9/ 0.9	2.2/ 1.6	2.5/ 1.9	2.5/ 2.0	1.5/1.2	11
31 - 40 inches	1.0/ 0.6	1.2/ 0.7	1.4/ 1.1	1.7/ 1.6	0.8/0.4	6
Over 40 inches	0.7/ 0.7	0.9/ 0.8	1.0/ 0.8	0.9/ 1.1	0.5/0.2	4
Total	44.5	71.2	81.3	55.5	17.0	269
Over 10 inches	8.2	13.1	12.4	10.4	7.2	55
Over 20 inches	2.6	4.3	4.9	5.1	2.8	21

Table 7. Characteristics of individual snags summarized from a sample of 2618 snags from intensive ecology plots in the western hemlock, grand fir and Douglas-fir series across the Willamette National Forest.

Decay class	Number of Snags	Diameter Class (inches)					Snag Species					Cavities Present	Feeding Present
		0-10	11-20	21-30	31-40	40+	PSME	TSHE	THPL	ABGR	PIMO		
		percent											
1	188	23	23	21	11	22	63	10	1	4	4	1	18
2	651	19	36	18	10	17	68	6	4	2	12	8	39
3	930	12	24	24	20	20	84	4	3	1	3	17	55
4	726	6	19	31	26	18	89	2	3	1	1	29	73
5	123	4	23	40	18	15	94	1	4	-	-	22	76

Table 8. Tons of down wood per acre by decay class and plant association from intensive ecology plots on the Willamette National Forest.

Association	No. of Plots	Tons of Down Wood per Acre — Decay Class 1	2	3	4	5	Total
		mean/se					
Douglas-fir/oceanspray-dwarf Oregon grape	5	0.1/ 0.1	0.8/ 0.4	6.8/ 3.1	1.9/ 0.6	1.1/ 0.6	10.7/ 4.2
Douglas-fir/oceanspray/grass	13	0.2/ 0.1	4.0/ 2.0	4.5/ 1.7	5.0/ 1.7	0.6/ 0.3	14.3/ 4.2
Douglas-fir/oceanspray-whipple vine	5	0.3/ 0.2	0.8/ 0.6	2.1/ 0.8	1.4/ 0.4	0.3/ 0.1	4.8/ 0.8
Douglas-fir/snowberry	5	0 .5/ 0.5	0.1/ 0.1	3.1/ 1.7	5.5/ 4.7	0.9/ 0.5	10.1/ 5.2
Douglas-fir-western hemlock/ dwarf Oregon grape	7	0.2/ 0.2	2.9/ 1.8	2.0/ 0.9	3.0/ 1.5	0.7/ 0.3	8.7/ 2.6
Douglas-fir-western hemlock/ salal	12	0.7/ 0.5	3.9/ 1.3	3.5/ 0.9	5.0/ 2.2	1.4/ 0.5	14.5/ 3.5
Douglas-fir-western hemlock/ rhododendron	5	1.1/ 1.0	1.6/ 1.2	6.3/ 4.0	5.0/ 1.4	1.1/ 0.5	15.1/ 5.0
Grand fir/bearberry	3	0.1/ 0.1	0.6/ 0.6	3.4/ 2.8	1.4/ 1.4	0.3/ 0.2	5.5/ 4.0
Grand fir/dwarf Oregon grape	11	2.3/ 2.2	6.7/ 2.9	9.4/ 2.1	7.9/ 2.3	1.4/ 0.3	27.9/ 5.6
Grand fir/prince's pine	9	11.8/10.8	1.3/ 0.6	9.9/ 4.7	6.8/ 2.2	1.5/ 0.8	31.3/12.3
Pacific silver fir - grand fir/false soloman's seal	3	0.0/ 0.0	0.7/ 0.2	4.1/ 2.0	3.9/ 2.2	0.5/ 0.3	9.0/ 2.7
Western hemlock/Alaska huckle-berry/dogwood bunchberry	7	0.1/ 0.1	11.3/ 5.6	20.6/ 6.4	13.5/ 3.8	3.8/ 1.5	49.2/12.7
Western hemlock/devil's club	7	0.4/ 0.3	50.7/35.9	36.9/15.8	14.5/ 5.6	2.0/ 0.6	104.4/52.4
Western hemlock/ dwarf Oregon grape	19	0.4/ 0.2	6.8/ 3.7	9.3/ 3.6	6.0/ 1.4	2.4/ 0.6	24.8/ 6.4
Western hemlock/dwarf Oregon grape/ Oregon oxalis	12	1.9/ 1.3	18.6/ 9.3	14.4/ 3.8	9.4/ 2.1	2.5/ 0.7	46.7/14.5
Western hemlock/dwarf Oregon grape-salal	12	1.5/ 0.9	7.2/ 3.8	11.7/ 4.1	4.7/ 6.0	4.9/ 1.7	39.9/11.4
Western hemlock/dwarf Oregon grape/vanilla leaf	12	0.1/ 0.1	2.6/ 1.1	17.4/ 5.8	6.3/ 1.6	2.0/ 0.7	28.4/ 7.5
Western hemlock/Oregon oxalis	17	0.8/ 0.4	9.5/ 6.6	16.4/ 3.1	15.4/ 3.2	2.2/ 0.5	44.3/ 9.4
Western hemlock/rhododendron-Alaska huckleberry/dogwood bunchberry	6	0.1/ 0.1	2.7/ 0.7	17.8/ 7.2	7.5/ 2.6	2.5/ 0.8	30.5/ 8.3
Western hemlock/rhododendron/ beargrass	8	0.1/ 0.1	4.4/ 2.6	11.0/ 3.9	9.9/ 7.5	1.7/ 0.9	27.0/10.6

Table 8. (continued)

Association	No. of Plots	Tons of Down Wood per Acre — Decay Class 1	2	3	4	5	Total
		Mean/Standard Error					
Western hemlock/rhododendron-dwarf Oregon grape	20	0.5/ 0.3	7.7/ 2.7	11.2/ 2.7	9.6/ 2.0	4.0/ 1.0	33.0/ 6.1
Western hemlock/rhododendron/ Oregon oxalis	6	0.0/ 0.0	6.1/ 4.7	15.5/ 4.1	9.3/ 2.8	0.6/ 0.3	31.5/ 5.5
Western hemlock/rhododendron-salal	11	0.1/ 0.1	3.7/ 1.9	15.5/ 4.1	12.2/ 6.5	1.3/ 0.5	32.9/ 9.8
Western hemlock/rhododendron/ twinflower	6	2.0/ 1.6	13.2/ 7.8	8.4/ 2.2	6.4/ 2.7	2.1/ 0.9	32.1/12.1
Western hemlock/salal	14	0.7/ 0.3	2.6/ 0.7	5.6/ 1.2	8.8/ 3.5	1.4/ 0.5	19.1/ 3.6
Western hemlock/swordfern	12	0.3/0.2	6.0/1.8	19.7/4.7	23.6/6.2	4.0/1.4	53.7/10.3
Western hemlock/twinflower	7	0.1/ 0.1	2.1/ 1.1	9.5/ 2.5	10.0/ 3.3	4.0/ 1.2	25.5/ 5.2
Western hemlock/vanilla leaf	8	0.3/ 0.2	3.5/ 1.9	11.8/ 4.0	4.2/ 1.7	2.5/ 0.9	22.4/ 6.7
All Associations Combined	256	0.8/ 0.2	6.7/ 1.1	12.3/ 0.9	9.1/ 0.7	2.1/ 0.2	31.0/ 2.1

Table 9. Physical characteristics of Douglas-fir logs by deterioration stage (from Bartels et al. 1985).

Log Characteristics	Decay Class 1	2	3	4	5
Bark	Intact	Intact	Trace	Absent	Absent
Twigs <1.8 in	Present	Absent	Absent	Absent	Absent
Texture	Intact	Intact to partly soft	Hard, large pieces	Small, soft, blocky pieces	Soft and powdery
Shape	Round	round	round	round to oval	oval
Color of wood	Original color	original color	original color to faded	light brown to faded brown or yellowish	faded to light yellow or gray
Portion of log	log elevated on support points	log elevated on support points but sagging slightly	log sagging near ground	all of log on ground	all of log on ground

Table 10. Wildlife habitat attributes by plant association for the Willamette National Forest.

Association	Number of Samples	Vegetative Cover			Forage			
		Canopy	Tall Shrubs	Herbs	Herb	Vine Maple	Oregon grape	Salal
		% X/SE	% X/SE	% X/SE	-- lbs/acre[1] -- X/SE	X/SE	X/SE	X/SE
DOUGLAS-FIR SERIES								
Douglas-fir/oceanspray-dwarf Oregon grape	16	69/ 1	26/ 1	27/ 1	10/ 10		12/12	
Douglas-fir/oceanspray/grass	9	81/ 1	10/ 1	24/ 2	169/ 58	3/ 3	27/20	
Douglas-fir/oceanspray-whipple vine	12	70/ 1	21/ 2	20/ 1	120/ 59		2/ 2	6/ 6
Douglas-fir/snowberry	7	84/ 2	27/ 3	19/ 3	92/ 63	2/ 2	26/24	
Douglas-fir-western hemlock/ dwarf Oregon grape	28	81/ 1	19/ 1	17/ 1	149/108		11/11	
Douglas-fir-western hemlock/ salal	25	73/ 1	40/ 1	17/ 1	200/ 62	8/ 3	56/34	54/32
Douglas-fir-western hemlock/ rhododendron	14	74/ 1	56/ 2	12/ 1	116/ 44	2/ 2	36/21	78/37
GRAND FIR SERIES								
Grand fir/bearberry	2	23/ 5	13/ 2	1/ 0	360/360			
Grand fir/dwarf Oregon grape	16	80/ 1	21/ 1	28/ 1	384/139	38/31	44/22	5/5
Grand fir/prince's pine	6	81/ 1	11/ 1	36/ 4	299/124		41/16	
MOUNTAIN HEMLOCK SERIES								
Mountain hemlock/big huckleberry/beargrass	25	51/ 1	34/ 1	49/ 1	309/13			
Mountain hemlock/grouse huckleberry	12	44/ 1	32/ 1	19/ 1	235/24			
Mountain hemlock/luzula	6	42/ 4	5/ 1	28/ 9				
Mountain hemlock/rhododendron beargrass	25	60/ 1	73/ 1	38/ 1				

[1] Green weight

Table 10. (continued)

Association	Forage		Wildlife Use			
	Rhododendron	Trailing blackberry	Pellet Elk	Presence Deer	Trail Freq.	Thermal Cover[1]
	-- lbs/acre[2] --		%	%	%	%
	X/SE	X/SE				X/SE
DOUGLAS FIR SERIES						
Douglas-fir/oceanspray-dwarf Oregon grape		2/ 2		13	100	24/ 1
Douglas-fir/oceanspray/grass		13/ 6	56	22	89	38/ 3
Douglas-fir/oceanspray-whipple vine			33	33	75	29/ 2
Douglas-fir/snowberry		4/ 4	29	43	100	33/ 3
Douglas-fir-western hemlock/dwarf Oregon grape		3/ 2	4	50	82	30/1
Douglas-fir-western hemlock/salal		7/ 3		8	52	35/ 1
Douglas-fir-western hemlock/rhododendron	36/22	26/19		14	79	23/ 1
GRAND FIR SERIES						
Grand fir/bearberry						20/ 4
Grand fir/dwarf Oregon grape	19/ 7		19	31	88	39/ 1
Grand fir/prince's pine		30/14	33	17	33	34/ 3
MOUNTAIN HEMLOCK SERIES						
Mountain hemlock/big huckleberry/beargrass			36	16	72	
Mountain hemlock/grouse huckleberry				25	50	
Mountain hemlock/luzula						
Mountain hemlock/rhododendron beargrass				5	19	

[1]Evergreen cover between 12 and 50 feet.

[2]Green weight.

Table 10. (continued)

Association	Number of Samples	Vegetative Cover			Forage			
		Canopy	Tall Shrubs	Herbs	Herb	Vine Maple	Dwarf Oregon grape	Salal
		%	%	%	-- lbs/acre[1] --			
		X/SE	X/SE	X/SE	X/SE	X/SE	X/SE	X/SE
Western hemlock/Alaska huckleberry/dogwood bunchberry	11	78/ 1	24/ 2	33/ 2	490/112	9/ 6	9/ 6	
Western hemlock/ dwarf Oregon grape	165	82/ 1	23/ 1	21/ 1	219/ 62	13/ 6	63/18	9/ 5
Western hemlock/dwarf Oregon grape/ Oregon oxalis	39	79/ 1	21/ 1	60/ 1	647/152	17/11	130/39	14/ 6
Western hemlock/dwarf Oregon grape-salal	80	79/ 1	31/ 1	20/ 1	249/123	23/13	150/82	106/14
Western hemlock/dwarf Oregon grape/vanilla leaf	40	77/ 1	29/ 1	37/ 1	262/103	9/ 9	114/37	23/21
Western hemlock/devil's club	13	64/ 1	49/ 2	64/ 2	1106/295	52/30		3/ 3
Western hemlock/Oregon oxalis	61	78/ 1	25/ 1	76/ 1	688/135	16/ 7	11/ 5	5/ 3
Western hemlock/rhododendron-Alaska huckleberry/dogwood bunchberry	6	68/ 2	71/ 3	29/ 2	380/148	22/22	5/ 5	5/ 3
Western hemlock/rhododendron/ beargrass	30	69/ 1	62/ 1	21/ 1	419/257		5/ 3	39/33
Western hemlock/rhododendron-dwarf Oregon grape	69	81/ 1	43/ 1	13/ 1	90/ 30	21/ 8	33/12	25/12
Western hemlock/rhododendron/ Oregon oxalis	10	78/ 2	38/ 2	45/ 2	360/120	5/ 5	72/71	
Western hemlock/rhododendron-salal	47	78/ 1	55/ 1	11/ 1	88/ 59	3/ 2	45/26	22/12
Western hemlock/rhododendron/ twinflower	24	75/ 1	41/ 1	35/ 1	20/ 20		3/ 3	
Western hemlock/salal	35	77/ 1	40/ 1	19 /1	241/ 68	49/41	31/15	131/ 52
Western hemlock/swordfern	16	85/ 1	18/ 1	41/ 1	205/ 65	6/ 5	16/13	
Western hemlock/twinflower	11	79/ 2	13/ 1	30/ 2	266/124		6/ 4	
Western hemlock/vanilla leaf	30	79/ 1	21 /1	50/ 1	898/289	5/ 3	19/14	

[1]Green weight.

Table 10. (continued)

Association	Forage: Rhododendron	Forage: Trailing blackberry	Wildlife Use: Pellet Elk	Wildlife Use: Presence Deer	Wildlife Use: Trail Freq.	Wildlife Use: Thermal Cover[1]
	-- lbs/acre[2] -- X/SE	X/SE	%	%	%	% X/SE
Western hemlock/Alaska huckleberry/dogwood bunchberry				9	27	51/ 1
Western hemlock/ dwarf Oregon grape	1/ 1	21/10	4	19	51	41/ 1
Western hemlock/dwarf Oregon grape/ Oregon oxalis	26/26	2/ 1	5	13	59	46/ 1
Western hemlock/dwarf Oregon grape-salal	18/10	16/ 7	3	13	47	31/ 1
Western hemlock/dwarf Oregon grape/vanilla leaf		9/ 4	20	28	45	37/ 1
Western hemlock/devil's club		14/10	15		15	49/ 2
Western hemlock/Oregon oxalis	2/ 2	5/ 2	16	20	52	36/ 1
Western hemlock/rhododendron-Alaska huckleberry/dogwood bunchberry	58/43	3/ 3			33	35/ 2
Western hemlock/rhododendron/ beargrass	18/15		2	8	11	46/ 1
Western hemlock/rhododendron-dwarf Oregon grape	41/18	3/ 1	12	25	43	45/ 1
Western hemlock/rhododendron/ Oregon oxalis	228/80	2/ 2	10	20	70	41/ 1
Western hemlock/rhododendron-salal	66/23	2/ 1	3	6	27	37/ 1
Western hemlock/rhododendron/ twinflower	30/30		8	29	29	37/ 1
Western hemlock/salal	33/27	14/ 6	3	14	49	26/ 1
Western hemlock/swordfern		6/ 4		13	44	42/ 1
Western hemlock/twinflower		16/ 8			36	38/ 2
Western hemlock/vanilla leaf		14/ 7	20	17	60	39/ 1

[1] Evergreen cover between 12 and 50 feet high.

[2] Green weight.

Table 10. (continued)

Association	Number of Samples	Vegetative Cover			Wildlife Use			Forage
		Canopy	Tall Shrubs	Herbs	Pellet Presence Elk	Deer	Trail Freq.	Herb
		% X/SE	% X/SE	% X/SE	%	%	%	lbs/ac[1] X/SE
Pacific silver fir-grand fir/false solomonseal	40	61/ 1	30/ 1	67/ 1	18	38	68	1060/34
Pacific silver fir/Alaska huckleberry/dogwood bunchberry	13	60/ 1	39/ 2	49/ 2		31	62	305/21
Pacific silver fir/Alaska huckleberry-salal	3	75/4	23/ 3	27/ 2				225/28
Pacific silver fir/big huckleberry/beargrass	23	62/ 1	29/ 1	41/ 1	9	30	52	246/15
Pacific silver fir/big huckleberry/queencup beadlily	22	62/ 1	33/ 1	39/ 1	18	18	50	225/15
Pacific silver fir/Cascades azalea/beargrass	2	60/14	85/ 4	88/ 5		50		262/16
Pacific silver fir/Cascades azalea/queencup beadlily	5	53/ 4	69/ 5	46/ 6			60	273/15
Pacific silver fir/coolwort foamflower	35	64/ 1	31/ 1	67/ 1	17	37	67	478/11
Pacific silver fir/Devil's club	21	60/ 1	55/ 1	78/ 1		5	19	499/25
Pacific silver fir/dwarf Oregon grape	58	67/ 2	37/ 1	43/ 1	9	31	59	230/45
Pacific silver fir/fool's huckleberry	9	59/1	65/ 4	41/ 2				242/36
Pacific silver fir/Oregon oxalis	17	70/ 1	31/ 2	61/ 2	6	24	53	580/77
Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry	18	57/ 1	77/ 1	37/ 1	6		22	236/12
Pacific silver fir/rhododendron/beargrass	46	61/ 1	67/ 1	38/ 1	7	13	48	222/12
Pacific silver fir/rhododendron/dwarf Oregon grape	12	65/ 1	73/ 5	21/ 1	17		50	109/33
Pacific silver fir/vine maple/coolwort foamflower	21	65/ 1	48/ 1	66/ 1	19	29	62	478/39
Pacific silver fir-western hemlock/rhododendron-salal	5	58/ 2	72/ 5	10/ 2		20	40	175/21

[1] Green weight.

TREE GROWTH

Our information on tree and stand growth comes from: 1) 275 intensive plots in the western hemlock, Douglas-fir and grand fir series, 2) site index measurements on over 1600 reconnaissance plots in all five conifer series, and 3) informantion for the Pacific silver fir and mountain hemlock series presented by Hemstrom et al. (1982). Due to the variety of information sources, complete data for every plant assocation is not available (Tables 11 and 12).

Douglas-fir and other conifers grow surprisingly well in the Douglas-fir series, particularly on the Rigdon and Oakridge Ranger Districts. Many sites in the Douglas-fir series at the south end of the Forest occur on relatively deep soils. Mild winter conditions allow high levels of photosynthesis throughout the year. Drought probably prevents net photosynthetic gain during late summer. The balance seems to be positive; sites at the south end of the forest have mean Douglas-fir site indices and stand volumes in the range of those of the drier western hemlock zone associations.

At the north end of the Forest, the overall climate is cooler and more moist. Sites which support Douglas-fir types are usually on nutrient-poor, steep sites with rocky soils and productivity is significantly lower. These differences probably fall out along SRI types. Douglas-fir sites on SRI mapping units 9, 21, 31, and 61 are likely to be less productive. Douglas-fir/oceanspray associations indicate harsher, drier sites than the other Douglas-fir types and, consequently, are less productive. Ponderosa pine and sugar pine seem to grow at least as well as Douglas-fir in the Douglas-fir series and should be managed for timber on some sites, particluarly at the south end of the Forest. Refer to Means and Helm (1985) for appropriate site index and height growth curves for dry-site Douglas-fir.

The western hemlock zone has, on average, the best sites for conifer growth on the Forest. Douglas-fir and several other conifers, including western hemlock, western redcedar, and grand fir, reach optimum development in the relatively warm, moist environment of the western hemlock zone. A few types, the western hemlock/rhododendron/beargrass assocation in particluar, occur on sites with poor nutrient and moisture status.

Stand volumes and volume increments from our intensive ecology plots in the western hemlock series (Table 11) reflect conditions in mature and old stands. Site trees in intensive plots in most western hemlock types averaged over 200 years old. Total stand volume, to a 4 inch top, ranged from less than 12,000 cubic feet per acre in the western hemlock/rhododendron/beargrass association to over 26,000 cubic feet per acre in the western hemlock/dwarf Oregon grape/Oregon oxalis and western hemlock/rhododendron/Oregon oxalis associations. Current periodic annual volume increment averaged between 80 and 100 cubic feet per acre per year (net) for most types in the western hemlock series, reflecting stand age more than potential. Refer to King (1966) for 50 year Douglas-fir site index curves, McArdle et al. (1961) for 100 year Douglas-fir site index curves, and Wiley (1978) for 50 year western hemlock site index curves.

Stand growth in the Pacific silver fir series varies, but is generally lower than in the western hemlock, Douglas-fir and grand fir series. Douglas-fir becomes less competitive at higher elevations and is generally absent above 5000 feet elevation. Several conifers grow well in the Pacific silver fir zone (Hemstrom et al. 1982), including Douglas-fir, noble fir, Pacific silver fir, western white pine (rust resistant varieties), and western hemlock (on some sites). In general, stand and individual tree growth rates are slower above 3000 feet elevation and markedly slower above 5000 feet elevation. Stand basal area, however, tends to be higher in the Pacific silver fir zone than in other zones. The conifer species that are dominant in the Pacific silver fir zone are generally more shade-tolerant than Douglas-fir, which may account for increased basal area. Refer to Herman et al. (1978) for 100 year noble fir site index curves and Curtis et al. (1974) for 100 year high-elevation Douglas-fir site index curves.

The mountain hemlock zone occurs on the poorest sites for tree growth on the Forest. Douglas-fir is rare or absent. The harsh, cold climate and deep, persistent snowpacks eliminate many of the conifers found at lower elevations. Pine species, especially western white pine and lodgepole pine, have the highest growth rates and also regenerate moderately well. Lodgepole pine is, in fact, the major pioneer species in the mountain hemlock zone. Many mountain hemlock zone stands are over 250 years old and consist of a mountain hemlock canopy with scattered Pacific silver fir and mountain hemlock seedlings and saplings. Stands in the mountain hemlock/grouse huckleberry assocation are particularly slow growing and difficult to regenerate. Refer to Johnson (1980) for appropriate 100 year site index curves.

The grand fir series is intermediate between the Douglas-fir and western hemlock series in both productivity and environment. Both the grand fir/dwarf Oregon grape and grand fir/prince's pine associations are as productive as most western hemlock associations. The grand fir/bearberry association occurs on very shallow soils, occasionally over lava. It is a very difficult type to regenerate, but fortunately it is rare and found in small patches. Conifer growth is very slow. Site index curves for grand fir east of the Cascades (Cochran 1979) may be appropriate for grand fir on the Willamette National Forest.

Table 11. Stand statistics and Douglas-fir site index for Douglas-fir, grand fir, and western hemlock series plant associations, Willamette National Forest. Dashes indicate missing or insufficient data.

	Number of Intensive Plots	Douglas-fir Age[1]		Douglas-fir SI50[2]		Douglas-fir SI100[3]		
		Mean	SE	Mean	SE	Mean	SE	N
Douglas-fir Series								
Douglas-fir/oceanspray-dwarf Oregon grape	5	115	16	96	7	115	3	11
Douglas-fir/oceanspray/grass	13	155	23	87	4	121	1	37
Douglas-fir/oceanspray-whipple vine	5	104	11	87	5	106	4	8
Douglas-fir/snowberry	5	91	12	104	6	123	6	7
Douglas-fir-western hemlock/dwarf Oregon grape	7	127	17	101	4	145	2	28
Douglas-fir-western hemlock/salal	12	170	28	108	8	138	1	41
Douglas-fir-western hemlock/rhododendron	5	217	57	105	4	133	1	21
Grand fir Series								
Grand fir/bearberry	3	164	18	64	-	86	1	16
Grand fir/dwarf Oregon grape	11	256	28	86	-	131	1	54
Grand fir/prince's pine	9	178	28	108	1	132	1	33
Grand fir-Pacific silver fir/false solomonseal	3	186	30	117	-	133	2	13

[1]Mean age of Douglas-fir site trees from intensive plots only.

[2]King (1966) for site trees less than 120 years old. Only data from intensive plots used.

[3]McArdle (1961) for trees in the Douglas-fir and grand fir series. Curtis et al. (1974) for trees in the mountain hemlock series. Mean, standard error and number of site trees from both reconnaissance and intensive plots.

Table 11. (continued)

	Total Stand Volume[1]		Periodic Annual Increment[2]		Total Basal Area[3]		Quadratic Mean Diameter[4]		Stand Density Index[5]	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Douglas-fir Series										
Douglas-fir/oceanspray-dwarf Oregon grape	9145	578	99	12	275	13	13	1	449	35
Douglas-fir/oceanspray/grass	10603	806	93	8	287	16	16	1	437	30
Douglas-fir/oceanspray-whipple vine	9116	750	103	32	283	18	17	3	429	51
Douglas-fir/snowberry	10450	1841	165	36	323	61	16	2	478	81
Douglas-fir-western hemlock/ dwarf Oregon grape	12500	1400	121	26	314	19	21	3	432	51
Douglas-fir-western hemlock/ salal	14275	1860	125	14	312	25	21	3	428	30
Douglas-fir-western hemlock/ rhododendron	11553	1722	76	21	270	33	17	3	405	46
Grand fir Series										
Grand fir/bearberry	6683	1100	47	7	227	42	15	3	346	40
Grand fir/dwarf Oregon grape	15711	835	74	16	348	11	19	2	493	26
Grand fir/prince's pine	18996	2901	64	79	416	31	16	2	671	94
Grand fir-Pacific silver fir/ false solomonseal	17852	2609	184	46	365	46	21	4	487	43

[1]Gross volume, cubic feet per acre to a 4 inch top. Equations by species as used in the 1981 Willamette National Forest Inventory.

[2]Cubic feet per acre per year, does not include mortality.

[3]Square feet per acre.

[4]Inches at breast height.

[5]Square feet per acre, Reineke (1933).

Table 11. (continued)

	Number of Intensive Plots	Douglas-fir Age[1]		Douglas-fir SI50[2]		Douglas-fir SI100[3]		
		Mean	SE	Mean	SE	Mean	SE	N
Western hemlock/Alaska huckleberry/dogwood bunchberry	7	280	73	94	-	137	1	32
Western hemlock/ dwarf Oregon grape	19	180	24	105	5	139	1	54
Western hemlock/dwarf Oregon grape/ Oregon oxalis	12	304	36	117	9	159	1	57
Western hemlock/dwarf Oregon grape-salal	12	203	45	101	5	133	1	36
Western hemlock/dwarf Oregon grape/vanilla leaf	12	236	29	117	7	158	1	55
Western hemlock/devil's club	7	315	66	111	12	168	1	20
Western hemlock/Oregon oxalis	17	308	40	114	7	158	1	62
Western hemlock/rhododendron-Alaska huckleberry/dogwood bunchberry	6	348	93	116	-	131	1	26
Western hemlock/rhododendron/ beargrass	8	181	37	84	7	122	1	26
Western hemlock/rhododendron-dwarf Oregon grape	20	294	36	99	12	136	1	80
Western hemlock/rhododendron/ Oregon oxalis	6	283	53	116	-	135	1	26
Western hemlock/rhododendron-salal	11	256	44	99	5	128	1	48
Western hemlock/rhododendron/ twinflower	6	183	54	105	18	130	1	19
Western hemlock/salal	14	166	32	107	4	137	1	42
Western hemlock/swordfern	12	284	83	120	5	159	1	36
Western hemlock/twinflower	7	170	64	110	4	148	1	16
Western hemlock/vanilla leaf	8	180	37	121	5	151	1	25

[1]Mean age of Douglas-fir site trees from intensive plots only.

[2]King (1966) for site trees less than 120 years old. Only data from intensive plots used.

[3]McArdle et al. (1961). Mean, standard error and number of site trees from both intensive and reconnaissance plots.

Table 11. (continued)

	Total Stand Volume[1]		Periodic Annual Increment[2]		Total Basal Area[3]		Quadratic Mean Diameter[4]		Stand Density Index[5]	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Western hemlock/Alaska huckleberry/dogwood bunchberry	23895	2686	62	8	478	12	23	2	611	33
Western hemlock/ dwarf Oregon grape	15534	1548	127	16	346	16	19	2	482	23
Western hemlock/dwarf Oregon grape/ Oregon oxalis	26441	2908	101	14	433	30	26	2	513	27
Western hemlock/dwarf Oregon grape-salal	13598	1687	108	14	324	28	17	2	487	48
Western hemlock/dwarf Oregon grape/vanilla leaf	23271	2659	117	12	400	26	27	1	474	29
Western hemlock/devil's club	18680	2260	98	17	308	26	31	5	363	49
Western hemlock/Oregon oxalis	19235	1631	111	19	351	20	21	2	470	22
Western hemlock/rhododendron-Alaska huckleberry/dogwood bunchberry	17200	2679	66	13	389	46	23	2	490	62
Western hemlock/rhododendron/ beargrass	11895	1162	90	17	316	18	20	2	473	20
Western hemlock/rhododendron-dwarf Oregon grape	16372	1391	93	14	346	18	20	2	473	20
Western hemlock/rhododendron/ Oregon oxalis	26014	4674	88	11	476	50	31	4	526	47
Western hemlock/rhododendron-salal	14572	2366	85	12	312	30	19	2	430	40
Western hemlock/rhododendron/ twinflower	16662	2476	105	18	419	37	17	2	616	55
Western hemlock/salal	12063	1126	108	16	286	16	17	2	426	27
Western hemlock/swordfern	15354	1572	119	15	302	16	19	1	415	18
Western hemlock/twinflower	17185	2708	150	19	403	26	15	2	623	43
Western hemlock/vanilla leaf	19201	3139	86	70	403	42	20	3	631	156

[1]Gross volume, cubic feet per acre to a 4 inch top. Equations by species as used in the 1981 Willamette National Forest Inventory.

[2]Cubic feet per acre per year, does not include mortality.

[3]Square feet per acre.

[4]Inches at breast height.

[5]Square feet per acre, Reineke (1933).

Table 12. Productivity summary for Pacific silver fir and mountain hemlock communities, Willamette National Forest (from Hemstrom et al. 1982).

Plant Association	Number of Plots	Douglas-fir[1] Site Index		Noble fir[2] Site Index		GBA[3] Douglas-fir		GBA Noble fir	
		Mean/n	SD	Mean/n	SD	Mean	SD	Mean	SD
Pacific silver fir/Alaska huckleberry/dogwood bunchberry[4]	9	102/ 6	6	110/ 1	-	384	74	407	-
Pacific silver fir/Alaska huckleberry-salal[4]	2	72/ 2	18	-	-	420	78	-	-
Pacific silver fir/big huckleberry/beargrass	12	96/ 6	12	94/ 6	12	301	39	337	71
Pacific silver fir/big huckleberry/queencup beadlily	9	112/ 6	26	126/ 2	20	254	53	453	86
Pacific silver fir/Cascades azalea/beargrass[5]	12	73/ 3	8	-	-	282	95	-	-
Pacific silver fir/Cascades azalea/queencup beadlily[5]	12	73/ 3	8	-	-	282	95	-	-
Pacific silver fir/coolwort foamflower	18	119/12	24	128/14	14	398	114	398	153
Pacific silver fir/Devil's club[6]	10	123/ 8	22	135/ 5	24	375	71	500	109
Pacific silver fir/dwarf Oregon grape[7]	6	104/ 6	25	76/ 2	23	296	60	303	81
Pacific silver fir/fool's huckleberry[5]	12	73/ 3	8	-	-	282	95	-	-
Pacific silver fir/Oregon oxalis[6]	10	123/ 8	22	135/ 5	24	375	71	500	109
Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry[4]	17	97/ 7	18	95/ 2	7	347	140	361	200
Pacific silver fir/rhododendron/beargrass	12	96/11	21	96/ 6	31	341	87	501	159
Pacific silver fir/rhododendron/dwarf Oregon grape[7]	6	104/ 6	25	76/ 2	23	296	60	303	81
Pacific silver fir/vine maple/coolwort foamflower	6	133/ 6	12	140/ 4	12	452	83	505	102
Pacific silver fir-western hemlock/rhododendron-salal[4]	5	101/ 5	32	-	-	276	93	-	-

Table 12. (continued)

Plant Association	Number of Plots	Douglas-fir[1] Site Index		Noble fir[2] Site Index		GBA[3] Douglas-fir		GBA Noble fir	
		Mean/n	SD	Mean/n	SD	Mean	SD	Mean	SD
Mountain hemlock/big huckleberry/beargrass	15	95/ 3	8	71/ 4	1	312	67	351	44
Mountain hemlock/grouse huckleberry	8	70/ 1	-	70/ 1	-	184	-	465	-
Mountain hemlock/luzula[8]		-	-	-	-	-	-	-	-
Mountain hemlock/rhododendron[4]	21	91/15	21	-	-	-	-	-	-

[1]100 year base, Curtis et al. (1974).

[2]100 year base, Herman et al. (1978).

[3]Growth basal area (Hall 1971).

[4]All information for this association based on reconnaissance plot data.

[5]Pacific silver fir/Cascades azalea/beargrass, Pacific silver fir/Cascades azalea/queencup beadlily and Pacific silver fir/fool's huckleberry associations combined for all estimates of productivity.

[6]Pacific silver fir/Oregon oxalis and Pacific silver fir/devil's club associations combined for all estimates of productivity.

[7]Pacific silver fir/dwarf Oregon grape and Pacific silver fir/rhododendron/dwarf Oregon grape associations combined for all estimates of productivity.

[8]No productivity data available.

Table 12 (continued).

Plant Association	Douglas-fir[1] GBA Cubes		Noble fir GBA Cubes		Stand Density[2] Index		Stand Density[3] Index Cubes	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Pacific silver fir/Alaska huckleberry/dogwood bunchberry[4]	210	40	224	-	500	96	118	29
Pacific silver fir/Alaska huckleberry-salal[4]	-	-	-	-	-	-	-	-
Pacific silver fir/big huckleberry/beargrass	146	34	156	28	556	161	125	63
Pacific silver fir/big huckleberry/queencup beadlily	144	58	284	9	460	117	137	37
Pacific silver fir/Cascades azalea/beargrass[5]	106	49	-	-	481	104	69	19
Pacific silver fir/Cascades azalea/queencup beadlily[5]	106	49	-	-	481	104	69	19
Pacific silver fir/coolwort foamflower	242	89	255	101	532	154	196	62
Pacific silver fir/Devil's club[6]	231	57	344	122	581	232	188	84
Pacific silver fir/dwarf Oregon grape[7]	158	54	126	61	469	103	138	63
Pacific silver fir/fool's huckleberry[5]	106	49	-	-	481	104	69	19
Pacific silver fir/Oregon oxalis[6]	231	57	344	122	581	232	188	84
Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry[4]	114	52	121	67	-	-	-	-
Pacific silver fir/rhododendron/beargrass	167	60	257	146	507	125	121	57
Pacific silver fir/rhododendron/dwarf Oregon grape[7]	158	54	126	61	469	103	138	63
Pacific silver fir/vine maple/coolwort foamflower	302	62	366	105	484	89	197	36
Pacific silver fir-western hemlock/rhododendron-salal[4]	138	46	-	-	-	-	-	-

Table 12 (continued).

Plant Association	Douglas-fir[1] GBA Cubes		Noble fir GBA Cubes		Stand Density[2] Index		Stand Density[3] Index Cubes	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Mountain hemlock/big huckleberry/beargrass	145	26	123	55	548	134	108	39
Mountain hemlock/grouse huckleberry	64	-	163	-	469	205	54	20
Mountain hemlock/luzula[8]	-	-	-	-	-	-	-	-
Mountain hemlock/rhododendron[4]	-	-	-	-	-	-	-	-

[1]Index of relative productivity based on GBA and site index, not a real estimate of cubic feet per acre per year.

[2]Reineke 1933, Knapp 1981.

[3]Index of relative productivity based on stand density index according to the method presented by Knapp 1981.

[4]All information for this association based on reconnaissance plot data.

[5]Pacific silver fir/Cascades azalea/beargrass, Pacific silver fir/Cascades azalea/queencup beadlily and Pacific silver fir/fool's huckleberry associations combined for all estimates of productivity.

[6]Pacific silver fir/Oregon oxalis and Pacific silver fir/devil's club associations combined for all estimates of productivity.

[7]Pacific silver fir/dwarf Oregon grape and Pacific silver fir/rhododendron/dwarf Oregon grape associations combined for all estimates of productivity.

[8]No productivity data available.

Table 12 (continued).

Plant Association	Quadratic Mean Diameter inches		Stand Basal Area square feet/acre		Productivity[1] Class
	Mean	SD	Mean	SD	
Pacific silver fir/Alaska huckleberry/dogwood bunchberry[2]	19	3	355	74	Medium
Pacific silver fir/Alaska huckleberry-salal[2]	-	-	440	113	Medium
Pacific silver fir/big huckleberry/beargrass	12	5	318	91	Medium
Pacific silver fir/big huckleberry/queencup beadlily	16	7	298	86	Medium
Pacific silver fir/Cascades azalea/beargrass[3]	15	4	303	51	Low
Pacific silver fir/Cascades azalea/queencup beadlily[3]	15	4	303	51	Low
Pacific silver fir/coolwort foamflower	19	6	364	82	High
Pacific silver fir/Devil's club[4]	19	9	387	117	High
Pacific silver fir/dwarf Oregon grape[5]	14	5	287	68	Medium
Pacific silver fir/fool's huckleberry[3]	15	4	303	51	Low
Pacific silver fir/Oregon oxalis[4]	19	9	387	117	High
Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry[2]	-	-	318	125	Medium
Pacific silver fir/rhododendron/beargrass	15	6	332	109	Medium
Pacific silver fir/rhododendron/dwarf Oregon grape[5]	14	5	287	68	Medium
Pacific silver fir/vine maple/coolwort foamflower	21	8	347	78	High
Pacific silver fir-western hemlock/rhododendron-salal[2]	-	-	296	108	Medium

Table 12 (continued).

Plant Association	Quadratic Mean Diameter inches		Stand Basal Area square feet/acre		Productivity[1] Class
	Mean	SD	Mean	SD	
Mountain hemlock/big huckleberry/beargrass	10	4	295	80	Low
Mountian hemlock/grouse huckleberry	8	2	234	102	Low
Mountain hemlock/luzula[6]	-	-	-	-	-
Mountain hemlock/rhododendron[2]	-	-	245	83	Low

[1]Empirical estimate of cubic feet per acre per year growth at culmination of mean annual increment: High - 135 to 205 cubic feet/acre/year, Medium - 80 to 180 cubic feet/acre/year, Low - 55 to 85 cubic feet/acre/year.

[2]All information for this association based on reconnaissance plot data.

[3]Pacific silver fir/Cascades azalea/beargrass, Pacific silver fir/Cascades azalea/queencup beadlily and Pacific silver fir/fool's huckleberry associations combined for all estimates of productivity.

[4]Pacific silver fir/Oregon oxalis and Pacific silver fir/devil's club associations combined for all estimates of productivity.

[5]Pacific silver fir/dwarf Oregon grape and Pacific silver fir/rhododendron/dwarf Oregon grape associations combined for all estimates of productivity.

[6]No productivity data available.

KEY TO PLANT ASSOCIATIONS

1. Select a vegetatively and topographically uniform area.

2. Identify and list tree, shrub, and herb species and estimate the cover of each. Cover is estimated to the nearest percent up to 10 percent cover and to the nearest 5 percent thereafter.

3. Work through the series and association keys (step by step) to a preliminary identification.

4. Review the association description to verify the identification.

It is important to follow these steps rigorously since a misidentification may lead to the wrong management implications.

The associations are abstractions based upon plot data taken throughout the Forest. In each case, plots were grouped according to plant community similarity and used as the basis for an abstraction process. Few stands will exactly conform to descriptions of average stands in the association descriptions.

Variation in vegetation across the landscape is continuous. Although we sampled in a systematic manner, there are many ecotonal areas which will not fit neatly into any particular association. Such areas should be managed according to the characteristics of the associations between which they fall. In most cases, floristically similar associations have similar management properties.

This key and guide should be used in the field to aid proper identification of associations. Questions concerning identification should be addressed in the field where species composition and cover are easily and correctly measured.

Series Key

1. Tree cover less than 10%, no indications that the area will be forested in the next 100 years. Non-forest communities, page 53.

2. Oregon white oak the major tree species, canopy open, understory grassy. Oregon white oak woodland, not present in sufficient amounts to describe.

3. Lodgepole pine the only regenerating species and makes up more than 75% of the canopy. Lodgepole pine-volcanic ash. Not described in this guide.

4. Mountain hemlock cover over 20% in canopy or over 2% in regeneration layer. Mountain hemlock series key, page 50.

5 Pacific silver fir cover over 20% in canopy or over 2% in regeneration layer. Pacific silver fir series key, page 51.

6. Grand fir regeneration at least as abundant as Douglas-fir or western hemlock, dry-site indicating species present. Grand fir series key, page 49.

7. Douglas-fir and incense cedar regeneration more abundant than western hemlock regeneration. Western hemlock absent or minor in both regeneration and canopy layers. Douglas-fir series key, page 49.

8. Western hemlock the most abundant regenerating species. Western hemlock series key, page 52.

9. Regeneration absent and canopy essentially pure Douglas-fir. Ocean spray cover over 10%, or any 2 of tall Oregon grape, poison oak, ocean spray, or whipple vine over 2% cover each. Douglas-fir series key, page 49.

10. Regeneration absent and canopy essentially pure Douglas-fir. Dry-site indicating species not common. Western hemlock series key, page 52.

Douglas-fir Series Key

1. At least two of the follwing present with at least 2% cover each: tall Oregon grape, poison oak, mock orange, hairy honeysuckle, whipplevine or oceanspray cover over 15 percent.....(2)
1. A combination of species indicating very dry sites lacking.....(5)

2. Dwarf Oregon grape over 10% cover.....PSME/HODI-BENE CDS2 11 p. 62
2. Dwarf Oregon grape minor.....(3)

3. Whipple vine cover over 10%.....PSME/HODI-WHMO CDS2 13 p. 70
3. Whipple vine minor.....(4)

4. Grass cover over 5%.....PSME/HODI/GRASS CDS2 12 p. 66
4. Grass minor, understory sparse. Return to step 2 and use relative cover.

5. Rhododendron cover over 15%.....PSME-TSHE/RHMA CDC7 12 p. 82
5. Rhododendron minor.....(6)

6. Snowberry cover over 20%.....PSME/SYMO CDS6 41 p. 74
6. Snowberry minor.....(7)

7. Dwarf Oregon grape over 10% cover and greater than salal cover.....PSME-TSHE/BENE CDC7 11 p. 78
7. Dwarf Oregon grape minor or salal more abundant.....(8)

8. Salal cover over 20%.....PSME-TSHE/GASH CDC7 13 p. 86
8. Salal minor, understory sparse. Shaded, return to step 1 and use relative cover.

Grand Fir Series Key

1. False solomonseal over 15%. Coolwort foamflower, wild ginger and other moist-site indicating herbs usually common. Elevation generally over 3500 feet.....ABAM-ABGR/SMST CFC3 11 p. 98
1. Moist-site indicating herbs minor.....(2)

2. Prince's pine cover over 20%.....ABGR/CHUM CWF2 11 p. 96
2. Prince's pine minor.....(3)

3. Bearberry or pinemat manzanita cover over 20 percent .....ABGR/ARUV CWS5 21 p. 90
3. Bearberry and pinemat manzanita minor.....(4)

4. Dwarf Oregon grape over 10%.....(5)
4. Sparse understory, return to step 1 and use relative cover.

5. Any three of the following with over 2% cover each: Baldhip rose, snowberry, oceanspray, California hazel, incense cedar, whipple vine.....ABGR/BENE CWS5 22 p. 92
5. Dry-site indicating species missing. Go to western hemlock series key, p. 51.

Mountain hemlock series key

1. Grouse huckleberry cover over 5%.....TSME/VASC CMS1 14 p.166
1. Grouse huckleberry minor.....(2)

2. Rhododendron cover over 10%.....TSME/RHMA CMS6 12 p.174
2. Rhododendron minor.....(3)

3. Beargrass over 5% cover.....TSME/VAME/XETE CMS2 16 p.162
3. Beargrass minor.....(4)

4. Luzula over 5% cover.....TSME/LUZUL CMG2 11 p.170
4. Luzula minor or absent.....(5)

5. Stand interlaced with subalpine meadows or non-forest areas. Subalpine parkland, not covered in this guide.
5. Understory nearly absent. Return to step 1 and use relative cover.

Pacific silver fir Series Key

1. Devil's club cover over 5%.....ABAM/OPHO CFS3 51 p. 128
1. Devil's club minor.....(2)

2. Cascades azalea cover over 5%.....(3)
2. Cascades azalea minor.....(4)

3. Herb poor, giant fawnlily or beargrass the only significant herbs.....ABAM/RHAL/XETE CFS5 51 p.116
3. Several herbs present, especially dogwood bunchberry, vanilla leaf, rosy twisted stalk, coolwort foamflower, and queencup beadlily. Beargrass can be abundant.....ABAM/RHAL/CLUN CFS5 52 p.120

4. Fool's huckleberry cover over 5% or greater than Alaska, oval-leaf, or big huckleberries.....ABAM/MEFE CFS2 54 p.135
4. Fool's huckleberry minor or absent.....(5)

5. Oregon oxalis cover over 5%.....ABAM/OXOR CFF1 53 p.138
5. Oregon oxalis minor or absent.....(6)

6. Salal cover over 5%.....(7)
6. Salal minor or absent.....(8)

7. Alaska or oval-leaf huckleberry cover over 10%.....ABAM/VAAL-GASH CFS2 55 p.105
7. Alaska and oval-leaf huckleberry minor, rhododendron usually abundant.....ABAM-TSHE/RHMA-GASH CFC2 51 p.154

8. False solomonseal cover over 15% (usually over 20%), grand fir (white fir) usually common in canopy and regeneration layers.....ABAM-ABGR/SMST CFC3 11 p. 98
8. Coolwort foamflower cover at least equal to false solomonseal cover or false solomonseal minor, grand fir may be present.....(9)

9. Coolwort foamflower or false solomonseal cover over 5% or three or more of the following herbs with over 2% cover each: coolwort foamflower, false solomonseal, rosy twisted stalk, wild ginger, inside-out-flower, and vanilla leaf.....(10)
9. Moist site indicating herbs minor.....(11)

10. Vine maple cover over 15%.....ABAM/ACCI/TITR CFS6 51 p.158
10. Vine maple minor or absent.....ABAM/TITR CFF1 52 p.124

11. Alaska or oval-leaf huckleberry cover over 10%.....(12)
11. Alaska and oval-leaf huckleberry minor.....(13)

12. Rhododendron cover over 30%.....ABAM/RHMA-VAAL/COCA CFS6 54 p.142
12. Rhododendron cover less than 30%.....ABAM/VAAL/COCA CFS2 53 p.102

13. Rhododendron cover greater than 30% or, in shrub poor areas, rhododendron the only significant tall shrub.....(14)
13. Rhododendron cover less than 30%.....(15)
14. Beargrass cover over 10% or beargrass the only herb present.....ABAM/RHMA/XETE CFS6 53 p.146
14. Beargrass minor or absent. Dwarf Oregon grape usually important.....ABAM/RHMA-BENE CFS6 52 p.150

15. Dwarf Oregon grape cover over 5%. Big huckleberry cover usually less than 10 percent.....ABAM/BENE CFS1 51 p.132
15. Dwarf Oregon grape minor or absent. Big huckleberry usually the major shrub.....(16)

16. Several herbs in addition to beargrass present, usually including queencup beadlily, false solomonseal, and vanilla leaf.....ABAM/VAME/CLUN CFS2 56 p.112
16. Beargrass the major herb, other herbs minor.....(17)

17. Beargrass over 5% cover, other herbs minor..ABAM/VAME/XETE CFS2 51 p.108
17. Understory nearly absent. Shaded, return to step 1 and use relative cover.

Western Hemlock Series Key

1. Devil's club cover over 10%.....TSHE/OPHO-WILL CHS5 11 p. 182
1. Devil's club minor.....(2)

2. Rhododendron cover over 20%.....(3)
2. Rhododendron minor.....(8)

3. Oregon oxalis cover over 15%.....TSHE/RHMA/OXOR CHS3 54 p. 218
3. Oregon oxalis minor.....(4)

4. Beargrass cover over 10%.....TSHE/RHMA/XETE-WILL CHS3 53 p. 210
4. Beargrass minor.....(5)

5. Dwarf Oregon grape cover over 15% and greater than salal cover..... TSHE/RHMA-BENE-WILL CHS3 52 p. 214
5. Dwarf Oregon grape minor or less than salal cover.....(6)

6. Salal cover over 20%.....TSHE/RHMA-GASH-WILL CHS3 51 p. 222
6. Salal minor.....(7)

7. Twinflower cover over 15%.....TSHE/RHMA/LIBO2 CHS3 55 p. 226
7. Shaded, return to step 3 and use relative covers

8. Alaska huckleberry and/or oval-leaf huckleberry cover over 5%.....(9)
8. Alaska huckleberry and oval-leaf huckleberry minor.....(10)

9. Rhododendron cover over 10%.....TSHE/RHMA-VAAL/COCA CHS3 26 p. 206
9. Rhododendron minor.....TSHE/VAAL/COCA CHS6 15 p. 178

10. Dwarf Oregon grape cover about equal to salal cover and each over 15% cover.....TSHE/BENE-GASH-WILL CHS1 24 p. 194
10. Dwarf Oregon grape or salal minor or covers not equal.....(11)

11. Dwarf Oregon grape cover over 20%.....(12)
11. Dwarf Oregon grape minor.....(14)

12. Oregon oxalis cover over 15%.....TSHE/BENE/OXOR CHS1 13 p. 190
12. Oregon oxalis minor.....(13)

13. Vanilla leaf cover over 10% or 2 of vanilla leaf, coolwort foamflower, or, false solomonseal over 2% cover each...TSHE/BENE/ACTR CHS1 14 p. 198
13. Herbs other than swordfern minor.....TSHE/BENE CHS1 25 p. 186

14. Salal cover over 20%.....TSHE/GASH-WILL CHS1 11 p. 230
14. Salal minor.....(15)

15. Oregon oxalis cover over 25%.....TSHE/OXOR-WILL CHF1 11 p. 202
15. Oregon oxalis minor.....(16)

16. Vanilla leaf cover greater than 10% or 2 of vanilla leaf, coolwort foamflower, or false solomonseal with 5% cover each.....TSHE/ACTR CHF2 21 p. 242
16. Vanilla leaf, coolwort foamflower and false solomonseal minor.....(17)

17. Twinflower cover over 20%.....TSHE/LIBO2 CHF3 21 p. 238
17. Twinflower minor.....(18)

18. Swordfern cover over 20%.....TSHE/POMU-WILL CHF1 51 p. 234
18. Swordfern minor, shaded. Return to step 1 and use relative covers.

Key to Non-Forest Communities

This key is based on analysis of 120 plots in non-forest communities across the Forest. Alpine parklands and tundra were not sampled. Do not use this key in areas above upper treeline. We could not sample all non-forest communities that exist on the Forest. As a consequence, this key will not always work. Open areas tend to be individual, each different from all the rest in the details of species composition and abundance. This key and the non-forest classification are designed around similarity of environment and the dominance of different vegetative life forms. We hope to gather additional samples, particularly in Wilderness Areas, and refine the classification and key in the near future.

1. Tree cover over 10 percent. Forested, go to page xx.
1. Tree cover less than 10 percent. No indications that the site will be forested in 100 years.....(2)

2. Vegetative cover less than 5 percent. Unvegetated, not sampled and not included in this guide.
2. Vegetative cover over 5 percent .....(3)

3. Surface rock over 70 percent cover.....(4)
3. Surface rock less than 70 percent cover .....(9)

4. Moss covered bedrock.....(5)
4. Talus or lava, often with moss cover.....(7)

5. Dry by early summer, herb cover less than 35 percent.....(6)
5. Moist through mid-summer, herb cover over 35 percent.....Rock Garden (steep, moist) NRL9 12 p. 253

6. Slope over 80 percent .....Rock Garden (steep, xeric) NRL9 11 p. 254
6. Slope less than 80 percent.....Rock Garden (flat, xeric) NRR9 11 p. 252

7. Recent lava flows, shrub cover over 10 percent.....Shrub (lava) NCS1 11 p. 257
7. Talus, occassionally covered with moss or thin soil .....(8)

8. Shrub cover, especially vine maple, over 25 percent ....Vine Maple (talus) NTS2 11 p. 263
8. Shrubs cover less than 25 percent.....Talus NTS9 11 p. 260

9. Soils less than 8 inches deep to bedrock, forbs dominate the vegetation, total vegetative cover usually less than 15 percent .....Woolly Eriophyllum-Varileaf Phacelia (xeric) FM99 11 p. 264
9. Soils deeper, vegetative cover usually over 15 percent ..... (10)

10. Vine maple cover over 35 percent..Vine Maple (rocky soil) SM81 12 p. 262
10. Vine maple minor or absent ..... (11)

11. Sitka alder cover over 35 percent.....Sitka Alder (rocky soil) SM81 11 p. 258
11. Sitka alder minor or absent..... (12)

12. Soils dry through most of the growing season ..... (18)
12. Soils moist or saturated most of the growing season..... (13)

13. Shrub cover over 10 percent..... (16)
13. Shrubs usually minor or absent ..... (14)

14. False hellebore or cowparsnip cover over 15 percent, forbs cover greater than that of sedges, rushes or grasses.....False Hellebore-Common Cowparsnip FW51 11 p. 251
14. Sedges, rushes, or grasses dominant..... (15)

15. Cover of forbs nearly equal to that of sedges and rushes.....Sedge-Twinflower Marshmerigold MM39 11 p. 256
15. Sedges and rushes dominate.....Sedge-Panicled Bulrush (hydric) MT19 11 p. 255

16. Huckleberries or blueberries codominant with spirea..... (17)
16. Spirea and willows dominant.....Spirea-Willow/Sedge SW41 23 p. 259

17. Sedges and forbs more abundant than grasses.....Douglas Spirea-Bog Blueberry/Sedge (hydric) SW41 22 p. 250
17. Grasses prominent, cover usually equal to or greater than sedges and forbs.....Blueberry-Subalpine Spirea/Grass SW41 21 p. 247

18. Beargrass common .....Beargrass-Red Fescue FM29 11 p. 246
18. Beargrass minor..... (19)

19. Thimbleberry and/or pokeweed fleeceflower common....Thimbleberry-Pokeweed Fleeceflower SM59 11 p. 261
19. Thimbleberry and pokeweed fleeceflower minor..... (20)

20. Vetches and fleabanes common, forb cover generally greater than grass cover.....Common Vetch-Peregrine Fleabane-Blue Wildrye FM30 11 p. 249
20. Vetches and fleabanes uncommon, grass cover often greater than forb cover..... (21)

21. Blue wildrye and brome grasses common..Blue Wildrye-Brome GM41 21 p. 248
21. Non-forest type not sampled and not included in this guide.

List of TRI abbreviations (Garrison et al. 1976), scientific (Hitchcock and Cronquist 1973) and common names (Garrison et al. 1976) of trees, shrubs and herbs used in the key and association descriptions. Species with missing codes or common names were not included in Garrison et al. (1976). An asterisk next to species code indicates species used in the keys to plant associations or cummunity types.

TREES

CODE	SCIENTIFIC NAME	COMMON NAME	INDICATION
ABAM *	Abies amabilis	Pacific silver fir	cool
ABCO	Abies concolor	White fir	
ABGR	Abies grandis	Grand fir	
ABLA2*	Abies lasiocarpa	Subalpine fir	cool
ABMAS	Abies procera shastensis	Shasta red fir	
ABPR *	Abies procera	Noble fir	
ACMA	Acer macrophyllum	Bigleaf maple	
ALRU	Alnus rubra	Red alder	
ARME	Arbutus menziesii	Madrone	dry, warm
CACH	Castanopsis chrysophylla	Chinquapin	dry
CADE	Calocedrus decurrens	Incense cedar	hot
CHNO	Chamaecyparis nootkatensis	Alaska cedar	cold, wet
LAOC	Larix occidentalis	Western larch	
PIAL	Pinus albicaulis	Whitebark pine	very cold
PIEN	Picea engelmannii	Engelmann spruce	cold
PICO	Pinus contorta	Lodgepole pine	
PILA	Pinus lambertiana	Sugar pine	
PIMO	Pinus monticola	Western white pine	
PIPO	Pinus ponderosa	Ponderosa pine	hot, dry
PREM	Prunus emarginata	Bitter cherry	
PSME	Pseudotsuga menziesii	Douglas-fir	
QUGA *	Quercus garryana	Oregon white oak	hot, dry
TABR	Taxus brevifolia	Pacific yew	
THPL	Thuja plicata	Western redcedar	
TSHE *	Tsuga heterophylla	Western hemlock	
TSME *	Tsuga mertensiana	Mountain hemlock	cold

SHRUBS

CODE	SCIENTIFIC NAME	COMMON NAME	INDICATION
ACCI *	Acer circinatum	Vine maple	
ACGLD	Acer glabrum douglasii	Rocky Mt. maple	
ALSI *	Alnus sinuata	Sitka alser	
AMAL	Amalanchier alnifolia	Serviceberry	
ARCO3	Arctostaphylos columbiana	Hairy manzanita	
ARNE	Arctostaphylos nevadensis	Pinemat manzanita	dry
ARPA	Arcotstaphylos patula	Greenleaf manzanita	dry
ARUV *	Arctostaphylos uva-ursi	Bearberry	dry
ARLU	Artemisia ludoviciana	Louisiana sagebrush	
BEAQ *	Berberis aquifolium	Tall Oregon grape	warm, dry
BENE *	Berberis nervosa	Dwarf Oregon grape	
CACH	Castanopsis chrysophylla	Chinquapin	warm
CEIN	Ceanothus integerrimus	Deerbrush ceanothus	disturbance
CEVE	Ceanothus velutinus	Snowbrush	disturbance
CHME	Chimaphila menziesii	Little prince's pine	
CHUM *	Chimaphila umbellata	Prince's pine	
COCO2	Corylus cornuta	California hazel	warm
CONU	Cornus nuttallii	Pacific dogwood	warm
COST	Cornus stolonifera	Red-osier dogwood	
GAOV	Gaultheria ovatifolia	Wintergreen	
GASH *	Gaultheria shallon	Salal	
HODI	Holodiscus discolor	Oceanspray	dry
HODU	Holodiscus dumosus	Bush rockspirea	dry, cool
JUCO4	Juniperus communis	Common juniper	
LOHI	Lonicera hispidula	Hairy honeysuckle	hot, dry
MEFE *	Menziesia ferruginea	Fool's huckleberry	cool
OECE	Oemelaria cerasiformis	Osoberry	
OPHO *	Oplopanax horridum	Devil's club	wet
PAMY	Pachistima myrsinites	Oregon boxwood	
PHLE2*	Philadelphus lewisii	Mockorange	dry
RHPU	Rhamnus purshiana	Cascara buckthorn	
RHAL *	Rhododendron albiflorum	Cascades azalea	cold,wet
RHMA *	Rhododendron macrophyllum	Rhododendron	
RHDI *	Rhus diversiloba	Poison oak	hot, dry
RIBES	Ribes spp.	Gooseberry	
RIBR	Ribes bracteosum	Stink currant	
RICR	Ribes cruentum	Shinyleaf gooseberry	
RILA	Ribes lacustre	Prickly currant	
RISA	Ribes sanguineum	Winter currant	
ROGY *	Rosa gymnocarpa	Baldhip rose	
RULA	Rubus lasiococcus	Dwarf bramble	cool
RULE	Rubus leucodermis	Black raspberry	
RUNI	Rubus nivalis	Snow dewberry	
RUPA *	Rubus parviflorus	Thimbleberry	
RUPE	Rubus pedatus	Five-leaved blackberry	cool
RUSP	Rubus spectabilis	Salmonberry	warm, wet
RUUR	Rubus ursinus	Trailing blackberry	warm
SALIX	Salix spp.	Willows	

CODE	SCIENTIFIC NAME	COMMON NAME	INDICATION
SALA2	Salix lasiandra	Pacific willow	
SARA	Sambucus racemosa	European red elder	
SOSI	Sorbus sitchensis	Sitka mountain ash	
SPDE *	Spiraea densiflora	Subalpine spirea	cool, moist
SPDO *	Spiraea douglasii	Douglas spirea	cool, moist
SYAL	Symphoricarpos albus	Common snowberry	
SYOR	Symphoricarpos oreophilus	Mountain snowberry	
SYMO *	Symphoricarpos mollis	Snowberry (trailing)	warm, dry
VACCI*	Vaccinium spp.	Huckleberry species	
VAAL *	Vaccinium alaskaense	Alaska huckleberry	cool
VACA	Vaccinium caespitosum	Dwarf blueberry	
VAME *	Vaccinium membranaceum	Big huckleberry	cool-cold
VAOC2	Vaccinium occidentale	Western bog-blueberry	
VAOV *	Vaccinium ovalifolium	Oval-leaf huckleberry	cool
VAPA	Vaccinium parvifolium	Red huckleberry	warm
VASC *	Vaccinium scoparium	Grouse huckleberry	cold, dry
VAUL *	Vaccinium uliginosum	Bog Blueberry	cool, wet
WHMO *	Whipplea modesta	Whipple vine	warm, dry

HERBS AND GRASSES

CODE	SCIENTIFIC NAME	COMMON NAME	INDICATION
ACMI	Achillea millifolium	Western yarrow	
ACTR *	Achlys triphylla	Vanilla leaf	moist
ACRU	Actaea rubra	Baneberry	
ADBI	Adenocaulon bicolor	Pathfinder	
ADPE	Adiantum pedatum	Maidenhair fern	wet
AGAU	Agoseris aurantiaca	Orange agoseris	
AGDI	Agrostis diegoensis	Thin bentgrass	
AGEX	Agrostis exarata	Spike bentgrass	
AGHA	Agrostis hallii	Hall's bentgrass	
AGTH	Agrostis thurberiana	Thurber bentgrass	
AIEL	Aira elegans	Elegant hairgrass	
ALLIU	Allium spp.	Onion	
ALCA	Allium campanulatum	Sierra onion	
ALCR	Allium crenulatum	Scalloped onion	
ANDE	Anemone deltoidea	Three-leaved anemone	moist
ANLY2	Anemone lyallii	Nine-leaved anemone	moist
ANGE	Angelica genuflexa	Kneeling angelica	
ANMI	Antennaria microphylla	Rosy pussytoes	
AQFO	Aquilegia formosa	Sitka columbine	
ARCA3	Aralia californica	California aralia	
ARMA3	Arenaria macrophylla	Bluntleaf sandwort	
ARLA	Arnica latifolia	Broadleaf arnica	

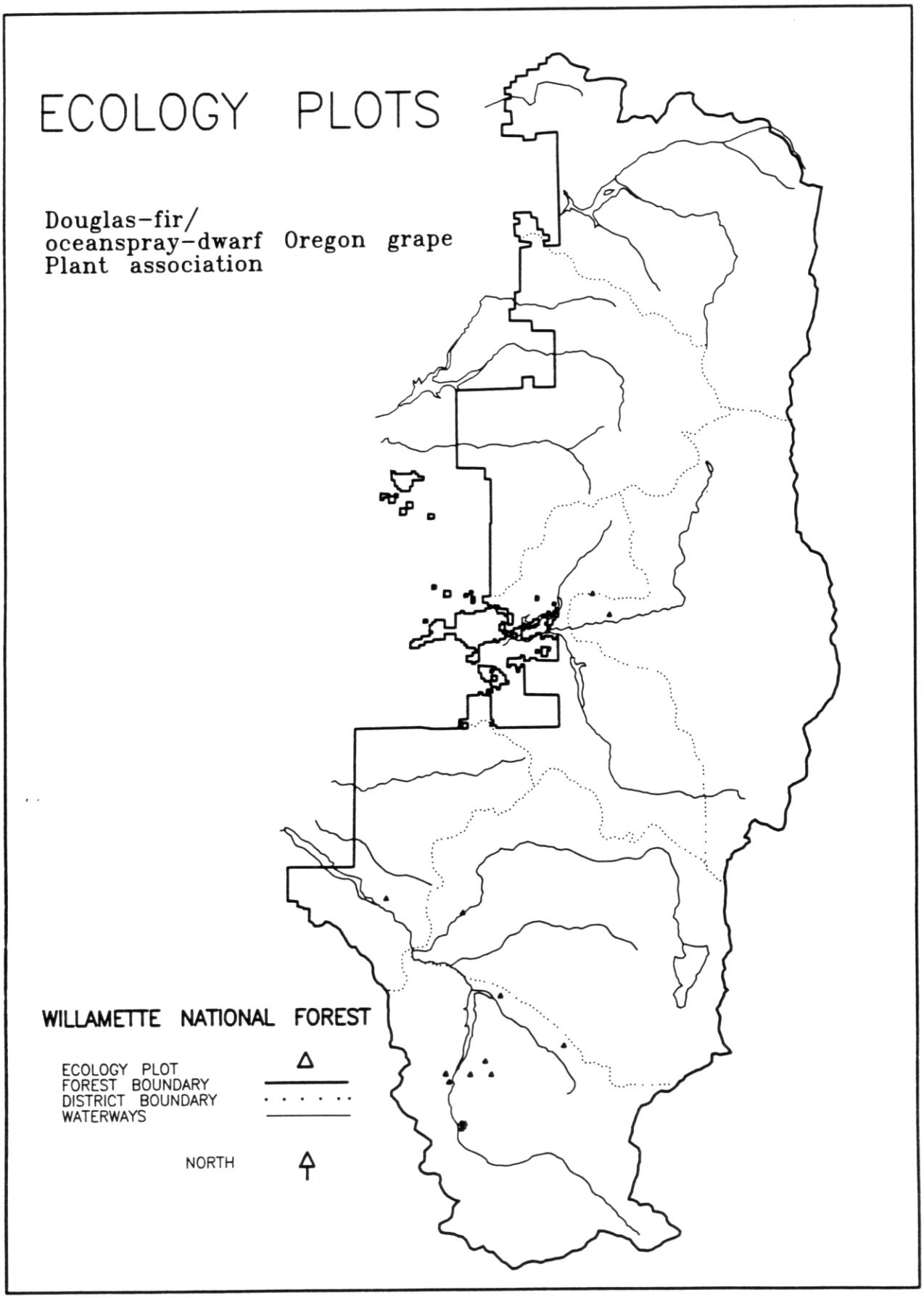
CODE	SCIENTIFIC NAME	COMMON NAME	INDICATION
ASCA3	Asarum caudatum	Wild ginger	moist
ASDE	Aspidotis densa	Aspidotis	
ASTER	Aster spp.	Aster	
ASAL	Aster alpigenus	Alpine aster	
ASGO	Aster gormanii	Gorman's aster	
ATFI	Athyrium filix-femina	Ladyfern	moist, wet
BLSP	Blechnum spicant	Deerfern	moist
BOMU	Botrychium multifidum	Leathery grapefern	
BOMA	Boykinia major	Sierra boykinia	
BROMU*	Bromus spp.	Brome	
BRCA	Bromus carinatus	California brome	
BRIN	Bromus inermis	Smooth brome	
BRTE	Bromus tectorum	Cheatgrass brome	
CACA	Calamagrostis canadensis	Bluejoint reedgrass	
CALOC	Calochortus spp.	Sego lily	
CABI *	Caltha biflora	twinflower marshmerigold	
CABU2	Calypso bulbosa	Calypso orchid	
CAMAS	Camassia spp.	Camas	
CALE	Camassia lechtlinii	Lechtlin's camas	
CASC2	Campanula scouleri	Scouler's bluebell	
CAREX*	Carex spp.	Sedge	
CACO5	Carex comosa	Bristly sedge	
CAHY	Carex hystricina	Porcupine sedge	
CALE5	Carex lenticularis		
CALU	Carex luzulina	Woodrush sedge	
CAME2	Carex mertensii	Merten's sedge	
CAMU2	Carex muricata	Muricate sedge	
CAOB	Carex obnupta	Slough sedge	
CAPE5	Carex pensylvanica	Long-stolon sedge	
CASA2	Carex saxatilis	Russet sedge	
CASI3	Carex sitchensis	Sitka sedge	
CATU	Carex tumulicola	Foothills sedge	
CAVE	Carex vesicaria	Blister sedge	
CERAS	Cerastium spp.	Chickweed	
CHGR	Cheilanthes gracillima	Lace lipfern	
CIDO	Cicuta douglasii	Western water-hemlock	
CIAL	Circaea alpina	Alpine circaea	
CIRSI	Cirsium spp.	Thistle	
CLUN *	Clintonia uniflora	Queencup beadlily	cool, moist
COHE	Collomia heterophylla	Varied-leaf collomia	
COLA	Coptis laciniata	Goldthread	moist
COMA3	Corallorhiza maculata	Coral-root	
COCA *	Cornus canadensis	Dogwood bunchberry	cool, moist
COCAC	Corydalis caseana cusickii	Case's corydalis	
CRMU	Crocidium multicaule	Spring-gold	

CODE	SCIENTIFIC NAME	COMMON NAME	INDICATION
CRCR	Cryptogramma crispa	rockbrake	dry, rocky
DANTH	Danthonia spp.	Danthonia	
DAIN	Danthonia intermedia	Timber danthonia	
DECA	Deschampsia caespitosa	Tufted hairgrass	
DIFO	Dicentra formosa	Pacific bleeding heart	moist
DIHO	Disporum hookeri	Fairybells	
DODEC	Dodecatheon spp.	Shootingstar	
DOJE	Dodecatheon jeffreyi	Jeffrey shootingstar	
DROSE	Drosera spp.	Sundew	
DRRO	Drosera rotundifolia	Sundew	
DRAU2	Dryopteris austriaca	Sheild-fern	
ELGL *	Elymus glauca	Blue wildrye	
EPGL	Epilobium glaberrimum	Smooth willowweed	
EPGL2	Epilobium glandulosum	Common willowweed	
EPMI	Epilobium minutum	Small-flowered willoweed	
ERCO5	Eriogonum compositum	Northern eriogonum	
ERMA2	Eriogonum marifolium	Mountain eriogonum	
ERNU	Eriogonum nudum	Barestem eriogonum	
ERUM	Eriogonum umbellatum	Sulphur eriogonum	
ERPO2	Eriophorum polystachion	Many-spiked cottongrass	
ERLA	Eriophyllum lanatum	Woolly eriophyllum	
ERMO *	Erythronium montanum	Avalanche lily	cold
EQUIS	Equisetum spp.	Horsetail	moist
ERCA3	Erigeron cascadensis	Cascades fleabane	
ERPE *	Erigeron peregrinus	Peregrine fleabane	
EROR	Erythronium oregonum	Giant fawnlily	warm
FECA	Festuca californica	California fescue	
FEID	Festuca idahoensis	Idaho fescue	
FEOC	Festuca occidentalis	Western fescue	
FEOV	Festuca ovina	Sheep fescue	
FERU *	Festuca rubra	Red fescue	
FESU	Festuca subulata	Bearded fescue	
FRAGA	Fragaria spp.	Strawberry	
FRVE	Frageria vesca	Strawberry	
FRUM	Frasera umpquaensis	Umpqua frasera	
FRLA	Fritillaria lanceolata	Riceroot fritillary	
GAAP	Galium aparine	Catchweed bedstraw	
GAOR	Galium oreganum	Oregon bedstraw	
GATR	Galium triflorum	Sweetscented bedstraw	
GEMA	Geum macrophyllum	Largeleaf avens	
GLGR	Glyceria grandis	American mannagrass	
GOOB	Goodyera oblongifolia	Rattlesnake plantain	
GYDR	Gymnocarpium dryopteris	Oak fern	moist
HADI2	Habenaria dilatata	White bog-orchid	
HAUN	Hebenaria unalasensis	Alaska habenaria	
HAHA	Haplopappus hallii	Hall's goldenweed	
HELA *	Heracleum lanatum	Common cowparsnip	
HEUCH	Heuchera spp.	Alumroot	

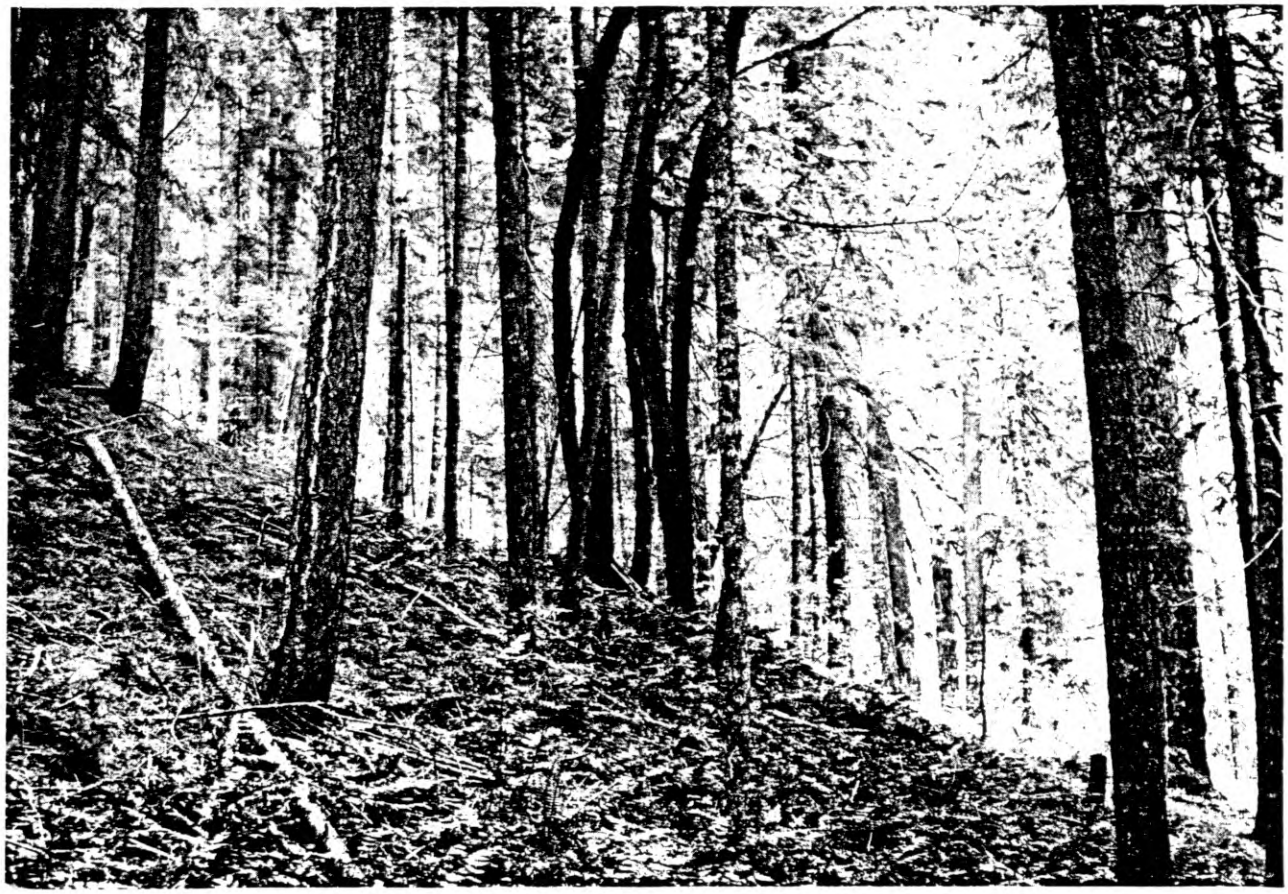
CODE	SCIENTIFIC NAME	COMMON NAME	INDICATION
HIAL	Hieracium albiflorum	White hawkweed	
HIOD	Hierocloe odorata	Seneca grass	
HYCA	Hydrophyllum capitatum	Ballhead waterleaf	
HYTE	Hydrophyllum tenuipes	Pacific waterleaf	
HYAN	Hypericum anagalloides	Trailing St. Johnswort	
HYFO	Hypericum formosum	Western St. Johnswort	
HYMO	Hypopitys monotropa	Pinesap	
JUBA	Juncus balticus	Baltic rush	
JUEN	Juncus ensifolius	Swordleaf rush	
JUPA	Juncus parryi	Parry rush	
JUPA2	Juncus patens	Spreading rush	
IRTE	Iris tenax	Oregon iris (purple)	
LICO4	Lilium columbianum	Columbia lily	
LIBO2*	Linnaea borealis	Twinflower	
LIBO	Listera borealis	Twayblade	
LOHA	Lomatium hallii	Hall's lomatium	
LOTR	Lomatium triternatum	Nineleaf lomatium	
LOUT	Lomatium utriculatum	Pomo-celery lomatium	
LUZUL	Luzula spp.	Luzula	
LYSI	Lycopodium sitchense	Alaska clubmoss	
LYAM	Lysichitum americana	American yellow skunkcabbage	
MADI2	Maianthemum dilatatum	False lily-of-the-valley	moist
MECA2	Mertensia campanulata	Idaho bluebells	
MIMUL	Mimulus spp.	Monkeyflower	
MIAL	Mimulus alsinoides	Chickweed monkeyflower	
MIGU	Mimulus gutattus	Common monkeyflower	
MIBR	Mitella breweri	Brewer miterwort	moist
MOSI	Montia sibirica	Miner's lettuce	moist
NEME	Nemophila menziesii	Baby blue-eyes	
NEPA	Nemophila paviflora	Smallflower nemophila	
OPVU	Ophioglossum vulgatum	Adder's tongue	
OSCH	Osmorhiza chilensis	Sweet cicely	
OXOR *	Oxalis oregana	Oregon oxalis	moist
PEDA	Penstemon davidsonii	Davidson penstemon	
PERU	Penstemon rupicola	Cliff penstemon	
PEGR	Pedicularis groenlandica	Elephanthead pedicularis	
PERA	Pedicularis racemosa	Sickletop pedicularis	cool, moist
PHHE *	Phacelia heterophylla	Varileaf phacelia	
PLRE	Pleuropogon refractus	Nodding semaphoregrass	
POPH *	Polygonum phytolaccefolium	Pokeweed fleeceflower	
POLYP	Polypodium spp.	Licorice fern	
POAN3	Polystichum andersonii	Anderson's swordfern	
POLO2	Polystichum lonchitis	Mountain hollyfern	
POMU	Polystichum munitum	Swordfern	
POTEN	Potentilla spp.	Cinquefoil	
PTAQ	Pteridium aquilinum	Bracken fern	disturbance
PYPI	Pyrola picta	White vein pyrola	
PYSE	Pyrola secunda	Sidebells pyrola	cool, dry

CODE	SCIENTIFIC NAME	COMMON NAME	INDICATION
PYAS	Pyrola asarifolia	Alpine pyrola	
ROCA	Romanzoffia californica	California mistmaiden	
ROTH	Romanzoffia thompsonii	Thompson's mistmaiden	
SADO	Satureja douglasii	Yerba buena	warm, dry
SALY	Saxifraga lyallii	Lyall saxifrage	
SAME3	Saxifraga mertensiana	Mertens saxifrage	
SAOC3	Saxifraga occidentalis	Western saxifrage	
SCMI *	Scirpus microcarpus	Panicled bulrush	
SCHA	Scoliopus hallii	Fetid adders-tongue	
SEDI	Sedum divergens	Spreading stonecrop	
SEOR3	Sedum oregonense	Creamy stonecrop	
SESP	Sedum spathulifolium	Spatula-leaf stonecrop	
SEWA2	Selaginella wallacei	Wallace selaginella	
SETR	Senecio triangularis	Arrowleaf groundsel	
SICU	Sidalcea cusickii	Cusick's checkermallow	
SISE2	Sidalcea setosa		
SIHY	Sitanion hysterix	Bottlebrush squirreltail	
SMRA	Smilacina racemosa	Feather solomonplume	moist
SMST *	Smilacina stellata	False solomonseal	moist
STCO4	Stachys cooleyae	Cooley's betony	
STOC	Stipa occidentalis	Western needlegrass	
STRO *	Streptopus roseus	Rosy twistedstalk	moist
SYRE	Synthyris reniformis	Snow queen	warm, dry
THLI	Thelypteris limbosperma	Mountain wood-fern	
TITR *	Tiarella trifoliata	Coolwort foamflower	moist
TOGL	Tofieldia glutinosa	Tofieldia	
TOME	Tolmiea menziesii	Menzie's tolmiea	
TRAR2	Trientalis arctica	Northern starflower	
TRLA2	Trientalis latifolia	Western starflower	
TROV	Trillium ovatum	Pacific trillium	
VASI	Valeriana sitchensis	Sitka valerian	moist, cool
VAHE *	Vancouveria hexandra	Inside-out-flower	
VERAT*	Veratrum spp.	False hellebore	
VECA	Veratrum californicum	California false hellebore	
VEVI	Veratrum viride	American false hellebore	
VISA *	Vicia sativa	Common vetch	
VIOLA	Viola spp.	Violet	
VIGL	Viola glabella	Pioneer violet	moist
VIOR2	Viola orbiculata	Vetch violet	moist
VISE	Viola sempervirens	Redwoods violet	
XETE *	Xerophyllum tenax	Beargrass	cold, dry

Environmental indication is strong when several similar species are present and their cover is high. Opposite indications should be weighed by number of indicators present and their percent cover.


ECOLOGY PLOTS
Douglas-fir/
oceanspray-dwarf Oregon grape
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Douglas-fir / oceanspray - dwarf Oregon grape
PSME / HODI - BENE CDS2 11



Western hemlock is not often present, even in the canopy layer. Douglas-fir, incense cedar, sugar pine, madrone, and bigleaf maple are the most common canopy species. Douglas-fir, incense cedar and sugar pine regenerate in most stands. Oregon white oak occurs on the driest sites, often at the edge of grassy openings or on rock balds.

Dwarf Oregon grape and oceanspray dominate the shrub layer, usually with California hazel, baldhip rose, snowberry, poison oak, vine maple, tall Oregon grape, and whipple vine. The herb layer is composed of swordfern, snow queen, pathfinder, three-leaved anemone, hairy hawkweed, and small amounts of other species.

Environmental Conditions

This association most often occurs on relatively steep, south or west-facing slopes between 2000 and 3000 feet elevation on the Rigdon Ranger District. Soils are generally thin and rocky or deep, heavy clay. Soil depth ranged from 21 to 40 inches in our soil pits (Table 3). Coarse fragments were abundant in our samples. The most common SRI mapping units were 3, 9, 33, and 61, which indicate shallow or skeletal soils. This association may occur on deep soils in areas of low precipitation or on steep south-facing slopes. The overall environment is hot and dry. The growing season is long with a substantial drought developing by mid-summer. Snowpacks are not generally deep or persistent.

Productivity and Management Implications

Severe growing conditions limit Douglas-fir average site index to 115 (Table 11). Sugar pine seems to grow substantially better, but our sample is small. Stand basal area averages 275 square feet per acre. Regeneration in clearcuts can be difficult due to heat, drought, and competition from grasses. Survival of Douglas-fir seedlings should be best in shade. Both sugar pine and ponderosa pine should grow as well or better than Douglas-fir and survive better in openings. Refer to Means and Helm (1985) for appropriate site index curves.

Slash fires that consume the duff may accelerate dry ravel of the skeletal soils common in this type and reduce already low levels of soil nitrogen. Large woody debris can act as a barrier to ravel and provide shade for seedlings.

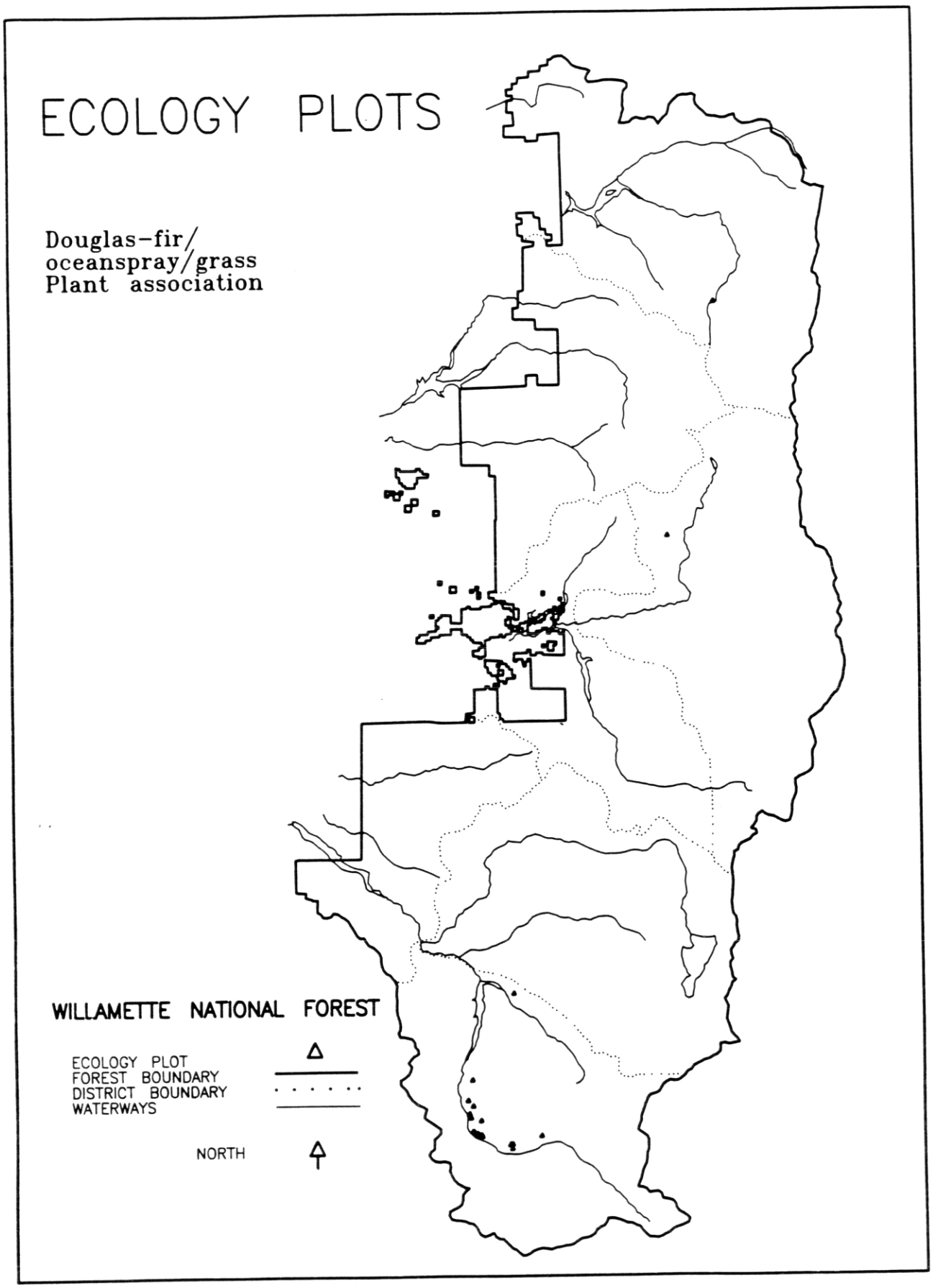
As is true for most of the Douglas-fir series, old-growth stands are structurally diverse with a mix of long-lived canopy species and an intermediate canopy of smaller, younger trees. Most of our stands were under 150 years old, reflecting a relatively high fire periodicity under natural conditions.

Because winter conditions are mild, this association is often important big game winter range. Wildlife trails were present in all our sample plots (Table 10). Deer pellets were present in a few plots, but we did not see elk pellets. Since many examples of this association occur on steep ground, most winter use may be for travel between resting areas and openings.

Comparisons

Similar associations, probably not as dry, have been described from the Douglas-fir-western hemlock transition on the Mt. Hood and Gifford Pinchot National Forests (Halverson et al. 1986, Topik et al. 1986). These lack substantial representation of poison oak, tall Oregon grape and other species which indicate severely dry sites. The Douglas-fir/baldhip rose-oceanspray type from the east side of the Olympic National Forest also lacks poison oak and is less productive (Henderson et al. 1986).

The Douglas-fir/oceanspray type from the H. J. Andrews Experimental Forest also lacks signigicant representations of these driest-site indicating species (Dyrness et al. 1974). Means' (1980) Douglas-fir/oceanspray/grass type is generally similar but has a lower dwarf Oregon grape component and occurs on more xeric sites. His Douglas-fir/oceanspray-vine maple, Douglas-fir/oceanspray/fairybells, and incense cedar/whipple vine types all seem to occur on slightly more moist, productive sites than the Douglas-fir/oceanspray-dwarf Oregon grape association described above.


ECOLOGY PLOTS
Douglas-fir/
oceanspray/grass
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Douglas-fir / oceanspray / grass
PSME / HODI / GRASS CDS2 12

While Douglas-fir dominates the canopy in most stands and is usually the major regenerating species, several other species commonly occur, including sugar pine, incense cedar, ponderosa pine, bigleaf maple and madrone. Incense cedar saplings are common in many stands, indicating that it is co-climax with Douglas-fir.

The shrub layer usually consists of small amounts of dwarf Oregon grape, Califiornia hazel, oceanspray, baldhip rose, snowberry, whipple vine, poison oak, and tall Oregon grape.

A diverse set of herbs occurs in the understory. Strawberry, western starflower, and swordfern are the most abundant herbs, but pathfinder, Festuca species, bluntleaf sandwort, snow queen, and smallflower nemophila occur in most stands.

Environmental Conditions

The Douglas-fir/oceanspray/grass association occurs on the warmest, driest sites occupied by closed canopy conifer forests on the Willamette National Forest. All but two of our nine reconnaissance plots are from the Rigdon Ranger District. All plots but one were from below 3000 feet elevation. This association most often occurs on moderate to steep slopes on south or west apects. Soils are thin and rocky or deep, heavy clay. Soil depth ranged from 24 to 47 inches in our soil pits (Table 3). Most of the soils were relatively low in coarse fragments and high in clay. SRI mapping unit 33 was most common in our reconnaissance plots (Table 2). Long, dry growing seasons and relatively mild winters are characteristic of this association.

Productivity and Management Implications

Regeneration is difficult, especially in clearcuts. Shade is essential for adequate Douglas-fir survival. Various grasses can become stiff competitors for limited moisture in openings. Sugar pine and ponderosa pine are more likely to survive than Douglas-fir, even in shaded spots. Once established, Douglas-fir grows moderately well. Douglas-fir site index averages 121 (Table 11). Sugar pine and pondersoa pine will grow better than Douglas-fir on may sites. Stand basal area averages 287 square feet per acre. Refer to Means and Helm (1985) for appropriate site index curves.

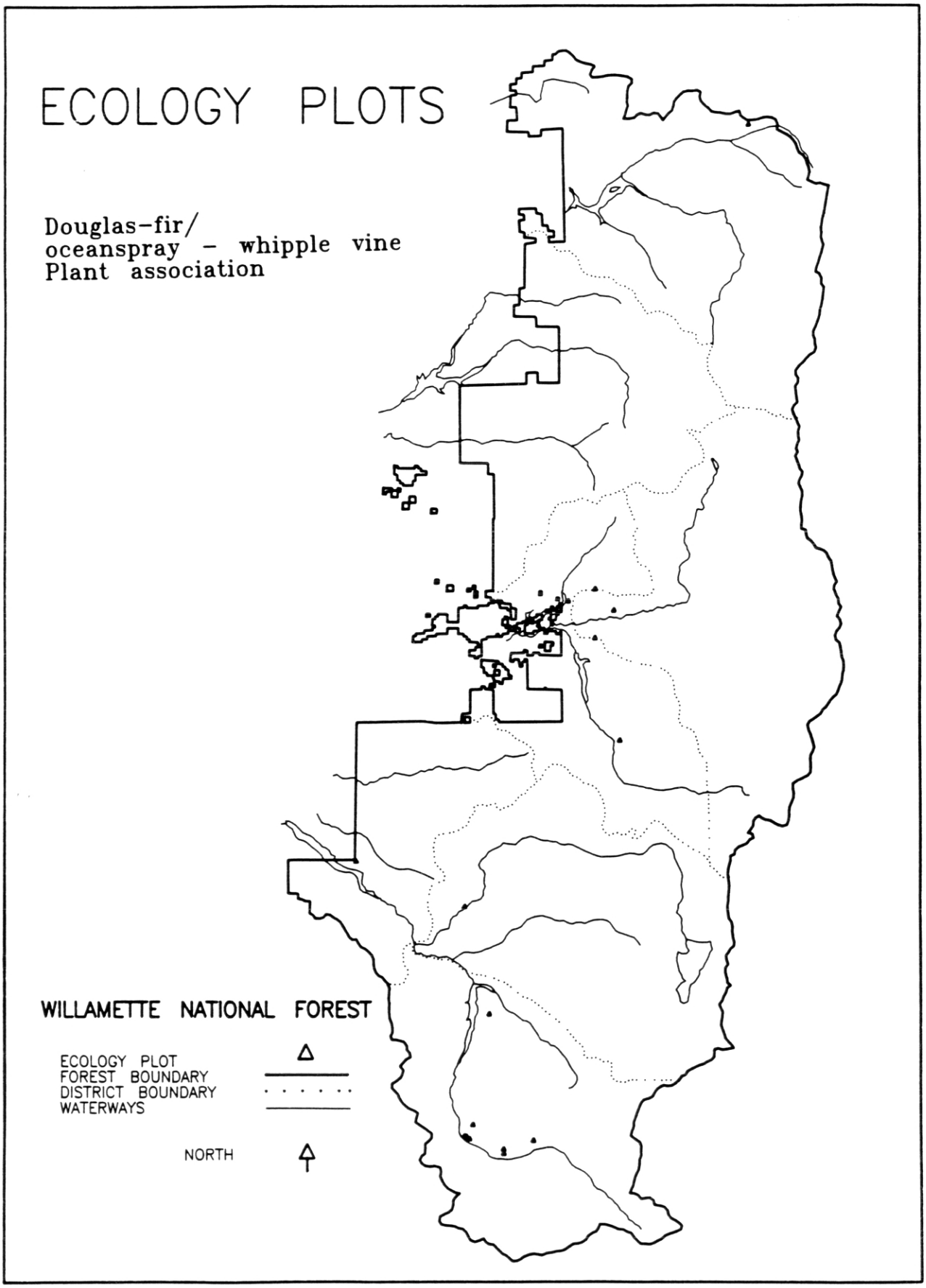
Slash fires that consume the duff may accelerate dry ravel of the skeletal soils common in this type and reduce already low levels of soil nitrogen.

Since winter conditions are relatively mild, big game winter use is often high. Wildlife trails were present in most of our sample plots (Table 10). The presence of elk pellets was higher in this association than in any other association in any series. Deer pellets were not as common. This association is very important as elk winter range.

As in the rest of the Douglas-fir series, old-growth stands usually have high structural diversity due to patchy stand conditions and a mix of age classes. Fire frequency under natural conditions was relatively high (Means 1980).

Comparisons

Means' (1980) Douglas-fir/oceanspray/grass type is very similar. His type is often associated with the margins of dry openings and contains species more characteristic of dry, non-forest associations. The Douglas-fir/oceanspray type from the H. J. Andrews Experimental Forest (Dyrness et al. 1974) is more shrubby and not as dry.


ECOLOGY PLOTS
Douglas-fir/
oceanspray - whipple vine
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Douglas-fir/oceanspray - whipple vine
PSME/HODI - WHMO CDS2 13

Douglas-fir and incense cedar dominate the canopy. Ponderosa pine, sugar pine, grand fir, and madrone occur in some stands. Western hemlock is uncommon. The regeneration layer consists mainly of Douglas-fir and incense cedar.

The shrub layer is generally similar to the Douglas-fir/oceanspray-dwarf Oregon grape association except that it lacks significant amounts of dwarf Oregon grape and salal. California hazel, vine maple, trailing blackberry, baldnip rose and snowberry occur on most sites. Dry-site indicating species, including whipple vine, tall Oregon grape, oceanspray and poison oak are common.

Swordfern, pathfinder, strawberry, hairy hawkweed, fairybells, western starflower, yerba buena and snow queen are the most common herbs.

Environmental Conditions

This association occurs on southerly-facing, steep slopes, generally below 3000 feet elevation. It is most common on the Rigdon Ranger District but occurs sporadically across the Forest. Total soil depth ranged from 21 to 60 inches in our soil pits (Table 3). Soils from our sample pits were rocky or deep clay. SRI mapping units 23 and 61 occurred in our reconnaissance plots (Table 2).

Growing seasons are long and dry. Thin, rocky soils or deep clay contribute to the development of high moisture stress by mid-summer. Winter snow is not persistent.

Productivity and Management Implications

Regeneration is difficult, especially in clearcuts. Substantial mortality may develop in unshaded Douglas-fir seedlings. Sugar pine and ponderosa pine may be better choices for planting in openings. Douglas-fir site index averages 106 (Table 11). Stand basal area averages 283 square feet. Once stands are established, conifer growth ia relatively good. Refer to Means and Helm (1985) for appropriate site index curves.

Slash fires that consume the duff may accelerate dry ravel of the skeletal soils common in this type and reduce the already low levels of soil nitrogen.

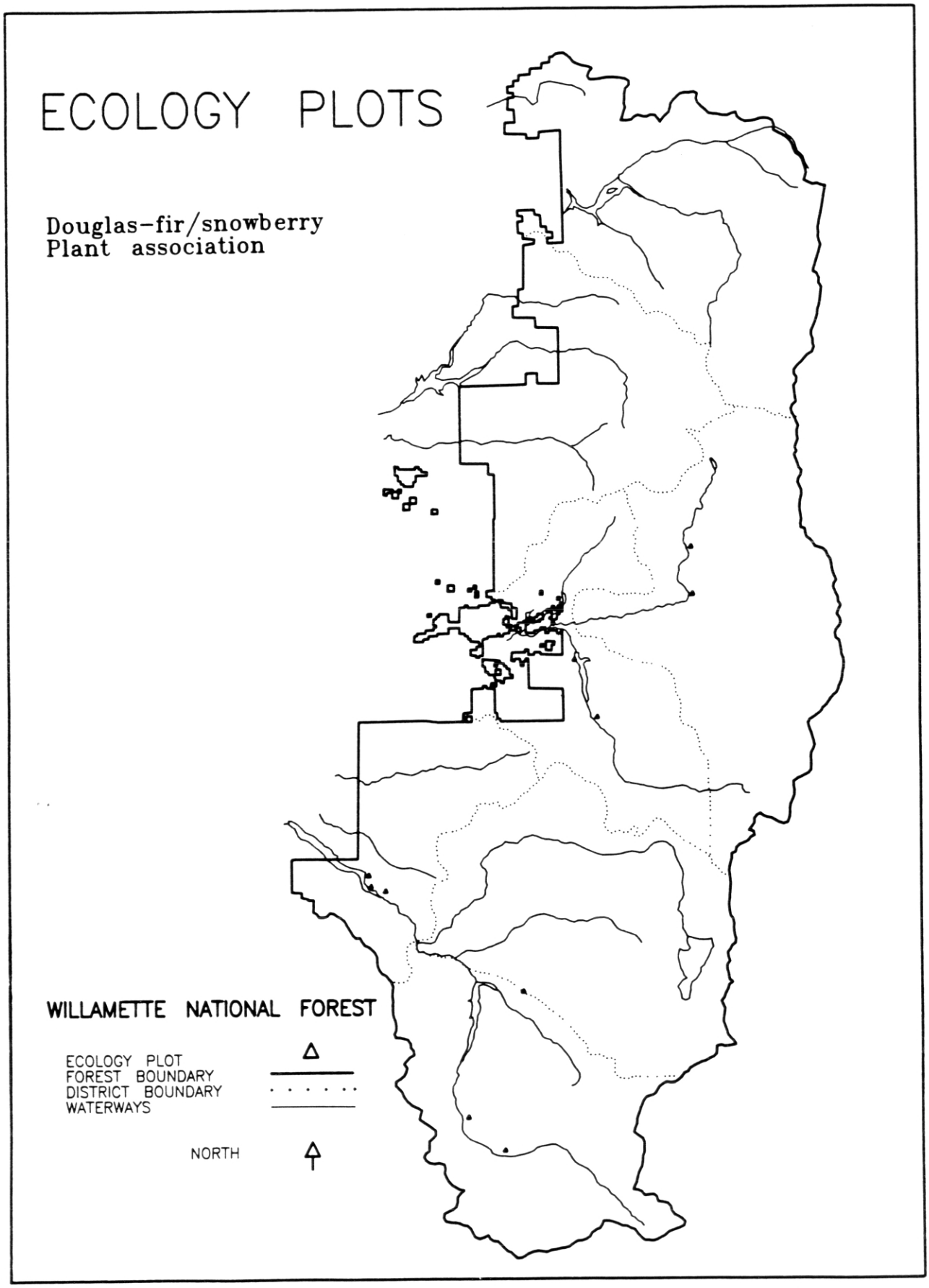
As in the rest of the Douglas-fir series, big game use for winter range is often high. Three-quarters of our plots contained wildlife

trails (Table 10). Deer and elk pellets were present in a third of the plots. Old-growth stands are characterized by high vertical structural diversity due to slow regeneration and openings resulting from periodic past fires. Most of our sample plots were in stands less than 150 years old, a result of the relatively high natural fire frequency.

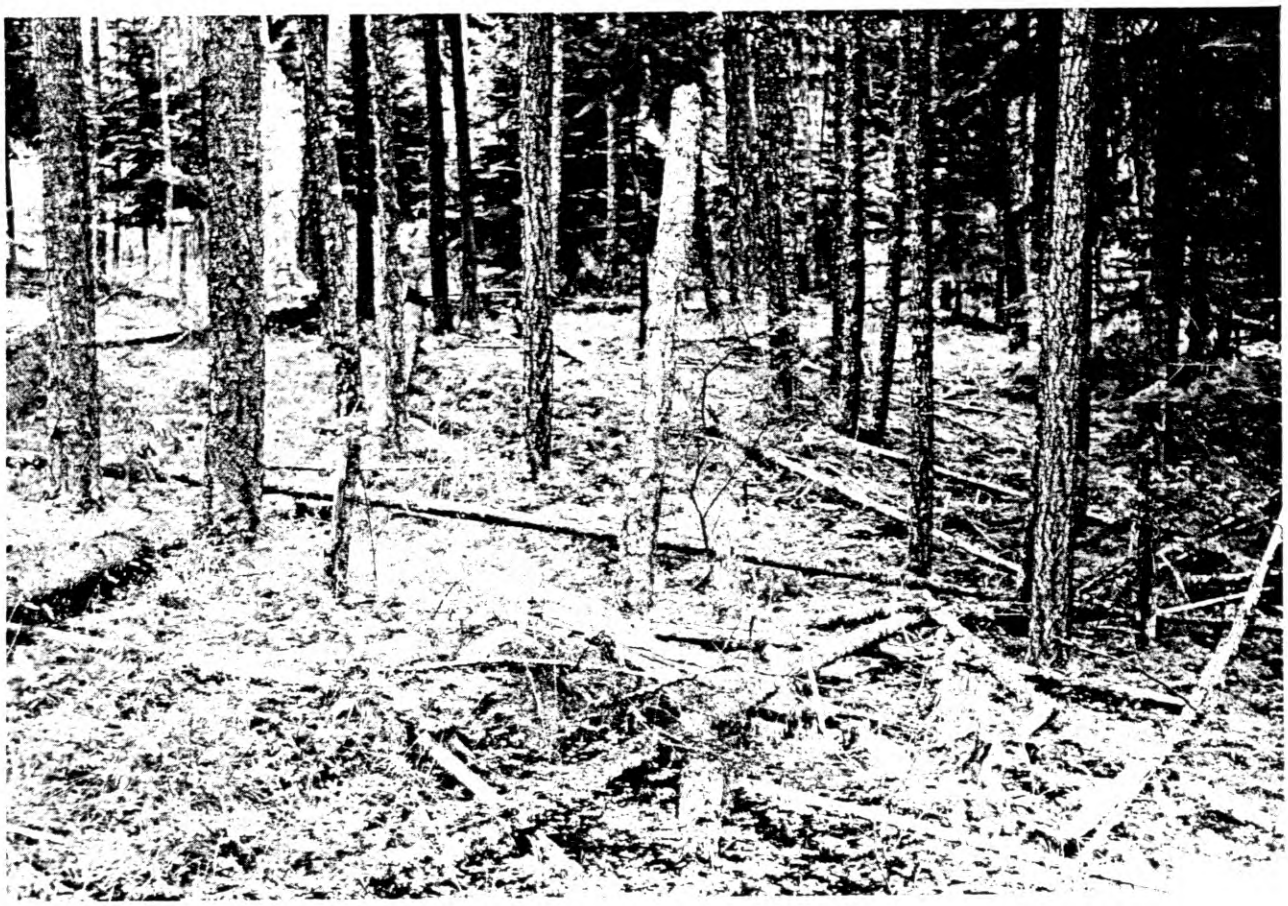
Comparisons

Means (1980) described a very similar incense cedar/whipple vine type, which he said was dominated by incense cedar in the climax condition. The Douglas-fir/oceanspray-whipple vine association also has a substantial incense cedar component which would be at least codominant with Douglas-fir at climax.

The Douglas-fir/oceanspray association (Dyrness et al. 1974) from the H. J. Andrews Experimental Forest contains more dwarf Oregon grape, and minor amounts of poison oak, tall Oregon grape and other indicators of the driest sites. The Douglas-fir/vine maple-whipple vine community (Dyrness et al. (1974)), also form the H. J. Andrews Experimental Forest, is a seral community in the western hemlock series and is not as dry.


ECOLOGY PLOTS
Douglas-fir/snowberry
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Douglas-fir / snowberry
PSME / SYMO — WILL CDS6 41



Douglas-fir, often mixed with incense cedar, dominates the canopy. Grand fir may be present. Traces of western hemlock may occur. Snowberry is the major shrub on most sites. The shrub layer may be diverse and often includes dwarf Oregon grape, oceanspray, California hazel, baldhip rose and whipple vine. Several herb species are common, including: strawberry, swordfern, western starflower, and grasses.

Environmental Conditions

Most sites are on gentle to moderately steep south or west facing slopes between 1000 and 2500 feet elevation. Soils are often skeletal or clay and are developed in colluvium. Soil depth in our two soil pits ranged from 16 to 35 inches (Table 3). Effective rooting depth ranged from 12 to 26 inches. Soils in these two plots matched SRI mapping units 23 and 33 (Table 2). A larger sample would undoubtedly reveal more variation in soil conditions. Most sites are free of snow much of the winter. Significant moisture stress develops by mid-summer.

Productivity and Management Implications

Douglas-fir site index averages 123 (Table 11). Most of our sample stands were relatively young, indicating recent fire. Stand basal area averaged 323 square feet per acre. Rapid regeneration following harvest will require attention to drought and heat stresses. Douglas-fir should survive well on most sites, though it may require shade on the steepest south-facing slopes. Once established, young Douglas-fir stands should grow well. Sugar pine should grow very well on most sites. Competition from grasses, cherry, and Ceanothus species may develop if regeneration is delayed. Refer to Means and Helm (1985) for appropriate site index curves.

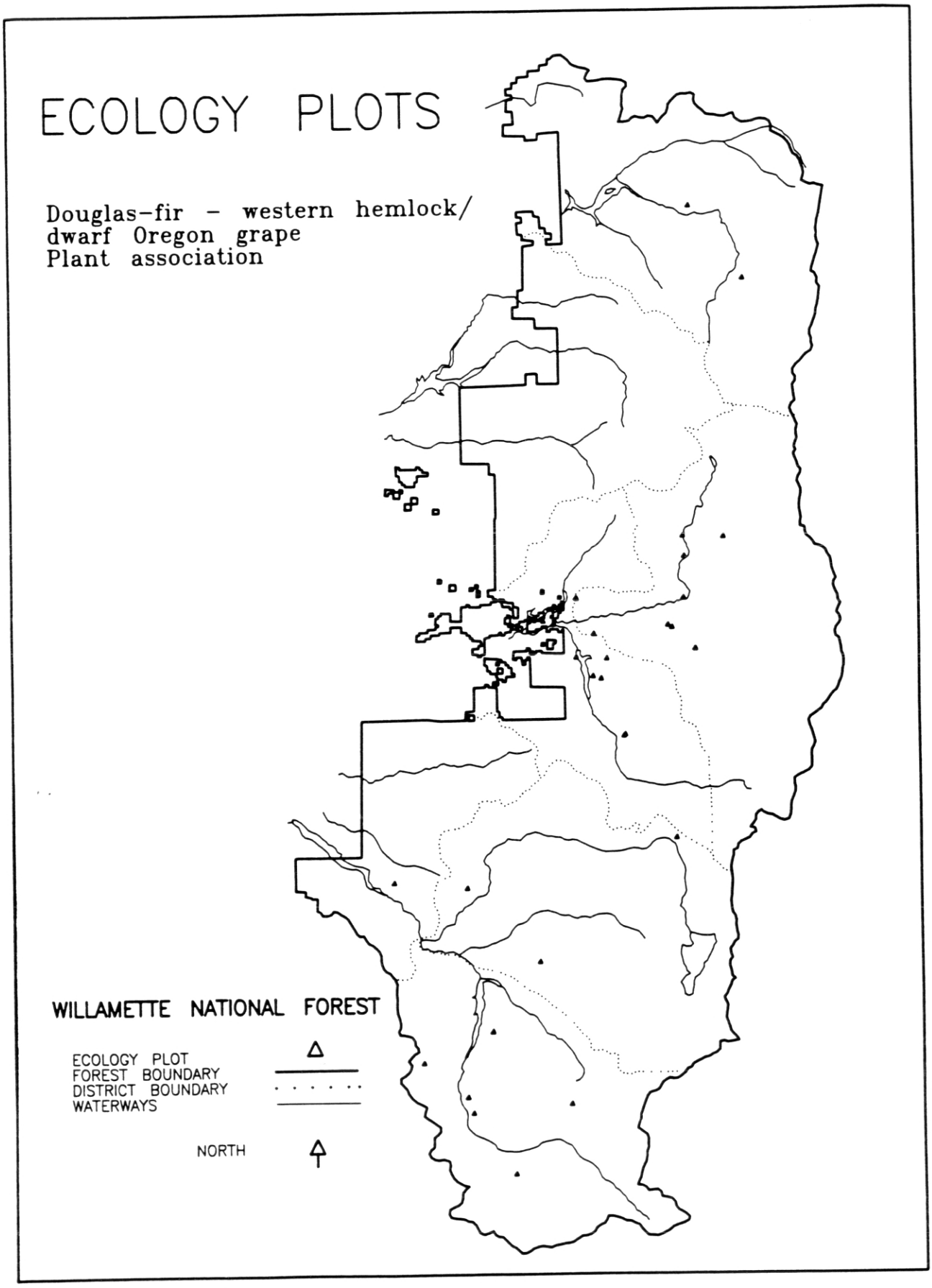
Slash fires that consume the duff may accelerate dry ravel of the skeletal soils common in this type and reduce already low levels of soil nitrogen.

As is the case in most of the Douglas-fir series, winter wildlife use is often high. Wildlife trails were present in all our sample plots. Both deer and elk pellets were also present in many plots (Table 10). These sites appear to provide good winter habitat for both deer and elk.

Comparisons

A Douglas-fir/snowberry type occurs on the east side of the Olympic National Forest (Henderson et

al. 1986). It is floristically similar to our association but substantially less productive. Douglas-fir/snowberry associations have frequently been described east of the Cascades (Johnson and Simon 1986, for example). Most of these communities are dominated by either common snowberry (Symphoricarpos albus) or mountain snowberry (S. oreophilus) instead of snowberry (S. mollis), which is the common species in our type. In addition, most of the communities east of the Cascades have a different herb compliment, especially the grasses.


ECOLOGY PLOTS
Douglas-fir - western hemlock/
dwarf Oregon grape
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Douglas-fir - western hemlock/dwarf Oregon grape
PSME - TSHE/BENE CDC7 11

The canopy usually consists of Douglas-fir and incense cedar with smaller amounts of western hemlock, sugar pine, madrone and bigleaf maple. Regeneration is mostly Douglas-fir and incense cedar with trace amounts of grand fir and western hemlock. Western hemlock would likely increase over time and codominate the canopy in most stands.

Dwarf Oregon grape dominates the shrub layer. Baldhip rose, snowberry, vine maple, Oregon boxwood, California hazel, and whipple vine are common. The herb layer usually consists of vanilla leaf, pathfinder, swordfern, three-leaved anemone, western starflower, twinflower and other species.

Environmental Conditions

The Douglas-fir - western hemlock/dwarf Oregon grape association usually occurs on southerly-facing, moderately steep slopes between 2000 and 3000 feet at the south end of the Forest. Soils vary from skeletal to relatively deep clay. Total soil depth ranged from 21 to 40 inches in our three soil pits in this assocaition (Table 3). SRI mapping units included 23, 35, and 66. The combination of environmental features produces warm, droughty sites.

This association is often transitional to the western hemlock series, especially western hemlock/dwarf Oregon grape. Declines in the importance of dry-site indicating species, such as whipple vine, snow queen, California hazel, oceanspray, and poison oak, and increases in swordfern indicate more mesic sites and often coincide with increased western hemlock regeneration. Deep snowpacks do not usually accumulate.

Productivity and Management Implications

As is true for all the Douglas-fir series, drought may hinder regeneration. While Douglas-fir seedlings survive substantially better in the shade, survival should be adequate in most clearcuts. Sugar pine and ponderosa pine may survive better than Douglas-fir. Once stands become established, growth rates can be as high as those in much of the western hemlock series (Table 11). Douglas-fir site index averages 141. Stand basal area averages 314 square feet per acre. Douglas-fir growth patterns do not conform to standard Douglas-fir site index tables. Refer to Means and Helm (1985) for appropriate curves.

Slash fires that consume the duff may accelerate dry ravel of the skeletal soils common in this

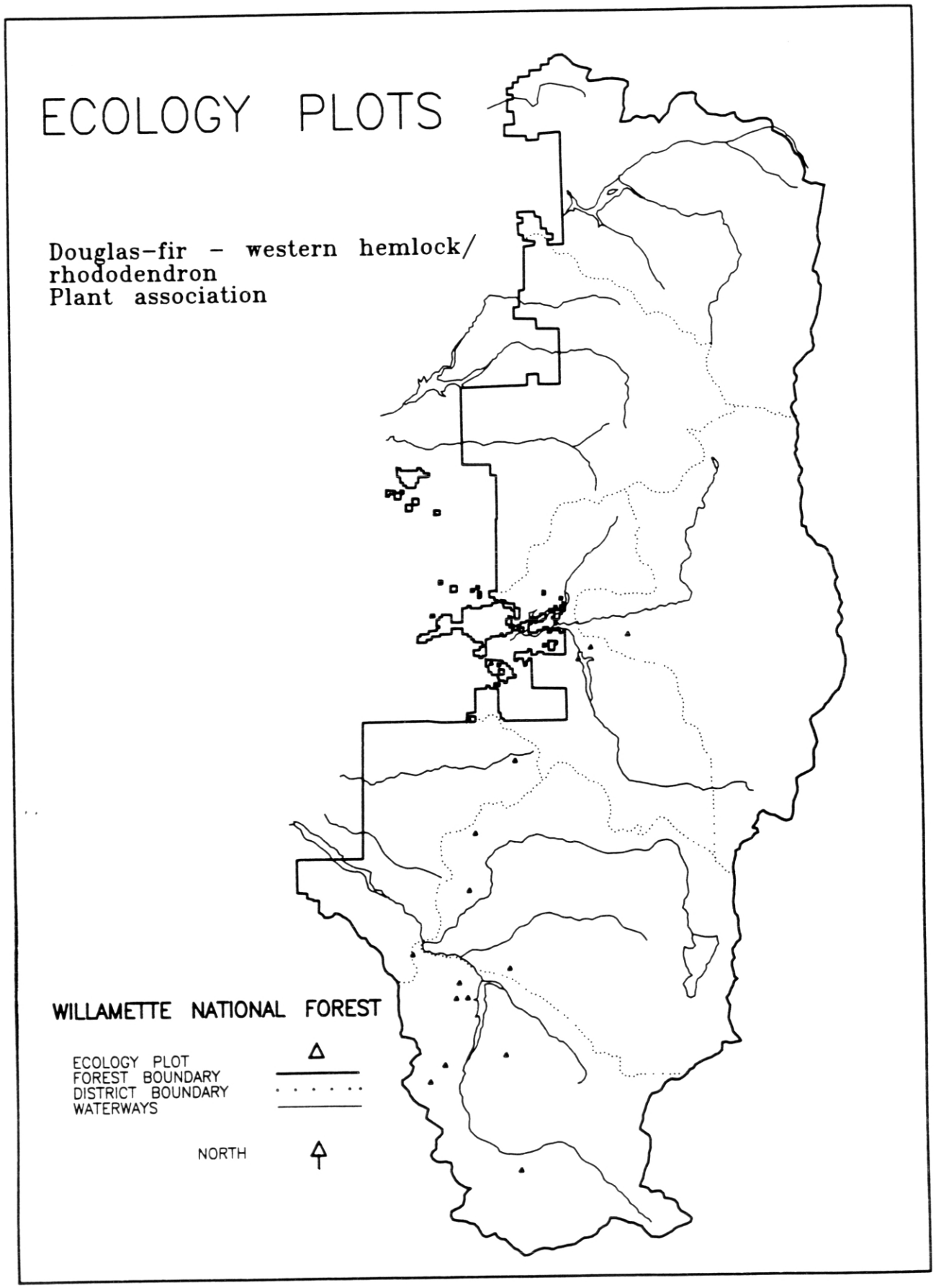
type and reduce already low levels of soil nitrogen.

Due to the relatively warm, snow-free conditions, this association is important for big game winter range. Wildlife trails were present in nearly all our plots. Elk pellets were not common, but deer pellets were present on 50 percent of the plots (Table 10). Thermal cover is relatively low.

Old-growth stands in this association, and in others of the Douglas-fir series, are usually patchy and relatively open with a mix of younger Douglas-fir and other conifers. This high structural diversity, important for wildlife habitat, is a result of relatively frequent surface fires and slow patch regeneration (Means 1980).

Comparisons

Means (1980) described a Douglas-fir/ oceanspray-vine maple association which has similar floristics but lacks significant amounts of western hemlock and is probably drier. His Douglas-fir/oceanspray/fairybells type is also similar but also lacks significant amounts of western hemlock. Similar associations are common in Southern Oregon. Atzet and Wheeler (1984) described a very similar Douglas-fir/dwarf Oregon grape association from the Siskiyou Mountains Dyrness et al. (1974) described a Douglas-fir - western hemlock/California hazel type on the H. J. Andrews Experimantal Forest which has slightly higher average covers of California hazel and salal, but otherwise is very similar. To the north, Topik et al. (1986) described a similar association on nutrient poor soils with lower productivity. The western hemlock/oceanspray association on the Mt. Hood National Forest has higher average covers of western hemlock and several shrubs, including tall Oregon grape, and oceanspray (Halverson et al. 1986).


ECOLOGY PLOTS
Douglas-fir - western hemlock/ rhododendron Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Douglas-fir - western hemlock / rhododendron
PSME - TSHE / RHMA CDC7 12

Douglas-fir and incense cedar dominate the canopy. Grand fir and sugar pine are often present. The regeneration layer usually consists of Douglas-fir, incense cedar and grand fir. Traces of western hemlock may be present in both the canopy and regeneration layers.

Rhododendron, salal and dwarf Oregon grape dominate the shrub layer. Small amounts of oceanspray and whipple vine may be present.

Herbs are often sparse. Twinflower may be present with 5 percent or more cover. Traces of other species, especially, rattlesnake plantain, sweetscented bedstraw, redwoods violet, bracken fern and snow queen, may be present.

Environmental Conditions

This relatively uncommon association occurs at the south end of the Forest on relatively dry sites in the Douglas-fir series. It is often found in depressions, swales or on east or west-facing slopes. It is occasionally transitional to the western hemlock/rhododendron-salal association, but most sites are too droughty for abundant western hemlock establishment. Most sites are below 3000 feet elevation and on gentle to moderately steep slopes. We don't have enough information on soils to provide accurate descriptions, but most sites appear to have moderately deep, stony soils. Some deep clay soils may occur (Table 2).

Productivity and Management Implications

The environment is not as severe as in the Douglas-fir/oceanspray associations. Douglas-fir should survive well when planted on most sites, but may require shade. Once established, Douglas-fir grows moderately well. Site index averages about 133 (Table 11). The few stands we measured were mature and old-growth, rare for the Douglas-fir series, but had relatively low basal area and stand volume. Early competition from shrubs and grasses may have limited the stocking of natural stands.

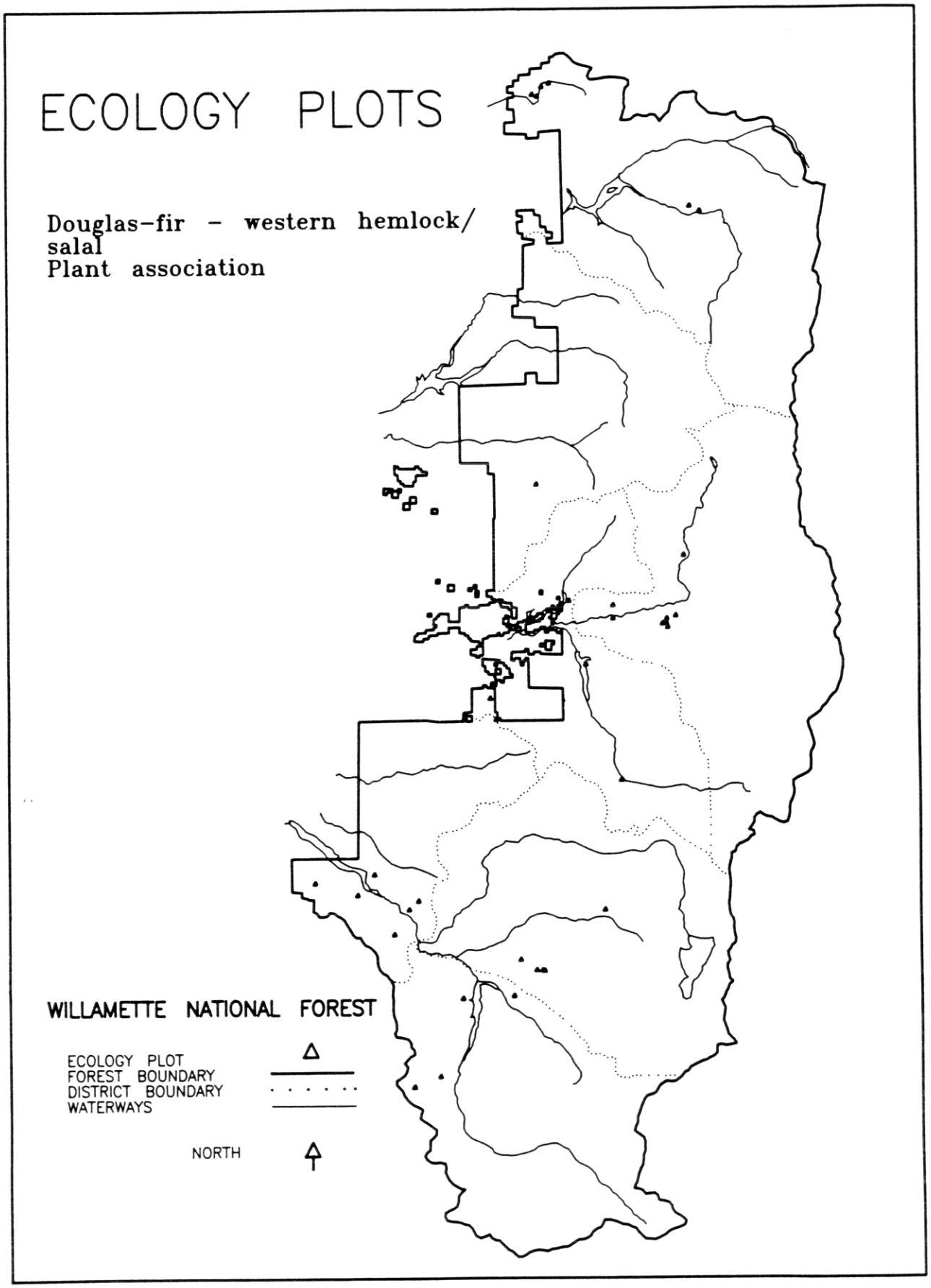
Competition could be a problem for small tree seedlings on many sites. Shrubs, including rhododendron and Ceanothus species, and grasses could develop substantial canopies by 3 to 5 years following stand opening. Competition for moisture may be severe. Since rhododendron dominated sites may be low in nitrogen, nitrogen fixing shrubs should be managed for both seedling establishment and nitrogen accumulation.

As is the case for most of the Douglas-fir series, slash fires should not consume the duff, if fire is used at all. In addition, large woody debris on the site may be significant moisture reservoirs upon which mycorrhizae and tree roots depend in the summer. Large woody debris may also provide shade for planted seedlings.

Wildlife trails were common in our plots (Table 10). Deer pellets were present in a few plots, but we did not find elk pellets. Herbaceous forage is not abundant. Relatively dense evergreen shrubs may provide both thermal and hiding cover, particularly for deer.

Comparisons

Rhododendron associations in the Douglas-fir series have not been described elsewhere. The western hemlock/rhododendron-salal and western hemlock/rhododendron/beargrass associations described in this guide are similar, but occur on more moist sites. The Douglas-fir/salal association on the Olympic National Forest has a much smaller rhododendron component (Henderson et al. 1986).


ECOLOGY PLOTS
Douglas-fir - western hemlock/ salal
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Douglas-fir - western hemlock / salal
PSME - TSHE / GASH CDC7 13

The canopy is usually a combination of Douglas-fir and incense cedar with smaller amounts of western hemlock, sugar pine, madrone and bigleaf maple. Douglas-fir and incense cedar are the major regenerating species. Regenerating grand fir and western hemlock may be present in some stands.

While salal dominates the shrub layer, vine maple, dwarf Oregon grape, California hazel, Oregon boxwood, snowberry, and baldhip rose are common. Dry-site indicating species, especially oceanspray and whipple vine, occur in most stands with relatively low cover. Swordfern, twinflower, redwoods violet, bracken fern, and western starflower are the most common herbs.

Environmental Conditions

This plant association occurs throughout the Forest on dry sites. Elevation generally ranges between 1000 and 3000 feet. Slopes vary from moderate to steep and are usually southerly-facing. Total soil depth ranged from 24 to 41 inches in our soil pits (Table 3). Effective rooting depth averaged 23 inches, a result of relatively high coarse fragment contents. SRI mapping units 16, 31, 35, 61, and 66 occurred in our plots with soil descriptions (Table 2).

On gentle terrain, this association indicates relatively low rainfall and unusual soil conditions such as heavy clay (e.g., SRI mapping unit 35). This combination of factors indicates slight winter snowpacks, rapid summer drying with high transpirational demands, and a relatively long growing season.

Productivity and Management Implications

Drought and heat could make regeneration with Douglas-fir difficult. Some mortality should be expected with unshaded Douglas-fir seedlings. Sugar pine or ponderosa pine should survive and grow well. Once stands are established, growth rates are relatively good. Douglas-fir site index (McArdle et al. 1961) averages 135 (Table 11). Stand basal area averages 312 square feet per acre. Refer to Means and Helm (1985) for appropriate site index curves.

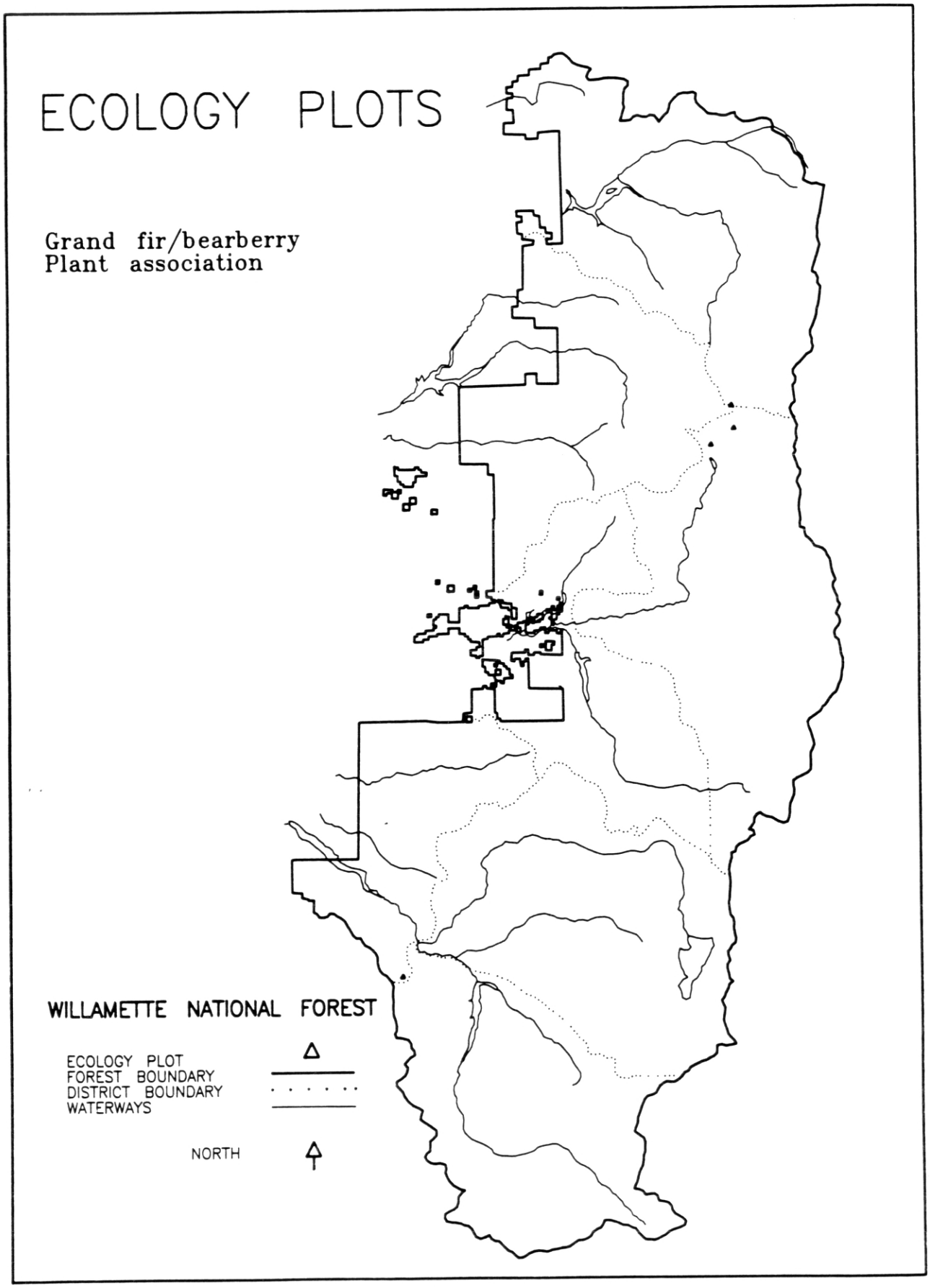
Slash fires that consume the duff may accelerate dry ravel of the skeletal soils common in this type and reduce already low levels of soil nitrogen.

This association receives the lowest amount of deer and elk use of all the Douglas-fir types (Table 10). Trails were present in about half our

plots, but deer and elk pellets were rare. Forage and thermal cover are not abundant. While use is relatively low for the Douglas-fir series, it is still higher than in most western hemlock types.

Comparisons

Henderson et al. (1986) described a similar plant association from the rainshadow of the Olympic Mountains. Their type is floristically similar but tree growth on the Olympic National Forest is much slower. Means' (1980) Douglas-fir /oceanspray-vine maple association has less salal and western hemlock and more poison oak and tall Oregon grape with similar average site index values. The Douglas-fir-western hemlock/California hazel type from the H. J. Andrews Experimental Forest is very similar with slightly more dwarf Oregon grape and California hazel (Dyrness et al. (1974).


ECOLOGY PLOTS
Grand fir/bearberry
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Grand fir/bearberry
ABGR/ARUV CWS5 21

The open canopy characteristic of this plant association grades into non-forest and consists of sparse Douglas-fir and grand fir. The understory consists of bearberry, vine maple and a few herbs.

Environmental Conditions

This association occurs in a few places on dry, rocky sites at 3000 to 4000 feet elevation. Soils are thin to moderately deep ash and residuum over lava or coarse rock. Soil depth ranged from 16 to 33 inches in our two soil descriptions. Both soils were stony, with effective rooting depths of 8 and 28 inches (Table 3). One soil was SRI mapping unit 16 and the other was SRI 33 (Table 2).

Productivity and Management Implications

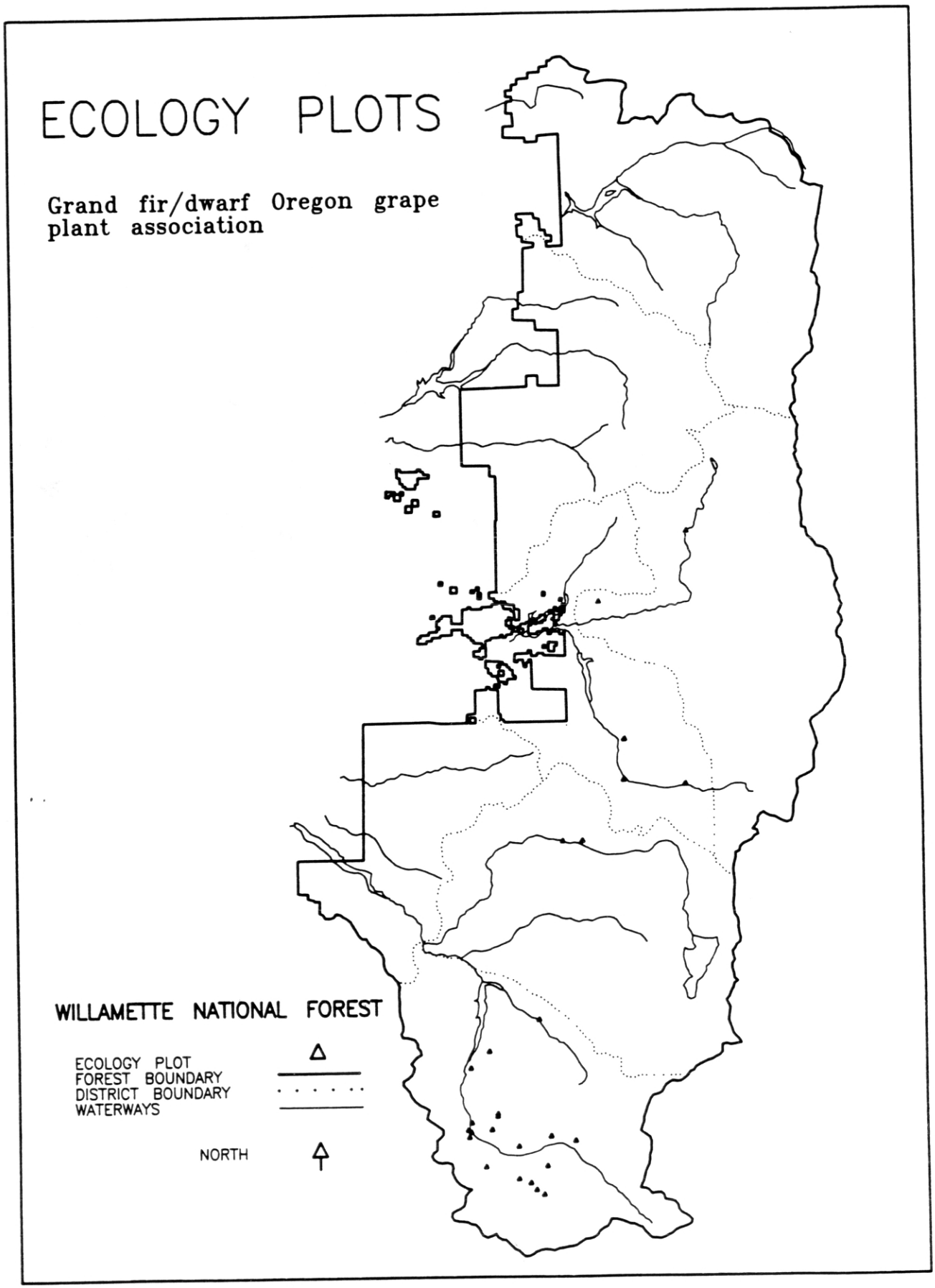
Tree growth is slow and regeneration difficult. Our sample stands were on soils classified as unsuitable due to regeneration problems.

Douglas-fir site index averages 86 (Table 11). Stand basal area averages 227. If sites in this type are managed for timber, extreme care should be taken with fire since soils are likely to be shallow and nutrient-poor. Advanced regeneration is likely to be the only reliable source of seedlings.

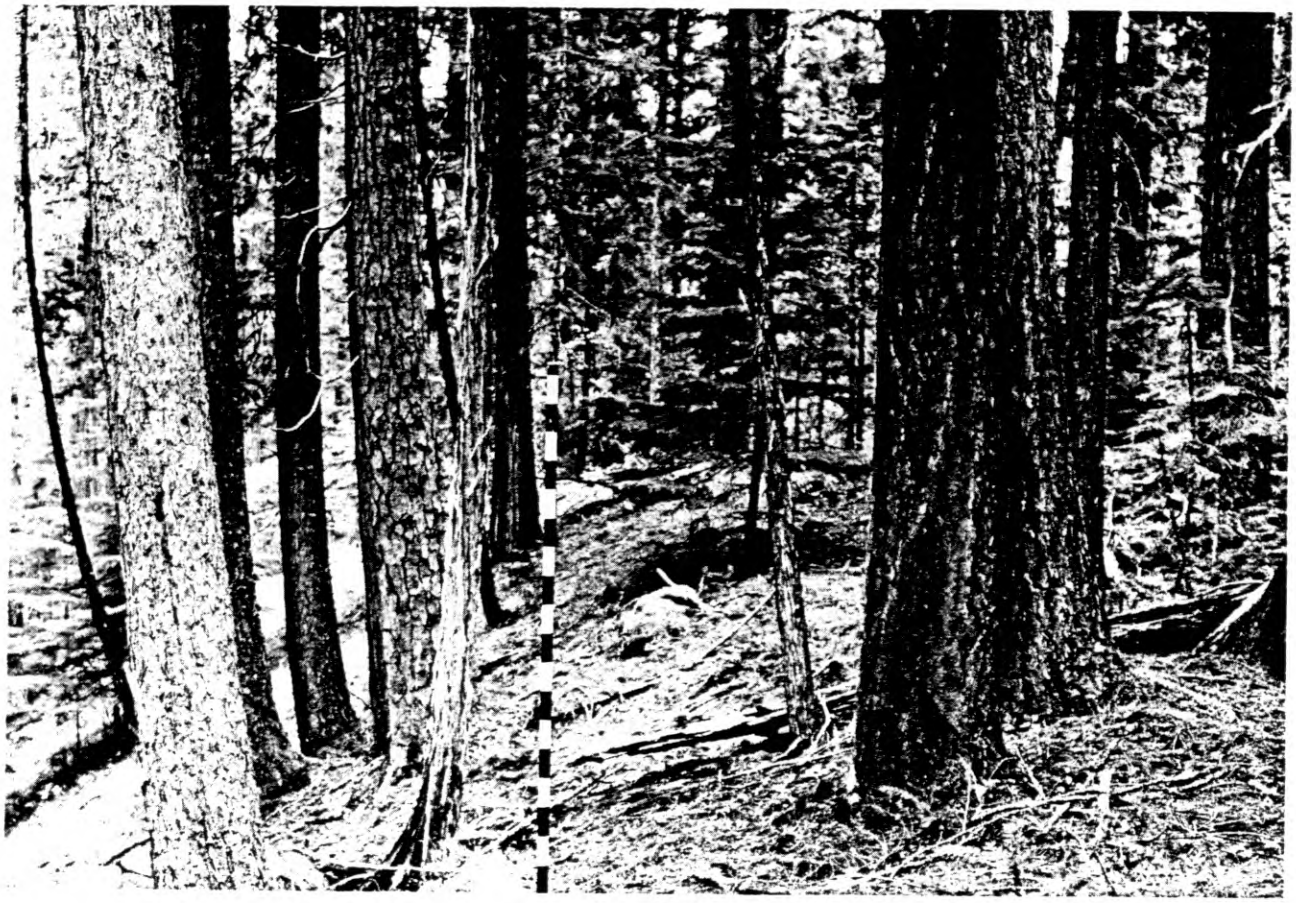
Wildlife use appears to be low. Little forage is available and sites are likely to be exposed to weather. We found little evidence of trails or deer or elk pellets (Table 10). A few examples of this type are tree islands in recent lava flows and may serve as the only vegetated habitat available in these areas.

Comparisons

A similar community, lodgepole pine/bearberry, exists on the Gifford Pinchot National Forest in some of the lava fields south of Mt. Adams (Topik et al. 1986). It occcurs at higher elevations where grand fir does not survive well.


ECOLOGY PLOTS
Grand fir/dwarf Oregon grape plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Grand fir/dwarf Oregon grape
ABGR/BENE CWS5 22



This is the most common grand fir association. Douglas-fir, incense cedar, and grand fir dominate the canopy. Grand fir regeneration is common in most stands, along with Douglas-fir and incense cedar. Grand fir regeneration is greater than that of any other species. Western hemlock occurs in the canopy and regeneration layer in many stands, indicating a transition to the western hemlock series. Ponderosa pine is occasionally present at the south end of the Forest.

Dwarf Oregon grape and dry-site indicating species dominate the shrub layer. Dwarf Oregon grape, vine maple, California hazel, baldhip rose, snowberry, oceanspray, and whipple vine are the most common and abundant shrubs.

The herb layer is a mix of mesic and dry-site indicating species, including: three-leaved anemone, twinflower, swordfern, western star flower, vanilla leaf, and grasses.

A variation of this type occurs above 3000 feet elevation on south-facing slopes on the Rigdon Ranger District. Dry site indicating species dominate both the shrub and herb layers. Oceanspray is particularly abundant. We have too few samples of this variant to adequately describe it as a separate plant association.

Environmental Conditions

The grand fir/dwarf Oregon grape association is most common at the south end of the Forest, especially on the Rigdon Ranger District. It occurs on steep, rocky soils, excessively drained glacial outwash, and deep clay soils. Total soil depth averaged 36 inches and effective rooting depth averaged 28 inches in our 5 soil descriptions (Table 3). SRI mapping unit varied substantially, but generally indicated relatively deep soils (Table 2). Even on deep soils, this association indicates relatively dry environments. Most stands are between 2000 and 4000 feet elevation on southerly-facing slopes. Many intergrade with the western hemlock/dwarf Oregon grape association as slope aspect moves away from south or with the Douglas-fir - western hemlock/dwarf Oregon grape association as sites become more well-drained and droughty.

Productivity and Management Implications

Douglas-fir, grand fir and sugar pine grow moderately well in this association. Douglas-fir site index averages 134 (Table 11). Douglas-fir site index drops substantially at elevations over 4000 feet. Natural stand basal areas are relatively high, averaging 348 square feet.

Seedling survival conditions are more severe than in the western hemlock/dwarf Oregon grape association but not as severe as in the Douglas-fir - western hemlock/dwarf Oregon grape association. Douglas-fir seedling survival may be reduced by heat and drought. Shade may be necessary for good seedling survival on some sites. Competition from Ceanothus species often develops after stand opening. Ceanothus species could be managed for recharge of soil nitrogen and establishment of conifers.

Detrimental nutrient loss may occur on steep, rocky sites or glacial outwash following slash fires.

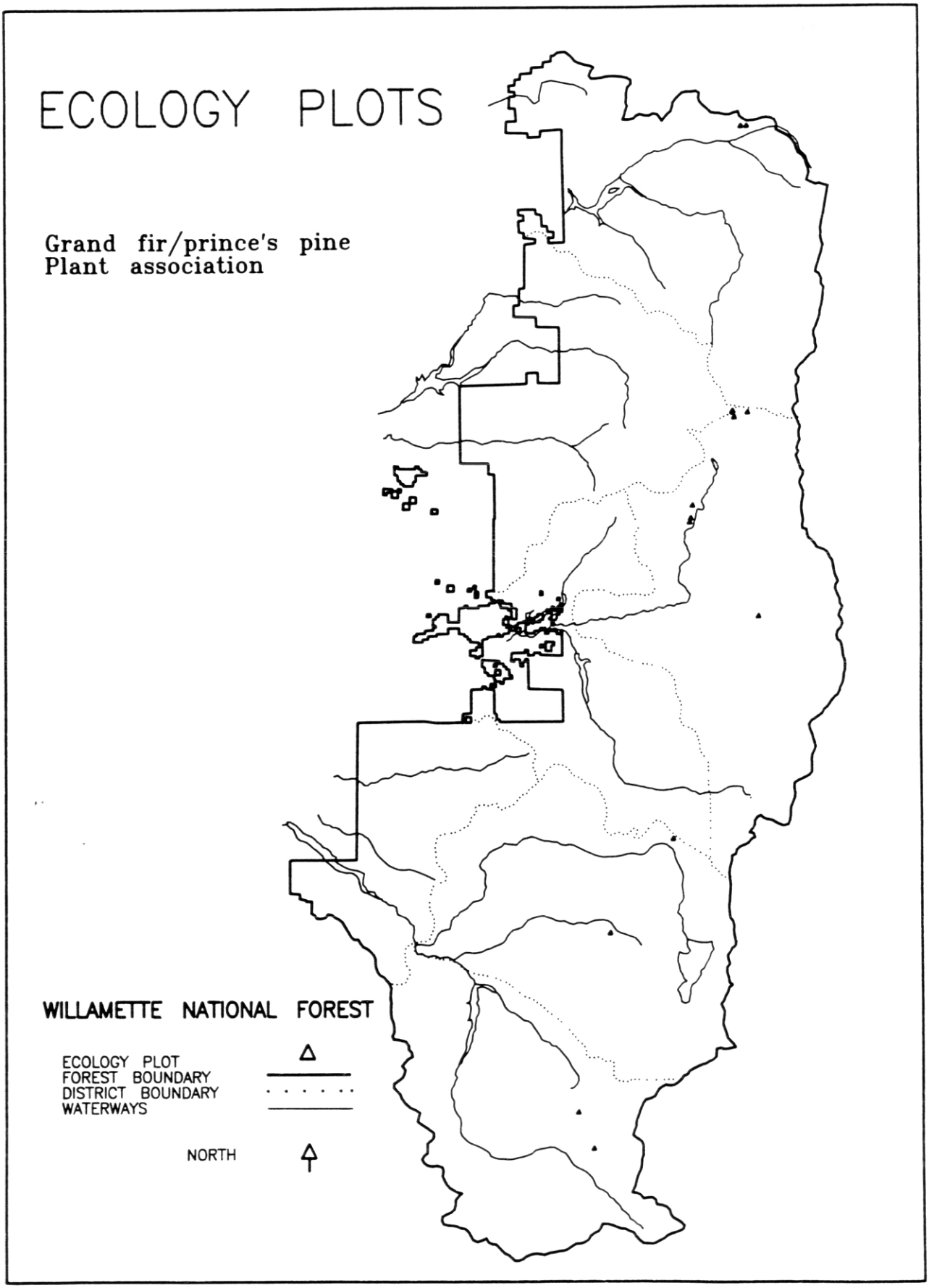
Since this association tends to occur at lower elevations on warm, southerly facing slopes, it often provides important winter range. Wildlife trails were present on most of our reconnaissance plots (Table 10). Deer and, to a smaller extent, elk pellet groups were present on many plots.

Forage and thermal cover are more abundant than in most of the other dry-site assocations.

Grand fir associations often occur on river terraces with gravelly soils and may be important in riparian systems. Wildlife and watershed values will be high in these areas.

Comparisons

Atzet and Wheeler (1984) described a similar association in the Siskiyou Mountains which has very similar floristics. Productivity is not yet know for their association. Our type tends to occur at lower elevations, as would be expected from the difference in latitude. A similar association on the Gifford Pinchot National Forest has less dwarf Oregon Grape and is more moist (Topik et al. 1986). This type has not been described on the Mt. Hood National Forest, but may occur there.


ECOLOGY PLOTS
Grand fir/prince's pine
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Grand fir/prince's pine
ABGR/CHUM CWF2 11

The canopy generally consists of Douglas-fir, grand fir and western hemlock with small amounts of incense cedar, Pacific silver fir or noble fir. Grand fir is the major regenerating species, usually accompanied by western hemlock.

The shrub and herb layers are sparse, usually dominated by prince's pine, dwarf Oregon grape, vine maple, and twinflower.

Environmental Conditions

The grand fir/prince's pine association occurs at upper elevations on gentle, northerly-facing slopes, usually with ash soils. Soil depth in our 6 soil pits ranged from 38 to 60 inches and effective depth from 26 to 58 inches (Table 3). SRI mapping units indicate relatively deep soils as well (Table 2). Our few sample plots come from the McKenzie Ranger District but the type also exists at the east ends of Oakridge and Rigdon Ranger Districts. In many places it merges into the Pacific silver fir and mountain hemlock zones.

Productivity and Management Implications

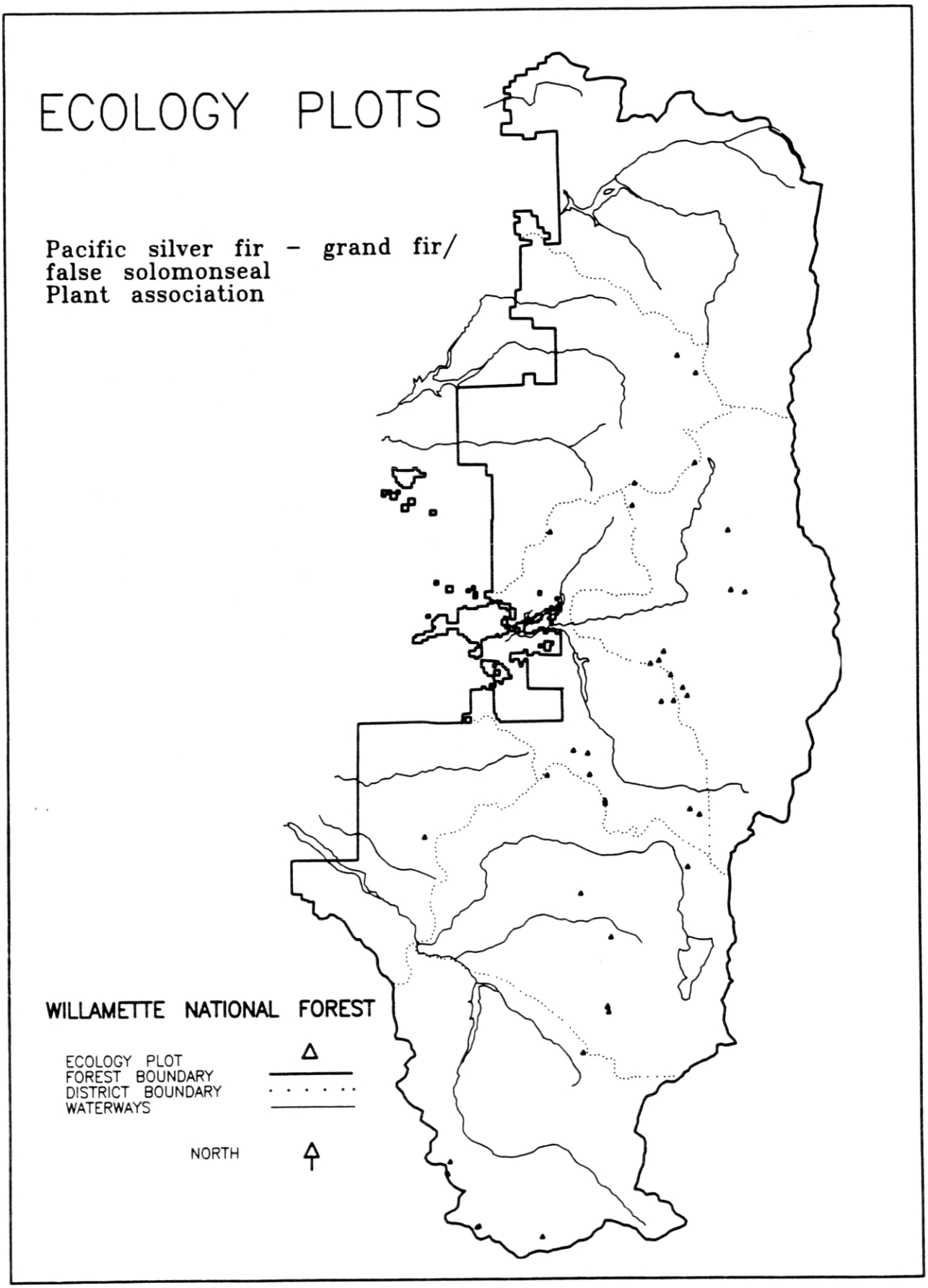
Douglas-fir, grand fir and noble fir all grow moderately well. Douglas-fir site index averages 132 (Table 11). Stand basal area is generally high, averaging 416 square feet per acre. Regeneration can be complicated by frost, drought, and Ceanothus spp. competition, but is generally not difficult.

Soils should be resistant to adverse impacts from moderate slash fires. Care should be taken to minimize loss of the duff and top soil which contain a substantial share of the available nitrogen on most sites.

Wildlife use appears to be moderate. A limited amount of forage is available in most stands (Table 10). Deer and elk pellets were often present. Wildlife trails were not as common as in the grand fir/dwarf Oregon grape and Douglas-fir types. Big game may find relief from summer heat under the dense canopy.

Comparisons

The white fir-Sadler's oak/prince's pine association on the Siskiyou National Forest (Atzet and Wheeler 1984) is somewhat similar with Shasta red fir, prince's pine and Sadler's oak as dominants. Otherwise, similar associations have not been described on the westside of the Cascades.


ECOLOGY PLOTS
Pacific silver fir - grand fir/
false solomonseal
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir - grand fir/false solomonseal
ABAM - ABGR/SMST CFC3 11

South of the McKenzie River, grand fir (white fir) becomes increasingly common at upper elevations, mixed with Pacific silver fir and noble fir. Grand fir may occur in most of the mesic upper-elevation types at the south end of the Forest. In some cases, grand fir codominates the canopy and regeneration layers. The Pacific silver fir-grand fir/false solomonseal association, in particular, usually includes a strong grand fir component.

Douglas-fir, western hemlock, noble fir, grand fir, and Pacific silver fir are the major canopy species. The regeneration layer is usually a mixture of grand fir, Pacific silver fir, and western hemlock. The shrub layer commonly consists of big huckleberry, prince's pine, baldhip rose, snowberry, and vine maple. Vanilla leaf, queencup beadlily, false solomonseal, and coolwort foamflower are the most common herbs.

Environmental Conditions

This relatively uncommon association occurs on moderately steep, southerly-facing slopes above 4000 feet elevation on the southern half of the Forest. It often merges into the Pacific silver fir series and indicates substantial winter snow accumulation, occasional growing season frost, and relatively moist soils.

Soils vary from shallow to deep, averaging 50 inches, and often contain abundant coarse fragments (Table 3). Effective rooting depth averaged 28 inches in our sample plots. SRI mapping units 61, 66, 74, 44 and 55 were the most common (Table 2).

Productivity and Management Implications

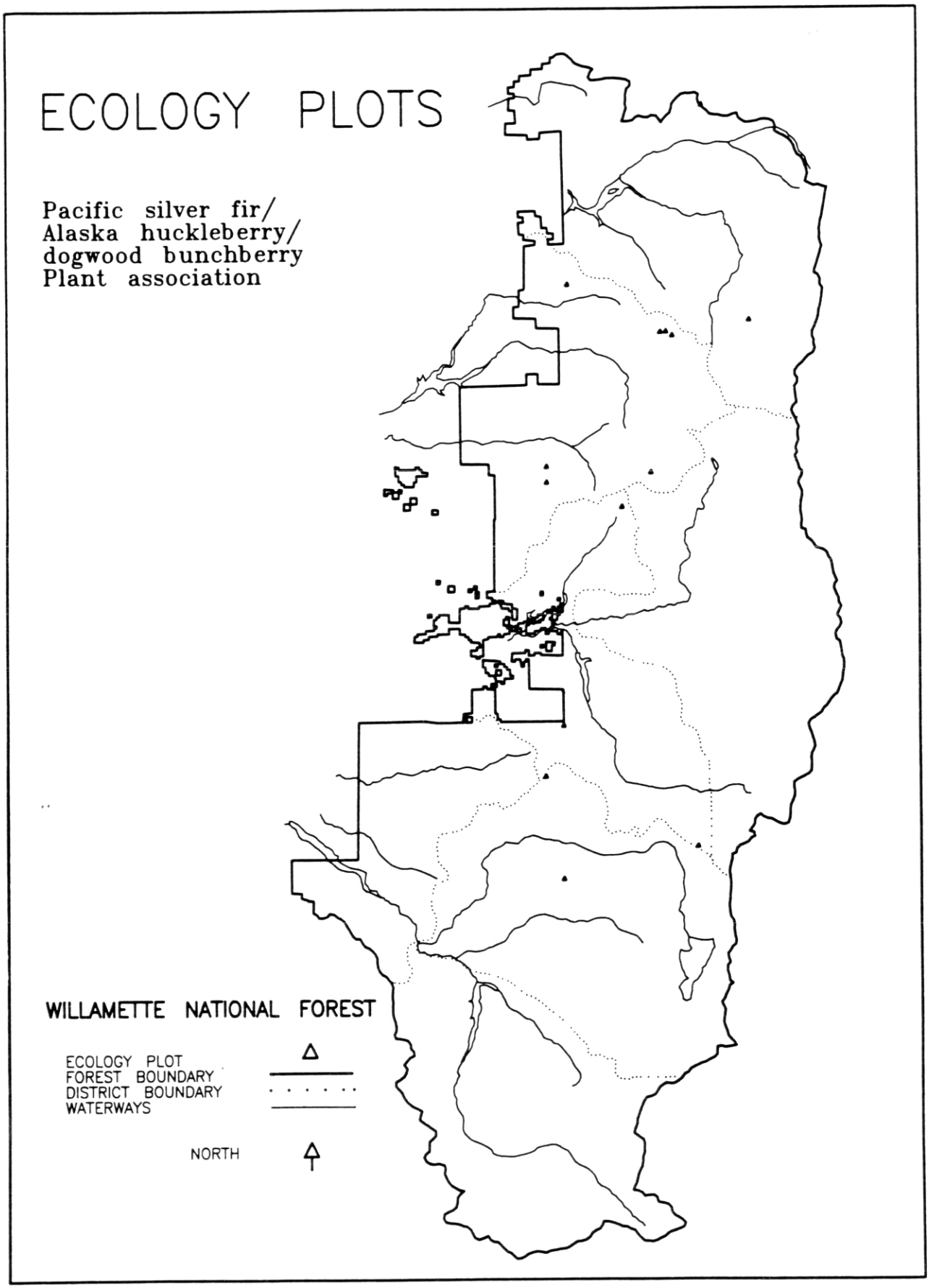
Conifer growth can be good, compared to other upper-elevation associations. Noble fir grows especially well and tolerates occasional growing season frost better than Douglas-fir. Douglas-fir site index averages 133 (Table 11). Stand basal area averages 365 square feet per acre. Sites are not usually droughty, but regeneration can be difficult due to rocky soils, summer frost, and high evaporative demand.

Soils should be resistant to adverse effects of moderate slash fires. Care should be taken to minimize loss of duff and topsoil, which contain a substantial share of the available nitrogen on most sites.

Big game often use this type extensively during the summer. Forage is abundant in most stands (Table 10). Wildlife trail presence was higher in this association than in all the other Pacific silver fir associations and was nearly equal to that of the grand fir/dwarf Oregon grape and Douglas-fir types.

Comparisons

The white fir/herb association in the Siskiyou Mountains (Atzet and Wheeler 1984) is somewhat similar but lacks false solomonseal, coolwort foamflower, and vine maple. Communities similar to the Pacific silver fir-grand fir/false solomonseal should occur in the Southern Oregon Cascades. Dyrness et al. (1974) described a seral community, noble fir/vanilla leaf, from the H. J. Andrews Experimental Forest which is similar but lacks significant amounts of grand fir.


ECOLOGY PLOTS
Pacific silver fir/
Alaska huckleberry/
dogwood bunchberry
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir/Alaska huckleberry/dogwood bunchberry
ABAM/VAAL/COCA CFS2 53

Most of our samples in this association are from old-growth stands in drainage bottoms or on benches near streams. Douglas-fir, western hemlock and Pacific silver fir dominate the canopy. Noble fir and western redcedar are prominent on some sites. Pacific silver fir, western hemlock and, occasionally, western redcedar dominate the regeneration layer.

Alaska huckleberry, oval-leaf huckleberry, big huckleberry, vine maple, and rhododendron contribute to the dense shrub layer. Red huckleberry, dwarf Oregon grape and trailing blackberry may also be present. Rhododendron cover is less than 30 percent.

Dogwood bunchberry, twinflower, vanilla leaf, beargrass and queencup beadlily are the most common and abundant herbs. The herb layer is well developed, averaging 37 percent cover, and may contain several additional species, especially Pacific trillium, three-leaved anemone, false solomonseal, coolwort foamflower, and sidebells pyrola. In general, this association is more herb rich and productive than the Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry association.

Environmental Conditions

The pacific silver fir/Alaska huckleberry/dogwood bunchberry association indicates mesic, relatively productive conditions. It occurs from 2700 to 4500 feet elevation, on a wide range of lower and mid-slope landforms, often near streams. Slopes are typically gentle with north or east aspects. The presence of moist-site indicating herbs combined with topographic location imply a cool, moist, well-drained environment.

Soils are usually deep, from 18 to 75 inches (Table 3), and occasionally stony. Soil depth averaged 49 inches and effective rooting depth averaged 40 inches. Soil texture is usually silt loam, clay loam, or loam, becoming more clayey near the bottom of the profile. Soils are frequently developed in colluvium, residuum or tephra.

Productivity and Management Implications

The Pacific silver fir/Alaska huckleberry/dogwood bunchberry association is moderately productive. Douglas-fir and noble fir site indices average 102 and 110 respectively

(Table 12). As in most of the Pacific silver fir zone, noble fir will probably produce more volume than Douglas-fir in managed stands. Volume growth appears to culminate at about 125 cubic feet/acre/year. Stand density index productivity estimates average 118 cubic feet/acre/year. Growth basal area productivity estimates rank near the middle for the Pacific silver fir zone.

Regeneration may be complicated by frost but should not generally be difficult. In frost-prone areas, western white pine or Engelmann spruce should be planted. On dry, warm slopes Douglas-fir should do well. Noble fir is appropriate for most sites.

Soils often have deep duff accumulations which can help protect them from nutrient loss following slash fire. Fires should not consume all the duff.

This association often occurs in riparian areas or in protected draws. Watershed and wildlife values are often high. Big game trails were noted in two-thirds of our sample stands and deer pellets were observed in a third of them (Table 10). Herbaceous forage was moderately high for the Pacific silver fir zone, averaging 305 pounds per acre (green weight).

Natural fires are infrequent and stands are usually old. Old-growth stands in riparian areas may be particularly important for wildlife habitat and diversity.

Comparisons

This association is almost identical to the Pacific silver fir/Alaska huckleberry/dogwood bunchberry association in the H. J. Andrews Experimental Forest (Dyrness et al. 1974). This association is essentially the same as the Pacific silver fir/Alaska huckleberry/dogwood bunchberry association on the Mt. Hood National Forest (Hemstrom et al. 1982). Similar associations have been described north of the Columbia River; the Pacific silver fir/Alaska huckleberry association on the Gifford Pinchot National Forest (Franklin et al. 1979, Brockway et al. 1983) and the Pacific silver fir/ Alaska huckleberry association on the Mt. Baker-Snoqualmie National Forest (Henderson and Peter 1981). This is the most widespread Pacific silver fir zone association in the central and northern Washington Cascades but becomes increasingly rare farther south. It is uncommon at the south end of the Willamette National Forest.

Pacific silver fir/Alaska huckleberry - salal
ABAM/VAAL - GASH CFS2 55

Our few samples from this type are from adjacent areas on the Mt. Hood National Forest. Douglas-fir, western hemlock, Pacific silver fir, and western redcedar are the primary canopy species. Although western hemlock and Pacific silver fir both occur in the regeneration layer, Pacific silver fir usually dominates. Western redcedar also commonly regenerates and would probably be well represented in climax stands.

A mixture of salal and Alaska huckleberry characterizes the shrub layer. Rhododendron, red huckleberry, dwarf Oregon grape, vine maple, chinquapin, prince's pine, wintergreen and dwarf bramble are common. Total shrub cover averages 62 percent.

The herbaceous layer is usually sparse. Dogwood bunchberry is the most important species and may be accompanied by twinflower, rattlesnake plantain, Pacific trillium, false solomonseal, and beargrass.

Environmental Conditions

While we did not sample examples of this association on the Willamette National Forest, it may occur on coarse mudflow or glacial deposits at the north end of the Forest. It occurs on warmer, drier sites than the Pacific silver fir/Alaska huckleberry/dogwood bunchberry association. It is found in the lower portion of the Pacific silver fir zone, between 2900 feet and 3300 feet. Based on our small sample, slopes are gentle and face southwest or northwest. In general, this association indicates cool, dry sites with long growing seasons and poor soil nutrient status.

Soils are deep, stony, loamy sands or clay loams in the upper horizons and clays farther down. Soil depths in sample pits ranged from 37 to 99 inches deep and averaged 59 inches, the deepest of any Pacific silver fir zone plant association (Table 3). However, the low average effective rooting depth (30 inches) indicates that these deep soils are quite rocky.

Productivity and Management Implications

Our few samples in this association may not adequately describe its productivity. Douglas-fir site index averaged 72, lower than all but one other association in the Pacific silver fir zone (Table 12). The two

stands sampled were well stocked and had average volume for the Pacific silver fir zone.

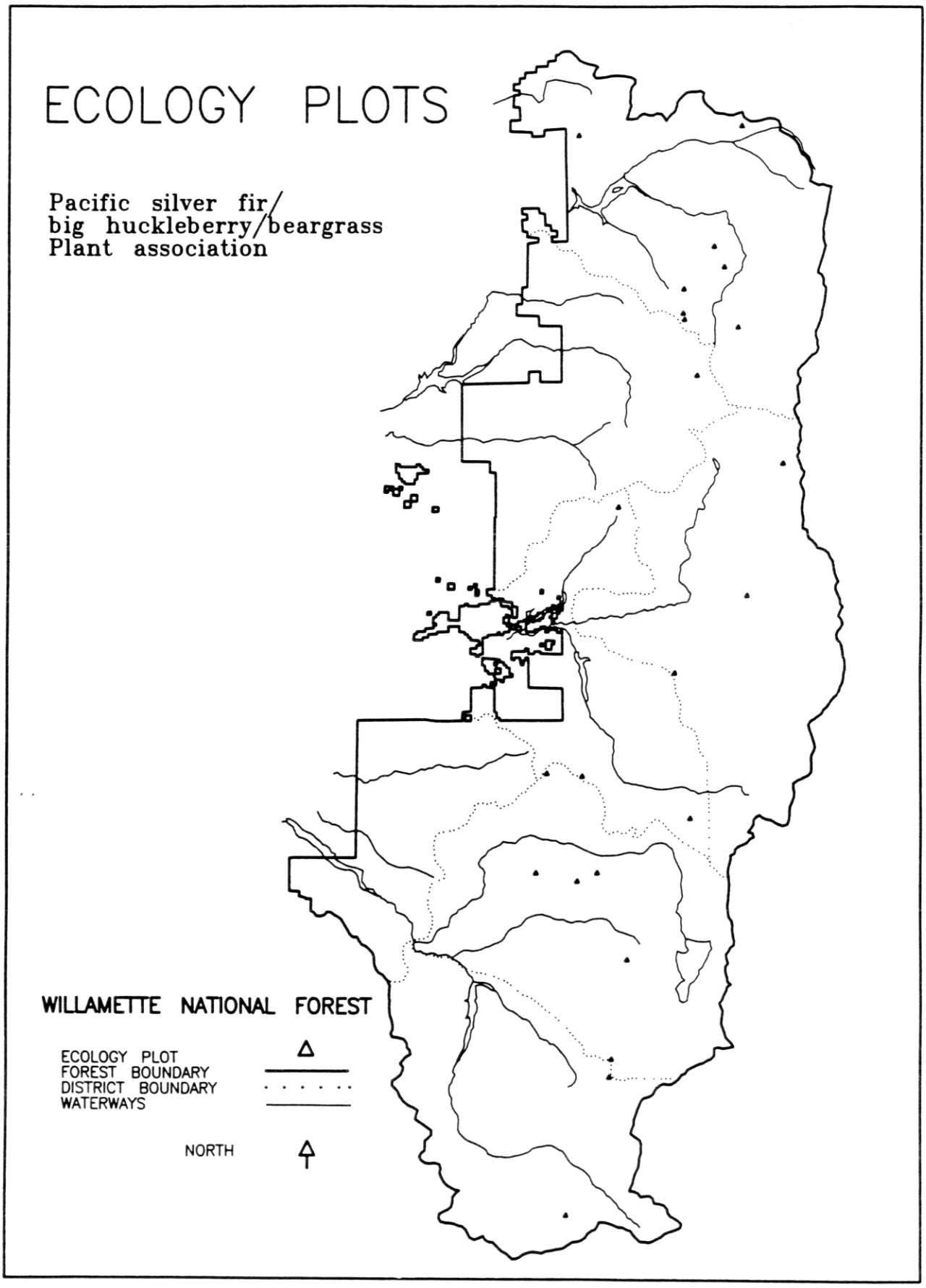
Heat damage to emergent natural seedlings and moisture stress in planted seedlings are the most common reforestation problems. As in the Pacific silver fir/rhododendron-salal association, shade protection of seedlings is desirable on south-facing slopes. Douglas-fir and noble fir are both suitable for planting. Douglas-fir grows well on warmer sites. Noble fir should be planted in flat areas or other sites likely to become frost pockets. The risk of frost is slightly higher than in the Pacific silver fir/rhododendron-salal association, but low compared to the Pacific silver fir zone as a whole. Shrub competition should not generally be intense, but snowbrush may become a major competitor on scarified or severely burned sites.

Coarse textured, nitrogen poor soils typical in this association may suffer significant nitrogen loss from moderate slash fires. Fires should not consume the duff, as it may act as a major source of nutrients.

Wildlife use was low in our sample stands. Little forage or thermal cover is available.

Comparisons

Similar associations are fairly common in the Washington Cascades and Olympic Mountains. The Pacific silver fir/salal associations on the Mt. Baker-Snoqualmie and Olympic National forests strongly intergrade into the western hemlock zone (Henderson and Peter 1981, Henderson et al. 1986). Franklin et al. (1979) described Pacific silver fir/salal and western hemlock/salal habitat types at Mt. Rainier National Park. Alaska huckleberry is less important and salal more important in these plant communities than in our Pacific silver fir/Alaska huckleberry-salal association. Brockway et al. (1983) identified a similar Pacific silver fir/Alaska huckleberry-salal association on the Gifford Pinchot National Forest and Hemstrom et al. (1982) described this association on the Mt. Hood National Forest. The western hemlock/rhododendron-salal type defined in the H. J. Andrews Experimental Forest (Dyrness et al. 1974) is much shrubbier and has a conspicuous rhododendron component.


ECOLOGY PLOTS
Pacific silver fir/
big huckleberry/beargrass
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir / big huckleberry / beargrass
ABAM / VAME / XETE CFS2 51

This is the most common plant association in the upper elevations of the Pacific silver fir zone. Pacific silver fir, Douglas-fir, noble fir and mountain hemlock are common canopy species. Western hemlock, western white pine, and grand fir (white fir) may also be present. Pacific silver fir is by far the most abundant regenerating species, usually mixed with minor amounts of either western or mountain hemlock.

Huckleberries, particularly big huckleberry, dominate the shrub layer. Several shrub species may be present, especially dwarf Oregon grape, vine maple, rhododendron, chinquapin, prince's pine, and dwarf bramble. Total shrub cover averages 30 percent.

Except for beargrass, which averages 35 percent cover, the herb layer is generally depauperate, averaging less than 10 percent cover. Several herbs are common in small amounts, including: twinflower, dogwood bunchberry, vanilla leaf, Pacific trillium, rattlesnake plantain, sidebells pyrola, and queencup beadlily.

Environmental Conditions

The Pacific silver fir/big huckleberry/ beargrass association occurs in harsh, high-elevation environments. It indicates well-drained soils, cool summers and long winters with deep snowpacks. Sites are more droughty than those of the Pacific silver fir/big huckleberry/queencup beadlily association and somewhat warmer than those of the mountain hemlock/big huckleberry/ beargrass association. Frost can occur any time during the growing season (Halverson and Emmingham 1982), especially on gentle slopes or in frost pockets. This association is usually found above 4500 feet but may drop to 3600 feet or lower in frost-prone areas. It is common on both flat terrain subject to frequent summer frost and steep upper slopes.

Soils are moderately deep, often very stony, and developed in glacial till, colluvium, volcanic ash or residuum. The most commmon soil textures are sand, sandy loams and loamy sands, occasionally grading into clay at depth. Soil depth ranged from 18 to 73 inches in sample pits and averaged 43 inches (Table 3). Effective rooting depth was quite shallow in our soil pits, averaging 28 inches deep.

Productivity and Management Implications

Tree growth rates and volume production are higher than in mountain hemlock associations and the Pacific silver fir/Cascades azalea and Pacific silver fir/fool's huckleberry associations, but less than in most of the Pacific silver fir zone. Douglas-fir and noble fir site indices average 96 and 94, respectively (Table 12). Although blister rust can severely reduce height growth, western white pine is very frost resistant and is often taller than either noble fir or Douglas-fir in natural stands. Pacific silver fir, which can provide good stocking through advanced regeneration, usually reaches 75 to 100 feet at age 100 (Hemstrom et al. 1982). Lodgepole pine, which may be suitable for a nurse crop on the coldest sites, reaches 75 to 90 feet in 100 years. Mountain hemlock usually exceeds 80 feet by 100 years and can sustain adequate height growth into the second and third centuries. Volume production culminates at about 125 cubic feet/acre/year from both stand density index and empirical estimates.

Frost, particularly on flat areas, deep, persistent snowpacks, beargrass-sedge mats and pocket gopher damage often delay reforestation. Cold sub-surface soil temperatures (which inhibit root function) coupled with high evaporative demand on sunny days may cause moisture stress and slow growth. For this reason, Douglas-fir is not usually suitable for planting. Noble fir and Pacific silver fir roots are more adapted to cold soils. Both species are somewhat susceptible to frost damage and should not be planted in severe frost pockets.

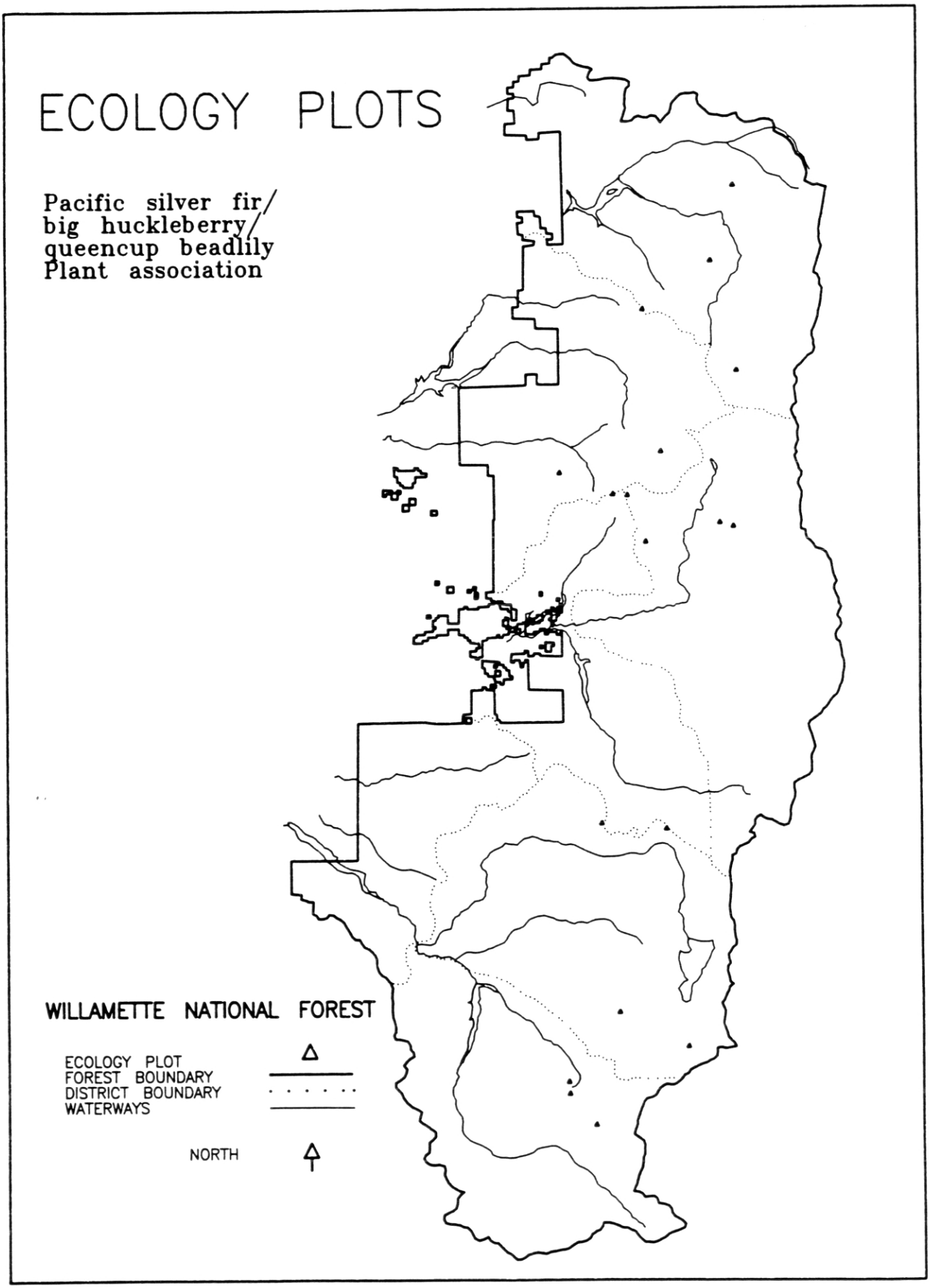
Beargrass-sedge mats may compete with seedlings and provide ideal pocket gopher feeding habitat. Gopher damage can cause high seedling mortality. Pines and Engelmann spruce are less likely to suffer pocket gopher damage. Sullivan (1978) suggests small clearcuts or shelterwoods, where windthrow is not a problem, to reduce environmental extremes.

Stony soils common in this association may suffer significant nutrient loss from moderate slash fires. Fires should not consume the duff. Fire may also eliminate advanced regeneration, often the most dependable source of stocking in harvested areas.

Where the canopy is open and huckleberries are abundant, this association provides summer range for deer and elk. Big game use is not as high as in herb-rich types because there is little herbaceous forage available (Table 10). Trails were observed on half of our sample plots and deer pellets were noted on a third of them. Early seral stages may have provided huckleberry fields for aboriginal peoples in the past.

Comparisons

The Pacific silver fir/big huckleberry/ beargrass association has often been described in the southern Washington and northern Oregon Cascades. The Pacific silver fir-mountain hemlock/big huckleberry/ beargrass association of the Mt. Adams province (Franklin 1966) has mountain hemlock as a co-climax species, but otherwise is environmentally and vegetatively similar. At Mt. Rainier National Park (Franklin et al. 1979), the Pacific silver fir/beargrass type is described in two phases: the more species-rich western hemlock phase and the higher elevation, depauperate mountain hemlock phase. The Pacific silver fir/beargrass association occurs on dry sites at the upper elevation end of the Pacific silver fir zone on the Mt. Baker-Snoqualmie National Forest (Henderson and Peter 1981). Brockway et al. (1983) described a very similar Pacific silver fir/big huckleberry/ beargrass association on the Gifford Pinchot National Forest. The Pacific silver fir/big huckleberry/beargrass association on the Mt. Hood National Forest (Hemstrom et al. 1982) is essentially the same as this association on the Willamette National Forest. Herbaceous diversity in this association increases from north to south.


ECOLOGY PLOTS
Pacific silver fir/
big huckleberry/
queencup beadlily
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir/big huckleberry/queencup beadlily
ABAM/VAME/CLUN CFS2 56

The canopy in this association can be diverse. Pacific silver fir, Douglas-fir, noble fir, mountain hemlock and western hemlock are common. Grand fir (white fir) becomes important at the south end of the Forest. Engelmann spruce may form nearly pure, very productive stands in particularly moist areas. Pacific silver fir dominates the regenerating layer, often with western hemlock on warmer sites and mountain hemlock on cooler sites. Cover of mountain hemlock regeneration is less than 2 percent, separating this association from the mountain hemlock zone.

Big huckleberry is the most important shrub. Small amounts of other huckleberries and rhododendron may be present. Dwarf bramble and prince's pine are present in most stands. Total shrub cover averages 35 percent.

An appreciable herb cover in addition to beargrass distinguishes this association from the Pacific silver fir/big huckleberry/ beargrass association. Fifteen or more herb species can occur, of which queencup beadlily, sidebells pyrola, vanilla leaf, dogwood bunchberry, coolwort foamflower,

false solomonseal, and beargrass are the most abundant. Total herb cover averages 48 percent.

Environmental Conditions

This association indicates relatively cool growing season conditions and long winters with deep snowpacks. The herb-rich understory indicates more moist conditions than in the Pacific silver fir/big huckleberry/beargrass association. Elevations range from 3500 to 5600 feet. Most sites are found on lower to middle slopes and aspect is variable. Slope steepness ranges from nearly flat to more than 50 percent.

Soil textures range from loamy sand to clay. Soils are usually fine textured at the surface and stony at depth. Soils range from 21 to over 60 inches deep. Average soil depth is in the normal range for the Pacific silver fir zone (49 inches, Table 3). Effective rooting depth averaged 29 inches in our sample soil pits. Most of the soils sampled were developed from colluvium or residuum.

Productivity and Management Implications

The Pacific silver fir/big huckleberry/ queencup beadlily association is more productive than the Pacific silver fir/big huckleberry/beargrass association. Noble fir site index is considerably higher than Douglas-fir site index, 126 versus 112 (Table 12). Many stands on moist, cool sites are dominated by rapidly growing Engelmann spruce. While our sample of spruce-dominated stands is small, they appear to be very productive. Dominant Engelmann spruce may reach 120 to 140 feet in 100 years with stand volume increment at culmination ranging from 125 cubic feet/acre/year to 175 cubic feet/acre/year (Hemstrom et al. 1982). Typical Pacific silver fir/big huckleberry/queencup beadlily stands are less productive, averaging 137 cubic feet/acre/year from stand density index estimates or 125 cubic feet/acre/year from empirical estimates.

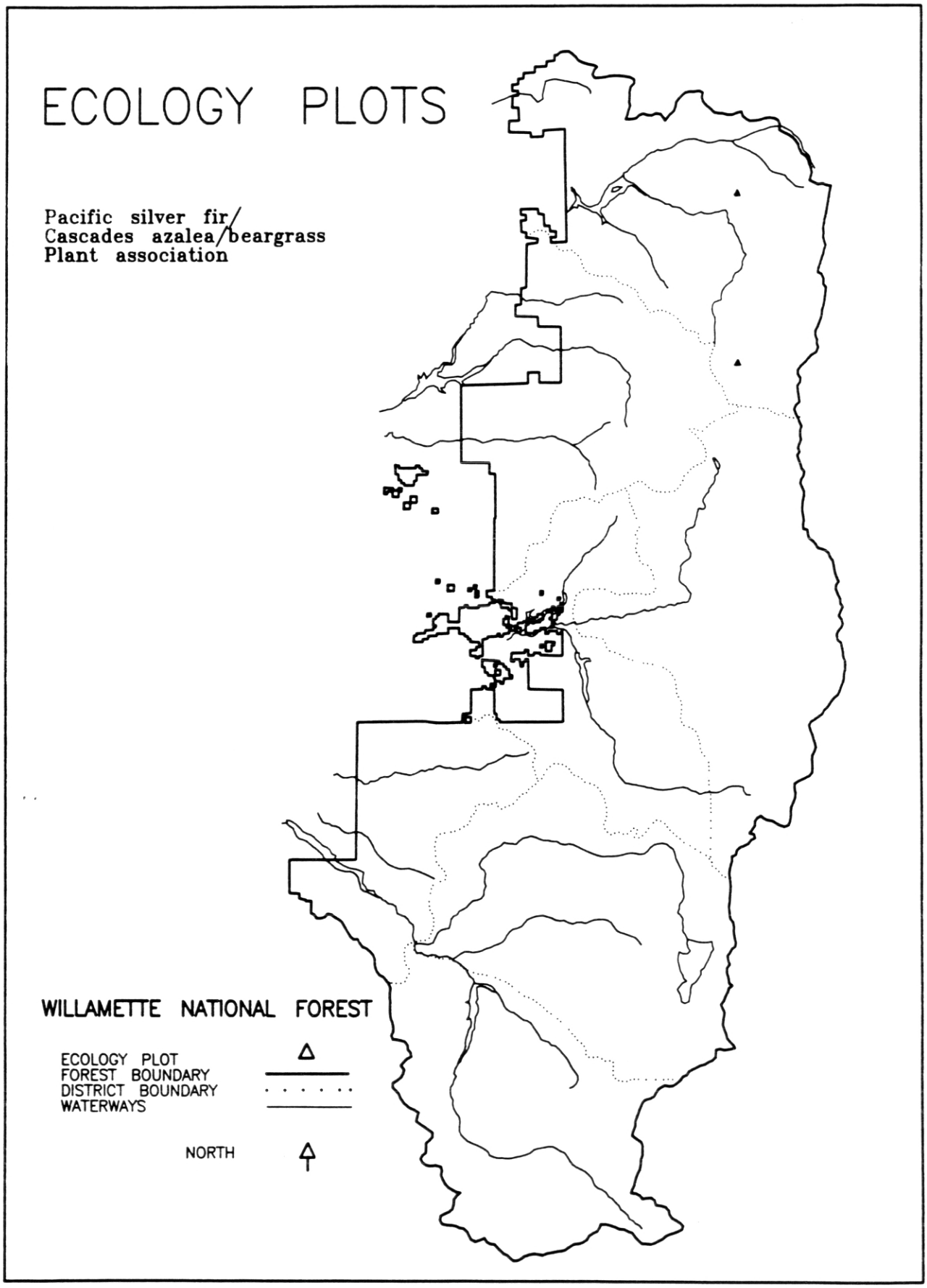
While sites are often cold, especially on flat terrain, frost is not as severe as in the mountain hemlock zone or Pacific silver fir/big huckleberry/beargrass association. Frost resistant species should be planted on gentle slopes and flats. Shrub competition should be moderate, mostly from huckleberry species. Beargrass-sedge mats and pocket gophers should be less common in clearcuts than in beargrass-dominated associations.

As in other cold, high-elevation associations, a significant portion of the soil nitrogen is in the duff and litter layers and could be lost during a hot slash burn. Soils may be moist and compactible through a good part of the summer.

Herbaceous forage is average for the Pacific silver fir zone, 225 pounds per acre (green weight, Table 10). This association provides important deer and elk summer range, especially where the canopy is open and huckleberries are abundant. Big game trails were evident in half of the stands sampled and deer and elk pellets were noted on 18 percent of the stands. Aboriginal people may have used the huckleberry fields which are a major part of early successional communities.

Comparisons

The Pacific silver fir/big huckleberry/ queencup beadlily association on the Willamette National Forest is very similar to the Pacific silver fir/big huckleberry/ queencup beadlily association on the Gifford Pinchot (Brockway et al. 1983) and Mt. Hood National Forests (Hemstrom et al. 1982). Farther north, this association occurs on lower slope positions and more often on east and south-facing aspects. Franklin's (1966) Pacific silver fir/big huckleberry association from the Mt. Adams province is similar, but typically has a depauperate understory dominated by beargrass. It is more closely related to our Pacific silver fir/big huckleberry/beargrass association. The Pacific silver fir/dwarf bramble/avalanche lily association at Mt. Rainier National Park (Franklin et al. 1979) is similar in many respects, but is not as herb-rich and often has a mountain hemlock climax component. Henderson and Peter's (1981) Pacific silver fir/big huckleberry association on the Mt. Baker-Snoqualmie National Forest is not as herb rich and has fewer moist site herbs. The seral noble fir/queencup beadlily community in the H. J. Andrews Experimental Forest (Dyrness et al. 1974) is not as shrubby and has a more profuse herb layer.


ECOLOGY PLOTS
Pacific silver fir/
Cascades azalea/beargrass
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir/Cascades azalea/beargrass
ABAM/RHAL/XETE CFS5 51

Pacific silver fir and mountain hemlock usually dominate the canopy. Alaska cedar, noble fir, western hemlock, Douglas-fir and western white pine may be present. Pacific silver fir, often with mountain hemlock and western hemlock, is the major regenerating species. The Pacific silver fir/Cascades azalea and Pacific silver fir/devil's club associations are the only ones in which Alaska cedar frequently regenerates.

Cascades azalea, Alaska huckleberry, big huckleberry, fool's huckleberry, and, occasionally, rhododendron dominate the shrub layer. Dwarf bramble and Sitka mountain ash are often present. Total tall shrub cover averages 63 percent. The herb layer is usually sparse. Often beargrass and avalanche lily are the only herbs present.

Environmental Conditions

The Pacific silver fir/Cascades azalea/ beargrass association indicates deep, late-melting winter snowpacks and cool summers. Frost can occur in openings any time during the growing season, particularly on gentle slopes or where cold air collects. Sites are colder than in the Pacific silver fir/devil's club association. It is wetter and has more persistent snowpacks than the Pacific silver fir/big huckleberry/queencup beadlily association. Elevations range from 4100 feet to 5200 feet. Slopes are usually moderate to steep, 10 to 70 percent, and face from northwest to east.

Soils are relatively shallow, 22 to 44 inches deep, and very stony (Table 3). The 33 inch average soil depth is the shallowest of all Pacific silver fir zone associations. Effective rooting depth, averaging 23 inches is among the shallowest in the Pacific silver fir zone. Soil textures range from loamy sands to sandy loams, silt loams and clay loams that are developed in colluvium, glacial till or, less often, residuum or volcanic tephra.

Productivity and Management Implications

The Pacific silver fir/Cascades azalea/ beargrass association indicates more well-drained soils than the Pacific silver fir/Cascades azalea/queencup beadlily association. It is slightly easier to manage for timber because soils are not usually saturated. Frost and deep, late-melting

snowpacks pose the same difficulties for regeneration as in the Pacific silver fir/Cascades azalea/queencup beadlily association. Growth rates are low. Refer to the Pacifc silver fir/Cascades azalea/queencup beadlily association for productivity estimates and management implications.

Soils are likely to be moist and compactible well into the summer. Moderately hot slash fires could accelerate erosion, especially on steep slopes. Shallow, stony soils may be sensitive to nutrient loss following slash fires.

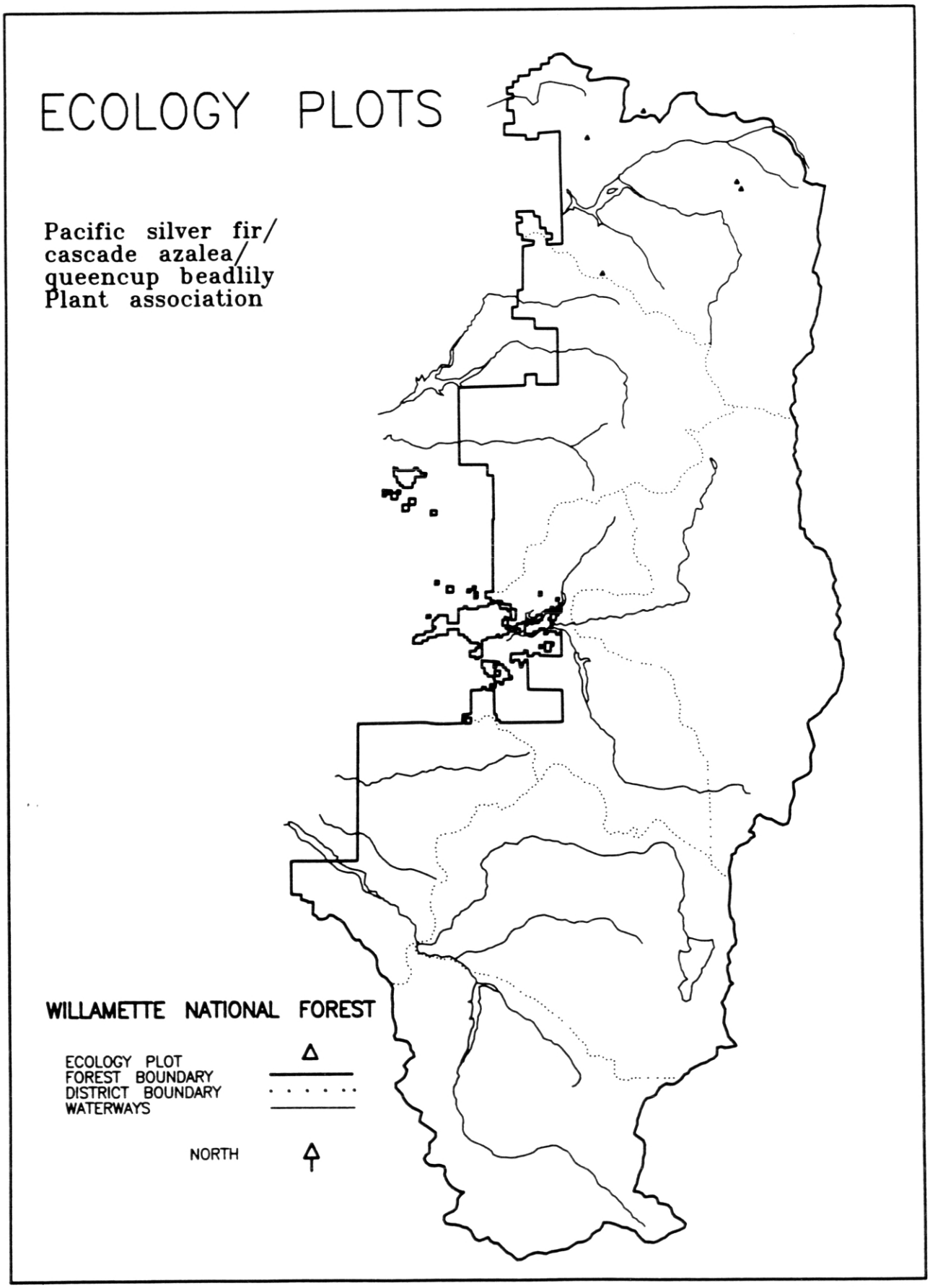
Wildlife use does not appear particularly high, but our sample was small. Big game may find relief from summer heat on the cool, moist north slopes typical for this type. Deer pellets were noted on half of our sample stands, but big game trails were infrequent and forage amounts were not substantial (Table 10).

Comparisons

In Franklin's (1966) Alaska cedar/Cascades azalea/gley podzol association of the Mt. Adams province, Alaska cedar is a climax codominant, Engelmann spruce is a locally common seral species, and beargrass is a minor species. His association is more closely related to our Pacific silver fir/Cascades azalea/queencup beadlily association. The same is true of the Pacific silver fir/Cascades azalea habitat type at Mt. Rainier National Park (Franklin et al. 1979).

This association is more common on the Mt. Hood National Forest (Hemstrom et al. 1982). Brockway et al. (1983) described a Pacific silver fir/Cascades azalea association on the Gifford Pinchot National Forest. This association has a slightly less prominent beargrass component. The mountain hemlock/Cascades azalea association on the Olympic National Forest (Henderson et al. 1986) is more herb-poor than the Pacific silver fir/Cascades azalea/queencup beadlily association and lacks beargrass. Mountain hemlock and avalanche lily are more abundant farther north.

Pacific silver fir/Cascades azalea associations become increasingly rare on the southern end of the Willamette National Forest. Our only samples are from the Detroit and Sweet Home Ranger Districts. No similar type has been described for the H.J. Andrews Experimental Forest (Dyrness et al. 1974).


ECOLOGY PLOTS
Pacific silver fir/
cascade azalea/
queencup beadlily
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir / Cascades azalea / queencup beadlily
ABAM / RHAL / CLUN CFS5 52

Pacific silver fir is the most common canopy species. Mountain hemlock and western hemlock are frequently present. Engelmann spruce, Douglas-fir, Alaska cedar, western white pine and noble fir may be locally abundant. Pacific silver fir dominates the regeneration layer. Mountain hemlock, western hemlock, Alaska cedar, and western white pine seedlings may be present.

Cascades azalea, rhododendron, big huckleberry, oval-leaf huckleberry, Alaska huckleberry, and fool's huckleberry comprise the dense, tall shrub layer. Dwarf bramble and five-leaved blackberry are also common. Total tall shrub cover averages 71 percent.

The herbaceous layer can be relatively rich and diverse, averaging 43 percent cover. Fifteen or more species may occur, of which beargrass, queencup beadlily, coolwort foamflower, three-leaved anemone, vanilla leaf and dogwood bunchberry are the most important. Avalanche lily may be locally important.

Environmental Conditions

The Pacific silver fir/Cascades azalea/queencup beadlily association is relatively rare. Our few samples are from steep, north-facing slopes generally above 3900 feet on the Detroit and Sweet Home Ranger Districts. The Pacific silver fir/Cascades azalea associations are apparently not found more than a short distance south of Santiam Pass.

This association occurs on sites with long, cold winters, deep snowpacks and short, frosty summers. Soil moisture is abundant. Elevations range from 3500 to 4800 feet. Slopes are usually, but not exclusively, gentle. Slope aspect is often northerly.

Soil depth varies from 33 inches to 60 inches, averaging 50 inches (Table 3). Effective rooting depth averages 36 inches and is the deepest of any Pacific silver fir plant association. Soil textures vary from deep sandy loams developed in volcanic ash to shallow, stony loams developed in colluvium, glacial till or residuum.

Productivity and Management Implications

Both of the Pacific silver fir/Cascades azalea associations produce low timber yields and are difficult to regenerate. The Pacific silver fir/Cascades azalea/queencup beadlily association is more moist than the Pacific silver fir/Cascades azalea/beargrass association. The Pacific silver fir/Cascades azalea associations and the Pacific silver fir/fool's huckleberry association were combined for productivity estimates. Noble fir site index averages 80 while Douglas-fir site index averages 73 (Table 12). Pacific silver fir grows slowly, reaching about 70 feet in 100 years. Mountain hemlock grows at about the same rate, approximately 70 feet in 100 years, but has more prolonged height growth, usually reaching a maximum of about 120 feet. Western white pine probably has the best height growth potential, but our sample was too small to develop height growth estimates. Volume growth estimates are equally low: 69 cubic feet/acre/year from stand density index and 75 cubic feet/acre/year from empirical data.

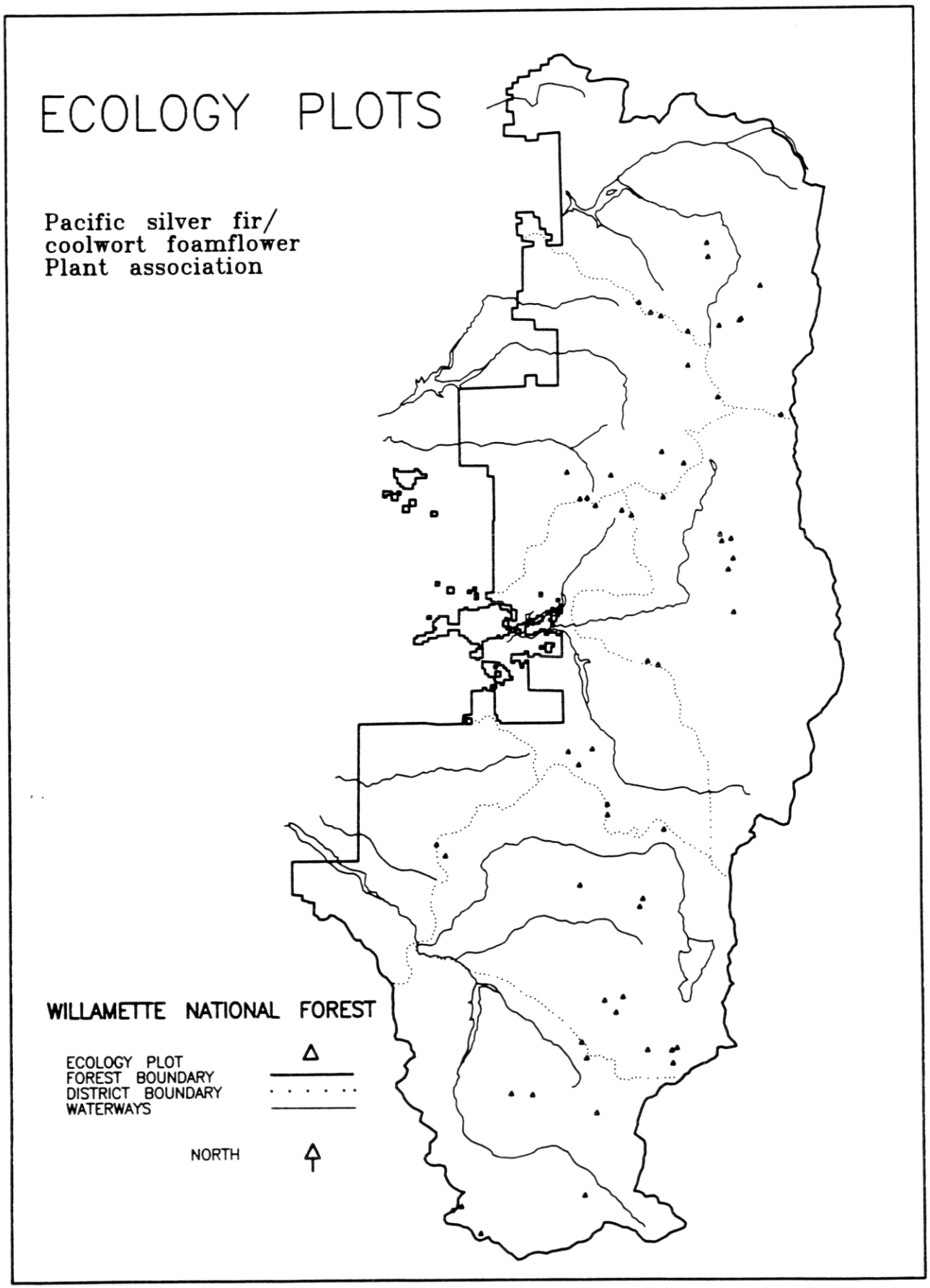
Summer frost, deep winter snowpacks and, to a smaller degree, competing vegetation make regeneration difficult. Winter snowpacks often exceed 10 feet and may not melt until June or July. Only frost resistant species should be planted. Noble fir from high elevation seed sources is the best choice on slopes. Western white pine, Engelmann spruce, mountain hemlock and advanced regeneration Pacific silver fir are most likely to survive and grow on flat terrain.

Moist, compactible, erodable soils will require careful falling and yarding. Shelterwood cuts would provide protection for seedlings and encourage natural regeneration. Blowdown can be a problem since soils are moist and often shallow.

Due to herb richness, the Pacific silver fir/Cascades azalea/queencup beadlily association provides better forage than the Pacific silver fir/Cascades azalea/beargrass association. Herbaceous forage averages 273 pounds per acre (green weight, Table 10). Both can be moderately important as deer and elk summer range. Big game trails were noted on 60 percent of our stands.

Comparisons

The Pacific silver fir/Cascades azalea/queencup beadlily association also occurs on the Mt. Hood National Forest (Hemstrom et al. 1982). This association is similar to Franklin's (1966) Alaska cedar/Cascades azalea/gley podzol, the Pacific silver fir/Cascades azalea association at Mt. Rainier National Park (Franklin et al. 1979) and the Pacific silver fir/Cascades azalea association on the Gifford Pinchot National Forest (Brockway et al. 1983), except that Alaska cedar plays a less important role south of the Columbia River. The mountain hemlock/Cascades azalea association on the Olympic and Mt. Baker-Snoqualmie National Forests (Henderson et al. 1986, Henderson and Peter 1981) is less herb-rich and more strongly dominated by mountain hemlock at climax. No similar type was described in the central Oregon Cascades (Dyrness et al. 1974).


ECOLOGY PLOTS
Pacific silver fir/
coolwort foamflower
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir/coolwort foamflower
ABAM/TITR CFF1 52

Douglas-fir, Pacific silver fir, western hemlock and noble fir are the major canopy species. Several other species may be common, including western white pine, Engelmann spruce, mountain hemlock, grand fir (white fir), and western redcedar. Pacific silver fir dominates the regeneration layer, usually accompanied by western hemlock. At the south end of the Forest, grand fir becomes an increasingly important canopy and regenerating species.

The shrub layer is characteristically less well-developed than the herb layer. Small amounts of dwarf Oregon grape, prince's pine, trailing blackberry, dwarf bramble, wintergreen, rhododendron, red huckleberry, big huckleberry, baldhip rose and snowberry may be present. Traces of devil's club and Sitka mountain ash may occur. Shrub cover averages 31 percent.

The herb layer is diverse and profuse. Twenty or more species may be present. Vanilla leaf, dogwood bunchberry, coolwort foamflower, false solomonseal, and queencup beadlily are usually abundant. Fairybells, Pacific trillium, inside-out flower, three-leaved and nine-leaved anemone, wild ginger, rosy twistedstalk, redwoods violet, and several species of pyrola also occur in most stands.

At the south end of the Forest, Pacific silver fir is gradually replaced by grand fir. Coolwort foamflower is less important and false solomonseal more important. Several other herbs become more common, particularly Scouler's bluebell, sweetscented bedstraw, and fairybells.

Environmental Conditions

The combination of moist, cool-site indicating plants and high tree growth rates in this association imply a moist, cool environment and relatively fertile soils. Snowpacks are shallower than in Pacific silver fir/Cascades azalea associations. The growing season is longer and warmer than in Pacific silver fir/big huckleberry and Pacific silver fir/Cascades azalea associations, but not as warm as in the Pacific silver fir/dwarf Oregon grape association. The Pacific silver fir/coolwort foamflower association is usually found between 4000 and 5000 feet. Above 5000 feet, environmental conditions are more severe and

summer frost more frequent. Sites are often on gentle flats and lower slopes or steeper lower or mid-slopes. Aspect varies.

Soils are shallow to moderately deep and often stony. Total soil depth in our soil pits ranged from 19 to 96 inches and averaged 52 inches (Table 3). Effective rooting depth ranged from 5 to 86 inches and averaged 35 inches. Soil texture varied from loamy sand or sandy loam to clay loam. Most soils were developed in colluvium, glacial till, volcanic tephra, or residual material.

Productivity and Management Implications

The Pacific silver fir/coolwort foamflower association is one of the most productive and easily regenerated associations in the Pacific silver fir zone. Noble fir grows faster than Douglas-fir. Noble fir site index averages 128 versus 119 for Douglas-fir (Table 12). Other species, particularly western white pine, also grow well. Volume productivity is about the same as in the Pacific silver fir/devil's club and Pacific silver fir/Oregon oxalis associations: 196 cubic feet/acre/year from stand density index, 175 cubic feet/acre/year from empirical data (Hemstrom et al. 1982). Height growth and productivity decline above 5000 feet elevation.

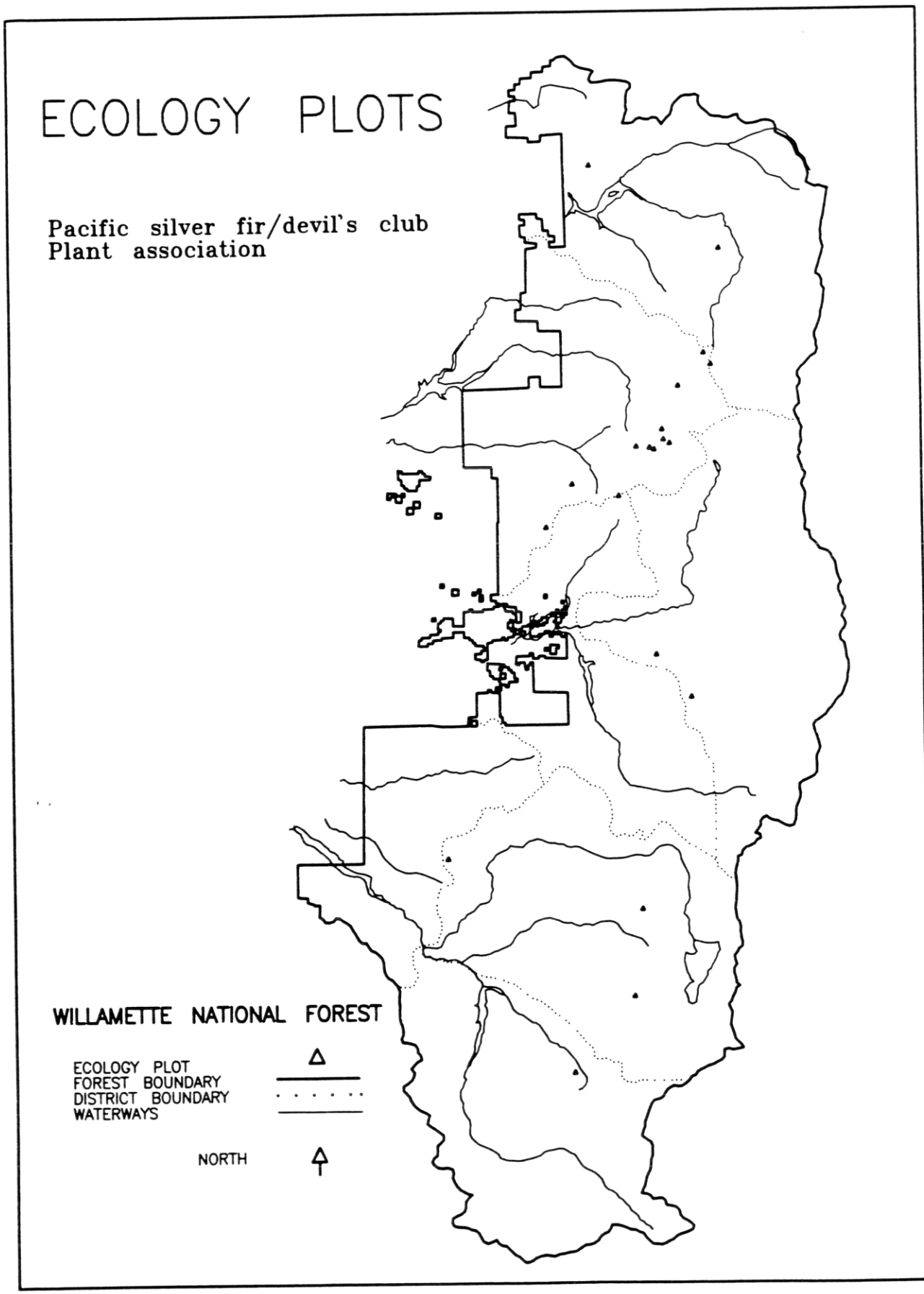
Regeneration should not be difficult in most cases. On slopes over 15 percent, noble fir and Douglas-fir should survive and grow well. Seedlings may require shade for survival on steep, south-facing slopes with rocky soils. Vegetative competition, usually huckleberries, vine maple, and rhododendron, should not be severe, especially if seedlings are established the first year after harvesting. Frost-hardy species should be planted and seedlings protected on slopes less than 15 percent or sites above 5000 feet elevation.

Soils may be moist and compactible well into the summer. Soils on most sites are not particularly sensitive to fire effects. Hot fires, which consume the duff, should be avoided.

Deer and elk use this association more than most others in the Pacific silver fir zone. Two-thirds of out plots had big game trails and deer pellet groups were noted on a third of them (Table 10). Forage is generally abundant, averaging 478 pounds per acre (green weight). Many sites are adjacent to streams or meadows which are also important habitat features.

Comparisons

This plant assemblage has often been described west of the Cascade Crest in Washington and Oregon. Franklin's (1966) Pacific silver fir/false solomonseal association is very similar but has a slightly more dense shrub layer. Pacific silver fir/coolwort foamflower associations from Mt. Rainier National Park (Franklin et al. 1979), the Gifford Pinchot National Forest (Brockway et al. 1983), the Mt. Hood National Forest (Hemstrom et al. 1982) and the central Oregon Cascades (Dyrness et al. 1974) have essentially identical floristic characteristics. Henderson and Peter's (1981) Pacific silver fir/rosy twistedstalk association on the Mt. Baker-Snoqualmie National Forest has a similar herb layer, but lacks an important shrub component and occurs on cooler sites. Stands on the Willamette National Forest tend to be more shrubby than those described elsewhere. Sites which support this association change from mid-elevation, warm, well-watered sites in Washington to higher elevation, cool, well-watered sites in Oregon. Excellent stands of noble fir are common in forests less than 350 years old, regardless of latitude.


ECOLOGY PLOTS
Pacific silver fir/devil's club
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir/devil's club
ABAM/OPHO CFS3 51

Douglas-fir, western hemlock, Pacific silver fir, noble fir and western redcedar dominate the overstory in most stands. Alaska cedar occurs in particularly cool environments. Pacific silver fir is usually more abundant than western hemlock in the regeneration layer. Western redcedar regenerates well in some stands.

Dense, spiny shrub thickets are usually painfully obvious. Devil's club cover is characteristically greater than 5 percent and usually ranges from 10 to 90 percent. Alaska huckleberry, big huckleberry, oval-leaf huckleberry, salmonberry, and vine maple are often abundant. Many other shrub species may be present.

At least 17 herbaceous species are common. Ten or more additional species may be present. The most common herbs include: dogwood bunchberry, fairybells, vanilla leaf, Pacific trillium, swordfern, inside-out flower, three-leaved anemone, wild ginger, pathfinder, rattlesnake plantain, sidebells pyrola, rosy twisted stalk, false solomonseal, coolwort foamflower, miner's lettuce, ladyfern, and queencup beadlily. Total herb cover is high, averaging 70

percent. Where the Pacific silver fir/devil's club association grades into the Pacific silver fir/Oregon oxalis association, Oregon oxalis cover may be greater than 20 percent.

Environmental Conditions

The Pacific silver fir/devil's club association indicates wet sites, usually with impeded drainage or near streams, which are warmer and accumulate shallower snowpacks than the Pacific silver fir/Cascades azalea associations. It is more moist than the Pacific silver fir/Alaska huckleberry and Pacific silver fir/coolwort foamflower associations with which it intergrades.

This association occurs at elevations between 3300 and 4500 feet. Most sites are situated on northerly-facing lower or mid-slopes with impeded drainage or near riparian areas.

The deep (average depth of 52 inches, Table 3) and moderately stony soils (effective rooting depth averages 35 inches) are usually sandy, silty or clay loams. The soils are developed in colluvium or, less often, residuum or volcanic tephra.

Productivity and Management Implications

The Pacific silver fir/devil's club association presents some management challenges. While conifer growth rates and volume production are often high, wet soils and proximity to streams may limit timber opportunities. Our intensive plots for the Pacific silver fir/devil's club and Pacific silver fir/Oregon oxalis assocaitions were combined because sample sizes were small and productivity appeared similar in both types.

Douglas-fir and noble fir grow well. Douglas-fir site index averages 123 and often exceeds 140 (Table 12). Noble fir site index averages 135. Since noble fir typically has better diameter growth in dense stands, it would probably produce more volume over a rotation.

Regeneration should not be difficult if seedlings are planted soon after timber harvest to allow them to gain a height advantage over competing shrubs. Shrub competition may be intense within 3 to 4 years following cutting, typically from vine maple, salmonberry, huckleberries and thimbleberry. Frost may be a problem in basins. High water tables may prevent establishment of Douglas-fir except on raised planting sites. Western redcedar, which is more tolerant of saturated soils, may do well under these conditions.

Soils are usually saturated through the summer. Harvesting methods should emphasize reduction of soil disturbance and compaction. Soils should not be overly sensitive to effects of moderate slash fires.

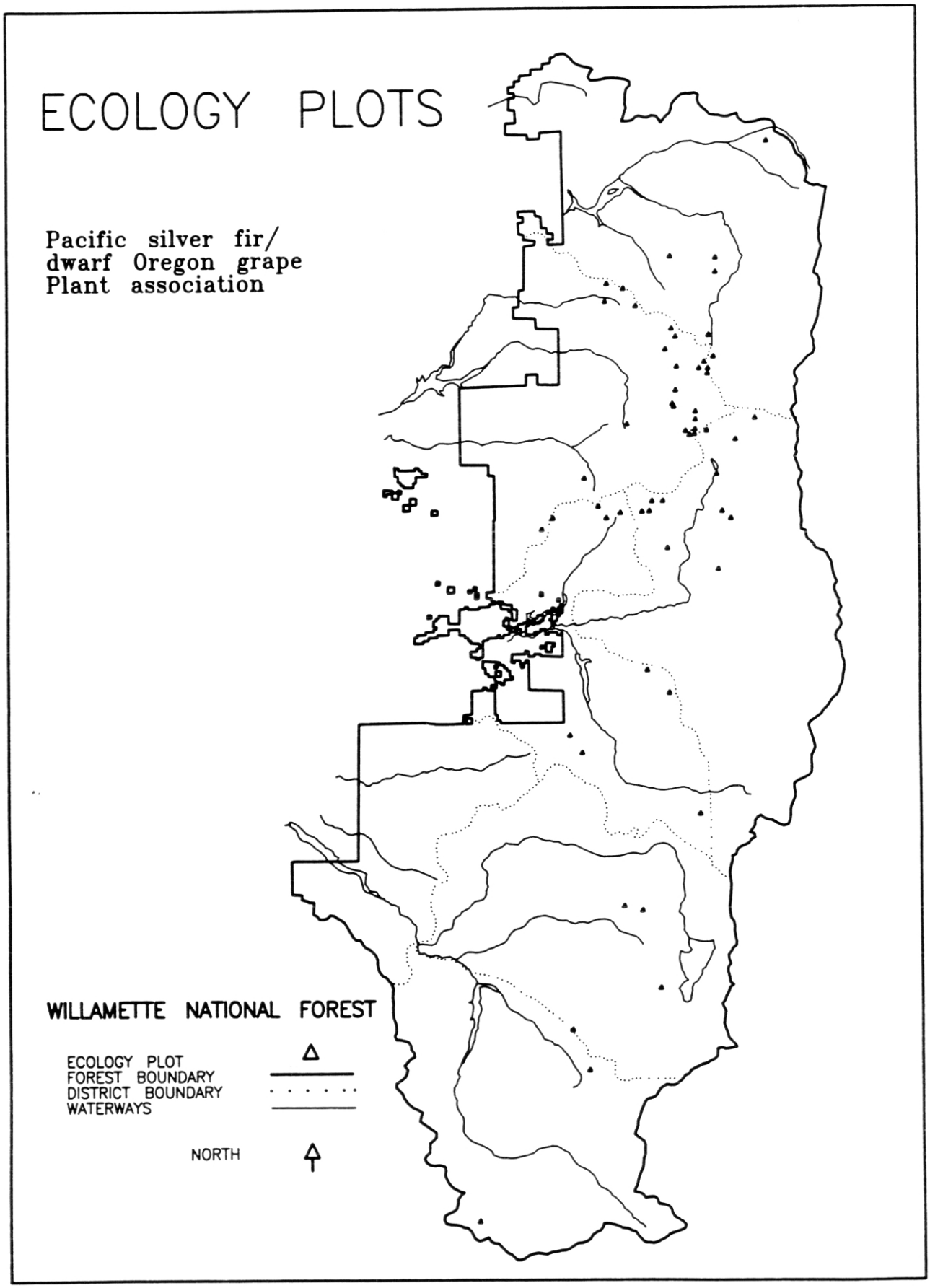
Wildlife values may be high. Herbaceous forage is among the highest for the Pacific silver fir zone, averaging 499 pounds per acre (green weight, Table 10). Palatable shrubs and herbs also abound in cutover Pacific silver fir/devil's club stands. Most natural stands are adjacent to streams and have high watershed and riparian values. Many are composed of widely spaced old-growth Douglas-fir which may be important habitat for some animal species.

Comparisons

The Pacific silver fir/devil's club association has been widely described in the Washington and Oregon Cascades. It changes from a common indicator of wet, relatively warm sites in the Washington Cascades and Olympic Mountains to an association of higher elevation, wet, cool sites in the central Oregon Cascades. Henderson and Peter (1981) did not describe a devil's club association in either the Pacific silver fir or western hemlock zones on the White River Ranger District, Mt. Baker-Snoqualmie National Forest. Henderson et al. (1986) described a western hemlock/devil's club association that occurs below 1500 feet near streams on the Olympic National Forest.

At Mt. Rainier National Park (Franklin et al. 1979), the Pacific silver fir/devil's club association ranges from the low elevation western hemlock zone into the mid-elevations of the Pacific silver fir zone. The Pacific silver fir/devil's club association on the Gifford Pinchot National Forest (Brockway et al. 1983) occurs along wet alluvial benches and on wet slopes at moderate elevations. This association is more extensive on the Mt. Hood National Forest (Hemstrom et al. 1982). In the H. J. Andrews Experimental Forest (Dyrness et al. 1974), the Alaska cedar/devil's club association occurs on steep, north-facing high elevation sites with persistent snowpacks.

The Pacific silver fir/devil's club association is scattered on the Detroit and Sweet Home Ranger Districts but becomes increasingly rare and restricted to higher elevations farther south. On the Oakridge and Rigdon Ranger Districts it most often occurs above 4000 feet in wet, cold cirque basins.


ECOLOGY PLOTS
Pacific silver fir/
dwarf Oregon grape
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir/dwarf Oregon grape
ABAM/BENE CFS1 51

Douglas-fir, western hemlock, Pacific silver fir and noble fir are the major canopy species. Pacific silver fir and western hemlock usually codominate the regeneration layer. Several other conifers may be present in either the canopy or regeneration layers, particularly western redcedar, western white pine and mountain hemlock.

Low shrubs are usually abundant, especially dwarf Oregon grape, trailing blackberry, prince's pine, baldhip rose, and dwarf bramble. Rhododendron, vine maple, big huckleberry, and occasionally chinquapin, usually contribute an additional 20 percent or more to the shrub cover. Rhododendron cover is less than 30 percent.

While the herb layer can be species rich, it is usually not as well developed as the shrub layer. Coolwort foamflower, three-leaved anemone, queencup beadlily, twinflower, dogwood bunchberry, Pacific trillium, and sidebells pyrola are the most common herbs.

Environmental Conditions

The Pacific silver fir/dwarf Oregon grape association is characteristically found on warmer, well-drained, lower elevation slopes in the Pacific silver fir zone. Soil moisture conditions and nutrient status seem to be better than in the Pacific silver fir/rhododendron associations. Elevations range from about 3000 to 4700 feet. Slopes are usually moderately steep and face various aspects.

Soils tend to be fairly deep and moderately high in coarse fragments. Soil depth ranged from 15 to 95 inches in our soil pits in this association (Table 3). The large difference between the average soil depth (49 inches) and effective rooting depth (31 inches) is an indication of the rockiness of the soils. Most of the soils had sandy or clay loam textures. This combination of characteristics produces a cool, well-drained to droughty site which experiences a relatively long frost-free growing season.

Productivity and Management Implications

The productivity of the Pacific silver fir/dwarf Oregon grape association falls in the middle to low portion of the range for the Pacific silver fir zone. Douglas fir site index averages 104 and is quite variable

(Table 12). Average noble fir site index is lower (76 feet) and equally variable. Basal area of sample stands averaged 267 square feet/acre (Hemstrom et al. 1982). Volume increment appears to culminate at roughly 135 cubic feet/acre/year.

The warm climate and long growing season of the Pacific silver fir/dwarf Oregon grape association usually produces conditions favorable for regeneration. Exposed south-facing slopes with well-drained soils may be droughty. Shading may improve survival on these sites. Heat damage to emergent natural seedlings may also occur on sites with high solar insolation. Frost is not usually a problem. Douglas-fir and noble fir are both suitable species for regeneration.

Canopy removal and soil disturbance may encourage shrub development, especially snowbrush and vine maple. If regeneration is delayed 2 or 3 years, shrub competition may inhibit seedling establishment.

Since soils are usually adequately drained in this association, compaction should not be a severe problem. Slash fires which do not consume the duff should cause little reduction in soil nutrient levels.

Elk use appears to be moderate and deer use relatively high (Table 10). Big game trails were noted on 59 percent of our sample stands. Most use is likely to be for thermal cover since forage availability is low.

Comparisons

The Pacific silver fir/dwarf Oregon grape association is similar to the Pacific silver fir/dwarf Oregon grape association found on the Mt. Hood (Hemstrom et al. 1982), Mt. Baker-Snoqualmie (Henderson and Peter 1981), and Gifford Pinchot National Forests (Brockway et al. 1983) and Mt. Rainier National Park (Franklin et al. 1979). All of these associations, except those of the Mt. Hood National Forest, lack rhododendron and have less well developed tall shrub layers. Dyrness et al. (1974) described a Douglas-fir/vine maple-dwarf Oregon grape community in the H. J. Andrews Experimental Forest which is a seral stage of the Pacific silver fir/dwarf Oregon grape and western hemlock/dwarf Oregon grape associations.

Pacific silver fir/fool's huckleberry
ABAM/MEFE CFS2 54

Pacific silver fir dominates the canopy. Western hemlock, Douglas-fir, mountain hemlock and, to a smaller degree, western redcedar, noble fir and Engelmann spruce may be present in the canopy. The regeneration layer is largely Pacific silver fir with small quantities of western hemlock, mountain hemlock, and, occasionally, western redcedar.

A profuse, species-rich shrub layer is characteristic of this association. Several huckleberry species and rhododendron may be the dominant shrubs, but fool's huckleberry cover is always greater than 5 percent. Cascades azalea, devil's club, salmonberry, wintergreen, dwarf bramble, five-leafed blackberry, and Sitka mountain ash may also be present. Fool's huckleberry cover is significantly greater than Cascades azalea cover. Devil's club cover is less than 5 percent.

The herb layer may be diverse and cover percentages substantial. Beargrass, dogwood bunchberry, queencup beadlily, false solomonseal, coolwort foamflower, Pacific trillium, vanilla leaf, and rattlesnake plantain are the most common herbs. Ten or more additional species may occur, but usually not all on one site.

Environmental Conditions

Our few samples of this association are from adjacent areas on the Mt. Hood National Forest. It may be expected to occur on upper elevation, high precipitation areas of the Detroit and Sweet Home Ranger Districts.

This association indicates a slightly more moist environment than the Pacific silver fir/big huckleberry/queencup beadlily association, but not as cold and wet as the Pacific silver fir/Cascades azalea associations. The Pacific silver fir/fool's huckleberry association occurs at higher elevations and often on steeper, cooler, more northerly-facing slopes than the Pacific silver fir/Alaska huckleberry/dogwood bunchberry association with which it intergrades in many places. Snowpacks are deep and long lasting. Elevations range from 3300 feet to 4300 feet. Slopes may be gentle but often exceed 50 percent.

Soils are shallow, rocky, sandy loams, silt loams, and clay loams. Total soil depth ranged from 17 to 61 inches in soil pits from this association (Table 3). Average soil depth was the shallowest of any Pacific silver fir zone plant association (37 inches). Effective rooting depth was among the lowest in the series also, averaging 24 inches. Soils are developed from a variety of parent materials, including, glacial till, volcanic ash and colluvium.

Productivity and Management Implications

Productivity information was combined for the Pacific silver fir/Cascades azalea/queencup beadlily, Pacific silver fir/Cascades azalea/beargrass and Pacific silver fir/fool's huckleberry associations. Refer to the Pacific silver fir/Cascades azalea/queencup beadlily association for productivity estimates.

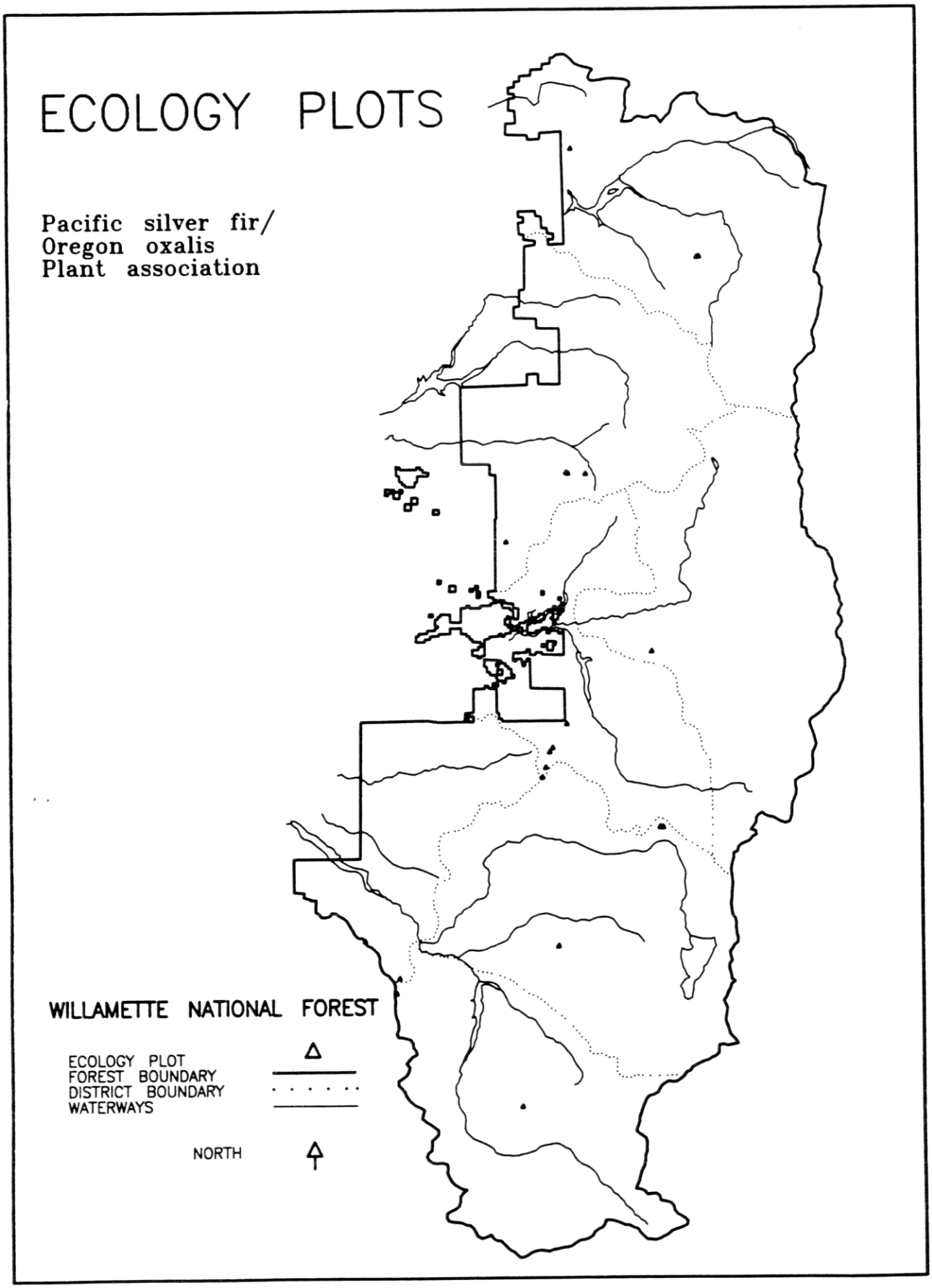
Summer frost is the major obstacle to planted seedling survival. Frost tolerant species should be planted. Shelterwood cutting may be necessary to provide frost protection, but blowdown may be a problem given the shallow soils.

Soils in this association dry out sooner in the summer and are not as susceptible to compaction as those in the Pacific silver fir/Cascades azalea associations. They should not be overly sensitive to slash fire effects, especially if the duff is not consumed.

Herb biomass is lower than in most other moist Pacific silver fir zone associations, averaging 242 pounds per acre (green weight, Table 10) but light summer range use by deer and elk may occur.

Comparisons

In the Pacific silver fir/oval-leaf huckleberry association of the Mt. Adams province (Franklin 1966), oval-leaf huckleberry is more common, fool's huckleberry is less conspicuous, and the herb layer is less rich. The Pacific silver fir/fool's huckleberry habitat type at Mt. Rainier National Park (Franklin et al. 1979) has an important Alaska cedar canopy component and a less well developed herb layer. The Pacific silver fir/fool's huckleberry association described for the Gifford Pinchot National Forest (Brockway et al. 1983) is similar but occurs more often on deep soils, usually with a pronounced rocky or popcorn pumice layer. A similar, uncommon, Pacific silver fir/fool's huckleberry association occurs on the Mt. Hood (Hemstrom et al. 1982) and Mt. Baker Snoqualmie National Forests (Henderson and Peter 1981). Dyrness et al. (1974) did not describe a similar community in the central Oregon Cascades.


ECOLOGY PLOTS
Pacific silver fir/
Oregon oxalis
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir/Oregon oxalis
ABAM/OXOR CFF1 53

Douglas-fir, western hemlock, Pacific silver fir, and noble fir are the major canopy species. Western redcedar is locally common. Pacific silver fir and western hemlock usually dominate the regeneration layer. Very large Douglas-fir and noble fir trees are common in older stands.

While the tall shrub layer is not usually well-developed, rhododendron, vine maple, several huckleberry species (red, Alaska, big and oval-leaf) and, to a lesser extent, devil's club may be present. High coverages, over 5 and 20 percent respectively, of devil's club and huckleberry species indicate gradation to other associations. Dwarf Oregon grape, prince's pine, dwarf bramble, and five-leaved blackberry are common in the low shrub layer. In some stands, rhododendron cover exceeds 30 percent, indicating lower site index and productivity.

The diverse herb layer is dominated by Oregon oxalis, which averaged 38 percent cover in sample plots. Vanilla leaf, false solomonseal, coolwort foamflower, swordfern and redwoods violet are also common. As many

as 10 other herbs may also occur. Total herb cover averages 61 percent.

Environmental Conditions

This uncommon association indicates wet, relatively warm conditions which are more typical of the western hemlock zone. Low devil's club cover implies better soil drainage than in the Pacific silver fir/devil's club association. Although both associations indicate well-watered, productive sites, the Pacific silver fir/Oregon oxalis association is less common and usually occurs on moist benches and slopes outside riparian zones.

The Pacific silver fir/Oregon oxalis association is most common on upper-slopes in high precipitation areas at the north end of the Forest. Farther south, it is increasingly rare and found at slightly higher elevations. We have only three sample plots on the Oakridge and Rigdon Ranger Districts, all of which are on cool, high-elevation slopes near 4500 feet.

Elevations range from 3400 to 4600 feet. Slopes are often moderately steep, 30 to 65 percent, and face various aspects. Summer frosts in openings are infrequent.

Soils were among the deepest in the Pacific silver fir zone, ranging from 18 to over 60 inches deep and averaging 55 inches (Table 3). Effective rooting depth in sample pits was the deepest of the Pacific silver fir associations, averaging 38 inches. Textures are stony silt loams, clay loams or loams developed from colluvium or, occasionally, glacial till.

Productivity and Management Implications

The Pacific silver fir/Oregon oxalis and Pacific silver fir/devil's club associations were combined for productivity analysis. Both associations occur on well-watered, productive sites. Tree growth rates are high. Both Douglas-fir and noble fir site indices often exceed 140 and average 123 and 135, respectively (Table 12). Diameter growth rates are usually better for noble fir at the same stand densities.

Competing vegetation should be the only major obstacle to successful regeneration. Since this association is not usually shrub-rich, shrub competition should not be as intense as in the Pacific silver fir/devil's club association. Frost should be a minor problem except in openings or frost pockets. In some areas, cutting may raise the water table enough to restrict survival of planted Douglas-fir and noble fir to high spots. Western redcedar may be a more suitable species on these sites.

Moist, compactible, erodable soils may require careful falling and yarding. Soils should not be overly susceptible to damage from moderate slash fires.

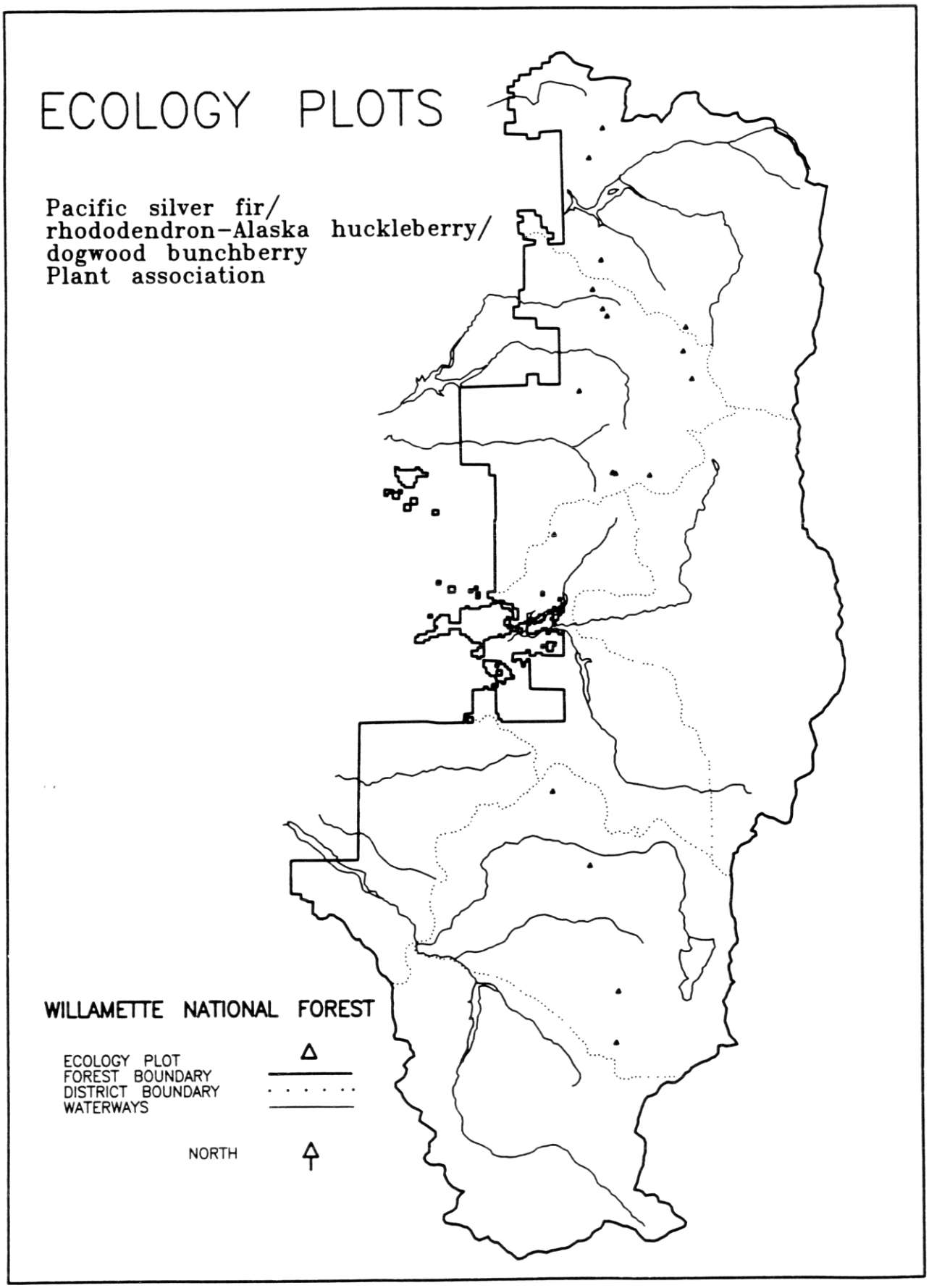
The common occurrence of old-growth noble fir and Douglas-fir stands in the Pacific silver fir/Oregon oxalis association reflects the low natural fire periodicity in these moist environments. Since many natural stands are composed of large old-growth trees, wildlife habitat values may be high.

Big game trails were found on over half of the sample stands in this plant association and deer pellet groups were noted on nearly a fourth of the plots (Table 10). Average herbaceous forage (580 pounds per acre, green weight) is among the highest of the Pacific silver fir plant associations.

The Pacific silver fir/Oregon oxalis association is aesthetically pleasing and would be good for trail location. Trails should be well-drained since soils are likely to be moist well into the summer.

Comparisons

Deerfern is a diagnostic species of the Pacific silver fir/Oregon oxalis association in the Mt. Rainier province (Franklin 1966), but is not as important south of the Columbia River. This association also occurs on the Mt. Hood Natioal Forest (Hemstrom et al. 1982). Franklin et al. (1979), Brockway et al. (1983) and Dyrness et al. (1974) did not describe a similar Pacific silver fir zone association. Oregon oxalis has more often been described as a component of the low elevation, moist western hemlock/swordfern-Oregon oxalis association (Dyrness et al. 1974). Henderson et al. (1986) list a similar Pacific silver fir/Oregon oxalis association that is most common on the westside of the Olympic Mountains.


ECOLOGY PLOTS
Pacific silver fir/
rhododendron-Alaska huckleberry/
dogwood bunchberry
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir/rhododendron - Alaska huckleberry/ dogwood bunchberry
ABAM/RHMA - VAAL/COCA CFS6 54

Douglas-fir dominates the canopy in most stands, usually accompanied by western hemlock and Pacific silver fir. Other species, including mountain hemlock, western redcedar, noble fir and western white pine may be present. Pacific silver fir is the major regenerating species, usually mixed with western hemlock.

Rhododendron dominates the shrub layer, averaging 65 percent cover. Alaska huckleberry cover exceeds 5 percent in most stands. Other common shrubs include prince's pine, big huckleberry, dwarf Oregon grape, trailing blackberry, dwarf bramble, and vine maple.

The herb layer is characteristically depauperate. Twinflower, dogwood bunchberry, beargrass and queencup beadlily occur in most stands. Vanilla leaf, Pacific trillium, false solomonseal, and other herbs may be present. Total herb cover averages 37 percent.

Environmental Conditions

The Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry association is not common. It occurs mostly on the Detroit and Sweet Home Ranger Districts.

It is found on sites with more well-drained, less fertile soils than the Pacific silver fir/Alaska huckleberry/dogwood bunchberry association. There may be low levels of available nitrogen on the most herb-poor sites (McKee et al. 1980). Elevations range from 3300 to 4500 feet. Slopes are gentle to moderate and usually north-facing. Most stands are on middle to lower slopes.

Soil depth is variable, from 16 to over 60 inches and averages 40 inches (Table 3). Soils may be rocky and are usually sandy loams, loams or clay loam textures. They are developed from colluvium, residuum, or volcanic tephra. Effective rooting depth is quite low (24 inches), indicating the rockiness of the soils.

Productivity and Management Implications

Productivity in the Pacific silver fir/rhododendron-Alaska huckleberry/ dogwood bunchberry association is lower than average for the Pacific silver fir zone and is slightly lower than that of the Pacific

silver fir/Alaska huckleberry/dogwood bunchberry association. Douglas-fir and noble fir site indices are roughly equal, averaging 97 and 95, respectively, in our samples (Table 12). We have no intensive plots in this association so volume increment can only be estimated from GBA and site index. The GBA-site index volume estimates average 114 and 121 cubic feet/acre/year for Douglas-fir and noble fir, lower than for most other associations (Hemstrom et al. 1982). Stand basal area averaged 318 square feet/acre and was highly variable.

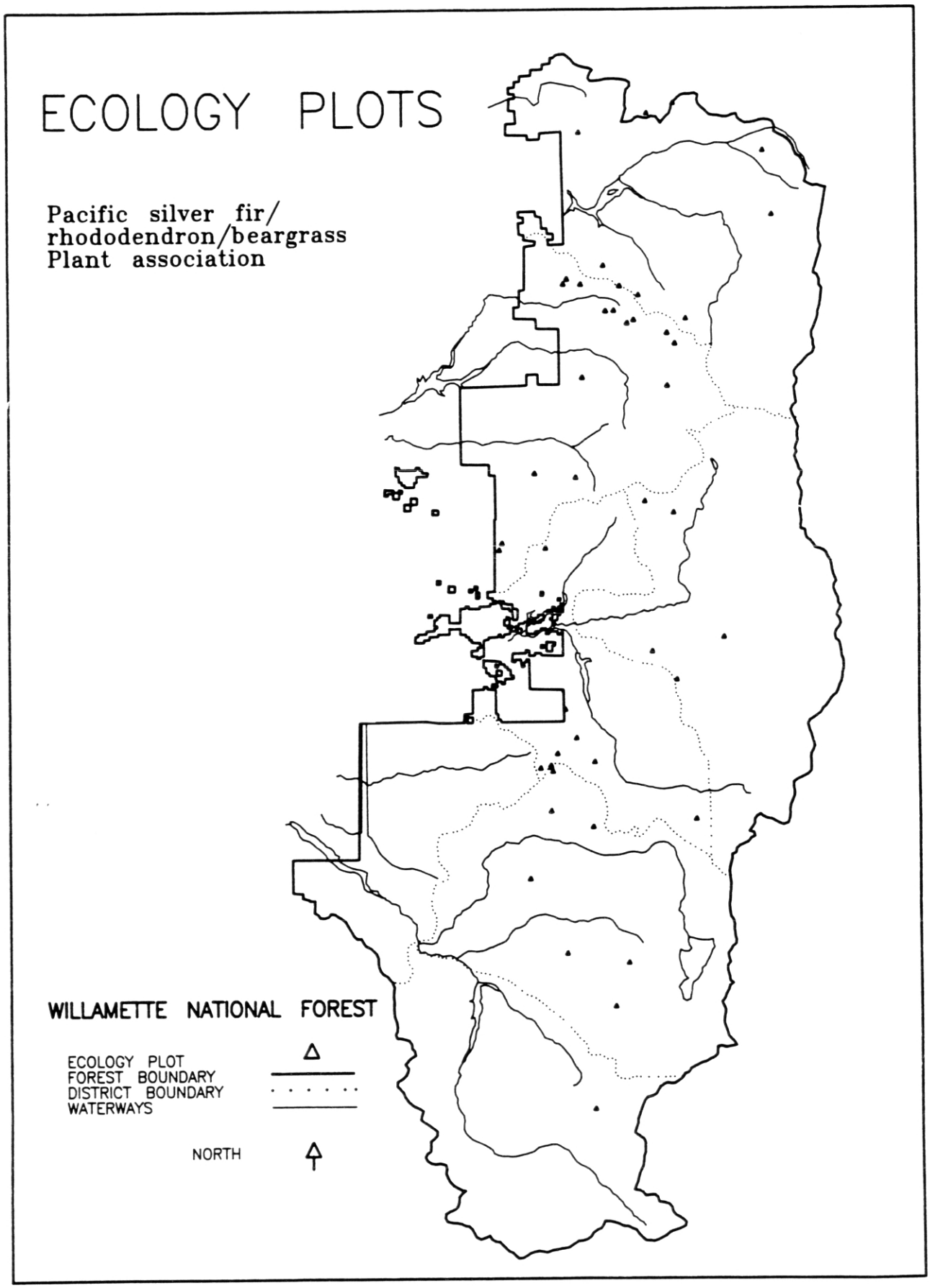
Since the Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry association occupies cool sites, planted noble fir is more likely to survive than Douglas-fir. Douglas-fir is an appropriate species on warmer slopes. Western white pine will survive best where a frost hazard exists, especially on flat areas. Moderate competition from shrub species, such as rhododendron, huckleberries and vine maple can occur in clearcuts. Seedlings should be established as soon as possible following timber harvest.

Soils are generally well-drained and soil compaction should not be severe. Many sites have relatively shallow, rocky soils with low nutrient levels. Slash fires which consume the duff may have a negative impact on the productivity of these sites.

Deer and elk use appears to be low. Trail frequency (22 percent) was among the lowest of the Pacific silver fir zone. Sites with high rhododendron cover can be difficult for big game to enter, but may provide good hiding cover.

Comparisons

A similar association has been described on the H. J. Andrews Experimental Forest (Dyrness et al. 1974) and the Mt. Hood National Forest (Hemstrom et al. 1982). Pacific silver fir/Alaska huckleberry (Henderson and Peter 1981, Henderson et al. 1986, Franklin 1966, Brockway et al. 1983) and Pacific silver fir/Alaska huckleberry/five-leaved blackberry (Franklin et al. 1979) associations which have been described north of the Columbia River are typically found on cooler sites and lack rhododendron. These associations are more herb rich than the Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry association south of the Columbia River.


ECOLOGY PLOTS
Pacific silver fir/
rhododendron/beargrass
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir / rhododendron / beargrass
ABAM / RHMA / XETE CFS6 53

The overstory in this widespread association is typically dominated by Douglas-fir, Pacific silver fir and western hemlock. Noble fir, mountain hemlock and western white pine are present in many stands. Pacific silver fir is the major regenerating species, usually in combination with western hemlock or, less frequently, mountain hemlock.

Rhododendron is the major shrub, averaging 55 percent cover. Dwarf Oregon grape, prince's pine, Alaska huckleberry, big huckleberry, wintergreen, and several other shrub species are usually present. Total shrub cover averages 68 percent. If rhododendron cover is less than 30 percent, other shrub and herb species will be similarly sparse.

The herb layer often consists of beargrass and little else. Twinflower, dogwood bunchberry, rattlesnake plantain, and a few other herbs may be present, generally at less than 2 percent cover each.

Environmental Conditions

The Pacific silver fir/rhododendron/beargrass association indicates a dry, cool environment and, possibly, low soil nitrogen. Elevations range from 3100 to 5300 feet. Slope aspect is variable. Slopes are moderate to steep.

Soils are well drained, shallow to moderately deep, and rocky. Total soil depth in sample pits ranged from 8 to 118 inches and averaged 46 inches (Table 3). Effective rooting depth also ranged widely, from 3 to 99 inches and averaged 30 inches.

The canopy often appears chlorotic, indicating low levels of available nitrogen in the soil. These conditions combine to produce fairly late snowmelt, relatively dry growing conditions and occasional summer frost. The Pacific silver fir/big huckleberry/beargrass association occurs at higher elevations on cooler sites. The Pacific silver fir/rhododendron-dwarf Oregon grape association is more moist and warm.

Productivity and Management Implications

As in other associations dominated by rhododendron, productivity is relatively low. Both Douglas-fir and noble fir site index averaged 96 in our sample (Table 12). Stand basal area and volume are low to moderate compared to the rest of the Pacific

silver fir zone. Productivity is highest below 4000 feet.

Drought and frost are the major threats to seedling survival. Frost pockets are likely to occur wherever cold air accumulates. Noble fir and western white pine should be planted in frost-prone areas. Drought becomes a problem where late snowmelt delays planting until late spring or early summer when evaporative demand is high. Early planting is essential. The roots of noble fir and Pacific silver fir can function and grow at the cold soil temperatures of early spring (Halverson and Emmingham 1982). Douglas-fir should be planted on warm sites. Shading may be necessary to reduce mortality.

If seedlings are not established quickly (within 3-4 years), competition from other vegetation may become severe. A number of shrubs (including snowbrush, huckleberries, rhododendron, and vine maple) dominate clearcuts. The worst problems are associated with extensive scarification or burning, which often encourage the spread of snowbrush, beargrass and long-stolon sedge. Careful management of snowbrush can be important in replenishing nitrogen while allowing conifer establishment. Pocket gopher populations often expand with the establishment of beargrass and sedge mats.

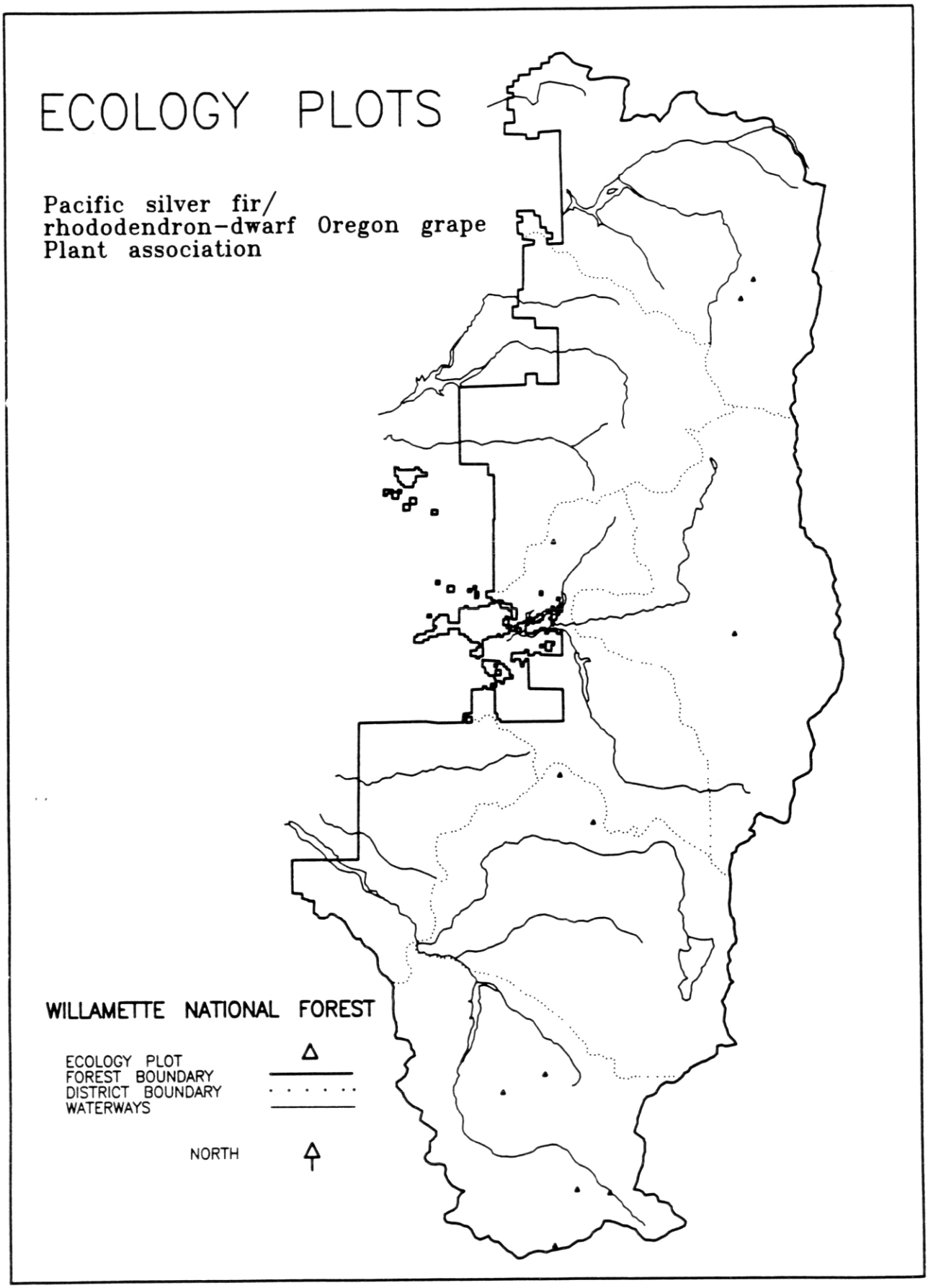
Alternatives to clearcutting and artificial reforestation should be considered in the Pacific silver fir/rhododendron/beargrass association. The shelterwood system may prevent problems associated with both frost and drought. In most cases, artificial regeneration is unnecessary following shelterwood harvest. In either clearcutting or shelterwood harvesting, management of residual Pacific silver fir seedlings can help ensure adequate stocking following harvest. If protected from damage during logging and slash disposal, Pacific silver fir can grow well and is quite resistant to defect-causing infections.

The rocky, nutrient-poor soils typical of this association can be adversely affected by moderately hot slash fires. Care should be taken to preserve the duff and litter layers which contain most of the available nitrogen on many sites.

Our plots showed some evidence of big game use. Trails were observed on 48 percent of the sample plots (Table 10). Herbaceous forage, consisting mainly of beargrass, averaged 222 pounds per acre (green weight).

Comparisons

This association has been described on the Mt. Hood National Forest (Hemstrom et al. 1982). The Pacific silver fir/beargrass (Franklin et al. 1979, Henderson and Peter 1981, Henderson et al. 1986) and Pacific silver fir/big huckleberry/beargrass (Brockway et al. 1983) associations described north of the Columbia River are similar in some respects to the Pacific silver fir/rhododendron/beargrass association. The absence of rhododendron and a slighly cooler microclimate are the major differences north of the Columbia River; other vegetative characteristics and environmental interpretations are similar. The Pacific silver fir/big huckleberry/ beargrass association in the H. J. Andrews Experimental Forest (Dyrness et al. 1974) lacks rhododendron and occurs on cooler sites.


ECOLOGY PLOTS
Pacific silver fir/
rhododendron-dwarf Oregon grape
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir/rhododendron - dwarf Oregon grape
ABAM/RHMA - BENE CFS6 52

Douglas-fir and western hemlock are the major canopy dominants. Pacific silver fir and noble fir are commonly present. Mountain hemlock, western redcedar, and western white pine occasionally occur. The regeneration layer is usually dominated by Pacific silver fir and western hemlock and may include Pacific yew, mountain hemlock and western redcedar.

Rhododendron usually forms a dense thicket. Sites with small amounts of rhododendron are usually depauperate in other shrub and herb species as well. Other shrubs may be abundant, especially dwarf Oregon grape, prince's pine, Oregon boxwood, red huckleberry, vine maple, wintergreen, dwarf bramble, and big huckleberry.

Although several herb species may be present, especially twinflower, dogwood bunchberry, Pacific trillium, vanilla leaf, rattlesnake plantain, and beargrass, total herb cover is usually low. Some stands have a dense evergreen shrub layer and no noticeable herb layer. Tree growth is often slow on these sites, probably due to a poor nutrient status.

Environmental Conditions

This association usually occurs on moderately steep to steep slopes between 3200 and 5300 feet elevation. At lower elevations, it grades into the western hemlock/rhododendron-dwarf Oregon grape association. Slope aspect varies.

Soils range from 30 to over 70 inches deep and tend to be well-drained, stony, loamy sands, loams or clays. Soil depth on sample plots averaged 46 inches (Table 3). Effective rooting depth (28 inches) was among the lowest in the Pacific silver fir zone, indicating the rockiness of soils in this plant association.

The growing season environment is relatively dry and warm. Snow accumulates during winter but melts early on most sites.

Productivity and Management Implications

Our small sample suggests that the productivity of this association is slightly lower than that of the Pacific silver fir/dwarf Oregon grape association. Samples

from both associations were combined for productivity analysis(Table 12). Douglas-fir site index seems lower on sites that lack deciduous shrubs and herbs. Average productivity was greater below 4000 feet elevation.

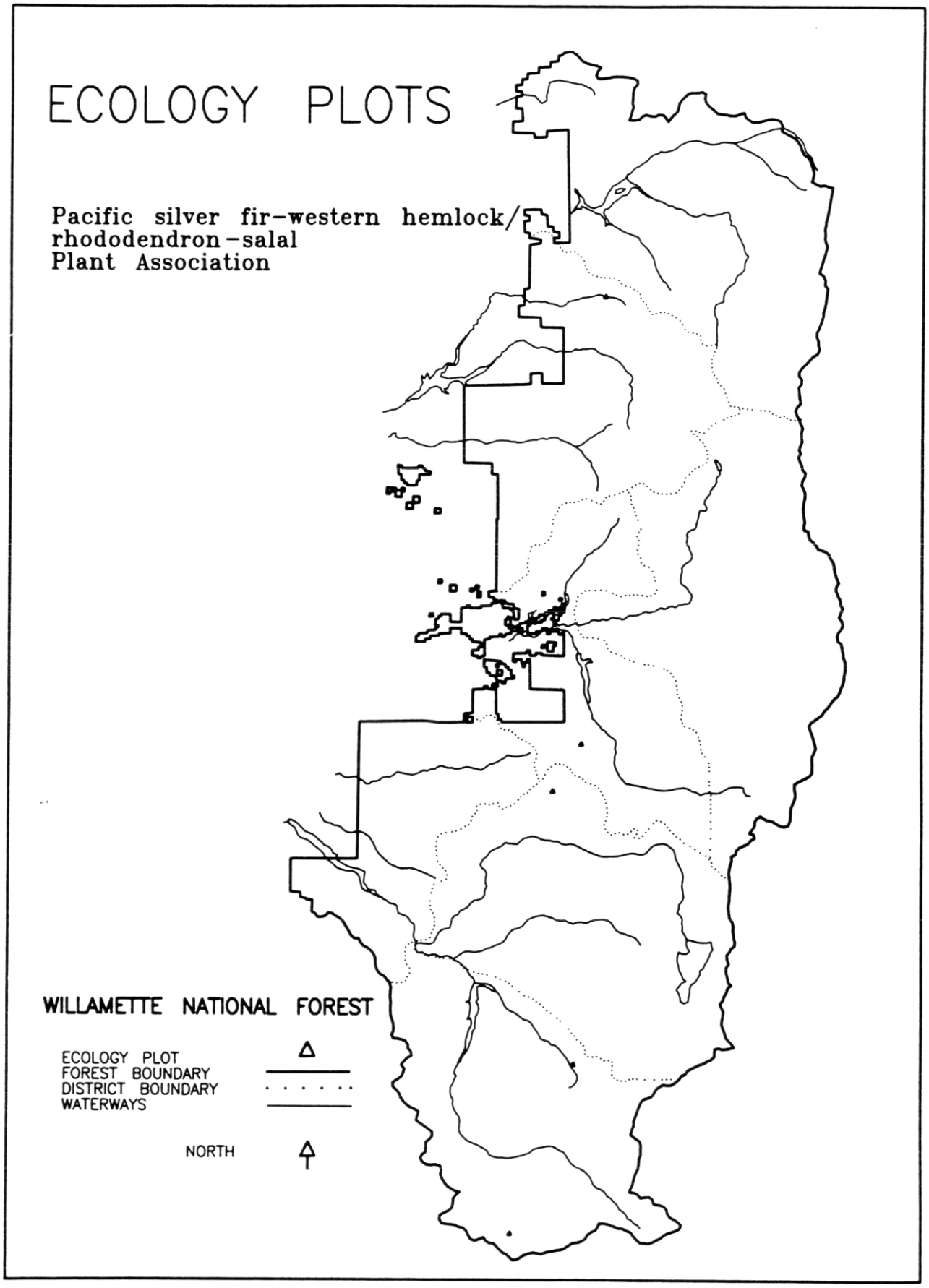
The growing season is relatively long and warm. Summer drought may develop on many sites. Shade blocking and early planting should improve seedling survival. Douglas-fir and noble fir seedlings should survive and grow well. Douglas-fir is more appropriate for droughty slopes. Although growing season frost is not a common problem, noble fir should be planted in flat areas where cold air may accumulate. Shrub field development (snowbrush, vine maple and rhododendron) often occurs, particularly where ground disturbance is severe. Careful management of snowbrush can provide both a recharging of soil nitrogen and aid conifer establishment.

Soils may be sensitive to moderately hot slash fires, particularly on sites which appear to be nitrogen deficient. Care should be taken to preserve the duff and topsoil.

Big game use is concentrated in openings where palatable species, such as Oregon boxwood, are abundant. Fourty percent of our sample plots had big game trails (Table 10). Herbaceous forage averaged 109 pounds per acre (green weight) in this association, the lowest amount for any of the Pacific silver fir series.

Comparisons

This association is also found on the Mt. Hood National Forest (Hemstrom et al. 1982). Since rhododendron is rare north of the Columbia River, no comparable associations were described at Mt. Rainier National Park (Franklin et al. 1979) or on the Gifford Pinchot, Olympic, or Mt. Baker-Snoqualmie National Forests (Brockway et al. 1983, Henderson et al. 1986, Henderson and Peter 1981). A very similar association, western hemlock-Pacific silver fir/rhododendron-dwarf Oregon grape was described by Dyrness et al. (1974) for the H. J. Andrews Experimental Forest.


ECOLOGY PLOTS
Pacific silver fir-western hemlock/rhododendron-salal
Plant Association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir - western hemlock / rhododendron - salal
ABAM - TSHE / RHMA - GASH CFC2 51

Western hemlock and Douglas-fir dominate the canopy. Pacific silver fir, western redcedar and noble fir occur in many stands. While Pacific silver fir regeneration is present in all stands, western hemlock is more abundant.

A dense shrub layer, dominated by rhododendron and salal, characterizes this association. Red huckleberry, vine maple, chinquapin, dwarf Oregon grape, prince's pine and Oregon boxwood are usually present. Total shrub cover averages nearly 100 percent. The herb layer is depauperate or absent. Beargrass, twinflower, and dogwood bunchberry are the most common species.

Environmental Conditions

We did not find examples of this association on the Willamette National Forest. It may be expected to occur on warm, dry sites in the Pacific silver fir zone at the north end of the Forest. Our samples are from adjacent areas on the Mt. Hood National Forest where it occurs on steep, south-facing lower and midslopes below 4100 feet elevation.

Soils range from less than 20 to 60 inches deep, averaging 43 inches (Table 3). They are usually very rocky. This association had the shallowest average effective rooting depth, 18 inches. Soil texture varied from sand to sandy loam and loam, often becoming more clay-rich with increasing depth. Parent material is most often colluvium or residuum.

Summers are warm and dry without growing season frosts. Winter snowpacks are neither deep nor long-lasting. Nitrogen may be limiting, especially in stands lacking an herb layer.

Productivity and Management Implications

The Pacific silver fir-western hemlock/rhododendron-salal association is rare. Our few samples may not adequately characterize productivity. Douglas-fir site index averages 101 but is highly variable (Table 12). As in other associations dominated by rhododendron, tree growth is often slow, possibly limited by low nitrogen availability. Growth of western white pine may exceed that of both Douglas-fir and noble fir on nutrient-poor sites.

Douglas-fir is generally more suitable than noble fir for artificial regeneration. On some sites, high surface temperatures may kill emergent natural seedlings. Although summer frost is infrequent, frost pockets may develop. Noble fir or western white pine are better choices than Douglas-fir for frost-prone sites. The Pacific silver fir-western hemlock/rhododendron-salal association is one of the few in the Pacific silver fir zone where drought is likely to contribute to regeneration difficulty. Shade protection may enhance seedling survival, especially on south slopes or droughty soils.

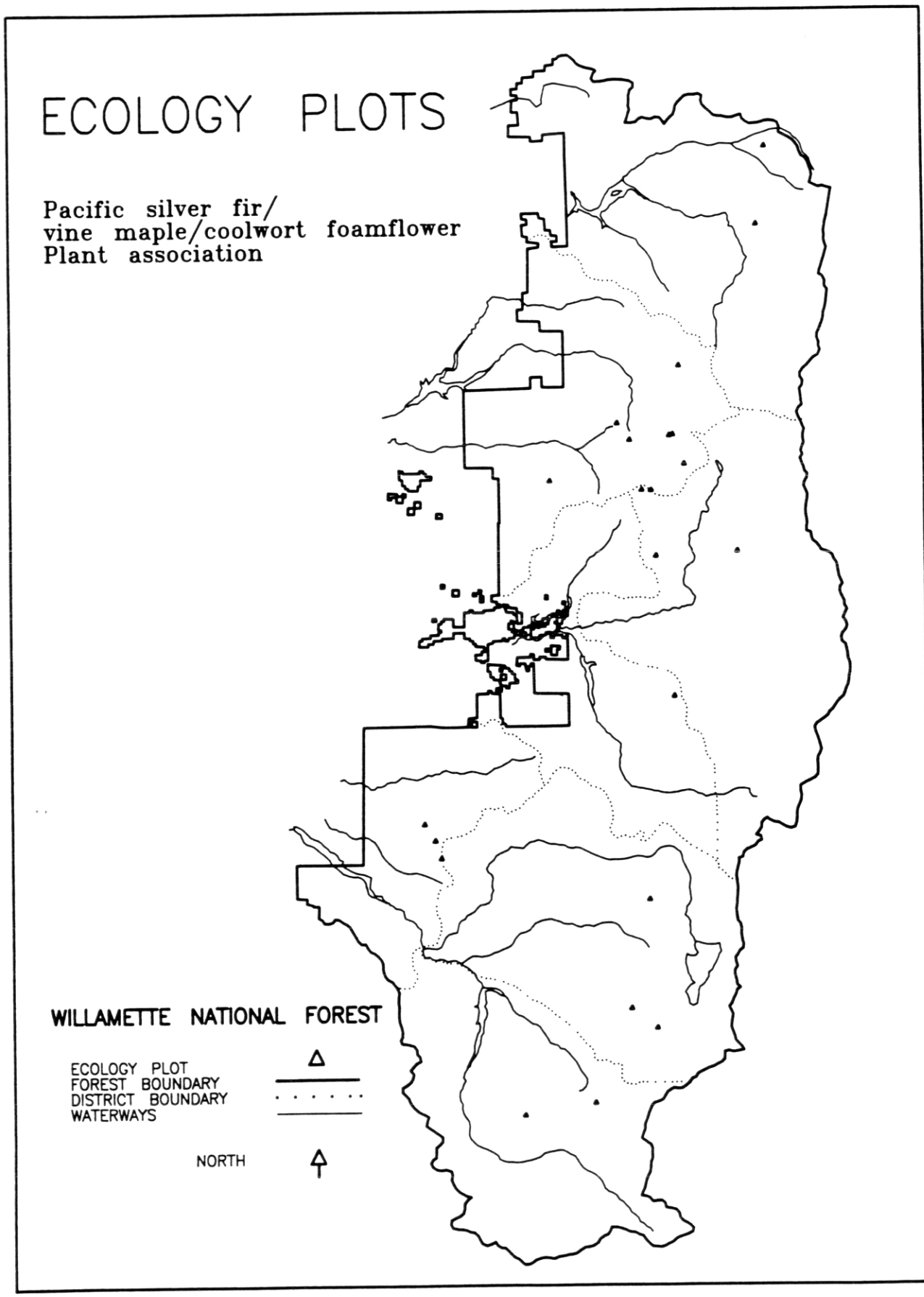
Dense fields of snowbrush, huckleberries, vine maple, rhododendron and salal may develop 4 to 5 years following clearcutting, especially where ground disturbance is severe. Careful management of snowbrush can allow both a recharging of soil nitrogen and aid conifer establishment.

Soils may be adversely affected by moderately hot slash fires. Care should be taken to preserve the duff and topsoil during slash disposal and site preparation.

Wildlife sign was not obvious on our plots. Big game trails were found on 40 percent of the sample plots (Table 10). Big game use is largely for thermal cover since forage is poor. Herbaceous forage averaged 175 pounds per acre (green weight).

Comparisons

This association is comparable to the western hemlock/rhododendron-salal association on the H. J. Andrews Experimental Forest (Dyrness et al. 1974) except that Pacific silver fir is the major climax species. Pacific silver fir-western hemlock/rhododendron-salal stands represent an extension of the western hemlock association into upper elevations where Pacific silver fir and western hemlock are co-climax species. This association is found on the Mt. Hood National Forest (Hemstrom et al. 1982). Pacific silver fir/Alaska huckleberry-salal and Pacific silver fir/salal associations described farther north (Franklin 1966, Franklin et al. 1979, Brockway et al. 1983, Henderson and Peter 1981, Henderson et al. 1986) lack significant rhododendron and occur in cooler environments.


ECOLOGY PLOTS
Pacific silver fir/
vine maple/coolwort foamflower
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Pacific silver fir/vine maple/coolwort foamflower
ABAM/ACCI/TITR CFS6 51

Douglas-fir, Pacific silver fir, noble fir and western hemlock usually dominate the canopy. Mountain hemlock and grand fir (white fir) may be locally common. The regeneration layer is composed almost entirely of Pacific silver fir and western hemlock. Grand fir (white fir) or western redcedar regenerate in some stands.

Shrubs are more prominent in this association than in the Pacific silver fir/coolwort foamflower association. Vine maple is always present. Big huckleberry, baldhip rose, rhododendron, Alaska huckleberry, prince's pine, dwarf Oregon grape, trailing blackberry and dwarf bramble are common.

The rich herbaceous layer resembles that of the Pacific silver fir/coolwort foamflower association. Vanilla leaf, wild ginger, three-leaved anemone, false solomonseal, coolwort foamflower and queencup beadlily occur in most stands. Several other herbs may be present, including: sweetscented bedstraw, pathfinder, inside-out flower, dogwood bunchberry, fairybells, redwoods violet, Pacific trillium, rattlesnake plantain and miner's lettuce.

Species composition changes slightly south of the McKenzie River. Grand fir is common in the canopy and regeneration layer and false solomonseal, Scouler's bluebell and sweetscented bedstraw are more important herbs.

Environmental Conditions

Most sites are on gentle to steep mid-slopes facing east, south, or west. Elevations range from 3300 feet to 4900 feet.

Soils are usually over 40 inches deep (averaging 50 inches, Table 3) and often rocky. Effective rooting depth averaged 33 inches in sample pits. Most are sandy, silty or clay loams developed in colluvium or residuum.

In general, this association indicates well-watered, well-drained, relatively warm, productive sites. Summer frost may occur in depressions or flat areas.

Productivity and Management Implications

The Pacific silver fir/vine maple/coolwort foamflower association is the most productive

in the Pacific silver fir zone. Noble fir and Douglas-fir site indices average 140 and 133, respectively (Table 12). Other species also grow very well, especially western white pine. Volume growth is high. Productivity decreases above 5000 feet elevation.

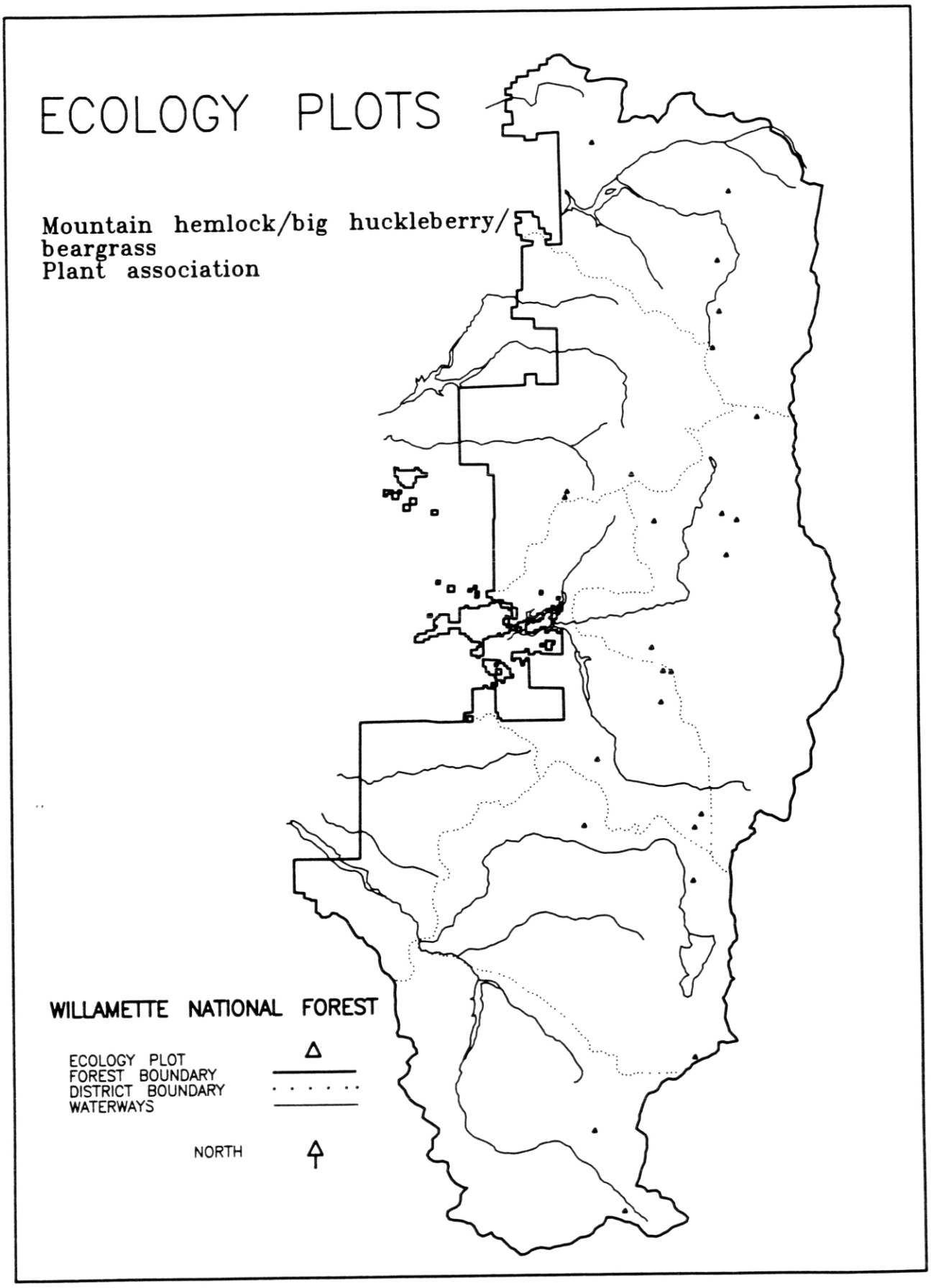
High soil surface temperatures may damage emergent seedlings on steep, south-facing, rocky slopes. Shade may increase seedling survival on these sites. Sullivan (1978) recommends shelterwood cutting, except where blowdown could occur, in the Pacific silver fir/vanilla leaf association (a generally similar association found on the H. J. Andrews Experimental Forest, Dryness et al. 1974). Shrub competition (snowbrush on warm slopes and vine maple, huckleberries and rhododendron) may develop within 3 to 4 years following stand opening. A lush herb layer in early successional stages may encourage large pocket gopher populations.

Soils may be moist and compactible through much of the summer. While soils are not as sensitive to adverse effects from moderately hot slash fires as in most Pacific silver fir associations, care should be taken to minimize topsoil damage.

Big game use is often high. Big game trails were noted on 62 percent of our plots (Table 10). Forage is generally abundant in both early seral and mature stands. Herbaceous forage averaged 478 pounds per acre (green weight) in sample stands.

Comparisons

Other than on the Mt. Hood National Forest (Hemstrom et al. 1982), the Pacific silver fir/vine maple/coolwort foamflower association has not been previously described. The closest descriptions are of the Pacific silver fir/coolwort foamflower habitat type from Mt. Rainier National Park (Franklin et al. 1979) and the Pacific silver fir/vanilla leaf-queencup beadlily association in southern Washington (Brockway et al. 1983). The Pacific silver fir/vanilla leaf-queencup beadlily association lacks the moist-site indicating herb dominance found in the Pacific silver fir/vine maple/coolwort foamflower association. The Pacific silver fir/vanilla leaf association described on the H. J. Andrews Experimental Forest (Dyrness et al. 1974) has a similar herb layer but is not as shrubby.


ECOLOGY PLOTS
Mountain hemlock/big huckleberry/ beargrass
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Mountain hemlock/big huckleberry/beargrass
TSME/VAME/XETE CMS2 16

Mature stands are dominated by mountain hemlock, western white pine, noble fir and Douglas-fir. Western hemlock, a seral species at high elevations (Thornburg 1969), may occur in the canopy. Lodgepole pine is prominent in stands which were burned less than 150 years ago or where laminated root rot has opened the canopy. Subalpine fir is common, particularly on exposed ridges. Although Pacific silver fir regenerates in most stands, regenerating mountain hemlock has at least 2 percent cover or cover equal to that of Pacific silver fir.

The shrub and herb layers are relatively species-poor. Big huckleberry is the most common shrub. Dwarf Oregon grape, prince's pine, grouse huckleberry, and dwarf bramble occur in small amounts.

Beargrass is the dominant herb on most sites. A few other species, such as sidebells pyrola, queencup beadlily, and sickletop pedicularis, may be present. Total herb cover is usually low.

Environmental Conditions

The mountain hemlock/big huckleberry/ beargrass association occurs in some of the harshest forested environments west of the Cascade Crest. Summers are short, cool and dry and sites are subject to frequent frost. Winters are long and snowpacks are deep. Elevations range from about 4100 to 6100 feet. Slopes are flat to moderately steep. Most stands occur on high elevation flats or on the middle to upper one-third of high ridges.

Soil depths range from 19 to 98 inches, averaging 47 inches (Table 3). Effective rooting depth averages 29 inches. Soils are developed in stony glacial till, colluvium, or deep volcanic tephra.

Productivity and Management Implications

Tree growth is slow and reforestation difficult. Mean Douglas-fir site index (95) is higher than noble fir, but noble fir has a better diameter increment in closed stands and may exceed Douglas-fir height by age 150 (Table 12). Pacific silver fir, mountain hemlock, western white pine and lodgepole

pine grow as well or better than Douglas-fir or noble fir and their seedlings can better survive the severe environment. Western white pine is usually taller than other species in stands over 100 years old, typically reaching 70 to 80 feet by age 100 and 110 to 120 feet by age 200. Blister rust can severely reduce it's height growth. Appropriate mountain hemlock site index curves can be found in Johnson (1980).

Regeneration is difficult. Cold subsurface soil temperatures and high soil surface temperatures immediately following snowmelt, rapid soil drying, beargrass-sedge mats, pocket gophers, and a short growing season with frequent summer frost reduce seedling survival. Careful species selection is essential. Advanced regeneration should be saved wherever possible. Sullivan (1978) recommends shelterwood cutting in the similar Pacific silver fir-mountain hemlock/beargrass association on the H. J. Andrews Experimental Forest. There are blowdown problems in some areas.

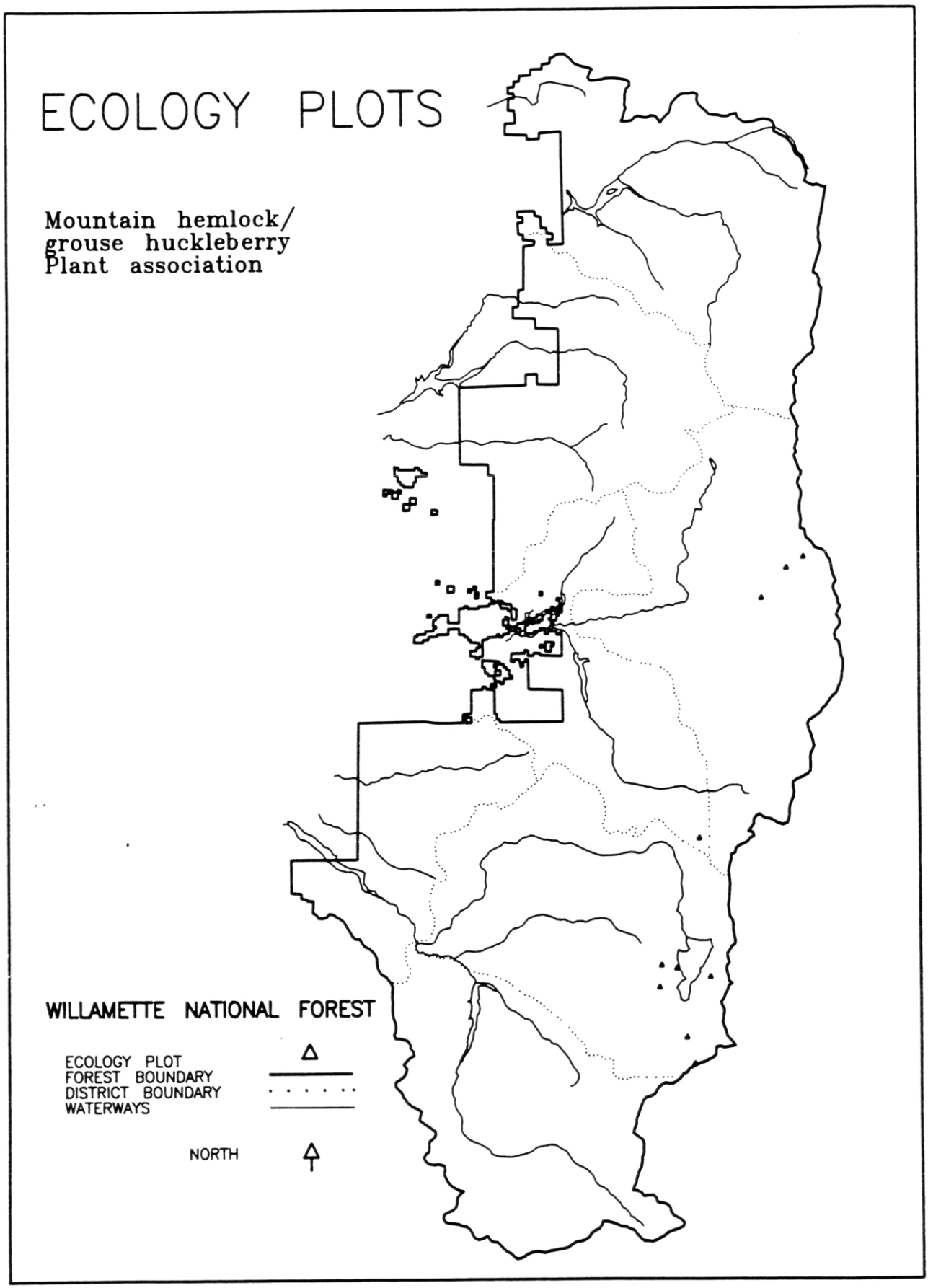
Much of the available nitrogen is in the litter and duff layers. Moderately hot burns can deplete nitrogen levels as well as eliminate advanced Pacific silver fir regeneration. Care must be taken to preserve the duff and topsoil during slash disposal and site preparation.

Big game summer use is significant where huckleberries are abundant and the canopy is open. Big game trails were found in 72 percent of the sample plots in this association (Table 10). Elk seem to be the prevalent big game species. Elk pellets occurred in 36 percent of our samples. Herbaceous forage was moderately high, averaging 309 pounds per acre (green weight).

Comparisons

This association occurs on the Mt. Hood National Forest (Hemstrom et al. 1982). The Pacific silver fir-mountain hemlock/big huckleberry/beargrass association described by Franklin (1966) and our mountain hemlock/ big huckleberry/beargrass association are similar in most respects. Species composition and environment are also quite similar to the Pacific silver fir/beargrass/ mountain hemlock habitat type at Mt. Rainier National Park (Franklin et al. 1974) and the mountain hemlock/big huckleberry association on the Gifford Pinchot National Forest (Brockway et al. 1983).

The mountain hemlock/big huckleberry association on the Olympic and Mt. Baker-Snoqualmie National Forests (Henderson et al. 1986, Henderson and Peter 1981) is found on more moist sites than the mountain hemlock/big huckleberry/ beargrass association in the Oregon Cascades. The Pacific silver fir-mountain hemlock/beargrass association of the H. J. Andrews Experimental Forest (Dyrness et al. 1974) is slightly more herb-rich and more often occurs on west and northwest-facing slopes, indicating more moist conditions.


ECOLOGY PLOTS
Mountain hemlock/
grouse huckleberry
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Mountain hemlock/grouse huckleberry
TSME/VASC CMS1 14

Mountain hemlock and Pacific silver fir dominate the canopy. Several other species, including lodgepole and western white pine, western hemlock, Engelmann spruce, noble fir, Douglas-fir and subalpine fir, may be locally common. Lodgepole pine often dominates disturbed areas. Pacific silver fir and mountain hemlock seedlings and saplings are present in most stands. Pacific silver fir may be more abundant. Other conifers common at high elevations may reproduce under broken canopies.

The depauperate shrub and herb layers often consist of only grouse huckleberry, big huckleberry, prince's pine, and beargrass.

Environmental Conditions

This association occurs in very cold environments with well-drained soils. Snowpacks are deep and persistent. Summers are short with frequent frost. Elevation ranges from 4700 to 5500 feet. Aspect varies. Slopes are usually gentle, causing cold air accumulation and accentuating summer frost.

This association characteristically occurs on the high Cascade plateau where moderately deep soils have developed from volcanic tephra, often over glacial till. Total soil depth averaged 42 inches in sample pits (Table 3). However, total effective rooting depth averaged only 29 inches. Soils are usually sand, sandy loams or loamy sand and are often rocky.

Productivity and Management Implications

The mountain hemlock/grouse huckleberry association is difficult to manage for timber. Productivity and conifer height growth are low. Our sampling included only one plot with Douglas-fir and noble fir. Site index averaged 70 for both species (Table 12). Other conifers grow as well and survive better in these environmentally severe conditions. Western white pine is usually taller than other species. Although our samples of western white pine were limited and variable, dominant trees seem to reach 70 to 80 feet by age 100 and continue to grow to 110 to 120 feet by 200 years (Hemstrom et al. 1982). Blister rust can severely reduce height growth. Mountain hemlock, lodgepole pine and Pacific silver fir survive well in this association, usually reaching 50, 50 to 70, and 50 to 70 feet by age 100, respectively. Mountain hemlock height growth is prolonged into the second and third centuries and dominants are usually taller than all other species except western white pine in old-growth stands. Consult Johnson (1980) for appropriate mountain hemlock site index curves.

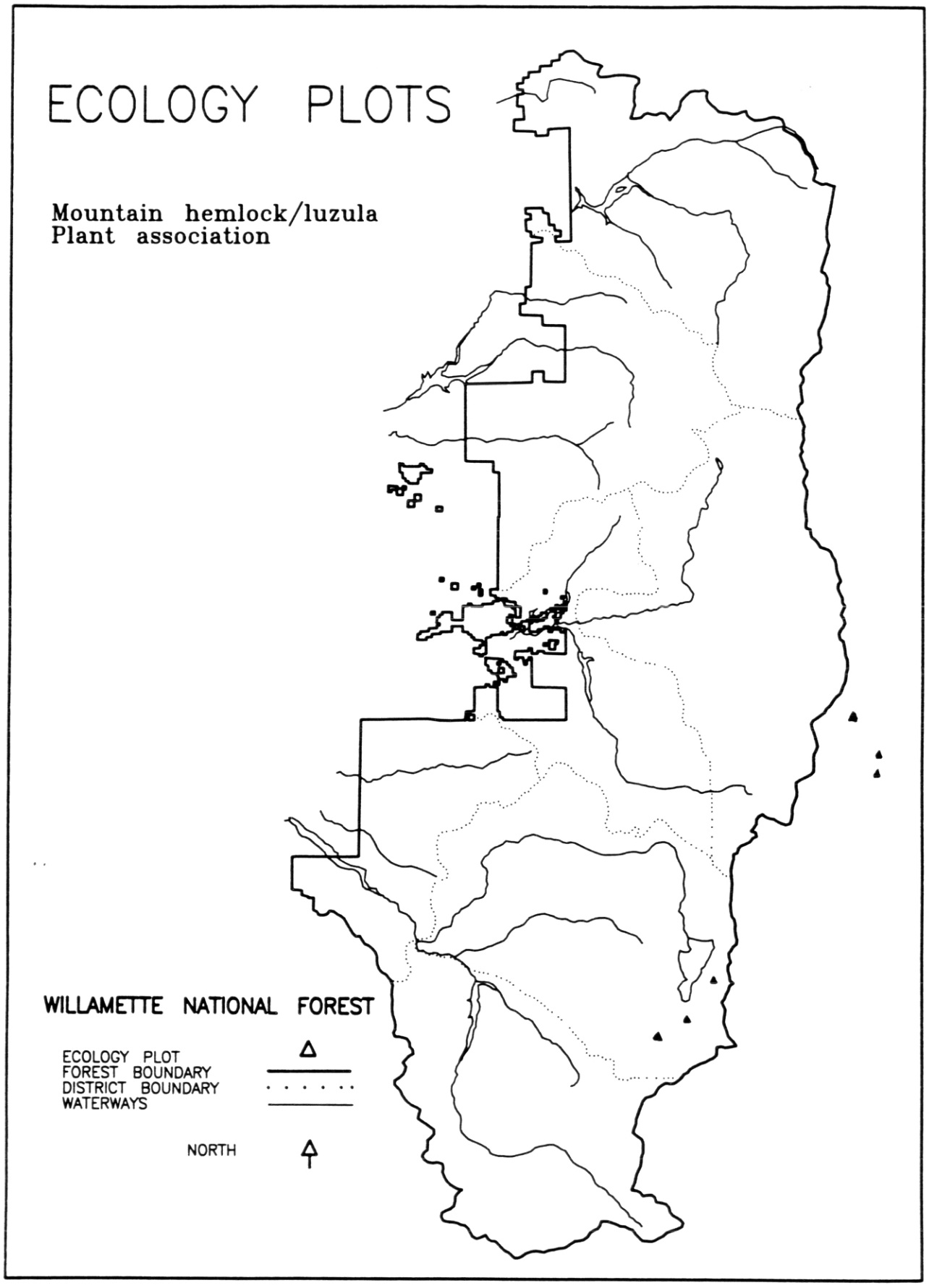
Frequent, severe summer frost, development of beargrass-sedge mats, pocket gopher damage and deep, persistent snowpacks make regeneration difficult. Sullivan (1978) recommends shelterwood cutting in the less severe Pacific silver fir-mountain hemlock/beargrass association on the H. J. Andrews Experimental Forest. Halverson and Emmingham (1982) found that high soil surface temperatures and low subsurface temperatures following snowmelt often induce seedling moisture stress. They also recommend shelterwood cutting and saving advanced Pacific silver fir regeneration wherever possible.

Much of the soil nitrogen is in the litter and duff layers where it can be lost during moderately hot slash fires. Care should be taken to preserve the duff and topsoil during slash disposal and site preparation. Fire can also eliminate the advanced Pacific silver fir regeneration that may be essential for rapid reforestation.

Since this association usually occurs on High Cascades flats and benches, recreational values may be high. Big game summer use may be substantial if the canopy is open and forage is available. Big game trails were recorded in half of the sample plots in this association and deer pellet groups were found in a fourth of them (Table 10). Herbaceous forage averaged 235 pounds per acre (green weight).

Comparisons

This high-elevation association has been described by Franklin (1966) near timberline in the eastern (drier) part of the Mt. Adams province of southwestern Washington. It is most common on the deep ash deposits of the high Cascade plateau at the southern end of the Willamette National Forest. Most of our samples are from the Oakridge Ranger District.


ECOLOGY PLOTS
Mountain hemlock/luzula
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Mountain hemlock/luzula
TSME/LUZULA CMG2 11

The canopy is frequently dense old-growth mountain hemlock with scattered western white pine, and Pacific silver fir. Lodgepole pine usually dominates disturbed areas. Subalpine fir may be present at the highest elevations. Mountain hemlock dominates the regeneration layer, which is typically sparse. Pacific silver fir seedlings may be present.

The shrub layer is nearly absent. Scattered clumps of big huckleberry and grouse huckleberry may be present.

The herb layer is often sparse. Luzula is the most common species, occasionally with as much as 50 percent cover. Beargrass, sidebells pyrola, and a few other species may be present.

Environmental Conditions

Our few samples in this type are from the Waldo Lake area of the Oakridge Ranger District. All the samples were on deep, volcanic ash soils. The topography is usually gentle, averaging above 5000 feet elevation. The climate is typical of the mountain hemlock zone; cold with deep snowpacks and short summers. Growing season frost can occur at any time on flat topographic positions.

Productivity and Management Implications

We have no intensive plots in this association. Douglas-fir is not often present. Tree growth rates are probably similar to those of the mountain hemlock/ grouse huckleberry assocation. Western white pine and lodgepole pine are the most rapidly growing and frost tolerant species. Frequent summer frost, persistent snowpacks, pocket gopher damage, and sedge mats are likely to make regeneration difficult.

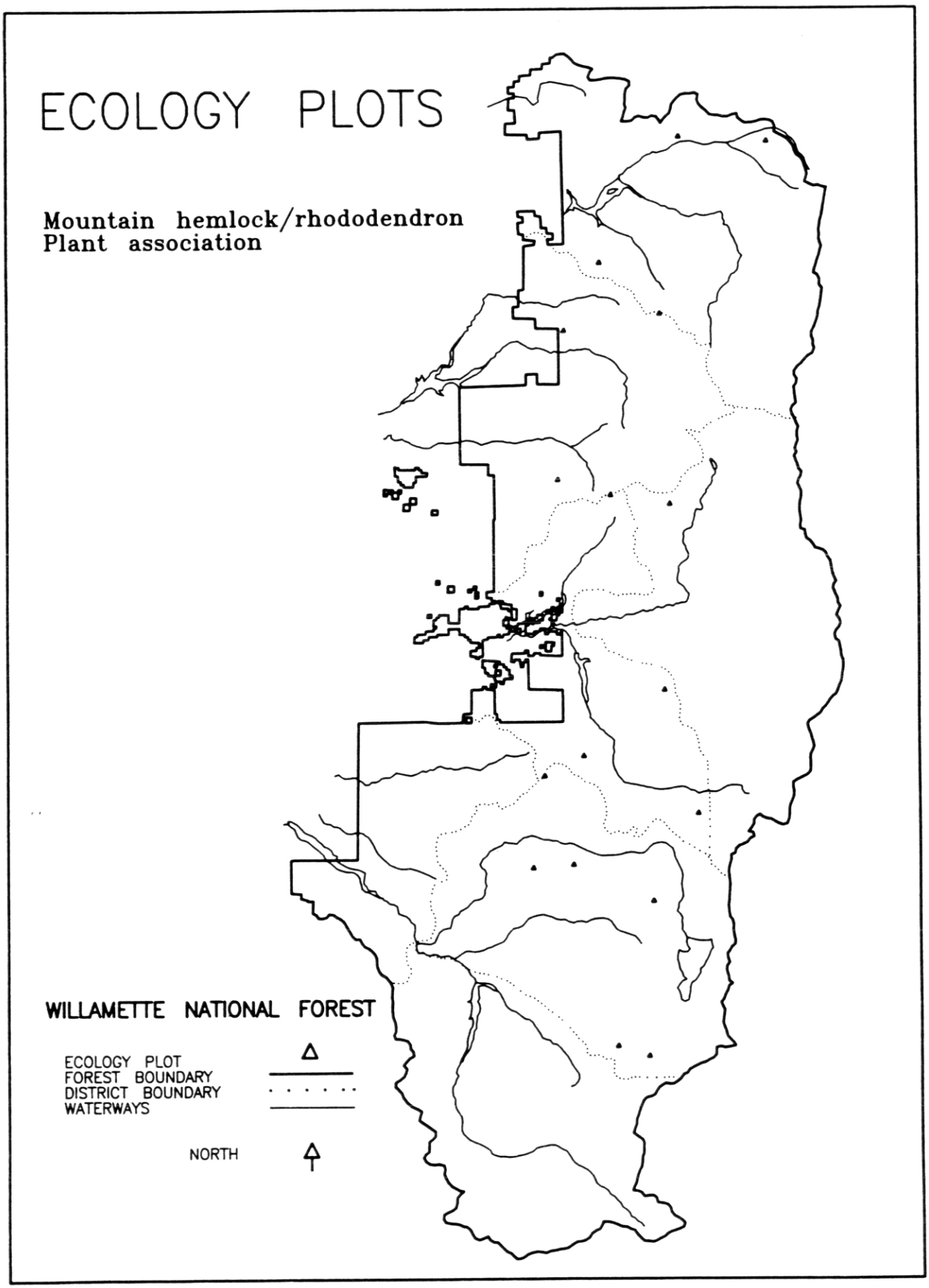
Soils are usually coarse ash with minimal duff accumulations and low nitrogen levels. They are likely to be adversely affected by moderately hot slash fires. Fire will also destroy advanced regeneration mountain hemlock and Pacific silver fir which are the most reliable source of regeneration in harvested areas.

Wildlife use does not appear to be high. This type may provide cover during big game migration to subalpine meadows in summer. It

is common in many heavily used recreation areas, especially around Waldo Lake and in portions of the Three Sisters Wilderness.

Comparisons

Johnson (1980) tenatively described a mountain hemlock/luzula habitat type from the High Cascades near Waldo Lake. The data upon which our description is based come from a research effort conducted by the U.S. Department of Agriculture--Forest Service Pacific Northwest Forest and Range Experiment Station.


ECOLOGY PLOTS
Mountain hemlock/rhododendron
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Mountain hemlock/rhododendron
TSME/RHMA CMS6 12

Mountain hemlock, Pacific silver fir and western hemlock dominate the canopy in most stands. Douglas-fir may be present. Seral stands often contain western white pine and lodgepole pine. The sparse understory consists of rhododendron, beargrass, and traces of wintergreen, prince's pine, and big huckleberry. Rhododendron cover varies from more than 50 percent to less than 10 percent, depending on the openness of the canopy.

Environmental Conditions

This association occurs at lower elevations in the mountain hemlock zone, usually between 4000 and 5000 feet. Most stands are on gentle to moderately steep cirque basins or ridges. Snowpacks are deep and persistent. Frost may occur any time during the summer.

Soils are usually shallow and stony or skeletal, often derived from glacial till. Total soil depth averaged 40 inches and effective rooting depth averaged only 24 inches in sample soil pits (Table 3).

Productivity and Management Implications

Our small sample of this association does not allow accurate estimates of tree growth. Growth rates are probably comparable to those in the mountain hemlock/big huckleberry/ beargrass association. Stands are often in poor condition, with broken-topped and stunted trees.

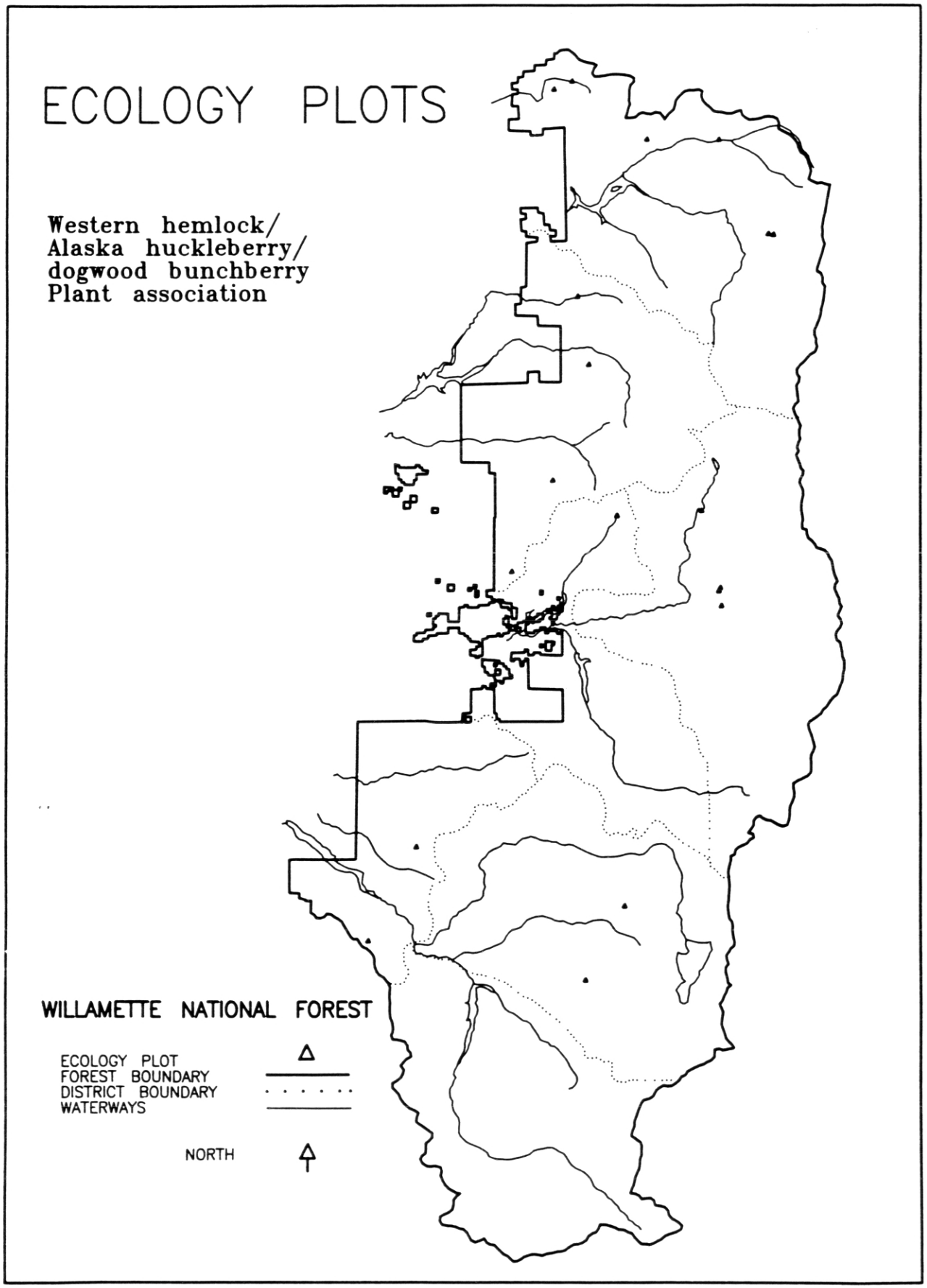
Soil nutrient levels are low. Regeneration is likely to be difficult due to short, cold summers and frequent summer frost. Stony soils may hinder planting. Advanced regeneration Pacific silver fir is the most likely source of stocking. Shelterwood cutting should be considered in areas where blowdown will not be a problem.

Soils are likely to be adversely effected by slash fires. Fire could eliminate most of the nitrogen capital on many sites and most or all of the advanced Pacific silver fir regeneration. Care should be taken to preserve the duff and top soil during slash disposal and site preparation. Snowbrush may develop on some sites and should be managed for nitrogen accumulation and conifer establishment.

Wildlife use was not high in our plots (Table 10). Some use for thermal cover during summer heat may occur.

Comparisons

This association has not been described elsewhere. It is similar to the Pacific silver fir/rhododendron/beargrass association of the Mt. Hood and Willamette National Forests (Hemstrom et al. 1982), but occurs in colder environments.


ECOLOGY PLOTS
Western hemlock/
Alaska huckleberry/
dogwood bunchberry
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock / Alaska huckleberry / dogwood bunchberry
TSHE / VAAL / COCA CHS6 15

Douglas-fir and western hemlock dominate the canopy. Western redcedar is often present. Western hemlock and western redcedar regenerate in most stands. Many stands contain small amounts of Pacific silver fir, indicating a transition to the Pacific silver fir series.

The shrub layer is more typical of the Pacific silver fir series than the western hemlock series. Alaska, oval-leaf, and big huckleberries are generally abundant. Vine maple, dwarf Oregon grape, and red huckleberry occur in most stands. Dogwood bunchberry, queencup beadlily, coolwort foamflower, false solomonseal, and redwoods violet are common herbs.

Environmental Conditions

This relatively uncommon association occurs most often at the north end of the Forest. It is usually found at elevations above 3000 feet on northerly-facing, gentle slopes and near streams. It intergrades strongly into the Pacific silver fir series. Summers are relatively cool compared to the rest of the western hemlock series. Summer drought is mild in most years. Winters are fairly severe with substantial snow accumulations. Occasional summer frost may occur on flat topography or in frost pockets.

SRI type 15 was most common in the soil pits from this plant association. SRI types 3, 63, and 66 were also encountered. These soils are mostly deep and non-rocky. Total soil depth averaged 38 inches and effective rooting depth averaged 31 inches.

Productivity and Management Implications

Douglas-fir growth is moderately good. Site index averages 137 (Table 11). Stand basal areas are generally high averaging 478 square feet per acre. Noble fir would probably grow well on cooler sites in this type. Regeneration may be hampered by summer frost, but Douglas-fir seedlings should generally survive well.

Soils are usually deep and fertile enough that moderate slash burns would not cause unacceptable nutrient loss. Examine the soils on a case-by-case basis.

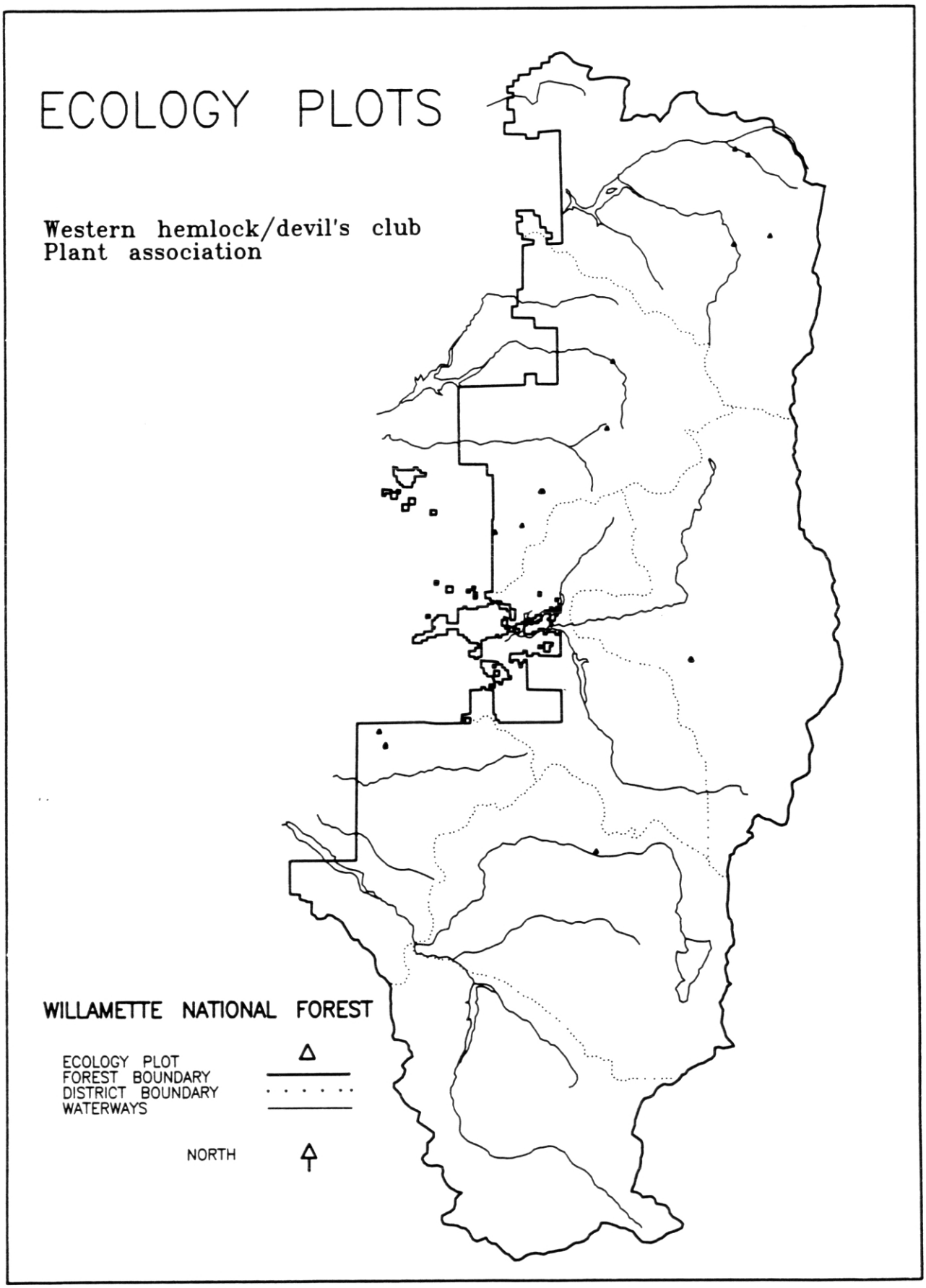
Big game apparently use this association for relief from summer heat. Although pellet

counts and big game trail frequencies were low for this association, thermal cover (51 percent) was higher than that of any other plant association (Table 10). Herbaceous forage was fairly high on plots installed in this type, 490 pounds per acre (green weight, Table 10). Snowpacks are generally too deep to allow winter use.

Old-growth stands are common in this association due to a relatively low natural fire history. Watershed values may be high since the type often occurs in riparian zones.

Comparisons

This association has been described on the Mt. Hood (Halverson et al. 1986) and Gifford Pinchot National Forests (Topik et al. 1986). Dyrness et al. (1974) described a Pacific silver fir/Alaska huckleberry/dogwood bunchberry type on the H. J. Andrews Experimental Forest. This association occurs on cooler, higher-elevation sites.


ECOLOGY PLOTS
Western hemlock/devil's club
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock/devil's club
TSHE/OPHO — WILL CHS5 11

Douglas-fir, western hemlock, and western redcedar dominate the canopy in most stands. Western hemlock is the major regenerating species, often accompanied by western redcedar.

The shrub layer is usually characterized by dense devil's club and vine maple, with smaller amounts of red huckleberry and, occasionally, salmonberry. The lush herb layer usually includes Oregon oxalis, coolwort foamflower, false solomonseal, inside-out-flower, swordfern, ladyfern, dogwood bunchberry, and, in swampy spots, skunk cabbage.

Environmental Conditions

The western hemlock/devil's club association occurs in isolated wet spots on the Sweet Home, Detroit, and Lowell Ranger Districts. It repesents a combination of abundant water and impeded drainage. It occurs mostly in high rainfall areas, especially at upper elevations. Many sites are transitional to the Pacific silver fir series. This type rarely extends over more than a portion of an acre and often occurs as stringers along drainages or seeps. Skunk cabbage may be present in areas of organic, anaerobic soils.

SRI types 15 and 25 occurred in our few sample soil pits (Table 2). Soils are relatively shallow (averaging 35 inches, Table 3) and usually rocky. Average effective rooting depth was among the lowest for all western hemlock plant associations (29 inches).

Productivity and Management Implications

This association requires special management considerations. Soils are wet and prone to compaction throughout the year. In addition, devil's club is usually found near streams or seeps where water quality can be easily impacted. The saturated soil conditions often found in this association should be carefully considered when planning road locations and timber sales. Serious soil damage may occur with heavy equipment use or log skidding across these sites.

Many of the sensitive plant species which might occur on the forested portions of the Willamette National Forest find optimum habitat in the western hemlock/devil's club association.

Douglas-fir site index averages 168 (Table 11). Stand basal area averages 308 square feet per acre.

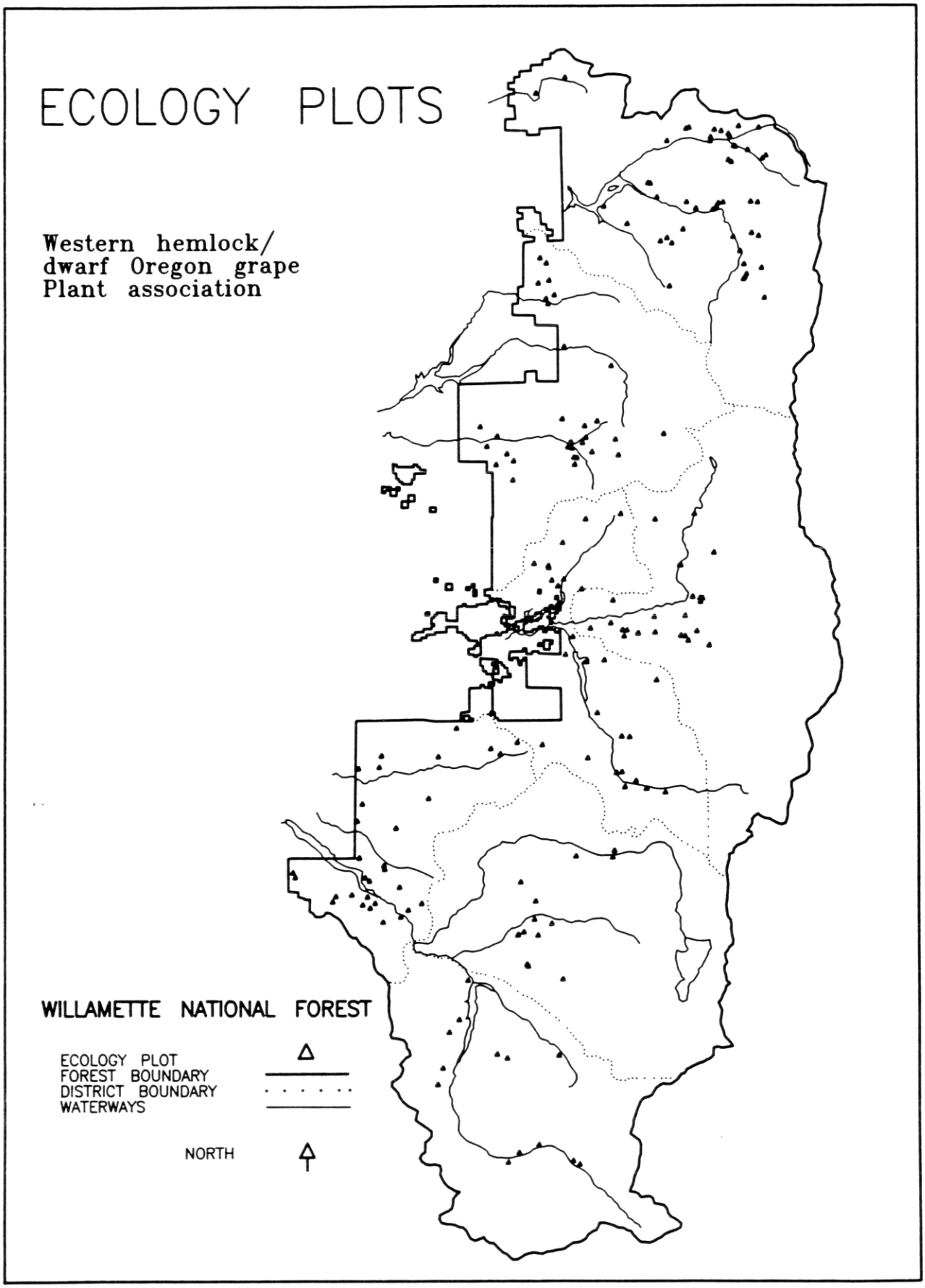
The western hemlock/devil's club association is valuable as wildlife habitat. There is adequate thermal cover and big game use during summer is often extensive. Herbaceous forage is often plentiful. Our sample stands in this type averaged over 1100 pounds of herbacous forage per acre (green weight, Table 10).

Old-growth stands are common due to relatively low natural fire frequency. The combination of typical old-growth structure and proximity to riparian zones indicate that stands in this association should be important for a wide variety of animal species.

Comparisons

Western hemlock/devil's club associations become more common North of the Willamette National Forest. A similar type, the western hemlock/devil's club/swordfern association has been described on the Gifford Pinchot National Forest (Topik et al. 1986). A western hemlock/devil's club/Oregon oxalis association which has large amounts of Oregon oxalis in the understory has been described on the Mt. Hood National Forest (Halverson et al. 1986). A floristically similar association with lower productivity has been described on the Olympic National Forest (Henderson et al. 1986).

Dyrness et al. (1974) described an Alaska cedar/devil's club type on the H. J. Andrews Experimental Forest which is part of the Pacific silver fir series. A western hemlock/devil's club association with high productivity and abundant swordfern and salmonberry occurs on the Siuslaw National Forest (Hemstrom and Logan 1986).


ECOLOGY PLOTS
Western hemlock/
dwarf Oregon grape
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock/dwarf Oregon grape
TSHE/BENE CHS1 25

The dwarf Oregon grape type is the most common western hemlock series association on the Forest. Douglas-fir, western hemlock, and western redcedar dominate the canopy. Western hemlock and, to a smaller extent, western redcedar regenerate in most stands. Bigleaf maple may also be present, especially on drier sites.

Dwarf Oregon grape and vine maple dominate the shrub layer. Prince's pine, trailing blackberry, and small amounts of salal, red huckleberry, rhododendron, and baldhip rose are common. Swordfern and twinflower are the most abundant herbs. Other common herb species include: vanilla leaf, three-leaved anemone, rattlesnake plantain, Pacific trillium, and redwoods violet.

Environmental Conditions

The western hemlock/dwarf Oregon grape association occurs across the Forest on warm, well-drained, moderately productive sites. It occurs on all aspects below 3000 feet elevation and on southerly exposures above 3000 feet. At lower elevations, it merges into the grand fir/dwarf Oregon grape or Douglas-fir - western hemlock/dwarf Oregon grape associations on drier sites. It often intergrades with the Pacific silver fir/dwarf Oregon grape association at upper elevations.

Most of our intensive plots fell in SRI types 15, 16 and 23 (Table 2). Several other SRI types occurred, most indicating moderately deep soils. Many of these SRI types are deep clay soils. The total soil depth on intensive sample pits ranged widely, from 5 to 60 inches (Table 3). Soil depth averaged 43 inches and effective rooting depth averaged 34 inches. In general, the western hemlock/dwarf Oregon grape association indicates relatively warm, well-drained, moderately productive sites.

Productivity and Management Implications

Moderate site conditions and competition levels should allow relatively easy Douglas-fir regeneration with few silvicultural restricitons. Vine maple or Ceanothus spp. may present competition problems if seedlings are not established quickly. Ceanothus spp. can become a competition problem on south aspects or on heavily burned sites. Light spring slash burns can reduce Ceanothus spp. competition problems.

Tree growth is relatively good. Douglas-fir site index averages 139 (Table 11). Stand basal area averages 346 square feet per acre (Table 11).

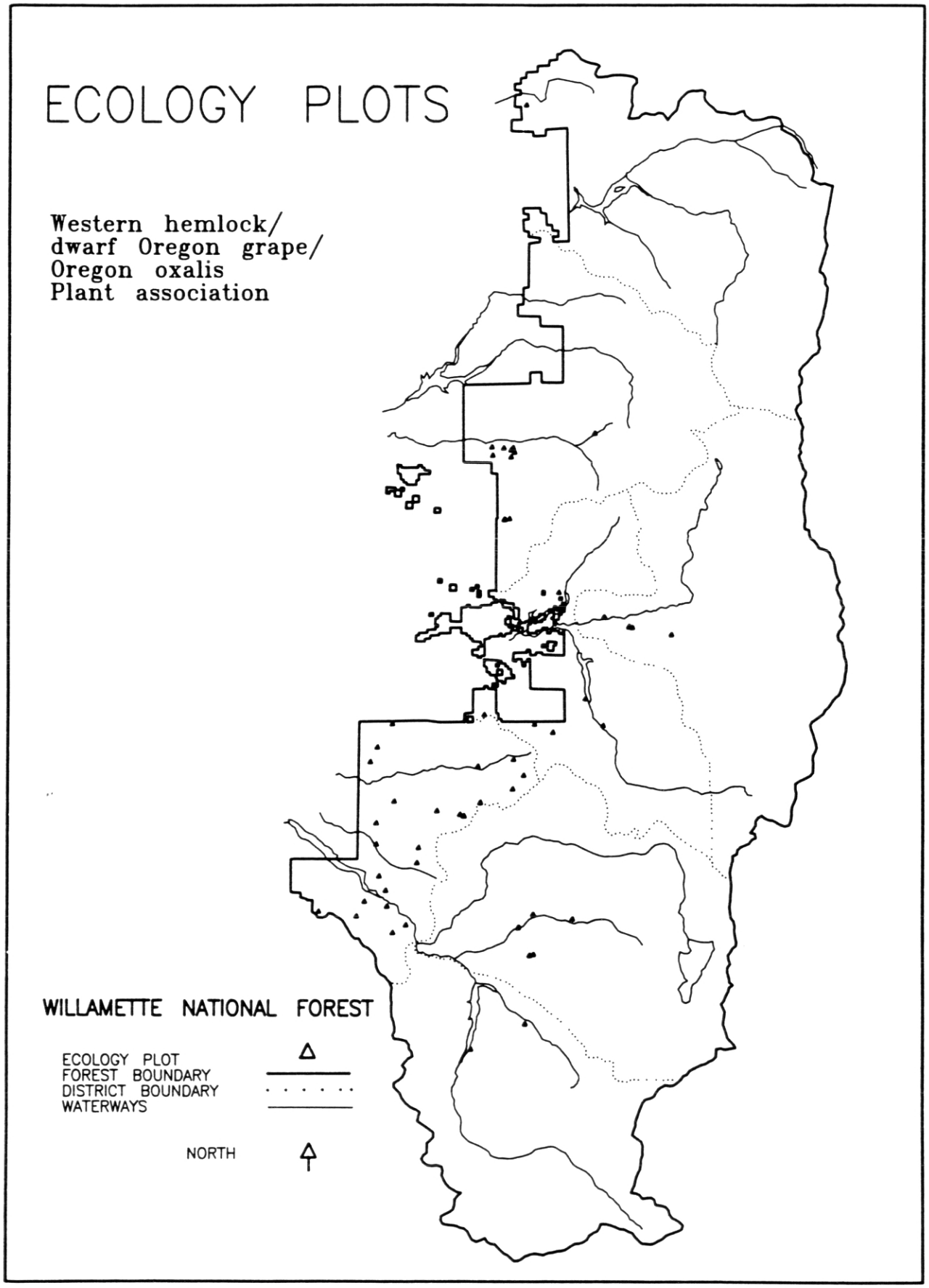
Soils are generally deep and rich enough to resist nutrient losses from moderate slash fires. Soils are usually well drained and not particularly susceptible to compaction, except where they are deep clays. Some sites have responded well to fertilization. Examine soils in the field on a case-by-case basis.

Western hemlock/dwarf Oregon grape sites at lower elevations seem to be frequently used for big game winter range. Big game trails were recorded on half of our sample plots and thermal cover was moderately high (41 percent, Table 10). Some elk damage has been noted on the fringes of north-facing clearcuts in this plant association. Shrub and herbaceous forage is not overly abundant in this plant association.

Old-growth structural characteristics develop in 200 to 250 years, as is typical for moderately productive sites in the western hemlock series.

Comparisons

Western hemlock/dwarf Oregon grape associations occur throughout western Oregon and Washington. Henderson et al. (1986), Halverson et al. (1986), and Topik et al. (1986) described similar types in western Washington and Northwestern Oregon. A similar, but more productive, type is found in the Oregon Coast Range (Hemstrom and Logan 1986). The Douglas-fir/vine maple-dwarf Oregon grape community of the H. J. Andrews Experimental Forest (Dyrness et al. 1974) is a seral stage of the western hemlock/dwarf Oregon grape association. Dwarf Oregon grape is usually accompanied by substantial amounts of rhododendron on the Siskiyou National Forest (Atzet and Wheeler 1984).


ECOLOGY PLOTS
Western hemlock/
dwarf Oregon grape/
Oregon oxalis
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock/dwarf Oregon grape/Oregon oxalis
TSHE/BENE/OXOR CHS1 13

Douglas-fir, western hemlock, and western redcedar dominate the canopy in most stands. Western hemlock is the major regenerating species, often associated with western redcedar. Bigleaf maple is frequently present.

Dwarf Oregon grape, vine maple, and salal dominate the prominent shrub layer. The herb layer consists of a variety of moist-site indicating species, including: Oregon oxalis, coolwort foamflower, inside-out-flower, and vanilla leaf. Oregon oxalis is the dominant species, averaging nearly 20 percent cover. Swordfern, twinflower, and redwoods violet may also be common.

Environmental Conditions

Moisture is more abundant than on typical western hemlock/dwarf Oregon grape sites. Nearly half of our plots in this association were from the Lowell Ranger District. Most of the plots were on gentle, northerly-facing slopes and flats below 3000 feet elevation. Growing seasons are long and generally drought free.

SRI type 23 was most common on our intensive plots (Table 2). This association also occurred on types 15, 16, 25, and 33. Soils tend to be relatively deep, well-drained and well-watered. Average soil depth and effective rooting depth were among the highest of any plant association, 49 and 42 inches respectively (Table 3).

Productivity and Management Implications

Regeneration should not be difficult. Competition from vine maple and other species should be moderate. Many sites will have moist soils well into the growing season. Care should be taken to minimize compaction. Tree growth is very good. Douglas-fir site index averages 159 (Table 11). Stand basal area averages 240 square feet per acre.

Soils should generally be more resistant to fire effects than most others in the western hemlock zone. Hot fires, however, could degrade the high productive potential of these sites.

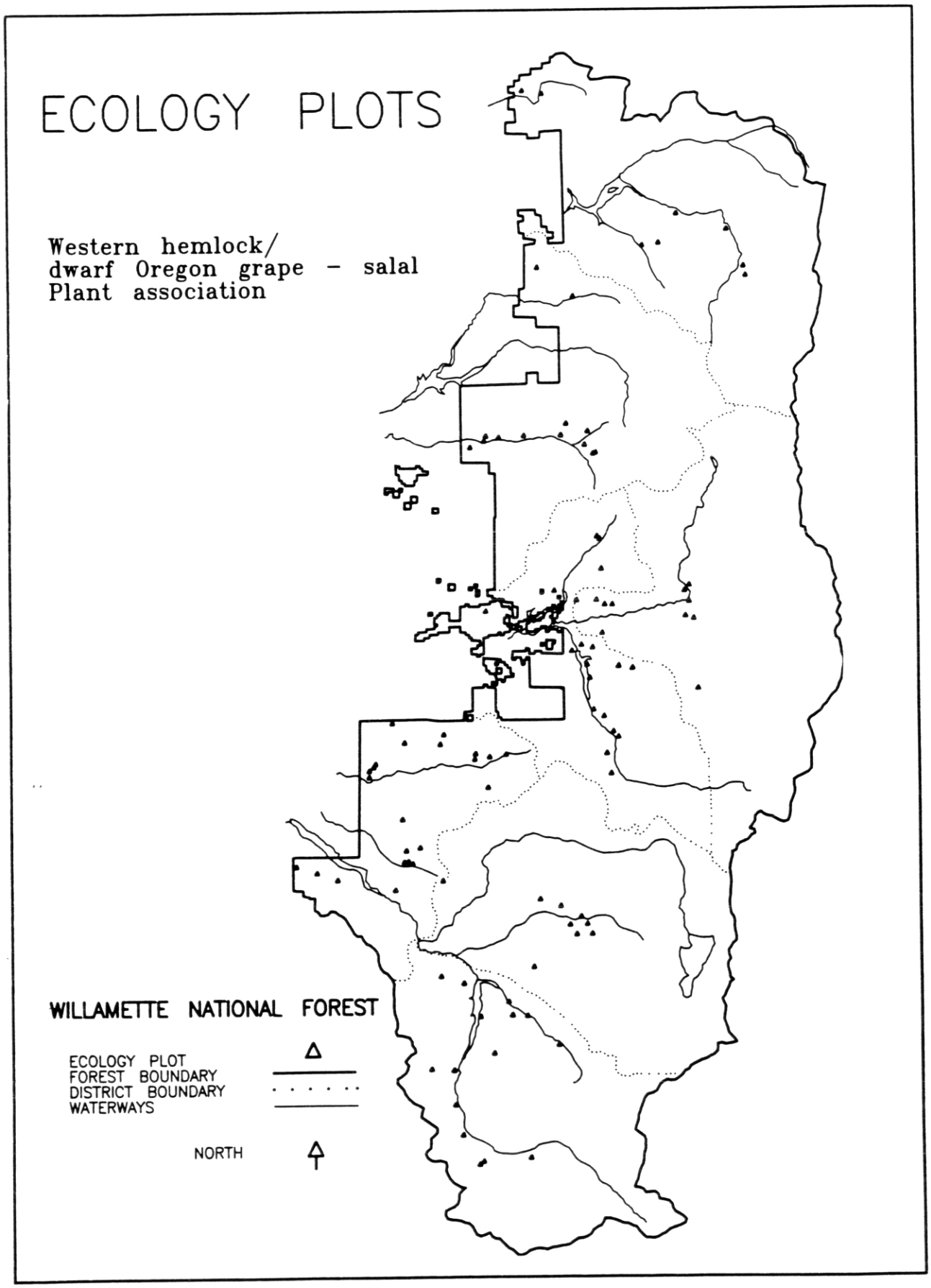
Since conifer growth rates are high, the live structural component of old-growth can be achieved in 150 to 200 years. With management

to produce large woody debris, threshold old-growth woody debris accumulations could be achieved in about the same time period.

Big game winter range use occurs, but is limited since stands are often on northerly-facing slopes. However, summer use may be high. Big game trails were recorded on 59 percent of our plots and thermal cover was relatively high (Table 10). Herbaceous forage is abundant, averaging 647 pounds per acre (green weight). Dwarf Oregon grape forage values were also high, averaging 130 pounds per acre (green weight). Big game browse has been reported in plantations in this type. Elk browse was more prevalent on south-facing slopes and deer browse was more prevalent on north-facing slopes.

Comparisons

Communities with substantial amounts of Oregon oxalis usually fall into western hemlock/Oregon oxalis or western hemlock/swordfern-Oregon oxalis types (Halverson et al. 1986, Topik et al. 1986, Hemstrom and Logan 1986, Dyrness et al. 1974). Our samples of western hemlock/Oregon oxalis communities on the Willamette National Forest had a distinct group of plots with a substantial dwarf Oregon grape component.


ECOLOGY PLOTS
Western hemlock/
dwarf Oregon grape - salal
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock/dwarf Oregon grape - salal
TSHE/BENE - GASH — WILL CHS1 24

Douglas-fir, western hemlock, and western redcedar dominate the canopy. Western hemlock regenerates in most stands, usually accompanied by western redcedar. Many stands contain a substantial bigleaf maple component.

The shrub layer is a combination of vine maple, dwarf Oregon grape, and salal. Small amounts of trailing blackberry, rhododendron, red huckleberry, and other shrubs may be present. The herb layer is generally sparse. Twinflower and swordfern are the only significant herbs in many stands. Vanilla leaf, three-leaved anemone, rattlesnake plantain, and redwoods violet may occur in small amounts.

Environmental Conditions

The western hemlock/dwarf Oregon grape-salal association occurs throughout the Forest on well-drained slopes, usually below 3000 feet elevation. Increased salal cover, compared to the western hemlock/dwarf Oregon grape association, indicates slightly drier conditions. This association is in the middle of the gradient from more mesic conditions in the western hemlock/dwarf Oregon grape association to drier conditions in the western hemlock/salal association. A large portion of the western hemlock series on the Willamette National Forest falls into the western hemlock/dwarf Oregon grape to western hemlock/salal gradient.

SRI types 14, 16, 21, and 23 were most common in our intensive plots (Table 2). Types 25, 35, and 235 also occurred. These SRI types indicate soils that tend to be fairly deep and moderately rocky. Total soil depth averaged 45 inches and effective rooting depth averaged 37 inches in our soil pits (Table 3). Effective rooting depth ranged widely from 9 to 60 inches.

Productivity and Management Implications

Douglas-fir site index averages 133 (Table 11). Stand basal area averages 324 square feet per acre. These values are not significantly different from either the western hemlock/dwarf Oregon grape or the western hemlock/salal associations. Regeneration of Douglas-fir in clearcuts should not be difficult if stands are quickly established. Ceanothus spp. may be a significant competitor in some places.

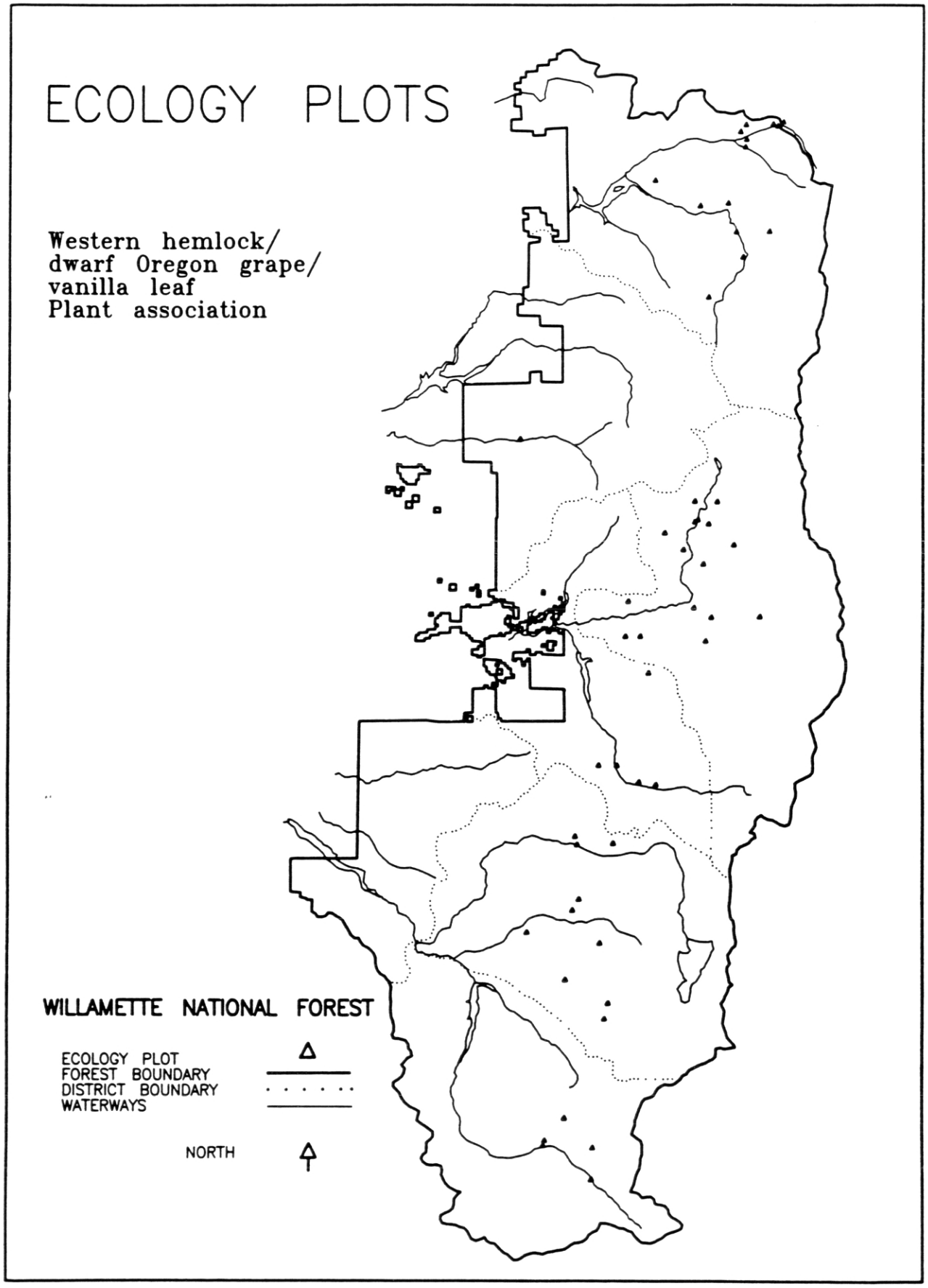
Soils are generally resistant to the effects of moderate slash fires. Special consideration should be given to the few sites with shallow soils or clay textures.

Wildlife values do not seem to be particularly high in this plant association. Big game winter use is not usually significant. This may be due to the low thermal cover which is among the lowest for the western hemlock zone (Table 10). Herbaceous forage is average for the western hemlock zone. Dwarf Oregon grape and salal forage values are high, averaging 150 and 106 pounds per acre (green weight, Table 10).

Old-growth stands have structural characteristics common to other relatively dry western hemlock series sites and growth is slow enough to require 200 years or more for old-growth structure to develop.

Comparisons

Both Halverson et al. (1986) and Topik et al. (1986) have described this plant association in Northwestern Oregon and Southwestern Washington. Henderson et al. (1986) described a western hemlock/salal-dwarf Oregon grape association on the Olympic National Forest. That association has similar productivity characteristics but much greater amounts of salal in the shrub layer.


ECOLOGY PLOTS
Western hemlock/
dwarf Oregon grape/
vanilla leaf
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock/dwarf Oregon grape/vanilla leaf
TSHE/BENE/ACTR CHS1 14

The canopy layer consists of Douglas-fir and western hemlock, often including western redcedar. Western hemlock is the major regenerating species, occasionally mixed with western redcedar and grand fir.

The shrub layer is typical of dwarf Oregon grape dominated communities. Vine maple, dwarf Oregon grape, snowberry, salal, and baldhip rose are the dominant shrubs. Vanilla leaf, coolwort foamflower, false solomonseal, queencup beadlily, swordfern, pathfinder, three-leaved anemone, and several other species are common in the diverse herb layer. Oregon oxalis is minor or absent.

Environmental Conditions

This association occurs in the relatively dry, cool portion of the western hemlock series. It is most often found on gentle, southwest-facing slopes between 2000 and 4000 feet elevation. It is most common on the McKenzie and Detroit Ranger Districts.

Summer drought develops more frequently and intensely than in the western hemlock/dwarf Oregon grape/Oregon oxalis association. The growing season is long and relatively cool.

SRI types 16 and 66 were most common on our intensive plots (Table 2). SRI types 21, 23, 25, and 64 also occurred. These soils, execpt 21, are relatively deep, often with a substantial coarse fragment component. Total soil depths in intensive soil pits ranged from 8 to 66 inches and averaged 42 inches (Table 3). Effective rooting depth averaged 35 inches.

Productivity and Management Implications

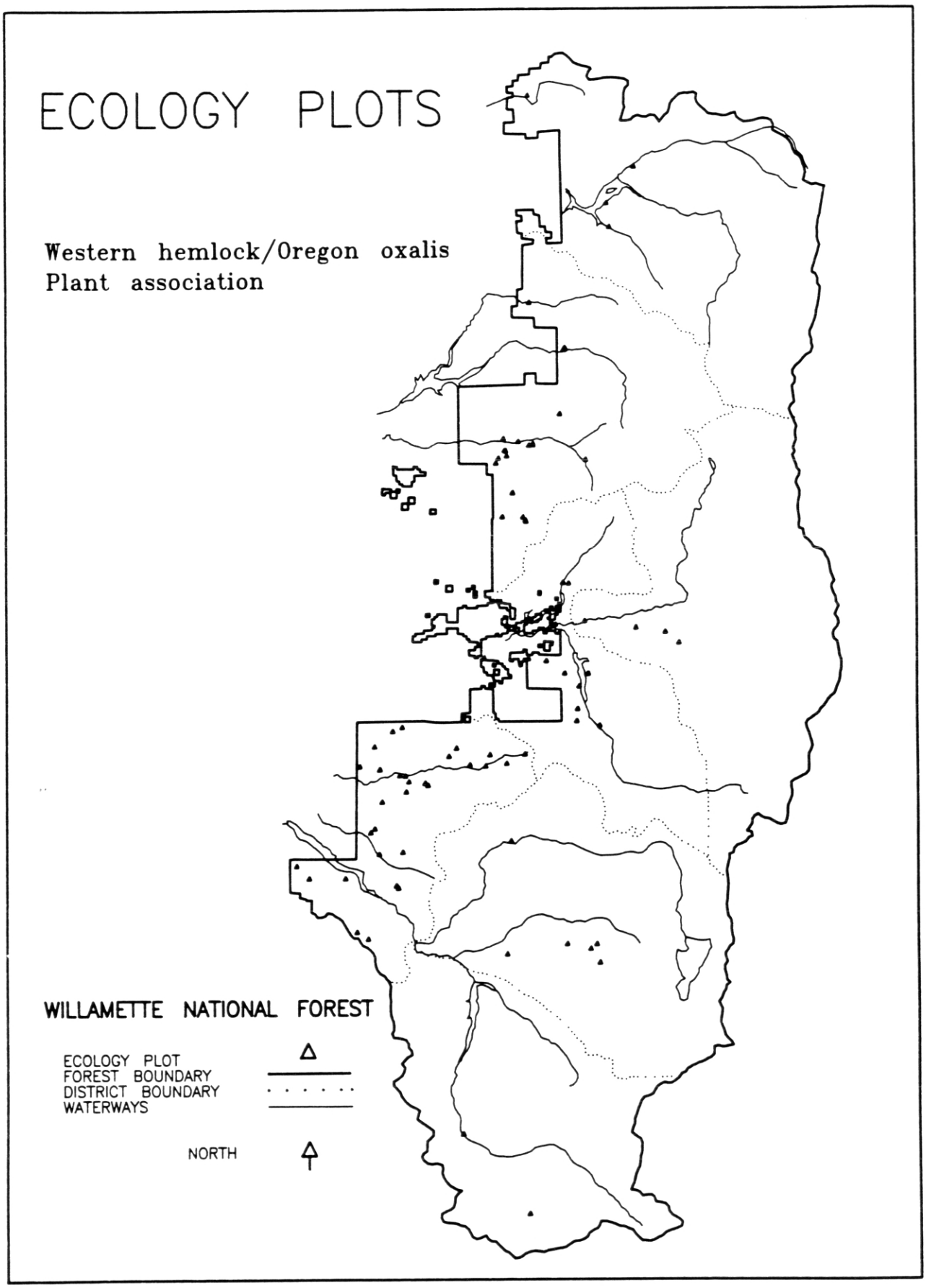
Conifer growth is generally better than in the western hemlock/dwarf Oregon grape association. Douglas-fir site index averages 158 and stand basal area averages 400 square feet per acre (Table 11). Regeneration can be difficult on some sites, due to planting difficulties in rocky soils, Ceanothus spp. and snowberry competition, gopher damage and summer drought. Sites can dry out quickly in the spring, especially when severely burned. At elevations near 4000 feet, growing season frost should be expected on flat terrain or in frost pockets. Once established, stands should grow very well. Soils should be generally resistant to impacts from moderate slash fires.

This association is not usually heavily used as winter range by big game. However, summer use may be extensive. Deer and elk pellets were recorded on one-fourth of our sample stands. Nearly half of our samples had big game trails (Table 10). Herbaceous forage is not overly abundant, averaging 262 pounds per acre (green weight). Dwarf Oregon grape was the most abundant shrub forage recorded, averaging 114 pounds per acre green weight (Table 10).

Old-growth characteristics are similar to the rest of the western hemlock/dwarf Oregon grape associations. Due to rapid tree growth, old-growth characteristics may begin to develop in less than 200 years.

Comparisons

This association is similar to the western hemlock/vanilla leaf types described for Northwestern Oregon and Southwestern Washington (Halverson et al. 1986 and Topik et al. 1986). However, the western hemlock/dwarf Oregon grape/vanilla leaf association has a substantial dwarf Oregon grape component and higher site index for Douglas-fir.


ECOLOGY PLOTS
Western hemlock/Oregon oxalis
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock/Oregon oxalis
TSHE/OXOR — WILL CHF1 11

The canopy consists of Douglas-fir, western hemlock, and western redcedar. Both western hemlock and western redcedar regenerate in most stands. Bigleaf maple is often present.

Vine maple and small amounts of dwarf Oregon grape, salal, and red huckleberry make up most of the sparse shrub layer. Oregon oxalis and swordfern dominate the herb layer. Many other herbs may be present, including: coolwort foamflower, false solomonseal, fairybells, sweetscented bedstraw, Pacific trillium, inside-out-flower, and redwoods violet.

Environmental Conditions

The western hemlock/Oregon oxalis association is found on moist, fertile sites throughout the Forest. It is most common at low elevations on gentle, northerly-facing slopes in the Lowell, Blue River and Sweet Home Ranger Districts. It indicates fertile soils and well-watered sites with long growing seasons.

SRI type varied on our intensive plots, including 8, 13, 15, 16, 23, 25, and 33 (Table 2). These are deep soils (total depth on sample plots averaged 47 inches, Table 3) found on gentle topography. Effective rooting depth was fairly deep, averaging 30 inches. Soils may be moist well into the summer, but should not be saturated.

Productivity and Management Implications

Tree growth in this association can be impressive. Douglas-fir site index averages 158 and often exceeds 170 (Table 11). Stand basal area averages 351 square feet per acre. Regeneration should be easy but on a few sites red alder or vine maple competition may develop. Mountain beaver may be present.

Soils are moist much of the growing season and subject to compaction. Soils should generally be resistant to impacts from moderate slash fires.

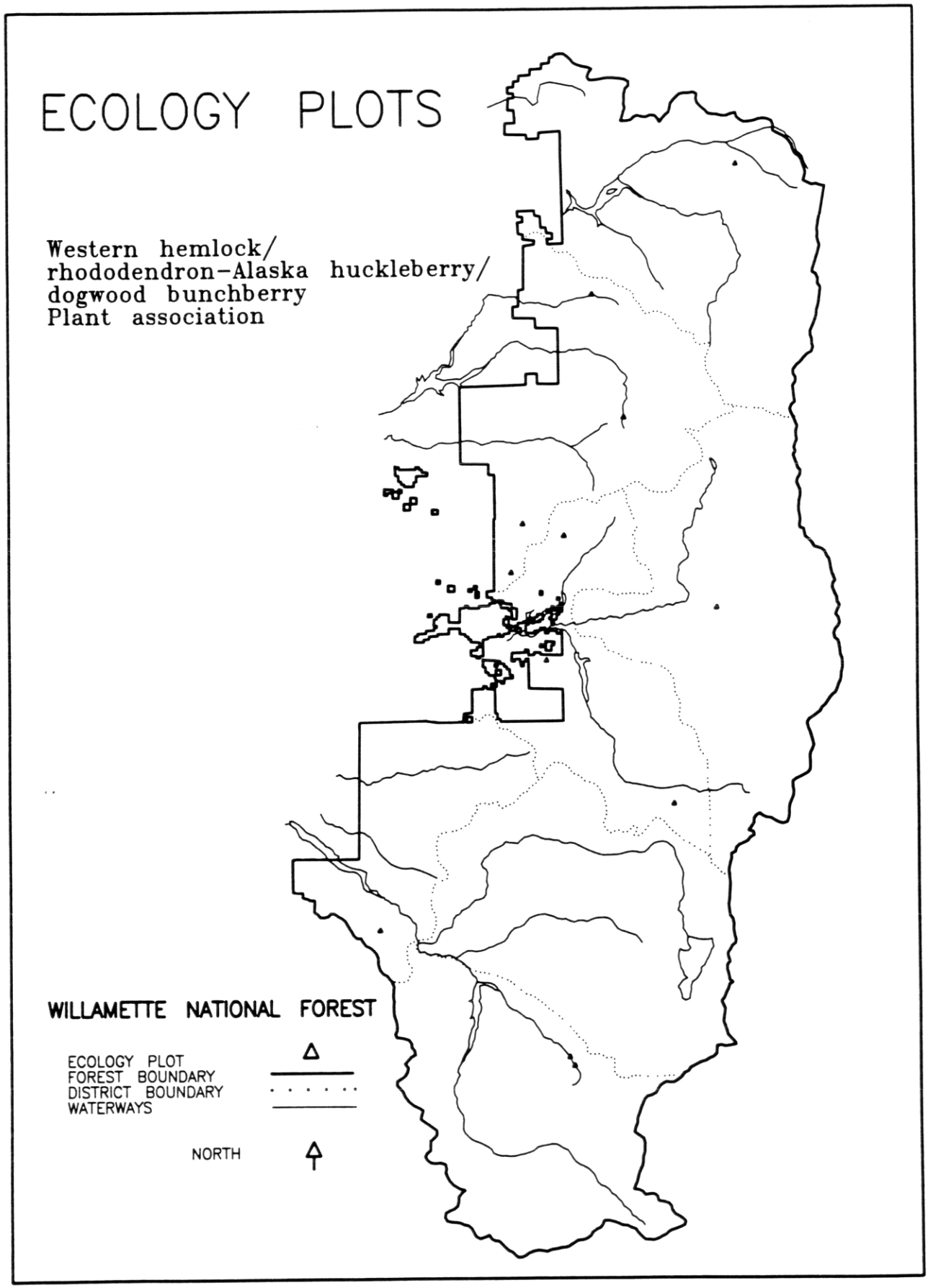
Wildlife habitat values are often high in natural stands. Big game trails were present in over half of our sample plots (Table 10). Herbaceous forage is also abundant in this type.

Since natural fire frequency has been relatively low, old-growth stands are common.

Large trees develop by 150 to 175 years due to high site quality. There is a good opportunity to manage for old-growth structure over a relatively short time period. This association often occurs in riparian zones where it provides important wildlife habitat and maintains water quality.

Comparisons

Western hemlock/Oregon oxalis communities occur throughout Northwestern Oregon and Southwestern Washington on moist sites with rich soils (Halverson et al. 1986, Hemstrom and Logan 1986, Dyrness et al. 1974). They invariably indicate high productivity. Similar associations have been described by others as western hemlock/ swordfern-Oregon oxalis types (Topik et al. 1986). Swordfern is not a diagnostic herb in our western hemlock/Oregon oxalis association.


ECOLOGY PLOTS
Western hemlock/
rhododendron-Alaska huckleberry/
dogwood bunchberry
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock / rhododendron - Alaska huckleberry / dogwood bunchberry
TSHE / RHMA - VAAL / COCA CHS3 26

Douglas-fir and western hemlock dominate the canopy, usually with western redcedar. Western hemlock is the major regenerating species, often with a trace of Pacific silver fir. Pacific yew occurs in most stands.

The shrub layer consists of dense rhododendron and Alaska huckleberry mixed with smaller amounts of vine maple, dwarf Oregon grape, salal, red huckleberry, and prince's pine.

The herb layer is very similar to the Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry association. Dogwood bunchberry, twinflower, queencup beadlily, coolwort foamflower, goldthread, and fairybells are common in most stands.

Environmental Conditions

This association occurs in the transition between the Pacific silver fir and western hemlock zones. Western hemlock is the indicated climax dominant. Stands of this type are spread across the Forest on northerly- facing, moderately steep slopes, usually above 3000 feet elevation. SRI types 13, 16, and 25 occurred in our few intensive samples (Table 2). Soils are well-drained to excessively well-drained and often rocky. Soil depth ranged from 30 to 60 inches and averaged 48 inches in our intensive soil pits (Table 3). Effective rooting depth averaged 35 inches.

Since this association characteristically occurs on steep, north aspects, transpirational demands and growing season drought stresses are lower than on similar soils in most other associations. Winter conditions are similar to those on the lower half of the Pacific silver fir zone. Winter snow accumulations can be substantial and summer frost may occur. Conifers often appear chlorotic, possibly due to nitrogen deficiency.

Productivity and Management Implications

Conifer growth is moderately good. Douglas-fir site index averages 131 (Table 11). Stand basal area is typically high, averaging 389 square feet per acre. Some sites will be difficult to plant due to rocky soils. Survival of planted Douglas-fir should be good. Competition due to rhododendron, huckleberries and other shrubs could develop after clearcutting. Ceanothus spp. may be an important competitor on south-facing slopes.

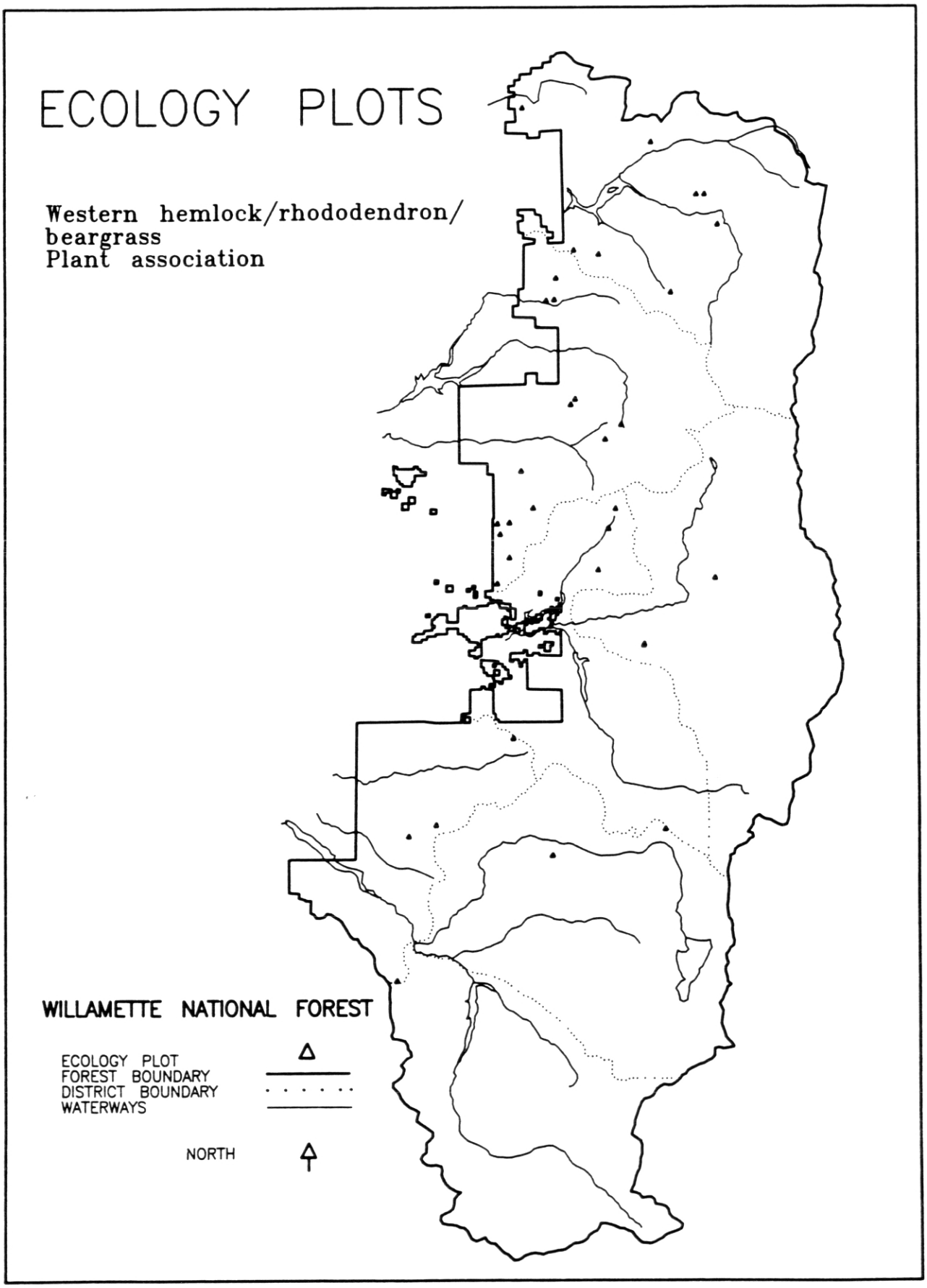
Stony, nutrient poor soils which may occur in this association are sensitive to impacts from moderate slash fires. Fires which do not remove the duff will probably not produce significant impacts.

Wildlife use of this association does not appear to be high. Snowpacks are generally too deep for good winter range. Herbaceous forage amounts are moderately high, averaging 380 pounds per acre (green weight) on sample plots (Table 10). Big game trails were observed on one-third of the plots.

Old-growth characteristics develop relatively slowly, as is typical for most rhododendron dominated types.

Comparisons

A similar association with slightly lower Douglas-fir site index has been described on the Mt. Hood National Forest (Halverson et al. 1986). At higher elevations and cooler sites on the H. J. Andrews Experimental Forest Dyrness et al. (1974) described a Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry association.


ECOLOGY PLOTS
Western hemlock/rhododendron/
beargrass
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock / rhododendron / beargrass
TSHE / RHMA / XETE — WILL CHS3 53

Douglas-fir and western hemlock are the major canopy species, often accompanied by western redcedar. Western hemlock is the major regenerating species. Pacific silver fir also occurred in several of our sample plots.

Rhododendron, vine maple, salal, and dwarf Oregon grape dominate the shrub layer in most stands. Chinquapin may be abundant. Red huckleberry, prince's pine, and trailing blackberry are usually present. Except for beargrass and twinflower, an herb layer is nearly absent.

Environmental Conditions

The western hemlock/rhododendron/beargrass association occurs on rocky ridges and upper slopes throughout the Forest. It is most common above 3000 feet elevation and is often transitional to the Pacific silver fir/rhododendron/beargrass association.

SRI types in our intensive plots varied substantially. Types 16, 23, and 61 were the most common (Table 2). Types 25, 33, 35, and 64 also occurred. The fairly deep average soil depth (48 inches, Table 3) and effective rooting depth (36 inches) on intensive plots indicate that factors other than soil depth seem to operate on many sites. Most stands are widely spaced and chlorotic. Nitrogen may be limiting on some sites.

Environmental conditions in this plant association are among the most severe encountered in the western hemlock zone. Sites are often dry and exposed. Winters are usually harsh and summers are hot and dry. Summer frost may occur on sites above 3000 feet elevation.

Productivity and Management Implications

This association has the poorest conifer growth potential in the western hemlock series. Douglas-fir site index averages 122 (Table 11). Stand basal area is usually low due to poor stocking and averages 316 square feet per acre. Sites with shallow, rocky soils may be difficult to plant. Drought and exposure may cause seedling survival problems. Ceanothus spp. and rhododendron competition may develop within three to five years following clearcutting.

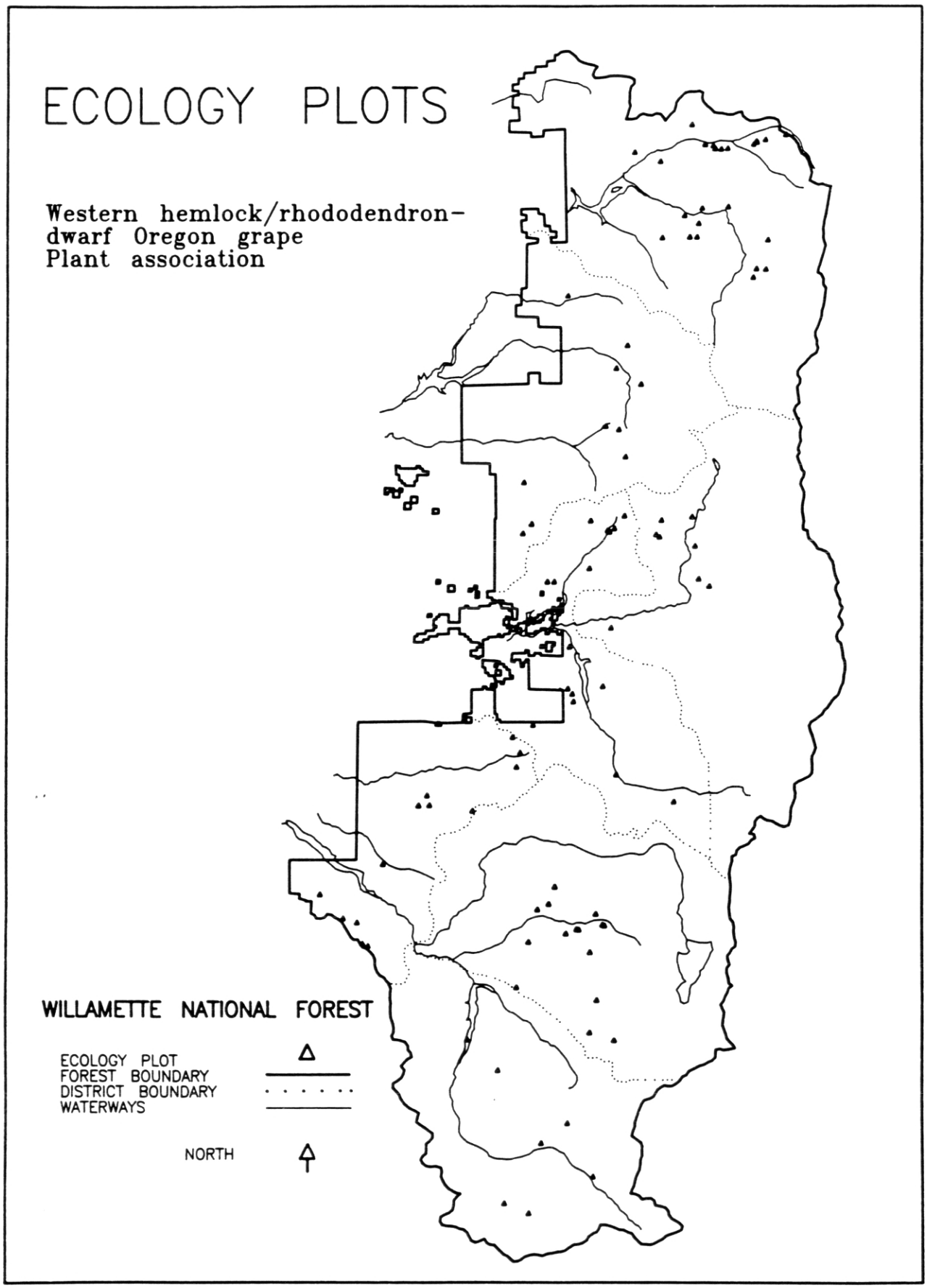
Nitrogen poor or rocky soils on steep sites in this type may be very sensitive to increased

dry ravel and nutrient loss following moderate slash fires.

This type may be used for ridgetop travel corridors. However, big game trails are not common. Plots in this type had the fewest number of big game trails of any western hemlock series plant association (Table 10). Areas with exposed bedrock and large boulders may serve as denning sites for some species. Other wildlife use apears to be minimal. Although herbaceous forage measured for this association was fairly high, averaging 419 pounds ber acre (green weight, Table 10), most of this was beargrass, an unpalatable species.

Comparisons

The western hemlock/rhododendron/beargrass associations on the Mt. Hood and Olympic National Forests occur on similar sites, but have much lower productivity (Halverson et al. 1986 and Henderson et al. 1986). The tanoak-western hemlock association on the Siskiyou National Forest (Atzet and Wheeler 1984) has tanoak as a climax codominant and an important evergreen huckleberry component, but is otherwise floristically similar.


ECOLOGY PLOTS
Western hemlock/rhododendron-
dwarf Oregon grape
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock/rhododendron - dwarf Oregon grape
TSHE/RHMA - BENE — WILL CHS3 52

Douglas-fir and western hemlock dominate the canopy. Western redcedar and Pacific yew are often well represented in the stand. Western hemlock and western redcedar regenerate in most stands.

Large amounts of rhododendron, dwarf Oregon grape, and vine maple may form a dense, impenetrable shrub layer. Small amounts of salal, red huckleberry, trailing blackberry, little prince's pine and prince's pine are also common in the shrub layer. The sparse herb layer is made up of small quantities of twinflower, swordfern, Pacific trillium, redwoods violet, rattlesnake plantain, and a few other species.

Environmental Conditions

Rhododendron dominated communities generally indicate thin, rocky, moderately droughty soils. The western hemlock/rhododendron-dwarf Oregon grape association occurs on relatively more moist and productive conditions within this continuum. It is widespread across the Forest on cool, dry sites within the western hemlock series. The environment is warm to moderately cool with pronounced, but not excessive, summer drought. It characteristically occurs on north-facing slopes between 2000 and 4000 feet elevation. At upper elevations, it merges into the Pacific silver fir/rhododendron-dwarf Oregon grape association.

SRI types 23, 16, 33, and 61 were most common in our intensive plots (Table 2). Types 56, 63 and 66 also occurred. These SRI types are generally rocky and may be moderately deep. Total soil depth varied from 20 to 60 inches (Table 3). Average soil depth was 41 inches but effective rooting depth was only 29 inches, indicating the rockiness of these soils.

Productivity and Management Implications

Tree growth is slower than on non-rhododendron dominated sites. Douglas-fir site index averages 134 (Table 11). Stand basal area averages 346 square feet per acre. While summer drought is not extreme, shade should enhance Douglas-fir seedling survival. Trees may be chlorotic, indicating nitrogen deficiency. Competition from snowbrush and rhododendron may be extreme during the first three years after clearcutting. Rapid regeneration is often essential.

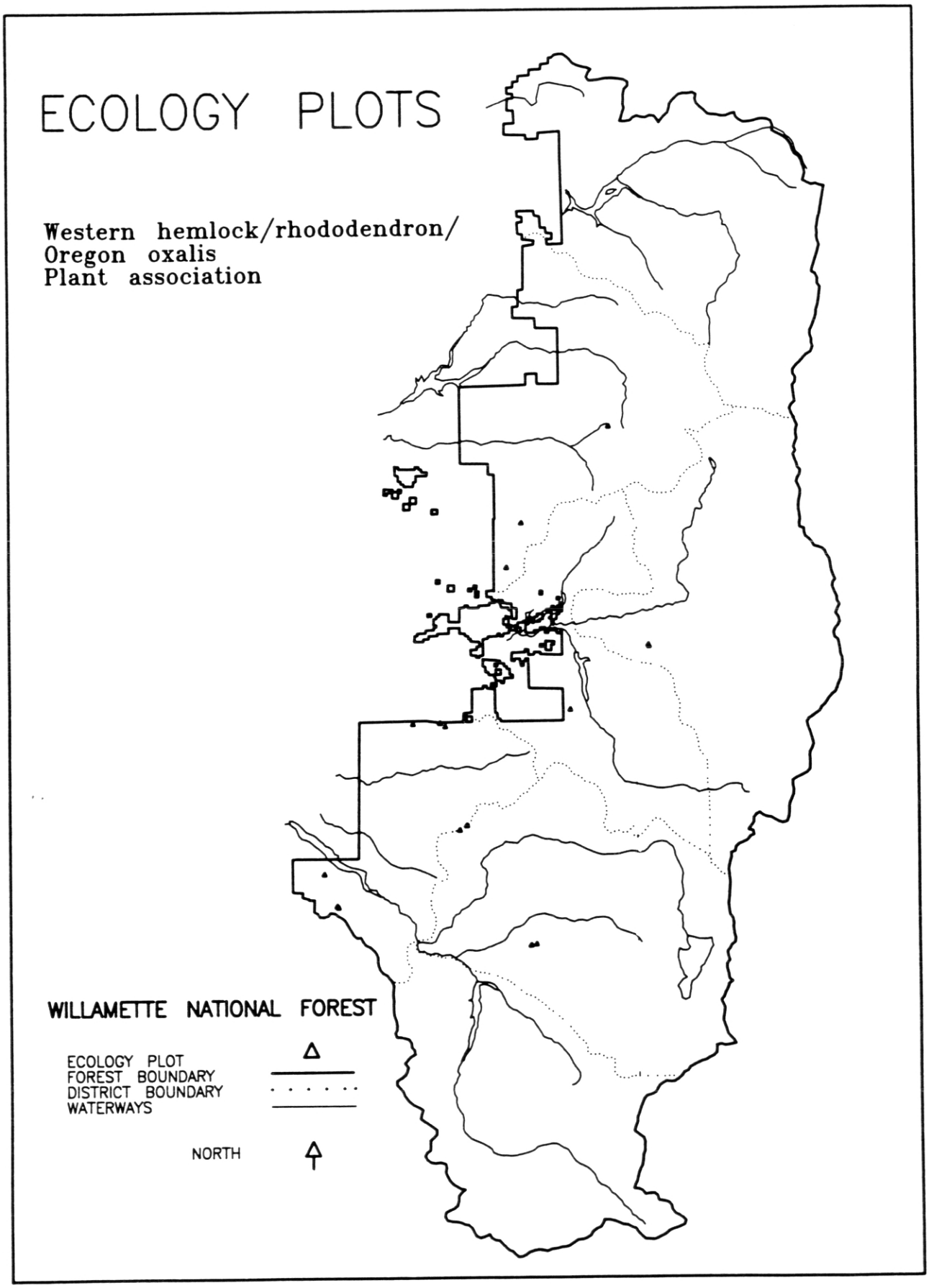
Soils may be sensitive to moderate slash fire impacts. Dry ravel and nitrogen loss may occur on severely burned sites.

Wildlife habitat values do not appear to be high. Forage was not abundant on sites in this plant association but big game trails were observed on 43 percent of the sample plots (Table 10).

Old-growth structural characteristics are similar to other relatively dry western hemlock series types. The canopy is often patchy with multiple age classes as a result of natural fires.

Comparisons

Rhododendron is rare in the Cascades north of the Columbia River, but a similar association has been described on the Olympic National Forest (Henderson et al. 1986). A similar type also exists on the Mt. Hood National Forest (Halverson et al. 1986). Both are substantially less productive and occur on poorer soils. Dyrness et al. (1974) described a western hemlock-Pacific silver fir/rhododendron-dwarf Oregon grape association on the H. J. Andrews Experimental Forest. This association is found on higher-elevation, cooler sites. On the Siuslaw National Forest swordfern is more abundant and productivity is higher in the western hemlock/rhododendron-dwarf Oregon grape association (Hemstrom and Logan 1986).


ECOLOGY PLOTS
Western hemlock/rhododendron/
Oregon oxalis
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock / rhododendron / Oregon oxalis
TSHE / RHMA / OXOR CHS3 54

Douglas-fir, western hemlock, and western redcedar dominate the canopy. Western hemlock and western redcedar regenerate in most stands.

Rhododendron is the major component of the shrub layer, usually associated with dwarf Oregon grape, salal, vine maple, red huckleberry and other species. The shrub layer tends to be less dense than is typical for other rhododendron dominated types. Oregon oxalis is the major herb, usually associated with coolwort foamflower, twinflower, redwoods violet, and several other species.

Enviromental Conditions

This association is most common at the south end of the Forest on fairly steep slopes above 3000 feet elevation. It occurs on a variety of landforms. Sites are usually cool, relatively well-watered, and well-drained. The growing season is cool with relatively minor drought development in most years. Summer frost may occur on flats or in frost pockets. Winter conditions are similar to those at the lower portion of the Pacific silver fir zone. Snow accumulations can be substantial. This association often merges into the Pacific silver fir/Oregon oxalis association.

SRI type 33 was the most common in our few intensive plots (Table 2). Types 16, 35 and 61 also occurred. These soil types are deep and relatively non-rocky. Average soil depth and effective rooting depth in our sample pits were deeper than in any other western hemlock plant association (55 and 48 inches respectively, Table 3).

Productivity and Management Implications

This plant association presents something of a paradox. Rhododendron types are generally infertile with rocky soils and slow tree growth. The western hemlock/rhododendron/Oregon oxalis type, on the other hand, often has relatively good tree growth rates and moderately rich, well-watered soils. Douglas-fir site index averages 135 and stand basal area averages 476 square feet per acre (Table 11). Survival of planted Douglas-fir should be good. Competition from rhododendron, vine maple and Ceanothus spp. may develop.

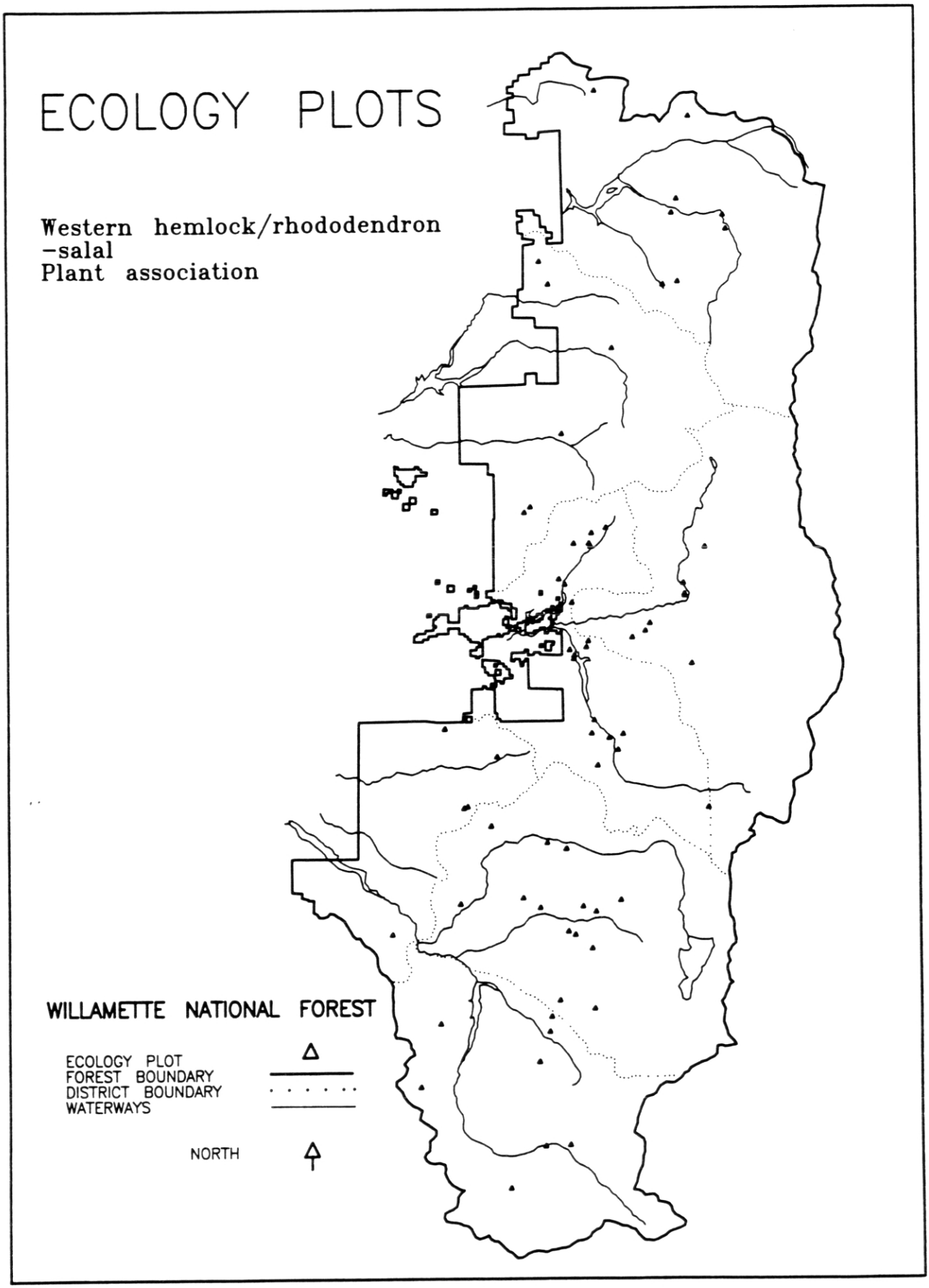
Soils are not as fragile as in other rhododendron associations but may still be nitrogen poor. Moderately hot slash fires may cause unacceptable declines in soil nitrogen, particularly if the duff is consumed.

Big game use is moderately high, probably more for summer range and migration habitat than for winter range. Big game trails were more frequently found on this type than in any other plant association (Table 10). Herbaceous forage amounts were moderate, averaging 360 pounds per acre (green weight), on our intensive samples (Table 10).

Old-growth characteristics are similar to the rest of the western hemlock/rhododendron associations. Old-growth structures accumulate fairly slowly. Natural old-growth stands are often patchy.

Comparisons

Similar associations have not been described in Oregon or Washington. Communities with important Oregon oxalis components are usually placed in western hemlock/swordfern-Oregon oxalis or western hemlock/Oregon oxalis associations (Halverson et al. 1986, Topik et al. 1986, Hemstrom and Logan 1986, Dyrness et al. 1974). Rhododendron does not occur in significant amounts in Oregon oxalis communities in other regions. Our western hemlock/rhododendron/Oregon oxalis association, however, has a substantial rhododendron layer. This indicates more well-driained conditions and lower productivity than is typical for western hemlock/Oregon oxalis or western hemlock/swordfern-Oregon oxalis associations.


ECOLOGY PLOTS
Western hemlock/rhododendron
-salal
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock / rhododendron - salal
TSHE / RHMA - GASH — WILL CHS3 51

Douglas-fir and western hemlock are the most common tree species present. Western redcedar and Pacific yew also occur in the canopy in many stands. Sugar pine, incense cedar or chinquapin may be common on more severe sites. Western hemlock is the major regenerating species. This association grades into the Douglas-fir series at the south end of the Forest.

This association has the highest mean shrub cover of any in the western hemlock series. The shrub layer consists of dense rhododendron and salal with small amounts of prince's pine, dwarf Oregon grape, trailing blackberry, vine maple and red huckleberry. The herb layer is nearly absent, often consisting only of trace amounts of rattlesnake plantain, twinflower, swordfern and redwoods violet.

Environmental Conditions

The western hemlock/rhododendron-salal association is common across the Forest on moderate to steep slopes, often with rocky soils. It is found over a wide range of elevations and aspects on warm, dry sites. Regardless of location, it indicates severe conditions within the western hemlock series. When it occurs on rocky, infertile, excessively well-drained or clay soils, early and substantial summer droughts may be common. The growing season is long and relatively frost-free. Many stands are chlorotic and appear to be nitrogen deficient.

SRI types 16 and 23 were most common in our intensive samples (Table 2). Types 13, 15, 33, 35 and 61 also occurred. Other than 61, these SRI types are deep clays. Soil depth averaged 43 inches and effective rooting depth averaged 35 inches (Table 3).

Productivity and Management Implications

Tree growth rates are slightly lower than in the western hemlock/rhododendron-dwarf Oregon grape association. Average site index for Douglas-fir is 128, only slightly better than the westen hemlock/ rhododendron/beargrass association (Table 11). Sugar pine appears to grow significantly better than Douglas-fir on drier sites. Stand basal area averages 312 square feet per acre.

Summer moisture stress can be substantial and may reduce survival of unshaded seedlings. Many sites will be difficult to plant due to

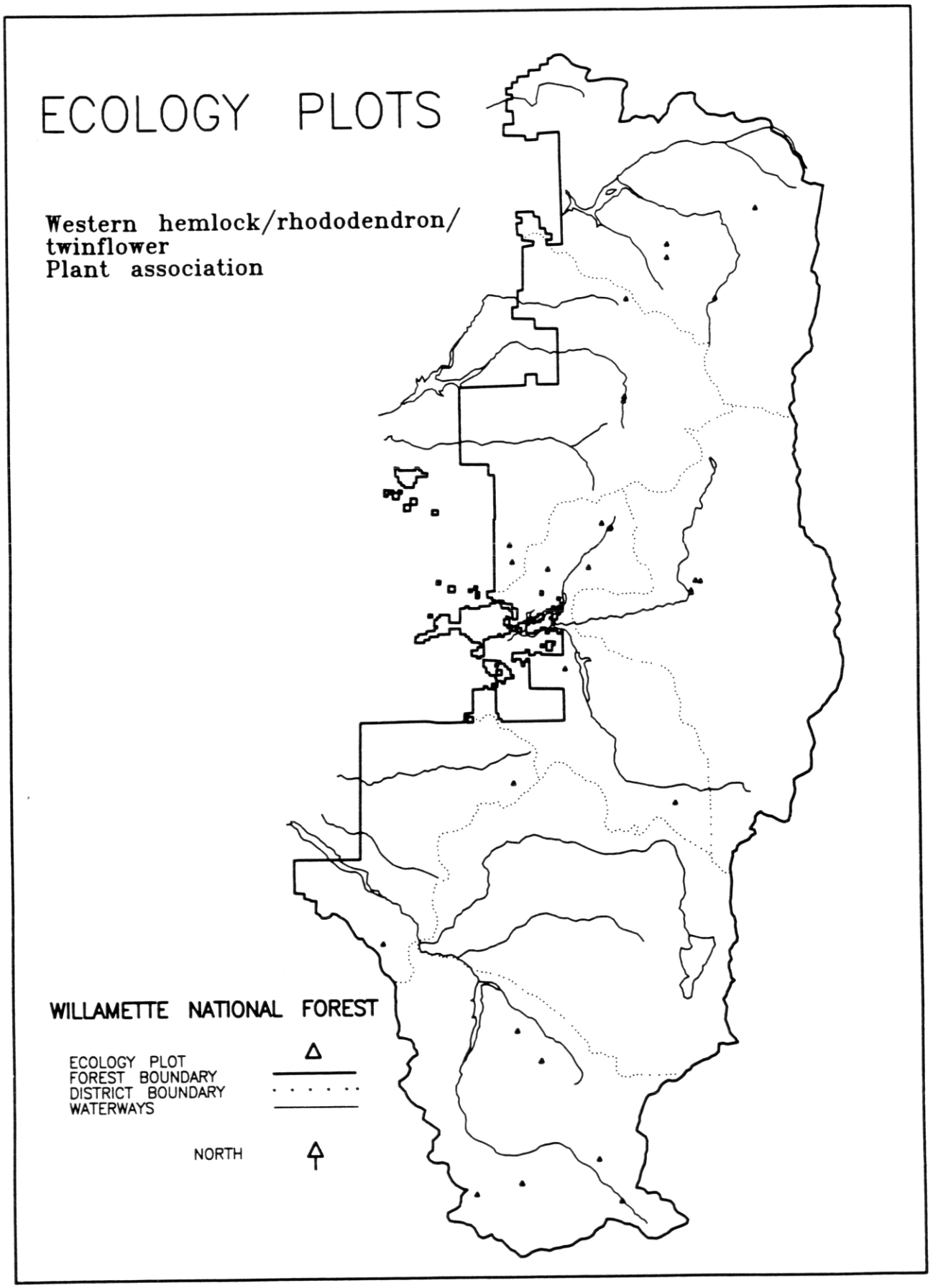
soil stoniness. Competition from rhododendron, Ceanothus spp., and other shrubs will develop several years after stand opening, making rapid seedling establishment essential.

Thin or very rocky soils that occur on many sites in this type may be sensitive to moderately hot slash fires, experiencing increased dry ravel and nitrogen loss.

Big game use was minimal on our sample plots of this type. Dense shrub layers probably impede access and forage was among the lowest measured in the western hemlock zone (Table 10). Many stands are patchy mosaics of age and size classes due to relatively frequent natural fire. This patchiness produces high vertical structural diversity. Even so, wildlife use appeared to be low.

Comparisons

Western hemlock/rhododendron-salal types defined by Dyrness et al. (1974) on the H.J. Andrews Experimental Forest and Halverson et al. (1986) on the Mt. Hood National Forest are floristically similar. Productivity is substantially lower on the Mt. Hood National Forest. Several associations from the Siskiyou National Forest have similar floristics, with the addition of Southwestern Oregon species (Atzet and Wheeler 1984). The western hemlock/rhododendron-salal association on the Siuslaw National Forest is more productive and can have extremely dense shrub layers (Hemstrom and Logan 1986).


ECOLOGY PLOTS
Western hemlock/rhododendron/
twinflower
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock / rhododendron / twinflower
TSHE / RHMA / LIBO2 CHS3 55

Douglas-fir and western hemlock usually dominate the canopy. Western redcedar is commonly present. Western hemlock and Pacific yew are the most important regenerating species. Over 20 percent of our sample plots contained Pacific silver fir, indicating a transition to the Pacific silver fir series. This association often grades into the Pacific silver fir/rhododendron-dwarf Oregon grape or Pacific silver fir/rhododendron/beargrass associations.

Rhododendron is the most important shrub species. Small amounts of dwarf Oregon grape, vine maple, salal, big huckleberry, red huckleberry, trailing blackberry, and other shrub species may be present. Twinflower is the most abundant herb. Other species occur in small quantiites, especially: dogwood bunchberry, redwoods violet, rattlesnake plantain, and Pacific trillium.

Environmental Conditions

This association occurs across the Forest, but is most common on gentle terrain, at upper elevations in the western hemlock zone. Climatic conditions are transitional to those of the Pacific silver fir series. Deep winter snowpacks are common and summer frost may occur on flat terrain or in frost pockets. Summer drought develops by late summer in most years and plant moisture stresses may exceed minus 8 bars (Emmingham and Lundberg 1977).

SRI types 16 and 23 occurred in our few intensive plots in this association (Table 2). Soils are usually moderately deep to deep, averaging 42 inches total depth on intensive plots (Table 3). The average effective rooting depth of 31 inches (Table 3) indicates that these soils can often be rocky and well-drained.

Productivity and Management Implications

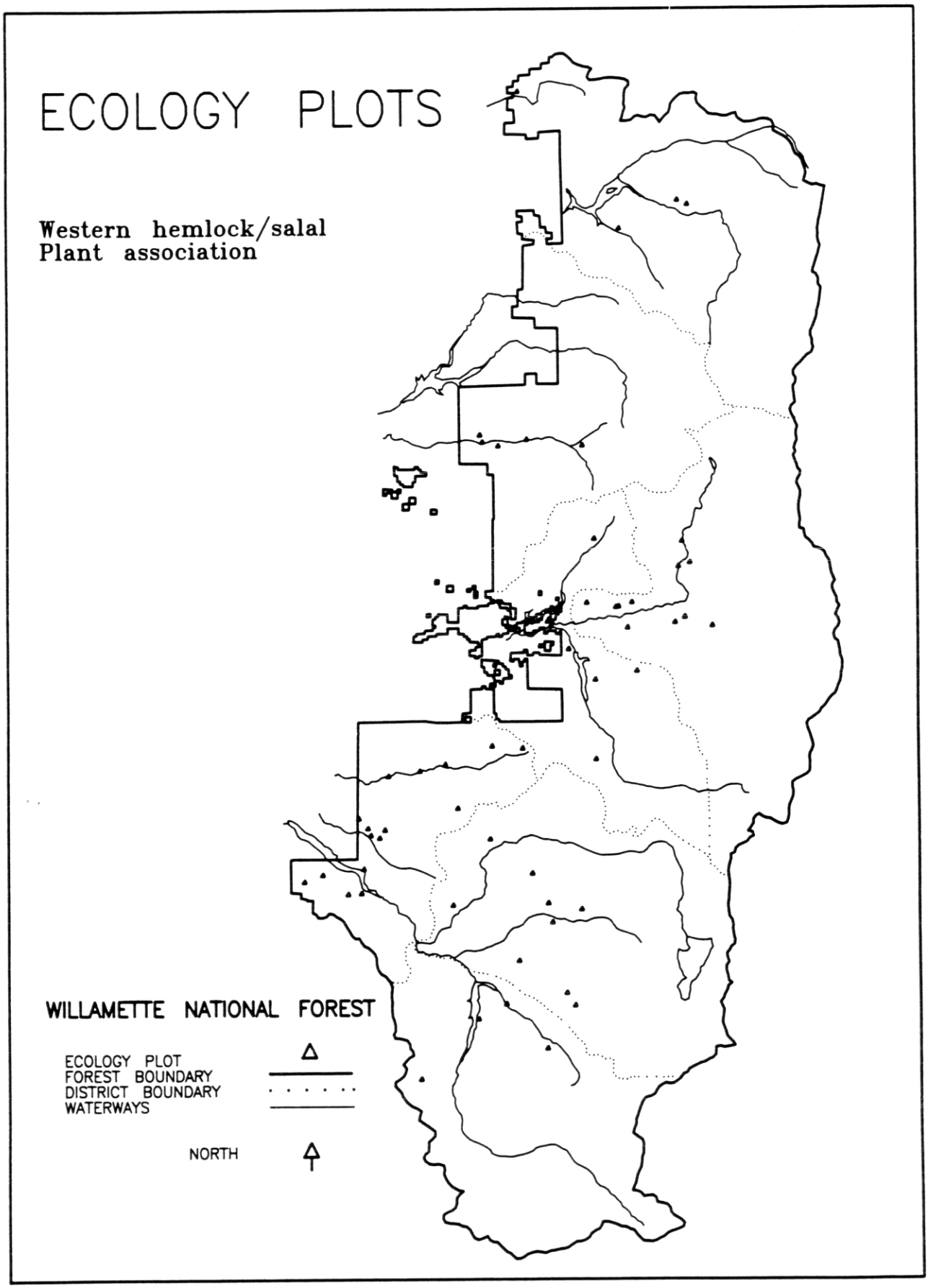
Douglas-fir site index averages 130 (Table 11). Stand basal area often reaches the high levels found in the Pacific silver fir zone and averages 419 square feet per acre. Reforestation with Douglas-fir should not be difficult in most cases. Occasional summer frost may be a problem on some sites. Competition from rhododendron and snowbrush frequently develops 3 to 5 years following harvest.

Soils often have deep duff accumulations and are not as sensitive to fire effects as in other western hemlock/rhododendron associations. Hot slash fires should be avoided.

Wildlife use does not appear to be high. Average forage weights for this plant association were the lowest in the western hemlock zone (Table 10). Big game may take advantage of the dense canopy and relatively cool conditions during hot summer days.

Comparisons

Dyrness et al. (1974) described the same association on the H. J. Andrews Experimental Forest. It has not been described elsewhere in Oregon and Washington.


ECOLOGY PLOTS
Western hemlock/salal
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock/salal
TSHE/GASH — WILL CHS1 11

The canopy is dominated by Douglas-fir, western hemlock, bigleaf maple, and western redcedar. Western hemlock is the major regenerating species, but many of our reconnaissance plots contained some Douglas-fir regeneration, indicating a transition to the drier Douglas-fir series.

Salal dominates the shrub layer, usually associated with large amounts of vine maple. Dwarf Oregon grape, pacific dogwood, California hazel, baldhip rose, snowberry, and whipple vine are common. The generally sparse herb layer consists of swordfern, twinflower, three-leaved anemone, western starflower, bracken fern, and several other species.

Environmental Conditions

The salal type is most common on the south half of the Forest. It generally occurs on moderately steep to steep, southerly-facing slopes below 3000 feet elevation. Dwarf Oregon grape communities frequently give way to a salal community on ridges or as topography becomes convex. This association often grades into the Douglas-fir series as summer drought becomes more severe. Growing seasons are long and warm.

SRI types varied in our intensive samples in this type. Types 15, 21, and 25 were most common, but 13, 14, 23, 35, and 61 also occurred (Table 2). Soils sampled for this plant association were among the shallowest in the western hemlock zone. Soil depth on sample plots averaged 34 inches and effective rooting depth averaged only 25 inches (Table 3).

Productivity and Management Implications

Regeneration should not be difficult if seedlings are established within the first three years after harvest. After three years, substantial shrub competition may develop from Ceanothus spp. and other species. Douglas-fir seedlings will survive best if some shade is provided, particularly on steep south-facing slopes. Tree growth is moderately good. Douglas-fir site index averages 137 and basal area averages 286 (Table 11). Soils may be susceptible to nutrient loss and erosion following slash fires.

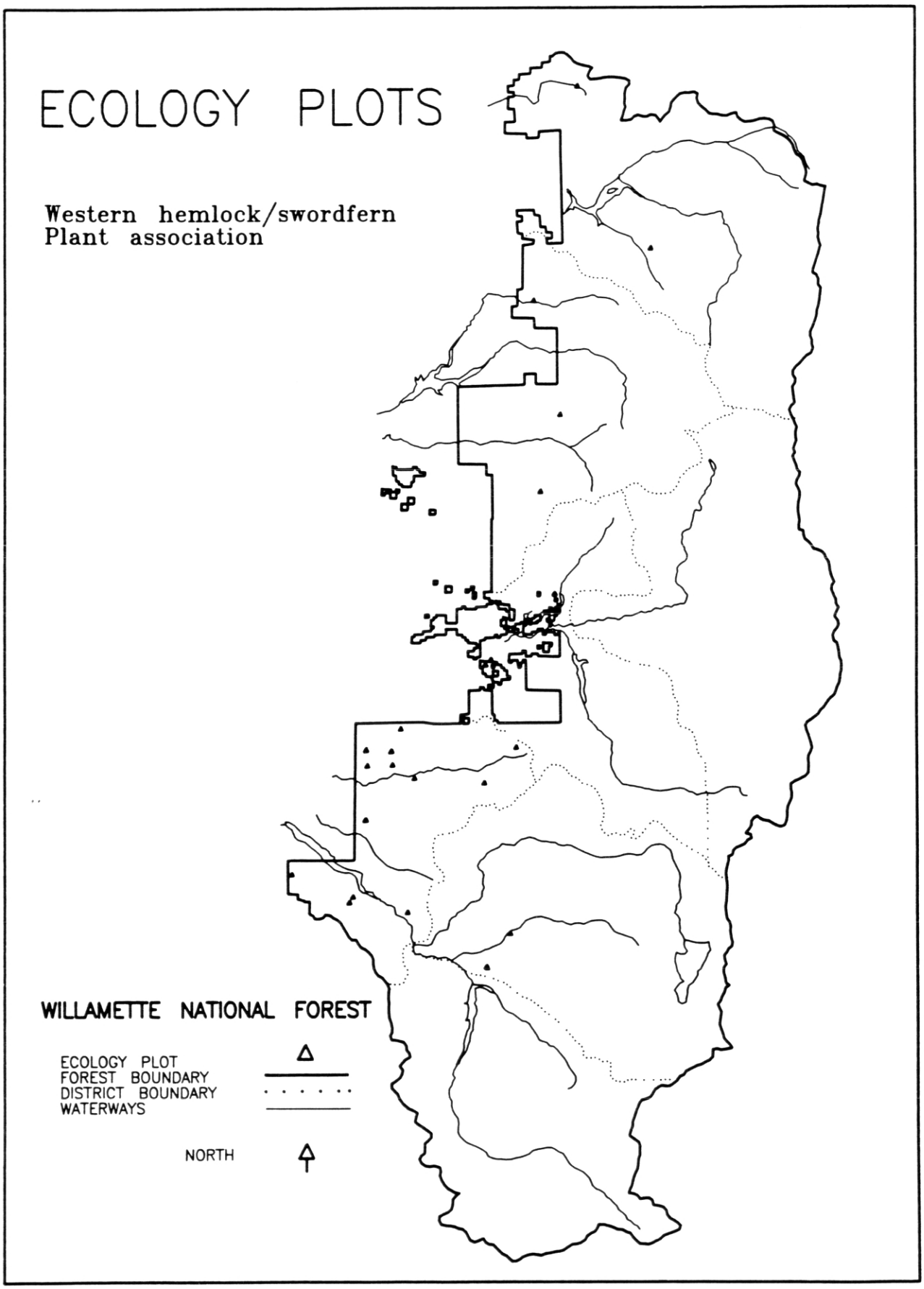
Nearly half of our plots had big game trails (Table 10). Amounts of herbaceous forage measured for this plant association were

generally low but there was a considerable amount of less palatable shrubby forage (Table 10).

Old-growth characteristics are similar to those of the Douglas-fir series, with patchy stands and high vertical structural diveristy. Natural fire occurence appears to have been relatively high, resulting in mosaics of stand sizes and ages.

Comparisons

Western hemlock/salal types are common throughout western Oregon and Washington (Henderson and Peter 1981, Halverson et al. 1986, Hemstrom and Logan 1986, Topik et al. 1986, Atzet and Wheeler 1984). The general pattern is for sites to become more severe and productivity to decrease from south to north. Douglas-fir site index decreases from 137 on the Willamette National Forest to less than 100 on the Mt. Baker-Snoqualmie National Forest, for example. Dyrness et al. (1974) described a Douglas-fir/vine maple-salal type on the H. J. Andrews Experimental Forest which is seral to the western hemlock/salal association.


ECOLOGY PLOTS
Western hemlock/swordfern
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock/swordfern
TSHE/POMU — WILL CHF1 51

The dense canopy is usually composed of Douglas-fir, western hemlock, and western redcedar. Bigleaf maple occurs in many stands. Western hemlock and western redcedar are the major regenerating species.

The shrub layer typically consists of sparse vine maple, dwarf Oregon grape, salal, trailing blackberry, red huckleberry and a few other species. Swordfern dominates the herb layer. Small amounts of Oregon oxalis, twinflower, and several other species may be present.

Swordfern often survives in deep shade. Some stands that appear to be in the western hemlock/swordfern type may be shaded varieties of other associations. If overall herb cover is low beneath a dense canopy, small stand openings and stand edges should be checked to be sure that the community fits the western hemlock/swordfern association.

Environmental Conditions

More than half of our sample plots in this association were from the Lowell Ranger District. It most often occurs on well-watered lower slopes and benches. Most sites are northerly-facing, moderately steep to steep slopes below 2500 feet elevation.

The overall environment is mesic, as in the western hemlock/Oregon oxalis association, but more well drained. Since this association is characteristically found on toe slopes, moisture from up-slope is available through the growing season.

SRI types 16, 23, 31, and 33 occurred in our few intensive plots in this type (Table 2). These soils are relatively deep, fertile, and often rocky. Soil depth averaged 44 inches and effective rooting depth averaged 36 inches on soil pits in this association (Table 3).

Productivity and Management Implications

Although the terrain is steeper than in the western hemlock/Oregon oxalis association, tree growth rates are similarly high. Douglas-fir site index averages 159 and stand basal area averages 302 square feet per acre (Table 11).

Soil compaction or mass movement could be the most serious hinderance to timber harvest. Regeneration should be relatively easy. Vine

maple or red alder competition may develop on a few sites. This association provides optimum habitat for mountain beaver.

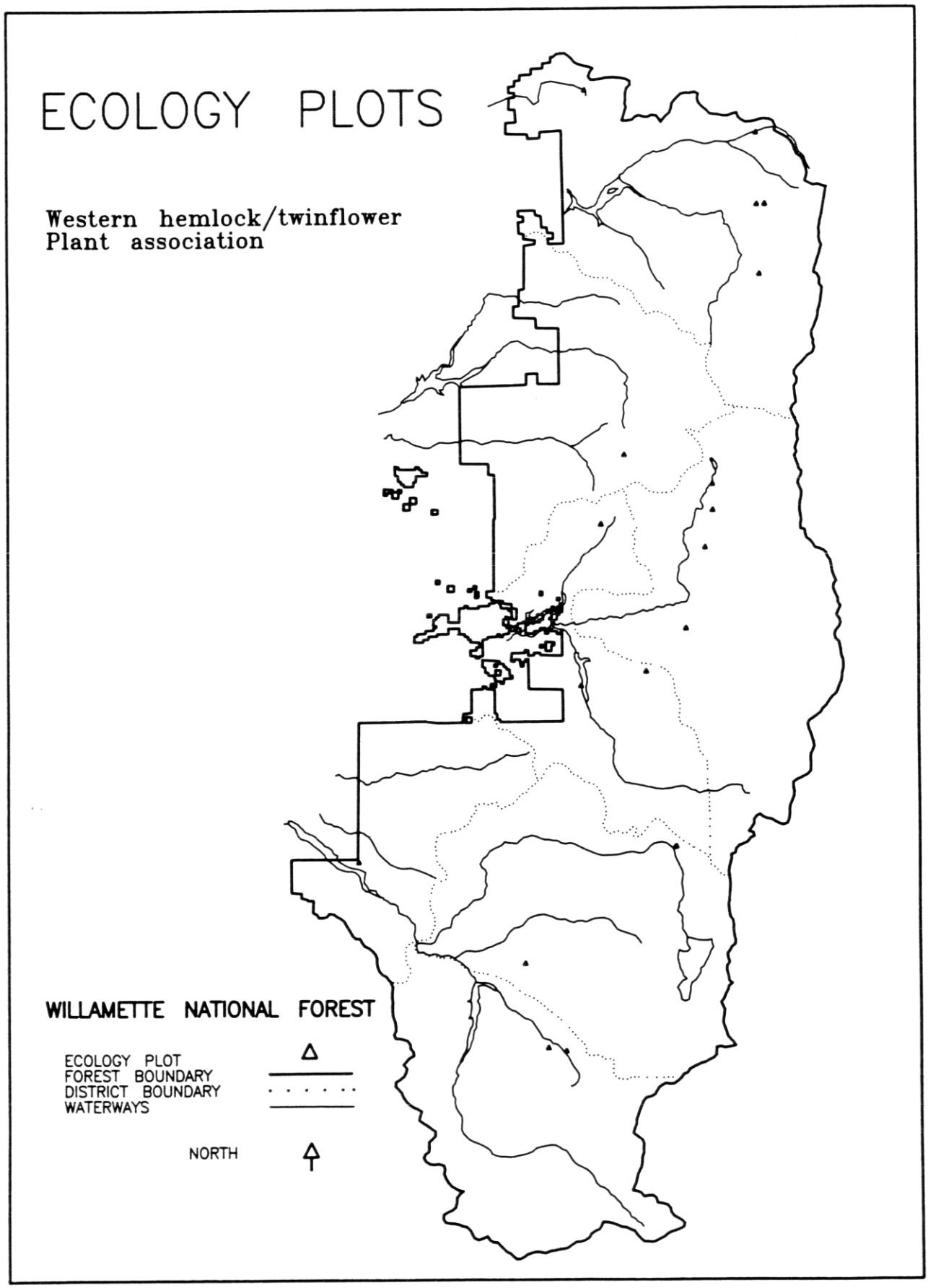
Soils are generally resistant to adverse nitrogen loss from moderate slash fires but may experience increased dry ravel and erosion.

Due to rapid tree growth rates, old-growth structural characteristics can be achieved in a relatively short time period if large dead wood accumulates to acceptable levels.

This association is often used by big game for winter range and is often found in riparian zones. In fact, big game trails were observed in nearly half of our sample stands (Table 10). Forage amounts were average for the western hemlock zone (Table 10).

Comparisons

Western hemlock/swordfern associations occur throughout Northwestern Oregon and Western Washington (Halverson et al. 1986, Hemstrom and Logan 1986, Topik et al. 1986, Dyrness et al. 1974). Productivity varies, but is usually among the highest in the western hemlock series. The western hemlock/swordfern association from the Mt. Hood and Gifford Pinchot National Forests occurs on drier sites and is less productive. The rest of the western hemlock/swordfern associations are similar in both productivity and floristics. Swordfern is also common in the western hemlock series in Southwestern Oregon, but swordfern communities without substantial salal or rhododendron cover have not been described (Atzet and Wheeler 1984).


ECOLOGY PLOTS
Western hemlock/twinflower
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock / twinflower
TSHE / LIBO2 CHF3 21

Douglas-fir, western hemlock and western redcedar dominate the canopy. Western hemlock and western redcedar regenerate in most stands. Pacific yew is usually present. This association is often transitional to the Pacific silver fir series and 20 percent of our sample stands contained Pacific silver fir regeneration.

The sparse shrub layer consists mostly of vine maple and scattered small amounts of dwarf Oregon grape, prince's pine, red huckleberry, trailing blackberry, and rhododendron.

Twinflower is by far the most abundant herb species. Several other herb species may be present, especially: swordfern, three-leaved anemone, redwoods violet, Pacific trillium and rattlesnake plantain.

Environmental Conditions

The western hemlock/twinflower association occurs across the Forest on gentle to moderate slopes, usually in the upper elevations of the western hemlock zone. Dense canopies and deep organic accumulations on the forest floor and the generally sparse shrub and herb layers may indicate that the type is an unusual seral phase or developmental condition of some of the more common dwarf Oregon grape dominated associations. However, several of our sample plots were in stands over 200 years old, so the condition is at least persistent if it does not truly reflect site potential.

Environmental conditions are similar to those of upper elevations in the western hemlock/dwarf Oregon grape association.

SRI types varied on our few intensive plots. Types 16, 33, and 64 were represented (Table 2). The soil pits we examined were extremely shallow. Soil depth ranged from 8 to 45 inches and averaged 23 inches (Table 3). Effective rooting depth was also shallow, averaging 20 inches (Table 3).

Productivity and Management Implications

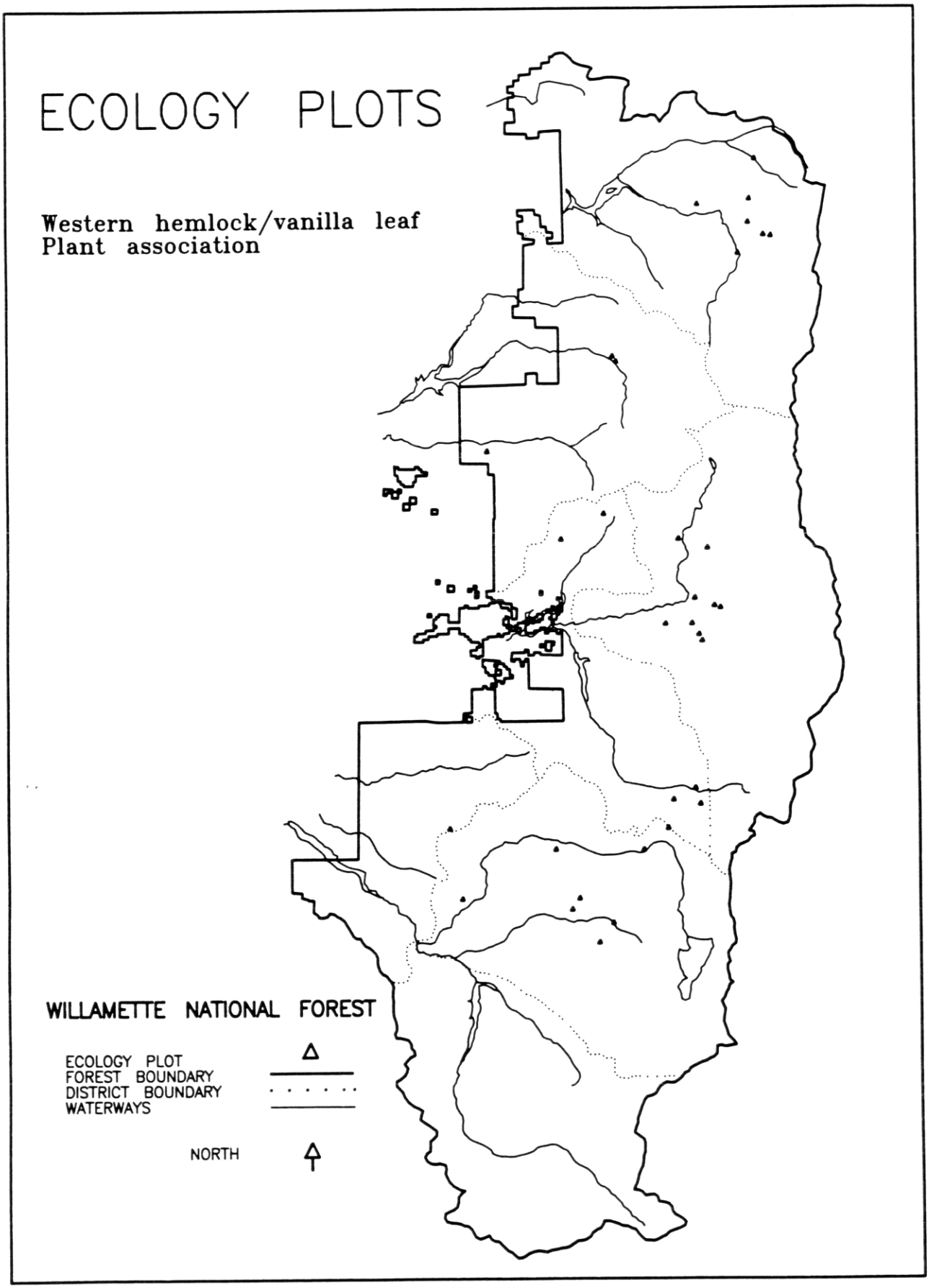
Regeneration may be complicated by Ceanothus spp. competition on some sites. Tree growth is moderate for the western hemlock series. Douglas-fir site index averages 148 and stand basal area averages 403 square feet per acre (Table 11).

Soils are usually protected by deep duff accumulations and are resistant to adverse fire impacts if the duff is not consumed.

This association was not heavily used by wildlife in our sample plots. Big game may take advantage of the dense canopy and relatively cool conditions to escape summer heat. Big game trails were observed on a third of our plots but forage was not abundant (Table 10).

Comparisons

The western hemlock-Pacific silver fir/twinflower type described by Dyrness et al. (1974) for the H. J. Andrews Experimental Forest is in the transition from the western hemlock series to the Pacific silver fir series and occurs on higher-elevation, cooler sites. Similar associations have not been described elsewhere.


ECOLOGY PLOTS
Western hemlock/vanilla leaf
Plant association
WILLAMETTE NATIONAL FOREST
ECOLOGY PLOT
FOREST BOUNDARY
DISTRICT BOUNDARY
WATERWAYS
NORTH

Western hemlock/vanilla leaf
TSHE/ACTR CHF2 21

Douglas-fir and western hemlock dominate the canopy in most stands, often with western redcedar. Western hemlock and, occasionally, western redcedar, regenerate in most stands. Nearly 20 percent of our plots had Pacific silver fir in the canopy and regeneration layer, indicating a transition to the Pacific silver fir series.

Vine maple, dwarf Oregon grape, prince's pine, and snowberry dominate the sparse shrub layer. Alaska and big huckleberry become more important in upper elevation stands that are transitional to the Pacific silver fir zone. Rhododendron may be present in small amounts.

The herb layer averages nearly 50 percent cover. Vanilla leaf, coolwort foamflower, pathfinder, inside-out-flower, redwoods violet, and three-leaved anemone dominate the herb layer. Oregon oxalis may be present but is not abundant. At upper elevations, this association often merges with the Pacific silver fir/coolwort foamflower association.

Environmental Conditions

The western hemlock/vanilla leaf association occurs on well drained, often south-facing, gentle slopes and flats at upper elevations in the western hemlock zone. It occurs across the Forest, but is most common on the McKenzie, Oakridge and Detroit Ranger Districts.

SRI types 15 and 33 were most common in our intensive samples (Table 2). Types 14, 23, and 66 also occurred. Soils were among the deepest in the western hemlock zone (averaging 54 inches), but tended to be rocky and well drained. Effective rooting depth averaged 47 inches in our sample soil pits (Table 3).

Moist-site indicating herbs reflect well-watered conditions. Since this association occupies gentle upper elevation sites within the western hemlock zone, winter snowpacks can be substantial and persist into early summer. Summer frost can occur on some sites, particularly on flats or in frost pockets.

Productivity and Management Implications

This association can pose significant regeneration problems due to a combination of environmental and biological conditions, especially where it grades into the Pacific

silver fir series (Sullivan 1978). These include excessively well-drained soils, an abrupt seasonal transition from snowpacks and cold soils to warm, dry conditions, pocket gopher damage, competition from Ceanothus spp. and vine maple and occasional summer frost.

Timber productivity is among the highest for the western hemlock series. Douglas-fir site index averages 151 (Table 11). Stand basal area averages 403 square feet per acre.

Soils on south aspects or with rocky profiles may be adversely affected by moderate slash fires. Slash fires should not consume too much of the duff layer.

Big game use appears to be extensive in this type, especially during the summer when the dense canopy and relatively cool conditions provide relief from heat. There were big game trails in 60 percent of our samples (Table 10). Deer pellets were found in 17 percent of the plots and elk pellets were noted in 20 percent of the plots (Table 10). Herbaceous forage was quite high for this association, averaging 898 pounds per acre (green weight, Table 10).

The open, herb-dominated stands that develop in this type are aesthetically pleasing and may have high recreational values for trail locations.

Comparisons

Similar associations have been described on the Mt. Hood National Forest (Halverson et al. 1986), the Gifford Pinchot National Forest (Topik et al. 1986) and the Olympic National Forest (Henderson et al. 1986). Douglas-fir site index decreases north of the Willamette National Forest. Henderson and Peter (1981) described a western hemlock/foamflower-oak fern association which is similarly herb rich but occurs in more moist, cooler environments on the Mt. Baker-Snoqualmie National Forest. Dyrness et al. (1974) described a Pacific silver fir/vanilla leaf type which intergrades with the western hemlock/vanilla leaf association at upper elevations in the western hemlock zone.

NON-FOREST COMMUNITIES

Beargrass - red fescue
XETE - FERU FM29 11

The beargrass (Xerophyllum tenax)-red fescue (Festuca rubra) community is not particularly rich in plant species. There were a total of 23 herb, 1 shrub and 7 tree species in our sample plots. Serviceberry (Amelanchier alnifolia) is the most common shrub but generally occurs in trace amounts. Scattered Douglas-fir (Pseudotsuga menziesii), Pacific silver fir (Abies amabilis), subalpine fir (A. lasiocarpa), noble fir (A. procera), grand fir (A. grandis), western white pine (Pinus monticola), and lodgepole pine (P. contorta) may be present, especially along the edges of adjacent stands. Western white pine is the most common invading species.

Beargrass is the most conspicuous and dominant plant, averaging 50 percent to 90 percent cover on most sites. Columbia lily (Lilium columbianum) and Lyall anemone (Anemone lyallii) are consistently present in trace amounts. About 14 other forb species may be present in small amounts. The few grass species which may be present are not abundant enough to be readily noticed. Red fescue (Festuca rubra) is the only species that occured on a majority of our plots. Long stolon sedge (Carex pensylvanica) and other sedges (Carex spp.) were present in small amounts in fewer than half our plots. Our plots in this type were taken in late summer and fall. Some early spring species were probably not seen. This type may be a prolonged successional stage following disturbance in upper elevation stands. However, the sites we sampled showed no evidence of being previously forested.

Environmental Conditions

This community is found in cold and dry environments. Most sites are located on mountain tops from 4700 feet to 5800 feet elevation with southerly aspects. Soils are poorly drained during the spring but excessively well-drained during the summer. Surface soil texture varies from gravelly silt loam to silt loam or rocky sil loams. These soils usually grade into gravelly o rocky hardpans (compacted glacial till) at depth. Slopes vary from 10 to 30 percent. As slopes become steeper or more northerly facing, the community type often changes.

Management Implications

The greatest potential for damage to this community is from erosion from runoff. The soils (often pumice) on these sites are easily eroded. In some cases, previously forested stands on harsh, cold sites could be converted into this community through careless management. Recovery to closed forest may take a very long time (e. g. over 100 years). Some wildlife use was observed. Deer and elk feed in this type in early spring an late fall, particularly where adequate hiding cover is available.

One sensitive species, Frasera umpquensis, is present in this community on the Lowell Ranger District. It is generally found at the ecotone between this community and closed forest or grass and forb dominated communities.

Blueberry - alpine spirea / grass
VACCI - SPDE / GRASS SW41 21

This community is described from one unique site but should be expected elsewhere on the Forest. Western bog-blueberry (Vaccinium occidentale), grouse huckleberry (Vaccinium scoparium), dwarf blueberry (Vaccinium caespitosum), and subalpine spirea (Spiraea densiflora) dominate the shrub layer. The grouse huckleberry may invade from adjacent mountain hemlock/grouse huckleberry stands. Bluejoint reedgrass (Calamagostis canadensis) and tufted hairgrass (Deschampsia caespitosa) were the major herbs. Timber danthonia (Danthonia intermedia), Alaska clubmoss (Lycopodium sitchense), leathery grapefern (Botrychium multifidium), alpine aster (Aster alpigenus), orange agoseris (Agoseris aurantiaca), rosy pussytoes (Antennaria microphylla), and cinquefoil (Potentilla spp.) were present in small amounts in our single sample plot. Alaska clubmoss and western bog-blueberry are not common west of the Cascade Crest. Beargrass, though present at this site, is an intruder from the adjacent forest stand.

Environmental Conditions

This community is usually found in the ecotone between more moist communities around open water and closed forest. It typically occurs above 4000 feet elevation, on deep soils which are saturated for at least a portion of the year. Frequent, summer frost, due to high elevation and frost pocket topography, and saturated soils slow or prevent tree establishment.

Management Implications

This community is often found on sites that are small in size and sheltered by the adjacent stand and a body of water. It may depend on the stand and regular water supply for the climatic and soil conditions necessary to maintain it. Management activities which disrupt the hydrologic regime are likely to change or eliminate this type. Deer and elk use this community for water and browse. We found no threatened, endangered, or sensitive plants.

Blue wildrye - brome
ELGL-BROMU GM41 21

Several species of grasses and sedges dominate most sites. Grass cover is generally, but not always, greater than forb cover. About 172 herbaceous species were identified: 106 forbs, 23 grasses, 11 sedges and rushes, and 2 ferns. Ten species of trees were found on our plots, but tree cover ranged from trace to 2 percent. Fourteen shrub species occurred in our plots. Serviceberry (Amalanchier alnifolia) and oceanspray (Holidiscus discolor) were most common, in amounts ranging from trace to 2 percent cover. Serviceberry was common above 3000 feet elevation and oceanspray below 2500 feet elevation. Poison oak (Rhus diversiloba) occured at lower elevations.

Blue wildrye (Elymus glauca) is the most characteristic grass, but was not always present. Eight species of brome grass occurred in our plots. Smooth brome (Bromus inermis) was the most constant and was found in 27 percent of our plots with cover ranging from 5 percent to 30 percent. Danthonia (Danthonia spp.), fescues (Festuca spp.), and Western needlegrass (Stipa occidentalis) were present in over a third of our plots. Western brome (Festuca occidentalis) and red fescue (F. rubra) were abundant, covering up to 60 percent of some sites. Cheatgrass brome (Bromus tectorum) was present on several plots. Two other species of annual grasses occurred on single plots.

Nine species of sedge (Carex spp.) and one woodrush species (Luzula spp.) were present in our sample plots. The sedges, as a group, are typical of relatively dry communities and one or two species were present 70 percent of our plots. Long-stolon sedge (Carex pensylvanica), was the most common species.

No single forb genus or species was present in more than 45 percent of our plots. Western yarrow (Achillea millifolium) was most common, with trace to 25 percent cover. Nineleaf lomatium (Lomatium triternatum) and Leichtlin camas (Camassia leichtlinii) were present in 36 percent of our plots. Annual species were more common at lower elevations. The remaining 105 species were sporadically present in small amounts.

Environmental Conditions

Our plots in this community occurred on relatively deep soils on dry exposures. Soils on a few sites were as shallow as 9 inches deep. Most soils were between 18 and 36 inches deep. Elevation ranged from 2440 feet to 5800 feet. Aspect varied, but was mostly southerly. Communities on north-facing slopes were located on or near the ridgetops where shallower soils and exposure compensate for reduced solar radiation. Many sites were protected by stands of timber on two or more sides.

Management Implications

These communities are heavily used by big game species. At lower elevations, use seemed heaviest in early spring when the vegetation is fresh and green. Upper elevation sites appeared to be used throughout the summer. Pocket gophers were present on all of the sites sampled. Road construction frequently alters the hydrologic system, often producing more well-drained, drier sites. Timber harvest from the perimeters removes big game hiding and thermal cover and, by reducing shading, may change species composition.

Common vetch - peregrine fleabane - blue wildrye
VISA - ERPE - ELGL FM30 11

Plant species diversity is high in this community. The dense herbaceous layer averages 70 percent cover. Our species list included 25 grass and grass-like species and 111 other herbaceous species. Herb species range from early blooming onions (Allium spp.) and annual grasses to the late blooming asters (Aster spp.) and fleabanes (Erigeron spp.). Bracken fern (Pteridium aquilinum) dominated the herb layer in a third of our sample plots. Although no single herb was constantly present, common vetch (Vicia sativa), peregrine fleabane (Erigeron peregrinus) and western yarrow (Achillea millefolium) were common. Grass cover varied from a trace to 20 percent. Blue wildrye (Elymus glauca), smooth brome (Bromus inermus) and other brome species (Bromus spp.) were usually present in small amounts. Dry-site sedges (Carex spp.) were also common components of the herb layer.

The shrub and tree layers are poorly developed. With the exception of an occasional seedling or lone mature tree, trees are restricted to the perimeter of these openings. Shrub cover is usually less than 5 percent. Serviceberry (Amelanchier alnifolia) and thimbleberry (Rubus parviflorus) are the most common shrub species. Oceanspray (Holodiscus discolor) is the dominant shrub on dry sites with shallow soils.

Environmental Conditions

These communities most often occur on south-facing, flat to very steep sites with shallow, rocky soils between 2900 and 5660 feet elevation. Soil depth ranges from 12 to 36 inches. Soil texture is usually coarse sand or cobbly or rocky silt loam. Soils on breccia parent material are often cobbly clay loams. Communities on northerly-facing slopes are often in cold valleys or cirque basins on rocky, sandy silt loam soils. Soils are always well drained and dry by late spring or early summer.

Management Implications

Management activities which alter soil or hydrologic conditions are likely to change community structure and diversity. At least one population of a sensitive species, Cusick's checkermallow (Sidalcea cusickii), was found in our survey.

This community generally produces significant amounts of palatable forage for many large and small mammals such as elk, deer, pocket goghers and mice. The profuse flowering in the spring provides an attractive display for recreationists, photographers and botanists.

Douglas spirea - bog blueberry / sedge (hydric)
SPDO - VAUL / CAREX (hydric) SW41 22

This is a diverse community containing about 74 shurb and herb species. The shrub component dominates the community, averaging 20 percent to 90 percent cover. Douglas spirea (Spiraea douglasii), bog blueberry (Vaccinium uliginosum), and four species of willow (Salix spp.) are the major shrubs. The remaining 11 shrub species were present on a small number of our sample plots.

Sedges and rushes dominate the lower vegetation layer, which contained 27 species. Swordleaf rush (Juncus ensifolius), blister sedge (Carex vesicaria), and Sitka sedge (C. sitchensis) were present in over half our plots. One of these two sedges dominated most plots. Woodrush sedge (Carex luzulina), muricate sedge (C. muricata), and slough sedge (C. obnupta) were each present in about a third of our plots. Slough sedge is abundant on some sites.

The 34 forb species we found varied considerably in presence and cover. Common willowweed (Epilobium glandulosum) and tofieldia (Tofieldia glutinosa) were the most consistently present though neither occurred in large quantities. Kneeling angelica (Angelica genuflexa) and twinflower marshmerigold (Caltha biflora) were common in small amounts. Grasses, while not abundant, occurred in trace amounts on many sites. Bluejoint reedgrass (Calamagrostis canadensis) and Thurber bentgrass (Agrostis thurberiana) were the most common species.

Environmental Conditions

Elevations ranged from 2500 to 5000 feet and aspect varied in our sample plots. Most of our samples were on alluvial or colluvial deposits, occasionaly earthflows, and often in valley bottoms. The water table is above or slightly below the soil surface. Organic matter accumulations from 6 to 36 inches deep forms the soil surface horizon. Where we managed to dig to mineral soil, it was silt loam or silt clay loam. This community often grades into one of the more well-drained non-forest types as topographic relief increases.

Management Implications

As with other hydric or mesic communities, the distribution, rate of flow, and seasonality of water is critical. Deer and elk use this community sparingly in most cases. Although no sensitive plants were observed, unique plants such as insectivorous sundews (Drosera spp.), bristly sedge (Carex comosa) and porcupine sedge (C. hystricina) (both uncommon west of the Cascade Crest), and poisonous western water-hemlock (Cicuta douglasii) were found in several plots.

This community usually occurs in mosaics with other hydric and mesic non-forest types in forest openings. It is part of the Forest's wetland and riparian diversity and deserves careful consideration in management activity planning.

False hellebore - common cowparsnip
VERAT - HELA FW51 11

This community is characterized by high herb cover and variety. The most common and abundant species are California false hellebore (Veratrum californica), American false hellebore (Veratrum viride) and to a lesser extent, common cowparsnip (Heracleum lanatum). Leichlin camas (Camassia leichlinii) occasionally replaces false hellebore and common cowparsnip as the dominant species. Arrowleaf groundsel (Senecio triangularis) and Cooley's betony (Stachys cooleyae) are common in small amounts. Other forbs such as violets (Viola spp.), common monkeyflower (Mimulus guttatus), largeleaf avens (Geum macrophyllum) and peregrine fleabane (Erigeron peregrinus) occur in about half of these communities.

Our species list includes 54 other herbs. Grasses, sedges (Carex spp.) or rushes are present on most sites, usually with less than 15 percent cover. Bluejoint reedgrass (Calamagrostis canadensis) and blue wildrye (Elymus glaucus) were the most common grasses. Several other grasses may occur, including American mannagrass (Glyceria grandis), Thurber bentgrass (Agrostis thurberiana), nodding semaphoregrass (Pleuropogon refractus), Mertens sedge (Carex mertensii) and foothill sedge (C. tumulicola).

Trees rarely occur. Shrubs such as salmonberry (Rubus spectabilis), devil's club (Oplopanax horridum), or Sitka alder (Alnus sinuata) may be present in small amounts.

Environmental conditions

This community occurs on gentle topography in basins, draws or on lower slopes between 3900 and 5600 feet elevation. Soil depth ranges from 28 to more than 36 inches. Soil texture varies but may be silt loam, silty clay loam, clay loam or shotty silt loam. The surface horizon (4 to 10 inches) is noticeably higher in organic matter than that of plant communities on drier sites. Rock fragments from 2 to 6 inches in diameter may be present. The water table is usually more than 8 inches deep. Small patches of this community occur on steep slopes with perched water tables or in seeps.

Management Implications

This community is often heavily grazed by elk and deer. Big game use seems to decrease as false hellebore cover increases.

Two sensitive plants, Cusick's checkermallow (Sidalcea cusickii) and S. setosa, were found on several sample sites and have been reported on other areas in this plant community.

Extensive removal of timber from the perimeter of these openings may reduce big game use and cause environmental changes which may alter the species composition. Changes in hydrology may also alter species composition.

ROCK GARDEN (flat, xeric) NRR9 11

This community occurs across the Forest on exposed ridges where patches of soil accumulate. We found 76 herb species: four ferns, two mosses, nine annual herbs, and 44 perennial herbs. In all, there were seventeen or more grass species, including two annual grasses. Grass or grass-like species were present in all of our sample plots and two or three species occurred in about 60 percent of the plots.

No single plant species occurred in more than half of our samples of this community. Pomo-celery lomatium (Lomatium utriculatum), Hall's lomatium (L. hallii), Idaho fescue (Festuca idahoensis), sheep fescue (F. ovina), western fescue (F. occidentalis) and other fescues (Festuca spp.) were present individually or in combination on 65 percent of the sites. With the exception of Wallace selaginella (Selaginella wallacei), no herbaceous species exceeded 8 percent cover on any site and only five species exceeded 3 percent cover on any one site.

Traces of Alask cedar (Chamaecyparis nootkatensis), Douglas-fir (Pseudotsuga menziesii) and bigleaf maple (Acer macrophyllum) were present. Nine shrub species occurred, generally with less than 2 percent cover each: winter currant (Ribes sanguineum), hairy manzanita (Arctostaphylos columbiana), greenleaf manzanita (A. patula), pinemat manzanita (A. nevadensis), Oregon boxwood (Pachistima myrsinites), bush rockspirea (Holodiscus dumosa), oceanspray (H. discolor), dwarf Oregon grape (10 percent cover on one site) and serviceberry (Amalanchier alnifolia). One to two shrub species were generally present but no single species occurred on more than 30 percent of our sample plots. Shrubs and trees in this community grow in moist microsites. The floristic variety in this community provides striking color displays into early summer depending on elevation.

Environmental Conditions

Though the plots in this community ranged in elevation from 2410 to 4820 feet, this association may be found from 1600 feet to over 5000 feet. The wide range in environmental conditons accounts for the high species diversity. The shallow (2-5 inches), gravelly loam, gravelly silt, clay loam, or sandy loam textured soil patches are excessively well-drained even on gentle topography. Slopes greater than 80 percent do not usually retain enough soil to support more than 10 percent herb cover. Aspect varies and does not seem to have much effect on species composition.

This community type was not sampled over the full range of its occurrence. Sites sampled were in conjunction with other types in larger forest openings. Xeric rock garden communities generally occur on rock outcrops surrounded by forest.

Management Implications

A casual look at this community, particularly during mid- to late summer, would certainly not impress the average viewer. They are hot and dry sites with remnant withered plants. In May and June they are alive with color - shades of green, white, purple, red, and yellow. Many of the plants that live here are adapted to harsh, open sites and cannot compete on more mesic sites. The Sierra onion (Allium companulatum), endemic to these communities, is listed as a threatened species in Oregon (Oregon Natural Heritage Data Base). The relatively rare scalloped onion (Allium crenulatum), known only from these communities, is not currently considered threatened and is known from several other sites not sampled.

Deer and Elk use of these communities was evident though not intense. Rodents graze on the foliage and dig for bulbs and corms. In some cases bears dig for onion bulbs and the corms of sego lily (Calochortus spp.) and camas (Camassia spp.).

Many of the species common in this plant community do not occur elsewhere in the Forest. Management should maintain the genetic viability of the plants in this community and recognize their important contribution to Forest diversity. The main threats to this community type will be rock quarrying and log skidding during timber harvest in adjacent stands.

ROCK GARDEN (steep, moist) NRL9 12

This type is a mix of wet and dry plant communities in alternating patches according to moisture availability. Wet or dry adapted species dominate depending on local conditions.

Although trees are not characteristic of this community, an occasional seedling or dwarfed Douglas-fir (Pseudotsuga menziesii) or western hemlock (Tsuga heterophylla) hangs from a local soil deposit or rock crevass. Shrub-like trees usually cover less than 5 percent of the area. Mosses and forbs dominate the ground cover. Indian lettuce (Montia spp.), saxifrages (Saxifraga spp.), stonecrops (Sedum spp.), mistmaidens (Romanzoffia spp.), and alumroots (Heuchera spp.) in various proportions characterize the forb cover. Alumroots are more abundant in shaded areas. Indian lettuces, saxifrages, and mistmaidens thrive in sunlight. Riceroot fritillary (Fritillaria lanceolata) is frequently present in soil patches. Aspidotis, (Aspidotis densa) and rockbrakes (Cryptograma spp.) are generally present in small amounts in drier parts of the community.

Environmental Conditions

Steep, moist rock gardens occur across a wide range of environmental conditions. They occur from 1600 feet to over 5000 feet elevation on slopes over 80 percent facing all aspects. Many rock gardens occur on steep bedrock at the foot of grass-forb or timber dominated terraces or rock outcrops. Site size varies from 2 to 60 or more feet in height and 10 to 100 or more feet in length.

Adjacent forest canopies often shade extensive portions of steep rock gardens. Wet, seepy conditions persist at least to mid-July. Moist rock gardens also form in perennially wet sites adjacent to waterfalls. This type was not well sampled. Lush vegetation, particularly in shade, holds substrate suitable for species such as fritillary and columbia lily. Soil 5 or more inches deep occasionally accumulates in bedrock pockets, encouraging vegetative development.

Management Implications

Road cuts and quarries may produce rock faces with water seeps which develop into moist rock gardens. Irregularly cut rock faces provide better niches for plant establishment and may also reduce construction costs. In other cases, construction activities have changed the hydrologic regime and eliminated this community from some sites. The main threats to this plant communities are inadvertent or purposeful draining and removing shade provided by an adjacent tree canopy.

The plant species in this community are not generally found elsewhere on the Forest. Thompson's mistmaiden (Romanzoffia thompsonii), an annual of the Hydrophylleace family found in this community, is classified in the Oregon Natural Heritage Data Base (March 1985) as limited in range but stable in population.

The extent of wildlife use is unknown. Bird and rodent droppings were seen on the small ledges and rock projections.

ROCK GARDEN (steep, xeric) NRL9 11

Dwarfed mature or seedling Douglas-fir (Pseudotsuga menziesii), ponderosa pine (Pinus ponderosa), chinquapin (Castanopsis chrysophylla), Oregon white oak (Quercus garryana), or madrone (Arbutus menziesii) may be present in trace amounts. Nine shrub species occurred on our sample plots, mostly in small areas of accumulated soil. Oceanspray (Holodiscus discolor) and Oregon boxwood (Pachistima myrsinites) are the most common and may provide up to 5 percent cover. Other shrubs, present in trace amounts, include: salal (Gaultheria shallon), vine maple (Acer circinatum), dwarf Oregon grape (Berberis nervosa), osoberry (Oemelaria cerasiformis), prince's pine (Chimaphila umbellata), and, at lower elevations, poison oak (Rhus diversiloba).

The herb and graminoid flora of dry, vertical rock gardens share some early-flowering species found in steep, moist rock gardens. California mistmaiden (Romanzoffia californica), Thompson's mistmaiden (R. thompsonii), and chickweed monkeyflower (Mimulus alsinoides), for example, may show up in the xeric rock garden in patches of accumulated soil.

Forbs and grass provide 10-15 percent total cover. Spatula-leaved stonecrop (Sedum spathulifolium), onion (Allium spp.), and Lyall saxifrage (Saxifraga lyallii) characterize the herb layer of the sites sampled. Cliff penstemon (Penstemon rupicola) and spreading stonecrop (Sedum divergens) are common at the south end of the Forest. Other forbs which were not found in our samples but known to occur in this community include: Cascades fleabane (Erigeron cascadensis - at upper elevations), rockbrake (Cryptogramma crispa), spring-gold (Crocidium multicaule - at lower elevations), barestem eriogonum (Eriogonum nudum), and northern eriogonum (E. compositum). Grasses are often present in small amounts (1 percent cover or less). Both perennial species such as western fescue (Festuca occidentalis) and sheep fescue (F. ovina) and annuals such as elegant hairgrass (Aira elegans) may occur. In general the herbs and graminoids complete their growth and flowering cycles in the early spring. Moss cover varies from traces to over 50 percent.

Environmental Conditions

Landform and parent material are somewhat variable. The sites examined were andesite or basalt rock walls with occasional soil and rocky material accumulations on small benches (2 to 3 feet wide). In other cases, soil accumulations were limited to small, shallow (1-4 inch) pockets. Similar communities may exist on breccia walls but were not sampled. These soil accumulations are usually patchy and sandy loam or a coarse gravelly loam (on rock benches) in texture. By mid-July, depending on aspect and altitude, available water is gone and the plants have matured and withered. The short period of time that adequate soil moisture is available limits species composition.

This type is found over a broad elevation range, from 1600-5000 feet. Our sample plots were taken from elevations between 2100 and 3200 feet. Slopes steepness ranged from 110 percent to vertical and aspects were southeast to south. Minimum slope for this community will be about 80 percent and aspect varies. Slopes tending to northwest, north or northeast are generally cooler and more moist. Under such conditions, sufficient vegetation develops on all but the steepest sites to hold enough soil for communities other than rock gardens to develop. Moss cover is lowest on the steepest, most exposed sites. Forest canopies from stands growing at the base of xeric rock walls have a significant influence (shade and wind reduction) on the environment of rock walls.

Management Implications

Big game use was restricted to deer browsing on accessable ledges. From the droppings evident, rodent and bird species use these communities at least some part of the year.

Steep, xeric rock gardens, like other rock garden communities, are characterized by a relatively small number of species, many of which are unique to these habitats. None of these plants are, as yet, considered threatened or endangered. In many cases these communities are biological islands between which plant migration to sustain genetic diversity is difficult. Activities that reduce the numbers and distribution of these types need to be carefully planned and applied to sustain species diversity.

Sedge - common bulrush (hydric)
CAREX - SCMI (hydric) MT19 11

A lush layer of moisture-loving herbs and a thick moss layer are characteristic of this plant community. Fifteen sedge and eight grass species dominate the herb layer. Sitka sedge (Carex sitchensis) and blister sedge (C. vesicaria) are the most common sedges. Panicled bulrush (Scirpus microcarpus) is the most common rush. Several grasses are common, including bluejoint reedgrass (Calamagrostis canadensis), Thurber bentgrass (Agrostis thurberiana) and American mannagrass (Glyceria grandis), but none are abundant. These grasses are not unique to this community. They occur in several other comunities and are often found on very dry sites. Nodding semaphoregrass (Pleuropogon refractus), which occurred on several of our sample plots, is restricted to hydric environments.

The most common herbs, chickweed mimulus (Mimulus alsinoides), western St. Johnswort (Hypericum formosum) and elephanthead pedicularis (Pedicularis groenlandica), are often also major components of other hydric communities. Twinflower marshmerigold (Caltha biflora), trailing St. Johnswort (Hypericum anagaloides) and western waterhemlock (Cicuta douglassi) are occasionally abundant. Lady fern (Athyrium felix-femina) and western shield-fern (Dryopteris austriaca) may be present.

Shrubs are not abundant, but small amounts may occur on some sites. Bog blueberry (Vaccinium uliginosum), Pacific willow (Salix lasiandra) and other willows, and Douglas spirea (Spiraea douglasii) are usually present. Trees are generally absent.

Environmental Conditions

This community is wet throughout the growing season. The water table is usually slightly above the soil surface. Spring or seep water may flow along small channels or stand in small depressions.

This community can be found throughout the Forest, usually adjacent to streams. The sites we examined were between 2,800 and 5,200 feet elevation and faced various aspects. Most were in glacial cirques or valleys or on colluvial failures. Beaver colonies are common and often increase the area of this community by creating high water tables.

Soils are usually developed in alluvial or volcanic pumice deposits. Most soils are histosols. The organic horizon varies from 8 to 20 inches deep. Average total soil depth ranges from 20 to over 36 inches. Shallower soils often contain large (12 inches and larger) rocks in the lower horizons. Soil texture is usually silt or silty clay loam.

Management Implications

This floristically diverse community has many unique and uncommon species. Our species list includes one sensitive species, Cusick's checkermallow (Sidalcea cusickii), and many-spiked cottongrass (Eriophorum polystachion), a plant listed by the Oregon National Heritage database (3/85) as needing more population distribution data to determine whether it should be classed as threatened or endangered. This plant community is excellent habitat for sundew (Drosera rotundifolia), an uncommon insectivorous plant. Bristly sedge (Carex comosa) and porcupine sedge (C. hystricina), plants rarely reported west of the Cascades, occasionally occur.

This community is usually in a mosaic with other meadow types in large forest openings. It adds significantly to the total diversity of the opening. Some sites in this plant community are too wet to be used by big game. As with other wet communities, abundant water is vital. Care should be taken not to reduce the rate, distribution or season of waterflow.

Sedge - twinflower marshmerigold
CAREX - CABI MM39 11

Sedges (Carex spp.) alone or in combination with grasses dominate this community. The combined cover of sedges and grasses always equals or exceeds that of forbs. Blister sedge (Carex vesicaria) and C. lenticularis are the most common species. Muricate sedge (Carex muricata) and woodrush sedge (C. luzulina) are found in about half of the communities. Eleven other species of sedges, rushes (Juncus spp.) and woodrushes (Luzula spp.) may be present. Tufted hairgrass (Deschampsia caespitosa), bluejoint reedgrass (Calamagrostis canadensis), Thurber bentgrass (Agrostis thurberiana) or Hall's bentgrass (A. hallii) occur on many sites. Sedges may be seral and give way to grasses and forbs later in succession.

Twinflower marshmerigold (Caltha biflora) and Jeffrey shootingstar (Dodecatheon jeffreyi) are present in most of these communitues. Trailing St. Johnswort (Hypericum angalloides), white bog-orchid (Habenaria dilatata) and 30 or more additional herbs may be present. Occasionally Sierra boykinia (Boykinia major) or American yellow skunkcabbage (Lysichitum americana) may be abundant on some sites.

Environmental Conditions

Most sites are between 4,000 and 5,000 feet elevation on gentle, southerly-facing topography. Landform varies from basins in glaciated valleys to benches and basins on colluvial or alluvial material. Volcanic ash overlays the substrate on some sites. The water table is at or above the surface in early summer and just below the surface by late summer. Anaerobic blue clays often occur from 18 to 36 inches below the surface. Some profiles include clay loams and shotty silt loams below 24 inches.

Management Implications

Palatable forage is abundant and often heavily used by elk and deer. This community often occurs in a mosaic with several other meadow types and tree islands within a forested landscape. These openings add significantly to forest diversity.

A sensitive species, Cusick's checkermallow (Sidalcea cusickii), was found on one site and occurs in other areas in this community. Cusick's checkermallow may not be absolutely dependent on high water tables and appears to maintain stable populations in this community.

Changes in the location, season, or amount of water flow into this community could alter species composition. Increased drainage could eliminate water-loving species and cause succession to another community.

Shrub (lava)
SHRUB (lava) NCS1 11

Lava beds vary from relatively recent, nearly barren formations to flows several thousands of years old. Older lava often supports vegetation ranging from shrub and herb patches to open forest. The vegetative description below characterizes the often extensive patches of accumulated soil on which open forests have developed.

Shrub or perennial herb cover is 10 percent or greater. Shrubs are generally more abundant than herbs. Vine maple(Acer circinatum), cascara buckthorn (Rhamnus purshiana) and bush rockspirea (Holodiscus dumosus) are most common and average from 5 percent to 10 percent cover. Smaller amounts of greenleaf manzanita (Arctostaphylos patula) and pinemat manzanita (A. nevadensis) may be present. Scattered trees, especially Douglas-fir (Pseudotsuga menziesii), Pacific silver fir (Abies amabilis) and western hemlock (Tsuga heterophylla), occur in local soil accumulation pockets. Where tree cover approches 10 percent, shrub cover tends to decrease, possibly due to competition for water. Two species of ferns, lace lipfern (Cheilanthes gracillima) and rockbrake (Cryptograma crispa), are common in small amounts. Several perennial forbs may be present. Spatula-leaf stonecrop (Sedum spathulifolium) may be abundant or absent. Davidson penstemon (Penstemon davidsonii), a drought-adapted species with a woody base, frequently occurs in small amounts (1-3 percent cover). Western saxifrage (Saxifraga occidentalis var. refidula), parry rush (Juncus parryi) and bottlebrush squirreltail (Sitanion hystrix) may be present in small amounts. Annual species were not present in our plots but may be expected to occur. Mosses often cover 60 percent to 90 percent of the rock surface.

Environmental Conditions

The lava beds are environmentally harsh sites. Local collections of fragments and pockets of soil support the scattered patches of vegetation. Sites at 3000 to 3600 feet elevation on more or less flat terrain tend to dry rapidly following snowmelt. By early summer rock surfaces and shallow soil patches are too dry to support most plants.

Management Implications

The rare geologic phenomena and fall color displays invite recreational use. Hiking overland without trails is slow and arduous. Difficult travel and lack of food contributes to low use by animals. Future human use of these sites will probably increase very slowly from present levels.

Sitka alder (rocky soil)
ALSI (rocky soil) SM81 11

Sitka alder (Alnus sinuata) and salmonberry (Rubus spectabilis) dominate this community. Sitka alder cover varies from 35 percent to 95 percent and salmonberry from 15 percent to 50 percent cover. Sitka alder is abundant above 3900 feet elevation, but sporadic below 3900 feet. Stink currant (Ribes bracteosum), European red elder (Sambucus racemosa) and devil's club (Oplopanax horridum) may be abundant, but do not always occur. Single trees or small clumps may be scattered through the community but average less than 10 percent cover.

Thirty-six forb and grass species and one fern species were present in our samples of this community. Pacific waterleaf (Hydrophyllum tenuipes) and Cooley's betony (Stachys cooleyae) occurred in nearly all of our plots with up to 25 percent cover. Four species of violet (Viola spp.) were present in our plots and one or two species occurred in 90 percent of our plots with covers ranging from trace to 35 percent. Small amounts of feathery solomonplume (Smilacina racemosa), false solomonseal (S. stellata) and bleeding heart (Dicentra formosa) were found in over 70 percent of our plots. Hooker fairybells (Disporium hookerii), Menzie's tolmiea (Tolmiea menziesii), Miner's lettuce (Montia siberica), common cowparsnip (Heracleum lanatum), and bluejoint reedgrass (Calamagrostis canadensis) occurred on many plots. Mountain wood-fern (Thelypteris limbosperma) and sheild-fern (Dryopteris austriaca) were abundant in a few plots. Many other species were sporadically present. Moss cover was between 30 percent and 50 percent on over half our sample plots.

Environmental Conditions

Our Sitka alder/rocky soil plots were on gentle to moderately steep slopes facing various aspects between 3920 feet and 5000 feet elevation. Soil profiles were quite similar: 10 inches to 36 inches or more of gravelly clay loam, silt clay loam, silt loam, or shotty loam to a substrate of large rock (4 inches to 12 inches diameter). About 70 percent of the soils contained 1 percent to 10 percent rock (1 inches to 3 inches in diameter) in the upper soil profile. In most cases there were 1 to 2 inches of leaf and other plant material on the soil surface. Soils usually appeared to be colluvially deposited. This type often extends into extremely steep headwalls at upper elevations, especially in avalanche tracks. In these cases, salmonberry is not typically present and the herb flora contains some subalpine species such as Sitka valerian (Valeriana sitchensis).

Management Implications

Management activities that alter water levels or change air currents (climate) will affect this community. Several species of birds were seen and hummingbirds, in particular, were abundant during the late summer blooming period of Cooley's betony (Stachys cooleyae). Mountain beaver (Aplodontia rufa) were frequently found in this community. Where they were present, Pacific waterleaf tops had been browsed. Evidence of deer and elk use was generally scarce even though palatable forage was abundant. One plot with dense Sitka alder, on Monument Peak, was heavily used by elk.

Threatened, endangered, or sensitive plant species were not found in this community. Case's corydalis (Corydalis caseana), a riparian species not listed by Hitchcock and Cronquist (1973) for west of the Cascade Crest, was found on one plot.

Spirea - willow / sedge
SPIRA - SALIX / CAREX SW41 23

Total shrub cover ranges from slightly less than 50 percent to nearly 100 percent cover. Douglas spirea (Spiraea douglasii) gives way to subalpine spirea (S. densiflorus) at about 4000 ft elevation. Willows (Salix spp.) and bog blueberry (Vaccinium uliginosum) are important on most sites. Five other shrub species were present in smaller amounts.

Several sedges (Carex spp.) are common. Woodrush sedge (Carex luzulina) is the most consistant species. Carex lenticularis, blister sedge (C. vesicaria), Sitka sedge (C. sitchensis) and russet sedge (C. saxatilis) are common. Sitka sedge occurs on cooler sites between 3500 and 5000 feet elevation. Eight or more additional Carex species may occur.

Several rushes and grasses are common. Panicled bulrush (Scirpus microcarpus) occurs below 5000 feet elevation. Baltic rush (Juncus balticus), spreading rush (J. patens) and swordleaf rush (J. ensifolius) are relatively common. Several grass species are important, including: bluejoint reedgrass (Calamagrostis canadensis), tufted hairgrass (Deschampsia caespitosa), spike bentgrass (Agrostis exarata), Hall's bentgrass (A. hallii), and Thurber bentgrass (A. thurberiana). Over 33 forb species occur in this community, none with regularity. Common willowweed (Epilobium glandulosum), smooth willowweed (E. glaberrimum) and trailing St. Johnswort (Hypericum anagalloides) are the most common. Shootingstars (Dodecatheon spp.) occur on the most moist sites.

Environmental Conditions

This community occurs in valley bottoms, on moist benchs or in cirque basins. The water table is often within 10 inches of the surface. Elevation ranges from 2500 feet to 5000 feet. Aspect is generally east, south, or west. The landform is flat to undulating.

Soils in our samples were clay loam, gravelly clay loam, silt clay loam or silt loam. Silt loam or silty clay loam often changed to clay loam or gravelly clay loam at about 36 inches depth. An organic horizon 1 to more than 10 inches deep was present at the surface.

Management Implications

The hydrologic regime is critical. Both water quantity and season of flow are important. Deer and elk frequently use these areas for foraging and wallows, particularly if hiding cover is available.

No threatened, endangered or sensitive plant species were found, although adders-tongue (Ophioglossum vulgatum) is know from similar sites. A rather unique species, northern starflower (Trientalis arctica), is known from only two sites on the Forest, both in this community. It is dependent on fresh, cold water, and open sun.

TALUS NTS9 11

A paucity of vegetation characterizes the large rock talus community. One to three percent cover of either trees, shrubs or herbs is usually a maximum. If trees occur, they are usually the same species as found in the surrounding forest. Tree seedling survival is extremely low.

Six shrub species were present in our sample plots: shinyleaf gooseberry (Ribes cruentum), cascara buckthorn (Rhamnus purshiana), trailing blackberry (Rubus ursinus), Oregon boxwood (Pachistima myrsinites), vine maple (Acer circinatum), and poison oak (Rhus diversiloba). Other shrubs, which occur in this type but not in our sample plots, may be present, including: oceanspray (Holodiscus discolor), bush rockspirea (Holodiscus dumosus), common juniper (Juniperus communis), and, where water flows through the rocks, red-osier dogwood (Cornus stolonifera) and willows (Salix spp.). Total shrub cover does not generally exceed 5 percent.

Herb species, usually amounting to only 2 to 5 percent total cover, are noticeable only on close inspection. Many are cool season annual plants and not generally recognizable after mid-July. Rockbrake (Cryptogramma crispa) and licorice ferns (Polypodium spp.) persist into the dry season. Chickweeds (Cerastium spp.), monkeyflowers (Mimulus spp.), varied-leaf collomia (Collomia heterophylla), small-flowered willowweed (Epilobium minutum), and catchweed bedstraw (Galium aparine) are cool season plants that may be present. Bleeding heart (Dicentra formosa) may occur in moist spots. Grasses such as western fescue (Festuca occidentalis), sheep fescue (F. ovina) and some annual species may occur in areas of soil accumulation.

Environmental Condition

The jumble of large andesite and basalt boulders supports a meager variety of plants and animals. An occasional shrub extends above the rock pile and small annual forbs or perennial grasses and ferns persist in the few pockets of soil. In most cases, flowing water is absent or so deep beneath the boulders that shrub cover averages only 5 percent. Slope steepness ranges from about 10 percent to 60 percent. Aspect and elevation vary. Our sampling was not extensive enough to document the full range of environments in which talus fields occur. Rodents are the most obvious form of wildlife and were most common in pockets of herbs and near the edges of talus fields. The pika (coney rabbit) is a common resident.

Management Implications

In general, this type does not suffer from the impacts of human activities. Large boulders might occasionally be used for slope or streambank stabilization. Based on present knowledge, these communities are most valuable for their contribution to landscape diversity. Future management activities involving these communities should include site-specific inventory and analysis to determine whether the impacts would be acceptable.

Thimbleberry / Pokeweed fleeceflower
RUPA / POPH SM59 11

Plant species diversity in this community is generally lower than in similar types. The total species list includes five trees, four shrubs, 29 forbs, and four grass and grass-like species. Thimbleberry (Rubus parviflorus), bracken fern (Pteridium aquilinum) and pokeweed fleeceflower (Polygonum phytolaccefolium) characterize this community. Idaho bluebells (Mertensia campanulata) and Louisiana sagebrush (Artemisia ludoviciana) are also important. Grass and grass-like species are not abundant. Small amounts of California brome (Bromus carinatus), blue wildrye (Elymus glaucus) and sedges (Carex spp.) may be present.

Trees, especially subalpine fir (Abies lasiocarpa), noble fir (A. procera), white fir (A. concolor), and Engelmann spruce (Picea engelmannii) may be widely scattered.

Environmental Conditions

This type occupies very dry, exposed sites at upper elevations. The five sites examined were at the north end of the Forest. Elevations ranged from 4200 to 4800 feet and aspects were south-facing. Slopes were moderately steep. Soils were well-drained silt loams to shotty silt loams greater than 24 inches deep. A consistent lack of soil structure (loosely compacted) seemed to be characteristic. Bare ground, gravel and rock ranged from 10 percent to 22 percent cover.

Management Implications

Floral displays in this community are not as colorful as in the rock garden types. The species bloom at various times during the summer or are so scattered that colorful blooms are inconspicuous. Some deer and elk use occurs. Mountain beaver may be present. Pocket gophers and other rodents are often present.

Management activities which change water movement, soils or microclimate may alter the species composition. We found no threatened, endangered or sensitive plants.

Vine maple (rocky soil)
ACCI (rocky soil) SM81 12

Vine maple (Acer circinatum) dominates this community, associated with smaller amounts of Sitka alder (Alnus sinuata). Stink currant (Ribes bracteosum) or European red elder (Sambucus racemosa) are common on some sites. Six other shrubs occurred in our sample plots in small amounts.

The herbaceous component consists of up to 16 forbs, 2 ferns, and one grass. Grass species, in this case a brome (Bromus sp.), appear to be invaders, encroaching on the edges or taking advantage of a soil disturbance or break in the canopy. The ferns, mountain shield-fern (Dryopteris austriaca) and Anderson's swordfern (Polystichum andersonii), are not regularly present (frequency less than 20 percent) and when present are not abundant. Pacific waterleaf (Hydrophyllum tenuipes) is usually the dominant herb, averaging 10 percent to 30 percent cover. Violets (Viola spp.) occurred on all plots. Pioneer violet (V. glabella) was the most common. Other forbs, including: bleeding heart (Dicentra formosa), Oregon oxalis (Oxalis oregana), Pacific trillium (Trillium ovatum), false solomonseal (Smilacina stellata), and miner's lettuce (Montia siberica) were present on about 60 percent of our plots with covers ranging from trace to 40 percent. Moss cover was generally low. Trees are rare.

Environmental Conditions

We have a relatively small sample of this community. Sites examined were between 3900 and 4600 feet elevation on gentle to moderately steep slopes. Soils were 7 inches to 24 inches deep over unconsolidated rock or, in one case, a stony clay hardpan. Soil texture varied from silt loam to shotty silt loam and clay loam. Small rocks (1 to 3 inches diameter) were common in the upper soil profile. These communities seem to be on more southerly aspects with drier soils than the Sitka alder (rocky soil) community. There is often an organic layer, 1 to 2 inches thick, on the soil surface. Water channels are generally dry by early summer. Water flowing into mid-season creates wet microsites with different species composition.

Management Implications

Careful consideration of hydrologic effects should be given to management activities in or adjacent to this community. Many sites are relatively small and surrounded by mature conifer forests. Changes to the environment caused by canopy removal on adjacent sites or road construction could easily change the community composition and structure. Big game use was observed on some sites. Heavy use by mountain beaver was observed on most sites. Pacific waterleaf was heavily browsed by mountain beaver. Several species of birds were observed feeding, but no nests were found.

No threatenened, endangered, or sensitive plants were observed. Case's corydalis (Corydalis caseana), an unusual species for the West Cascades, and Anderson's swordfern (Polystichum andersonii), a relatively uncommon fern once listed as sensitive, were found on one site.

Vine maple (talus)
ACCI (talus) NTS2 11

This community consists of abundant vine maple (Acer circinatum) (25 percent to 95 percent cover) over a field of large andesite and basalt boulders. European red elder (Sambucus racemosa) and salmonberry (Rubus spectabilis) often contribute 5 to 10 percent cover. Gooseberries (Ribes spp.), cascara buckthorn (Rhamnus purshiana), and, occasionally, devil's club (Oplopanax horridum) may be present at less than 5 percent cover. Some 20 species of herbs occur in trace amounts. Bleeding heart (Dicentra formosa), feather solomonplume (Smilacina racemosa), and false solomonseal (S. stellata)are the most common species. False solomonseal and baneberry (Actaea rubra) may be abundant (up to 10 percent cover) in moist microsites. The single populations of fetid adderstongue (Scoliopus hallii) and Seneca grass (Hierochloe odorata) found on the Forest were in this community type. The latter species was in a open (25 percent cover) stand of vine maple. Perennial grasses, especially western fescue (Festuca occidentalis) and Idaho fescue (F. idahoensis), may be present in trace amounts.

Environmental Conditions

Water is near the surface in all vine maple/talus communities. In spring and early summer, orthroughout the year on some sites, water flows through the subsurface rocks or comes to the surface in springs and seeps. Abundant water and shade produce humid microsites carpeted by lush moss, swordfern and mountain hollyfern (Polystichum lonchitis) communities. Patchy accumulations of fine materials and soil often support diverse herb gardens.

Management Implications

Management activities which alter hydrologic conditions will have the most serious impacts on this community. Fetid adderstongue (Scoliopus hallii), a member of the liliaceae family found in riparian and wet habitats such as the vine maple (talus) community, was listed as a Region 6 sensitive species but has recently been removed from the list. It was found in one shrub rock talus community on the Forest and is known from one other location near the Forest (Gate Creek). Management activities in this community could jeopardize the viability of fetid adderstongue on the Forest.

Pika and other rodents and several bird species, including hummingbirds, were observed. Though substantial paltable browse is available, use by big game animals was minimal. Large, jumbled boulders are probably an effective travel barrier for big game animals.

Woolly eriophyllum - varileaf phacelia
ERLA-PHHE FM 99 11

The most noticeable aspects of this community are floral color and bare ground. Herbaceous cover ranged from 35 percent to 80 percent, moss cover from 15 percent to 55 percent, and bare ground from 35 percent to 50 percent cover. Thirteen to 25 plant species were present in each of our sample plots. A total of 40 tree, shrub and herb species were identified on the sites inventoried in this community.

Trees are rare, occurring on isolated pockets of deeper soil. Shrubs make up a small component (less than 2 percent cover) of the community. Common juniper (Juniperis communis), serviceberry (Amelanchier alnifolia), oceanspray (Holodiscus discolor) and common snowberry (Symphoricarpos albus) may be found, but usually only one of these species occurs on a site.

Forbs dominate the herbaceous component. Woolly eriophyllum (Eriophyllum lanatum) was present on all our sample plots, averaging 2 percent to 5 percent cover. Varileaf phacelia (Phacelia heterophylla) was present in trace amounts in about 75 percent of our sample plots. Creamy stonecrop (Sedum oregonense), spreading stonecrop (S. divergens), spatula-leaf stonecrop (S. spathulifolum), mountain eriogonum (Eriogonum marifolium), sulphur eriogonum (E. umbellatum), northern eriogonum (E. compositum) and barestem eriogonum (E. nudum) were present in various combinations. Creamy stonecrop and northern eriogonum were most constant, with covers ranging from 1 percent to 10 percent. All but four of the plants listed are perennials and flower in spring or early summer. Gorman's aster (Aster gormanii), Hall's goldenweed (Haplopappus halli), and Scouler's bluebell (Campanula scoulerii) are exceptions that bloom in early fall.

Seven grass and grass-like species were observed in this community. Thin bentgrass (Agrostis diegoensis) and bottlebrush squirreltail (Sitanion hysterix) are the most typical for this community and occur in small amounts (trace to 2 percent cover).

Environmental Conditions

Shallow soils, from 2 to 6 inches deep, over bedrock are characteristic of this community. Most sites occur on south- or west-facing, steep, upper slopes or ridgetops between 4800 feet and 5300 feet elevation. Sites located on lower or midslopes are usually south-facing and dry out early in the summer. Environmental conditions are extremely severe. Winter snowpacks are often deep. Many sites are on ridges exposed to desiccating winds, blowing snow and rime ice. The transition to severe summer drought quickly follows snowmelt. Soils are so shallow and well-drained that severe drought develops by early summer. Plant communities which persist under such conditions are fragile and are easily disturbed.

Management Implications

The greatest threat to these communities are activities that would destroy the sparse soil mantle. Some ridge top sites at the north end of the Forest support populations of Gorman's aster (Aster gormanii), currently listed as sensitive. Populations of Hall's goldenweed (Haplopappus hallii), an uncommon species, often occur on south-facing slopes on the same ridges that support Gorman's aster. Hall's goldenweed is found in similar environments at the south end of the Forest. Most of the plants in this community tolerate severe environments and would probably not be competitive on more mesic sites. This is a unique and relatively uncommon component of the Forest's diversity.

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APPENDIX I—Vegetative Tables by Plant Association

Mean relative percent cover (average cover for all plots in which the species occurs) and percent constancy for selected trees, shrubs and herbs of Douglas-fir, grand fir, and western hemlock associations.

ASSOCIATION	DOUGLAS-FIR/ OCEANSPRAY-DWARF OREGON GRAPE			DOUGLAS-FIR/ OCEANSPRAY/GRASS			DOUGLAS-FIR OCEANSPRAY-WHIPPLE VINE		
# OF PLOTS	16			9			13		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM							5	0.9	46
ABGR	10	2.7	19	2	1.0	22	4	1.2	38
ACMA	8	0.9	50	6	1.0	67			
ALRU							4	0.8	38
ARME	4	0.4	56	5	1.7	44	1	0.0	8
CACH	4	0.5	19				17	1.9	54
CADE	10	1.3	50	14	3.0	44	7	1.4	23
CONU	9	2.4	19				8	1.3	31
PILA	7	2.6	31	8	1.6	44	5	2.5	15
PIMO							16	2.1	31
PIPO				19	3.8	33	51	1.0	100
PSME	58	0.9	100	68	1.7	100	20	0.0	8
TABR				2	0.0	11	5	0.0	8
THPL				6	3.2	22	4	1.0	15
TSHE	2	0.0	6				69	1.0	100
Total Tree Cover	69.4	0.77	100	81	1.1	100			
Regenerating Trees									
ABAM							5	1.3	46
ABGR	7	2.0	31	1	0.0	22	6	1.0	46
CADE	2	0.2	38	17	6.0	22	1	0.0	8
PILA	1	0.0	44	1	0.0	11			
PIMO									
PIPO							12	2.0	54
PSME	8	1.2	50	3	0.4	44	5	0.0	8
TABR	1	0.0	6						
THPL				3	0.0	11	1	0.2	23
TSHE	2	0.4	19						
Shrubs									
ACCI	21	2.1	50	5	0.0	22	12	2.5	54
ACGLD	2	0.0	6	10	0.0	11	5	0.0	8
ARUV									
BEAQ	2	0.1	44	3	0.4	78	5	0.8	69
BENE	26	1.2	100	4	0.4	56	7	0.7	77
CACH							5	0.0	8
CHME	1	0.0	25	1	0.0	22	1	0.0	15
CHUM	1	0.2	19	3	0.0	11	2	0.4	23
COCO2	7	0.6	63	4	0.6	67	5	0.3	92
CONU	1	0.0	25	2	0.0	11	2	0.3	54
GASH	3	0.3	25				5	1.5	23
HODI	10	0.5	75	4	0.9	78	10	1.0	77
LOCI	1	0.0	25	1	0.0	11	1	0.0	15
LOHI	2	0.1	38	2	0.4	22	1	0.0	8
OPHO									
PAMY	1	0.0	6				1	0.0	8
RHDI	7	0.8	63	2	0.3	56	2	0.2	62
RHMA	22	4.8	10				2	0.0	8
RIBR									
RILA				1	0.0	11			
ROGY	3	0.1	94	2	0.1	89	4	0.4	100
RUPA	1	0.0	6	1	0.0	11	2	0.0	15
RUSP									
RUUR	2	0.1	81	2	0.1	78	2	0.1	69
SYAL									
SYMO	5	0.3	94	3	0.3	78	5	0.3	92
VAAL									
VAME									

ASSOCIATION	DOUGLAS-FIR OCEANSPRAY-DWARF OREGON GRAPE			DOUGLAS-FIR OCEANSPRAY/GRASS			DOUGLAS-FIR OCEANSPRAY- WHIPPLE VINE		
# OF PLOTS	16			9			13		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
VAOV									
VAPA	2	0.3	25				2	0.2	23
WHMO	5	0.3	94	3	0	44	20	1.1	100
Total Cover:									
High Shrubs	26	1.1	10.0	10	0.8	100	24	1.5	100
Low Shrubs	40	1.2	10.0	10	1.0	100	25	1.3	92
Herbs									
ACTR	3	0.4	50	1	0.0	33	1	0.0	38
ADBI	2	0.1	69	1	0.1	67	2	0.1	69
ANDE	1	0.1	81	2	0.1	44	2	0.2	31
ANLY2									
ARMA3	2	0.1	63	2	0.2	78	2	0.1	69
ASCA3									
ATFI									
BLSP									
BRVU	1	0.0	13	9	2.4	33	3	0.6	31
CABU2	1	0.0	13						
CASC2	1	0.1	56	1	0.1	67			
CLUN	1	0.0	6				2	0.2	31
COCA									
COLA							1	0.0	8
DIHO	1	0.1	69	1	0.1	44	2	0.1	46
FECA	1	0.0	6	2	0.1	67	1	0.0	8
FEOC	1	0.0	6	2	0.0	11	2	0.4	23
FESU				5	1.7	44	3	0.6	31
FRVE	1	0.1	75	4	1.0	78	2	0.1	77
GAOR	2	0.0	6						
GATR	1	0.1	50	1	0.1	56	1	0.0	46
GOOB	1	0.1	38	1	0.1	44	1	0.1	38
HIAL	1	0.1	94	1	0.1	100	2	0.1	69
IRTE	1	0.0	13	1	0.0	11	2	0.4	15
LIBO2	8	0.9	50	14	6.0	33	4	0.4	54
MOSI	1	0.0	13	1	0.1	44	1	0.0	23
OXOR									
POMU	4	0.2	94	2	0.1	78	6	0.6	85
PTAQ	1	0.0	38	1	0.0	44	1	0.0	23
PYSE									
SADO	1	0.1	44	1	0.2	33	1	0.1	31
SMST	2	0.3	25				1	0.0	23
STRO	1	0.0	6				1	0.0	8
SYRE	3	0.2	88	2	0.3	56	3	0.3	38
TITR									
TRLA2	1	0.1	63	3	0.2	78	1	0.1	62
TROV				1	0.0	11			
VAHE	1	0.0	44	2	0.4	22	1	0.1	54
VISE	1	0.1	31	1	0.0	22	3	0.4	15
XETE									
Total Herb Cover	27	16	100	24	1.9	100	21	0.9	92

ASSOCIATION	DOUGLAS-FIR/ SNOWBERRY			DOUGLAS-FIR-WESTERN HEMLOCK/ DWARF OREGON GRAPE			DOUGLAS-FIR-WESTERN HEMLOCK/ RHODODENDRON		
# OF PLOTS	7			26			14		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM									
ABGR	6	2.5	43	4	0.8	12	3	0.6	43
ACMA	20	0.0	14	10	0.8	46			
ALRU							4	0.8	29
ARME	19	7.6	57	6	0.7	35	14	1.4	64
CACH				5	0.6	31	15	1.5	71
CADE	4	0.7	71	18	0.9	65	8	0.3	43
CONU	8	0.0	14	13	3.6	19	8	1.1	43
PILA				10	4.3	12			
PIMO				1	0.0	4			
PIPO				13	5.3	8			
PSME	72	2.8	100	67	0.5	100	56	1.5	100
TABR				1	0.0	4	4	1.8	14
THPL				18	3.7	12	12	2.5	21
TSHE	1	0.0	14	4	0.6	27	5	0.1	50
Total Tree Cover	85	1.6	100	81	0.3	100	74	0.9	100
Regenerating Trees									
ABAM									
ABGR	3	1.1	57	2	0.1	23	2	0.7	14
CADE	3	0.7	57	4	0.4	46	6	1.2	43
PILA				1	0.0	4	1	0.0	7
PIMO	1	0.0	14						
PIPO				1	0.0	8	2	0.0	7
PSME	2	0.3	86	2	0.1	81	4	0.7	50
TABR	1	0.0	14	1	0.0	4	1	0.0	7
THPL	1	0.0	14	6	1.6	15	1	0.0	14
TSHE	1	0.0	29	1	0.1	38	2	0.2	43
Shrubs									
ACCI	1	0.0	14	15	1.0	54	19	1.4	57
ACGLD									
ARUV									
BEAQ	2	0.1	71	2	0.2	23			
BENE	6	1.0	100	26	0.8	100	13	0.8	100
CACH	1	0.0	14	6	1.9	23			
CHME	1	0.0	14	1	0.0	31	1	0.0	29
CHUM	1	0.0	14	6	0.9	38	2	0.2	43
COCO2	6	1.0	100	9	0.8	69	2	0.3	29
CONU	2	0.3	43	2	0.1	35	1	0.1	36
GASH				13	1.2	35	39	1.9	100
HODI	13	1.8	71	5	0.7	46	4	0.6	36
LOCI	3	1.4	29	1	0.0	15	1	0.0	21
LOHI	3	0.4	29	1	0.0	4			
OPHO									
PAMY				2	0.4	8			
RHDI	3	1.1	43	1	0.1	27	1	0.0	7
RHMA							39	1.6	100
RIBR									
RILA									
ROGY	6	0.6	86	3	0.1	69	2	0.1	86
RUPA	1	0.0	14	4	1.7	12	3	0.0	7
RUSP									
RUUR	2	0.1	100	1	0.1	73	1	0.1	86
SYAL									
SYMO	37	3.2	100	4	0.3	73	2	0.2	43
VAAL									
VAME	1	0.0	14	2	0.0	4			

ASSOCIATION	DOUGLAS-FIR/ SNOWBERRY			DOUGLAS-FIR- WESTERN HEMLOCK/ DWARF OREGON GRAPE			DOUGLAS-FIR- WESTERN HEMLOCK/ RHODODENDRON		
# OF PLOTS	7			26			14		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
VAOV									
VAPA	8	5.0	29	3	0.6	19	1	0.1	43
WHMO	7	2.2	57	5	0.3	58	4	0.3	79
Total Cover:									
High Shrubs	21	2.0	100	22	0.9	88	56	1.8	100
Low Shrubs	47	3.7	100	37	1.0	96	56	1.9	100
Herbs									
ACTR				4	0.3	69	3	0.6	43
ADBI	2	0.6	43	3	0.3	73	1	0.0	43
ANDE	1	0.1	57	2	0.1	58	1	0.1	43
ANLY2				1	0.0	4	1	0.0	7
ARMA3	1	0.0	43	1	0.1	42			
ASCA3	1	0.0	14	1	0.0	4	1	0.0	7
ATFI									
BLSP									
BRVU	2	0.4	43	1	0.0	23	1	0.0	7
CABU2	1	0.0	14	1	0.0	4			
CASC2	5	0.0	14	1	0.1	38	2	0.2	29
CLUN									
COCA									
COLA									
DIHO	1	0.2	43	2	0.1	42	1	0.1	50
FECA	15	0.0	14	2	0.1	15	1	0.0	7
FEOC	1	0.0	14	1	0.0	31			
FESU	2	0.4	29	1	0.2	12			
FRVE	2	0.1	71	2	0.1	50	1	0.0	29
GAOR				1	0.0	4	1	0.0	7
GATR	1	0.5	57	1	0.1	46	1	0.0	57
GOOB	1	0.0	57	1	0.1	65	1	0.1	43
HIAL	1	0.5	57	1	0.1	85	1	0.0	43
IRTE	1	0.0	14	1	0.0	31	1	0.0	21
LIBO2	16	8.5	43	4	0.2	50	7	0.6	50
MOSI	1	0.0	14	1	0.2	19	2	0.4	14
OXOR	0.0	0.0	0.0	1	0.0	4			
POMU	11	3.4	57	6	0.5	77	7	1.2	64
PTAQ	2	0.7	43	3	0.2	27	2	0.2	50
PYSE									
SADO	1	0.1	71	3	0.4	12	1	0.0	7
SMST				2	0.3	15	2	0.0	7
STRO				1	0.0	4	1	0.0	14
SYRE	3	0.0	43	3	0.2	35	1	0.1	43
TITR									
TRLA2	2	0.1	86	2	0.1	88	1	0.1	50
TROV	1	0.0	14	1	0.0	19	1	0.0	14
VAHE	1	0.1	57	1	0.1	27	1	0.0	29
VISE	1	0.0	14	2	0.1	46	2	0.3	50
XETE							2	0.1	29
Total Herb Cover	20	2.4	100	17	0.4	96	12	0.8	100

ASSOCIATION	DOUGLAS-FIR-WESTERN HEMLOCK/SALAL		
# OF PLOTS	26		
	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees			
ABAM			
ABGR	3	0.4	19
ACMA	9	0.6	35
ALRU			
ARME	5	0.8	27
CACH	7	0.5	42
CADE	15	0.7	50
CONU	10	1.5	27
PILA	12	2.0	23
PIMO	5	0.0	4
PIPO	4	0.0	4
PSME	59	0.7	100
TABR	5	1.0	15
THPL	6	0.6	38
TSHE	9	0.5	65
Total Tree Cover	74	0.4	100
Regenerating Trees			
ABAM			
ABGR	3	0.3	19
CADE	5	0.6	42
PILA	1	0.0	8
PIMO	1	0.0	4
PIPO			
PSME	4	0.1	73
TABR	3	0.3	23
THPL	2	0.3	15
TSHE	2	0.2	46
Shrubs			
ACCI	21	1.2	73
ACGLD			
ARUV			
BEAQ	3	1.4	8
BENE	9	0.3	96
CACH	3	0.3	19
CHME	1	0.0	23
CHUM	1	0.1	27
COCO2	8	0.4	65
CONU	5	0.7	35
GASH	61	0.9	100
HODI	12	0.8	58
LOCI	2	0.3	15
LOHI	2	0.4	15
OPHO			
PAMY	1	0.0	4
RHDI	6	1.6	19
RHMA	3	0.3	38
RIBR			
RILA			
ROGY	2	0.1	88
RUPA	1	0.0	15
RUSP			
RUUR	2	0.1	81
SYAL			
SYMO	5	0.3	58
VAAL			
VAME	1	0.0	4

ASSOCIATION	DOUGLAS-FIR WESTERN HEMLOCK/SALAL		
# OF PLOTS	26		
	Mean Relative Cover %	Standard Error	Constancy %
VAOV			
VAPA	3	0.1	54
WHMO	5	0.4	69
Total Cover:			
High Shrubs	41	1.0	100
Low Shrubs	58	1.1	96
Herbs			
ACTR	2	0.1	50
ADBI	2	0.1	50
ANDE	1	0.1	69
ANLY2	1	0.0	8
ARMA3	2	0.2	12
ASCA3			
ATFI			
BLSP			
BRVU	1	0.1	23
CABU2	1	0.0	8
CASC2	1	0.1	23
CLUN	1	0.1	15
COCA			
COLA	1	0.0	4
DIHO	1	0.1	42
FECA	1	0.0	8
FEOC	1	0.0	38
FESU	1	0.0	4
FRVE	1	0.1	38
GAOR	1	0.0	12
GATR	1	0.1	50
GOOB	1	0.1	58
HIAL	1	0.0	54
IRTE	1	0.0	19
LIBO2	6	0.3	81
MOSI	2	0.2	19
OXOR			
POMU	4	0.2	88
PTAQ	4	0.3.	62
PYSE			
SADO	3	0.4	23
SMST	2	0.4	8
STRO	1	0.0	4
SYRE	2	0.1	35
TITR			
TRLA2	2	0.1	58
TROV	1	0.1	19
VAHE	2	0.1	38
VISE	3	0.3	62
XETE	1	0.0	8
Total Herb Cover	14	0.4	96

ASSOCIATION	GRAND-FIR/ BEARBERRY			GRAND-FIR/ DWARF OREGON GRAPE			GRAND-FIR/ PRINCE'S PINE		
# OF PLOTS	2			18			6		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM									
ABGR	2	0.0	50	14	0.5	100	17	3.5	83
ACMA				3	0.3	39	1	0.0	17
ALRU									
ARME				4	0.0	6			
CACH				5	1.5	17	2	0.0	17
CADE				17	0.8	67	7	0.0	17
CONU				7	1.2	28	2	0.0	17
PILA	5	0.0	50	4	0.9	33			
PIMO									
PIPO				11	6.7	11			
PSME	23	5.3	100	46	1.2	100	68	3.4	100
TABR				7	1.0	28			
THPL				43	12.4	11	4	0.0	17
TSHE				11	1.2	33	5	2.1	33
Total Tree Cover	23	5.3	100	79	0.7	100	81	1.6	100
Regenerating Trees									
ABAM							1	0.0	33
ABGR	2	0.4	100	7	0.5	89	9	1.7	100
CADE				5	1.0	39	3	0.0	17
PILA									
PIMO				2	0.0	6	1	0.0	17
PIPO				1	0.0	6			
PSME				2	0.4	22	2	0.4	33
TABR				2	0.0	6	1	0.0	17
THPL				3	0.7	17			
TSHE				2	0.2	17	1	0.0	67
Shrubs									
ACCI	6	0.6	100	15	1.2	61	2	0.2	50
ACGLD				2	0.4	11			
ARUV	25	0.0	100						
BEAQ				3	0.8	28	1	0.0	50
BENE				31	0.9	100	15	2.9	100
CACH	5	0.0	50	2	0.0	11	3	0.7	67
CHME				1	0.0	22	1	0.0	50
CHUM	1	0.0	50	2	0.3	28	28	2.5	100
COCO2				7	0.4	67	7	1.0	33
CONU				10	2.6	39	7	2.4	50
GASH				30	6.0	22			
HODI	2	0.4	100	8	0.6	44	3	0.4	67
LOCI				4	1.8	11			
LOHI									
OPHO									
PAMY	5	0.0	50	1	0.0	6	5	0.0	17
RHDI				2	0.4	11			
RHMA				1	0.0	6			
RIBR									
RILA				2	0.0	6			
ROGY				3	0.2	100	2	0.2	83
RUPA	2	0.0	50	1	0.0	11	1	0.0	33
RUSP									
RUUR				1	0.0	67	2	0.1	100
SYAL				5	0.0	6	1	0.0	33
SYMO				4	0.3	83	2	0.1	67
VAAL				1	0.0	6			
VAME				1	0.0	6	1	0.0	50

ASSOCIATION	GRAND-FIR BEARBERRY			GRAND-FIR/ DWARF OREGON GRAPE			GRAND FIR/ PRINCE'S PINE		
# OF PLOTS	2			18			6		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
VAOV									
VAPA				1	0.0	6			
WHMO				4	0.2	72			
Total Cover:									
High Shrubs	13	1.7	100	27	1.4	94	11	1.4	100
Low Shrubs	25	0.0	100	42	1.4	89	39	4.5	100
Herbs									
ACTR	1	0.0	50	4	0.3	83	7	1.4	67
ADBI				2	0.1	72	1	0.0	50
ANDE				2	0.2	83	2	0.2	83
ANLY2				1	0.0	6			
ARMA3				1	0.1	22	1	0.0	33
ASCA3				1	0.0	17			
ATFI									
BLSP									
BRVU				8	1.6	28	1	0.1	83
CABU2									
CASC2				3	0.2	33	2	0.0	17
CLUN				1	0.2	17	2	0.4	33
COCA									
COLA				3	0.4	17			
DIHO				2	0.1	83			
FECA				1	0.0	22			
FEOC				3	0.7	17	1	0.0	17
FESU									
FRVE				2	0.1	50	1	0.0	67
GAOR				1	0.0	6			
GATR				1	0.1	39	1	0.0	17
GOOB				1	0.1	61	1	0.0	100
HIAL				1	0.1	56	1	0.0	83
IRTE				2	0.0	6	1	0.0	17
LIBO2				10	0.6	78	47	4.5	67
MOSI				1	0.0	17			
OXOR				3	0.0	6			
POMU				3	0.1	72	1	0.0	17
PTAQ				8	5.0	11	2	0.4	50
PYSE							2	0.3	67
SADO				2	0.5	22	3	0.0	17
SMST				2	0.2	28	1	0.0	17
STRO				2	0.4	11	1	0.0	17
SYRE				2	0.1	50			
TITR				1	0.0	22			
TRLA2				2	0.1	67	1	0.1	67
TROV				1	0.0	33	1	0.0	50
VAHE				2	0.1	56			
VISE				2	0.1	56	6	3.2	33
XETE	1	0.0	50				1	0.0	17
Total Herb Cover	1	0.0	100	28	1.3	89	36	4.1	100

ASSOCIATION	WESTERN HEMLOCK/ ALASKA HUCKLEBERRY/ DOGWOOD BUNCHBERRY			WESTERN HEMLOCK/ DWARF OREGON GRAPE			WESTERN HEMLOCK/ DWARF OREGON GRAPE/ OREGON OXALIS		
# OF PLOTS	13			179			47		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM				1	0.1	3			
ABGR	2	0.3	23	4	0.2	8	10	5.0	4
ACMA	2	0.7	15	11	0.2	32	10	0.5	43
ALRU	2	0.0	8	5	0.9	3	3	1.4	4
ARME				2	0.2	3			
CACH				5	0.3	12	0	0.0	2
CADE	1	0.0	8	6	0.4	9			
CONU				5	0.2	16	8	1.6	11
PILA				6	0.6	2			
PIMO				3	0.3	3			
PIPO									
PSME	41	1.3	100	52	0.1	99	20	0.4	100
TABR	3	0.2	23	6	0.1	26	6	0.3	40
THPL	11	0.9	62	21	0.2	55	14	0.5	62
TSHE	46	1.3	100	33	0.1	88	23	0.5	96
Total Tree Cover	77	0.8	100	81	0.1	100	12	0.3	100
Regenerating Trees									
ABAM	1	0.0	31	1	0.1	7			
ABGR				2	0.1	10	0.7	0.4	4
CADE				2	0.1	3			
PILA				1	0.0	1			
PIMO				1	0.0	1			
PIPO				1	0.0	1			
PSME				2	0.1	14	5	1.1	9
TABR	5	0.7	46	3	0.1	35	3	0.3	19
THPL	2	0.2	46	5	0.1	47	7	0.4	38
TSHE	10	1.1	85	7	0.1	89	11	0.3	89
Shrubs									
ACCI	19	2.0	85	23	0.1	77	22	0.6	85
ACGLD	3	0.0	8	1	0.2	3	0	0.0	2
ARUV									
BEAQ				1	0.1	4			
BENE	9	1.2	85	31	0.1	100	17	0.4	100
CACH	1	0.0	15	3	0.1	30	2	0.4	11
CHME	1	0.0	46	1	0.1	42	0	0.0	19
CHUM	8	0.6	38	4	0.1	44	3	1.4	4
COCO2	2	0.0	8	4	0.1	29	4	0.4	26
CONU				5	0.2	25	3	0.2	26
GASH	9	4.6	23	5	0.1	56	13	0.4	76
HODI				3	0.1	9	0	0.0	4
LOCI				1	0.1	6			
LOHI				1	0.0	2			
OPHO									
PAMY	1	0.0	15	2	0.1	11			
RHDI				2	0.0	1			
RHMA	5	0.7	54	4	0.1	44	4	0.2	34
RIBR				1	0.0	1			
RILA				1	0.0	2			
ROGY	4	1.2	38	2	0.1	46	2	0.1	28
RUPA	1	0.0	8	2	0.1	11	0	0.0	9
RUSP	1	0.0	8				0	0.0	2
RUUR	1	0.1	69	1	0.1	72	0	0.1	53
SYAL									
SYMO	2	0.4	15	3	0.1	27	1	0.2	11
VAAL	17	2.1	62	2	0.2	5	1	0.3	6
VAME	2	0.1	54	1	0.1	16	0	0.0	2

ASSOCIATION	WESTERN HEMLOCK/ ALASKA HUCKLEBERRY/ DOGWOOD BUNCHBERRY			WESTERN HEMLOCK/ DWARF OREGON GRAPE			WESTERN HEMLOCK/ DWARF OREGON GRAPE/ OREGON OXALIS		
# OF PLOTS	13			179			47		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
VAOV	22	13.1	15						
VAPA	7	0.6	85	3	0.1	69	2	0.1	83
WHMO				3	0.1	25	0	0.1	13
Total Cover:									
High Shrubs	31	1.0	100	27	0.1	95	27	0.6	100
Low Shrubs	22	1.6	85	35	0.1	92	20	0.5	83
Herbs									
ACTR	5	0.0	62	2	0.1	54	16	0.7	47
ADBI	1	0.1	31	2	0.1	25	1	0.1	32
ANDE	1	0.0	23	2	0.1	52	1	0.1	40
ANLY2				1	0.0	3			
ARMA3				1	0.1	9			
ASCA3	2	0.4	15	2	0.1	17	1	0.1	19
ATFI	1	0.0	8	1	0.1	3	0	0.0	13
BLSP	3	0.4	23	2	0.5	3	1	0.1	19
BRVU				1	0.1	8			
CABU2	1	0.0	15	1	0.0	26	0	0.0	17
CASC2				1	0.1	12	0	0.0	13
CLUN	4	0.6	46	2	0.1	13	3	0.4	17
COCA	7	0.3	85	4	0.2	16	0	0.0	2
COLA	9	0.7	38	2	0.1	17	4	0.3	32
DIHO	1	0.0	54	1	0.1	25	1	0.1	49
FECA				1	0.1	5			
FEOC				1	0.0	7			
FESU	1	0.0	8	1	0.0	3	0	0.0	2
FRVE				2	0.1	8	0	0.0	2
GAOR	1	0.0	8	1	0.1	7	1	0.1	19
GATR	1	0.0	8	1	0.1	39	1	0.1	62
GOOB	1	0.1	62	1	0.1	50	3	0.2	23
HIAL	1	0.0	15	1	0.1	26	0	0.0	13
IRTE				1	0.1	7	0	0.0	2
LIBO2	16	1.5	100	9	0.1	74	13	0.6	47
MOSI				2	0.1	9	1	0.1	21
OXOR	40	10.6	15	3	0.1	13	20	0.4	100
POMU	6	0.9	69	11	0.1	82	17	0.4	100
PTAQ	2	0.6	46	2	0.1	35	1	0.1	19
PYSE	1	0.0	8	1	0.1	7			
SADO				1	0.0	1			
SMST	8	1.5	54	2	0.1	23	4	0.2	36
STRO	1	0.0	15	1	0.1	3	0	0.0	9
SYRE				2	0.1	14	0	0.0	6
TITR	4	0.3	92	2	0.1	30	2	0.1	53
TRLA2	1	0.0	8	2	0.1	46	1	0.1	26
TROV	1	0.1	54	1	0.1	63	0	0.1	64
VAHE	6	2.1	38	2	0.1	39	5	0.2	47
VISE	3	0.2	62	4	0.1	82	4	0.1	64
XETE	2	0.7	15	3	0.1	13	0	0.0	2
Total Herb Cover	33	2.0	85	21	0.1	92	19	0.5	83

ASSOCIATION	WESTERN HEMLOCK/ DWARF OREGON GRAPE-SALAL			WESTERN HEMLOCK/ DWARF OREGON GRAPE/ VANILLA LEAF			WESTERN HEMLOCK/ DEVIL'S CLUB		
# OF PLOTS	96			44			13		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM				2	0.1	9	2	0.2	31
ABGR	16	2.9	5	8	0.5	25	6	0.6	23
ACMA	11	0.3	45	8	0.8	20	1	0.0	23
ALRU	3	0.7	2	2	0.4	5	3	1.4	15
ARME	6	1.3	4	2	0.0	2			
CACH	4	0.2	16	4	1.6	7			
CADE	5	0.4	10	18	8.3	9			
CONU	10	0.4	32	15	2.8	16			
PILA	3	1.4	2	5	0.0	2			
PIMO	1	0.0	1	2	0.3	11			
PIPO									
PSME	53	0.2	100	56	0.4	100	29	1.7	92
TABR	6	0.3	24	11	0.8	27	10	1.4	15
THPL	16	0.2	56	20	1.1	36	25	2.1	54
TSHE	24	0.2	84	28	0.5	86	32	1.5	100
Total Tree Cover	77	0.1	100	76	0.4	100	64	1.5	100
Regenerating Trees									
ABAM	1	0.0	3	2	0.2	14	1	0.0	23
ABGR	5	0.6	9	3	0.3	36			
CADE	1	0.1	5	3	0.3	9			
PILA	1	0.0	2	1	0.3	2			
PIMO				1	0.0	2			
PIPO									
PSME	2	0.1	20	2	0.3	9	1	0.0	8
TABR	2	0.1	20	2	0.2	30	1	0.0	8
THPL	5	0.1	46	2	0.1	30	1	0.1	38
TSHE	8	0.1	88	6	0.2	89	4	0.2	100
Shrubs									
ACCI	25	0.3	90	22	0.6	86	36	2.4	69
ACGLD	5	2.5	2						
ARUV									
BEAQ	1	0.0	2	2	0.4	14			
BENE	29	0.2	100	31	0.5	100	12	3.9	31
CACH	2	0.1	25	3	0.2	43			
CHME	1	0.1	28	1	0.1	32	1	0.0	15
CHUM	2	0.1	41	5	0.2	57	4	2.1	15
COCO2	5	0.2	42	5	0.3	41	2	0.0	31
CONU	4	0.2	38	6	0.5	36	3	0.0	8
GASH	34	0.2	100	30	3.7	16	5	1.1	31
HODI	2	0.2	8	2	0.4	5			
LOCI	1	0.0	5	1	0.1	9			
LOHI	1	0.0	1	1	0.0	2			
OPHO							28	1.8	100
PAMY				2	0.2	18			
RHDI									
RHMA	4	0.1	40	3	0.2	25	1	0.0	15
RIBR							2	0.4	23
RILA				3	0.8	9	1	0.0	8
ROGY	2	0.1	41	2	0.1	80	2	0.3	38
RUPA	2	0.4	8	1	0.1	14			
RUSP	1	0.0	2				2	0.1	54
RUUR	1	0.1	79	2	0.1	82	2	0.2	46
SYAL									
SYMO	3	0.1	22	3	0.1	57			
VAAL	2	0.1	4	1	0.0	2	5	2.5	15
VAME	1	0.0	8	4	0.5	27			

ASSOCIATION	WESTERN HEMLOCK/ DWARF OREGON GRAPE-SALAL			WESTERN HEMLOCK/ DWARF OREGON GRAPE/ VANILLA LEAF			WESTERN HEMLOCK/ DEVIL'S CLUB		
# OF PLOTS	96			44			13		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
VAOV							4	0.0	8
VAPA	3	0.1	81	3	0.1	57	2	0.1	85
WHMO	4	0.1	40	5	0.8	18			
Total Cover:									
High Shrubs	37	0.3	97	33	0.1	95	49	2.0	92
Low Shrubs	56	0.3	85	37	0.5	91	16	1.7	92
Herbs									
ACTR	2	0.1	47	12	0.4	84	4	0.7	38
ADBI	1	0.1	35	2	0.1	66	1	0.4	54
ANDE	2	0.1	58	2	0.1	84	1	0.0	31
ANLY2	1	0.0	1	1	0.0	5			
ARMA3	1	0.0	4	1	0.0	14			
ASCA3	3	0.4	10	2	0.1	45	2	0.1	54
ATFI	1	0.0	1	2	0.4	9	10	0.9	85
BLSP				8	5.0	5	5	1.3	46
BRVU	1	0.1	6	1	0.0	18			
CABU2	1	0.1	14	1	0.0	5	1	0.0	31
CASC2	1	0.1	13	1	0.1	18	2	0.0	8
CLUN	3	0.3	15	3	0.1	52	3	0.4	46
COCA	5	0.0	1	8	0.5	41	6	0.8	69
COLA	6	0.5	19	2	0.2	7	9	3.2	23
DIHO	1	0.1	31	1	0.1	48	2	0.3	31
FECA	1	0.1	6	1	0.2	7	1	0.0	8
FEOC	1	0.1	6	1	0.0	7			
FESU				1	0.0	7			
FRVE	1	0.1	7	1	0.0	18			
GAOR	2	0.1	10	1	0.1	11	1	0.0	8
GATR	1	0.1	51	1	0.1	50	2	0.3	54
GOOB	1	0.1	55	1	0.1	59	1	0.0	23
HIAL	1	0.0	28	1	0.1	25	1	0.0	15
IRTE	1	0.0	6	1	0.0	5			
LIBO2	11	0.2	70	11	0.4	73	4	0.9	46
MOSI	1	0.1	16	1	0.0	9	1	0.1	46
OXOR	11	0.8	20				40	7.1	31
POMU	9	0.2	86	5	0.2	66	8	0.8	85
PTAQ	3	0.1	36	2	0.1	52	1	0.0	23
PYSE				1	0.0	25	1	0.0	15
SADO	1	0.0	2	1	0.0	5			
SMST	1	0.1	20	3	0.1	61	6	0.4	77
STRO	1	0.0	5	1	0.0	9	1	0.1	38
SYRE	2	0.1	18	1	0.0	2			
TITR	2	0.1	18	6	0.2	75	15	1.1	100
TRLA2	2	0.1	46	1	0.1	57			
TROV	1	0.1	57	1	0.1	59	1	0.1	85
VAHE	2	0.1	41	3	0.1	50	6	0.8	62
VISE	4	0.1	75	4	0.1	84	2	0.2	54
XETE	1	0.1	10	1	0.0	2			
Total Herb Cover	21	0.2	85	37	0.5	91	64	1.8	100

ASSOCIATION	WESTERN HEMLOCK/ OREGON OXALIS			WESTERN HEMLOCK/ RHODODENDRON-ALASKA HUCKLEBERRY/ DOGWOOD BUNCHBERRY			WESTERN HEMLOCK/ RHODODENDRON/BEARGRASS		
# OF PLOTS	66			11			39		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM	3	0.4	3	1	0.0	18	2	0.1	13
ABGR	11	0.8	12	1	0.0	9	6	3.2	5
ACMA	13	0.1	62	5	0.0	9			
ALRU	7	1.2	9	2	0.0	9			
ARME									
CACH							3	0.4	21
CADE									
CONU	5	0.5	14				2	0.0	3
PILA							7	3.9	5
PIMO							2	0.1	10
PIPO									
PSME	42	0.4	97	43	2.4	100	38	0.4	100
TABR	6	0.5	20	10	1.7	27	7	0.6	10
THPL	20	0.1	64	19	1.6	73	12	0.6	56
TSHE	32	0.4	95	30	1.4	100	34	0.5	100
Total Tree Cover	78	0.2	15	72	1.4	100	68	0.4	100
Regenerating Trees									
ABAM	2	0.0	2	1	0.0	18	2	0.1	15
ABGR	3	0.4	6				3	1.1	10
CADE									
PILA									
PIMO							1	0.0	3
PIPO									
PSME	1	0.0	8				1	0.1	10
TABR	2	0.1	17	8	0.7	64	2	0.1	33
THPL	2	0.1	45	3	0.4	36	2	0.1	46
TSHE	7	0.1	83	11	1.3	73	7	0.3	92
Shrubs									
ACCI	25	0.4	82	26	4.0	64	18	1.2	54
ACGLD	1	0.0	2	2	0.4	18	9	0.4	8
ARUV									
BEAQ	1	0.0	2						
BENE	5	0.1	85	10	1.1	100	9	0.2	97
CACH	1	0.1	9	2	0.4	18	3	0.2	46
CHME	1	0.0	3	2	0.1	55	1	0.1	33
CHUM	3	0.7	5	4	0.5	64	3	0.1	69
COCO2	5	0.6	23				1	0.0	5
CONU	3	0.2	18	1	0.0	18	2	0.4	5
GASH	7	0.3	47	3	0.4	18	22	1.1	49
HODI							1	0.2	8
LOCI	1	0.0	5						
LOHI				1	0.0	9			
OPHO									
PAMY				2	0.3	27	3	0.1	44
RHDI									
RHMA	2	0.3	12	30	2.1	100	52	0.6	100
RIBR									
RILA									
ROGY	3	0.6	20	1	0.2	55	1	0.1	28
RUPA	1	0.1	6	1	0.0	9			
RUSP	2	0.3	12						
RUUR	2	0.1	70	1	0.0	64	1	0.1	44
SYAL									
SYMO	2	0.5	6				2	0.5	8
VAAL	2	0.0	2	17	2.0	82	9	0.8	38
VAME	3	0.3	8	3	0.4	45	2	0.1	46

ASSOCIATION	WESTERN HEMLOCK/ OREGON OXALIS			WESTERN HEMLOCK/ RHODODENDRON-ALASKA HUCKLEBERRY/ DOGWOOD BUNCHBERRY			WESTERN HEMLOCK/ RHODODENDRON/BEARGRASS		
# OF PLOTS	66			11			39		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
VAOV	1	0.0	2	1	0.0	9			
VAPA	1	0.1	88	4	0.3	91	3	0.1	87
WHMO	5	0.0	5				1	0.2	8
Total Cover:									
High Shrubs	28	0.4	92	50	2.5	100	62	0.6	100
Low Shrubs	11	0.2	91	23	1.7	91	28	0.6	79
Herbs									
ACTR	4	0.4	38	3	0.7	64	2	0.1	26
ADBI	1	0.1	39	1	0.0	27	1	0.0	3
ANDE	1	0.1	23	1	0.0	36	1	0.1	21
ANLY2	1	0.0	2				1	0.0	3
ARMA3	2	0.4	3				1	0.0	3
ASCA3	2	0.1	24						
ATFI	5	0.3	30						
BLSP	2	0.1	33						
BRVU	1	0.1	9				1	0.0	3
CABU2	1	0.0	8	1	0.0	9	1	0.0	10
CASC2	2	0.1	8				1	0.1	10
CLUN	1	0.1	9	3	0.3	55	1	0.0	5
COCA	6	1.0	8	11	0.9	91	1	0.2	13
COLA	6	0.5	20	4	1.3	36	3	0.4	15
DIHO	2	0.1	61	1	0.0	64	1	0.0	3
FECA	2	0.2	6						
FEOC							1	0.0	3
FESU	1	0.0	2						
FRVE	1	0.0	5						
GAOR	1	0.1	9				1	0.0	3
GATR	2	0.1	68	1	0.0	9	1	0.0	8
GOOB	1	0.0	14	1	0.1	55	1	0.4	64
HIAL	1	0.0	11	1	0.0	18	1	0.0	21
IRTE	1	0.0	2				1	0.0	3
LIBO2	6	0.3	44	22	1.7	91	8	0.3	85
MOSI	2	0.1	24	1	0.0	9			
OXOR	52	0.3	100	11	6.7	18	2	0.0	3
POMU	30	0.3	98	4	0.5	36	2	0.2	31
PTAQ	1	0.1	33	1	0.0	18	1	0.1	10
PYSE				1	0.0	9	1	0.0	3
SADO									
SMST	3	0.1	41	4	1.3	45	1	0.2	8
STRO	1	0.1	18	1	0.0	9	1	0.0	3
SYRE	1	0.0	5				1	0.0	8
TITR	2	0.1	59	3	0.2	64	1	0.0	3
TRLA2	1	0.1	23	2	0.4	18	1	0.1	23
TROV	1	0.1	67	1	0.0	55	1	0.0	21
VAHE	5	0.2	64	1	0.0	27	1	0.1	10
VISE	3	0.1	50	6	0.6	55	2	0.1	31
XETE	2	0.0	2	1	0.0	36	19	0.4	100
Total Herb Cover	76	0.3	92	31	1.5	91	22	0.4	77

ASSOCIATION	WESTERN HEMLOCK/ RHODODENDRON-DWARF OREGON GRAPE			WESTERN HEMLOCK/ RHODODENDRON/ OREGON OXALIS			WESTERN HEMLOCK/ RHODODENDRON-SALAL		
# OF PLOTS	86			13			72		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM	1	0.1	8	1	0.0	15			
ABGR	7	1.0	8	6	0.0	8	3	0.2	10
ACMA	2	0.1	13	1	0.0	8	3	0.4	10
ALRU									
ARME	3	0.0	1				2	0.4	3
CACH	4	0.4	13	4	0.0	8	12	0.6	32
CADE	6	0.5	9				9	0.6	24
CONU	4	0.3	15	1	0.0	8	6	0.3	24
PILA	8	1.8	2				6	0.5	19
PIMO	9	2.1	5				4	0.7	7
PIPO							5	0.0	1
PSME	46	0.2	100	40	1.7	100	47	0.3	100
TABR	8	0.3	34	5	1.0	23	8	0.4	31
THPL	18	0.2	66	13	1.6	54	16	0.3	60
TSHE	34	0.2	99	40	1.3	100	25	0.3	86
Total Tree Cover	78	0.1	100	77	1.1	100	73	0.2	100
Regenerating Trees									
ABAM	1	0.1	8	1	0.0	15	1	0.0	1
ABGR	2	0.1	10	4	0.0	8	3	0.3	7
CADE							1	0.1	13
PILA									
PIMO	1	0.0	1				1	0.2	4
PIPO									
PSME	1	0.1	7				2	0.1	15
TABR	4	0.1	44	2	0.4	31	3	0.2	26
THPL	4	0.1	53	4	0.5	38	5	0.2	36
TSHE	6	0.1	93	6	0.4	100	6	0.1	85
Shrubs									
ACCI	14	0.3	70	18	1.5	92	16	0.3	71
ACGLD	4	1.7	3						
ARUV							1	0.0	1
BEAQ							16	0.2	96
BENE	25	0.2	100	16	1.6	69	6	0.3	35
CACH	2	0.1	43	2	0.4	15	1	0.0	31
CHME	1	0.1	57	2	0.1	38	3	0.1	58
CHUM	4	0.1	71	5	1.7	31	4	0.7	10
COCO2	3	0.4	9	4	1.4	15	2	0.2	19
CONU	2	0.3	7	1	0.0	8	46	0.3	100
GASH	8	0.1	59	9	1.6	46	2	0.7	4
HODI				3	0.0	15	1	0.0	4
LOCI	1	0.0	3						
LOHI	2	0.0	1						
OPHO				1	0.0	8			
PAMY	1	0.0	20				3	0.3	15
RHDI									
RHMA	35	0.2	100	34	1.4	100	42	0.3	100
RIBR									
RILA									
ROGY	2	0.1	27	2	0.3	31	2	0.1	44
RUPA	1	0.0	3						
RUSP	1	0.0	1						
RUUR	1	0.1	56	2	0.4	15	1	0.1	54
SYAL									
SYMO	2	0.2	14	3	0.1	38	2	0.1	14
VAAL	3	0.4	9				2	0.2	4
VAME	1	0.1	23	7	2.5	15	1	0.1	8

ASSOCIATION	WESTERN HEMLOCK/ RHODODENDRON-DWARF OREGON GRAPE			WESTERN HEMLOCK/ RHODODENDRON/ OREGON OXALIS			WESTERN HEMLOCK/ RHODODENDRON-SALAL		
# OF PLOTS	86			13			72		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
VAOV									
VAPA	3	0.1	73	4	0.6	69	3	0.1	64
WHMO	1	0.1	14				4	0.2	26
Total Cover:									
High Shrubs	46	0.3	100	44	1.9	100	63	0.4	100
Low Shrubs	30	0.2	90	25	1.8	77	55	0.5	78
Herbs									
ACTR	2	0.1	38	4	0.6	77	2	0.1	26
ADBI	1	0.1	8	1	0.0	23	1	0.1	18
ANDE	1	0.1	37	1	0.0	38	1	0.1	38
ANLY2				1	0.0	8	1	0.0	3
ARMA3									
ASCA3	1	0.0	2	4	2.1	15			
ATFI									
BLSP	1	0.0	1	1	0.0	8			
BRVU	1	0.0	1				1	0.1	6
CABU2	1	0.0	15	1	0.0	8	1	0.0	11
CASC2	2	0.0	1	2	0.0	8	1	0.1	6
CLUN	1	0.1	9	2	0.4	15	1	0.1	8
COCA	3	0.1	22	4	1.4	15	2	0.6	4
COLA	5	0.3	23	5	0.8	69	2	0.2	11
DIHO	1	0.1	16	1	0.1	31	1	0.1	19
FECA							1	0.0	1
FEOC	2	0.0	1				1	0.0	1
FESU	1	0.0	1				1	0.0	3
FRVE	1	0.0	2				1	0.0	4
GAOR				1	0.0	8	3	1.0	3
GATR	1	0.1	13	1	0.0	15	1	0.1	17
GOOB	1	0.1	70	1	0.1	31	1	0.1	63
HIAL	1	0.0	17	1	0.0	8	1	0.0	15
IRTE							1	0.0	3
LIBO2	8	0.1	87	3	0.3	54	8	0.2	75
MOSI	1	0.0	5	2	0.4	15	1	0.0	6
OXOR	4	0.5	7	37	1.9	100	2	0.7	3
POMU	4	0.1	57	6	0.8	92	4	0.1	43
PTAQ	1	0.1	17	1	0.0	23	2	0.1	26
PYSE	1	0.0	5						
SADO							1	0.0	3
SMST	1	0.1	13	4	0.5	54	1	0.1	7
STRO	1	0.0	2	1	0.0	15	1	0.0	3
SYRE	1	0.0	5	1	0.0	15	1	0.1	11
TITR	2	0.1	30	5	0.5	62	1	0.1	10
TRLA2	1	0.0	22	1	0.0	8	2	0.1	40
TROV	1	0.1	64	1	0.1	77	1	0.0	26
VAHE	2	0.1	16	2	0.3	38	1	0.1	18
VISE	2	0.1	77	1	0.1	46	2	0.1	64
XETE	3	0.1	36	2	0.1	31	5	0.4	42
Total Herb Cover	14	0.2	90	45	2.4	77	9	0.1	78

ASSOCIATION	WESTERN HEMLOCK/ RHODODENDRON/TWINFLOWER			WESTERN HEMLOCK/ SALAL			WESTERN HEMLOCK/ SWORDFERN		
# OF PLOTS	13			42			18		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM	1	0.2	23	11	6.7	5			
ABGR	5	2.5	15	10	0.6	48			
ACMA				2	0.7	5	17	1.5	67
ALRU				5	2.5	5			
ARME				13	1.5	17			
CACH				16	4.1	12			
CADE	5	0.0	8	10	1.0	26	5	1.7	22
CONU				1	0.0	2			
PILA	7	2.4	23						
PIMO	5	0.9	31						
PIPO	3	0.0	8						
PSME	41	2.0	92	54	0.6	100	46	1.1	100
TABR	5	0.6	38	12	2.2	10			
THPL	25	2.4	62	17	0.6	40	19	1.1	50
TSHE	34	1.4	92	22	0.5	81	37	1.5	100
Total Tree Cover	75	1.1	100	75	0.3	100	84	0.5	100
Regenerating Trees									
ABAM	1	0.0	8						
ABGR	15	0.0	8	3	0.4	14			
CADE	1	0.0	8	3	0.6	14			
PILA									
PIMO				1	0.0	2			
PIPO									
PSME	1	0.0	8	4	0.9	29			
TABR	3	0.2	46	2	0.3	17	2	0.3	22
THPL	6	1.2	46	5	0.5	31	3	0.3	39
TSHE	6	0.5	85	7	0.3	86	4	0.2	94
Shrubs									
ACCI	8	0.7	62	29	0.6	90	15	1.0	83
ACGLD	5	0.0	8						
ARUV									
BEAQ				1	0.0	2			
BENE	8	1.4	92	9	0.2	93	6	0.3	78
CACH	1	0.1	38	3	0.2	21	1	0.0	6
CHME	1	0.0	23	1	0.0	14	2	0.4	28
CHUM	3	0.2	85	4	0.6	31	1	0.0	11
COCO2	2	0.4	15	4	0.1	67	3	1.4	11
CONU	1	0.0	8	9	0.9	43	4	0.7	28
GASH	7	1.0	46	54	0.5	100	4	0.3	67
HODI				4	1.2	12			
LOCI	1	0.0	8	1	0.0	5			
LOHI				2	0.0	2			
OPHO									
PAMY	2	0.3	31						
RHDI				1	0.0	2			
RHMA	36	1.7	100	6	0.3	36	2	0.0	11
RIBR									
RILA									
ROGY	2	0.3	38	2	0.1	62	1	0.0	17
RUPA	2	0.0	8	3	1.0	14	1	0.0	6
RUSP				1	0.0	2			
RUUR	1	0.1	77	2	0.1	79	1	0.1	67
SYAL									
SYMO	5	0.0	8	3	0.2	40			
VAAL	6	1.6	31	5	0.0	2	2	0.0	6
VAME	2	0.1	69	1	0.0	7			

ASSOCIATION	WESTERN HEMLOCK/ RHODODENDRON/TWINFLOWER			WESTERN HEMLOCK/ SALAL			WESTERN HEMLOCK/ SWORDFERN		
# OF PLOTS	13			42			18		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
VAOV									
VAPA	5	0.4	77	4	0.1	79	2	0.1	67
WHMO	2	0.0	8	4	0.2	38	3	0.0	6
Total Cover:									
High Shrubs	43	1.8	100	46	0.6	100	21	1.1	83
Low Shrubs	11	0.7	92	67	0.6	83	6	0.3	89
Herbs									
ACTR	4	0.9	46	3	0.2	36	1	0.1	33
ADBI	1	0.0	23	2	0.1	48	1	0.1	22
ANDE	1	0.1	62	2	0.1	71	1	0.0	28
ANLY2	1	0.0	8						
ARMA3	1	0.0	8				1	0.0	6
ASCA3				2	0.2	14	7	2.5	28
ATFI				1	0.0	2	1	0.0	6
BLSP							3	0.4	28
BRVU				1	0.0	5			
CABU2	1	0.0	15	1	0.0	7	1	0.0	17
CASC2	1	0.0	8	1	0.0	10	1	0.0	11
CLUN	2	0.4	15	5	1.1	12	5	0.0	6
COCA	3	0.4	38						
COLA	3	0.4	46	3	0.7	7	3	0.7	11
DIHO	1	0.0	31	1	0.1	43	1	0.1	50
FECA				1	0.0	12	1	0.0	11
FEOC									
FESU				1	0.0	2			
FRVE	1	0.0	8	1	0.1	14			
GAOR	5	0.0	8	1	0.1	17			
GATR	1	0.0	23	2	0.1	60	1	0.0	61
GOOB	1	0.1	77	1	0.1	33	3	1.4	11
HIAL	1	0.0	31	1	0.0	21			
IRTE				1	0.0	5			
LIBO2	24	1.2	100	15	0.8	50	1	0.1	44
MOSI	1	0.0	8	1	0.0	12	1	0.0	28
OXOR	3	0.0	8	7	0.6	26	5	0.2	56
POMU	3	0.6	46	9	0.2	74	36	1.1	100
PTAQ	1	0.1	31	6	0.4	60	1	0.2	17
PYSE	1	0.1	31						
SADO	2	0.0	8	1	0.0	7			
SMST	5	1.8	15	2	0.2	14	2	0.3	17
STRO	1	0.0	15	1	0.0	7	1	0.0	11
SYRE	1	0.0	8	3	1.0	5	1	0.0	6
TITR	1	0.1	62	2	0.4	12	2	0.2	39
TRLA2	1	0.1	31	3	0.2	52	1	0.0	6
TROV	1	0.0	92	1	0.1	50	1	0.1	83
VAHE	2	0.0	8	2	0.1	38	2	0.2	28
VISE	3	0.1	85	2	0.1	71	3	0.5	72
XETE	1	0.2	23	2	0.7	5			
Total Herb Cover	39	1.5	92	19	0.5	83	41	1.3	89

ASSOCIATION	WESTERN HEMLOCK/ TWINFLOWER			WESTERN HEMLOCK/ VANILLA LEAF		
# OF PLOTS	14			31		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees						
ABAM	3	0.0	7	2	0.3	19
ABGR				4	0.5	23
ACMA	24	8.0	29	6	2.6	10
ALRU	5	0.0	7			
ARME						
CACH	1	0.0	7	1	0.0	3
CADE	15	0.0	7	12	2.1	13
CONU				12	5.6	6
PILA						
PIMO	1	0.0	7	2	0.0	3
PIPO						
PSME	40	1.0	100	56	0.6	100
TABR	3	0.0	7	8	0.9	26
THPL	19	1.0	86	19	0.7	52
TSHE	23	1.5	86	30	0.7	90
Total Tree Cover	76	1.2	100	78	0.4	100
Regenerating Trees						
ABAM	1	0.2	21	1	0.1	19
ABGR	6	3.2	14	1	0.1	26
CADE	15	0.0	7	5	2.1	6
PILA						
PIMO	1	0.0	7	1	0.0	3
PIPO						
PSME	1	0.0	14	2	0.5	13
TABR	2	0.3	50	2	0.1	39
THPL	3	0.2	64	2	0.1	35
TSHE	9	0.8	93	8	0.4	87
Shrubs						
ACCI	13	1.5	71	16	0.5	90
ACGLD						
ARUV						
BEAQ				1	0.0	6
BENE	3	0.1	93	5	0.1	90
CACH	2	0.3	36	2	0.1	19
CHME	1	0.1	36	1	0.0	32
CHUM	3	0.5	64	5	0.3	48
COCO2	2	0.0	7	5	0.5	35
CONU	2	0.4	14	9	1.4	29
GASH	1	0.0	14	3	0.3	23
HODI						
LOCI	1	0.0	7			
LOHI	1	0.0	7			
OPHO				1	0.0	6
PAMY	2	0.3	31	2	0.4	13
RHDI						
RHMA	3	0.6	43	4	0.4	35
RIBR						
RILA	1	0.0	7	2	0.3	10
ROGY	5	1.7	36	2	0.1	19
RUPA	5	2.0	21	1	0.0	19
RUSP	1	0.0	7	1	0.0	3
RUUR	1	0.1	64	1	0.1	71
SYAL						
SYMO	3	1.2	21	6	0.5	58
VAAL	5	1.7	14	2	0.5	13
VAME	1	0.2	21	2	0.1	39

ASSOCIATION	WESTERN HEMLOCK/ TWINFLOWER			WESTERN HEMLOCK/ VANILLA LEAF		
# OF PLOTS	14			31		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
VAOV				1	0.0	3
VAPA	3	0.1	93	3	0.1	68
WHMO	3	0.3	79	4	0.4	6
Total Cover:						
High Shrubs	19	1.5	100	22	0.6	97
Low Shrubs	6	0.3	79	13	0.3	97
Herbs						
ACTR	2	0.3	36	15	0.5	90
ADBI	1	0.1	36	5	0.3	74
ANDE	2	0.2	57	2	0.1	74
ANLY2				1	0.0	6
ARMA3	1	0.0	7	1	0.2	10
ASCA3				2	0.1	55
ATFI				1	0.1	13
BLSP				8	1.4	6
BRVU				2	0.4	19
CABU2	2	0.0	7	1	0.0	3
CASC2	3	1.1	14	2	0.1	32
CLUN	1	0.0	7	3	0.1	52
COCA	4	0.4	29	8	0.4	61
COLA	5	1.5	21	4	0.6	19
DIHO	3	0.8	36	1	0.1	45
FECA	1	0.0	7			
FEOC				1	0.0	3
FESU				1	0.0	16
FRVE				2	0.1	39
GAOR				1	0.1	26
GATR	2	0.3	36	1	0.1	58
GOOB	2	0.1	79	1	0.1	74
HIAL	1	0.1	36	1	0.0	32
IRTE				2	0.4	6
LIBO2	23	1.4	100	8	0.5	77
MOSI	1	0.0	14	1	0.2	10
OXOR	5	0.0	7			
POMU	5	0.3	71	4	0.2	68
PTAQ	1	0.1	36	4	0.4	52
PYSE	1	0.0	7	1	0.0	19
SADO				2	0.3	13
SMST	3	1.4	14	6	0.3	74
STRO	1	0.0	14	1	0.0	3
SYRE	1	0.0	14	1	0.0	3
TITR	2	0.2	43	12	0.5	84
TRLA2	3	0.5	50	2	0.1	39
TROV	1	0.1	79	1	0.1	48
VAHE	1	0.1	43	4	0.1	65
VISE	6	0.4	71	5	0.2	94
XETE	1	0.0	21	1	0.0	3
Total Herb Cover	30	0.2	79	50	0.6	97

APPENDIX II

Mean relative percent cover (average cover for all plots in which the species occurs) standard error, and percent constancy for selected trees, shrubs and herbs of the Pacific silver fir and mountain hemlock zone plant associations.

ASSOCIATION	PACIFIC SILVER FIR-GRAND FIR/FALSE SOLOMONSEAL			PACIFIC SILVER FIR/ALASKA HUCKLEBERRY/DOGWOOD BUNCHBERRY			PACIFIC SILVER FIR/ALSAKA HUCKLEBERRY-SALAL		
# OF PLOTS	40			13			3 (MT. HOOD PLOTS)		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM	12	0.3	88	18	1.2	13	8	2.5	100
ABGR	11	2.3	13						
ABLA	6	3.2	5						
ABPR	23	1.0	40	8	1.9	31	1	0.0	67
CACH									
CHNO	3	0.4	5						
PICO	1	0.0	3						
PIEN									
PIMO	3	0.2	33	4	1.1	15			
PSME	28	0.4	95	19	0.9	100	26	0.6	100
TABR	15	0.0	3	3	0.0	8			
THPL				5	0.2	15	15	4.2	100
TSHE	11	0.5	12	11	0.7	69	20	1.7	100
TSME	8	1.0	18	20	6.0	31			
Total Tree Cover	61	0.3	100	60	0.7	100	75	4.4	100
Regenerating Trees									
ABAM	11	0.2	98	19	0.9	100	18	1.8	67
ABCO									
ABLA	15	0.0	3						
CHNO									
PIMO	2	0.2	8						
PSME	3	0.5	13	2	0.0	8			
TABR	5	0.0	3						
THPL				3	1.4	15	3	1.4	67
TSHE	4	0.2	50	8	0.7	77	3	0.4	67
TSME	3	0.2	18	2	0.0	8			
Shrubs									
ACCI	23	1.3	38	15	1.4	77	20	0.0	33
ACGLD	3	0.1	10						
ALSI									
BENE	5	0.4	35	3	0.3	46	5	0.0	33
CACH	2	0.3	8	4	0.0	8	2	0.0	67
CHME	2	0.1	48	1	0.1	54	1	0.0	67
CHUM	8	0.3	73	7	0.7	85	4	0.4	67
COCO2	5	0.0	3						
GAOV	6	0.9	10	2	0.4	3	3	0.7	67
GASH							9	2.0	100
HODI	4	0.4	10						
MEFE				2	0.0	8			
OPHO	1	0.0	3						
PAMY	3	0.1	28	4	0.6	31			
RHAL									
RHMA	22	4.8	10	6	0.6	62	12	0.8	100
ROGY	6	0.4	50	2	0.3	31	2	0.0	33
RUUR	3	0.2	35	3	0.3	69			
SOSI	2	0.0	5	1	0.0	8			
SYMO	7	0.3	45						
VAAL	7	1.2	8	21	1.0	100	23	5.4	100
VAME	9	0.3	68	6	0.5	62			
VAOV	4	1.3	8	11	6.4	15	10	0.0	33
VAPA	2	0.0	3	2	0.2	23	6	1.2	100
VASC									
WHMO									
Total Cover:									
High Shrubs	30	0.7	75	24	1.8	100	23	2.5	100
Low Shrubs	21	0.6	50	10	3.5	23	38	11.7	100

ASSOCIATION	PACIFIC SILVER FIR-GRAND FIR/FALSE SOLOMONSEAL			PACIFIC SILVER FIR/ALASKA HUCKLEBERRY/DOGWOOD BUNCHBERRY			PACIFIC SILVER FIR/ALSAKA HUCKLEBERRY-SALAL		
# OF PLOTS	40			13			3 (MT. HOOD PLOTS)		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Herbs									
ACRU	3	0.3	53						
ACTR	13	0.4	83	09	1.2	77			
ADBI	5	0.2	65	5	0.0	8			
ANDE	6	0.3	60	2	0.0	23			
ARCO									
ARLA									
ASCA	6	0.2	53	3	0.0	8			
ATFI									
BLSP									
CASC2	5	0.2	58						
CLUN	8	0.2	73	9	1.6	85			
COCA	12	1.0	25	13	0.7	92	8	2.0	100
COLA				5	2.5	15			
DIHO	6	0.6	28	1	0.0	15			
DRAU2									
ERMO									
GAOR	5	0.1	60	4	0.0	8			
GATR	4	0.1	53						
GYDR				2	0.0	8			
LIBO2	8	1.2	20	12	1.2	69	15	0.0	33
MOSI	12	1.1	28						
OXOR									
PERA	2	0.1	13	5	0.7	38	2	0.0	33
POMU	3	0.6	15	2	0.0	15			
PTAQ	8	0.6	40	5	1.0	31			
PYSE	4	0.1	63	2	0.2	46	3	0.0	33
SMST	22	0.5	100	3	0.4	31	3	0.0	33
STRO	5	0.0	3	5	0.0	8			
SYRE	3	1.1	5						
TITR	8	0.1	48	3	0.3	46	1	0.0	33
TRCA3									
TRLA	3	0.1	33						
TROV	2	0.1	60	2	0.1	85	2	0.0	67
VAHE	4	0.2	33	2	0.0	15			
VASI	2	0.3	15						
VERAT	1	0.1	10						
VEVI									
VICIA									
VISE	4	0.1	40	3	0.3	54			
XETE	14	0.6	45	10	3.8	38			
Total Herb Cover	67	0.6	100	48	2.1	100	27	1.9	100

Mean relative percent cover (average cover for all plots in which the species occurs) standard error, and percent constancy for selected trees, shrubs and herbs of the Pacific silver fir and mountain hemlock zone plant associations.

ASSOCIATION	PACIFIC SILVER FIR/ BIG HUCKLEBERY/ BEARGRASS			PACIFIC SILVER FIR/ BIG HUCKLEBERRY/ QUEENCUP BEADLILY			PACIFIC SILVER FIR/ CASCADES AZALEA/ BEARGRASS		
# OF PLOTS	24			22			2		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM	28	0.9	96	25	0.7	100	45	10.6	100
ABGR									
ABLA				25	0.0	5			
ABPR	14	0.8	67				5	0.0	100
CACH				19	0.8	55			
CHNO							5	0.0	50
PICO									
PIEN									
PIMO	4	0.1	33	4	1.1	18			
PSME	22	0.9	67	25	0.7	73	5	0.0	50
TABR									
THPL	4	0.8	013						
TSHE	19	1.2	54	14	0.9	50	5	0.0	50
TSME	8	0.4	58	11	0.8	50	20	0.0	50
Total Tree Cover	62	0.6	100	62	0.7	100	60	14.2	100
Regenerating Trees									
ABAM	22	0.7	100	18	0.6	100	11	5.3	100
ABCO									
ABLA									
CHNO							5	0.0	50
PIMO	1	0.2	13	1	0.0	5			
PSME	1	0.0	4	2	0.0	5			
TABR	5	0.0	4	1	0.0	5			
THPL	2	0.0	4						
TSHE	3	0.2	33	5	0.3	36	6	0.0	50
TSME	2	0.1	33	8	2.1	23	4	0.7	100
Shrubs									
ACCI				10	1.4	27			
ACGLD									
ALSI									
BENE	4	0.6	17	2	0.2	23			
CACH	1	0.0	4	1	0.0	5			
CHME	2	0.2	21	2	0.1	50			
CHUM	5	0.6	25	6	0.3	73			
COCO2									
GAOV	2	0.4	13	5	0.0	5			
GASH									
HODI									
MEFE									
OPHO									
PAMY	2	0.0	8	3	0.3	23			
RHAL							30	0.6	100
RHMA	13	1.0	29	3	0.4	18	50	0.0	50
ROGY	3	0.7	13	4	0.7	23			
RUUR	2	0.0	13	3	0.2	32			
SOSI	2	0.0	8	2	0.3	18	2	0.0	50
SYMO	3	0.0	4	2	0.0	14			
VAAL				3	0.0	9			
VAME	16	0.8	96	18	0.9	100	18	1.8	100
VAOV	4	0.4	17	6	0.7	18			
VAPA	3	0.7	13						
VASC	2	0.7	8						
WHMO									
Total Cover:									
High Shrubs	29	1.0	88	33	1.1	91	85	3.6	100
Low Shrubs	21	3.4	17	14	1.7	23			

ASSOCIATION	PACIFIC SILVER FIR/ BIG HUCKLEBERRY/ BEARGRASS			PACIFIC SILVER FIR/ BIG HUCKLEBERRY/ QUEENCUP BEADLILY			PACIFIC SILVER FIR/ CASCADES AZALEA/ BEARGRASS		
# OF PLOTS	24			22			2		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Herbs									
ACRU									
ACTR	3	0.1	50	7.6	0.3	77			
ADBI				2	0.2	18			
ANDE	2	0.3	21	4	0.7	23			
ARCO									
ARLA									
ASCA									
ATFI									
BLSP									
CASC2	3	0.5	13	3	0.0	9			
CLUN	4	0.2	67	8	0.5	91	5	2.1	100
COCA	9	1.0	25	3	1.0	55			
COLA	1	0.0	4						
DIHO									
DRAU2									
ERMO									
GAOR				2	0.0	5			
GATR	1	0.0	4						
GYDR									
LIBO2	8	1.3	13	7	1.5	18			
MOSI									
OXOR									
PERA	2	0.1	33	27	7.8	18			
POMU	2	0.0	4						
PTAQ	1	0.0	4	2	0.5	18			
PYSE	5	0.3	54	4	0.2	82			
SMST	1		4	3	0.1	32			
STRO	1		4	1	0.2	14			
SYRE	1		4						
TITR	1		8	3	0.1	36			
TRCA3									
TRLA				4	1.1	9			
TROV	2	0.1	25	2	0.1	73	2		50
VAHE									
VASI				2	0.1	14			
VERAT									
VEVI				3	0.0	5			
VICIA									
VISE	2	0.2	17	4	0.6	36			
XETE	37	1.2	92	4	0.2	50	68	15.9	100
Total Herb Cover	41	1.2	100	39	1.1	100	88	5.3	100

Mean relative percent cover (average cover for all plots in which the species occurs) standard error, and percent constancy for selected trees, shrubs and herbs of the Pacific silver fir and mountain hemlock zone plant associations.

ASSOCIATION	PACIFIC SILVER FIR/ CASCADES AZALEA/ QUEENCUP BEADLILY			PACIFIC SILVER FIR/ COOLWORT FOAMFLOWER			PACIFIC SILVER FIR/ DEVIL'S CLUB		
# OF PLOTS	5			59			21		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM	33	2.9	80	16	0.2	97	20	0.6	95
ABGR				10	3.6	3	4	1.1	10
ABLA				8	1.8	3			
ABPR	33	1.5	40	18	0.4	59	8	1.5	29
CACH									
CHNO	5	0.0	40	10	0.0	2	18	8.9	10
PICO									
PIEN									
PIMO				3	0.2	20			
PSME	10	3.6	40	30	0.3	81	25	1.1	81
TABR				1	0.0	2	8	1.8	10
THPL				9	2.7	7	11	1.5	19
TSHE	12	2.4	80	15	0.2	75	16	0.7	90
TSME	7	2.4	60	6	0.3	24	3	1.4	10
Total Tree Cover	53	3.6	100	64	0.2	100	60	0.9	100
Regenerating Trees									
ABAM	14	3.1	100	20	0.3	100	13	0.4	100
ABCO									
ABLA				8	2.5	5			
CHNO	3	0.5	60				2		5
PIMO				1	0.0	2			
PSME									
TABR				22	12.8	3	14	2.7	19
THPL				6	1.7	7	4	1.0	19
TSHE	4	0.6	60	8	0.3	64	9	0.5	76
TSME				3	0.4	14	2	0.0	5
Shrubs									
ACCI				5	0.2	29	21	1.5	52
ACGLD									
ALSI							11	0.0	5
BENE	8	0.0	20	10	0.5	46	5	0.9	29
CACH				3	0.3	5			
CHME	2	0.0	20	2	0.1	41	2	0.2	29
CHUM				9	0.2	69	5	0.5	33
COCO2				3	0.0	2			
GAOV				4	0.5	8	2	0.4	10
GASH									
HODI									
MEFE				5	0.0	2			
OPHO	1	0.0	20				35	1.3	100
PAMY	1	0.0	20	4	0.2	19			
RHAL	17	1.5	100						
RHMA	53	26.5	40	12	1.0	24	6	1.5	19
ROGY				3	0.1	44	2	0.3	14
RUUR				4	0.1	39	2	0.1	43
SOSI	3	0.0	40	3	0.5	12			
SYMO				4	0.2	24	2	0.0	5
VAAL	30	3.6	40	13	1.7	12	16	2.9	33
VAME	24	2.6	100	8	0.2	78	7	0.6	52
VAOV	5	0.0	20	6	0.5	12	9	1.2	29
VAPA				3	0.3	17	2	0.2	19
VASC				1	0.0	2			
WHMO									
Total Cover:									
High Shrubs	69	4.6	100	31	0.5	83	55	1.3	100
Low Shrubs				24	1.0	29	32	6.3	14

ASSOCIATION	PACIFIC SILVER FIR/ CASCADES AZALEA/ QUEENCUP BEADLILY			PACIFIC SILVER FIR/ COOLWORT FOAMFLOWER			PACIFIC SILVER FIR/ DEVIL'S CLUB		
# OF PLOTS	5			59			21		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Herbs									
ACRU				3	0.4	14	2	0.2	38
ACTR	3	0.5	60	14	0.2	97	14	0.7	86
ADBI				5	0.3	39	6	0.5	43
ANDE	3	0.0	20	3	0.1	36	3	0.2	38
ARCO									
ARLA				2	0.4	3			
ASCA				5	0.1	44	6	0.3	71
ATFI				5	1.0	7	18	1.3	67
BLSP				41	1.1	3	10	0.0	5
CASC2				3	0.1	24	2	0.7	10
CLUN	11	3.3	100	9	0.2	85	10	0.5	86
COCA	7	0.6	80	16	0.5	54	12	0.7	76
COLA				18	5.3	3	5	0.7	19
DIHO				6	1.0	22	6	0.6	48
DRAU2									
ERMO									
GAOR				7	0.4	44	5	0.5	29
GATR				3	0.2	24	3	0.2	38
GYDR							6	0.6	14
LIBO2	6	2.5	60	16	0.9	42	8	0.6	33
MOSI				6	0.8	15	9	1.2	33
OXOR				4	0.0	2	45	10.6	10
PERA				10	2.3	15	4	0.0	5
POMU				3	0.2	15	5	4.8	48
PTAQ				4	0.2	32	3	0.4	19
PYSE	3	0.4	40	4	0.1	66	2	0.1	33
SMST	2	9	20	8	0.1	86	25	1.2	90
STRO	1	0.0	20	7	0.4	7	7	1.0	24
SYRE				1		3			
TITR	4	0.7	40	10	0.2	88	16	0.5	86
TRCA3				1	0.0	2			
TRLA				4	0.2	19	3	0.4	19
TROV	2	0.0	20	2	0.1	63	2	0.1	57
VAHE				6	0.5	27	15	3.2	24
VASI				4	0.7	8	9	1.1	10
VERAT				1	0.0	3	2	0.2	14
VEVI				3	0.0	2			
VICIA				2	0.0	2			
VISE	2	0.0	20	4	0.1	49	4	0.3	33
XETE	25	7.1	40	11	0.7	41	2	0.0	5
Total Herb Cover	46	6.1	100	67	0.4	100	78	0.8	100

Mean relative percent cover (average cover for all plots in which the species occurs) standard error, and percent constancy for selected trees, shrubs and herbs of the Pacific silver fir and mountain hemlock zone plant associations.

ASSOCIATION	PACIFIC SILVER FIR/ DWARF OREGON GRAPE			PACIFIC SILVER FIR/ FOOL'S HUCKLEBERRY			PACIFIC SILVER FIR/ OREGON OXALIS		
# OF PLOTS	58			9 (MT. HOOD PLOTS)			17		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM	15	0.3	83	31	2.0	89	19	1.2	88
ABGR	8	0.0	2						
ABLA									
ABPR	14	1.1	22	13	8.5	22	18	2.5	35
CACH	5	0.0	2				4	0.0	6
CHNO							15	0.0	6
PICO				5	0.0	11			
PIEN									
PIMO	4	0.2	29	1	0.0	11	5	0.0	6
PSME	29	0.2	100	13	0.9	67	35	1.1	100
TABR	9	1.3	22				10	0.0	6
THPL	12	0.5	21	15	3.6	44	13	3.8	24
TSHE	20	0.2	97	14	1.5	89	14	0.5	88
TSME	4	0.9	7	10	1.2	67	7	3.7	18
Total Tree Cover	67	0.2	100	59	1.3	100	70	0.7	100
Regenerating Trees									
ABAM	14	0.2	93	15	0.7	89	13	0.1	94
ABCO									
ABLA									
CHNO									
PIMO	2	0.0	5	3	0.0	11			
PSME	3	0.5	9	1	0.0	11	1	0.0	6
TABR	10	0.6	21				5	0.0	6
THPL	4	0.3	17	4	0.8	33	7	1.4	18
TSHE	12	0.3	88	5	0.6	89	6	0.2	94
TSME	3	0.6	5	4	1.7	33	3	1.4	12
Shrubs									
ACCI	16	0.4	52	6	3.2	22	15	3.0	41
ACGLD	1	0.0	2						
ALSI									
BENE	17	0.3	98	3	0.0	11	5	0.5	47
CACH	4	0.2	33	5	0.0	11			
CHME	2	0.1	36				2	0.2	41
CHUM	10	0.1	88				11	2.3	29
COCO2	2	0.4	3						6
GAOV	5	0.3	21	7	1.4	33	3	0.0	6
GASH									
HODI									
MEFE				22	1.6	89			
OPHO				3	1.4	22	3	0.6	18
PAMY	5	0.2	55	2		11	1	0.2	18
RHAL	4	0.0	2						
RHMA	14	0.4	40	20	6.7	44	32	4.4	35
ROGY	4	0.1	41	1	0.0	11	3	0.0	6
RUUR	3	0.1	67	5	0.0	11	3	0.3	59
SOSI	2	0.0	2	1	0.0	56			
SYMO	3	0.1	19				2	0.0	12
VAAL	10	0.8	26	17	2.8	56	19	2.5	47
VAME	7	0.2	67	21	1.7	89	7	0.7	29
VAOV	4	0.4	7	28	3.1	67	2	0.4	12
VAPA	4	0.2	31				4	0.7	41
VASC	5	0.4	3	10	0.0	11			
WHMO	3	0.6	5						
Total Cover:									
High Shrubs	37	0.4	98	65	3.9	100	31	2.1	82
Low Shrubs	33	1.5	24	42	3.5	33	19	2.7	29

ASSOCIATION	PACIFIC SILVER FIR/ DWARF OREGON GRAPE			PACIFIC SILVER FIR/ FOOL'S HUCKLEBERRY			PACIFIC SILVER FIR/ OREGON OXALIS		
# OF PLOTS	58			9 (MT. HOOD PLOTS)			17		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Herbs									
ACRU	1	0.0	2						
ACTR	8	0.2	78	11	2.8	56	10	0.6	71
ADBI	1	0.2	16				1	0.2	29
ANDE	1	0.1	26	3	0.0	11	2	0.2	35
ARCO									
ARLA				7	0.0	11			
ASCA	2	0.2	14	2	0.4	22	4	1.1	24
ATFI				3	0.7	33			
BLSP	4	0.0	2	9	2.9	22	15	0.0	6
CASC2	8	0.0	2				4	0.4	18
CLUN	5	0.2	47	15	1.7	56	5	0.5	53
COCA	12	0.3	62	10	1.2	78	8	0.9	47
COLA	3	0.4	7				5	0.4	35
DIHO	1	0.5	9				2	0.4	18
DRAU2									
ERMO									
GAOR	2	0.0	2				2	0.0	12
GATR	2	0.2	10	1	0.0	11	3	0.4	12
GYDR									
LIBO2	14	0.4	67	3	0.7	33	8	2.0	41
MOSI	4	0.0	2				3	0.8	29
OXOR							38	1.5	100
PERA	6	0.6	10	3	1.1	22	2	0.4	12
POMU	3	0.1	22				2	0.1	65
PTAQ	3	0.2	12	1	0.0	11	6	1.8	12
PYSE	3	0.1	66	2	0.4	22	2	0.4	24
SMST	3	0.1	34	2	0.4	33	7	0.1	76
STRO	5	2.1	3	4	0.6	44	1	0.0	6
SYRE									
TITR	4	0.2	38	4	0.4	56	5	0.3	88
TRCA3									
TRLA	5	0.3	21	2	0.0	11	3	0.0	6
TROV	2	0.1	67	1	0.0	56	2	9.8	82
VAHE	2	0.2	10	1	0.0	11	2	0.3	24
VASI				4	1.7	33			
VERAT									
VEVI				2	0.0	11			
VICIA									
VISE	5	0.1	36				5	0.4	47
XETE	8	0.5	100	17	1.8	89	1	0.0	24
Total Herb Cover	43	0.5	100	41	2.0	100	61	1.5	100

Mean relative percent cover (average cover for all plots in which the species occurs) standard error, and percent constancy for selected trees, shrubs and herbs of the Pacific silver fir and mountain hemlock zone plant associations.

ASSOCIATION	PACIFIC SILVER FIR/ RHODODENDRON- ALASKA HUCKLEBERRY/ DOGWOOD BUNCHBERRY			PACIFIC SILVER FIR/ RHODODENDRON/ BEARGRASS			PACIFIC SILVER FIR/ RHODODENDRON- DWARF OREGON GRAPE		
# OF PLOTS	18			48			12		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM	15	0.4	89	16	0.3	43	12	0.7	75
ABGR							8	4.6	17
ABLA									
ABPR	11	1.5	33	8	0.5	38	11	2.9	42
CACH				3	0.7	6	5	0.0	8
CHNO									
PICO									
PIEN									
PIMO	4	1.8	11	4	0.2	31	2	0.3	42
PSME	25	0.6	100	26	0.3	45	31	1.1	100
TABR	2	0.0	6	2	0.4	4	2	0.0	8
THPL	9	1.8	17	5	0.8	15	16	3.7	33
TSHE	20	0.8	83	22	0.3	88	21	0.9	83
TSME	45	0.0	6	9	0.8	29	5	1.6	25
Total Tree Cover	57	0.6	18	61	0.2	100	65	1.1	100
Regenerating Trees									
ABAM	21	0.8	100	15	0.3	96	9	0.7	100
ABCO									
ABLA									
CHNO	3	0.0	6						
PIMO				2	0.3	8			
PSME				5	0.0	2			
TABR	3	1.4	11	2	0.0	2	2	0.0	8
THPL	5	0.0	6	2	0.2	15	8	3.4	25
TSHE	5	0.5	61	6	0.1	73	9	0.6	58
TSME				3	0.3	13	4	0.7	17
Shrubs									
ACCI	12	2.6	22	11	0.8	27	18	3.2	33
ACGLD	10	0.0	6	3	0.0	4			
ALSI									
BENE	5	0.3	78	7	0.2	60	10	0.7	92
CACH	1	0.0	6	4	0.9	13	5	0.0	8
CHME	2	0.1	44	2	0.1	23	2	0.8	25
CHUM	5	0.3	67	4	0.1	58	5	0.5	83
COCO2									
GAOV	11	2.0	22	7	0.3	40	6	1.0	33
GASH									
HODI				3	0.0	2			
MEFE									
OPHO				1	0.0	2			
PAMY	3	1.4	11	3	0.1	38	6	0.8	42
RHAL									
RHMA	65	1.0	100	53	0.5	100	62	1.2	100
ROGY	10	0.0	6	3	0.4	8	2	0.2	25
RUUR	04	0.5	72	3	0.1	35	4	0.5	33
SOSI	1	0.0	17	2	0.4	6			
SYMO				4	0.0	2	3	0.0	8
VAAL	16	0.5	72	16	0.5	46			
VAME	7	0.7	50	8	0.3	69	3	0.1	50
VAOV	15	1.8	28	4	0.7	15			
VAPA	2	0.1	28	4	0.2	31	8	1.5	33
VASC				1	0.0	4			
WHMO									
Total Cover:									
High Shrubs	74	0.9	100	67	0.5	100	73	1.1	100
Low Shrubs	28	8.9	1	15	0.0	2	32	5.4	25

ASSOCIATION	PACIFIC SILVER FIR/ RHODODENDRON- ALASKA HUCKLEBERRY/ DOGWOOD BUNCHBERRY			PACIFIC SILVER FIR/ RHODODENDRON/ BEARGRASS			PACIFIC SILVER FIR/ RHODODENDRON- DWARF OREGON GRAPE		
# OF PLOTS	18			48			12		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Herbs									
ACRU									
ACTR	4	0.2	61	4	0.4	21	11	4.2	25
ADBI							3	0.0	8
ANDE				2	0.1	13	2	0.0	17
ARCO									
ARLA									
ASCA									
ATFI									
BLSP	1	0.0	6						
CASC2				3	1.4	4	1	0.0	8
CLUN	8	1.4	67	5	0.4	25	5	0.9	33
COCA	13	0.7	89	6	0.2	38	6	0.5	42
COLA	10	4.3	17	3	0.2	6			
DIHO							3	0.0	8
DRAU2				1	0.0	2			
ERMO									
GAOR				3	0.4	4			
GATR									
GYDR				2	0.0	2			
LIBO2	8	0.4	72	7	0.2	58	15	2.4	50
MOSI									
OXOR				1	0.0	2			
PERA	13	1.6	33	9	1.5	21	1	0.0	8
POMU	1		6						
PTAQ	2		6	4	0.7	4	6	3.2	17
PYSE	2	0.3	28	2	0.1	25	3	0.3	25
SMST	3	0.3	17	7	2.4	6	1	0.0	17
STRO									
SYRE									
TITR	2	0.1	22	4	1.0	8	1	0.0	8
TRCA3									
TRLA				8	5.0	4			
TROV	2	0.2	44	2	0.1	31	2	0.2	33
VAHE	3	1.1	11	2	0.0	4	4	0.0	8
VASI									
VERAT									
VEVI									
VICIA									
VISE	2	0.2	44	2	0.3	10	4	0.2	17
XETE	6	0.6	67	23	0.4	100	6	0.1	17
Total Herb Cover	37	1.3	100	38	0.6	100	21	1.2	100

Mean relative percent cover (average cover for all plots in which the species occurs) standard error, and percent constancy for selected trees, shrubs and herbs of the Pacific silver fir and mountain hemlock zone plant associations.

ASSOCIATION	PACIFIC SILVER FIR-WESTERN HEMLOCK/ RHODODENDRON-SALAL			PACIFIC SILVER FIR/ VINE MAPLE/ COOLWORT FOAMFLOWER			MOUNTAIN HEMLOCK/ BIG HUCKLEBERRY/ BEARGRASS		
# OF PLOTS	5			21			42		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM	16	2.8	80	13	0.6	100	14	0.4	76
ABGR				3	0.0	5			
ABLA							8	1.8	5
ABPR				16	0.7	62	16	0.6	55
CACH	5	1.1	40	1	0.0	5			
CHNO							15	0.0	2
PICO							6	0.8	17
PIEN									
PIMO	1	0.2	60	2	0.0	5	4	0.2	45
PSME	29	2.9	100	35	0.8	95	11	0.5	48
TABR				10	0.0	5			
THPL	7	2.3	80						
TSHE	23	4.6	100	14	1.1	67	7	1.4	5
TSME				10	1.4	33	33	0.6	98
Total Tree Cover	12	2.4	100	65	0.5	100	51	0.2	98
Regenerating Trees									
ABAM	6	1.2	100	9	0.5	95	14	0.3	93
ABCO									
ABLA							4	0.5	21
CHNO							3	1.4	5
PIMO							4	0.9	14
PSME				2	0.4	10	2	0.7	5
TABR				6	2.9	10			
THPL	2	0.4	40						
TSHE	8	2.1	80	6	0.3	62	2	0.3	14
TSME				5	0.9	19	9	0.3	76
Shrubs									
ACCI	30		20	31	0.6	95	5		2
ACGLD									
ALSI									
BENE	23	10.6	60	13	1.8	33	2	0.5	10
CACH	5		40	2		10	4		2
CHME	2	0.4	40	1	0.1	38	1	0.1	12
CHUM	4	0.8	60	10	0.4	76	3	0.3	33
COCO2				5	2.1	10			
GAOV	1		20				2	0.2	21
GASH	30	5.5	100						
HODI				5	0.0	5			
MEFE									
OPHO									
PAMY	3	0.2	60	4	1.2	24	5	1.5	7
RHAL									
RHMA	62	5.9	100	15	2.5	24	6	0.8	31
ROGY				6	0.7	43	4	1.1	10
RUUR				4	0.3	57	4	0.7	7
SOSI							2	0.2	7
SYMO				6	0.8	33			
VAAL	1	0.0	20	9	0.9	43			
VAME	2	0.0	20	7	0.4	71	21	0.5	100
VAOV	4	0.5	60	2	0.0	5	4	0.0	2
VAPA				5	0.0	5	4	0.0	2
VASC				15	0.0	5	2	0.3	21
WHMO									
Total Cover:									
High Shrubs	72	4.8	100	48	0.8	100	34	0.6	83
Low Shrubs	80	10.6	40	28	5.1	14	27	3.6	17

ASSOCIATION	PACIFIC SILVER FIR-WESTERN HEMLOCK/ RHODODENDRON-SALAL			PACIFIC SILVER FIR/ VINE MAPLE/ COOLWORT FOAMFLOWER			MOUNTAIN HEMLOCK/ BIG HUCKLEBERRY/ BEARGRASS		
# OF PLOTS	5			21			28		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Herbs									
ACRU				3	0.2	38	1	0.0	2
ACTR	1	0.0	20	15	0.6	90	3	0.3	17
ADBI				4	0.2	71	1	0.0	2
ANDE				3	0.1	67	2	0.3	12
ARCO									
ARLA				2	0.0	5			
ASCA				6	0.4	86			
ATFI				2	0.0	5			
BLSP				2	0.0	5			
CASC2				3	0.2	29	1	0.0	2
CLUN				8	0.3	81	2	0.1	26
COCA				14	1.5	43	10	3.9	5
COLA				15	3.2	24			
DIHO	1	0.0	20	2	0.1	43			
DRAU2									
ERMO									
GAOR				3	0.1	48			
GATR				3	0.2	48			
GYDR				3	0.0	5	1	0.0	2
LIBO2	15		20	18	4.0	29	1	0.0	2
MOSI				13	5.3	10			
OXOR									
PERA				2	0.2	14	2	0.1	12
POMU	1	0.0	20	3	0.2	38			
PTAQ				3	0.4	38	3	0.7	7
PYSE				3	0.1	62	2	0.1	25
SMST				18	0.9	81	1	0.0	2
STRO									
SYRE									
TITR				12	0.8	86			
TRCA3									
TRLA				5	0.6	29			
TROV	1	0.0	20	2	0.1	57	2	0.2	10
VAHE				10	1.9	24			
VASI									
VERAT									
VEVI									
VICIA									
VISE				4	0.3	43	1	0.1	19
XETE	7	2.3	60	8	1.6	10	45	0.9	88
Total Herb Cover	10	1.9	100	66	1.2	100	49	0.9	93

Mean relative percent cover (average cover for all plots in which the species occurs) standard error, and percent constancy for selected trees, shrubs and herbs of the Pacific silver fir and mountain hemlock zone plant associations.

ASSOCIATION	MOUNTAIN HEMLOCK/ GROUSE HUCKLEBERRY			MOUNTAIN HEMLOCK/ LUZULA			MOUNTAIN HEMLOCK/ RHODODENDRON		
# OF PLOTS	36			6			22		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Mature Trees									
ABAM	14	0.5	53	33	10.8	50	12	0.6	77
ABGR									
ABLA	8	0.8	19	16	7.4	33			
ABPR	14	2.8	14				13	1.3	45
CACH							3	0.0	5
CHNO									
PICO	11	0.8	36				5	0.0	5
PIEN									
PIMO	6	0.3	47				4	0.5	41
PSME	9	4.6	6				21	0.7	82
TABR							2	0.0	5
THPL							5	0.0	5
TSHE				22	0.0	17	19	1.8	41
TSME	64	0.9	100	74	6.0	100	22	0.6	95
Total Tree Cover	44	0.7	64	42	3.8	50	60	0.7	100
Regenerating Trees									
ABAM	7	0.4	28	5	1.3	83	19	1.1	82
ABCO									
ABLA	4	0.4	28	2	0.4	67			
CHNO									
PIMO	2	0.1	50				2	0.4	9
PSME									
TABR									
THPL									
TSHE							4	0.3	41
TSME	5	0.2	81	2	0.3	83	8	0.4	77
Shrubs									
ACCI							13	3.0	18
ACGLD									
ALSI									
BENE	1	0.0	3				5	0.5	27
CACH	1	0.0	3				4	1.6	14
CHME							2	0.5	18
CHUM	3	0.2	39	1	0.0	17	3	0.3	45
COCO2									
GAOV							5	0.4	45
GASH							2	0.0	5
HODI									
MEFE									
OPHO									
PAMY	3	0.0	3	1	0.0	17	5	0.7	23
RHAL									
RHMA							63	0.9	100
ROGY							2	0.0	5
RUUR	1	0.0	3				2	0.3	18
SOSI							1	0.0	9
SYMO									
VAAL							7	0.9	27
VAME	18	0.6	36	44	29.0	33	8	0.6	77
VAOV							1	0.2	14
VAPA							2	0.0	5
VASC	29	0.7	100	11	3.2	33	10	9	5
WHMO									
Total Cover:									
High Shrubs	32	1.2	61	5	0.7	33	73	0.8	100
Low Shrubs							8	0.0	5

ASSOCIATION	MOUNTAIN HEMLOCK/ GROUSE HUCKLEBERRY			MOUNTAIN HEMLOCK/ LUZULA			MOUNTAIN HEMLOCK/ RHODODENDRON		
# OF PLOTS	36			6			22		
	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %	Mean Relative Cover %	Standard Error	Constancy %
Herbs									
ACRU									
ACTR							2	0.3	18
ADBI									
ANDE							2	0.0	5
ARCO									
ARLA				1	0.0	17			
ASCA							1	0.0	5
ATFI									
BLSP									
CASC2									
CLUN							2	0.0	9
COCA							3	0.0	14
COLA									
DIHO									
DRAU2									
ERMO									
GAOR									
GATR									
GYDR									
LIBO2							5	0.5	27
MOSI									
OXOR									
PERA	3	0.4	11	1	0.0	33	4	0.4	14
POMU				1	0.0	17	1	0.0	5
PTAQ							1	0.0	5
PYSE	2	0.5	11				4	1.0	18
SMST							3	0.0	5
STRO									
SYRE									
TITR							2	0.4	9
TRCA3									
TRLA									
TROV							1	0.0	27
VAHE									
VASI									
VERAT									
VEVI	1	0.0	3						
VICIA									
VISE	1	0.0	3	1	0.0	33	2	0.2	23
XETE	17	3.2	17				35	0.9	95
Total Herb Cover	19	1.4	58	28	9.2	50	38	0.9	100

APPENDIX III

Growth basal area (Hall 1971) for Willamette National Forest plant associations from intensive plot data, execpt where noted.

	Growth Basal Area							
	Psme		Tshe		Abpr		Thpl	
	Mean/N	SE	Mean/n	SE	Mean/N	SE	Mean/n	SE
Douglas-fir Series								
Douglas-fir/oceanspray-dwarf Oregon grape	311/ 5	28						
Douglas-fir/oceanspray/grass	312/13	22						
Douglas-fir/oceanspray-whipple vine	290/ 5	33						
Douglas-fir/snowberry	496/ 5	73						
Douglas-fir-western hemlock/dwarf Oregon grape	400/ 7	77						
Douglas-fir-western hemlock/rhododendron	317/ 5	59						
Douglas-fir-western hemlock/salal	404/12	39						
Grand fir Series								
Grand fir/bearberry	213/ 3	36						
Grand fir/dwarf Oregon grape	370/11	46						
Grand fir/prince's pine[1]								
Grand fir-Pacific silver fir/false solomonseal	496/ 3	96			416/ 1	-		
Pacific silver fir Series								
Pacific silver fir/Alaska[2] huckleberry/dogwood bunchberry	394/ 9	9			407/ 1	-		
Pacific silver fir/Alaska[2] huckleberry-salal	420/ 2	39						
Pacific silver fir/big huckleberry/beargrass	301/12	4			337/12	6		
Pacific silver fir/big huckleberry/queencup beadlily	254/ 9	6			453/ 9	10		
Pacific silver fir/Cascades[3] azalea/beargrass	282/12	8						
Pacific silver fir/Cascades[3] azalea/queencup beadlily	282/12	8						
Pacific silver fir/coolwort foamflower	398/18	6			398/18	9		
Pacific silver fir/Devil's[4] club	375/10	7			500/ 7	11		

Growth basal area (continued).

	Growth Basal Area							
	Psme		Tshe		Abpr		Thpl	
	Mean/N	SE	Mean/n	SE	Mean/N	SE	Mean/n	SE
Pacific silver fir/dwarf Oregon grape[5]	296/ 6	10			303/ 6	14		
Pacific silver fir/fool's huckleberry[3]	282/12	8						
Pacific silver fir/Oregon oxalis[4]	375/10	7			500/ 7	11		
Pacific silver fir/rhododendron-Alaska huckleberry/dogwood bunchberry[2]	347/17	8			361/17	12		
Pacific silver fir/ rhododendron/beargrass	341/12	7			501/12	13		
Pacific silver fir/rhododendron/dwarf Oregon grape[5]	296/ 6	10			303/ 6	14		
Pacific silver fir/vine maple/ coolwort foamflower	452/ 6	14			505/ 6	17		
Pacific silver fir-western hemlock/rhododendron-salal[4]	276/ 5	19						
Mountain hemlock Series								
Mountain hemlock/big huckleberry/beargrass	312/15	6			351/15	10		
Mountain hemlock/grouse huckleberry	184/ 1	-			465/ 1	-		
Mountain hemlock/luzula[1]								
Mountain hemlock/rhododendron[1]								
Western hemlock Series								
Western hemlock/Alaska huckleberry/dogwood bunchberry	422/ 7	21						
Western hemlock/ dwarf Oregon grape	424/19	22	443/ 4	65				
Western hemlock/dwarf Oregon grape/Oregon oxalis	514/12	32	524/ 2	190				
Western hemlock/dwarf Oregon grape-salal	361/12	31	461/ 2	231			406/ 2	27
Western hemlock/dwarf Oregon grape/vanilla leaf	476/12	42						
Western hemlock/devil's club	413/ 7	60	466/ 1	-				
Western hemlock/Oregon oxalis	467/16	28	482/ 5	95			690/ 1	-
Western hemlock/rhododendron-Alaska huckleberry/dogwood bunchberry	395/ 6	61	519/ 1	-			394/ 1	-

Growth basal area (continued).

	Growth Basal Area							
	Psme		Tshe		Abpr		Thpl	
	Mean/N	SE	Mean/n	SE	Mean/N	SE	Mean/n	SE
Western hemlock/rhododendron/ beargrass	298/ 8	11	336/ 2	24			355/ 1	-
Western hemlock/rhododendron-dwarf Oregon grape	367/20	26	343/ 7	41			350/ 1	-
Western hemlock/rhododendron/ Oregon oxalis	495/ 6	51						
Western hemlock/rhododendron-salal	338/11	40	350/ 2	75			259/ 1	-
Western hemlock/rhododendron/ twinflower	447/ 6	35						
Western hemlock/salal	334/14	31	385/ 1	-				
Western hemlock/swordfern	402/11	29	389/ 4	46			415/1	-
Western hemlock/twinflower	525/ 7	42						
Western hemlock/vanilla leaf	477/ 8	34						

[1]No data available.

[2]GBA estimated from reconnaissance plot data only.

[3]Pacific silver fir/Cascades azalea/beargrass, Pacific silver fir/Cascades azalea/ queencup beadlily and Pacific silver fir/fool's huckleberry associations combined for GBA estimates.

[4]Pacific silver fir/Oregon oxalis and Pacific silver fir/devil's club associations combined for GBA estimates.

[5]Pacific silver fir/dwarf Oregon grape and Pacific silver fir/rhododendron/ dwarf Oregon grape associations combined for GBA estimates.