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A study of the McKenzie River floodplains, terraces and glacial outwash plains was undertaken to classify and describe the vegetation and soils of a previously little studied synecological unit.

During the summer of 1971, 54 analytic vegetation and soil plots (stands) were studied. Cover and frequency of all trees, shrubs, herbs and mosses were recorded as well as a soil description for each stand. Using Braun-Blanquet manual-visual association tables and computerized SIMORD analysis, four communities were identified. Further analysis of the four communities revealed two sequences of seral associes leading to the development of two basic habitat types: one a climatic climax and the other a topo-edaphic climax association.

Succession on floodplains, terraces, and glacial outwash plains appears initially to follow a change from coarse, shallow soils to fine, deep soils. The climatic climax (Tsuga heterophylla/Acer circinatum/Polystichum munitum-Oxalis oregana association) then develops on

floodplains and terraces with deep, fine textured soils. The topo-edaphic climax (Tsuga heterophylla/Berberis nervosa-Gaultheria shallon/Linnaea borealis association develops on terraces and glacial outwash plains with shallow, coarse textured soils that have large amounts of stones and cobbles in all horizons of the soil profile.

Further modifications of sites by fire and flooding also create different plant communities which add to the total diversity of forest vegetation occurring on alluvial deposits of the McKenzie River, Oregon.

Forest Vegetation and Soils of Terraces and Floodplains Along the McKenzie River, Oregon

by

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FOREST VEGETATION AND SOILS OF TERRACES AND FLOODPLAINS ALONG THE MCKENZIE RIVER, OREGON

INTRODUCTION

Most synecological work on the west slope of the Oregon Cascades has emphasized the vegetation and environmental characteristics of the dissected valley and ridge terrain. Little or no analytic work had been done along any of the major waterways where flow is sufficient to carry and deposit alluvial material or to cut terraces of sufficient area for study by conventional ecological techniques. In March, 1971, a reconnaissance trip was taken to observe possible study areas along major rivers. Those observed included the Middle and South Santiam and McKenzie Rivers.

The logistics involved in a study of this nature made the choice of the McKenzie River drainage system almost a necessity. The McKenzie River appears to be no more disturbed than the Middle or South Santiam Rivers though all of them show moderate disturbance by man along the length of their courses where terraces and floodplains occur. The McKenzie River is generally more accessible than the Santiam River, and the terraces as well as the floodplains can be reached with little or no fording of spring high water. Perhaps most important, the McKenzie River lies much closer to the H. J. Andrews Experimental Forest, where the vegetation has been studied in considerable detail in connection with the Oregon State University's participation in the International Biological Program.

The objectives of this study are: 1) to describe the forest vegetation and soils on terraces and floodplains, 2) to classify the vegetation and soils, and 3) to determine what relationships may exist between the vegetation and environmental factors or complexes of factors.

THE STUDY AREA

General Description and Location

The study area includes nearly level waterlaid and watercut terraces, floodplains, and glacial deposits adjacent to the McKenzie River and one major tributary, Horse Creek. A floodplain is here defined as any deposit of material near the river that is low enough to be submerged by flooding each year for a period of two or more weeks. Terraces are defined as any of the level or near level landforms which have resulted either from water deposition of materials or by water cutting and removal of previously deposited materials. Most terraces never receive continuous flooding. However, lower terraces are periodically flooded for less than two weeks during periods of heavy precipitation. Materials in both floodplains and terraces may include cobbles, stones, gravel, sand, silt, and/or clay.

The McKenzie River flows south for approximately 15 miles from its origin at Clear Lake, on Oregon Highway 126. Near Belknap Springs the river changes direction and flows west along a winding path for 70 miles until it joins the Willamette River outside Springfield, Oregon. The McKenzie River is one of two major drainage systems of the central Western Cascade Province of Oregon (Franklin and Dyrness, 1969). It drains nearly 343 square miles above the town of McKenzie Bridge, Oregon. An equal area to the south and east is drained by the South Fork McKenzie River (Stearns, 1928).

For this study, the McKenzie River valley was arbitrarily divided into three sections, upper, middle, and lower. The upper portion of the valley is above the confluence of Boulder Creek and McKenzie River (Figure 1). The middle McKenzie River valley extends from the mouth of Boulder Creek to a point a few hundred meters south of Quartz Creek (Figure 2). The lower valley is west of the above location. The middle McKenzie River valley section is the only section studied and hereafter shall be referred to as the study area. It was selected because it still maintains some relatively undisturbed forest vegetation on active floodplains and terraces.

The boundaries of the study area were established after reconnaissance of the river bottomland areas revealed that size and accessibility of the terraces and floodplains were sufficient for the application of standard vegetation sampling techniques. In the upper valley, the valley walls are too close to the river and the inclination of the river bed itself prohibits the deposition of large amounts of material in anything other than very local and restricted spots because of the rapidity of water movement. In the lower valley there had been too much recent disturbance by fire, logging, and agriculture to allow meaningful vegetation sampling. The study area includes the banks of

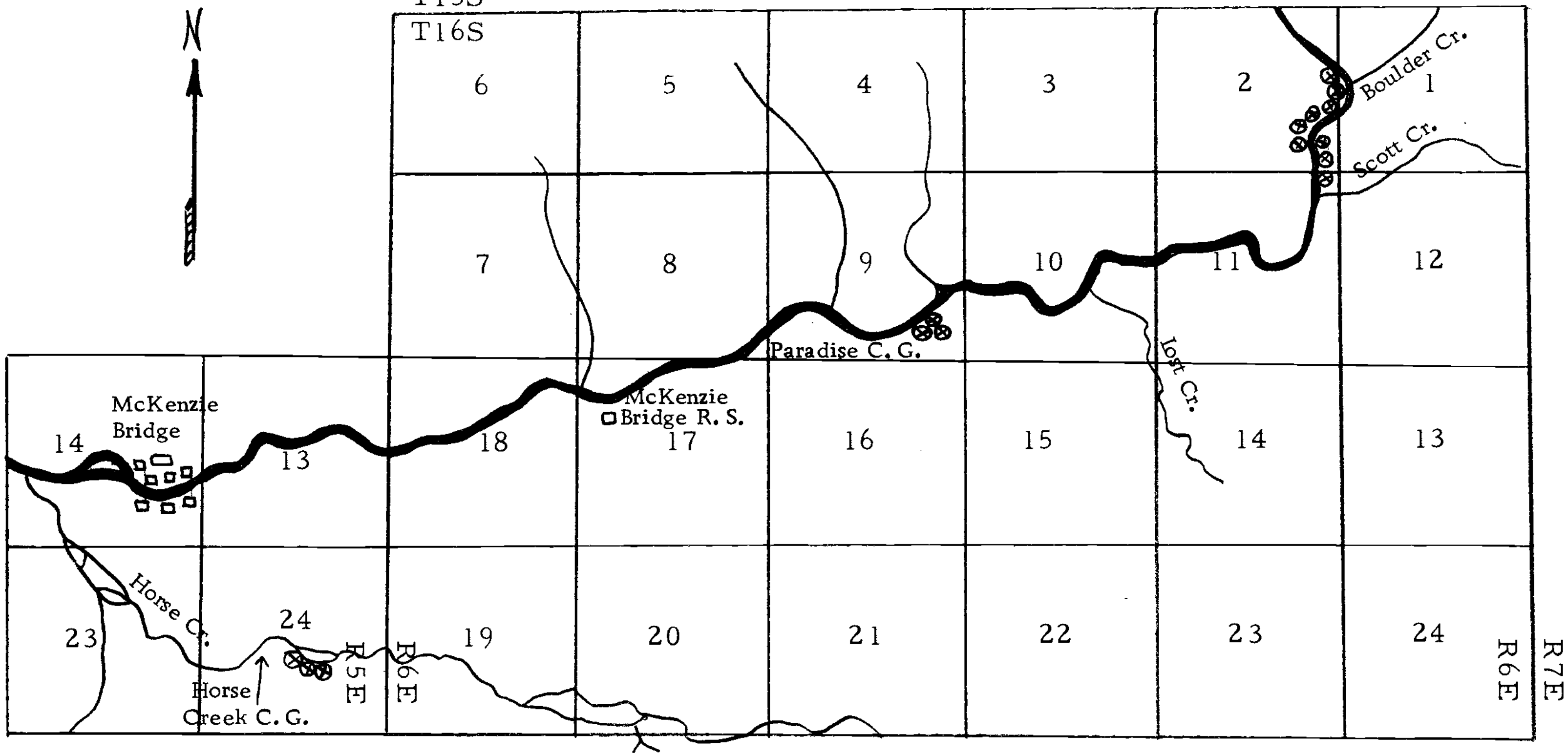

Figure 1. Upper middle McKenzie River valley (⊗ = analytic plot location).

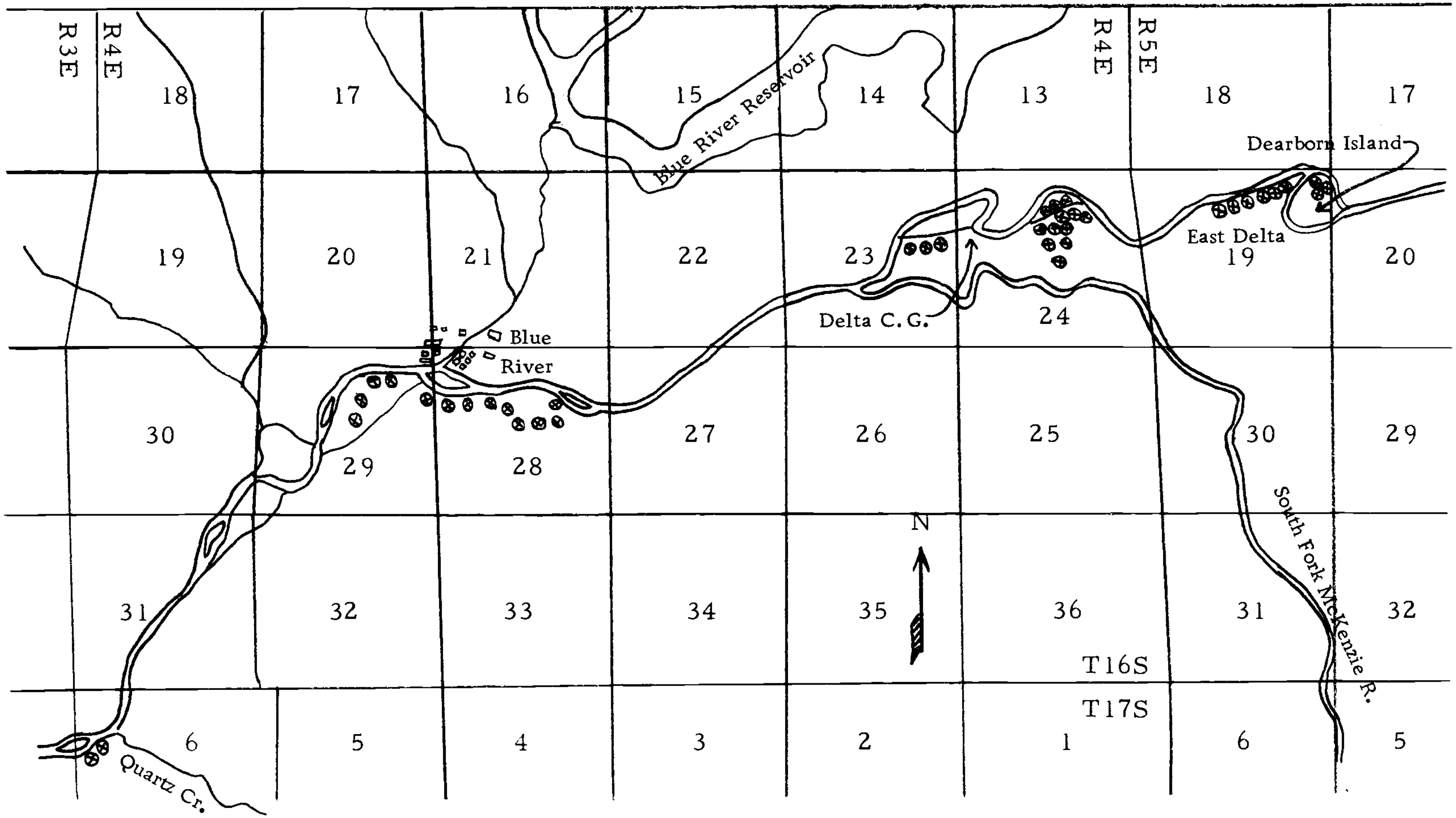

Figure 2. Lower middle McKenzie River valley (⊗ = analytic plot).

the McKenzie River, lower Horse Creek, and several plots located on floodplains and terraces within the Delta area at the confluence of the McKenzie and the South Fork McKenzie Rivers (see Figures 1 and 2 as well as Appendix 1 for location of analytic plots).

Geomorphology, Physiography, and Soils

The stratigraphy of the area from recent to Cenozoic marine deposits consists of the Sardine Formation, the Little Butte Volcanics, the Colestin Formation, and the Tyee and Umpqua marine deposits (Peck *et al.*, 1964). The Colestin Formation consists primarily of volcanic and pyroclastic rocks with andesites and lapilli tuffs being the most common rock types (Beaulieu, 1971). This formation is late Eocene in age. The Colestin Formation is overlain by the Little Butte Volcanic Series which fills in much of the sharp relief that existed prior to its origin. The Little Butte Volcanic Series is Oligocene to early Miocene in age and is a gently sloping, moderately dissected formation composed of about 25% olivine basalts, basaltic andesite, and pyroxene andesite with pyroclastic rocks making up the remainder. These include vitric tuffs, vitric lapilli tuffs, and water-laid tuffs (Beaulieu, 1971). These pyroclastic materials are andesitic and dacitic in their composition. The Little Butte Volcanic Series is overlain by the Sardine Formation in most areas to the north of the study area and in some areas to the south as well. The Sardine

Formation is middle Miocene in age and consists of volcanic flows, tuff breccia, lapilli tuff and tuff of hypersthene andesites. It may also include amounts of olivine basalts, basaltic andesites and dacites (Beaulieu, 1971).

Little Butte Volcanics make up most of the Western Cascades that are exposed south of the McKenzie River with only small amounts exposed at lower elevations north of the river. The Sardine Formation, which makes up most of the exposed Western Cascades north of the Santiam River, fills much of the irregular terrain that existed during its deposition. The area between the Santiam and the McKenzie Rivers, including part of the study area, is not as well known as the areas to the north and the south. In this area small amounts of both the Little Butte Volcanics and the Sardine Formation are exposed. According to Wheeler and Mallory (1969), much of what has been called the Sardine Formation in the past is in fact part of the Little Butte Volcanic Series.

Geomorphological factors important in the formation of the Western Cascades include volcanic flows and uplift as well as erosion, either by ice during the glacial periods or by water during periods of glacial recession and melt.

In the early Eocene Epoch the Cascades were beginning to form from andesite produced by steep cones occurring in a north to south belt. Volcanism continued throughout the Oligocene Epoch with increasing activity in both the present Coast Range and in the Western Cascades. Several thousand feet of lava were deposited on the Western Cascades, but the mountains subsided almost as fast as they were built up. Thus the Cascades were elevated only a few hundred feet above the sea level of that time (Williams, 1962).

By the late Oligocene and the early Miocene Epochs the Western Cascades had been uplifted enough to sever drainage channels that had previously originated in what is now eastern Oregon. The present dendritic drainage pattern of the Western Cascades began at that time. Periodic lava flows filled and plugged many streams during a period of intra-canyon flows, forming high mountain lakes such as Clear Lake, which is the headwaters of the main branch of the McKenzie River.

Massive uplift of the pre-Pliocene caused marked increases in the erosion of the range. Volcanism had been the chief geomorphologic factor prior to middle and late Miocene times. Erosion then became important and deeply dissected the Western Cascades into the system of valleys and ridges which exists today. Volcanism was important once again in the Pliocene Epoch, but the Pliocene volcanic flows differed in consistency from earlier forms. Olivine basalts and olivine basaltic andesites were the predominant ingredients of the flows. These volcanics poured from fissures and vents to form large shield volcanoes with a few of the previously more common upright andesitic cones scattered among them. The shield volcanoes of the High Cascades formed to the east of the Western Cascades. The High Cascades consist primarily of these shield volcanoes with little relief and very little dissection or disturbance. Very generally speaking, the upper part of the McKenzie River forms a good borderline between the High and the Western Cascades as they are distinguished and divided by Peck et al. (1964).

Volcanism, which played the early role in the formation of the Cascade Mountains, has continued to be important with some flows being dated at less than 1000 years old. As elevation by uplift and deposition proceeded, erosion once again became the major geomorphologic factor until late Pliocene time.

In the Pleistocene Epoch a series of glacial buildups and recessions had a major influence in the formation of the present Cascade Mountains. There were three great episodes of glaciation in the Pleistocene Epoch of the Oregon Cascades (Taylor, 1968). The oldest of these is pre-latest Wisconsin. The second oldest ended about 10 to 12 thousand years ago in the latter part of the Wisconsin Period. Glaciation of the second episode reached far down the valley of Lost Creek and deposited a terminal moraine within the study area just south of the confluence of Scott Creek with the McKenzie River (Figure 3). The third episode was less extensive and ended about 2500 years ago.

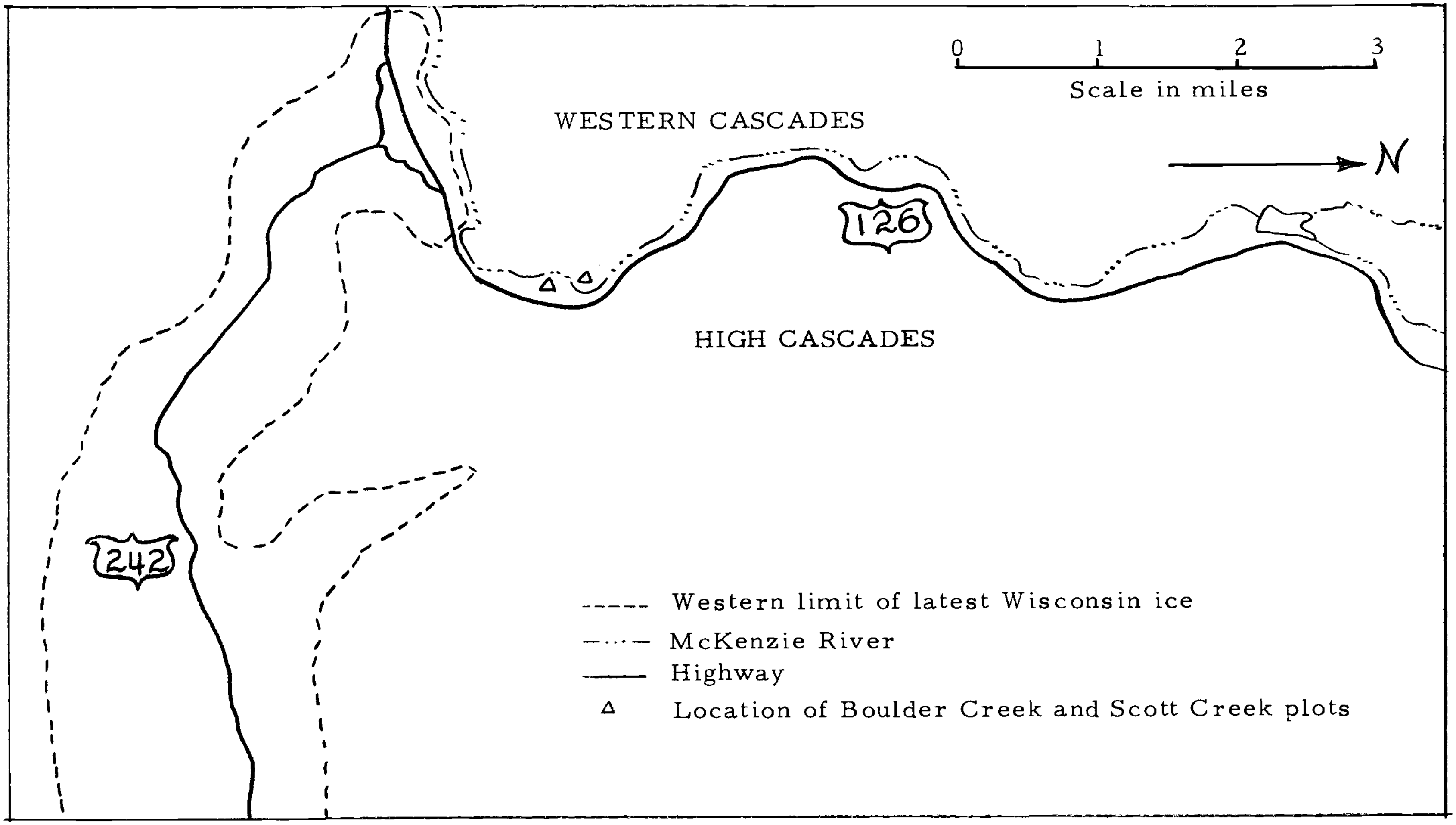

Figure 3. Western limits of Pleistocene glaciation (after Taylor, 1968).

As large glaciers melted, great amounts of material moved down the major drainages and deposited over wide areas to form a glacial outwash plain. This outwash plain is wide and relatively deep in the Delta campground area and narrow and dissected in the Scott Creek area. In all cases the outwash plain has been modified by more recent terrace cuttings and redeposition.

Glaciation and volcanism have been in progress recently but on a much reduced scale as compared to the past. Erosion is now the primary factor in changing the form of the gently sloping, undisturbed High Cascades and the already deeply dissected and folded Western Cascades. Materials from both of these areas serve as parent material for the soils developing on the floodplains and terraces of the McKenzie River. The strata around the study area do not change, but the alluvial deposits and terraces adjacent to the McKenzie River are subject to annual changes, even major shifting of the river channel. The middle portion of the McKenzie River valley is in a moderately mature stage of development. The river meanders slightly in some areas, as exemplified by the Delta Campground area, often shifting its course in years of unusually high precipitation and runoff. The last major course change occurred in 1964 when the McKenzie River shifted its channels near Dearborn Island. Observations in March, 1972, revealed that there may have been additional shifts in the area of Dearborn Island during the winter of '71-'72, but not as great as those of 1964.

Sedimentary materials carried from the highlands to the east are deposited on the floodplains and terraces of the study area. The deposits immediately adjacent to the river are usually sandy, with poorly developed horizons if any, and they are highly transient. Those on successively higher levels have increasing amounts of soil horizonal development and vary from sandy loams to clay loams, shallow to deep, and from stony to stone-free. These higher level terrace soils resemble the ridge and slope soils in most respects except that they occur on level terrain.

Soil surveys within the study area have concentrated on the more stable soils rather than on those of the floodplains and lower terraces. The United States Department of Agriculture, Soil Conservation Service, in Eugene, Oregon, under the direction of Mr. W. R. Patching, has recently studied soils of the higher terraces and uplands adjacent to the upper and middle McKenzie River. There have been four tentative series described which occur on alluvial deposits within the boundaries of the study area (W. R. Patching, personal communication, 1972). These include the Haflinger, Jimbo, Cupola, and Saturn Series. All series are members of the Order Inceptisols in accordance with recent supplements to Soil Classification - A Comprehensive System - 7th Approximation (1967).

Inceptisols are soils which are found on young surfaces. They usually show only marginal horizon development, and they show very little or no evidence of illuviation or eluviation (Buckman and Brady, 1969).

The Haflinger Series is further classified as a Typic Haplumbrept of the sandy skeletal, mixed, mesic family. The two phases listed in the McKenzie River survey are a cobbly loam and a loam to sandy loam. In both cases the upper horizons are dark brown sandy loams or loams, with or without large amounts of cobbles and gravels. The subsoil is usually a dark brown, very cobbly, sandy loam or loamy sand.

The Jimbo Series usually consists of deeper soils which are medium textured and well drained. It also occurs on the alluvial deposits adjacent to the river at 650 to 1400 feet elevation. The surface layers of this series are typically very dark brown and dark brown loam or silt loam, and the subsoil characteristically is a dark yellowish brown loam or loamy sand. These soils usually overlie sand and gravel at depths of over 102 cm (40 in.).

The Cupola Series is classified as a Typic Dystrochrept of the loamy, skeletal, mixed, mesic family. They are medium textured soils that occur on areas of colluvium mixed with glacial outwash from elevations of 1000 feet to 2500 feet. The surface layer is a dark brown cobbly loam overlying a very cobbly dark brown loam. This series is associated with the other terrace and alluvial series named above and with soils more characteristic of upland positions.

The Saturn Series is an Andic Haplumbrept of the fine loamy over sandy, skeletal or fragmental, mixed, mesic family. Soils of this series are well drained and develop in areas of poorly sorted recent alluvium. The surface horizon is a dark brown silt loam, somewhat gravelly, overlying a B horizon with some clay. The clay content of the B horizon lends a structural quality to the soil, as this horizon is generally made up of subangular blocky peds with no clay films present. Textures of the B horizon range from clay loam to sandy clay loam.

The soils of the lower terraces and floodplains have not been classified to the series level. They typically consist of shallow to deep gravelly or sandy deposits over cobbles, gravels or large stones. Older floodplains characteristically have additional increments of silty and loamy materials deposited over the sands or loamy sands characteristic of immature floodplains. These additional deposits result from periodic flooding also characteristic of the lower flood-plains and terraces.

The study area itself is on floodplains and terraces with an average slope of one degree or less over the 18-mile distance included in the middle section of the McKenzie River valley. The elevation ranges from 274 meters at Quartz Creek to just over 560 meters at Boulder Creek.

The higher terraces, being either remnants of the original glacial outwash plain or river modified outwash plains, are generally very flat except where dissected by subsidiary streams. Lower terraces and older terraces are hummocky and rolling as a result of either subsidiary channel dissection in the case of the low terraces or of tree-fall holes and rotting logs overgrown with new vegetation in the case of the older terraces. The floodplains show the greatest amount of diversity in topography but are generally characterized by a higher side toward the stream and a very gentle slope away from the river. In many cases the floodplains or lower terraces are actually large or small islands cut off by a major subsidiary stream or by a series of subsidiary streams and seeps.

Climate

The climate of the study area is controlled by three important physiographic features: the Pacific Ocean, the Western and High Cascades, and the McKenzie River.

The first of these, the proximity of the Pacific Ocean, insures a maritime climate as the prevailing westerlies carry moist air masses eastward from the ocean. The Coast Range is the only barrier to these air masses between the Pacific Ocean and the study area. Its approach effect does remove considerable moisture from the air masses but the Cascades still cause enough uplifting and cooling of the westerlies to allow abundant precipitation.

The second feature, presence of the Western and High Cascades, poses a more formidable barrier to the passage of the maritime air masses. The approach effect removes most of the moisture from these air masses while they are still west of the crest of the High Cascades. Thus the precipitation in the study area is relatively high (Table 1). Higher rainfall at Blue River than at McKenzie Bridge, farther upslope, is possibly the result of the canyon effect mentioned by Baker (1944). The H. J. Andrews climatic station data is collected at a point a few hundred meters from the mouth of Lookout Creek where it enters Blue River Reservoir, and the McKenzie Bridge data is collected at the McKenzie Bridge Ranger Station located on Oregon Highway 126 (Figure 1).

The higher ridges and peaks of the Western and High Cascades also serve as a source of cool air which moves down into the valley of the McKenzie River.

The third feature is the McKenzie River itself, which further moderates the temperature and raises the humidity of the floodplains and lower terraces. Mist over the river and immediately adjacent areas for several hours after sunrise is common during most of the year. Also, moisture can be seen dripping from herbaceous and shrubby vegetation several hundred feet from the river several hours after sunrise in the summer months, probably resulting from condensation.

Table 1. Precipitation data collected from McKenzie Bridge Ranger Station and H. J. Andrews Climatic Station from 1960 through 1970 (in inches).

Year	H. J. Andrews	McKenzie Bridge
1960	100.97	78.81
1961	107.36	84.67
1962	76.72	61.74
1963	83.28	65.17
1964	107.37	60.25
1965	68.77	38.92
1966	79.04	65.29
1967	74.91	55.95
1968	100.48	71.45
1969	78.20	29.49 (data missing)
1970	95.97	71.80

Eleven-year average at H. J. Andrews station = 88.5 in.; ten-year average for McKenzie Bridge station, discarding 1969, = 65.3 in.; and twelve-year average for Blue River station - 74.6 in. (Blue River annual data not included).

The result of all of the interacting factors, including those mentioned above, is an area characterized by warm, dry summers with cool nights, particularly at lower elevations. Temperature inversions accompany the cold air movements down slope, often resulting in warmer night temperatures on the higher slopes and ridges (Baker, 1944). Temperature data taken at Delta Campground near analytic plots 1-15 and at Lookout Mountain (10 km to the northeast and 915 m higher in elevation than Delta Campground) illustrate this point well (Table 2).

The frost-free period in the study area ranges from 150 to 200 days a year. Diurnal fluctuations in temperatures during the summer months range from 20 to 30°F at lower elevations and from 13.4 to 18.0°F at higher elevations.

Less than 15% of the total annual precipitation comes between April 1 and September 31. The winter months are cool and mild with moderately high precipitation.

Snow is not common in the study area, but it may accumulate on the adjacent slopes and uplands. Higher elevation analytic plots at Boulder Creek and Scott Creek receive snow for short periods of time each year, but this contributes little to total precipitation.

History

The present flora of the study area is, in part, derived from

Table 2. Temperature data from Delta Campground (elevation 360 m) and Lookout Mountain (elevation 1275 m) for 1969 and 1970, Jul-Sep (^{o}F) (Zobel, unpublished data, 1972).

	Delta Campground	Lookout Mountain
Average day temperatures		
July	66.9	59.9
August	66.1	60.7
September	58.3	50.9
Average night temperatures		
July	59.4	52.2
August	58.9	56.3
September	52.9	47.5
Average daily maximum temperatures		
July	78.7	65.9
August	78.7	66.9
September	66.7	56.9
Average daily minimum temperatures		
July	45.2	49.5
August	48.3	48.9
September	45.5	43.5
Average daily fluctuation		
July	28.6	16.8
August	30.4	18.0
September	21.4	13.4

ancient flora. Statements concerning ancient vegetation of the area are basically extrapolations from what little research has been done on Tertiary and Quaternary paleobotany in the Pacific Northwest. Statements may also be based on the theory that the homogeneity of the vegetation in most of the early history of the area probably greatly exceeded that of present vegetation. This follows from hypotheses that early conditions included a lack of seasonality and a much more even distribution of precipitation as well as reduced fluctuations in temperature.

For this discussion, the history of the vegetation of the Western Cascade Range of Oregon is divided into two segments; 1) from the Cretaceous to the late Pleistocene Epochs, and 2) from the Pleistocene to the present with emphasis on both natural phenomena and the effects of man.

Late Mesozoic to Pleistocene Epoch

Comments concerning vegetation and flora during this time are based on widespread collections indicating that the level of homogeneity of the vegetation was indeed extensive. Fossil flora of eastern and western Oregon contain many of the same genera. Late Mesozoic vegetation of eastern and western Oregon was similar with slightly more tropical representatives in the west (Chaney, 1948).

The study area was a sediment basin of a large embayment or eugeosyncline at the beginning of the Cenozoic Era. In the Cretaceous Period there were few land masses present in what is now Washington and Oregon. These batholiths made up the Nevadan orogenic arc (Detling, 1968), which consists of the Okanagan Highlands of Washington and British Columbia, the Blue Mountains of northeastern Oregon, and the Klamath Mountains of southwestern Oregon. The flora of these land masses was composed of at least 80 genera identified from fossil remains (Chaney, 1948).

The flora has been divided into three elements based on present distribution patterns of the genera: the West American Element, the East American Element, and the East Asian and Subtropical American Element (Detling, 1968). Most representatives of the first element still remain in western North America. Those of the second element were mostly eliminated from this area after the uplift of the Rocky Mountains. Members of the third element were eliminated from the Pacific Northwest as a result of changes in seasonality. Many of the genera included in the third element depend on summer rainfall that is characteristic of more continental rather than marine climate. These three elements were spread over the entire orogenic arc and served as a source of vegetation when new land masses were exposed.

The fossil floras of the Cretaceous suggest a humid, warm, temperate climate with little seasonality and even precipitation over the year. The vegetation was a temperate deciduous forest.

The fossil floras of the Eocene Epoch have a high degree of similarity based on the presence of genera, especially when one considers the long distances between the collection sites being compared (Chaney and Sanborn, 1933; Sanborn, 1935; Chaney, 1948). The vegetation in Eocene time was near a tropical or subtropical forest, resulting from a general warming trend of the early Eocene. Mean annual temperature was approximately 68°F and the annual rainfall was 70 in. (Chaney and Sanborn, 1933). The study area was within 50 miles of the Eocene coastline delimited by Snavely and Wagner (1963).

Changes to a cooler and more xeric environment in the late Eocene and early Oligocene Epochs caused the migration of the Arcto-Tertiary Geoflora (Chaney, 1936), from its Eocene refugia at higher elevations along the orogenic arc as well as from more boreal regions of the north. Coastal areas still maintained many tropical genera (Chaney, 1948).

The development of a more marked seasonality in combination with the geologic uplift of the Coast Range in late Oligocene time added to the drying trend, causing the elimination of many continental genera of the Arcto-Tertiary Geoflora. The vegetation was temperate deciduous forest mixed with a few Pinaceae. Representative genera included _Acer_, _Alnus_, _Amelanchier_, _Betula_, _Corylus_, _Crataegus_, _Fraxinus_, _Mahonia_, _Malus_, _Philadelphus_, _Populus_, _Quercus_, _Ribes_, *Rosa*, *Salix*, *Sambucus*, *Carya*, *Castania*, *Fagus*, *Ilex*, *Liquidambar*, *Tilia*, *Sequoia*, *Metasequoia*, *Taxodium*, *Abies*, *Picea*, *Pinus*, *Pseudotsuga*, and *Tsuga*.

The Miocene Epoch was a period of great geologic uplift and volcanic deposition. The increased elevation, decreased temperature, and changes in the spatial and temporal distribution of precipitation resulted in the transformation of much of the temperate deciduous forest into coniferous forest vegetation dominated by the dawn redwood, *Metasequoia*, throughout much of western Oregon. Members of the families Pinaceae and Cupressaceae began to dominate the vegetation.

The drying trend that began in the Oligocene continued into the Pliocene, and the region was invaded by another great assemblage of genera referred to as the Madro-Tertiary Geoflora (Axelrod, 1958). The members of this floral group are thought to have southern origins, but many of the genera are noted in fossil localities prior to the supposed immigration of the Madro-Tertiary Geoflora (Wolfe, 1964).

The climate became more xeric and the plants which remained were those capable of adjusting to the changing climate. By the end of the Pliocene Epoch many genera of the East Asian and Eastern American Elements vanished from the flora. A further cooling trend began that was to increase during the ensuing Pleistocene Epoch and the Ice Ages. The latter change in climate resulted in a temperate coniferous forest quite similar to the present forests of the Western Cascades (Detling, 1968).

Pleistocene Epoch to Present

During the Pleistocene Epoch and up to the present time many changes in vegetation of the central portion of the Western Cascades have occurred. Volcanic activity, uplifting and folding, glaciation, increased erosion, and marked drainage fluctuations due to glacial recessions have formed a mountain range with a series of east-west ridges and valleys. The vegetation of the study area, particularly on the floodplains, has become established in a relatively recent soil complex.

The flora over the past several thousand years has maintained many of the genera of both the Arcto-Tertiary and the Madro-Tertiary Geofloras. This has been possible because of the diversity of habitats created in mountainous regions by geologic activity and subsequent erosion. Also the marked change in the environment, in a very short distance, from the Willamette Valley to the foothills of the Western Cascades maintains a diverse assemblage of plants.

The vegetation of the slopes and ridges rising from the McKenzie River valley is in the Tsuga heterophylla Zone of Franklin and Dyrness (1969), the only zone of these authors included in the study area. The zone is dominated by a subclimax species, Pseudotsuga menziesii, Douglas-fir, due to the long fire history of the Pacific Northwest. Increment borings on analytic plots reveal that the age of most lies between 90 and 475 years. Douglas-fir is a seral species in most cases, and the climatic climax species is Tsuga heterophylla (western hemlock). The vegetation surrounding the study area represents a cross section of semi-mature to mature climatic climaxes as defined by Munger (1940).

Prior to the mid-19th century, fire was an important factor in the forest vegetation of the Willamette and its tributary valleys. Since the last Indian fires, about 1830-1850, the needs of the immigrant Americans have been the major factors deciding the fate of the terraces and floodplains. Many fertile and accessible terraces are being used for the production of timber. Logging has already occurred in much of the lower McKenzie River valley. The climate is suitable for year round living along the lower and middle sections of the valley, therefore much of the terrace acreage is used as residential property. High recreational demands during the summer has resulted in many parks on the terraces. These include Delta, Horse Creek, and Paradise Campgrounds as well as private resort areas such as Belknap Hotsprings. Most of the terraces below Nimrod, Oregon, have been converted to orchards or pasture.

Almost all areas within the study area are at least partially disturbed by man either through his logging, camping, fishing, or hiking activities.

METHODS

Vegetation

Field Methods

In late spring, 1971, two weeks of concentrated reconnaissance were completed within and around the study area (Figures 1 and 2), and a series of 30 reconnaissance plots were located. At each plot the extent and homogeneity of the stand was estimated; the coverage by species of overstory trees was estimated to the nearest 5%; and estimated coverage and frequency data were collected for all shrub and herb species using reconnaissance methods employed and described by Franklin, Dyrness and Moir (1970). Voucher specimens of most species included in the study were collected and are presently stored at the Oregon State University Herbarium.

The reconnaissance made it obvious that the area of undisturbed terraces, floodplains and glacial deposits was restricted. The purpose of the study, to describe and classify vegetation types and environmental interactions occurring on riverside deposits, precluded the use of any area with more than a minimal amount of disturbance.

During July and August, 1971, a series of 54 analytic vegetation and soil plots were located on floodplains and terraces of the McKenzie River and one tributary, Horse Creek. These analytic plots are similar to those used by Daubenmire (1959). Each macroplot is 25 m long and 15 m wide. In all cases the macroplots were placed perpendicular to the direction of stream flow of the McKenzie River or its subsidiary channels. This plot orientation was for uniformity only. Since the terrain averaged only 1° slope downstream over the length of the study area, there was no obvious reason for placing plots otherwise, nor did sufficient variation occur within stands to warrant any special placement patterns.

Since the floodplains and terraces are of restricted area, placement of groups of plots was necessary. Therefore, most terraces and floodplains have been sampled with two or more plots each. Each plot occurs between 35 and 100 m from the nearest plot in the same group. In highly homogenous areas wider dispersion of plots in a group increases the likelihood of sampling the range of variation. In more heterogeneous areas it emphasizes the amount of variation that can occur due to environmental changes over short distances.

At each analytic macroplot noticeable drainage peculiarities were recorded. The slope over approximately 30 m was measured with an Abney level. The elevation of each plot was estimated using topographic maps and bench marks, and each plot was located by section, township, and range using the U.S. Geological Survey quadrangle maps.

Macroplots were laid out by selecting a location for the first corner, which was always the upstream corner on the closest end to the stream, and then stretching out a line that had been measured and marked to delimit a plot 25 m by 15 m.

Each macroplot was then divided in accordance with the method used by Daubenmire (1959). Within each of three sections, each 25 m by 5 m, every tree over 1 m tall was recorded by species and diameter at breast height (DBH). Those trees between 1 m tall and breast height (1. 37 m) were given a DBH of 1 cm. The estimated maximum crown radius was also recorded for each tree.

In a 1 m wide strip outside of each subdivision line, along the length of the macroplot, trees less than 1 m tall were recorded by species and height (dm). On the inside of each of the subdivision lines 25 microplots were taken at 1 m intervals for a total of 50 per macroplot. Each microplot was 20 cm by 50 cm. Use of a painted, steel plot frame aided in cover estimation (Daubenmire, 1959). Within each of the 50 microplots the shrubs, herbs and mosses were recorded by species and percent coverage. Microplots which fell on rock outcrops, logs, or standing trees were classified as special microhabitats and the vegetation, usually mosses, was not recorded.

After completing coverage estimates, species present in or near the macroplot (but not previously recorded) were noted. The center of the plot was marked for future location of soil pits. At this time further notes were recorded concerning distance to and height above the streams and the direction to the nearest substantial opening in the canopy, if any existed. The direction to the nearest substantial opening in the canopy was regarded as the aspect of the plot.

Upon revisiting the stands for soil field analysis it was noted that there was little noticeable difference in vegetation on the plots from early July and early August when soils were examined.

During the week of March 13-17, 1972, increment borings were taken on and near all accessible plots. High water prevented access to the floodplains at Dearborn Island and those across the McKenzie River from the town of Blue River. Due to the size of the increment borer used, 40 cm, sampling of trees was restricted to those generally less than 80 cm DBH. In many cases borings made on the side opposite of reaction wood made it possible to gain age data from trees up to 100 cm DBH. All borings were made at breast height.

In addition to the boring of standing trees, rings were counted on recently logged trees or stumps at cutting height, usually two feet from ground level. Extensive thinning and salvage operations since 1971 in the Boulder Creek area allowed for accurate dating of many size classes of trees, including those greater than 80 cm DBH.

In some cases trees much too large for complete increment bores were bored for information about environmental changes or microclimatic changes on site. All samples were counted in the field and recorded by species, DBH, plot number, age, and any peculiarities about the boring core, e. g., whether the center of the tree was contacted. Replicate borings were made only in those cases where growth form of the tree was sufficiently deceptive to mask the center of the tree.

Several trees of all size classes and species were sampled on and around all accessible plots. Particular emphasis was placed on nonsuppressed *Pseudotsuga menziesii* between 70 and 76 cm DBH, *Thuja plicata* between 38 and 76 cm DBH, *Tsuga heterophylla* between 38 and 61 cm DBH, and *Abies grandis* between 10 and 30 cm DBH. These size classes were chosen because of the common occurrence of many of the species in these classes on most plots as determined by reviewing data sheets taken in 1971.

Analysis

Data calculations were made for cover, frequency, constancy within study area, and constancy within community type. Cover is the actual percent of the area covered by a given species. Frequency is defined as the percent of the microplots of a given macroplot in which a species occurs. Constancy within the study area is the percentage of macroplots, out of the total of 54, in which a species occurs. Constancy within community type is the percentage of the total of plots assigned to one community type in which a species occurs. Average cover of a species within a community type was also calculated.

The total coverage values for all shrub and herb species for all plots were arranged on one sheet of graph paper so that they could easily be subjected to a modification of the Braun-Blanquet manual-visual table-sorting techniques described by Ellenberg (1956). By this method an association table was assembled to use in differentiating types of plant communities. All plot numbers were arranged horizontally on the sheet with a list of the species encountered arranged vertically on the association sheet. Those stands whose species composition seemed to be similar were grouped together. This first separation of plots and species was based merely on the presence or absence of the species without regard to coverage or frequency. The species were then regrouped in order to better delimit spatial groupings within the plot groupings. Ubiquitous species, those occurring with greater than 80% constancy in the study area, and rare species, those occurring with less than 5% constancy within study area, were removed from consideration by moving them to the bottom of the association table.

By arranging the plot-species groupings so that they showed a progression from the upper left of the association table to the lower right of the sheet further spatial relationships of the community types could be inferred. Therefore the association table represents an ordination of plots and species along a complex of gradients and is based on the overall species composition of the stands. By the above method four groups or community types were identified.

After completing the final association table the data were prepared so that the material could be subjected to computerized analysis using the similarity ordination, SIMORD, program. This program is a derivative of the Sorenson K approach to determining similarity of stands. SIMORD, or similar programs, have been used extensively by several recent researchers (Whittaker, 1967; Dick-Peddie and Moir, 1970; Franklin, Dyrness and Moir, 1970; Mitchell, 1972). Perhaps the best explanation of the program can be found in Dick-Peddie and Moir's <u>Vegetation of the Organ Mountains, New Mexico</u> (1970).

Rod Mitchell, of the Oregon State University General Science Department, adapted the SIMORD program to the campus computer system. Coverage, frequency, size classes, edaphic factors and climatic factors were all entered into the total data bank to be partially analyzed by SIMORD. Some researchers have chosen to enter cover classes rather than actual cover values (Mitchell, 1972). This method enables the data to be entered on cards in half the space required for actual cover values. Similarity of stands based on cover classes is not as precise, however, as similarity based on actual cover values. Cover class limits usually are based on a scale of 1 to 100 and are determined in accordance with Daubenmire's cover class limits (1959). Thus, any species with a cover value between 25 and 49% for instance is included in a single cover class, class III. Therefore, stands judged similar on the basis of cover classes can be very misleading. Using the SIMORD program each species in stands I and J is compared, and then the total of similarity values for all species included in the comparison is totaled to give a similarity index for those two stands. Stands I and J are then compared with all other stands to establish a matrix of similarity. In theory, this can lead to two stands being very similar when in actuality their species composition can be markedly different when using cover classes. For this study actual cover values were used for all herbaceous and shrub species. Frequency information was converted to frequency classes using the intervals established by Daubenmire (1959).

The identification of community types through the use of the SIMORD program is based totally on the floristic nature of the stands. The SIMORD program yields a two dimensional ordination of stands based on the similarity of the components of stands.

Perhaps the major drawback with the SIMORD program is the limitation of the input capacity. SIMORD is capable of comparing 125 stands with up to 50 species each on the Oregon State University computer. Thus the user is forced to subjectively pick the stands and species to be used in analysis. Since only 54 stands were used, only species were selected to fit the system capacity in this study.

Using a combination of the computer's speed and the ecologist's experience and judgement has been shown to yield satisfying results

(Franklin, Dyrness and Moir (1970). Subjectivity in this case was deemed necessary and useful. Species were removed from the manual-visual table created earlier in the study by selecting only those species which showed higher fidelity for one or the other of the original community types delineated in the association table. SIMORD analysis was then accomplished on the following: 1) cover of 50 herbaceous and shrub species as picked by investigator, using computer picked endstands; 2) cover of same species as above, using altered X axis endstands and subjectively picked Y axis endstands; 3) frequency classes for the same species used above, using the same endstands as those in no. 2; 4) size classes and numbers present of trees, using the endstands of no. 2 (size classes of trees were 0-1 dm DBH, 1-4 dm DBH, 4-8 dm DBH, and greater than 8 dm DBH); 5) size class and numbers present of trees, using computer picked endstands; 6) the same characters as nos. 4 and 5 in addition to moss cover classes, using computer picked endstands (moss cover classes were assigned in such a way so as to maintain the same order of magnitude for mosses and trees, therefore making similarity values more meaningful); 7) cover values for 50 of the remaining herbaceous and shrubby species that were not included in previous analysis, using endstands from no. 2 analysis; and 8) frequency classes for species used in no. 7, using endstands from no. 7 as well. For preparation of visual displays of the output of the SIMORD program analysis it was necessary to assign symbols to the representatives of each of the community types. Stands that occurred well within a particular community type according to the original association table were assigned specific symbols, and those that occurred as ecotone or borderline stands were assigned these same symbols in accordance with the computer analysis and placement of the stands with respect to the X and Y axes.

Computer picking of endstands operates as follows: the similarity of each stand to each other stand is calculated as mentioned above. The most dissimilar stand to all stands becomes the left end of the X axis, and the stand most dissimilar to that stand becomes the right end of the X axis. The distance between these stands is dependent on their degree of dissimilarity to each other. Y axis endstands are chosen from a group of stands located centrally on the X axis, thus they show a great deal of dissimilarity to both ends of the X axis. The stand most dissimilar to both X axis endstands, and located within 2-12 units from the center of the X axis, is picked as the bottom of the Y axis. The stand most dissimilar to that stand, and within the distance limits of the X axis center, is chosen as the top endstand of the Y axis. It is helpful for the user to subjectively pick endstands in order to spread the groupings on the visual display, but computer endstands probably show truer affinities of stands.

There are several advantages to using the SIMORD or similar computer programs: 1) it is much faster, 2) it is virtually error free if the input is verified prior to analysis, 3) the calculation of similarity of each species in each plot is much more reliable than the manual-visual association table, which is completed more on the presence of a species rather than its relative importance. Thus the computerized program can place many stands in proper perspective with relationship to other stands much more efficiently than the ecologist using a manual-visual table. Analyses nos. 7 and 8 above were made in order to check the subjectivity of the investigator in picking which species to include in similarity analysis.

Soils

Field Methods

A soil pit was located as close to the center of each macroplot as practical. Each pit was approximately 1.5 m by 1 m at the surface and narrowed gradually to a depth of over 1 m unless prohibited by nature of the regolith. Within each pit roots were noted and recorded by size classes (fine, medium and coarse) and abundance classes (few, common, and abundant). These classes follow the definitions in the Soil Survey Manual (USDA, 1951). The depth of the roots in each size class was also recorded.

Each soil profile was divided into horizons on the basis of visual, textural, or structural differences. The soil description included depth limits of and composition of humus or detritus layer, depth of each horizon, moist color, texture, structure, moist consistence, wet consistence, and boundary characteristics, all in accordance with guidelines prescribed by the Soil Survey Manual. Color of the moist samples was determined by matching with Munsell Color Charts.

Estimates of stones and cobbles were recorded by percentage volume in each horizon. Additional notes were taken on mottling, presence of charcoal or detritus in various horizons, suspected buried profiles and evidence of recent flooding at each plot. Upon completion of the soil description a sample of approximately 885 cc of each horizon in each profile was collected for further analysis in the laboratory unless the plot descriptions in the same group of plots showed only minor differences between pits. In the latter case the most representative pit of the group was sampled for laboratory analysis.

At completion of the field soil work many of the more noticeable plot markers were removed. Pits were left open for future water table observations unless they occurred where they might present a danger to fishermen or campers. If they were refilled, the vegetation was restored by replacing the mats of mosses or herbaceous vegetation that had been carefully removed.

Soil Analysis

All soil samples were first subjected to moist color determination under constant fluorescent lighting. They were then allowed to air dry for three days at room temperature. After air drying, dry color was determined with Munsell color charts. All samples were then hand ground, if grinding was needed to break up the peds, and passed through a 2 mm sieve. This procedure separated the gravel from the fine materials in the samples. Volumes and weights were recorded for the gravels and the fines. The total volume was also recorded.

The fine material, that less than 2 mm diameter, was then spread and mixed so that 130 g subsamples could be removed for further analysis. Fifty-five g of the fine material was then analyzed for size class distribution of sand, silt and clay. This textural analysis was completed using a modification of the hydrometer method (Day, 1956). Approximately 20 g subsamples of each sample were used for determination of soil moisture content. Each 20 g subsample was weighed, oven dried for 24 hours at $105^{o}F$, and then reweighed. Another 10 g subsample of each sample was then analyzed for pH using a Corning pH meter, and a 1:1 ratio of soil to double-distilled water. Replicates were made for each of the samples analyzed for pH.

RESULTS AND DISCUSSION

Vegetation

Introduction

Manual-visual tables and computer ordination of stands resulted in the identification of four plant communities within the study area. These four communities are composed of 115 species of vascular plants and 8 species of mosses. The vascular plants include 10 species of trees, 26 shrub or small tree species, and 79 herbaceous species. The communities have been named on the basis of the dominant species rather than hypothetical climax species.

A study of the stands occurring on such young substrates as the McKenzie River terraces and floodplains is of necessity a study representing a number of successional stages. Because of this, the communities may include a wide range of seral stages including mature and immature stands. An effort has been made to group the stands into more inclusive communities rather than spreading them over the continuum and describing each. The communities include; 1) *Tsuga heterophylla*/*Acer circinatum*/*Polystichum munitum*-*Oxalis oregana* (*Tshe*/*Acci*/*Pomu*-*Oxor*), 2) *Alnus rubra*-*Abies grandis*/*Ribes lobbii*-*Acer circinatum*/*Montia sibirica*-*Polystichum munitum* (*Alru*-*Abgr*/*Rilo*-*Acci*/*Mosi*-*Pomu*, 3) *Pseudotsuga menziesii*/*Corylus cornuta*-*Symphoricarpos mollis*/*Polystichum munitum* (*Psme*/*Coco*-*Symo*/

Pomu), and 4) Pseudotsuga menziesii-Libocedrus decurrens/Berberis nervosa-Gaultheria shallon/Linnaea borealis (Psme-Lide/Bene-Gash/Libo).

The four communities within the study area occur on a variety of floodplains, terraces, and glacial outwash plains. Floodplains are divided into two levels, low floodplains that are elevated between 1 and 4 feet above the adjacent river or subsidiary channel, and high floodplains that are elevated 4 to 7 feet above normal mid-summer water level. Terraces are divided into three categories based on their elevation above the normal mid-summer water level of the adjacent McKenzie River. Low terraces range from 5 to 8 feet above water level, medium terraces between 8 and 15 feet, and high terraces greater than 15 feet above water level. Glacial outwash plains are normally 20 to 25 feet above water level within the study area.

Community Discussion

The Tsuga heterophylla/Acer circinatum/Polystichum munitum-Oxalis oregana Community. This community is the most extensive one in the study area. It has been sampled on 18 plots with timber stands ranging from mature to old-growth (200 to 500 years based on increment borings). It occurs on low to high terraces composed of deep, well drained to moderately well drained, silt loam to loam surface soils overlying sandy loam to coarse sandy subsoils.

Most soils are stone free, and only a few have cobbles present. The stands sampled occur between 290 and 550 meters in elevation within the study area. Stands representative of this community are most common in the Delta and Horse Creek regions, but they also occur at Boulder and Quartz Creek localities. The terrain typical of this community is commonly hummocky in mature stands because of the downed Pseudotsuga menziesii presently serving as decaying nurse logs upon which are growing large numbers of Tsuga heterophylla seedlings. Windthrow of Pseudotsuga menziesii also causes large pits where their root masses are pulled up. Stands within this community are not commonly flooded even in years of high precipitation and stream flow.

The overstory canopy is dominated by Pseudotsuga menziesii in younger stands and by Tsuga heterophylla in old-growth stands. Since Tsuga heterophylla is quite shade tolerant and replaces itself well, and because there are usually multiple layers in the tree canopy, tree coverage often exceeds 100%. Disregarding overlapping of layers, the younger stands have a more dense canopy, with less, open canopy area than the old-growth stands. This is due to the difference in the size classes of the species of trees in the stands. In "mature" stands the canopy is dominated by large well-developed Pseudotsuga menziesii ranging from 300 to 450 years old. Within this community these stands are classified as mature stands. In "old-growth" stands, older than mature stands, most of the larger Pseudotsuga menziesii have fallen out leaving large openings in the canopy which are only partially filled by young, previously suppressed, thin crowned Tsuga heterophylla. A stand is considered to be old-growth if only few of the larger size class, trees greater than 80 cm DBH, of Pseudotsuga menziesii remain while all size classes of Tsuga heterophylla are represented (Appendix 4).

On wetter sites, such as at Horse Creek, Thuja plicata is a codominant species in the tree layer. Acer macrophyllum occurs commonly as a minor species in all successional levels within this community, with 94% constancy and an average cover value of 23%. Abies grandis also occurs in greater than 50% of the stands that were sampled in this community.

The shrub layer of the Tshe/Acci/Pomu-Ocor community is relatively sparse as compared to that in other communities within the study area. It is dominated by Acer circinatum which occurs in all stands with an average cover of 11%. The second most abundant tall shrub is Corylus cornuta var. californica followed by the more restricted Cornus nuttallii. Vaccinium parvifolium occurs commonly but with low coverage values. The low shrub layer is also poorly developed in this community. It is dominated by Berberis nervosa and Rubus ursinus. Nine other tall and low shrubs contribute little to the total of 31% cover average of the combined shrub layers in this community (Table 3).

Table 3. Cover and constancy table for the Tsuga heterophylla/Acer circinatum/Polystichum munitum-Oxalis oregana community.*

Layers and species	Stands representing this community																		% Ave. cover	% Constancy
	51	52	53	36	44	45	46	47	48	34	35	28	1	2	3	13	14	15		
	Percent coverage																			
Overstory tree layer																				
Tsuga heterophylla	132	134	135	103	5	38	27	18	1	39	29	4	74	66	60	48	82	60	59	100
Acer macrophyllum	13	36	13	22	65	5	35	14	4	25	45	22	29	27	23	10	30	6	23	94
Pseudotsuga menziesii	10	-	10	30	13	13	26	52	40	8	36	66	25	17	17	-	34	18	23	89
Thuja plicata	5	-	-	9	44	24	55	32	54	49	11	50	1	1	1	-	-	5	18	78
Abies grandis	1	5	2	-	-	5	3	4	2	-	3	1	1	-	-	-	-	2	2	61
Libocedrus decurrens	-	-	-	-	-	-	-	-	-	-	19	-	-	-	-	18	13	-	3	17
Tall shrub and small tree layer																				
Acer circinatum	5	6	20	21	13	16	20	14	9	1	9	14	14	4	12	13	1	13	11	100
Corylus cornuta	1	2	-	1	1	14	16	2	1	3	23	2	6	1	4	1	1	1	4	95
Cornus nuttallii	15	-	4	1	-	-	-	13	13	10	9	-	-	-	1	1	1	9	4	61
Taxus brevifolia	-	-	-	-	-	-	-	-	2	-	-	-	3	-	-	-	-	17	1	17
Vaccinum parvifolium	1	1	1	3	-	-	-	-	1	1	-	-	-	2	3	1	1	1	1	61
Osmoronia cerasiformis	-	-	-	-	-	3	-	-	-	-	-	1	-	1	-	-	-	-	T	17
Rhamnus purshiana	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	11
Rubus parviflorus	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	T	11
Castanopsis chrysophylla	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	6
Rubus leucodermis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	T	6
Philadelphus lewisii	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	T	6
Amelanchier alnifolia	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	T	6
Small shrub layer																				
Berberis nervosa	10	9	16	2	3	11	4	12	6	1	-	35	9	2	5	2	7	3	8	95
Rubus ursinus	2	1	3	1	1	3	3	2	1	1	3	2	4	1	3	2	1	1	2	100
Gaultheria shallon	-	4	3	-	-	1	-	1	1	-	-	-	-	-	-	-	1	-	1	33
Rosa gymnocarpa	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	T	22
Symphoricarpos mollis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	T	6

(Continued on next page)

Table 3. (Continued)

Layers and species	51	52	53	36	44	45	46	47	48	34	35	28	1	2	3	13	14	15	% Ave. cover	% Constancy
	Stands representing this community																			
	Percent coverage																			
Herb layer																				
Oxalis oregana	15	22	32	34	47	30	36	21	31	30	23	-	21	22	21	34	30	20	26	95
Polystichum munitum	32	28	23	12	17	21	8	29	24	39	33	6	18	27	21	20	9	30	22	100
Vancouveria hexandra	2	2	1	12	17	9	16	-	-	13	25	1	5	6	13	1	3	5	7	89
Galium triflorum	1	1	1	1	1	2	1	2	4	1	3	2	3	1	1	1	1	1	2	100
Galium bifolium	-	-	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	-	1	89
Tiarella unifoliata	1	1	2	1	1	1	1	-	-	1	-	6	1	1	1	1	1	1	1	83
Asarum caudatum	1	-	1	1	1	2	1	-	1	-	1	1	1	1	1	-	1	1	1	77
Linnaea borealis	1	1	1	3	-	1	-	-	-	1	-	6	-	1	1	1	2	4	1	66
Trillium ovatum	1	-	1	1	-	1	-	-	1	1	-	1	-	1	-	-	1	1	1	55
Adenocaulon bicolor	-	-	-	1	1	1	1	1	-	-	-	1	1	1	1	1	-	1	1	61
Viola sempervirens	-	-	-	4	-	1	-	-	-	-	-	1	1	1	1	1	1	1	1	50
Anemone deltoidea	1	-	-	-	-	-	-	1	1	-	1	1	1	-	-	1	1	1	1	50
Smilacina stellata	1	-	1	-	-	1	2	1	1	-	2	-	-	-	-	-	-	-	1	39
Adiantum pedatum	-	-	-	-	1	1	1	-	-	3	-	-	1	-	1	-	-	1	1	39
Pteridium aquilinum	-	-	-	1	-	-	-	8	1	1	-	-	3	-	3	-	-	-	1	33
Athyrium filix-femina	-	-	-	-	6	1	1	-	-	-	1	-	1	-	-	-	-	-	1	28
Blechnum spicant	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	-	T	17
Disporum hookeri	-	-	1	-	1	1	1	-	1	-	1	-	-	-	1	-	-	1	T	44
Polypodium glycyrrhiza	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	T	6
Achlys triphylla	1	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	-	-	T	22
Goodyera oblongifolia	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1	1	1	T	33
Bromus vulgaris	-	-	-	1	-	-	-	-	1	1	1	-	-	-	-	1	-	-	T	33
Polystichum lonchitis	-	1	-	-	-	-	-	1	-	1	1	-	-	-	-	1	-	-	T	28
Anemone lyallii	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	T	11
Smilacina racemosa	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	T	6
Clintonia uniflora	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	T	6
Prunella vulgaris	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	T	11
Hieracium albiflorum	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	T	6
Synthyris reniformis	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	1	T	17

(Continued on next page)

Table 3. (Continued)

Layers and species	Stands representing this community																		*% Ave. cover	% Constancy
	51	52	53	36	44	45	46	47	48	34	35	28	1	2	3	13	14	15		
	Percent coverage																			
Dicentra formosa	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	T	6
Circaea alpina	-	1	-	-	1	-	-	-	1	-	3	1	-	1	-	-	-	-	T	33
Thalictrum occidentale	-	1	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	T	17
Viola glabella	-	-	1	1	-	1	1	-	1	-	1	-	-	-	-	-	-	-	T	33
Collomia heterophylla	-	-	-	--	-	-	-	-	-	-	1	-	-	-	-	-	-	-	T	6
Stachys palustris	-	-	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	T	17
Hydophyllum tenuipes	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	T	6
Cystopteris fragilis	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	T	6
Eburophyton austinae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	T	6
Dryopteris sp.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	T	6
Monotropa uniflora	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	T	11
Osmorhiza chilensis	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	T	11
Whipplea modesta	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	T	6
Heuchera micrantha	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	6
Atrostis tenuis	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	6
Montia sibirica	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	6
Trientalis latifolia	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	6
Petasites frigidus	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	T	6
Bryophyte layer																				
Eurhynchium oreganum	7	3	2	8	1	17	9	6	6	30	25	20	15	17	21	20	23	15	14	100
Rhytidiadelphus triquetrus	4	4	6	12	1	9	4	7	12	15	13	5	1	7	15	30	15	25	10	100
Hylocomium splendens	8	20	9	8	1	7	-	-	-	11	7	-	15	5	5	15	25	15	8	77
Plagiomnium insigne	1	1	3	-	19	3	13	1	1	-	17	-	9	8	8	-	-	3	5	71
Leucolepis menziesii	-	-	1	-	2	1	1	1	2	13	10	-	10	3	1	5	-	-	3	66
Dicranum fuscescens	2	1	-	-	-	-	-	-	-	1	-	-	2	-	1	-	1	1	1	38
Isothecium spiculiferum	2	2	-	-	-	-	-	-	1	3	2	-	-	-	-	-	1	1	1	38
Hypnum circinale	1	1	-	-	-	-	-	-	-	-	-	-	1	2	8	-	10	-	1	33

*Average cover percent of less than 1% was given a T (trace). All other figures are averaged to the nearest whole percent.

The herb layer consists of 47 species, 12 of which occur in greater than half of the sampled stands. The layer is dominated by Polystichum munitum and Oxalis oregana with 22 and 26% average cover respectively. Vancouveria hexandra is the only other important species from the standpoint of coverage, with an average value of 7%.

The mosses are well represented in this community and are dominated by Rhytidiadelphus triquetrus and Eurhynchium oreganum. Hylocomium splendens and Plagiomnium (Mnium) insigne each occur in greater than 70% of the stands sampled within this community. The total moss cover average was 43% per stand.

Distinguishing characteristics of this community include: 1) high amount of coverage in the tree layer by Tsuga heterophylla in the medium to large size classes (all those above 40 cm DBH), 2) a poorly developed shrub layer, and 3) large amounts of both Polystichum munitum and Oxalis oregana (Table 3).

Alnus rubra-Abies grandis/Ribes lobbii-Acer circinatum/Montia sibirica-Polystichum munitum Community. This community is the most restricted community included in this study. It occurs on active low and high floodplains consisting of deep, extremely well drained, loamy sand to sand surface soils over coarse sandy and gravelly subsoils. Stones and cobbles are quite common at greater depths, usually deeper than 60 cm. The terrain within this community is generally level or sloping at one to two degrees away from the river.

The community as a whole contains 10 species of trees, 16 shrub species, 64 herb species and 8 species of moss (Table 4).

This community is divided into three phases which represent seral stages within the community. The three phases are the Alnus rubra phase, the Abies grandis phase, and the Pseudotsuga menziesii phase. The stands in each of these phases are probably covered with water for extensive continuous periods in many years, two weeks or more as noted in 1971 and 1972.

Alnus rubra phase. The Alnus rubra phase is represented by five stands located in the Delta and Blue River regions of the study area. In this phase the overstory tree canopy is dominated by Alnus rubra and Acer macrophyllum. Other common trees include Populus trichocarpa and Abies grandis, which are both common in the smaller size classes in this early successional stage. Increment borings indicate that these stands are between 30 and 50 years old. The Alnus rubra phase usually occurs in a narrow band flanked on the river side by a narrow zone made up of Salix sp. and other pioneer species.

Abies grandis phase. The Abies grandis phase appears to replace the Alnus rubra phase in 50-70 years or less as evidenced by my stands and differs from it in having greater amounts of Pseudotsuga menziesii, Abies grandis, and Libocedrus decurrens in the canopy. Ribes lobbii, which is common in the shrub layer of the Alnus rubra phase, disappears completely in the Abies grandis phase, and Acer

Table 4. Cover and constancy table of the Alnus rubra-Abies grandis/Ribes lobbii-Acer circinatum/Montia sibirica-Polystichum munitum community.*

Layers and species	Stands in this community												% Ave. cover	% Constancy
	10	11	12	37	38	4	5	6	43	49	50	54		
						Cover in percent								
Overstory tree layer														
Acer macrophyllum	18	46	-	29	45	46	17	38	44	54	31	17	32	100
Abies grandis	26	34	36	5	-	58	34	51	1	34	50	52	32	93
Alnus rubra	137	72	55	28	36	-	-	-	-	-	-	15	29	50
Pseudotsuga menziesii	-	-	-	17	-	25	8	-	86	57	-	8	17	50
Populus trichocarpa	-	49	56	39	48	-	-	-	17	-	-	-	17	43
Libocedrus decurrens	-	-	3	24	-	45	15	4	21	5	-	-	10	59
Thuja plicata	-	-	5	11	-	-	8	21	34	-	-	-	7	43
Fraxinus latifolia	15	2	2	1	37	-	-	-	-	-	-	10	6	50
Tsuga heterophylla	-	-	-	-	-	-	-	-	-	3	63	-	5	17
Tall shrub and small tree layer														
Acer circinatum	4	5	11	8	44	19	21	47	9	25	30	27	22	100
Corylus cornuta	15	30	37	12	7	4	20	13	18	5	7	3	14	100
Ribes lobbii	6	8	14	1	16	-	-	-	-	-	-	-	4	42
Osmoronia cerasiformis	3	1	1	1	1	-	-	-	-	17	5	8	3	68
Taxus brevifolia	-	-	-	-	-	-	-	-	-	-	9	-	1	9
Cornus nuttallii	8	-	-	-	-	-	-	-	-	-	-	-	1	9
Rubus parviflorus	1	-	1	1	2	-	-	-	-	-	-	-	T	34
Cytisus scoparius	1	-	-	-	-	-	-	-	-	-	-	-	T	9
Physocarpus capitatus	1	-	-	-	-	-	-	-	-	-	-	-	T	9
Rubus procerus	-	1	-	-	-	-	-	-	-	-	-	-	T	9
Vaccinium parvifolium	-	-	-	-	-	-	-	-	-	-	1	-	T	9
Small shrub layer														
Rubus ursinus	8	5	5	8	9	4	4	4	6	1	7	5	7	10
Symphoricarpos mollis	-	1	2	1	1	-	1	1	1	2	-	1	1	77
Berberis nervosa	-	-	-	-	-	-	-	-	2	12	-	-	1	17
Rosa gymnocarpa	-	-	-	1	-	-	-	-	-	1	-	-	T	17

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Table 4. (Continued)

Layers and species	Stands in this community												% Ave. cover	% Constancy
	10	11	12	37	38	4	5	6	43	49	50	54		
	Cover in percent													
Gaultheria shallon	-	-	-	-	-	-	-	-	-	1	-	-	T	9
Berberis aquifolium	-	-	-	-	-	-	-	-	-	-	-	1	T	9
Herb layer														
Oxalis oregana	1	2	17	5	3	20	23	43	31	12	36	60	21	100
Polystichum munitum	-	-	-	2	1	7	11	19	23	26	20	1	9	77
Montia sibirica	18	6	1	17	17	1	3	1	4	-	1	1	6	93
Circaea alpina	2	1	2	4	11	10	17	11	10	1	2	4	6	100
Petasites frigidus	2	1	14	8	10	4	1	1	-	1	1	1	4	93
Nemophila parviflora	8	8	1	7	6	2	2	1	3	-	-	-	3	68
Galium triflorum	15	6	1	4	4	3	5	4	4	1	3	1	4	100
Galium bifolium	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Tolmiea menziesii	2	1	2	2	1	1	1	1	1	-	1	1	1	93
Viola glabella	1	1	1	1	-	1	2	1	1	-	1	1	1	85
Osmorhiza chilensis	1	1	1	3	-	-	1	1	2	1	1	1	1	85
Stachys cooleyae	4	2	1	1	1	1	1	1	-	-	-	-	1	68
Stachys palustris	1	1	2	2	1	-	1	1	1	-	-	-	1	68
Carex bolanderi	-	-	-	1	1	-	1	1	4	-	1	1	1	59
Thalictrum occidentale	1	-	1	1	-	-	-	1	-	1	1	1	1	59
Heracleum lanatum	4	1	5	-	1	1	-	1	-	-	-	-	1	50
Elymus glaucus	2	2	1	1	1	1	-	-	-	-	-	-	1	50
Vancouveria hexandra	-	-	1	1	-	-	1	1	-	1	1	-	1	50
Bromus vulgaris	-	-	-	1	-	-	1	1	1	1	1	-	1	50
Equisetum arvense	9	1	6	1	1	1	-	-	-	-	-	-	1	50
Trientalis latifolia	-	1	-	1	-	-	1	-	1	1	1	-	1	50
Smilacina stellata	-	1	-	-	-	-	-	-	2	-	1	6	1	34
Polystichum lonchitis	-	-	-	-	-	-	-	-	-	-	1	5	1	17
Tiarella unifoliata	-	1	-	-	1	1	-	1	1	-	1	-	T	50
Disporum hookeri	-	-	-	-	-	1	1	-	1	-	1	1	T	42
Adenocaulon bicolor	1	-	1	1	-	-	1	-	1	-	-	-	T	42

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Table 4. (Continued)

Layers and species	Stands in this community												% Ave. cover	% Constancy
	10	11	12	37	38	4	5	6	43	49	50	54		
	Cover in percent													
Prunella vulgaris	-	-	-	1	-	1	1	1	-	-	1	-	T	42
Synthyris reniformis	1	1	1	-	-	-	-	-	-	1	1	-	T	42
Collomia heterophylla	1	1	1	-	-	-	-	-	-	-	-	1	T	34
Anemone lyallii	-	1	1	-	-	-	-	-	1	1	-	-	T	34
Agrostis tenuis	-	-	-	-	-	1	1	-	-	1	1	-	T	34
Hydrophyllum tenuipes	1	-	-	-	-	1	1	-	-	-	-	1	T	34
Asarum caudatum	-	-	-	-	-	-	1	1	1	-	1	-	T	34
Fragaria vesca	-	-	1	-	-	-	-	-	1	-	1	1	T	25
Dicentra formosa	-	-	-	-	1	-	1	-	-	-	-	1	T	25
Stellaria crispa	-	-	-	-	1	-	1	1	-	-	-	-	T	25
Coptis laciniata	-	-	1	-	-	-	1	1	-	-	-	-	T	25
Adiantum pedatum	-	-	-	-	-	1	-	-	1	-	-	-	T	17
Urtica lyallii	-	-	-	1	2	-	-	-	-	-	-	-	T	17
Campanula scouleri	1	-	-	-	-	-	-	-	-	-	1	-	T	17
Hieracium albiflorum	1	-	-	-	-	-	-	-	-	-	1	-	T	17
Smilacina racemosa	-	-	-	-	-	-	-	-	-	-	1	1	T	17
Athyrium filix-femina	-	-	-	-	-	1	-	-	-	-	-	-	T	9
Anemone deltoidea	-	-	-	-	-	-	-	-	1	-	-	-	T	9
Trillium ovatum	-	-	-	-	-	-	-	-	-	-	1	-	T	9
Vicia americana	1	-	-	-	-	-	-	-	-	-	-	-	T	9
Epilobium watsonii	1	-	-	-	-	-	-	-	-	-	-	-	T	9
Cirsium vulgare	1	-	-	-	-	-	-	-	-	-	-	-	T	9
Digitalis purpurea	1	-	-	-	-	-	-	-	-	-	-	-	T	9
Actaea arguta	-	-	-	-	-	-	-	1	-	-	-	-	T	9
Ranunculus uncinatus	-	-	-	-	-	-	-	1	-	-	-	-	T	9
Polypodium glycyrrhiza	-	-	-	1	-	-	-	-	-	-	-	-	T	9
Stellaria calycantha	-	-	-	1	-	-	-	-	-	-	-	-	T	9
Aralia californica	-	-	-	-	5	-	-	-	-	-	-	-	T	9

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Table 4. (Continued)

Layers and species	Stands in this community												% Ave. cover	% Constancy
	10	11	12	37	38	4	5	6	43	49	50	54		
	Cover in percent													
Bryophyte layer														
Plagiomnium insigne	-	-	2	-	-	17	12	11	3	1	6	4	5	66
Leucolepis menziesii	-	-	-	-	-	15	10	17	2	-	1	3	4	50
Rhytidiadelphus triquetrus	-	-	-	-	-	5	5	3	1	1	3	5	2	58
Eurhynchium oreganum	-	-	-	-	-	7	15	-	1	1	3	1	2	50
Dicranum fuscescens	-	-	-	-	-	15	2	1	-	4	3	-	2	43
Hylocomium splendens	-	-	-	-	-	7	-	-	1	-	1	1	1	34
Hypnum circinale	-	-	-	-	-	2	2	2	-	-	-	-	1	25
Isothecium spiculiferum	-	-	-	-	-	-	-	-	-	1	1	-	T	17

*Average cover percent of less than 1% was given a T (trace). All other figures are averaged to the nearest whole percent.

circinatum increases in importance. The Abies grandis phase also has a well developed moss layer whereas the Alnus rubra phase has virtually no terrestrial moss cover.

Pseudotsuga menziesii phase. This phase is represented by only two stands, plot 43 and plot 49. They occur on floodplains that have recently been created by major channel shifting of the McKenzie River. These shifts have caused increased frequency of flooding on what were previously low to medium terraces. Both of these stands were probably members of the Tshe/Acci/Pomu-Oxor community type prior to recent flooding and deposition of large amounts of sand over the site. This deposition has greatly altered shrub and herb layer development, while the tree layer remains similar to that typical of the Tshe/Acci/Pomu-Oxor community.

The tree layer of the Alru-Abgr/Rilo-Acci/Mosi-Pomu community as a whole is dominated by Acer macrophyllum and Abies grandis in older stands and by Acer macrophyllum, Abies grandis and Alnus rubra in young stands. Populus trichocarpa is also an important component of the Alnus rubra phase.

The Alru-Abgr/Rilo-Acci/Mosi-Pomu community is characterized by a distinct zonation. Ranging from the river these zones are usually arranged with a narrow Salix band followed by Alnus rubra and Populus trichocarpa, and then Abies grandis in the deeper soils of more elevated areas of the floodplain.

The tall shrub layer is dominated by Acer circinatum and Corylus cornuta with 22% and 14% average cover respectively, and both occur in all sampled stands. Ribes lobbii and Osmoronia cerasiformis are common in young stands and Osmoronia is maintained in older stands. The small shrub layer is poorly developed and dominated by Rubus ursinus. Symphoricarpos mollis also occurs quite regularly but in small amounts.

The herb layer is characterized by Galium triflorum, Montia sibirica, Nemophila parviflora, Tolmiea menziesii, Petasites frigidus, Stachys cooleyae, and Equisetum arvense in the Alnus rubra phase and by Polystichum munitum, Oxalis oregana, and Circaea alpina in more mature Abies grandis and Pseudotsuga menziesii phases. Sixteen species of vascular plants occur only within this community in the study area. None of them are dominant species (all have 1% or less average cover) and they occur mostly within the Alnus rubra phase.

Distinguishing characteristics of the community include: 1) a well developed tree canopy, averaging 156% cover per stand, 2) presence of thickets of Ribes lobbii within the Alnus rubra phase, and 3) presence of the characteristic species listed above in greater than 80% of the stands. Other species which show maximum development in this community, and their cover averages, include Rubus ursinus

(7%), Circaea alpina (6%), Petasites frigidus (4%), and Fraxinus latifolia (6%).

The Pseudotsuga menziesii/Corylus cornuta-Symphoricarpos mollis/Polystichum munitum Community. This community is a common community that occurs on medium terraces within the study area. The soils are of medium depth (about one meter), well drained silt loam to sandy loam surface soils over coarse sandy subsoils, and they may be stonefree or stony below 20 cm. Terrain within this community is typically level with few high water channels dissecting the community. All stands within this community are relatively young in age. Tree increment borings indicated an average age of 85 to 135 years for the tree layer. Sampled plots within the community contained 9 species of trees, 15 shrub species, 39 herb species and 7 moss species (Table 5). All species except Lathyrus nevadensis in the herb layer were recorded in other communities in greater or lesser amounts. This community is thought to be representative of a portion of the developmental sequence which begins with holocaustic fire.

The overstory tree canopy in this community is the least well developed of the communities included in this study. Average cover of the tree layer is 118% per stand. This layer is dominated by Pseudotsuga menziesii, which occurs in all sampled stands with an average cover of 57%. Acer macrophyllum is the second most

Table 5. Cover and constancy table for the Pseudotsuga menziesii/Corylus cornuta-Symphoricarpos mollis/Polystichum munitum community.*

Layers and species	Stands representing this community										% Ave. cover	% Constancy
	7	8	9	16	17	18	42	41	40	39		
	Cover percentage											
Overstory tree layer												
Pseudotsuga menziesii	57	45	44	49	71	64	64	30	80	61	57	100
Acer macrophyllum	14	10	1	10	-	38	4	86	33	90	28	90
Libocedrus decurrens	3	21	18	13	3	-	5	24	25	10	12	90
Abies grandis	22	7	17	-	13	17	17	3	5	6	11	90
Thuja plicata	-	2	-	5	-	13	8	-	-	10	4	50
Tsuga heterophylla	1	1	10	-	6	-	-	-	-	1	2	40
Fraxinus latifolia	1	-	1	3	-	-	1	2	5	-	1	60
Populus trichocarpa	-	-	-	-	-	-	-	-	1	18	2	20
Tall shrub and small tree layer												
Corylus cornuta	28	33	24	18	34	19	43	25	51	27	30	100
Acer circinatum	25	38	27	11	7	18	-	27	2	9	16	90
Vaccinum parvifolium	7	2	2	2	5	9	2	1	-	-	3	80
Osmoronia cerasiformis	-	1	1	1	2	-	-	4	7	1	2	70
Cornus nuttalli	1	1	8	1	-	1	-	-	-	-	1	50
Taxus brevifolia	-	-	-	-	-	-	10	-	-	-	1	10
Philadelphus lewisii	-	-	-	-	-	-	5	-	-	-	1	10
Ribes lobbii	-	-	1	-	-	-	-	-	-	-	T	10
Lonicera ciliosa	-	-	-	1	-	-	-	-	1	-	T	20
Holodiscus discolor	-	-	-	-	-	-	4	-	-	-	T	10
Small shrub layer												
Symphoricarpos mollis	36	16	30	3	5	4	8	1	9	5	18	100
Rubus ursinus	1	4	4	2	4	7	3	2	3	2	3	100
Berberis nervosa	10	1	8	1	1	1	1	-	6	-	3	80
Rosa gymnocarpa	2	1	2	1	-	-	1	-	1	-	1	60
Gaultheria shallon	-	-	-	2	-	1	2	-	-	-	1	30
Berberis aquifolium	-	-	-	-	-	-	3	-	-	-	T	10

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Table 5. (Continued)

Layers and species	Stands representing this community										% Ave. cover	% Constancy
	7	8	9	16	17	18	42	41	40	39		
	Cover percentage											
<u>Herb layer</u>												
<u>Polystichum munitum</u>	10	11	8	23	30	32	26	45	42	36	26	100
<u>Oxalis oregana</u>	5	2	-	3	16	25	1	19	10	14	10	90
<u>Adenocaulon bicolor</u>	2	4	1	11	11	7	9	4	1	1	6	100
<u>Vancouveria hexandra</u>	2	13	6	8	10	12	6	6	-	1	6	90
<u>Galium triflorum</u>	2	4	2	3	4	1	2	1	3	5	3	100
<u>Smilacina stellata</u>	9	7	6	1	1	1	2	-	1	1	3	90
<u>Synthyris reniformis</u>	5	5	4	3	1	-	2	-	3	3	3	80
<u>Thalictrum occidentale</u>	1	-	2	5	1	-	6	4	2	2	2	80
<u>Circaea alpina</u>	-	1	1	-	1	-	1	1	4	10	2	70
<u>Bromus vulgaris</u>	1	1	1	1	1	1	1	1	1	1	1	100
<u>Viola glabella</u>	1	1	2	2	2	1	1	1	1	2	1	100
<u>Galium bifolium</u>	1	1	1	1	1	1	1	1	1	1	1	100
<u>Fragaria vesca</u>	1	1	1	1	1	1	1	-	1	1	1	90
<u>Goodyera oblongifolia</u>	1	1	1	1	1	1	2	1	-	-	1	80
<u>Trientalis latifolia</u>	1	1	1	1	1	1	1	-	1	-	1	80
<u>Stellaria calycantha</u>	1	1	-	1	-	-	1	-	1	-	1	60
<u>Pteridium aquilinum</u>	-	1	1	1	1	3	-	-	-	-	1	50
<u>Stachys palustris</u>	-	-	-	1	1	1	-	1	-	1	1	50
<u>Coptis laciniata</u>	1	2	1	1	1	-	-	-	-	-	1	50
<u>Linnaea borealis</u>	1	3	1	1	-	1	-	-	-	-	1	50
<u>Whipplea modesta</u>	-	-	2	-	1	-	1	-	-	1	1	40
<u>Osmorhiza chilensis</u>	-	1	1	1	1	-	-	-	1	1	1	60
<u>Polystichum lonchitis</u>	-	-	1	1	1	-	-	1	-	-	T	40
<u>Disporum hookeri</u>	-	1	-	1	-	1	1	-	-	-	T	40
<u>Anemone lyallii</u>	1	-	1	-	-	1	-	-	-	-	T	30
<u>Vicia americana</u>	-	1	1	1	-	-	-	-	-	-	T	30
<u>Asarum caudatum</u>	-	1	-	1	1	-	-	-	-	-	T	30
<u>Listera caurina</u>	-	-	1	-	-	-	1	-	-	-	T	20

(Continued on next page)

Table 5. (Continued)

Layers and species	Stands representing this community										% Ave. cover	% Constancy
	7	8	9	16	17	18	42	41	40	39		
	Cover percentage											
Anemone deltoidea	-	-	-	1	-	1	-	-	-	-	T	20
Lathyrus nevadensis	-	-	-	1	-	-	-	-	1	-	T	20
Agrostis tenuis	1	-	-	-	-	-	-	-	-	-	T	10
Viola sempervirens	-	-	-	-	1	-	-	-	-	-	T	10
Stellaria crispa	-	-	-	-	-	-	1	-	-	1	T	20
Athyrium filix-femina	-	-	-	-	-	-	-	1	-	-	T	10
Montia sibirica	-	-	-	-	-	-	-	1	-	1	T	20
Adiantum pedatum	-	-	-	-	-	-	-	1	-	-	T	10
Dryopteris sp.	-	-	-	-	-	-	-	1	-	-	T	10
Carex bolanderi	-	-	-	-	-	-	-	-	1	3	T	20
Nemophila parviflora	-	-	-	-	-	-	-	-	1	1	T	20
Bryophyte layer												
Rhytidiadelphus triquetrus	16	30	19	24	21	15	8	6	3	7	15	100
Eurhynchium oreganum	25	15	25	17	25	22	2	5	-	-	14	80
Hylocomium splendens	1	9	-	7	-	1	30	1	22	1	7	80
Plagiomnium insigne	-	5	-	3	-	2	1	5	1	3	2	70
Dicranum fuscescens	-	1	3	1	2	1	2	1	-	1	1	80
Leucolepis menziesii	-	5	-	-	-	-	2	2	1	1	1	50
Hypnum circinale	-	2	3	3	2	-	-	-	-	-	1	40

*Average cover percent of less than 1% was given a T (trace). All other figures are averaged to the nearest whole percent.

important tree species with an average cover value of 28%. Abies grandis and Libocedrus decurrens are quite common in medium size classes (Appendix 4), and Thuja plicata is also common, being present in 50% of the stands sampled.

The shrub layer of the Psme/Coco-Symo/Pomu community type is more developed than that in any other community studied. Dominants include Corylus cornuta, Acer circinatum and Symphoricarpos mollis with 30%, 16% and 18% cover averages respectively. Other commonly occurring species include Vaccinium parvifolium, Berberis nervosa, Rubus ursinus, Osmoronia cerasiformis, Rosa gymnocarpa, and Cornus nuttallii each with 3% cover or less but occurring within greater than 50% of the stands of the community.

The herb layer consists of 39 species dominated by Polystichum munitum with 26% average cover. Other important herbs include Oxalis oregana, Vancouveria hexandra, Adenocaulon bicolor, all with 5-10% average cover; and Galium triflorum, Synthyris reniformis, Smilacina stellata, Thalictrum occidentale, and Circaea alpina, each with 2-3% cover averages.

The moss layer in this community is well developed. Of the seven species which occur over 41% of the area within sampled stands, Rhytidiadelphus triquetrus and Eurhynchium oreganum are the most important.

Several species occurring within the study area are most abundant in this community type. These include Pseudotsuga menziesii, Libocedrus decurrens, Corylus cornuta, Vaccinium parvifolium, Symphoricarpos mollis, Polystichum munitum, Synthyris reniformis, Adenocaulon bicolor, Thalictrum occidentale, and Smilacina stellata (Table 5).

Distinguishing characteristics of the Psme/Coco-Symo/Pomu community include the following: 1) the relatively thin overstory tree canopy, 2) the presence of many pole size, young, Pseudotsuga menziesii as well as smaller size classes of other species mixed with very few old-growth trees, evidence of fire history, 3) the high amount of coverage by Corylus cornuta and Symphoricarpos mollis in the shrub layers, and 4) the common occurrence of herbs such as Trientalis latifolia, Synthyris reniformis, Adenocaulon bicolor and Fragaria vesca, which usually occupy more open areas.

The Pseudotsuga menziesii-Libocedrus decurrens/Berberis nervosa-Gaultheria shallon/Linnaea borealis Community. The Psme-Lide/Bene-Gash/Libo community is a fairly widely distributed community type occurring on low to high terraces as well as glacial outwash plains. The community was sampled in 14 stands located within the Blue River, Paradise Campground, Scott Creek, and Boulder Creek regions. Soils are generally of medium depth with well drained, cobbly, sandy loam surface soils overlying coarse sandy subsoils. The terrain occupied by this community is usually level and adjacent to the toeslopes of the adjacent valley slopes. Increment borings indicate that most stands in this community type are between 250 and 450 years old. The stands range from "mature" (225-300 years old) at the Blue River, Scott Creek, and Boulder Creek areas to "old-growth" (350-500 years old) stands at Paradise Campground area. In addition to the difference in the age of the stands, those stands located in the Blue River area have been affected by logging to their immediate south in the past 40 years. Although this disturbance has not noticeably modified the tree layer, it has probably modified the low shrub and herb layers.

The tree canopy of this community is poorly developed in young stands and well developed in older stands where Tsuga heterophylla is common in medium and larger size classes. The canopy is dominated by Pseudotsuga menziesii, Libocedrus decurrens and Thuja plicata in the young stands while Tsuga heterophylla is codominant to dominant in mature stands. Abies grandis and Acer macrophyllum in the smaller size classes are also common within this community.

The shrub layer is dominated by Acer circinatum, Berberis nervosa, and Gaultheria shallon with 19, 22, and 18% cover averages respectively. Corylus cornuta also appears in most stands with an average of 8% cover, and Cornus nuttallii is present in more than half of the stands in this community. In more open areas, Berberis nervosa and Symphoricarpos mollis are generally more common than

Gaultheria shallon and Acer circinatum. This situation is reversed when the density of the canopy increases as it does in more mature stands.

The herb layer of the Psme-Lide/Bene-Gash/Libo community is perhaps its most distinctive layer. It consists of 42 species, 10 of which were found only in this community. Many of the herbaceous species are those more commonly found on the upland regions flanking the study area (Table 6). The herb layer is not truly dominated by any one species. Linnaea borealis is the most abundant in terms of constancy and coverage, occurring in all stands with an average cover of 6%. Other common species include Viola sempervirens, Trientalis latifolia, Anemone deltoidea, Goodyera oblongifolia, Vancouveria hexandra, Pteridium aquilinum, Smilacina stellata, Disporum hookeri , Clintonia uniflora, Pyrola asarifolia, Listera caurina, Trillium ovatum, Chimaphila umbellata, and Chimaphila menziesii.

The moss layer is well developed with Eurhynchium oreganum dominating and Rhytidiadelphus triquetrus and Hylocomium splendens important locally. In the old-growth stands (e.g., Paradise Campground area) this layer is so well developed that any space not occupied by vascular plants is likely to be matted with mosses.

Distinguishing characteristics of this community include: 1) a well developed low shrub layer consisting of Berberis nervosa,

Table 6. Cover and constancy table of the <u>Pseudotsuga menziesii</u>-<u>Libocedrus decurrens</u>/<u>Berberis nervosa</u>-<u>Gaultheria shallon</u>/<u>Linnaea borealis</u> community.*

Layers and species	Stands representative of this community														% Ave. cover	% Constancy
	19	20	21	27	22	23	24	25	26	29	30	31	32	33		
	Cover percentages															
Overstory tree layer																
Pseudotsuga menziesii	55	44	77	61	14	23	82	49	55	60	78	47	58	45	53	100
Thuja plicata	54	31	86	-	33	25	49	55	-	48	50	5	31	16	35	86
Tsuga heterophylla	1	11	1	-	47	72	50	15	10	9	7	-	-	-	16	71
Libocedrus decurrens	13	16	-	7	1	8	-	4	5	-	-	23	31	24	9	71
Abies grandis	2	14	2	1	2	3	1	6	16	-	9	1	1	10	5	93
Acer macrophyllum	4	1	-	11	-	6	-	-	8	2	1	-	1	1	3	64
Tall shrub and small tree layer																
Acer circinatum	11	37	6	45	21	4	17	13	68	-	18	24	1	1	19	92
Cornus nuttallii	9	19	22	2	5	8	11	4	-	-	23	7	-	-	8	71
Corylus cornuta	16	21	1	11	2	6	14	-	3	-	10	8	6	17	8	85
Vaccinum parvifolium	6	11	1	-	-	2	-	1	1	1	-	1	1	4	2	71
Taxus brevifolia	5	8	6	-	2	-	-	1	-	-	-	2	1	1	2	57
Rhamnus purshiana	-	-	-	-	1	1	1	-	1	-	-	1	1	-	T	43
Lonicera ciliosa	-	-	-	1	-	-	-	-	-	-	-	1	1	1	T	28
Osmoronia cerasiformis	-	-	-	1	-	-	-	1	-	-	1	-	-	-	T	21
Castanopsis chrysophylla	-	-	-	1	-	1	-	-	-	-	-	-	-	1	T	21
Vaccinum membranaceum	-	-	-	-	-	-	-	1	1	-	1	-	-	-	T	21
Amelanchier alnifolia	-	1	-	-	-	-	-	-	-	-	-	-	-	-	T	7
Rubus parviflorus	-	-	-	1	-	-	-	-	-	-	-	-	-	-	T	7
Holodiscus discolor	-	-	-	-	-	-	-	-	-	-	1	-	-	-	T	7
Pachystima myrsinites	-	-	-	-	-	-	-	-	-	-	-	-	1	-	T	7
Low shrub layer																
Berberis nervosa	15	21	15	25	2	6	18	11	31	44	28	36	23	23	22	100
Gaultheria shallon	20	27	21	32	3	5	28	23	23	8	11	20	15	21	18	100
Rubus ursinus	1	2	1	7	1	1	7	1	4	2	4	2	1	2	3	100

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Table 6. (Continued)

Layers and species	Stands representative of this community														% Ave.	%
	19	20	21	27	22	23	24	25	26	29	30	31	32	33	cover	Constancy
	Cover percentages															
Symphoricarpos mollis	12	6	3	4	-	1	-	-	1	1	-	1	-	-	2	65
Rosa gymnocarpa	4	2	1	2	1	1	-	1	1	1	-	1	1	4	1	85
Rubus nivalis	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	7
Herb layer																
Linnaea borealis	6	3	4	3	15	9	7	11	2	2	4	5	5	2	6	100
Trientalis latifolia	2	1	3	1	7	1	1	1	1	1	1	1	2	2	2	100
Viola sempervirens	1	1	2	1	3	3	3	1	2	-	2	1	4	2	2	92
Clintonia uniflora	-	-	1	-	9	9	7	1	1	-	-	1	3	1	2	65
Goodyera oblongifolia	1	1	1	-	1	2	1	1	1	1	1	1	1	1	1	92
Anemone deltoidea	1	1	2	1	1	1	-	1	1	-	1	1	1	1	1	85
Vancouveria hexandra	4	5	3	1	1	1	-	-	1	-	1	1	-	1	1	71
Smilacina stellata	1	1	1	-	2	4	1	1	-	1	1	1	-	-	1	71
Trillium ovatum	-	-	-	-	3	1	1	1	1	1	1	1	1	1	1	71
Galium triflorum	2	1	3	-	1	1	1	-	1	1	-	-	-	1	1	65
Disporum hookeri	1	1	1	-	1	1	-	1	1	-	-	1	1	-	1	65
Pyrola asarifolia	-	-	-	1	1	3	1	1	-	-	-	1	1	1	1	57
Listera caurina	-	-	-	1	-	1	1	1	1	-	1	1	-	1	1	57
Pteridium aquilinum	2	1	1	4	-	3	-	1	-	-	-	1	-	1	1	57
Synthyris reniformis	3	4	1	-	1	-	1	1	1	-	-	-	-	-	1	50
Achlys triphylla	-	1	-	1	1	1	-	1	-	1	-	1	-	-	1	50
Anemone lyallii	1	1	-	-	1	1	-	-	-	-	1	-	1	1	1	50
Chimaphila umbellata	-	-	-	-	1	-	-	4	-	-	1	1	2	1	1	43
Asarum caudatum	1	1	-	-	1	3	1	-	-	-	-	-	-	-	1	36
Polystichum munitum	1	1	-	-	7	2	-	-	-	1	-	-	-	-	1	36
Tiarella unifoliata	-	-	-	-	1	4	5	-	-	-	1	-	-	-	1	28
Chimaphila menziesii	-	-	-	-	-	-	1	1	-	1	1	-	1	1	T	43
Galium bifolium	-	1	1	1	1	-	1	-	1	-	-	-	-	-	T	43
Adenocaulon bicolor	1	1	1	-	-	-	-	-	-	-	-	-	1	1	T	36
Pyrola picta	-	-	-	-	-	-	1	1	-	-	-	1	1	1	T	36

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Table 6. (Continued)

Layers and species	Stands representative of this community														% Ave. cover	% Constancy
	19	20	21	27	22	23	24	25	26	29	30	31	32	33		
	Cover percentages															
Lilium columbianum	-	-	-	-	1	-	-	-	-	-	1	1	-	1	T	28
Calypso bulbosa	-	-	-	-	-	-	-	1	1	-	1	1	-	-	T	28
Osmorhiza chilensis	-	1	1	-	-	-	-	-	-	-	1	-	-	-	T	21
Campanula scouleri	-	-	-	-	-	-	-	-	-	1	-	1	-	1	T	21
Coptis laciniata	1	-	1	-	-	-	-	-	-	-	-	-	-	-	T	14
Whipplea modesta	1	1	-	-	-	-	-	-	-	-	-	-	-	-	T	14
Bromus vulgaris	-	-	-	1	-	-	-	-	-	-	-	-	-	-	T	7
Fragaria vesca	-	-	-	1	-	-	-	-	-	-	-	-	-	-	T	7
Viola glabella	-	-	1	-	-	-	-	-	-	-	-	-	-	-	T	7
Hieracium albiflorum	-	-	-	1	-	-	-	-	-	-	-	-	-	-	T	7
Polystichum lonchitis	-	1	-	-	-	-	-	-	-	-	-	-	-	-	T	7
Polypodium glycyrrhiza	-	1	-	-	-	-	-	-	-	-	-	-	-	-	T	7
Oxalis oregana	-	1	-	-	-	-	-	-	-	-	-	-	-	-	T	7
Streptopus amplexifolius	-	1	-	-	-	-	-	-	-	-	-	-	-	-	T	7
Smilacina racemosa	-	-	-	-	-	-	-	-	-	-	-	1	-	-	T	7
Corallorhiza maculata	-	-	-	-	-	-	-	-	-	-	-	-	1	-	T	7
Satureja douglasii	-	-	-	-	-	-	-	-	-	-	-	-	-	1	T	7
Bryophyte layer																
Eurhynchium oreganum	28	25	35	7	15	25	18	49	18	18	24	15	20	13	23	100
Rhytidiadelphus triquetrus	12	15	10	1	21	17	1	4	3	3	8	11	10	7	9	100
Hylocomium splendens	2	9	5	1	27	22	7	3	1	2	8	-	4	1	7	92
Hypnum circinale	2	2	-	-	-	1	1	-	1	-	-	-	-	-	1	36
Isothecium spiculiferum	1	2	-	-	1	-	2	-	1	-	-	-	-	-	1	36
Leucolepis menziesii	-	-	-	-	1	1	1	-	-	-	-	-	-	-	T	21
Dicranum fuscescens	1	1	1	-	1	-	1	-	-	-	-	-	-	-	T	36
Plagiomnium insigne	-	-	-	-	1	-	1	-	-	-	-	-	-	-	T	14

*Average cover percent of less than 1% was given a T (trace). All other figures are averaged to the nearest whole percent.

Gaultheria shallon and some Symphoricarpos mollis; 2) generally low tree growth rates in all size classes of trees; and 3) the presence in the shrub and herb layers of such species as Pachystima myrsinites, Vaccinium membranaceum, Pyrola asarifolia, Pyrola picta, Chimaphila menziesii, Chimaphila umbellata, Lilium columbianum, Calypso bulbosa, and Corallorhiza maculata--all species which do not occur in any other community within the study area.

In addition to the above species, species which show their greatest development within this community of the study area include Thuja plicata, Cornus nuttallii, Berberis nervosa, Gaultheria shallon, Viola sempervirens, Linnaea borealis, Clintonia uniflora, and Trientalis latifolia (Table 6).

Though Libocedrus decurrens does not play a large role in the tree canopy of present stands in this community, it was felt that its presence in earlier seral stages, not studied here, is much more important. It has been included in the community name because it is much more indicative of the warm site that this community is commonly found to occupy, whereas Thuja plicata, which has greater coverage in these stands, is generally more indicative of mesic sites. The fact that Libocedrus decurrens occurs with higher coverage in the Psme/Coco-Symo/Pomu community is only further evidence that that community developed with the intervention of holocaustic fire leaving it wide open to colonization by such species as *Pseudotsuga menziesii* and *Libocedrus decurrens*, which both commonly colonize warm, dry sites in this area.

SIMORD Analysis

The SIMORD two dimensional ordinationsof stands (Figures 4-11) indicate that these groupings remain relatively constant even though different stand characteristics are analyzed for similarity. Figure 4 is based on shrub and herb coverage data of 50 species (Appendix 3) picked from the total of 105 shrubs and herbs. The ordination in this figure is based on computer picked endstands. The 50 species that were used in the ordination analysis were chosen because they were most effective in separating groupings of stands in the manual-visual association table. They include only species which occurred with between 80% and 5% constancy within the study area. Some species were further eliminated, in order to meet the capacity of the computer, by subjectively eliminating those that either occurred with low cover or those that were dispersed over the range of community types delimited by higher fidelity species. The stands of the *Alru*-*Abgr*/*Rilo*-*Acci*/*Mosi*-*Pomu* community and the *Tshe*/*Acci*/*Pomu*-*Oxor* community are widely distributed over the ordination plane. This is probably due to the fact that both of these communities are composed of a wide variety of ages of stands or seral stages.

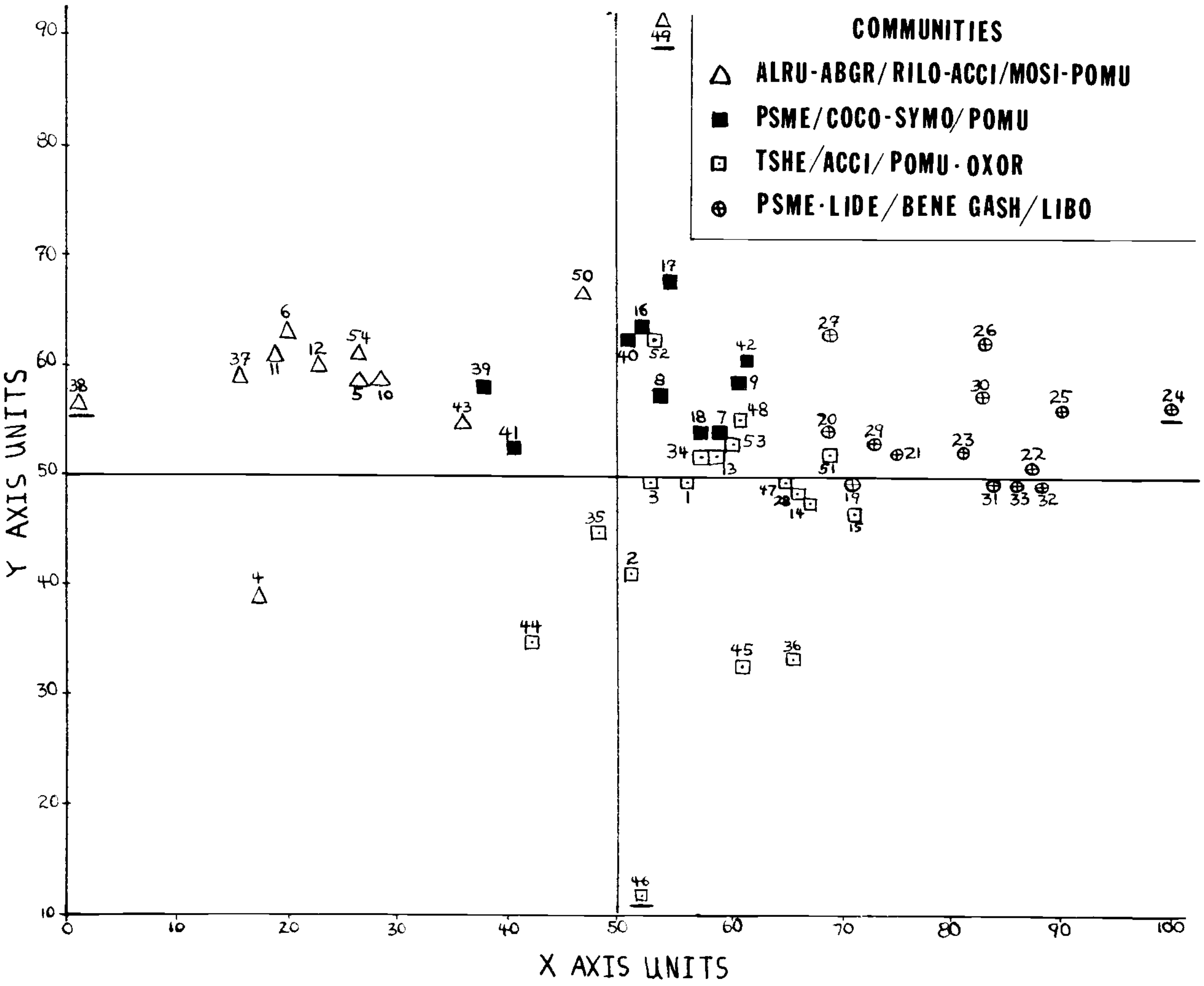

Figure 4. Similarity ordination of stands based on cover percentages of the 50 shrub and herb species with the most indicator significance and end-stands (underscored) picked by computer for both X and Y axes.

Figure 5 is based on the same species as above, but the X and Y axis endstands were subjectively picked in order to better group the stands. X axis endstands were altered by replacing endstand 38 with 37 and leaving stand 24 on the right side of the X axis. The Y axis endstands were changed from plots 46 and 49 (lower and upper) to plots 2 and 8, respectively. Endstands were picked on the basis of my own field observations of the stands grouped in the middle of the X axis. This was done because computer picking of endstands often results in the selection of highly unusual or unique stands. Thus the remainder of the stands tend to cluster in the center of the ordination plane, all being very dissimilar to the unique stands selected as end-stands.

In picking the original 50 species, all of the species in the initial manual-visual table were reviewed from the top to the bottom, subjectively picking those which were felt to have the greatest indicator significance in identifying community groupings. This procedure was followed until the first three communities identified in original association tables were well represented in terms of individual community indicator species in the list. During SIMORD analysis of data, however, actual cover values for the species were analyzed and the result was the ordination of stands into four groupings. The fact that the groups or clusters of stands are separated from each other to some degree yet composed of stands with similar ordination distance

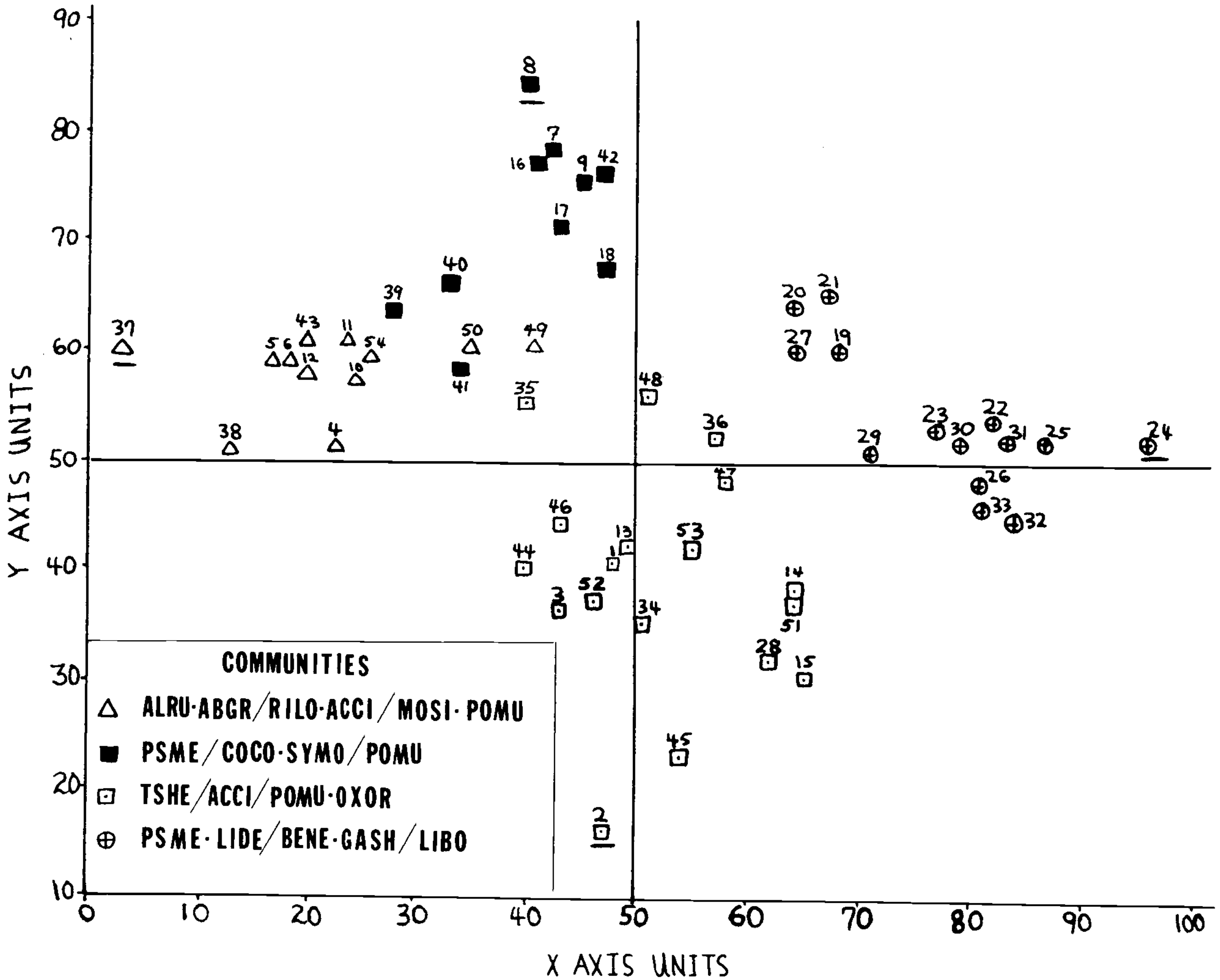

Figure 5. Similarity ordination of stands based on cover percentages of the 50 shrub and herb species with the most indicator significance and end-stands (underscored) picked subjectively for X and Y axes.

indicates that the species chosen were valid indicators of the communities. Even though no particular subjective effort was made to pick indicator species representative of the Tshe/Acci/Pomu-Oxor community, this community still appears to be composed of stands with comparable ordination distances.

Figure 6 is based on ordination of cover values of 50 of the remaining 55 species of ubiquitous, rare, or subjectively eliminated herbs and shrubs, which had been left out of previous ordination analyses. The endstands remained the same as those in Figure 5. Due to the high amounts of coverage in most stands of most ubiquitous species and low amounts of coverage for rare species, stands tend to be grouped together in the middle of the X and Y axes. The comparison of species within plots by SIMORD is only completed for those species satisfying an inequality programmed by the user. With the inequality of 1% used here, a given species is compared in any two stands only if it occurs at least 1% of the time in at least one of the stands. Using this formula with a 1% inequality limitation, and having assigned 1% values for trace amount occurrence of species in stands causes a much higher degree of similarity based on rare species. Similarly, the relatively high coverage of most of the ubiquitous species, regardless of which community they occurred in, results in high similarity based on those characteristics. The net result is a clustering of all stands in the centers of the X and Y axes. It should

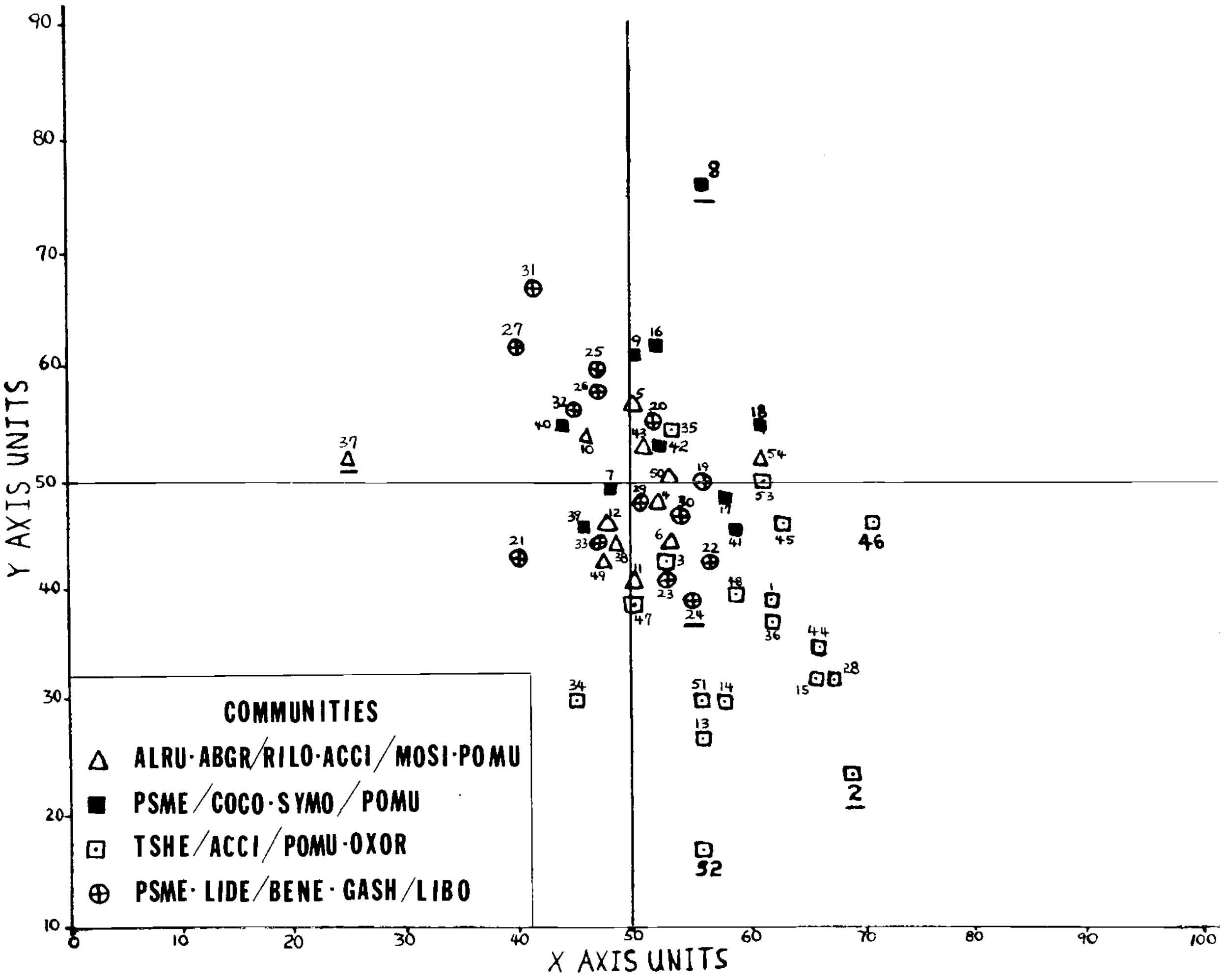

Figure 6. Similarity ordination of stands based on cover percentages of 50 ubiquitous, rare, or subjectively eliminated species of shrubs and herbs and endstands (underscored) from ordination Figure 5.

be pointed out that this in turn indicates that the original choice of species was, indeed, a valid choice showing greater indicator significance. It should also be noted that the ordination of stands based on the ubiquitous, rare and subjectively eliminated species resulted in the open cluster of the Tshe/Acci/Pomu-Oxor community stands. This is once again the result of having originally picked species from the manual-visual tables until the first 50 species were taken. In effect, the above method tended to eliminate many of the best indicator species of the fourth community (Tshe/Acci/Pomu-Oxor). These species were then virtually all included in the analysis portrayed in ordination Figure 6, resulting in distribution of stands in this community that is similar to that seen in Figure 5.

Figures 7 and 8 are based on ordination of frequency classes of the 50 species having greatest information value and on the 50 ubiquitous, rare and subjectively eliminated species of shrubs and herbs respectively. The ordination seen in Figure 7 is similar to that in Figure 5 with the exception that the communities are more tightly clustered in Figure 7. This is probably the result of using frequency classes rather than actual frequency percentages in the analysis. Figure 8, based on frequency of ubiquitous, rare and subjectively eliminated species, indicates a much greater degree of similarity among stands with almost complete overlap of communities. This ordination based on species with little indicator significance further

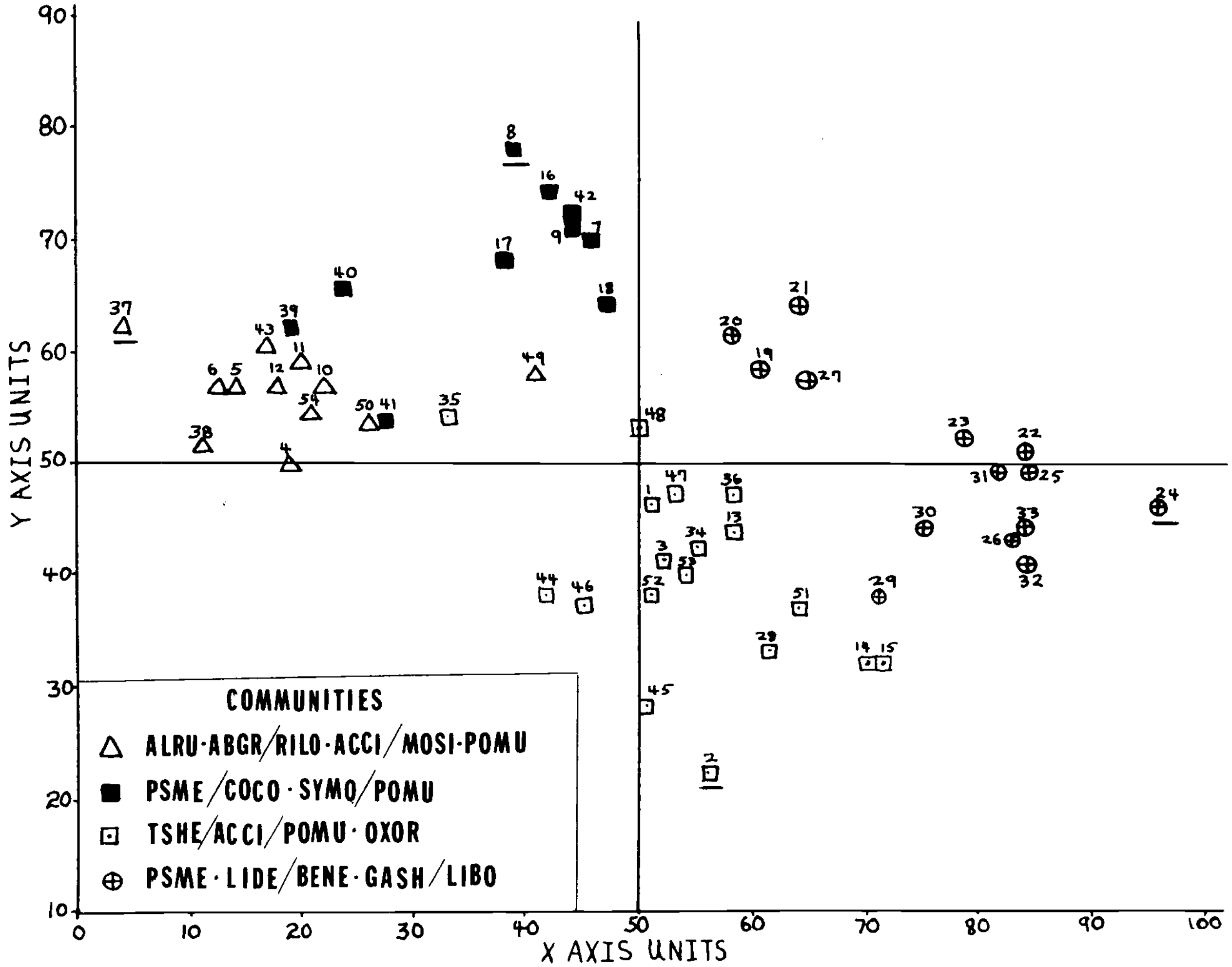

Figure 7. Similarity ordination of stands based on frequency classes of the 50 species of shrubs and herbs with the most indicator significance and endstands from ordination shown in Figure 5 (endstands underscored).

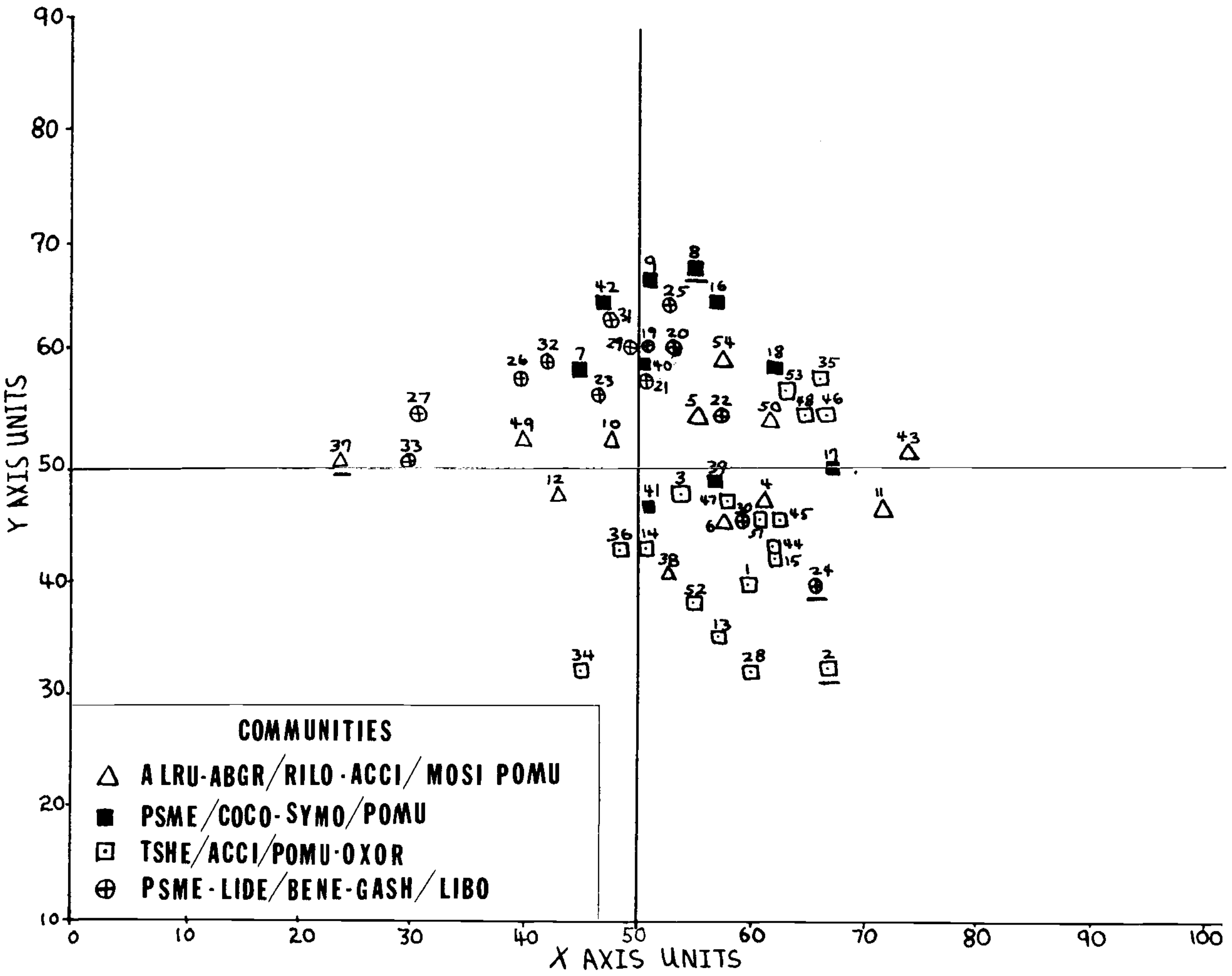

Figure 8. Similarity ordination of stands based on frequency classes of 50 ubiquitous, rare, or subjectively eliminated species of shrubs and herbs and endstands (underscored) used in ordination Figure 5.

indicates that the choice of the original 50 species for ordination analysis was valid. The communities in Figure 8 are located much closer to the centers of the X and Y axes than those in Figure 6. Once again, this is probably due to the use of frequency classes rather than actual frequency percentages. Endstands for Figures 7 and 8 are the same as those in Figure 5.

Figures 9 and 10 are based on similarity indices derived from analysis of 40 tree characteristics. Figure 9 endstands are the same as in Figure 5, and those for Figure 10 are computer picked endstands based solely on the tree characteristics. These characteristics include density of ten species of trees with four size classes for each species. Each size class of each species was then treated as a single input in the ordination analysis. Similarity indices obtained for stands were used to ordinate stands on the X and Y axes. Due to the presence of many seral stages within some communities, the stands were widely distributed in both Figures 9 and 10, thus there is much overlap of community types. This is to be expected since the homogeneity of the forest canopy is much greater than that of the understory. This possibly indicates a difference in responsiveness of the tree layer, as opposed to the herb or shrub layers, to microenvironmental changes at a given site. Figure 10, based on computer picked endstands, emphasizes the overlap of communities to even a greater degree.

The Alru-Abgr/Rilo-Acci/Mosi-Pomu community, being the

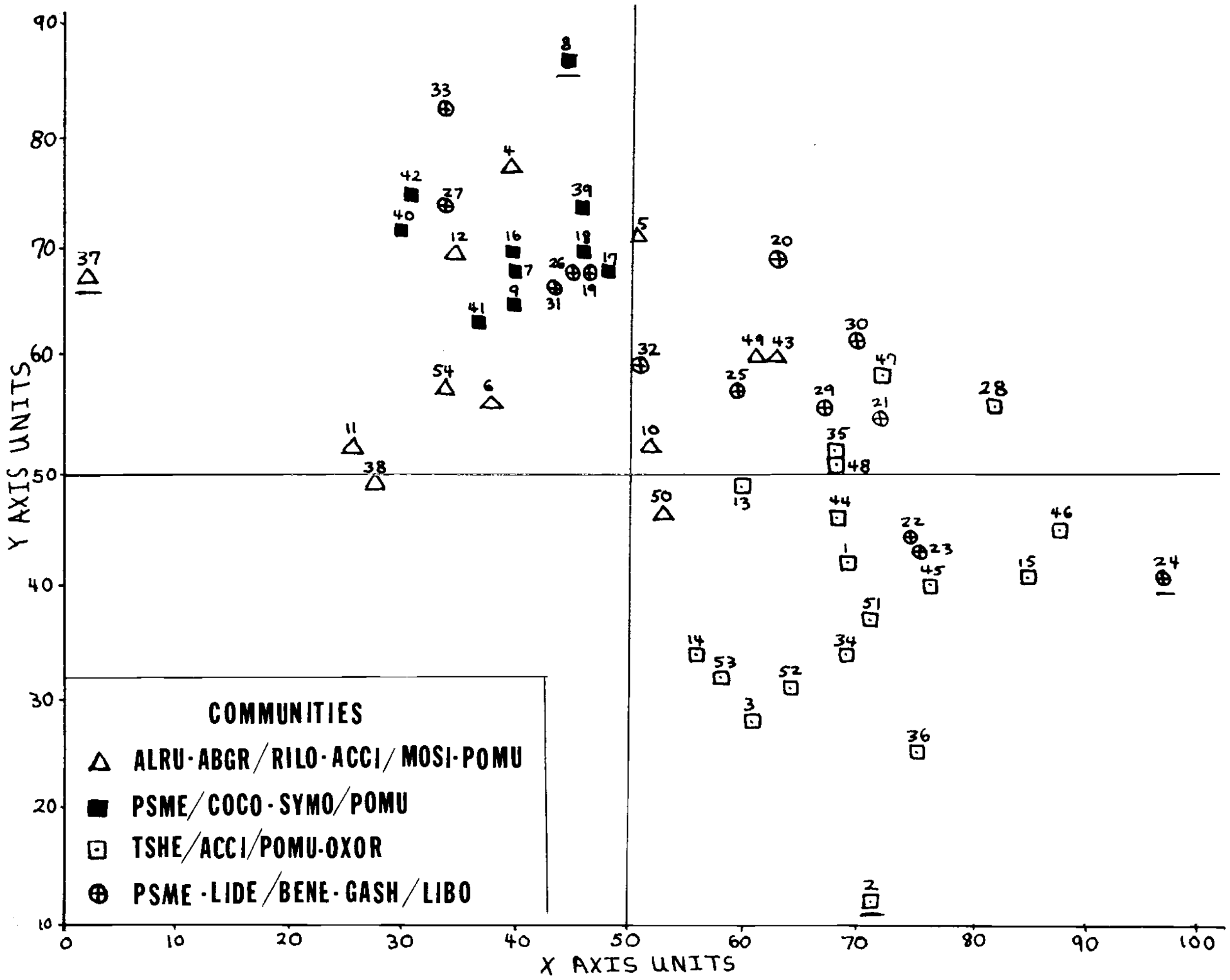

Figure 9. Similarity ordination of stands based on 40 tree characteristics using endstands (underscored) derived from shrub-herb ordination, Figure 5.

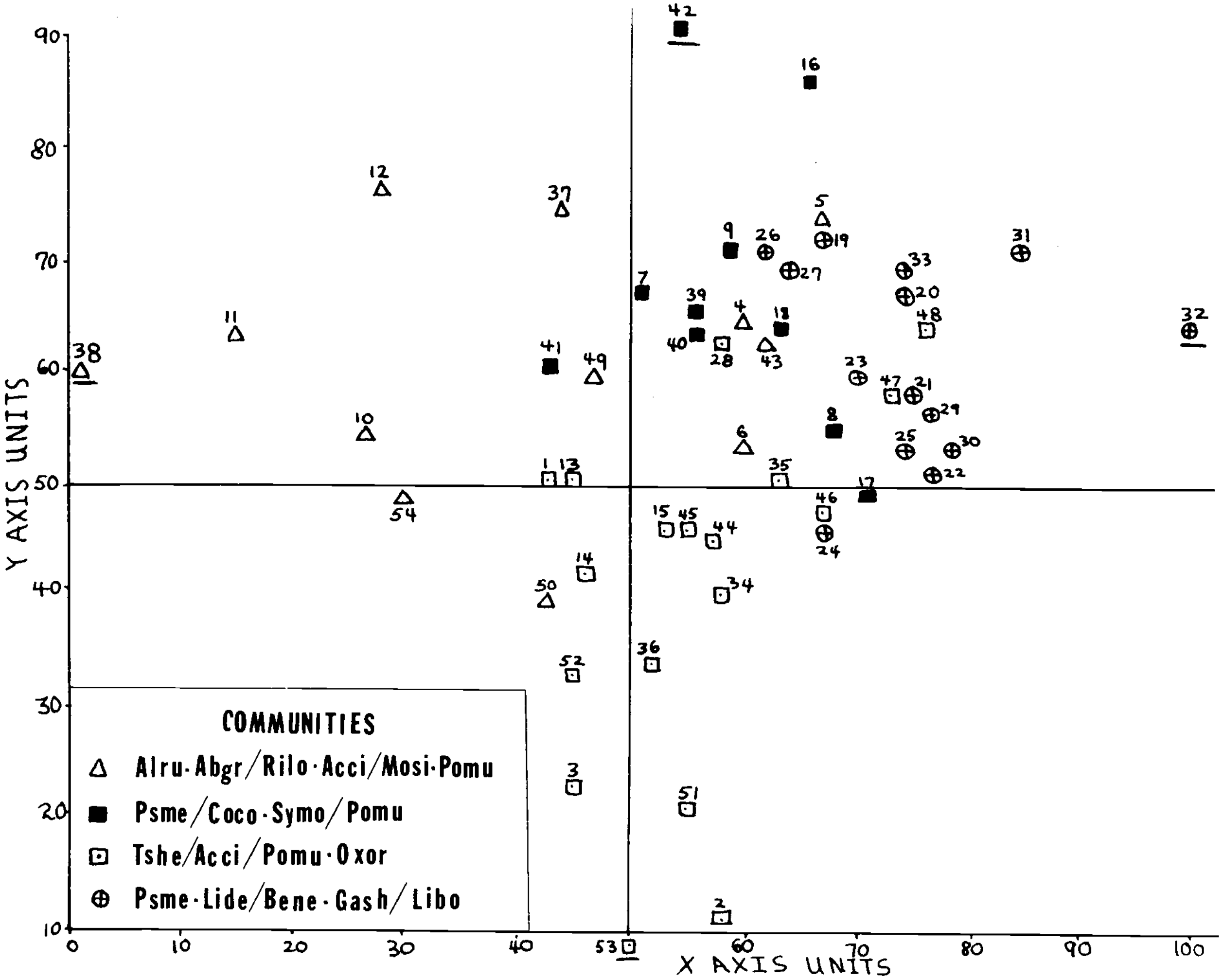

Figure 10. Similarity ordination of stands based on 40 tree characteristics and endstands (underscored) picked by the computer.

most diverse in terms of the seral stages included within one community, has stands distributed over two-thirds of the length of the X axis. The Tshe/Acci/Pomu-Oxor community has stands distributed over two-thirds of the length of the Y axis. The latter community also includes a wide variety of stands with relatively constant species composition, but having substantial stand to stand variation in species importance. The Psme/Coco-Symo/Pomu and the Psme-Lide/Bene-Gash/Libo community types are both composed of stands with a higher degree of similarity, thus they remain fairly well clustered in the ordination plane in Figure 10.

In the ordination shown in Figure 11 it was assumed that the mosses would respond quite well to the light and moisture regime resulting from differences in the tree coverage. Since the SIMORD program can compare up to 50 stand characteristics, the eight moss species were included in ordination analysis with the 40 tree characteristics used in Figures 9 and 10. Cover classes for the moss species were used in order to maintain the same order of magnitude used in tree size class density notation. The distribution of stands in this ordination is very little changed from that seen in Figure 10 except that all stands are closer to the center of the X and the Y axes. This indicates that the response of the mosses to the coverage of trees is as expected since the addition of moss data to the tree data in analysis had the same effect as weighting the data. Weighting data in ordination

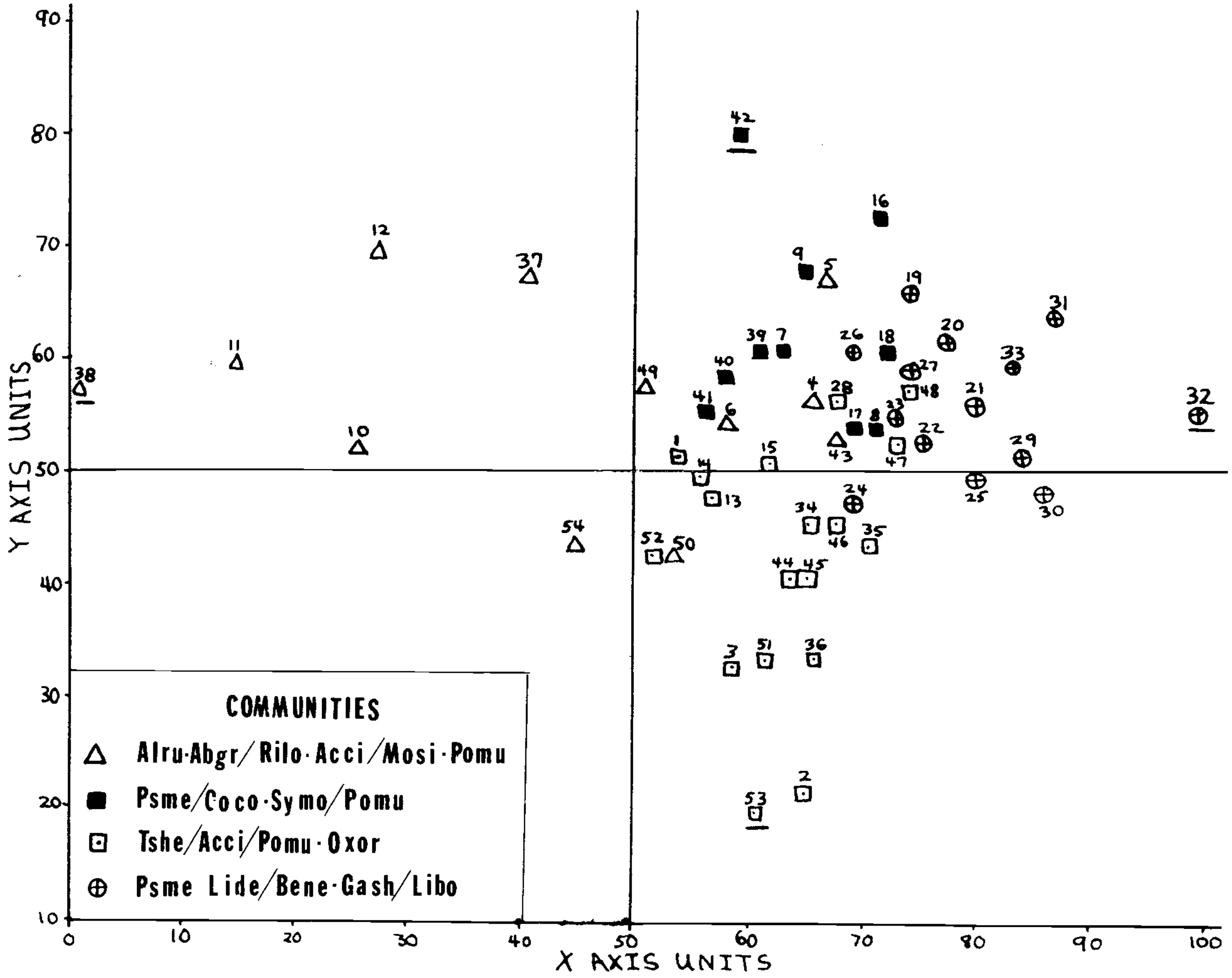

Figure 11. Similarity ordination of stands based on combined analysis of 40 tree characteristics and eight moss characteristics using the same end-stands (underscored) as those used in ordination Figure 10.

analysis causes a grouping of the stands into tighter clusters. The more similar the stands, the tighter will be the cluster.

Though the clusters shift from place to place on the ordination planes seen in Figures 4 through 11, they change internally very little whether based on frequency, cover values, trees, shrubs and herbs combined, or trees and mosses combined, as long as the same group of species is being analysed. Using computer picked endstands results in ordination of stands high in similarity of component floristic characteristics. Subjective picking of endstands spreads the communities apart for ease of visual differentiation, but does not markedly alter the distribution of the stands within the community in relation to each other. In all cases, when stands of a single community type are widely distributed in ordination, the distribution can be explained by the variety of seral stages included within the community.

Soils

Introduction

A discussion of the soils occurring on floodplains, terraces, and glacial outwash plains within the study area is not complete without some explanation of the physical factors involved in the formation of these landforms. Many of the present day landforms were derived from widespread para- and post-Pleistocene alluvial deposits. These outwash deposits have been altered by erosion due to extensive flooding. Flooding has been the result of glacier melting or of annual overflow of streams due to precipitation or snow melt. This has resulted in the formation of a complex series of water-cut or water-laid terraces. However, some of the glacial outwash plains were not removed entirely. Where they still exist, the soil profile commonly contains rounded and subrounded gravels, cobbles, and stones dispersed throughout the profile. There are generally higher percentages of coarser fragments in the deeper horizons, but some profiles have larger stones even in the upper horizons. Other outwash plains have been modified to terraces by continued erosion. Most soils of the resultant terraces show a greater degree of layering of depositional size classes. It is not uncommon for these terraces to consist of more than one sequence of graded strata. In instances where soil formation has been sufficient in the lower sequences of strata during the interim between major depositions, these sequences constitute buried profiles. In areas where flooding has removed the finer textured, upper horizons of previous profiles prior to redeposition of a second graded series, soil profile interpretation may be very difficult.

As the McKenzie River cut into these outwash materials, finer textured fractions of the surface soils were transported further downstream, and some were redeposited on floodplains or terraces. The coarser materials accumulated in the river channel. Periods of flooding often resulted in substantial changes in the river channel.

Floodwaters also removed large quantities of topsoil as well as coarser deposits from areas adjacent to the main channel. If enough of this material was removed, a new channel began to carry the major volume of the river, leaving the old channel bottom exposed and elevated above the new channel water level after recession of flood water. During subsequent periods of flooding, sand, silt, and some clay size particles, as well as gravel, were deposited over the exposed stones and cobbles of the old channel. In Orloci's work in British Columbia he concluded:

> While the meander cuts away the bank where the turbulence of water is greatest, it deposits sediments along the opposite bank where turbulence is least. This causes migration of the meander and builds up a new terrain that is open to plant colonization. Additional deposits of sediments will raise the surface of the terrain above a critical level suitable to plant colonization (Orloci, 1965, p. 29).

Floodplains are created in this way, and annual increments of sand, silt and clay transform them into terraces by elevating them above the normal flood levels. Higher terraces were undoubtedly created by a combination of sequence depositions and down-cutting of the McKenzie River.

Rates of soil development are often slow in raw, coarse, alluvial deposits such as those found on young floodplains. However, establishment of vegetation substantially increases the rate of soil formation by the addition of organic matter to the parent material. Also vegetation increases the rate of soil accumulation by reducing erosion through the establishment of extensive root systems in the upper soil horizons.

The process of floodplain transition to terrace may take many decades in cases where streamflow and flood pattern result in only slight, if any, annual deposition of new material. In other cases the transition may occur rapidly. An example of the development of a floodplain is seen in the Blue River region of the study area. Stands 37 and 38 occur on soil that consists of up to four buried profiles. The surface layer of each buried, graded sequence within the profile still contains partially decomposed wood and root mases, as well as substantially larger amounts of finer soil fractions than do the immediately adjacent overlying strata. The presence of large amounts of silt and clay in strata far from the surface of the present profile indicates that deposition of overlying graded series probably occurred over a short period of time and by relatively rapidly moving water. Continued flooding over longer periods by rapidly moving water would surely remove finer textured surface strata prior to deposition of new materials. On the other hand, had the water been slow moving water, the sediments deposited would probably not include the extensive amounts of coarse sand included in the graded sequence occurring between 138 cm and 68 cm in the present profile of soil in stand 38.

Researchers studying other floodplains have noted similar patterns of development by means of the deposition of graded series over existing profiles. Shelford (1954), in his study of the Mississippi River floodplains near Tiptonville, Tennessee, found that the period of flooding and the swiftness of the current determined the size class distribution of sediments deposited. He reports that as much as 2 feet (61 cm) or more of sand was deposited during one flood period, and further states that siltation over the sands will occur in future flooding if the sand is not removed initially in these subsequent floods. Floodplain buildup on the Mississippi is much more marked than that which occurs on the McKenzie River within the study area. Ten to 20 feet of sand will normally be deposited before the cottonwood (Populus deltoidea) communities begin to replace the willow phase (Shelford, 1954).

In his studies of the soils of the Coastal Western Hemlock Zone in the Coast Range of British Columbia, Lesko (1961) found that floodplain communities are annually flooded and that the texture of the sedimentary material deposited each year becomes finer after the establishment of vegetation. He also states that the development of soils on floodplains begins only after the vegetation has developed to a point that the soils can retain the organic material through periods of flooding. A further note on the transition of floodplains to terraces is quoted; the Elymus glaucus phase of the floodplain community

> . . . never reaches the maturity of the forest stand, because within one or two decades the soil surface is elevated sufficiently and enriched by organic material to give place

to the formation of different shrub, herb and moss layers (Lesko, 1961, p. 14).

The vegetation can be used as an indicator of the approximate age of the last deposition of sediments. On the floodplain sampled by stands 37 and 38 the vegetation belongs to the Alru-Abgr/Rilo-Acci/Mosi-Pomu community and is in the late part of the Alnus rubra phase of this community. The trees are mostly 30-50 years old Alnus rubra and 50-70 years old Populus trichocarpa, both being replaced by 30-60 years old Pseudotsuga menziesii and Libocedrus decurrens. The presence of the latter two species indicates that flooding is not as much a part of the annual chain of events occurring on this floodplain as it is in lower floodplain areas. All indications are that the last substantial deposit (42 cm) was probably laid down within the last century.

In some areas, shifting of channels has changed the landform status by altering the regularity or pattern of flooding. For example, stands 43 and 49 are located on floodplains reclaimed from low terraces as a result of channel shifting, flooding, and deposition of new surface layers. These stands are placed in the Alru-Abgr/Rilo-Acci/Mosi-Pomu community, Pseudotsuga menziesii phase, primarily on the basis of results of similarity ordination of stands using coverage of herbaceous and shrub species. Analysis revealed that many of the understory plant species included in stands 43 and 49 were those apparently well-adapted to the edaphic conditions normally found on floodplains. The altered flooding status of the reclaimed terraces on which stands 43 and 49 occurred resulted in increased deposition of sandy strata over the loam surface horizons of pre-existing soil profiles. This sandy surface material is suitable for the development of many early seral floodplain species. The fact that these two stands were previously members of the Psme/Coco-Symo/Pomu community type or the Tshe/Acci/Pomu-Oxor community type, which both commonly occur on soils with finer surface soil textural classes, is indicated by the position of these two stands in an ordination based on the characteristics of the slower reacting tree layer of the stands (Figure 10).

In areas where streamflow volume was great during post-Pleistocene flooding, deep deposits of gravel and finer soil fractions accumulated. An example of this is found in the Delta region of the study area, at the confluence of the McKenzie and the South Fork McKenzie Rivers. In the central, most elevated, portion of this area soils are deep and usually show one or more buried profiles, each with marked textural changes from adjacent profiles or graded sequences. Most of these soils are located on high and medium terraces. Low terraces and some lower level, medium terraces commonly have shallower soils, although a few are over 150 cm to stones and cobbles. Parent materials in all cases include weathered alluvium from basaltic and andesitic materials originating in upland regions. In the McKenzie River drainage system, most of these materials are probably derived from rocks belonging to the Sardine Formation and the Little Butte Volcanics.

A discussion of soil characteristics and how they interact with plant community distribution will follow in the next section. Here, soil characteristics will be discussed in relation to the landforms on which they occur. In this discussion the use of the previously defined elevational limits of alluvial landforms will be followed. Of the 54 sampled stands, four occurred on low floodplains, 4 feet (1.2 m) or less above mid-summer normal water level; eight occurred on high floodplains, 4 to 8 feet (1.2-2.4 m) above water level; six occurred on low terraces, 5 to 8 feet (1.5-2.4 m) above water level; 24 occurred on medium terraces 8 to 15 feet (2.4-4.6 m) above water level; six occurred on high terraces, greater than 15 feet (4.6 m) above the water level; and six occurred on glacial outwash plains, which, within the study area, were between 20 and 25 feet (6.1-7.5 m) above the water level.

The overlap of the height of high floodplain and low terrace classes is explained by the fact that at higher elevations (upstream) flooding does not seem to be as common nor as long in duration as it is in the lower elevation (downstream) portions of the study area. This is the result of several factors including depth of stream, gradient of the stream, amount of precipitation occurring in the higher elevation areas, and the distribution of that precipitation after interception by upland regions. Thus higher elevation terraces, in the upstream portion of the study area, are lower with relation to water level than are terraces in the downstream portions of the study area. All of the stands that have been designated as low terrace stands occur at the Boulder Creek locality which is the highest elevation area included in the study.

Low Floodplains

Low floodplains occur as restricted, water-laid deposits lying adjacent to major streams. These deposits are often separated from adjacent low to medium terraces by one or more subsidiary channels that branch from the main waterway at the upstream end of the floodplain island and then converge with that same waterway at some point downstream. Low floodplains may also occur as small lenses of material, too small to have been sampled in this study, adjacent to the McKenzie River or any of its tributaries. These low floodplains characteristically slope away from the main channel with a gradient of about 1^{o}.

Redeposition of additional sediments is a common occurrence on low floodplains. Floodplains commonly begin as abandoned channels or as stream deposits of larger fragments, stones and cobbles, usually on the inside of major bends in the river. Development of these low floodplains is concurrent with the development of a series of early pioneer vegetation types listed earlier and including Salix, Alnus rubra, and Abies grandis phases. Each of these phases is discussed later with a more complete description of the soil characteristics.

Soil profiles occurring on low floodplains characteristically show very little, if any, development (Appendix 5). Horizons are usually distinguished solely on the basis of textural changes within the profile. Soil profiles usually exhibit one or more buried, graded sequences consisting of A, AC, and C horizons. These soils are typically dark gray when dry and black when wet. The fine fraction of all horizons sampled on low floodplains was composed of greater than 90% sand, and clay content was generally higher than silt content. This is due to the clay particles adhering to the sand grains. The clay is separated from the sand grains during preparation of the soils for textural analysis, but is not normally removed by water movement within the soil.

Soils occurring on low floodplains are usually less than 1 m deep and overlie unweathered cobbles and stones. Rooting is common in the upper horizons, and root lines are commonly present where buried profiles previously supported trees. These root masses may indicate the level of pre-existant profile surfaces as they do in the profile of stand 11 (Appendix 5).

Soil reaction of low floodplain surface horizons ranges from extremely acid (pH 3.9) to very strongly acid (pH 4.9). This is probably due to leaching of soluble bases in these excessivly drained, sandy soils.

Classification of these soils has been ignored in the past because of their small extent and limited economic importance. They should be included in the order Entisols, the azonal soils of previous classification systems. Entisols are mineral soils that have little or no genetic horizon formation. These low floodplain soils are further classified to the suborder Fluvents, a suborder containing brownish to reddish soils that are subject to flooding but are well drained and lack the mottling that occurs in the suborder Aquents.

High Floodplains

High floodplains generally occur adjacent to or as elevated extensions of low floodplains in close proximity to major waterways. These floodplains still receive annual flooding and generally receive additional sediment during more intensive flooding periods. Subsidiary channels are common in this landform much the same as in low floodplain areas. There may also be high water channels that dry up after spring floods. These channels are smaller than subsidiary channels and modify the surfaces of high floodplains by increasing variability of the microhabitats available for plant invasion.

High floodplains are the product of continued buildup through time or the downcutting of the adjacent river, and in most cases they show an increase in finer fractions in more recent deposits. This is probably due to the fact that as floodplains are elevated, floodwaters pass over them more slowly, and are thus less capable of maintaining particles in suspension than are the deeper, more rapid waters which swirl over lower floodplains. Often the development of plant communities on high floodplains will cause floodwater to deposit greater quantities of fine sediments by slowing the velocity of the water and creating eddies.

Like low floodplains, high floodplains are not extensive within the study area, occurring usually in a narrow band parallel to the McKenzie River. Vegetation is that of the Abies grandis and the Pseudotsuga menziesii phases of the Alru-Abgr/Rilo-Acci/Mosi-Pomu community.

This landform has been sampled by eight stands. The soil characteristics are represented by those listed for stands 5 and 38 (Table 7 and Appendix 5). Soil profiles in older, high floodplains, represented by stand 5, show considerably more development than those in low floodplains or less elevated high floodplains, stand 38. The textures of soil horizons on the floodplain at stand 38 are somewhat less sandy than those on lower floodplains. The decrease in the amount of sand in high floodplain soils is nearly equal to the increase

Table 7. Soil characteristics of representative stands in the study area.

Stand no. and landform*	Horizon designation	Depth (cm)	% by Volume of coarse fragments		% by Weight of gravels	% by Weight of fraction less than 2 mm diameter			Texture	pH
			stones[1]	cobbles[2]	gravels[3]	sand[4]	silt[5]	clay[6]		
<u>Tshe</u>/<u>Acci</u>/<u>Pomu</u>-<u>Oxor</u> community										
34	A	0-20			15	52.0	43.8	4.2	sandy loam	5.81
	B2	20-40			18	47.9	46.9	5.2	sandy loam	6.02
HT	C1	40-50			55	93.5	3.7	2.8	gravelly sand	6.05
	C2	50-72			10.	91.5	4.7	3.8	sand	5.74
	C3	72-90		30	55	97.2	.6	2.2	cobbly sand	5.87
48	A1	0-19				38.7	42.6	18.8	loam	6.13
	A3	19-35				49.0	38.2	12.8	loam	5.81
MT	B2	35-59				46.7	38.5	14.8	loam	5.63
	C	59-78				86.6	8.6	4.8	loamy sand	5.73
	IIB2	78-95				42.9	42.0	15.0	loam	5.92
	IIC	95-128				81.7	14.5	3.9	loamy sand	5.73
46	A1	0-11				14.7	68.7	16.7	silt loam	6.05
	A3	11-30				16.1	61.6	22.3	silt loam	5.75
HT	B21	30-52				33.1	45.7	21.3	loam	5.83
	B22	52-73				41.3	37.5	21.1	loam	5.87
	B23	73-95				58.7	28.2	13.0	sandy loam	5.75
	C	95-150		15		64.3	23.3	12.5	cobbly, loamy sand	5.83
<u>Alru</u>-<u>Abgr</u>/<u>Rilo</u>-<u>Acci</u>/<u>Mosi</u>-<u>Pomu</u> community										
11	A	0-20			75	93.7	1.5	4.9	gravelly sand	4.95
	C	20-50			55	93.7	4.3	2.0	gravelly sand	5.10
LF	IIAC	50-65		10	70	91.8	3.3	4.8	gravelly sand	5.05
	IIC	65-75		18	53	96.3	.9	2.8	gravelly sand	4.85
	IIIAC	75-90		45	30	91.6	3.7	4.7	cobbly sand	5.12

(Continued on next page)

Table 7. (Continued)

Stand no. and landform*	Horizon designation	Depth (cm)	% by Volume of coarse fragments		% by Weight of gravels	% by Weight of fraction less than 2 mm diameter			Texture	pH
			stones[1]	cobbles[2]	gravels[3]	sand[4]	silt[5]	clay[6]		
Alru-Abgr/Rilo-Acci/Mosi-Pomu community (continued)										
5	A1	0-12				59.0	34.8	6.2	sandy loam	6.06
	AB	12-22				52.0	41.8	6.1	sandy loam	5.83
	B2	22-47				67.4	26.5	6.1	sandy loam	5.83
HF	C1	47-65				79.1	16.7	4.2	loamy sand	5.75
	C2	65-90				84.0	11.0	4.1	loamy sand	6.39
	IIAC	90-128				50.2	42.1	7.6	loam	5.75
	IIC	128-160		33	25	76.8	17.4	5.8	cobbly, loamy sand	5.81
38	A	0-20				86.8	9.4	3.8	loamy sand	5.67
	C	20-42				94.4	3.4	2.3	sand	5.58
	IIAC	42-53				77.1	15.3	7.6	sandy loam	5.74
	IIC	53-70				94.4	2.4	3.2	sand	4.80
HF	IIIA	70-81				84.0	10.4	5.6	loamy sand	5.77
	IIIAC	81-93				86.6	9.5	3.8	loamy sand	5.82
	IIIC	93-138				84.1	9.1	6.8	loamy sand	5.75
	IVAC	138-165				71.0	21.3	7.7	sandy loam	5.73
	IVC	165-200				93.4	2.8	3.8	sand	5.72
Psme/Coco-Symo/Pomu community										
8	A	0-15				69.4	22.9	7.7	sandy loam	6.22
MT	B2	15-33				67.4	24.6	8.0	sandy loam	6.16
	C1	33-80			10	75.4	18.5	6.0	loamy sand	6.06
	C2	80-90			52	90.6	5.3	4.1	gravelly sand	5.93

(Continued on next page)

Table 7. (Continued)

Stand no. and landform*	Horizon designation	Depth (cm)	% by Volume of coarse fragments		% by Weight of gravels	% by Weight of fraction less than 2 mm diameter			Texture	pH
			stones[1]	cobbles[2]	gravels[3]	sand[4]	silt[5]	clay[6]		
Psme/Coco-Symo/Pomu community (continued)										
17	A	0-13				30.9	60.8	8.3	silt loam	6.00
	C	13-39				69.4	24.6	5.2	sandy loam	6.10
MT	IIB2	39-66				54.1	40.7	5.2	sandy loam	6.30
	IIC1	66-80			16	77.3	20.8	2.3	loamy sand	6.16
	IIC2	80-110			61	96.3	1.5	2.2	gravelly sand	5.43
40	A	0-12				43.3	46.1	10.6	loam	5.98
	B2	12-28				69.4	25.8	4.8	sandy loam	6.06
	IIA1	28-48				45.7	42.7	11.6	loam	5.92
MT	IIB2	48-68			22	48.3	44.1	7.7	gravelly loam	5.94
	IIB3	68-81				71.8	21.4	6.8	sandy loam	5.93
	IIC	81-110	3	20	66	95.3	.6	4.1	gravelly sand	5.30
Psme-Lide/Bene-Gash/Libo community										
33	A	0-12	10	15	9	68.6	27.1	4.3	cobbly, sandy loam	5.37
	AC	12-34	12	10	6	81.3	15.9	2.8	cobbly, loamy sand	5.71
LT										
	C1	34-74	30	20	2	78.6	19.1	2.3	cobbly, loamy sand	5.59
	C2	74-110	35	10	50	96.3	.6	3.2	cobbly sand	4.73
24	A	0-10	1	3	22	42.1	48.8	9.1	gravelly loam	5.73
	C	10-33	3	10	15	74.5	21.6	3.9	gravelly, sandy loam	5.82
MT	IIB2	33-53	3	12	25	64.3	24.9	10.9	gravelly, sandy loam	5.94

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Table 7. (Continued)

Stand no. and landform*	Horizon designation	Depth (cm)	% by Volume of coarse fragments		% by Weight of gravels	% by Weight of fraction less than 2 mm diameter			Texture	pH
			stones[1]	cobbles[2]	gravels[3]	sand[4]	silt[5]	clay[6]		
<u>Psme</u>-<u>Lide</u>/<u>Bene</u>-<u>Gash</u>/<u>Libo</u> community (continued)										
	IIC1	53-90	4	20	21	80.6	17.5	1.9	cobbly, loamy sand	5.93
	IIC2	90-105	10	15	66	93.4	3.4	3.2	cobbly sand	4.50
19	A	0-15		8	12	39.4	48.7	11.9	loam	5.99
	B2	15-31	2	10	21	63.0	33.1	3.9	gravelly, sandy loam	6.11
GO	C1	31-63	4	14	17	69.3	26.9	3.9	cobbly, sandy loam	6.00
	C2	61-100	20	10	16	73.2	23.9	2.9	cobbly, loamy sand	5.62

*Landform types: HT = high terrace; MT = medium terrace; LF = low floodplain; HF = high floodplain; LT = low terrace; GO = glacial outwash plain.

[1] greater than 25 cm in diameter

[2] 7.5 cm to 25 cm in diameter

[3] 2 mm to 7.5 cm in diameter

[4] .05 mm to 2 mm in diameter

[5] .002 to .05 mm in diameter

[6] less than .002 mm in diameter

in silt, while clay content stays about the same. Textures of horizons located in stand 5 are much finer. This is probably the result of the manner of deposition and the elevation of the pre-existing floodplain at the time of more recent depositions. The high floodplain that supports stands 4 through 6 is located in a large bend in the McKenzie River, and appears to have been built up over a long period of time. This is evident from the development of the vegetation occurring there which is transitional between the Abies grandis phase and the Pseudotsuga menziesii phase of the floodplain community type. Floods that deposit coarse to fine sands on the low floodplains are depositing sediments containing approximately 60% sand, 35% silt and 5% clay on the high floodplains (soil profile 5, Table 7). Soils that were sampled showed sandy and loamy sand surfaces over coarse sand in lower level, high floodplains; and sandy loam over loam and loamy sand in higher level, high floodplains. Soils occurring on high floodplains are typically moderately deep to very deep with cobbles occurring in some cases below 130 cm.

Other high floodplains, represented by stands 43 and 49, reveal soils with much finer textured horizons at 30-50 cm below surface soils that are composed of greater than 90% sand. These are reclaimed floodplains. Subsoils are silt loam and loam in stands 43 and 49 respectively.

Rooting is extensive in the upper 15-30 cm of all high floodplain soils, and root masses are evident in the recently buried profiles occurring on the reclaimed floodplains supporting stands 43 and 49. Rooting seems to be more common in the medium acid horizons.

The surface soil reaction of the high floodplains is on the average much less acid than that of low floodplain surface soils. Surface soils tend to be medium acid (pH 5.5-6.0) to slightly acid (pH 6.0-6.5). Some subsoil horizons are strongly acid (pH 5.0-5.5).

Soils on high floodplains are classified in the same manner as those occurring on low floodplains, as members of the Fluventic suborder of the Order Entisols.

Low Terraces

The only site within the study area that meets the elevational limits and the flooding criteria of the low terrace landform occurs in the Boulder Creek region. This region is at the highest elevation included in the study area. There are extensive areas of this landform class all along the McKenzie River between Boulder Creek and Quartz Creek, but most have been used for residential development, and thus they were not sampled. High water drainage channels that are dry in all but the wettest years are present. Subsidiary channels also occur but not as commonly as in floodplain areas. The slope of this landform class is usually one to two degrees in the downstream direction and level to hummocky away from the stream.

The low terrace at Boulder Creek probably represents an area where initial glacial outwash was removed by erosion leaving a shallow, stony and cobbly surface layer which has since become buried by successively finer fractions of soil until entrenchment of the McKenzie River advanced to such a state that flooding was no longer common. This in turn allowed the establishment of more stable plant assemblages and increased rates of soil development.

There is a slight textural gradient existing over the length of the terrace at Boulder Creek. On the upstream end of the terrace the soil is a shallow, cobbly, sandy loam; and on the downstream end it is a deep, loam to sandy loam with only a few cobbles and stones at depths greater than 130 cm. Deeper soils, however, have accumulated only on a very small portion of the total terrace, probably as the result of an eddy effect on the downstream end of the terrace. The shallower phase included here is best exemplified by stand 33 (Table 7 and Appendix 5). The deeper phase is quite similar to soils found on medium terraces that will be discussed next. There are no buried depositional sequences occurring on the one low terrace that was sampled. A small inclusion in this low terrace is a rock outcrop located about two-thirds of the way down the terrace sampled (between stands 29 and 30). In this 300 to 400 square meter area the soil is less than a foot (25 cm) deep, and very little vegetation occurs except for a mat of mosses dominated by Eurhynchium oreganum and Hylocomium splendens.

Vegetation on this terrace is that of the Psme-Lide/Bene-Gash/Libo community described earlier, with the exception of stand 28 which occurred in the deeper soil. This stand was placed in the Tshe/Acci/Pomu-Oxor community on the basis of similarity ordination as well as subjective reasoning.

The soils occurring on the Boulder Creek terrace have been classified as members of two phases of the Haflinger series, Haflinger cobbly loam and Haflinger sandy loam. The soils are further classified as Typic Haplumbrepts by the Soil Conservation Service (W. R. Patching, personal communication, 1972). These soils are excessively to well-drained, moderately deep and contain cobbles and gravels. They develop in recent alluvium from basic igneous rocks and glacial outwash materials. They typically have dark brown sandy loam surface horizons that may be cobbly or gravelly. Cobbles and gravels are common in the upper 35-75 cm in the Haflinger cobbly loam phase, but are confined to lower levels in the sandy loam phase. Subsoils are characteristically dark brown sandy loam or cobbly, loamy sands that are underlain by coarse sands, stones, cobbles, and gravels.

Plant roots are common in all upper horizons and extend to a depth of 50-70 cm. Medium and fine roots are extremely well developed in the surface horizons of stands supporting the Psme-Lide/Bene-Gash/Libo community. Soil reaction is usually strongly acid in the surface mineral soil horizons, and the pH increases with depth through the B or AC horizons. C horizons typically are strongly acid (pH 5.0-5.5).

Stands 28 through 33 occur on the low terrace landform and all exhibit shallow to moderately deep soils showing a definite stratification of depositional size classes.

Medium Terraces

Medium terraces occupy the greatest surface area of any of the landform classes occurring in the study area. Twenty-four of the 54 sampled stands occur on this landform. Soils range from moderately deep cobbly loams in stands 22-24 in the Paradise locale to deep, relatively stone free loams at stands 47 and 48 at Quartz Creek. They also include moderately deep sandy loams and silt loams in the Blue River and Delta regions (stands 16-18, 39-42, and 7-9 respectively). These stands growing on moderately deep cobbly loams are all within the Psme-Lide/Bene-Gash/Libo community. Those occurring on the deep loams are within the Tshe/Acci/Pomu-Oxor community, and all other soils on this landform support the Psme/Coco-Symo/Pomu community.

The moderately deep cobbly loams, stands 22-24, are within the limits of variation expected for Haflinger cobbly loam phase. They are typically composed of dark brown gravelly-to-cobbly, loam to sandy loam surface horizons underlain by dark brown cobbly sandy loam and loamy sand. Drainage is excessive to well drained, and soil reaction is medium acid down through the C horizons where it becomes strongly acid.

The deep, stone free loams, as in stand 47 and 48, are similar to the soils described as the Saturn series, but they lack the large amounts of clay found in the B horizon of the Saturn series. They have very dark brown surface horizons overlying moderate- to weak-structured transitional A3 horizons and B2 horizons. These in turn are underlain by dark brown coarse sand at depths of over 95 cm. Soils on medium terraces in the Blue River and Delta regions are classified as Haflinger sandy loam. In both of the last two regions mentioned there are smaller inclusions of Haflinger cobbly loam.

Surface soil reaction of these soils is typically medium acid to slightly acid. The pH of lower horizons decreases with depth and C horizons are strongly acid (pH 5.0-5.5).

High Terraces

High terraces are extensive in the Delta region of the study area. This region lies at the most elevated part of a convex lens of alluvial deposits occurring at the confluence of the two main branches of the

McKenzie River. Other high terraces occur at Horse Creek, again quite extensively. High terraces also occur near the town of McKenzie Bridge, between McKenzie Bridge and Paradise Campground, and between Blue River and Delta regions, but all have been too recently disturbed for sampling.

The soils in the Delta region are classified as Haflinger sandy loam. Here also there are small inclusions of Haflinger cobbly loam soils. Most high terrace soils in the Delta region consist of very dark brown sandy loam A horizons. These overlie dark yellowish brown loam to sandy loam B2 horizons 20-40 cm thick over coarse sands and gravels to moderate depths.

The soils on high terraces in the Horse Creek area (stands 44-46) are included in the Jimbo series, a loam soil on 0-8° slopes. The stands at Horse Creek occur on slopes of less than 5° and are situated on old terrace edges. They have very dark brown silt loam A horizons overlying B horizons comprised of dark brown to dark yellowish brown loam. Mottling often occurs in deeper B and C horizons. The subsoil consists of dark brown loamy sand and cobbles may occur between 130 and 150 cm depth. The soils are moderately well drained to well drained with mottling occurring only in the lower B horizons (B23) and in C horizons of some profiles. These soils occur in areas where water table seepage from higher elevations supplements the moisture supply of the entire profile throughout the summer months.

All vegetation on sampled high terraces was included within the Tshe/Acci/Pomu-Oxor community. Horse Creek soils support stands composed of species found in more moist habitats such as Thuja plicata and Acer macrophyllum.

Reaction of the surface horizons of soils occurring on high terraces ranged from medium to slightly acid (pH 5.5-6.5). The underlying horizons tested were typically medium acid (pH 5.5-6.0).

Glacial Outwash Plains

Glacial outwash plains occupy limited areas over the entire length of the study area. In many cases these areas have been recently logged in order to provide access roads to lower terraces or to the foothills and valley slopes surrounding the McKenzie River. Glacial outwash plains have been sampled in the Blue River and the Scott Creek regions. In all cases they were situated at least 20 feet above the normal mid-summer water level of the McKenzie River.

Soil profiles within this landform consist of randomly mixed stones and cobbles in a matrix of dark brown to dark yellowish brown loam to sandy loam finer materials. These soils are much more characteristic of the Haflinger cobbly loam than any other soils studied (soil 19, Table 7). The usual horizon sequence is A, B2, C1, C2.

These well-drained, coarse-textured soils support stands of the Psme-Lide/Bene-Gash/Libo community. Reaction of the surface soils is medium to slightly acid. The pH does not change appreciably throughout the profile. Stones and cobbles are common to a depth of 20-30 cm and abundant below this. Inclusions of Haflinger sandy loam do occur (stand 21, in Blue River region).

Forest Floors

The forest floor of stands studied is composed of varying amounts of organic matter in the form of decaying leaves, twigs, etc. There are also varying degrees of mixing of the organic matter with the upper mineral horizons. Since the type of forest floor varied in accordance with vegetation types, this aspect of the soils has been saved so that it could be presented in one section.

Of the four humus types listed by Williams and Dyrness (1967) (felty mor, fine mull, thin duff mull, and thick duff mull), felty mor was the most common within the study area. The above forest humus types follow the definitions of Hoover and Lunt (1952) with the exception that the fine mull A1 horizon of Hoover and Lunt's definition is interpreted as an H layer rather than a mineral horizon.

The types include:

1) Felty mor - H layer is present, there is little mixing of the organic and the mineral matter, and there are common fungal hyphae present

2) Fine mull - no H layer present, A1 is a mixture of organic

and mineral soil, has fine granular structure, and organic matter is usually greater than 30%

3) Thin duff mull - H and F are both present over an A1. F and H combined are less than 2.5 cm thick

4) Thick duff mull - combined F and H layer more than 2.5 cm thick

(follows Williams and Dyrness, 1967).

Stands within the Tshe/Acci/Pomu-Oxor community on all levels of terraces usually had a felty mor type of humus accumulation. This was generally 3-5 cm thick with the upper 1 to 2 cm consisting of recognizable conifer and deciduous tree leaves and twigs, while the lower portions were fluffy masses of material permeated with fungal mycelia giving them a very felty texture and appearance. Stands that are more xeric within this community commonly have fine mull humus type ranging from 1-3 cm thick. This layer consists of leaves and twigs overlying a gradual transition to fluffy or light mineral horizons with very low bulk density.

The Alru-Abgr/Rilo-Acci/Mosi-Pomu community shows much more variation in forest floor humus types. Low floodplains usually have no humus accumulations at all, as they are washed away each year. The only organic matter that stays on these low floodplains is that which manages to get mixed in with the sandy surface horizons. Even with this mixing there is not enough organic matter to fit the modified definition of fine mull. High floodplains characteristically have a thin felty mor humus type forest floor or one similar to the low floodplains where flood removal of most organic matter is an annual occurrence.

The Psme/Coco-Symo/Pomu community forest floor is typically a fine mull. Three to 5 cm of leaf litter overlie thin surface layers of organic and mineral matter intermixed into a well aerated surface horizon with very low bulk density. Stands that are transitional from high floodplains and stands showing no evidence of ever having burned typically have thicker litter deposits apparently as a result of more frequently occurring deciduous trees such as Acer macrophyllum and Populus trichocarpa. More xeric, open sites support a thin duff mull type of humus.

Stands within the Psme-Lide/Bene-Gash/Libo community display a range of humus types ranging from thin duff mulls in the more open younger stands at Blue River and Boulder Creek regions and felty mor in old growth stands in the Paradise region. Thin duff mull type is only a scant layer of mixed decaying plant parts and scattered fungal hyphae. Thick duff mull consists of 3-7 cm of leaves, needles and twigs overlying 1-3 cm of dry, decaying and unrecognizable organic matter with little or no fungal mycelia present. Felty mor which occurs in the old growth stands of this community consists of a 3-5 cm layer of recognizable organic debris from plants overlying 2-3 cm of very fluffy, mycelia-filled masses of unrecognizable organic matter.

Environmental and Successional Relationships of the Vegetation

Introduction

> . . . simple observation tells us that the vegetation is one of the best expressions of the combined influence of all factors of the environment--or any one piece of landscape--climate, physiography, soils, the influence of the biota itself and of site history (Bell, 1971, p. 203).

An important point about vegetation is that it, like most other broad aspects of nature, is a continuum. Regardless of the associations or communities studied, intermediate stands can almost certainly be found. It has also been pointed out that vegetation has a tendency to repeat itself along certain parts of established gradients. It is the repetition that facilitates the study of vegetation and its associated environment using grouping methods. Vegetation represents a repetitive continuum portions of which can be grouped for classification or ordinated on environmental gradients that exist (Bell, 1971).

The ordination of stands by comparing similarity values or indices of their constituent species appears to distribute the stands over the range of environmental gradients that exist within the area of study. The species that have been used in computerized ordination of stands in this study appear to be those with the highest indicator significance in identifying recognizable groupings of stands. Some species which have very high frequency within an area of study may be so universally present in all habitats that their indicator significance is very low (Goff and Cottam, 1967). Therefore, the selection of species for analysis is an attempt to identify those which are characteristic of certain habitats. It follows that quantitative data should be closely scrutinized in the process of picking species, particularly if the data come from an area where many seral stages are commonly encountered. A knowledge of climax types of the area is invaluable for the more subjective aspects of selecting characteristics for analysis.

Certain individual species are often called indicator species because of their growth response to a set of environmental factors in a given area (the effective environment of Bailey and Poulton, 1968). These species grow within specific tolerance ranges to which they are adapted to survive. No single species, however, should be cited as the sole indicator of a particular habitat type or community, as its presence could be the result of highly peculiar microhabitat differences, long range seed dispersal, genetic anomolies, or other such circumstances.

The reliability of indicator species would be greatly enhanced if groups of species which tend to occur together were used to identify communities. Plant communities serve as integrated indicators of environmental interactions of species over gradients of factor complexes. The indicator value of the community is thus the summation of species-interaction with the total environment of the area studied. Thus, in the case of two communities occurring in close proximity to each other a gradual change in species composition is more likely to be observed between them than a sharp delineation across which species do not move. This ecotone may be extensive, or it may consist of only a narrow band between recognized seral stages or communities, depending largely on the rate of change of any limiting environmental factors and the extent of response to these by species. In regions where microhabitat differences are numerous, as in most regions of the Pacific Northwest, ecotones are narrow, making the community classification approach much more appealing.

In previous portions of this study the vegetation groupings identified by manual-visual association tables, as well as by SIMORD analysis, have been referred to as communities. These are defined as homogeneous and repetitious groupings of species. I now will expand upon them using the seral classes of Daubenmire (1952). The definition given above for the community will remain the same. If a community maintains itself, then it will be called an association. The collective area that is occupied, or will become occupied, by a given association is the habitat type. The habitat type may be locally occupied by associes, which are defined as seral equivalents of the association into which they ultimately will evolve (Daubenmire, 1952).

It is hypothesized that the study area includes two habitat types, with the Tsuga heterophylla/Acer circinatum/Polystichum munitum-Oxalis oregana (Tshe/Acci/Pomu-Oxor) association being a climatic climax; and the Tsuga heterophylla/Berberis nervosa-Gaultheria shallon/Linnaea borealis (Tshe/Bene-Gash/Libo) association being a topo-edaphic climax. The Alru-Abgr/Rilo-Acci/Mosi-Pomu, Psme/Coco-Symo/Pomu, and Tshe/Acci/Pomu-Oxor communities discussed previously are interpreted as associes of the Tshe/Acci/Pomu-Oxor habitat type. The phases that were discussed within the floodplain community (Alru-Abgr/Rilo-Acci/Mosi-Pomu) have each been included as associes as well, with the exception of the Pseudotsuga menziesii phase. The Psme-Lide/Bene-Gash/Libo community is considered an associes of the Tshe/Bene-Gash/Libo habitat type.

This reclassification places the vegetation into more natural groupings that depict their successional status, and in no way changes the usefulness of the previous classification scheme comprised of more inclusive groupings which contain, in some cases, many recognizable seral stages. Since the stands that are included in this investigation represent a wide range of seral stages, they will be discussed in their hypothetical seral order from pioneer to climax stages. Each stage develops under a set of environmental conditions which is composed of climatic, edaphic, topographic, temporal, and biotic factors, any one of which may be limiting to certain groups of plants. These factors generally complement each other (Krajina, 1965), and usually no one factor within an area can be interpreted as the sole causative factor for stand distribution along an environmental gradient. Only in limited areas (microhabitats) can such cause-effect relationships be hypothesized, and rarely can they be proved without room for doubt. Correlations between vegetation and individual environmental factors are only rarely meaningful or significant (Bailey and Poulton, 1968).

Habitat variations in the mountainous Pacific Northwest are numerous as a result of topographic, climatic, and edaphic changes over relatively small areas. This is further complicated in the study area by disturbance by holocaustic fires and severe floods, both of which occurred prior to the arrival of European man. Fire in the study area has been of such regularity and importance that few climatic climax stands in the classical sense remain. However, there has been sufficient time between burns that there has probably been less actual species adaptation to fire as an integral part of the system than is reported by Bailey and Poulton (1968) in the Tillamook Burn area. Other disturbances that markedly affect the development of larger or smaller areas include flooding and logging. These will be discussed, where pertinent, later in this section.

In a previous section each community was discussed with emphasis on its species composition. In this section environmental and successional relationships will be discussed for each associes.

Salix Associes. The Salix associes is usually the first sere to occupy areas where recent alluvial materials are exposed. It occurs on low floodplains with large stones and cobbles exposed and only a small amount of sand or finer particles between the stones. It is restricted within the study area at this time, due at least partially to the establishment of upstream reservoirs which moderate the streamflow.

This associes is short lived and subject to perhaps the most severe environment of any sere studied. Moisture, however, is probably never a serious limiting factor as the water table is usually within reach of the roots of plants common to this associes. The exposure to sunlight is maximum with the additional effects of reflection from the river. Temperatures are extreme due to the lack of a well developed tree canopy. During summer nights cooling and the effects of dew and fog from the river probably aid in daily recharging of turgor of some herbaceous species that occur here.

Plants of this associes include the dominant Salix spp. and several herbaceous species dispersed widely between the stones and cobbles, including Gilia capitata, Cytisus scoparious, Chrysanthemum leucanthemum, Anaphalis margaritacea, Cirsium vulgare, Hieracium albiflorum, Epilobium paniculatum, E. angustifolium, and E. watsonii. Members of the Compositae, Scrophulariaceae, Cruciferae and Graminae are common components of the Salix associes. Many of the plants listed above are common early invaders of logged and burned upland regions as well as of early floodplains (Dyrness, 1965; Mueller-Dombois, 1965).

As succession advances this associes is replaced by the early seral stages of either the Tshe/Acci/Pomu-Oxor or the Tshe/Bene-Gash/Libo association (Figure 12). The sequence of seral stages leading to one or the other is often quite different and depends primarily on how subsequent flooding modifies the existing floodplains.

Tsuga heterophylla/Acer circinatum/ Polystichum munitum-Oxalis oregana Habitat Type

Alnus rubra Associes. Subsequent flooding and deposition of gravels and sand over areas occupied by the *Salix* associes results in the establishment of *Alnus rubra*. This usually follows the deposition of 20-30 cm of coarse to fine gravelly sand. The *Alnus rubra* associes, while it may be immediately adjacent to the river, generally occurs in a narrow band separated from the river by a narrow band of the *Salix* associes. The *Alnus rubra* associes is more extensive and of longer duration than the *Salix* associes on the McKenzie River.

Alnus rubra is the dominant tree, though *Acer macrophyllum* germinates and survives in large numbers in this sere. Sediment from subsequent flooding and concurrent canopy density changes create conditions suitable for the growth of *Acer circinatum*. More

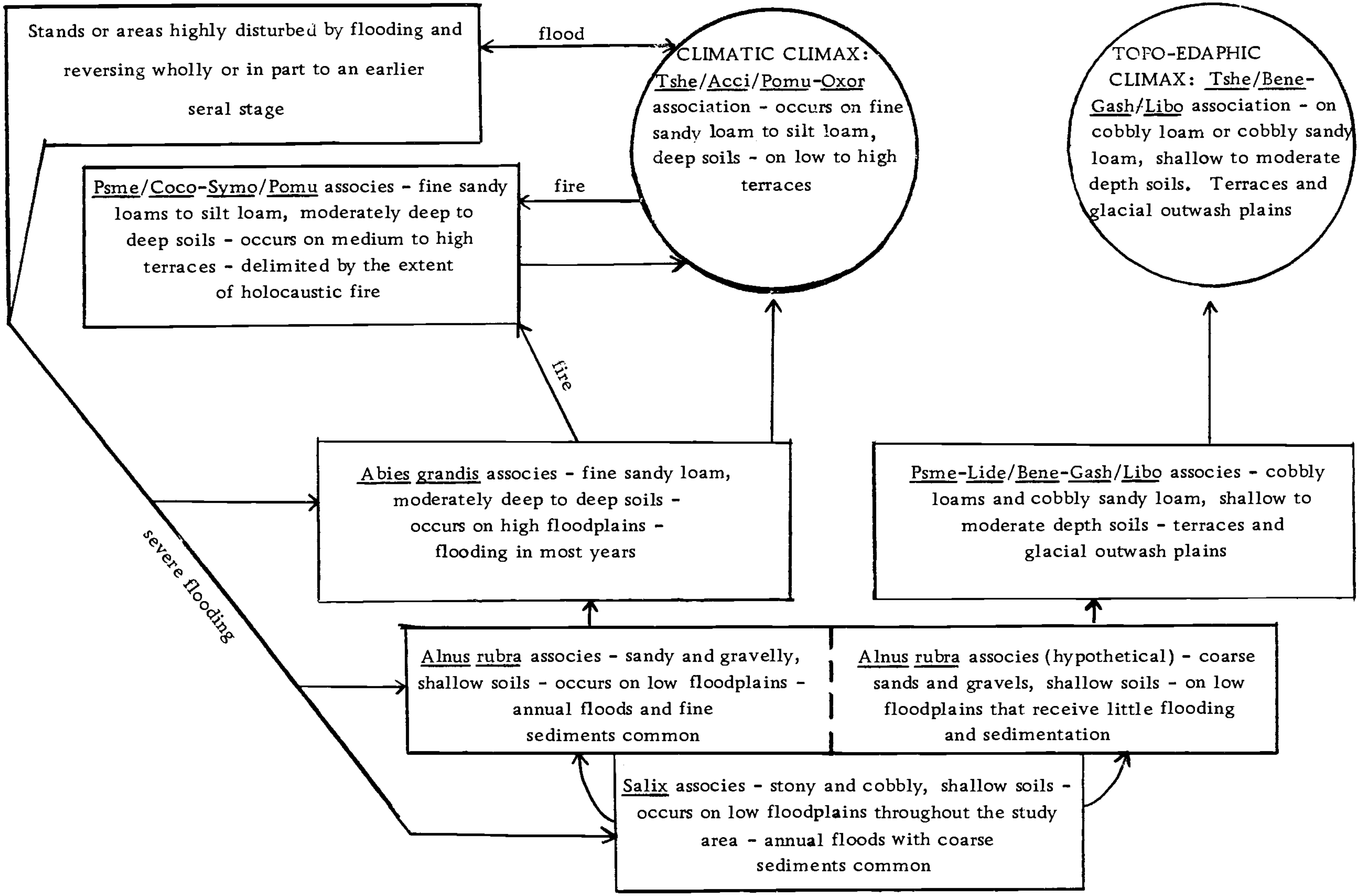

Figure 12. Hypothetical successional sequence of vegetation associes on floodplains, terraces and glacial outwash plains, McKenzie River, Oregon.

open areas are occupied by *Corylus cornuta* and *Osmoronia cerasiformis*. Where the tree and the tall shrub layers are quite dense, *Ribes lobbii* is a commonly found understory shrub.

The total soil depth over stones and cobbles ranges from about 30 to 60 cm. With additional vegetative development the soils become more stable due to extensive surface rooting. Soil development is also accelerated by additions of organic matter. Soils supporting this sere are usually more than 90% sand; consequently moisture holding capacity is very low. Thus, supplies of available water might be expected to be exhausted early in the summer dry period. That wilting was observed only in larger open areas during excessively hot summer days implies some ameliorative effects of the total environment. The water table is well out of the reach of most herbaceous species. The tree canopy cover of this associes is normally quite high, over 150% average per sampled stand. Thus herbaceous strata are probably not under great temperature or moisture stress; that is, evapotranspiration is greatly reduced as compared to that in more open areas. The moisture balance of this associes, and others closely related to it, may be moderated by fog or dew near the river for extended periods during nights and mornings all through the summer months. It is well documented that dew may reduce evapotranspiration stress (Stone, 1957).

Even if many of the herbaceous species occurring on these sandy soils are incapable of moisture uptake by leaf absorption, they still serve as condensation points for cool, moisture-laden air that flows down the valley during summer temperature inversions. Condensation and drip can greatly recharge sandy soils that are not exposed for long periods to direct sunlight. Soil pits dug during mid August revealed that in most cases the upper 12 cm of these floodplain soils were moist in continually shaded areas even though the soil at depths of 18-30 cm was often dry and loose.

Flooding for certain periods of time excludes some species (Brink, 1954; Minore, 1968; Stone, 1968). Flooding in the Alnus rubra associes is a common annual event. Since the establishment of reservoirs flooding normally occurs in the late winter or early spring after the reservoirs are filled and less capable of exerting flood control. This is usually during the dormant periods of most species of trees occurring on floodplains. Death of tree seedlings may result from oxygen deficits in submerged or buried soils, or from mechanical action of debris carried by flood water. Pseudotsuga menziesii seedlings usually die whether flooding occurs during the dormant season or not (Brink, 1954). Minore (1968) reports similar reaction of young Pseudotsuga menziesii to short periods of flooding. Tsuga heterophylla has also been found to be sensitive to flooding. Thuja plicata became highly chlorotic but survived flooding during the growing season (Brink, 1954). Stone (1968) states that flooding accompanied by siltation kills all size classes of Pseudotsuga menziesii and Abies grandis growing on the redwood alluvial flats in northern California.

The fact that no coniferous tree species are important in the Alnus rubra associes is only partially the result of flood fatality of their seedlings. Biotic interactions seem also to be very important. The presence of the highly competitive Alnus rubra reduces the likelihood of success of conifers during the first 20-25 years of growth (Fowells, 1965). Alnus rubra is a vigorously growing pioneer species that has often been noted as a hardy competitor as well as an excellent soil developing species (Newton, El Hassan and Zavitkovski, 1968). Another factor that may tend to regulate species composition of the Alnus rubra associes is soil reaction. The high acidity of the surface soils supporting this associes may be responsible for the exclusion of species from the area.

In most cases the short-lived Alnus rubra is replaced within 30-50 years by one of two major tree species. It appears that if little elevation of the floodplain occurs by either sedimentation or down-cutting of the river, the Alnus rubra is quickly replaced by Populus trichocarpa, another rapidly growing but short-lived species. In areas where additional sediments, usually of increasingly fine texture, have been deposited to elevate the floodplain Abies grandis may replace Alnus rubra in 50-70 years. Time of replacement apparently depends on the rate of deposition of sediments. Areas of the Populus trichocarpa associes occur in the Blue River region of the study area, but they were not sampled.

Abies grandis Associes. This associes is typical of high floodplains. These floodplains usually receive progressively greater amounts of flood-deposited fine sediments. Soil developmental processes also increase quantities of the finer size particles. This in turn increases the moisture holding capacity of the soil. In immature stands of this associes young Abies grandis seedlings and saplings grow in dense clumps until about 10-12 years of age when more hardy specimens survive the competition, apparently for root space and light. Populus trichocarpa is commonly a member of the overstory in this associes since it becomes established at about the same time as Abies grandis. Because it grows in height much faster than Abies grandis, Populus trichocarpa dominates the canopy during the first few years. The high floodplains that the Abies grandis associes occupies are sufficiently elevated so that extensive flooding occurs only during short periods in years of extreme precipitation. Consequently, they also support such species as Pseudotsuga menziesii and Libocedrus decurrens. Acer macrophyllum also maintains an active role in the canopy of this associes.

Many of the same species are present in the Abies grandis associes as in the Alnus rubra associes. However, relative importance of the species changes apparently as a result of increased elevation above water table and the increase in soil moisture holding capacity in the upper horizons of the profile.

In stand 37 the ages and composition of tree species indicates abnormal development. This stand contains 30- to 50-year-old Alnus rubra and 50- to 70-year-old Populus trichocarpa, both being replaced by 40- to 60-year-old Pseudotsuga menziesii and Libocedrus decurrens. In most other areas this four species combination does not exist as an even-aged stand. Root masses indicate that the last great period of deposition (depositing 42 cm of material grading from coarse sand to fine loamy sand) occurred at about the time just prior to the establishment of the above species. The effects of a deposit of this nature is two-fold. First, it causes sufficient burial to eliminate pre-existing tree species, leaving the area open to invasion by fast colonizing species such as Alnus rubra and Populus trichocarpa. Secondly, it elevates the level of the floodplain enough that flood-caused fatality of newly germinated Pseudotsuga menziesii and Libocedrus decurrens is uncommon. The obvious result is an even-aged stand of the species listed above, since conditions were probably such that each could utilize the seed bed as long as moisture and light were not limiting.

The shrub layer within the Abies grandis associes is less diverse than that in the Alnus rubra associes. Acer circinatum and Corylus cornuta are the most common shrubs, with Ribes lobbii and Osmoronia cerasiformis confined to younger Abies grandis stands.

The vegetation occupying these high floodplains compares well with Bailey and Poulton's (1968) Acer macrophyllum-Alnus rubra associes in the Oregon Coast Range near Tillamook, Oregon. Major differences are: Rubus spectabilis and Rubus parviflorus are common in the coastal associes but not in the McKenzie associes; and Acer circinatum is a component of the McKenzie associes, but it is not found within the coastal associes. Many herbaceous plants are common to both associes. Both are located in river bottomlands, and both occur on slopes of less than 10°.

Within the study area, all stands of this associes are sheltered to the south by more mature seral stages. They are often open to the north as this is the side toward the river. Stands belonging to this associes are common in the Delta and Blue River regions of the study area.

The floodplain associes and the substrate that they occur on are probably recent in origin. Ages of the older trees are usually less than 120 years, these associes occur on banks within meander range of the McKenzie River, and they show no evidence of fire. However, most terraces support associes that appear to have been the result of re-invasion after either fire or exceptionally high flooding.

Flooding modifies the seed bed while at the same time it often eliminates the vegetation present by excessive burial of the roots. This allows the invasion of all plants that can compete successfully on the new seed bed. Flooding can occur at almost any time and place if the river channel has shifted sufficiently. Thus some more advanced seres may be forced back to a lower successional stage because of flood mortality and opportunity for invasion by pioneer species. It is this type of successional reversal that may be in progress at a very early stage in stands 43 and 49, the reclaimed floodplains mentioned earlier. Areas exemplified by the latter two stands occur in very restricted amounts at Dearborn Island and in the Blue River region of the study area. Since they are restricted they are not assigned associes status.

The reversion to an earlier stage of seral development is probably effected over a range of different time periods for different strata of vegetation. The herb and moss layers are the first to disappear with the complete burial of all but the very tallest and strongest species. A complete sword fern (Polystichum munitum) was uncovered in new sediments at stand 49, and the degree of decomposition indicated that it had not been buried very long. The shrub, small tree, and tall tree layers will probably be killed if further sedimentation occurs. The new herb layer is beginning to form in the sandy surface deposits resulting from recent flooding. This substrate supports vegetation that can survive in coarse textured soils. Thus the resultant species composition would be expected to more closely resemble floodplain vegetation than what was previously in the area. Barring further disturbance this will then develop through the sequence to the climatic climax, Tshe/Acci/Pomu-Oxor association.

Psme/Coco-Symo/Pomu Associes. Fire is important in the Tshe/Acci/Pomu-Oxor habitat type. Munger (1940) stated that two-thirds of the Pseudotsuga menziesii Region of the Pacific Northwest was then even-aged timber (mostly Pseudotsuga menziesii) that had resulted from reseeding after holocaustic fires. These stands may be anywhere from seedlings to 500 years old, and stands resulting from the same fire vary only slightly in age.

The Psme/Coco-Symo/Pomu associes is restricted to the limits of relatively recent burns (100-200 years ago). Within the study area such stands are restricted to medium and high terraces. Representative stands occur in the Blue River and Delta regions of the study area, and are all included in the Psme/Coco-Symo/Pomu community described earlier (Table 5).

One merely has to glance at this associes to realize that it differs markedly from those of similar age arising without the intervention of fire. This is more adequately explained by Bailey and Poulton (1968, p. 3-4):

> In burned over forest environments the ameliorating influence of the forest canopy is lacking; thus seral

associes may become sorted on a more intricate environmental mosaic than might be evident in the eventual climax equilibrium. Minor soil and relief differences may be ecologically more significant than beneath a full forest canopy. Thus, one must accept the possibility that quite different associes might change and become the same community as succession advances, or that, at a fixed point in time, a habitat type may be occupied by strongly contrasting seral communities.

Mueller-Dombois (1965) concluded that dominant plants following clear-cutting of _Pseudotsuga menziesii_ and _Tsuga heterophylla_ may be divided into the following three groups:

1) forest plants - those which are characteristic of the original vegetation of the area;
2) semi-tolerant forest weeds - those that were present in original vegetation but never as dominants; and
3) intolerant weeds - those that are rare in forest stands.

I submit that these same three classes can be applied to burned-over as well as cut-over areas. The age of stands in the _Psme/Coco-Symo/Pomu_ associes is sufficiently advanced so that they no longer contain any members of the third class above. However, species such as _Symphoricarpos mollis_, _Synthyris reniformis_, _Adenocaulon bicolor_, _Fragaria vesca_, and _Whipplea modesta_ fit within the second class above quite well, and they occur in unusually large amounts within these stands. Other common to abundant species, including _Polystichum munitum_, _Vancouveria hexandra_, and _Oxalis oregana_, are common to the original vegetation of the area.

In many cases species that are common to both the climax and the seral stages appear to be growing with less vigor in the seral stage. This is evidenced by the chlorotic and thin-leaved Polystichum munitum growing in the fire sere. This is to be expected in these younger stands typified by more open tree canopies. Moisture stress is surely greater in plants occurring in the fire sere than in those occurring in the climax stands.

An additional effect of the open canopy in the Psme/Coco-Symo/Pomu associes is the abundant growth of the low shrubs. Symphoricarpos mollis, Rubus ursinus, and Berberis nervosa are common species in this layer. The high shrub layer also responds to the open canopy situation, with Corylus cornuta replacing Acer circinatum in dominance. This relationship between the latter two plants appears to be reversed from the dominance relationship in areas where fire disturbance has not been as recent and where the overstory canopy is more dense. My own experience in the area adjacent to the study area reveals that Corylus cornuta is a stronger competitor with Acer circinatum on open south slopes than in more mesic areas.

Within 150-200 years this associes takes on the appearance of the Tshe/Acci/Pomu-Oxor association. Tree age data for the stands included in this associes indicate a range of ages starting at 90-100 years at stand 41 and getting older as one approaches stand 18 to the east and 42 to the west. The older stands are between 165 and 200 years old, and all stands have occasional large Pseudotsuga menziesii stems within them that are over 350 years old. Measurement of non-suppressed trees of the same species and of equal or near equal diameter in each stand reveals that tree size differences in the stands are the result of age differences rather than variation in growth rate in different stands.

Tshe/Acci/Pomu-Oxor Association. This is the most common vegetation unit within the study area and develops from previously described associes resulting from fire or floods. This association typically occurs on deep, well drained soils ranging from loam to sandy loam overlying one or more graded soil sequences of past terraces. In most cases the remains of the buried sequences are coarser grained than soil in the present surface layer.

The tree layer of this association varies markedly in response to a wide variety of moisture and topographic factors. This is more evident within this association than the associes just described because of the large area occupied by the type, which includes microhabitats that do differ significantly. The stands representing this association are listed in Table 3 along with species cover and constancy. They include stands at Delta, East Delta, Horse Creek, Quartz Creek, and Boulder Creek which occur on low, medium and high terraces. This wide distribution is further indication that this is likely to be the climatic climax, even though most of the stands included are not fully mature. The only stands that have reached old-growth status are those located in the East Delta region (stands 51-53). The whole area between the Blue River region and Dearborn Island (Figure 2), except where logging has occurred, represents a gradual west to east increase in age that terminates in old-growth stands of the hypothetical climax habitat type at East Delta, where the McKenzie River turns 90^{o} and the forest progression stops short of Dearborn Island.

Observations made in more xeric portions of the range of the Tshe/Acci/Pomu-Oxor association (in the southern portions of the Delta region) indicate that Thuja plicata becomes an understory reproductive dominant prior to Tsuga heterophylla. This is probably a result of a greater tolerance of Thuja plicata for an open canopy (Krajina, 1965), or to side lighting which are both common in more xeric areas. Sexual reproduction of Thuja plicata seems to be favored on sites where plenty of light reaches the forest floor. Habeck (1968) found that Thuja plicata was a good early successional competitor in more open areas but that it was dominated by Tsuga heterophylla in later successional stages.

The overstory canopy within much of the Tshe/Acci/Pomu-Oxor association consists of mature (200-250 year old) Pseudotsuga menziesii with scattered, old (250-300 year old) Abies grandis and Thuja plicata all occurring over a lower layer of Acer macrophyllum and uneven-aged Tsuga heterophylla. In areas where soils are finer textured (loams to silt loams) drainage appears to become important in determining dominance relationships of the various older trees. Stands located at Horse Creek and Quartz Creek, for example, occur on soils that are silt loam and loam respectively. Soils at both sites show evidence of poorer internal drainage than that noted in other stands within the association. Stands at both sites contain noticeably more Thuja plicata and less Tsuga heterophylla than most other stands in the association. This agrees with the findings of Habeck (1968) and others that in areas where both Tsuga heterophylla and Thuja plicata occur, Thuja plicata dominates in more hygric areas while Tsuga heterophylla dominates well-drained areas. Both species are well represented on mesic sites. All 13 stands other than those at Horse Creek and Quartz Creek average 74% cover for Tsuga heterophylla and 10% cover for Thuja plicata (Table 3). The averages for the five stands in the Horse Creek and the Quartz Creek regions are 18% for Tsuga heterophylla and 42% cover of Thuja plicata.

A further look at stands 34, 35, and 28, which occur on more modal soils for this association, might indicate an age relationship of the stands rather than an edaphic difference. Due to the sizes of the larger trees in the area it was impossible to get accurate age data on them. If the tree size difference does not result from a drainage difference then it is probably due to different ages of the stands. The difference in the cover of and the number of Pseudotsuga menziesii indicates that stands with a higher coverage of Thuja plicata are younger than those where Tsuga heterophylla has greater cover. This further agrees with the findings of Habeck (1968).

Species which dominate a climatic climax are those that consistently replace themselves under normal conditions, being highly shade tolerant in most cases. Krajina (1965) says that such tree species become shade dependent in xeric areas and shade intolerant in wet climates.

Soils within this association are seldom dry in any horizon, due to increased moisture holding capacity of the soils from greater amounts of silt and clay in the profile. Added organic materials increase the aggregation of and the aeration of these soils as well as increasing the moisture holding capacity. Floodplains with earlier seral stages generally lack this aggregation process in their soils because most of the organic material is swept away during the winter flooding periods.

After about 450-550 years a transition begins to occur rather rapidly as the old Pseudotsuga menziesii dies. This process is speeded up in some areas because of the instability of the alluvial substrate. However, in most areas the trees appear to die, begin to decay, and then blow over. As they fall out of the canopy the Tsuga heterophylla, suppressed beneath them for 200 or more years, becomes more vigorous upon being released. Between the windthrow of Pseudotsuga and response by Tsuga and other species of trees, the light reaching the herb and low shrub layers increases sufficiently to alter dominance relationships of species for a short number of years.

Most of the area occupied by the Tshe/Acci/Pomu-Oxor association is on medium to high terraces, far removed from flooding actions of the river both spatially and temporally. Most of the stands in the mature to old-growth stages of this association have probably been through more than one cycle of regeneration from fire since their origin at a time when the terraces were first deposited. The estimated average age of many of the mature stands is between 350 and 450 years old, and many of the older trees show evidence of fire high up on their boles.

Tsuga heterophylla/Berberis nervosa-
Gaultheria shallon/Linnaea borealis
Habitat Type

It was noted earlier that the Salix associes was the first sere leading to both the Tshe/Acci/Pomu-Oxor and the Tshe/Bene-Gash/Libo associations. I will now discuss the less common, but nonetheless extensive, sequence in the Tshe/Bene-Gash/ Libo habitat type.

The major environmental difference between the two associations is the depth and texture of the soils on which they occur. The Tshe/Bene-Gash/Libo association occurs on coarser, shallower soils than the Tshe/Acci/Pomu-Oxor association.

The sequence leading to the Tshe/Bene-Gash/Libo association is made up primarily of late seral associes. Early seral stages are not extensive at higher elevations, probably because of less disturbance by the river than occurs in lower elevations. Further field research may reveal more information regarding the nature of the seral stages leading to the Tshe/Bene-Gash/Libo association.

Hypothetical Associes Leading to the Tshe/Bene-Gash/Libo Association. Logging and recreational activities on the north bank of the South Fork McKenzie River in the southwest end of the Delta region have disturbed the only extensive area found where early successional stands of the Tshe/Bene-Gash/Libo association may have occurred. The vegetation is similar to that of stands 10-12 with the exception that hotter microenvironments exist primarily as a result of the southern exposure. The age of the area is similar to that of stand 11 but the seral development is not as great in this locale as at stand 11. *Alnus rubra* makes up a thick canopy with most trees less than 2 dm DBH. There also occurs a thin belt of *Populus trichocarpa* and *Salix* on the river side of the alder stand. The floodplain is composed mostly of sand and some silt, with a high percentage of gravels at streamside.

A second level floodplain, about three feet higher, exists adjacent to the first. It is separated from the first plain by an extensive belt of *Salix* spp., again occurring in an area covered with large stones and cobbles and coarse sand. A third level, terrace, exists approximately six feet above the second level floodplain. The upper level was most disturbed, so it was not sampled.

There are some boggy areas on the terrace where Rubus parviflorus, Equisetum arvense, Heracleum lanatum and Petasites frigidus are found. The lower floodplain includes the above species of herbaceous plants as well as Ribes lobbii and Alnus rubra in the shrub layer. The Salix belt contains many composites and members of the Scrophulariaceae in the herb layer.

The area that is described above indicates that the early development of the Tshe/Bene-Gash/Libo association is possibly quite similar to that of the more mesic Tshe/Acci/Pomu-Oxor association. Differences appear to be that large amounts of overlying finer textured soils are not as common, and there are greater amounts of the coarser fragments included in the profile of the Tshe/Bene-Gash/Libo association soils. Also, the low shrub layer development is markedly different in the two with Berberis nervosa and Gaultheria shallon dominating this layer in the early seral stages of the Tshe/Bene-Gash/Libo association and little of these two species occurring in the early seral stages of the Tshe/Acci/Pomu-Oxor association. The sere just described has not been given full associes status primarily because of the great disturbance of the only extensive sample. Thus the sere will remain a hypothetical associes.

Psme-Lide/Bene-Gash/Libo Associes. This associes occurs on lower terraces in the higher elevation (upstream) parts of the study area and on glacial outwash plains in all parts of the study area. Development of these areas follows the hypothetical associes partially described above. The successional sequence leading to the Psme-Lide/Bene-Gash/Libo associes is probably little affected by flooding, as flooding does not play an important role in preparing modified strata of sediments in this habitat type. Stands located at Boulder Creek further emphasize the lack of flooding. These are the only stands of this associes that presently occur on a level attainable by high flood water. A network of high water channels probably removes most of the flood waters before extensive sedimentation can occur, assuming that flooding does occur in years of unusually high precipitation. That little flooding occurs is probably partially the result of the down-cutting of the McKenzie River and the gradient of the river in this area, which is steeper than in other areas of the study.

The soils are shallow over large amounts of stones and cobbles. Other areas where the associes occurs are glacial outwash plains typified by shallow stony or cobbly loams or sandy loams. Texture of soils of this associes is similar to that of the high and medium terraces within the Tshe/Acci/Pomu-Oxor habitat type, but the amount of coarse fragments is much higher. The overall effect of the increased coarse fragments is to speed up drainage as well as to reduce the total amount of finer particles, which are capable of holding more moisture than are stones and cobbles. The ultimate result is a decrease in available moisture within the total soil profile. This obstacle in the moisture balance of the site type may be important early in the development of the tree layer when the initial competition for available moisture starts between Pseudotsuga menziesii, Libocedrus decurrens, Thuja plicata and other vegetation colonizing the original habitat.

Observations within some recently disturbed sites indicates that Libocedrus decurrens is an important pioneer species, at least on elevated areas where moisture from the river is not available. Pharis' (1966) work with drought resistance of conifers in southwestern Oregon showed young Libocedrus seedlings to be more drought resistant than Pseudotsuga menziesii and Pseudotsuga more drought resistant than Abies grandis. Marshall (1931) found that young seedlings of Abies grandis, Pseudotsuga menziesii, and Thuja plicata were all intermediate in drought resistance when grown on coarse quartz sand. However, recently disturbed sites may not be representative of the competitive relationships that occur under natural seral conditions.

Within this associes, species distribution changes with elevation (Table 6). Lower elevation stands commonly do not contain many of the characteristic species found in higher elevation stands. The similarity of the herbaceous layer of higher elevation stands to upland slope vegetation was noted earlier. Those herbaceous species listed in the community description as characteristic species characterize this associes in the Boulder Creek and Scott Creek regions as well as the near climax stands at Paradise Campground.

Lower elevation representatives of the Psme-Lide/Bene-Gash/Libo associes appear to be intergrades of the seres of the Tshe/Acci/Pomu-Oxor and Tshe/Bene-Gash/Libo habitat types. They (stands 19-21) appear as intergrades in the ordination of stands based on the cover value of shrub and herb species (Figure 5). They are subjectively included in the more xeric topo-edaphic habitat type (Tshe/Bene-Gash/Libo) because of the similarity of their soils, high coverage of Berberis nervosa and Gaultheria shallon, as well as the location of the plots on the ordination plane mentioned above.

Edaphic factors appear once again to be the most important factors involved in species composition within the associes. One of the other very important factors is that in all areas where this associes occurs there is some degree of open exposure to the south. This results in stands that appear to be much drier than those encountered in any other associes studied, even the Salix associes. This exposure from sidelighting and through a broken canopy is responsible in part for further limitations of species composition and distribution.

The tree and tall shrub layers tend to modify the lower strata of vegetation by reducing the total radiation, and changing the spectral qualities of radiation (Federer and Tanner, 1966) and by causing spatial inequities in throughfall precipitation (Tarrant et al., 1968; Anderson, Loucks and Swain, 1969). The development of all layers, particularly understory herb layers and low shrub layers, is often dependent on moisture content of surface horizons. In fine textured, deep loams, silt loams, and fine sandy loams herbaceous competition is usually much more successful than in areas where soils are shallow, gravelly, cobbly, or stony. This results partially from the fact that these shallow, stony soils usually support a less vigorous stand of more widely spaced trees. The open nature of the resultant canopy encourages the development of more light tolerant, schlerotic shrubs, such as Berberis nervosa and Gaultheria shallon rather than the delicate herbs common to the shadier habitats.

Shallow, gravelly, sandy loams often support patches of Symphoricarpos mollis. Cobbly sandy loams with higher silt and clay content support mixed stands of Gaultheria shallon and Berberis nervosa as dominants in the low shrub layer. In the less exposed areas of the Psme-Lide/Bene-Gash/Libo associes, Gaultheria shallon dominates even over Berberis nervosa, while more exposed sites are dominated by Berberis nervosa. The sequence from Symphoricarpos mollis to Berberis nervosa to Gaultheria shallon apparently represents a response to a moisture gradient as it is modified by various exposures and light regimes.

The relative positions of Berberis nervosa and Gaultheria shallon along the gradient are reversed from those found by Orloci (1965) in the coastal Western Hemlock Zone of British Columbia and Vancouver Island. This might be because Berberis nervosa is common to the more open sites. Throughfall precipitation during average light rains late in the spring would tend to recharge the soils. Gaultheria shallon, occurring usually under more dense canopies, may receive less precipitation. Anderson, Loucks and Swain (1969) found that 40% of a .05 inch rainfall over coniferous forests of Wisconsin was intercepted by the tree layer. Interception is inversely related to intensity of the storm, and decreased percentages of rain are intercepted during shorter periods of greater rainfall. That Berberis nervosa is commonly a more mesic site species is indicated in its common occurrence within the Tshe/Acci/Pomu-Oxor association. Haig (1936) observed that soil drought extends deeper in shade-free or very densely shaded situations than under normal forest cover.

Thus within this associes soil factors are still very important, but exposure also apparently plays a large role in species distribution. The Tshe/Bene-Gash/Libo association follows this stage at an age of about 450 to 500 years in the study area. Most of the stands that have been studied in the Psme-Lide/Bene-Gash/Libo associes have gone through one or more fires in the past. The presence of the climax stands in this habitat type is probably much less likely than in the Tshe/Acci/Pomu-Oxor habitat type since this habitat is much drier and more flammable.

Tshe/Bene-Gash/Libo Association. This association is the climax stage that is recognizable when the developing Psme-Lide/Bene-Gash/Libo associes becomes more mesic with maturity and supports a greater amount of reproductive Tsuga heterophylla. Old-growth Pseudotsuga menziesii and Libocedrus decurrens fall out of the canopy between 350-450 years of age except in hygric sites next to bogs or subsidiary channels that contain water throughout the year. In these areas Pseudotsuga menziesii and Thuja plicata remain as codominants of the canopy until 450-550 years of age for the Pseudotsuga menziesii and probably somewhat less for the Thuja plicata. These species are then replaced in the canopy by the Tsuga heterophylla mentioned above. The stands at Paradise Campground have not fully reached old-growth status, but are very close. The decline of Pseudotsuga menziesii and increase in Tsuga heterophylla has only become apparent in one stand.

Included in this association are large or small areas where soil may be less than 20 cm deep and where many rocks are exposed. In these areas there is little vascular vegetation growing, but the ground is covered with dense mats of Eurhynchium oreganum, Hylocomium splendens and patches of Rhytidiadelphus triquetrus, three mosses that occur frequently within all stands of this association.

The climatic conditions and elevation of the Coastal Western Hemlock Zone (Orloci, 1965) are similar to those of higher elevation areas in the study area. Similarly the vegetation described herein as the Tshe/Bene-Gash/Libo association is quite similar to the Gaultheria shallon association of Orloci. He describes his Gaultheria shallon association as being one specific to thick raw humus on lithic soils along the forest edge (Orloci, 1965).

SUMMARY AND CONCLUSIONS

A study of the McKenzie River floodplains, terraces, and glacial outwash plains was undertaken to describe the vegetation and soils of a previously little studied synecological unit. Its specific objectives were:

1) to describe and classify forest vegetation and soils on terraces and floodplains,
2) to determine relationships between the vegetation and environmental factors or factor complexes, and
3) to determine successional relationships.

The study area is located from 59 to 88 km east of Eugene, Oregon. Parent material is of sedimentary (alluvial) origin, carried in and modified by river action during and since the Pleistocene periods of glaciation. It is derived from the upland Sardine Formation and Little Butte Volcanic Series, and probably was deposited originally in a massive glacial outwash plain. This has since been eroded into terraces and floodplains with little remaining area where outwash plains have not been removed.

The climate of the study area is moderate with a marine influence due to prevailing westerlies from the Pacific Ocean. The warm, low valley to the west and the High Cascade Mountains to the east cause an approach effect, so that precipitation in the area is relatively high

(1650 to 2235 mm per year based on a ten-year average). Precipitation is primarily in the fall and winter months, with a small amount of snow in the study area. In the summer months the days are warm while many nights are cool as a result of temperature inversions in the McKenzie River Valley. Winters are cold but not excessively so. Areas near the river experience fog and dew during all parts of the year.

Fifty-four analytic vegetation and soil plots (stands) were measured during the summer of 1971 for frequency and cover data on trees, shrubs, herbs, and mosses occurring on floodplains, terraces, and glacial outwash plains. Stand samples were of the size used and described by Daubenmire (1959). Vegetation data were analyzed in two ways: first, the data were arranged on a manual-visual table using Braun-Blanquet methods; second, the stands were ordinated on two linear axes using groups of 50 species of shrubs, herbs, trees or mosses analyzed by computerized SIMORD analysis.

Soil was described and sampled from a pit within each of the above stands. Standard field descriptions included horizon designation, horizon depth, moist color, texture, structure, consistence, boundary characteristics, and drainage peculiarities. Laboratory analysis of texture and pH of each horizon of 12 representative profiles was completed.

On the basis of manual-visual association tables and SIMORD analysis, four communities were identified as follows:

1) *Tsuga heterophylla*/*Acer circinatum*/*Polystichum munitum*-*Oxalis oregana* community (*Tshe*/*Acci*/*Pomu*-*Oxor*),

2) *Alnus rubra*-*Abies grandis*/*Ribes lobbii*-*Acer circinatum*/*Montia sibirica*-*Polystichum munitum* community (*Alru*-*Abgr*/*Rilo*-*Acci*/*Mosi*-*Pomu*)

3) *Pseudotsuga menziesii*/*Corylus cornuta*-*Symphoricarpos mollis*/*Polystichum munitum* community (*Psme*/*Coco*-*Symo*/*Pomu*), and

4) *Pseudotsuga menziesii*-*Libocedrus decurrens*/*Berberis nervosa*-*Gaultheria shallon*/*Linnaea borealis* community (*Psme*-*Lide*/*Bene*-*Gash*/*Libo*).

The *Alru*-*Abgr*/*Rilo*-*Acci*/*Mosi*-*Pomu* community was then subdivided into three phases: the *Alnus rubra* phase, the *Abies grandis* phase and the *Pseudotsuga menziesii* phase. Communities were named on the basis of presently dominant or important species rather than using dominants of the hypothetical climax community.

Due to the variation within some of the four general communities, the communities were divided into more natural groupings of stands and arranged in hypothetical seral sequences towards climax habitat types (Figure 12). The *Pseudotsuga menziesii* phase was not given associes status. There were sequences present leading to the climax of two habitat types. The climax communities of these habitat types are the *Tsuga heterophylla*/*Acer circinatum*/*Polystichum munitum*-*Oxalis oregana* association (*Tshe*/*Acci*/*Pomu*-*Oxor*) and the *Tsuga heterophylla*/*Berberis nervosa*-*Gaultheria shallon*/*Linnaea borealis* association (*Tshe*/*Bene*-*Gash*/*Libo*). The *Tshe*/*Acci*/*Pomu*-*Oxor* association is considered the climatic climax over most of the area of the McKenzie River terraces. The habitat type it represents consists of several associes, which are seral to the association (see Figure 12). The *Tshe*/*Bene*-*Gash*/*Libo* association is considered to be a topo-edaphic climax common to glacial outwash plains and higher elevation, low terraces where soils are shallow and coarse. It consists of a *Salix* associes, an *Alnus rubra* associes, the *Psme*-*Lide*/*Bene*-*Gash*/*Libo* associes and the final climax *Tshe*/*Bene*-*Gash*/*Libo* association.

The first two associes in the sequences that lead to either habitat type appear to be very similar for either habitat type; these include the *Salix* and the *Alnus rubra* associes. Differences lie in the amount of flooding and sedimentation occurring after establishment of floodplains, with much less sedimentation in the *Tshe*/*Bene*-*Gash*/*Libo* habitat type associes. The *Salix* associes normally occurs on slightly elevated low floodplains with a large accumulation of stones and cobbles with sand between them. The major tree species, *Salix*, never attains more than shrub status prior to being replaced or removed. Soils in this associes are shallow to nonexistent. The *Alnus* rubra associes of either habitat type is usually elevated a little above the typical level of the Salix associes. Here the soils are deeper (up to 60 cm) due to material deposited by annual flooding over the low floodplains. The major tree species in this associes is Alnus rubra, while Acer macrophyllum shares dominance in more mature stands. Where there have been slight increases in sedimentation and elevation, Populus trichocarpa increases in importance, while in areas with considerable sedimentation and elevation Abies grandis increases in importance.

The next associes in the Tshe/Acci/Pomu-Oxor habitat type, the Abies grandis associes, occurs on deep soils on high floodplains that have been slowly built up by annual accumulations of sediments of decreasing particle size. With the finer texture comes an increase in the moisture holding capacity of the soil and changes in the dominance patterns of the vegetation. Stands are dominated by a mixture of Abies grandis and Populus trichocarpa. The Populus trichocarpa grows rapidly for a few years before being overtopped by Abies grandis, which then shares dominance with the ever-present Acer macrophyllum. The shrub layer immediately becomes dominated by Acer circinatum, and annuals that are common to the lower floodplains are replaced by perennials in the herbaceous layer.

The soils of this associes, classified merely as alluvial soils are very poorly developed. Soil genesis increases on these higher floodplains because of the additions of the organic matter to the mineral soil. The soils are 110 cm to 200 cm deep and commonly lack coarse fragments in the upper horizons. As the high floodplains are built up, the likelihood of flooding becomes less, and Pseudotsuga menziesii, Libocedrus decurrens, and Thuja plicata, killed by siltation or flooding, begin filling the holes left by death of short-lived species such as Alnus rubra and Populus trichocarpa. With increased reproduction of Tsuga heterophylla from surrounding seed sources the stands begin to take on the appearance of the climax association. The actual transition from the Abies grandis associes to the Tshe/Acci/Pomu-Oxor association was not seen in the study area. Most of the terraces having the climax association probably resulted from disturbance by fire or major flooding.

There is evidence of fire almost everywhere within the study area except on the floodplains. The Psme/Coco-Symo/Pomu associes is found where burning occurred from 100 to 200 years ago. These stands typically have large numbers of even-aged, pole size (2 dm DBH) and larger Pseudotsuga menziesii, Abies grandis, Libocedrus decurrens, and Acer macrophyllum in the tree layer. They are typically open stands with a well developed herb layer and a low shrub layer dominated by Symphoricarpos mollis. The tall shrub layer is dominated by the light tolerant Corylus cornuta rather than Acer circinatum, found in more shaded areas. The soils are deep to moderately deep and are usually fine sandy loams to loams. Soil formation is well advanced within this associes with a large amount of organic matter incorporated in the surface mineral horizons.

The Tshe/Acci/Pomu-Oxor association is found on low, medium, and high terraces and has a well developed tree layer, dominated in mature stands by Pseudotsuga menziesii 200 to 450 years old. Understory trees are large Thuja plicata and Libocedrus decurrens as well as a few scattered Abies grandis. Tree reproduction is mostly Tsuga heterophylla which may occur at any height in the canopy. In the oldest stands the Pseudotsuga menziesii has fallen out of the canopy and the Tsuga heterophylla is beginning to assume dominance. This occurs about 450-550 years after the establishment of Pseudotsuga menziesii stands, following fire or other large scale disturbance.

In the Tshe/Bene-Gash/Libo habitat type the Alnus rubra associes is followed by the Psme-Lide/Bene-Gash/Libo associes. This associes occurs on low terraces in the higher elevations of the study area and on glacial outwash plains throughout the study area. In most cases it occurs on shallow soils with large amounts of coarse fragments even in the upper horizons of the profile. All stands within this associes are exposed to high amounts of light due to their exposure to the south, being on the north bank of the river or north of clearcut areas. The associes is marked by an open canopy of

Pseudotsuga menziesii, Thuja plicata, Acer macrophyllum, Tsuga heterophylla, and Libocedrus decurrens. There are a few younger Abies grandis, which apparently seldom grow very large within this community. The tall shrub layer in this associes, often very dense, is dominated by Acer circinatum, Corylus cornuta and Cornus nuttallii. The low shrub layer is very well developed, with Berberis nervosa and Gaultheria shallon having very high cover values. The higher elevation stands of this associes usually have many species common to uplands adjacent to the study area. The herb layer is poorly developed, but well represented by many small Ericads such as Chimaphila menziesii and Chimaphila umbellata. The lower elevation stands also have a well-developed shrub layer with Symphoricarpos mollis more important, while Berberis nervosa and Gaultheria shallon are both still quite common. Stand ordination based on shrubs and herbs separated the low elevation stands of this associes from the others. However, the soils and major shrub and tree species are alike for the two areas.

The Tshe/Bene-Gash/Libo association is composed of mature to old-growth Pseudotsuga menziesii, beginning to fall out, with Tsuga heterophylla filling in the open spaces in the canopy. The only place where this association was found was on a medium terrace with northern exposure, as opposed to the southern exposure found for all seral stages. This has probably changed the tree species composition very little since exposure at the time of invasion after fire is probably the important factor in determination of tree species composition. A distinguishing characteristic of this association is the occurrence of large patches of moss with few vascular plants in areas with exposed rocks or surface soils less than 20 cm deep.

The major factors responsible for distribution of plant groupings occurring on the McKenzie River floodplains, terraces and glacial outwash plains appear to be the edaphic factors, and the effects they have on moisture availability to plant communities. In the early stages of succession the plant communities respond to a difference in texture of sediments deposited in successive flooding of an area. Successive flooding and meandering of the McKenzie River removes some older terraces and starts new floodplains. These floodplains accumulate finer textured deposits during each successive flood as their elevation above flood level increases. These finer textured soils and the increased depth to water table seem to be highly responsible for community distribution on various levels and substrate within the study area (Figure 13). When the floodplains are elevated beyond normal flood level, the communities develop towards the climax unless they are interrupted either by flooding or by fire. Either disturbance may cause a reversal in the seral development of the stands by greatly altering soils through sedimentation or by burning mature stands followed by replacement by <u>Psme</u>/<u>Coco</u>-<u>Symo</u>/<u>Pomu</u> or <u>Psme</u>-<u>Lide</u>/

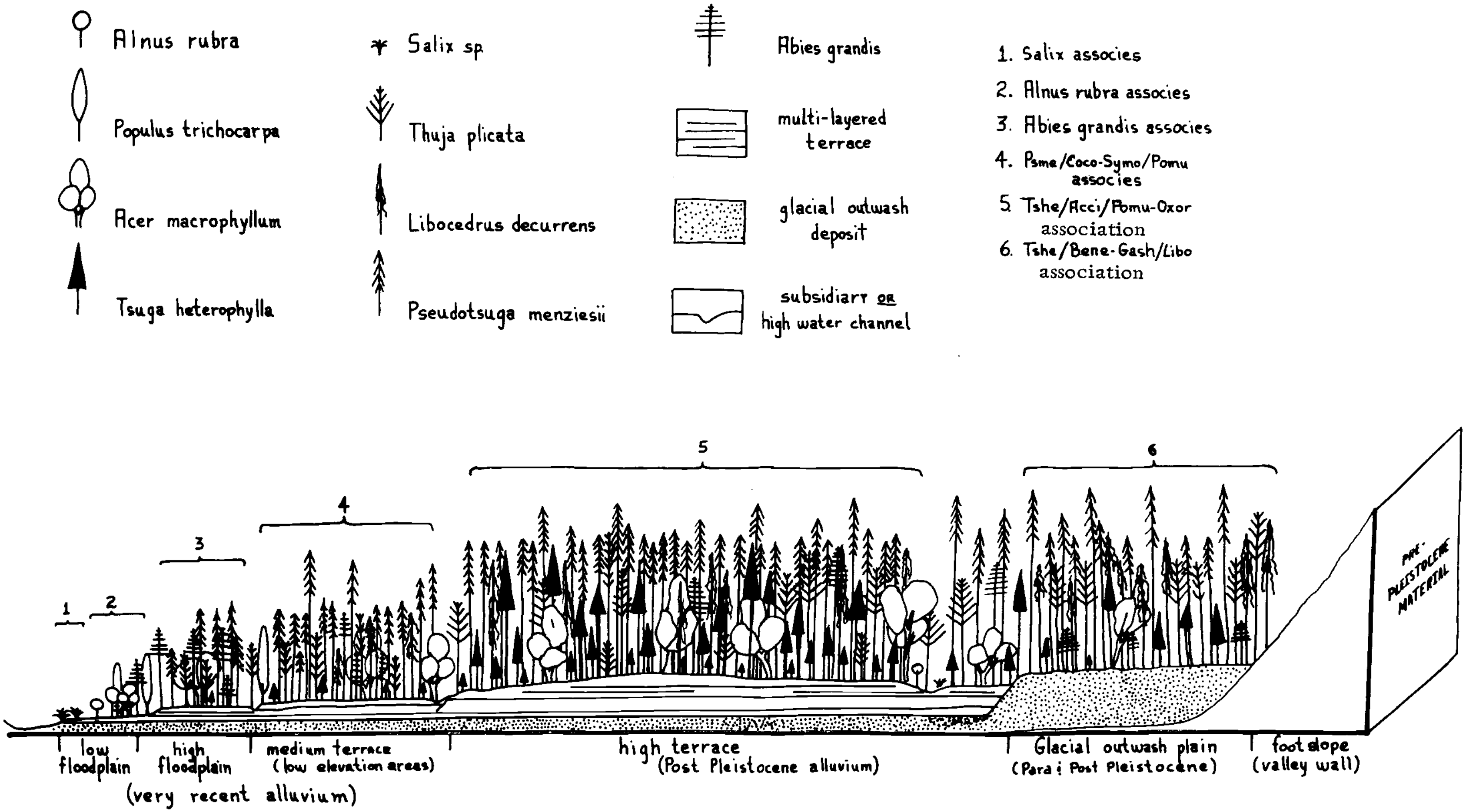

Figure 13. Diagramatic cross section of floodplains, terraces and glacial outwash plains on the McKenzie River, Oregon.

<u>Bene</u>-<u>Gash</u>/<u>Libo</u> associes. It appears that most of the stands included in this study, representing both of the associations, were established following fire. In many stands there are large burns far up on the boles of older trees as well as burned roots in the soil. In addition to responses to soil texture and moisture, the stand composition appears to be regulated also by elevation and exposure in the case of the <u>Tshe</u>/<u>Bene</u>-<u>Gash</u>/<u>Libo</u> association. The likelihood of flooding in a given area and the amount of sedimentation that occurs during that flooding seems to play a most important role in determining which habitat type is created. <u>Tshe</u>/<u>Bene</u>-<u>Gash</u>/<u>Libo</u> association areas typically occur on elevated areas or in high elevation (upstream) areas where little flooding and burying of coarse textured soils occurs.

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APPENDICES

APPENDIX 1

LOCATION OF ANALYTIC PLOTS ON THE MIDDLE SECTION OF THE MCKENZIE RIVER

Delta Campground	AP #1	SW1/4 SE1/4 NE1/4 Sec. 23 R4E T16S
Delta Campground	AP #2	SW1/4 SE1/4 NE1/4 Sec. 23 R4E T16S
Delta Campground	AP #3	SW1/4 SE1/4 NE1/4 Sec. 23 R4E T16S
Delta Campground	AP #4	SW1/4 NE1/4 Sec. 24 R4E T16S
Delta Campground	AP #5	SW1/4 NE1/4 Sec. 24 R4E T16S
Delta Campground	AP #6	SW1/4 NE1/4 Sec. 24 R4E T16S
Delta Campground	AP #7	SW1/4 NE1/4 Sec. 24 R4E T16S
Delta Campground	AP #8	SW1/4 NE1/4 Sec. 24 R4E T16S
Delta Campground	AP #9	SW1/4 NE1/4 Sec. 24 R4E T16S
Delta Campground	AP #10	NW1/4 NE1/4 Sec. 24 R4E T16S
Delta Campground	AP #11	NW1/4 NE1/4 Sec. 24 R4E T16S
Delta Campground	AP #12	NW1/4 NE1/4 Sec. 24 R4E T16S
East Delta	AP #13	NW1/4 NE1/4 Sec. 19 R5E T16S
East Delta	AP #14	NE1/4 NW1/4 Sec. 19 R5E T16S
East Delta	AP #15	NE1/4 NW1/4 Sec. 19 R5E T16S
Blue River	AP #16	SE1/4 NW1/4 Sec. 28 R4E T16S
Blue River	AP #17	SE1/4 NW1/4 Sec. 28 R4E T16S
Blue River	AP #18	SE1/4 NW1/4 Sec. 28 R4E T16S
Blue River	AP #19	SW1/4 NE1/4 Sec. 28 R4E T16S
Blue River	AP #20	SW1/4 NE1/4 Sec. 28 R4E T16S
Blue River	AP #21	SW1/4 NE1/4 Sec. 28 R4E T16S
Paradise Campground	AP #22	SW1/4 SE1/4 Sec. 9 R6E T16S
Paradise Campground	AP #23	SW1/4 SE1/4 Sec. 9 R6E T16S
Paradise Campground	AP #24	SW1/4 SE1/4 Sec. 9 R6E T16S
Scott Creek	AP #25	SE1/4 SE1/4 Sec. 2 R6E T16S
Scott Creek	AP #26	SE1/4 SE1/4 Sec. 2 R6E T16S
Scott Creek	AP #27	SE1/4 SE1/4 Sec. 2 R6E T16S
Boulder Creek	AP #28	SW1/4 SE1/4 Sec. 2 R6E T16S
Boulder Creek	AP #29	SW1/4 SE1/4 Sec. 2 R6E T16S
Boulder Creek	AP #30	SW1/4 SE1/4 Sec. 2 R6E T16S
Boulder Creek	AP #31	SE1/4 NE1/4 Sec. 2 R6E T16S

(Continued on next page)

Boulder Creek	AP #32	SE1/4 NE1/4 Sec. 2 R6E T16S
Boulder Creek	AP #33	SE1/4 NE1/4 Sec. 2 R6E T16S
Delta Campground	AP #34	SW1/4 NE1/4 Sec. 24 R4E T16S
Delta Campground	AP #35	NW1/4 SE1/4 Sec. 24 R4E T16S
Delta Campground	AP #36	SW1/4 NE1/4 Sec. 24 R4E T16S
Blue River	AP #37	SW1/4 NE1/4 Sec. 29 R4E T16S
Blue River	AP #38	SW1/4 NE1/4 Sec. 29 R4E T16S
Blue River	AP #39	SW1/4 SW1/4 NE1/4 Sec. 29 R4E T16S
Blue River	AP #40	SE1/4 NW1/4 Sec. 29 R4E T16S
Blue River	AP #41	SW1/4 NW1/4 Sec. 28 R4E T16S
Blue River	AP #42	SW1/4 NW1/4 Sec. 28 R4E T16S
Blue River	AP #43	SW1/4 NE1/4 Sec. 28 R4E T16S
Horse Creek Campground	AP #44	NW1/4 SE1/4 Sec. 24 R5E T16S
Horse Creek Campground	AP #45	NW1/4 SE1/4 Sec. 24 R5E T16S
Horse Creek Campground	AP #46	NW1/4 SE1/4 Sec. 24 R5E T16S
Quartz Creek	AP #47	SW1/4 NW1/4 Sec. 6 R4E T17S
Quartz Creek	AP #48	SW1/4 NW1/4 Sec. 6 R4E T17S
Dearborn Island	AP #49	NE1/4 NE1/4 Sec. 19 R5E T16S
Dearborn Island	AP #50	NE1/4 NE1/4 Sec. 19 R5E T16S
East Delta	AP #51	NE1/4 NW1/4 Sec. 19 R5E T16S
East Delta	Ap #52	NW1/4 NE1/4 Sec. 19 R5E T16S
East Delta	AP #53	NW1/4 NE1/4 Sec. 19 R5E T16S
Dearborn Island	AP #54	NE1/4 NE1/4 Sec. 19 R5E T16S

APPENDIX 2

ANNOTATED CHECKLIST OF VASCULAR PLANTS AND MOSSES OCCURRING ON OR NEAR ANALYTIC VEGETATION PLOTS

The nomenclature followed here is that of Franklin and Dyrness (1971) and Peck (1961). Following common names are one or more pairs of letters indicating community types and abundance within those communities of the species.

Community types are:

W = Tsuga heterophylla/Acer circinatum/Polystichum munitum-Oxalis oregana

X = Alnus rubra-Abies grandis/Ribes lobbii-Acer circinatum/Montia sibirica-Polystichum munitum

Y = Pseudotsuga menziesii/Corylus cornuta-Symphoricarpos mollis/Polystichum munitum

Z = Pseudotsuga menziesii-Libocedrus decurrens/Berberis nervosa-Gaultheria shallon/Linnaea borealis

Abundance categories are:

R = Rare (less than 25% constancy in community)

O = Occasional ($> 25\% < 50\%$ constancy in community)

C = Common ($> 50\% < 75\%$ constancy in community)

A = Abundant ($> 75\%$ constancy in community)

EQUISETOPHYTA

Equisetaceae

Equisetum arvense L., common horsetail (X-C)

POLYPODIOPHYTA

Polypodiaceae

Adiantum pedatum L., maidenhair-fern (W-O, X-R, Y-R)
Athyrium filix-femina (L.) Roth, lady-fern (W-O, X-R, Y-R)
Blechnum spicant (L.) With., deer-fern (W-R)
Cystopteris fragilis (L.) Bernh., bladder-fern (W-R)
Dryopteris arguta (Kaulf) Watt., coastal wood-fern (W-R, Y-R)
Dryopteris dilatata (Hoffm.) A. Gray, spreading wood-fern (W-R)
Polypodium glycyrrhiza D, C. Eat., licorice fern (W-R, X-R, Z-R)

Polystichum lonchitis (L.) Roth, holley-fern (W-O, X-R, Y-O, Z-R)
Polystichum munitum (Kaulf.) Presl, western sword-fern (W-A, X-A, Y-A, Z-O)
Pteridium aquilinum (L.) Kuhn var. pubescens Underw., bracken or western brake-fern (W-O, Y-C, Z-C)

PINOPHYTA

Taxaceae

Taxus brevifolia Nutt., western yew (W-R, X-R, Y-R, Z-C)

Cupressaceae

Libocedrus decurrens Torr., incense cedar (W-R, X-C, Y-A, Z-C)
Thuja plicata Donn, western redcedar (W-A, X-O, Y-C, Z-A)

Pinaceae

Abies grandis (Dougl.) Lindl., grand fir (W-C, X-A, Y-A, Z-A)
Pseudotsuga menziesii (Mirb.) Franco, Douglas-fir (W-A, X-C, Y-A, Z-A)
Tsuga heterophylla (Raf.) Sarg., western hemlock (W-A, X-R, Y-O, Z-C)

MAGNOLIOPHYTA

Cyperaceae

Carex bolanderi Oln., Bolander's sedge (X-C, Y-R)

Gramineae

Agrostis tenuis Sibth., colonial bent-grass (W-R, X-O, Y-R)
Bromus vulgaris (Hook.) Shear, narrow-flowered brome-grass (W-O, X-C, Y-A, Z-R)
Elymus glaucus Buckl., western rye-grass (X-C)

Araceae

Lysichitum americanum Hulten and St. John, yellow skunk-cabbage (off plots at Paradise Campground, Horse Creek, and East Delta locations)

Liliaceae

Clintonia uniflora (Schult.) Kunth, one-flowered clintonia (W-R, Z-C)
Disporum hookeri (Torr.) Nicholson var. oreganum (Wats.) Q. Jones, Hooker's fairy bells (W-O, X-O, Y-O, Z-C)

Disporum smithii (Hook.) Piper, large flowered fairy bell (off plot, Delta)
Lilium columbianum Hanson in Baker, Columbia or tiger lily (Z-O)
Lilium washingtonianum Kell. var. purpurascens Stearn, Washington's lily (off plot Scott Creek location)
Smilacina racemosa (L.) Desf., false Solomon's seal (W-R, X-R, Z-R)
Smilacina stellata (L.) Desf., few-flowered false Solomon's seal (W-O, X-O, Y-A, Z-C)
Streptopus amplexifolius (L.) DC. in Lam. & DC., larger twisted-stalk (Z-R)
Trillium ovatum Pursh, western trillium or wake-robin (W-C, X-R, Z-C)

Iridaceae

Iris tenax Dougl. ex Lindl., Oregon iris (off plot, Scott Creek)

Orchidaceae

Calypso bulbosa (L.) Oakes in Thompson, calypso (fairy slipper) (Z-O)
Corallorhiza maculata Raf., spotted coral-root (Z-R)
Eburophyton austinae (Gray) Heller, ghost orchid (W-R)
Goodyera oblongifolia Raf., rattlesnake plantain (W-O, Y-A, Z-A)
Listera caurina Piper, western twayblade (Y-R, Z-C)

Salicaceae

Populus trichocarpa T. & G. ex Hook., black cottonwood (X-O, Y-R)
Salix sp. (Tourn.) L., willow (off plot on river bank all locations)

Betulaceae

Alnus rubra Bong., red alder (X-C)
Corylus cornuta Marsh. var. californica (DC.) Sharp, California hazel (W-A, X-A, Y-A, Z-A)

Fagaceae

Castanopsis chrysophylla (Dougl.) A. DC., golden chinquapin (W-R, Z-R)

Urticaceae

Urtica lyallii Wats., northwest nettle (X-R)

Aristolochiaceae

Asarum caudatum Lindl., western wild ginger (W-A, X-O, Y-O, Z-O)

Portulacaceae

Montia sibirica (L.) Howell, western spring beauty (W-R, X-A, Y-R)

Caryophyllaceae

Silene menziesii Hook., Menzie's campion or pink (off plot Delta Campground)
Stellaria calycantha (Ledeb.) Bong., northern starwort (X-R, Y-C)
Stellaria crispa Cham. & Schlecht., crisped starwort (X-O, Y-R)

Ranunculaceae

Actaea rubra (Ait.) Willd., western baneberry (X-R)
Anemone deltoidea Hook., western white anemone (W-C, X-R, Y-R, Z-A)
Anemone lyallii Britt., little mountain anemone (W-R, X-O, Y-O, Z-C)
Coptis laciniata Gray, western gold-thread (X-O, Y-C, Z-R)
Ranunculus uncinatus D. Don in G, Don var. parviflorus (Torr.) Benson, little buttercup (X-R)
Thalictrum occidentale Gray, western meadow-rue (W-R, X-C, Y-A)

Berberidaceae

Achlys triphylla (Smith) DC., vanilla-leaf (W-R, Z-C)
Berberis aquifolium Pursh, Oregon grape (X-R, Y-R)
Berberis nervosa Pursh, long-leaved Oregon grape (W-A, X-R, Y-A, Z-A)
Vancouveria hexandra (Hook.) Morr. & Dec., inside-out flower (W-A, X-C, Y-A, Z-C)

Fumariaceae

Dicentra formosa (Andr.) Walpers, western bleeding-heart (W-R, X-O)

Saxifragaceae

Heuchera micrantha Dougl. ex Lindl., small-flowered heuchera (W-R)
Tiarella trifoliata L., three-leaved coolwort (off plot mid-Delta)
Tiarella unifoliata Hook., western coolwort or foam flower (W-A, X-C, Z-C)

Tolmiea menziesii (Pursh) T. & G., youth-on-age (X-A)

Grossulariaceae

Ribes lobbii Gray, pioneer gooseberry (X-O, Y-R)

Hydrangeaceae

Philadelphus lewisii Pursh var. gordonianus (Lindl.) Jeps., western syringa (W-R, Y-R)
Whipplea modesta Torr., modest whipplea (W-R, Y-O, Z-R)

Rosaceae

Amelanchier alnifolia Nutt. var. humptulipensis (G. N. Jones) C. L. Hitchc., western serviceberry (W-R, Z-R)
Aruncus sylvester Kostel in Ind., goat's-beard (off plot Horse Creek)
Fragaria vesca L. var. bracteata (Heller) Davis, western wood strawberry (X-O, Y-A, Z-R)
Holodiscus discolor (Pursh) Maxim., ocean-spray (Y-R, Z-R)
Osmoronia cerasiformis (T. & G.) Greene, Indian plum (W-R, X-C, Y-C, Z-R)
Physocarpus capitatus (Pursh) Ktze., ninebark (X-R)
Rosa gymnocarpa Nutt. in T. & G., little wildrose (W-R, X-R, Y-C, Z-A)
Rubus laciniatus Willd., evergreen blackberry (off plot Delta and East Delta)
Rubus leucodermis Dougl. ex T. & G., western blackcap (W-R)
Rubus nivalis Dougl. ex Hook., snow bramble (Z-R)
Rubus parviflorus Nutt., thimbleberry (W-R, X-O, Z-R)
Rubus procerus Muell. in Boulay, Himalaya berry (X-R)
Rubus spectabilis Pursh, salmonberry (off plot Delta Campground)
Rubus ursinus Cham. & Schlect., western dewberry (W-A, X-A, Y-A, Z-A)

Leguminosae

Cytisus scoparius (L.) Link, Scotch broom (X-R)
Lathyrus nevadensis Wats., Sierra Nevada pea (Y-R)
Vicia americana Muhl. ex Willd. var. villosa (Kell.) Hermann, California vetch (X-R, Y-O)

Oxalidaceae

Oxalis oregana Nutt. ex T. & G., Oregon oxalis (W-A, X-A, Y-A, Z-R)

Anacardiaceae

Rhus diversiloba T. & G., poison oak (off plot Boulder Creek and Delta Campground)

Celastraceae

Pachystima myrsinites (Pursh) Raf., Oregon boxwood (Z-R)

Aceraceae

Acer circinatum Pursh, vine maple (W-A, X-A, Y-A, Z-A)
Acer macrophyllum Pursh, bigleaf maple (W-A, X-A, Y-A, Z-C)

Rhamnaceae

Rhamnus purshiana DC., cascara (W-R, Z-O)

Hypericaceae

Hypericum perforatum L., common St. John's-wort (off plot, East Delta)

Violaceae

Viola glabella Nutt. in T. & G., smooth woodland violet (W-O, X-A, Y-A, Z-R)
Viola sempervirens Greene, evergreen violet (W-C, Y-R, Z-A)

Onagraceae

Circaea alpina L., small enchanter's nightshade (W-O, X-A, Y-C)
Epilobium angustifolium L., fire-weed (off plot, Dearborn Island)
Epilobium paniculatum Nutt. ex T. & G., tall annual willow-herb (off plot Dearborn Island, Southwest Delta Area)
Epilobium watsonii Barbey in Brew. & Wats., common western willow-herb (X-R)

Araliaceae

Aralia californica Wats., western aralia, ginseng, elk clover (X-R)

Umbelliferae

Daucus carota L., wild carrot (off plot, Dearborn Island)

Heracleum lanatum Michx., cow parsnip (X-C)
Osmorhiza chilensis H. & A., western sweet cicely (W-R, X-A, Y-C, Z-R)

Cornaceae

Cornus nuttallii Aud. ex T. & G., flowering dogwood (W-C, X-R, Y-C, Z-C)

Ericaceae

Chimaphila menziesii (R. Br.) Spreng., little prince's pine (Z-O)
Chimaphila umbellata (L.) Bart. var. occidentalis (Rydb.) Blake, western prince's pine (Z-O)
Gaultheria shallon Pursh, salal (W-O, X-R, Y-O, Z-A)
Monotropa uniflora L., Indian pipe (W-R, Z-R)
Pterospora andromedea Nutt., pine drops (Z-R)
Pyrola aphylla Smith in Rees, leafless pyrola (off plot Paradise Campground)
Pyrola asarifolia Michx., large pyrola (Z-C)
Pyrola picta Smith in Rees, white veined pyrola (Z-O)
Rhododendron macrophyllum G. Don, Pacific rhododendron (off plot Boulder Creek and Delta)
Vaccinium membranaceum Dougl. ex Hook., thin-leaved huckleberry (Z-R)
Vaccinium parvifolium Smith in Rees, red huckleberry (W-C, X-R, Y-A, Z-C)

Primulaceae

Trientalis latifolia Hook., broad-leaved star-flower (W-R, X-C, Y-A, Z-A)

Oleaceae

Fraxinus latifolia Benth., Oregon ash (X-C, Y-C)

Polemoniaceae

Collomia heterophylla Hook., varied-leaved collomia (W-R, X-O)
Gilia capitata Sims, blue field gilia (off plot Delta Campground and and East Delta)

Hydrophyllaceae

Hydrophyllum tenuipes Heller, slender-stemmed waterleaf (W-R, X-O)

Nemophila parviflora Dougl. ex Benth. var. parviflora, small-flowered nemophila (X-C, Y-R)

Labiatae

Prunella vulgaris L. var. lanceolata (Barton) Fern., heal-all (W-R, X-O)
Satureja douglasii (Benth.) Briq., Yerba buena (Z-R)
Stachys cooleyae Heller, great hedge nettle (X-C)
Stachys palustris L. var. pilosa (Nutt.) Fern., swamp hedge nettle (W-R, X-C, Y-C)

Scrophulariaceae

Digitalis purpurea L., foxglove (W-R)
Mimulus guttatus DC., common monkeyflower (off plot East Delta and Southwest Delta)
Synthyris reniformis (Dougl.) Benth. in DC., round-leaved synthyris or snowqueen (W-R, X-O, Y-A, Z-C)

Rubiaceae

Galium bifolium Wats., low mountain bedstraw (W-A, X-A, Y-A, Z-R)
Galium triflorum Michx., fragrant bedstraw (W-A, X-A, Y-A, Z-C)

Caprifoliaceae

Linnaea borealis L. var. longiflora Torr., American twinflower (W-C, X-C, Y-A)
Lonicera ciliosa (Pursh) DC., orange honeysuckle (X-R, Y-R, Z-O)
Symphoricarpos mollis Nutt. in T. & G., creeping snowberry (W-R, X-A, Y-A, Z-C)

Campanulaceae

Campanula scouleri Hook. ex A. DC., Scouler's campanula (X-R, Z-R)

Compositae

Adenocaulon bicolor Hook., trail plant (W-C, X-O, Y-A, Z-O)
Anaphalis margaritacea (L.) B. & H., pearly everlasting (off plot West Delta)
Chrysanthemum leucanthemum L., ox-eyed daisy (off plot on flood-plains near Delta Campground)
Cirsium vulgare (Savi) Airy-Shaw, bull thistle (X-R)

Hieracium albiflorum Hook., white-flowered hawkweed (W-R, X-R, Z-R)

Petasites frigidus (L.) Fires var. palmatus (Ait.) Cronq., western coltsfoot (W-R, X-A)

BRYOPHYTA

Leucolepis menziesii (Hook.) Steere (W-C, X-C, Y-C, Z-R)

Plagiomnium insigne (Mitt.) Koponen (W-C, X-C, Y-C, Z-R)

Hylocomium splendens (Hedw.) B.S.G. (W-A, X-O, Y-A, Z-A)

Hypnum circinale Hook. (W-O, X-O, Y-O, Z-O)

Isothecium spiculiferum (Mitt.) Ron. and Card. (W-O, X-R, Z-O)

Rhytidiadelphus triquetrus (Hedw.) Wornst. (W-A, X-C, Y-A, Z-A)

Eurhynchium oreganum (Sull.) Jaeg and Sauerb. (W-A, X-C, Y-A, Z-A)

Dicranum fuscescens Turn. (W-O, X-O, Y-A, Z-O)

APPENDIX 3

List of 50 shrub and herb species with the greatest indicator significance for use in similarity ordination.

Species	% Constancy in study area	Species	% Constancy in study area
Stachys cooleyae	14.8	Stellaria calycantha	14.8
Heracleum lanatum	13.0	Coptis laciniata	18.5
Elymus glaucus	11.1	Whipplea modesta	13.0
Equisetum arvense	11.1	Anemone deltoidea	44.4
Collomia heterophylla	9.3	Berberis nervosa	75.9
Petasites frigidus	24.1	Gaultheria shallon	44.4
Tolmiea menziesii	20.4	Pteridium aquilinum	35.2
Prunella vulgaris	14.8	Viola sempervirens	42.6
Carex bolanderi	16.7	Vaccinium parvifolium	55.6
Nemophila parviflora	20.3	Cornus nuttallii	50.0
Montia sibirica	25.9	Goodyera oblongifolia	50.0
Ribes lobbii	11.1	Trillium ovatum	38.9
Circaea alpina	46.3	Clintonia uniflora	18.5
Viola glabella	50.0	Pyrola asarifolia	14.8
Thalictrum occidentale	35.2	Listera caurina	18.5
Oxalis oregana	72.2	Chimaphila umbellata	11.1
Polystichum munitum	77.8	Chimaphila menziesii	11.1
Osmoronia cerasiformis	40.7	Pyrola picta	9.3
Symphoricarpos mollis	51.9	Rhamnus purshiana	14.8
Osmorhiza chilensis	38.9	Linnaea borealis	57.4
Stachys palustris	33.3	Trientalis latifolia	53.7
Fragaria vesca	24.1	Smilacina racemosa	7.4
Bromus vulgaris	42.6	Smilacina stellata	55.6
Adenocaulon bicolor	57.4	Athyrium filix-femina	13.0
Synthyris reniformis	42.6	Blechnum spicant	5.6

APPENDIX 4

SIZE CLASS DISTRIBUTION OF TREES ON MCKENZIE RIVER TERRACES, FLOODPLAINS, AND GLACIAL OUTWASH PLAINS

Community type and tree species	Number of trees per hectare				
	<1 m tall	0-1 dm DBH	1-4 dm DBH	4-8 dm DBH	> 8 dm DBH
Tshe/Acci/Pomu-Oxor Community					
Tsuga heterophylla	1112	162	156	33	6
Acer macrophyllum	621	4	52	22	2
Thuja plicata	297	18	68	25	2
Abies grandis	121	29	2	0	2
Pseudotsuga menziesii	22	0	25	24	48
Libocedrus decurrens	0	0	2	8	8
Taxus brevifolia	0	3	4	0	0
Alru-Abgr/Rilo-Acci/Mosi-Pomu Community					
Abies grandis	409	30	90	30	25
Acer macrophyllum	1171	61	56	23	7
Fraxinus latifolia	385	27	18	0	0
Alnus rubra	83	0	130	12	0
Populus trichocarpa	34	0	7	14	23
Libocedrus decurrens	0	3	47	9	5
Pseudotsuga menziesii	0	0	28	23	56
Thuja plicata	0	0	16	3	0
Tsuga heterophylla	0	0	14	5	0
Psme/Coco-Symo/Pomu Community					
Pseudotsuga menziesii	19	0	185	108	43
Abies grandis	228	75	54	3	3
Fraxinus latifolia	338	17	6	0	0
Acer macrophyllum	1000	0	78	16	0
Libocedrus decurrens	19	19	113	19	3
Tsuga heterophylla	59	6	8	0	0
Thuja plicata	0	0	16	0	0
Taxus brevifolia	0	0	3	0	0
Populus trichocarpa	0	0	27	0	30

(Continued on next page)

Community type and tree species	Number of trees per hectare				
	< 1 m tall	0-1 dm DBH	1-4 dm DBH	418 dm DBH	> 8 dm DBH
Psme-Lide/Bene-Gash/Libo Community					
Pseudotsuga menziesii	0	0	129	129	62
Libocedrus decurrens	14	35	79	10	0
Thuja plicata	113	45	163	18	4
Abies grandis	286	45	27	0	0
Taxus brevifolia	16	14	6	0	0
Acer macrophyllum	259	0	12	0	0
Tsuga heterophylla	116	73	75	4	0

APPENDIX 5

SOIL DESCRIPTIONS FROM REPRESENTATIVE STANDS WITHIN THE STUDY AREA

Each description is numbered with the number of the stand that it was taken from. Location of the stand can be found in Appendix 1 or in Figures 1 or 2. Colors for all soils are moist colors unless stated otherwise. Cobble and stone percentages by volume and gravel percent by weight.

Tshe/Acci/Pomu-Oxor Community

Soil #34
Slope: 1° downstream
Rooting: Fine roots are common in the top 15 cm and few to 30 cm. fine and medium roots are abundant from 30 to 60 cm, and few below this level. Coarse roots are common from 50 to 70 cm and few at all other levels.

01	2-0 cm	thin felty mor
A	0-20 cm	very dark brown (10YR2/2) sandy loam, very dark grayish brown (10YR3/2) when dry; weak medium to fine granular structure; friable, slightly sticky, non plastic; medium acid (pH 5.81); abrupt, smooth boundary; 15% gravel
B2	20-40 cm	dark yellowish brown (10YR3/4) loam to sandy loam, yellowish brown (10YR5/4) when dry; moderate, fine subangular blocky structure; friable, slightly sticky and very slightly plastic; medium acid (pH 6.02); abrupt, smooth boundary; 18% gravel
C1	40-50 cm	very dark brown (10YR2/2) coarse sand, grayish brown (10YR5/2) when dry; loose, single grain; nonsticky, non plastic; slightly acid (pH 6.05); abrupt, smooth boundary; 55% gravel
C2	50-72 cm	very dark grayish brown (10YR3/2) coarse sand; loose, single grain, structureless; non sticky and non plastic; medium acid (pH 5.74); clear, smooth boundary; 10% gravel
C3	72-90 cm	very dark brown (10YR2/2) coarse sand, dark gray (10YR4/1) when dry; loose, single grain,

structureless; non sticky and non plastic; medium acid (pH 5.87); gravels 55% and cobbles 30%

Soil #48
Slope: 2° downstream (west) and 1° gradient toward the south, away from the river
Rooting: All size classes of roots are few to 100 cm

01	2-0 cm	thin duff mull
A1	0-19 cm	very dark brown (10YR2/2) loam, dark grayish brown (10YR4/2) when dry; moderate, fine to medium subangular blocky structure; firm, slightly sticky and slightly plastic; slightly acid (pH 6.13); clear smooth boundary
A3	19-35 cm	dark yellowish brown (10YR3/4) loam, yellowish brown (10YR5/4) when dry; weak, fine granular structure, very friable, non sticky, non plastic; medium acid (pH 5.81); abrupt, smooth boundary
B2	35-59 cm	dark brown (10YR3/3) loam, brown (10YR5/3) when dry; weak, medium subangular blocky structure; friable, non sticky, non plastic; medium acid (pH 5.63); clear smooth boundary
C	59-78 cm	dark brown (7.5YR3/2) loamy sand; very fine single grain; loose, non sticky, non plastic; medium acid (pH 5.73); abrupt smooth boundary
IIB2	78-95 cm	dark yellowish brown (10YR3/4) loam, fine to medium subangular blocky structure; very friable, non sticky, non plastic; medium acid (pH 5.92); clear smooth boundary
IIC	95-128 cm	dark brown (10YR3/3) loamy sand; weak, fine to medium subangular blocky structure; friable, non sticky, non plastic; medium acid (pH 5.73)

Soil #46
Slope: 4° to the north, downstream
Rooting: Medium roots are common in the top 30 cm and few to 90 cm. Coarse roots are common from 30 cm to 40 cm and few in all other levels. Fine roots are common only in top 10-15 cm.

01	2-1 cm	conifer leaves and twigs
02	1-0 cm	detritus and mycelia--felty mor
A1	0-11 cm	very dark brown (7.5YR2/2) silt loam, dark grayish brown (10YR4/2) when dry; strong, medium to coarse granular structure; friable, slightly sticky, slightly plastic; medium acid (pH 6.05); abrupt, smooth boundary
A3	11-30 cm	some charcoal present; very dark brown (10YR2/2) silt loam, dark grayish brown (10YR4/2) when dry; strong, medium and fine subangular blocky structure; firm, slightly sticky, plastic; medium acid (pH 5.75); gradual smooth boundary
B21	30-52 cm	dark brown (7.5YR3/2) loam, dark brown (10YR4/3) dry; moderate, medium and fine subangular blocky structure; friable, slightly sticky, slightly plastic; medium acid (pH 5.83); clear, smooth boundary. Dark red (2.5YR3/6) and dark reddish brown (5YR3/3), 1 in. diameter mottles and streaks are common
B22	52-73 cm	dark yellowish brown (10YR3/4) loam; moderate, medium to coarse subangular blocky structure; firm, slightly sticky, slightly plastic; medium acid (pH 5.87); abrupt, smooth boundary
B23	73-95 cm	mixed dark yellowish brown (10YR3/4) and dark reddish brown (5YR3/4) massive fine sandy loam; non sticky and non plastic; friable; medium acid (pH 5.75); gradual, smooth boundary
C	95-150 cm	extremely wet at 135 cm; dark brown (7.5YR 4/4) loamy sand; massive to single grain, extremely wet, non sticky, non plastic; medium acid (pH 5.83); cobbles 15% starting at 135 cm

Alru-Abgr/Rilo-Acci/Mosi-Pomu Community

Soil #11
Slope: 2^{o} downstream (west) and lenticular from north to south between the main McKenzie River and one subsidiary channel
Rooting: fine roots are common in top 50 cm; fine medium and coarse roots are common to abundant starting at 50 cm and becoming fewer to none at 90 cm

A	0-20 cm	black (10YR2/1) fine to medium sand, dark gray (10YR4/1) when dry; loose, single grain, non sticky, non plastic; very strongly acid (pH 4.95); gradual, smooth boundary; 75% fine gravel
C	20-50 cm	black (10YR2/1) coarse sand, dark gray (10YR4/1) when dry; loose, single grain; non sticky, non plastic; strongly acid (pH 5.10); clear, smooth boundary; 55% fine gravel
IIAC	50-65 cm	black (10YR2/1) medium coarse sand, dark gray (10YR4/1) when dry; loose, single grain; non sticky, non plastic; very strong acid (pH 5.05); abrupt, smooth boundary; 70% medium to coarse gravels, 10% cobbles
IIC	65-75 cm	black (10YR2/1) coarse sand, dark gray (10YR4/1) when dry; loose, single grain, non sticky, non plastic; very strongly acid (pH 4.85); clear, smooth boundary; 53% coarse gravel, 18% cobbles
IIIAC	75-90 cm	black (10YR2/1) coarse sand, dark gray (10YR4/1) when dry; loose, single grain, non sticky, non plastic; strongly acid (pH 5.12); 30% coarse gravels, 45% cobbles

Soil #5
Slope: 1^{o} downstream (west) and 2^{o} away from stream (south)
Rooting: Fine roots are few in the top 20 cm. Fine and medium roots are common from 20 to 35 cm, few to 55 cm and becoming more common by 60 cm. Coarse roots are few from 50 to 70 cm and none at other levels in pit.

01	2-0 cm	felty mor
A1	0-12 cm	dark brown (7.5YR3/2) sandy loam, dark grayish brown (10YR4/2) when dry; weak, fine to medium granular, very friable, non sticky,

		non plastic; slightly acid (pH 6.06); abrupt, wavy boundary
AB	12-22 cm	very dark grayish brown (10YR3/2) sandy loam to loam, grayish brown (10YR5/2) when dry; very weak, fine to medium subangular blocky structure; very friable, very slightly sticky, and non plastic; medium acid (pH 5.83); abrupt, wavy boundary
B2	22-47 cm	very dark brown (10YR2/2) medium to coarse sandy loam, dark grayish brown (10YR4/2) when dry; weak, fine to medium subangular blocky structure; friable, slightly sticky, non plastic; medium acid (pH 5.83); clear, smooth boundary
C1	47-65 cm	dark brown (7.5YR3/2) loamy sand, dark grayish brown (10YR4/2) when dry; weak, medium, subangular blocky structure; friable, non sticky, non plastic; medium acid (pH 5.75); clear, smooth boundary
C2	65-90 cm	vary dark grayish brown (10YR3/2) loamy sand, grayish brown (10YR5/2) when dry; very weak, medium subangular blocky structure; friable, non sticky, non plastic; slightly acid (pH 6.39); gradual, smooth boundary
IIAC	90-128 cm	dark brown (7.5YR3/2) loam, brown (10YR4/3) when dry; weak, medium subangular blocky structure; slightly sticky, slightly plastic, friable to firm; medium acid (pH 5.75); gradual smooth boundary. Common mottles 1 to 2 in. in diameter, dark reddish brown (5YR3/3).
IIC	128-160 cm	dark brown (7.5YR3/2) loamy sand, brown (10YR4/3) when dry; weak, fine subangular blocky structure; friable, non sticky, non plastic; medium acid (pH 5.81); 25% gravel, 33% cobbles

Soil #38
Slope: 2^{o} slope downstream (west) and 1^{o} away from the stream (south)
Rooting: Fine and medium roots are common in the top 30 cm and abundant from 30 to 55 cm, few to 70 cm, and common from 70 to 90 cm, few from 90 to 138 cm, common from 138 to 150 cm

01	1-0 cm	thin duff mull
A	0-20 cm	very dark grayish brown (10YR3/2) fine loamy sand, dark grayish brown (10YR4/2) when dry; very fine single grain, structureless; loose, non sticky and non plastic; medium acid (pH 5.67); abrupt smooth boundary
C	20-42 cm	very dark gray (10YR3/1) coarse sand, gray (10YR5/1) when dry; very fine single grain, structureless; loose, non sticky, non plastic; strongly acid (pH 5.58); abrupt, smooth boundary
IIAC	42-53 cm	very dark grayish brown (10YR3/2) sandy loam, dark grayish brown (10YR4/2) when dry; very fine single grain, structureless; loose, non sticky, non plastic; medium acid (pH 5.74); abrupt smooth boundary
IIC	53-70 cm	very dark gray (10YR3/1) coarse sand, dark gray (10YR4/1) when dry; very fine, single grain, structureless; loose, non sticky, non plastic; strongly acid (pH 4.80); abrupt, smooth boundary
IIIA	70-81 cm	very dark grayish brown (10YR3/2) medium loamy sand, dark grayish brown (10YR4/2) when dry; very fine, single grain, structureless; loose, non sticky, non plastic, medium acid (pH 5.77); abrupt, smooth boundary
IIIAC	81-93 cm	very dark brown (10YR2/2) loamy sand, dark gray brown (10YR4/2) when dry; very fine, single grain, structureless; loose, non sticky, non plastic; medium acid (pH 5.82); abrupt, smooth boundary
IIIC	93-138 cm	very dark grayish brown (10YR3/2) loamy sand, dark gray (10YR4/1) when dry; very fine, single grain, structureless; loose, non sticky, non plastic; medium acid (pH 5.75); abrupt smooth boundary
IVAC	138-165 cm	very dark grayish brown (10YR3/2) sandy loam, dark grayish brown (10YR4/2) when dry; weak, fine to medium subangular blocky structure; very friable, slightly sticky, non plastic; medium acid (pH 5.73); abrupt, smooth boundary

IVC	165-200 cm	very dark grayish brown (10YR3/2) coarse sand, brown (10YR5/3) when dry; very fine, single grain structureless; loose, non sticky, non plastic; medium acid (pH 5.72); water seepage very slow at this level (175 cm)

Psme /Coco-Symo /Pomu Community

Soil #8
Slope: Level (east to west) 2° away from the stream (south)
Rooting: Fine and medium roots are common in the top 18 cm and then are few to 35 cm. Medium roots are common from 35 cm to 50 cm and few below this level. Coarse roots are common from 50 to 70 cm, and fine roots are few from 50 to 70 cm.

01	2-0 cm	thin duff mull
A	0-15 cm	dark brown (7.5YR3/2) coarse sandy loam, dark grayish brown (10YR4/2) when dry; weak, fine to medium granular structure; very friable, non sticky, non plastic; slightly acid (pH 6.22); abrupt, smooth boundary
B2	15-33 cm	dark brown (7.5YR3/2) sandy loam, very dark grayish brown (10YR3/2) when dry; weak, medium and coarse granular structure; friable, non sticky, non plastic; slightly acid (pH 6.16); abrupt, smooth boundary
C1	33-80 cm	dark brown (10YR3/3) coarse loamy sand, brown (10YR4/3) when dry; very weak, fine and medium subangular blocky structure; friable, non sticky, non plastic; medium acid (pH 6.06); abrupt, smooth boundary, 10% gravel
C2	90-90 cm	dark brown (7.5YR3/2) sand, brown (10YR4/3) when dry; loose, single grain, non sticky, non plastic; medium acid (pH 5.93); 52% gravel

Soil #17
Slope: Level (east to west) and 1° toward stream (north)
Rooting: All size classes of roots are few from 10 to 50 cm. Coarse roots are common from 50 to 75 cm. Medium roots are common from 50 to 75 cm and fine roots are few in these limits.

01	2-0 cm	fine mull
A	0-13 cm	very dark brown (10YR2/2) silt loam, dark grayish brown (10YR4/2) when dry; moderate, fine granular structure; friable, slightly sticky, non plastic; medium acid (pH 6.00); clear, smooth boundary

C	13-39 cm	very dark grayish brown (10YR3/2) sandy loam, grayish brown (10YR5/2) when dry; weak, fine to medium granular structure; very friable, non sticky, non plastic; slightly acid (pH 6.10); clear, smooth boundary
IIB2	39-66 cm	dark brown (10YR3/3) sandy loam, brown (10YR5/3) when dry; weak, medium subangular blocky structure; very friable, slightly sticky, non plastic; slightly acid (pH 6.30); abrupt, smooth boundary
IIC1	66-80 cm	very dark grayish brown (10YR3/2) loamy sand, grayish brown (10YR5/2) when dry; weak, medium, subangular blocky structure; friable, non sticky, non plastic; slightly acid (pH 6.16); abrupt, smooth boundary; 16% gravel
IIC2	80-110 cm	very dark brown (10YR2/2) coarse sand, dark gray (10YR4/1) when dry; loose, single grain, non sticky, non plastic; strongly acid (pH 5.43); 61% gravel

Soil #40
Slope: 1° downstream (southwest)
Rooting: Fine and medium roots are common from 0 to 25 cm, abundant from 25 to 40 cm and few from 40 to 110 cm. Coarse roots are common from 40 to 75 cm and few above or below these limits.

01	3-0 cm	fine mull
A	0-12 cm	very dark grayish brown (10YR3/2) loam, dark grayish brown (10YR4/2) when dry; weak, very fine granular; very friable, slightly sticky and non plastic; medium acid (pH 5.98); abrupt, smooth boundary
B2	12-28 cm	very dark grayish brown (10YR3/2) sandy loam, dark grayish brown (10YR4/2) when dry; weak, fine and medium subangular blocky structure; friable, slightly sticky and non plastic; slightly acid (pH 6.06); clear, smooth boundary
IIA1	28-48 cm	very dark grayish brown (10YR2/3) loam, dark grayish brown (10YR4/2) when dry; weak, medium granular structure; very friable, non sticky and non plastic; medium acid (pH 5.92); abrupt, smooth boundary

IIB2	48-68 cm	very dark grayish brown (10YR3/2) loam, dark grayish brown (10YR4/2) when dry; moderate, fine subangular blocky structure; friable, slightly sticky and non plastic; medium acid (pH 5.94); abrupt, smooth boundary; 22% gravel
IIB3	68-81 cm	very dark grayish brown (10YR3/2) fine sandy loam, dark yellowish brown (10YR4/4) when dry; weak, fine subangular blocky structure; friable, slightly sticky and non plastic; medium acid (pH 5.93); abrupt, smooth boundary
IIC	81-110 cm	black (10YR2/1) coarse sand, dark gray (10YR4/1) when dry; very fine single grain, structureless; loose, non sticky, non plastic; strongly acid (pH 5.30); 66% gravel, 20% cobbles, and 3% stones

Psme-Lide/Bene-Gash/Libo Community

Soil #33
Slope: 1° downstream (south)
Rooting: Fine and medium roots are common in the top 50 cm and few at all other levels. Coarse roots are common from 50 to 75 cm.

01	10-3 cm	detritus; leaves, twigs, dead mosses
02	3-0 cm	mycelia and decaying organic matter, thick duff mull
A	0-12 cm	dark brown (7.5YR3/2) sandy loam, dark grayish brown (10YR4/2) when dry; weak, fine to medium granular structure; friable to loose, non sticky and non plastic; strongly acid (pH 5.37); gradual, smooth boundary, 9% gravel, 15% cobbles, 10% stones
AC	12-34 cm	dark yellowish brown (10YR3/4) loamy sand, dark yellowish brown (10YR4/4) when dry; moderate, fine to medium subangular blocky structure; firm to friable, non sticky, non plastic; medium acid (pH 5.71); gradual, smooth boundary; 6% gravel, 10% cobbles, 12% stones
C1	34-74 cm	dark brown (10YR3/3) loamy sand, yellowish brown (10YR5/4) when dry; weak, fine to medium subangular blocky structure breaking to single grain; very friable, non sticky, non plastic; strongly acid (pH 5.59); diffuse wavy boundary; 2% gravel, 20% cobbles, 30% stones
C2	74-110 cm	very dark brown (10YR2/2) coarse sand, with yellowish red (5YR4/8) gravels; very fine, single grain, structureless; loose, non sticky, non plastic; very strongly acid (pH 4.73); 50% gravels, 10% cobbles, 35% stones

Soil #24
Slope: 1° downstream (west) and 1° away from stream (south)
Rooting: Fine and medium size classes of roots are common in the top 30 cm, and all classes of all roots are few below this level.

01	3-0 cm	felty mor
A	0-10 cm	dark brown (7.5YR3/2) loam, dark yellowish brown (10YR4/4) when dry; weak to moderate,

		fine subangular blocky; friable to firm, non sticky, non plastic, medium acid (pH 5.73); abrupt, smooth boundary; 22% gravel, 3% cobbles, 1% stones
C	10-33 cm	dark brown (7.5YR3/2) sandy loam to loamy sand, dark yellowish brown (10YR4/4) when dry; moderate, medium to fine subangular blocky structure; friable, non sticky, non plastic; medium acid (pH 5.82); clear, smooth boundary; 15% gravel, 10% cobbles, 3% stones
IIB2	33-53 cm	dark brown (10YR3/3) sandy loam, brown (10YR5/3) when dry; weak, fine to medium subangular blocky structure; very friable, non sticky, non plastic; medium acid (pH 5.94); gradual, smooth boundary; 25% gravel, 12% cobbles, 3% stones
IIC1	53-90 cm	dark brown (10YR3/3) loamy sand, brown (10YR5/3) when dry; weak, fine to medium subangular blocky structure; very friable, non sticky, non plastic; medium acid (pH 5.93); gradual, irregular boundary; 21% gravel, 20% cobbles, 4% stones
IIC2	90-105 cm	dark brown (10YR3/3) coarse sand, grayish brown (10YR5/2) when dry; loose, single grain, structureless; non sticky, non plastic, very strongly acid (pH 4.50); 66% gravel, 15% cobbles, 10% stones

Soil #19

Slope: 1^{o} downstream (west) and just under 1^{o} toward the stream (north)

Rooting: Fine roots are few in the top 20 cm, common from 20 to 45 cm and few below 45 cm. Medium roots are common in the top 45 cm and few below 45 cm. Coarse roots are common from 30 to 60 cm and few at all other levels

01	2-0 cm	thin duff mull
A	0-15 cm	very dark brown (10YR2/2) loam, dark grayish brown (10YR4/2) when dry; weak, fine granular structure; friable, non sticky to very slightly sticky, non plastic; medium acid (pH 5.99); abrupt, smooth boundary; 12% gravel, 8% cobbles

B2	15-31 cm	dark brown (7.5YR3/2) coarse sandy loam, dark yellowish brown (10YR4/4) when dry; moderate, fine subangular blocky structure; friable, non sticky, non plastic; slightly acid (pH 6.11); clear, smooth boundary; 21% gravel, 10% cobbles, 2% stones
C1	31-63 cm	dark yellowish brown (10YR3/4) sandy loam, yellowish brown (10YR5/4) when dry; weak, medium subangular blocky; very friable, non sticky, non plastic; medium acid (pH 6.00); clear, smooth boundary; 17% gravel, 14% cobbles, 4% stones
C2	63-100 cm	dark brown (10YR3/3) loamy sand, brown (10YR5/3) when dry; moderate, medium subangular blocky structure; very friable, non sticky, non plastic; medium acid (pH 5.62); 16% gravel, 10% cobbles, 20% stones with stone line starting at about 80 cm

APPENDIX 6

Cover and constancy percentages for the original four McKenzie River floodplain and terrace communities identified by stand ordination (SIMORD) and manual-visual tables.

Layer and species	Tshe/Acci/Pomu-Oxor		Alru-Abgr/Rilo-Acci/ Mosi-Pomu		Psme/Coco-Symo/Pomu		Psme-Lide/Bene-Gash/Libo	
	constancy (%)	cover (%)	constancy (%)	cover (%)	constancy (%)	cover (%)	constancy (%)	cover (%)
Overstory tree layer								
Tsuga heterophylla	100	59	17	5	40	2	71	16
Acer macrophyllum	94	23	100	32	90	28	64	3
Thuja plicata	78	18	43	7	50	4	86	35
Abies grandis	61	16	93	32	90	11	93	5
Pseudotsuga menziesii	89	23	50	17	100	57	100	53
Libocedrus decurrens	17	3	50	10	90	12	71	9
Alnus rubra	-	-	5-	29	-	-	-	-
Fraxinus latifolia	-	-	5-	6	60	1	-	-
Populus trichocarpa	-	-	43	17	20	2	-	-
Tall shrub and small tree layer								
Taxus brevifolia	17	1	9	1	10	1	57	2
Acer circinatum	100	11	100	22	90	16	92	19
Corylus cornuta	95	4	100	14	100	30	85	8
Vaccinium parvifolium	61	1	9	T	80	3	71	2
Osmoronia cerasiformis	17	T	68	3	70	2	21	T
Cornus nuttallii	61	4	9	1	50	1	71	8
Rubus leucodermis	6	T	-	-	-	-	-	-
Rubus parviflorus	11	T	34	T	-	-	7	T
Castanopsis chrysophylla	6	T	-	-	-	-	21	T
Rhamnus purshiana	11	T	-	-	-	-	43	T
Philadelphus lewisii	6	T	-	-	10	1	-	-
Amalanchier alnifolia	6	T	-	-	-	-	7	T

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Appendix 6. (Continued)

Layer and species	Tshe/Acci/Pomu-Oxor		Alru-Abgr/Rilo-Acci/ Mosi-Pomu		Psme/Coco-Symo/Pomu		Psme-Lide/Bene-Gash/Libo	
	constancy (%)	cover (%)	constancy (%)	cover (%)	constancy (%)	cover (%)	constancy (%)	cover (%)
Ribes lobbii	-	-	42	4	10	T	-	-
Cytisus scoparius	-	-	9	T	-	-	-	-
Physocarpus capitatus	-	-	9	T	-	-	-	-
Rubus procerus	-	-	9	T	-	-	-	-
Lonicera ciliosa	-	-	-	-	20	T	28	T
Holodiscus discolor	-	-	-	-	10	T	7	T
Vaccinium membranaceum	-	-	-	-	-	-	21	T
Pachystima myrsinites	-	-	-	-	-	-	7	T
Low shrub layer								
Berberis nervosa	95	8	17	1	80	3	100	22
Rubus ursinus	100	2	100	7	100	3	100	3
Symphoricarpos mollis	6	T	77	1	100	18	65	2
Rosa gymnocarpa	22	T	17	T	60	1	85	1
Gaultheria shallon	33	1	9	T	30	1	100	18
Berberis aquifolium	-	-	9	T	10	T	-	-
Rubus nivalis	-	-	-	-	-	-	7	1
Herb layer								
Polystichum munitum	100	22	77	9	100	26	36	1
Viola sempervirens	50	1	-	-	10	T	92	2
Galium triflorum	100	2	100	4	100	3	65	1
Hieracium albiflorum	6	T	17	T	-	-	7	T
Synthyris reniformis	17	T	43	T	80	3	50	1
Anemone deltoidea	50	1	9	T	20	T	85	1
Adenocaulon bicolor	61	1	42	T	100	6	36	T
Tiarella unifoliata	83	1	50	T	-	-	28	1
Vancouveria hexandra	89	7	50	1	90	6	71	1

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Appendix 6. (Continued)

Layer and species	Tshe/Acci/Pomu-Oxor		Alru-Abgr/Rilo-Acci/ Mosi-Pomu		Psme/Coco-Symo/Pomu		Psme-Lide/Bene-Gash/Libo	
	constancy (%)	cover (%)	constancy (%)	cover (%)	constancy (%)	cover (%)	constancy (%)	cover (%)
Pteridium aquilinum	33	1	-	-	5-	1	57	1
Oxalis oregana	95	26	100	21	90	10	7	T
Asarum caudatum	77	1	34	T	30	T	36	1
Athyrium filix-femina	27	1	9	T	10	T	-	-
Dicentra formosa	6	T	25	T	-	-	-	-
Circaea alpina	33	T	100	6	70	2	-	-
Adiantum pedatum	39	1	17	T	10	T	-	-
Galium bifolium	89	1	100	1	100	1	43	T
Thalictrum occidentale	17	T	58	1	80	2	-	-
linnaea borealis	66	1	-	-	50	1	100	6
Trillium ovatum	55	1	9	T	-	-	71	1
Blechnum spicant	17	T	-	-	-	-	-	-
Disporum hookeri	44	T	42	T	40	T	65	1
Polypodium glycyrrhiza	6	T	9	T	-	-	7	T
Achlys triphylla	22	T	-	-	-	-	5-	1
Goodyera oblongifolia	33	T	-	-	80	1	92	1
Bromus vulgaris	33	T	50	1	100	1	7	T
Polystichum lonchitis	27	T	17	1	40	T	7	T
Anemone lyallii	11	T	34	T	30	T	50	1
Smilacina racemosa	6	T	17	T	-	-	7	T
Clintonia uniflora	6	T	-	-	-	-	65	2
Prunella vulgaris	11	T	42	2	-	-	-	-
Smilacina stellata	39	1	34	1	90	3	71	1
Viola glabella	33	T	85	1	100	1	7	T
Collomia heterophylla	6	T	34	T	-	-	-	-
Stachys palustris	17	T	68	1	50	1	-	-
Hydrophyllum tenuipes	6	T	34	T	-	-	-	-
Cystopteris fragilis	6	T	-	-	-	-	-	-
Eburophyton austinae	6	T	-	-	-	-	-	-

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Appendix 6. (Continued)

Layer and species	Tshe/Acci/Pomu-Oxor		Alru-Abgr/Rilo-Acci/ Mosi-Pomu		Psme/Coco-Symo/Pomu		Psme-Lide/Bene-Gash/Libo	
	constancy (%)	cover (%)	constancy (%)	cover (%)	constancy (%)	cover (%)	constancy (%)	cover (%)
Dryopteris sp.	6	T	-	-	10	T	-	-
Monotropa uniflora	11	T	-	-	-	-	-	-
Osmorhiza chilensis	11	T	85	1	60	T	21	T
Whipplea modesta	6	T	-	-	40	1	14	T
Heuchera micrantha	6	T	-	-	-	-	-	-
Agrostis tenuis	6	T	34	T	10	T	-	-
Montia sibirica	6	T	93	6	20	T	-	-
Trientalis latifolia	6	T	50	1	80	1	100	2
Petasites frigidus	6	T	93	4	-	-	-	-
Nemophila parviflora	-	-	68	3	20	T	-	-
Tolmiea menziesii	-	-	93	1	-	-	-	-
Heracleum lanatum	-	-	5-	1	-	-	-	-
Elymus glaucus	-	-	5-	1	-	-	-	-
Stachys cooleyae	-	-	68	1	-	-	-	-
Equisetum arvense	-	-	6-	1	-	-	-	-
Coptis laciniata	-	-	25	T	50	1	14	T
Carex bolanderi	-	-	59	1	20	T	-	-
Stellaria crispa	-	-	25	T	20	T	-	-
Actaea arguta	-	-	9	1	-	-	-	-
Ranunculus uncinatus	-	-	9	T	-	-	-	-
Campanula scouleri	-	-	17	T	-	-	21	T
Vicia americana	-	-	9	T	30	T	-	-
Epilobium watsonii	-	-	9	T	-	-	-	-
Cirsium vulgare	-	-	9	T	-	-	-	-
Digitalis purpurea	-	-	9	T	-	-	-	-
Fragaria vesca	-	-	25	T	90	1	7	T
Stellaria calycantha	-	-	9	T	60	1	-	-
Urtica lyallii	-	-	17	T	-	-	-	-

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Appendix 6. (Continued)

Layer and species	Tshe/Acci/Pomu-Oxor		Alru-Abgr/Rilo-Acci/ Mosi-Pomu		Psme/Coco-Symo/Pomu		Psme-Lide/Bene-Gash/Libo	
	constancy (%)	cover (%)	constancy (%)	cover (%)	constancy (%)	cover (%)	constancy (%)	cover (%)
Aralia californica	-	-	9	T	-	-	-	-
Listera caurina	-	-	-	-	20	T	57	1
Lathyrus nevadensis	-	-	-	-	20	T	-	-
Streptopus amplexifolius	-	-	-	-	-	-	7	T
Pyrola asarifolia	-	-	-	-	-	-	57	1
Chimaphila umbellata	-	-	-	-	-	-	43	1
Lilium columbianum	-	-	-	-	-	-	28	T
Chimaphila menziesii	-	-	-	-	-	-	43	T
Pyrola picta	-	-	-	-	-	-	36	T
Calypso bulbosa	-	-	-	-	-	-	28	T
Corallorhiza macullata	-	-	-	-	-	-	7	T
Satureja douglasii	-	-	-	-	-	-	7	T
Bryophyte layer								
Leucolepis menziesii	66	3	50	4	50	1	21	T
Hypnum circinale	33	1	25	1	40	1	36	1
Rhytidiadelphus triquetrus	100	10	58	2	100	15	100	9
Eurhynchium oreganum	100	14	50	2	80	14	100	23
Hylocomium splendens	77	8	34	1	80	7	92	7
Dicranum fuscescens	38	1	43	2	80	1	36	T
Isothecium spiculiferum	38	1	17	T	-	-	36	1
Plagiomnium (Mnium) insigne	71	5	66	5	70	2	14	T