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Title AN ANALYSIS OF MONTANE FOREST VEGETATION ON THE EAST FLANK OF THE CENTRAL OREGON CASCADES

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Montane forest vegetation as it occurs on the east flank of the central Oregon Cascades has provided excellent conditions for a "natural experiment" in the use of various methodologies in studying vegetational distribution. This "experiment" has reflected on some theory and practice for the discipline of plant synecology. Detailed descriptions, analysis, and interpretation of the data also document present conditions in relation to the past and allow prognostication of future changes, which in turn may be of silvicultural importance for a portion of this forest type found extensively on the east flank of the Sierra Nevada-Cascades cordillera.

A major objective of this study was to determine the relative merits and deficiencies of attempting to transpose to this vegetation the methods of analyzing vegetation based on the individualistic or continuum philosophy of phytosociology that has developed and been practiced principally in the north-central United States. These

attempts have been contrasted to strengths and short-comings of poly-climax theory, the most widely used basis of vegetational classification in the Pacific Northwest, in relation to the analysis of this and other vegetation types. The influences on and of these varying interpretations have been outlined and presented in tabular form.

The study area is nearly ideal for posing these questions because edaphic and topographic factor complexes remain surprisingly uniform. The vegetation is superimposed in apparent primary response to the condensed gradient of total precipitation due to the orographic "rain shadow" effect from the Cascades intervening in this region of prevailing westerly winds. The stability of the vegetation concomitant with this nearly ideal set of "naturally controlled " physical conditions, minimized variations in successional status, except that due to fire exclusion. This latter variation, however, paralleled the complex gradient studied, a happenstance which allowed silviculturally important interpretations to be made. Stable vegetation occurring in general contiguity allowed stands to be sampled systematically, leaving little doubt concerning the validity of interpolation between stands and the areal representation of the samples.

Another main objective of the study was to obtain and analyze data to substantiate the hypothesized influence of light periodic ground fires in initiating and maintaining the characteristic mosaic of size-age class distribution of ponderosa pine. The data also yielded a quantitative indication of the shift in species composition and dominance that is in largest measure due to the continued exclusion of fire by man for approximately the past 50 years. From these data the future appearance of the forest can be surmised, and silvicultural manipulations can be suggested that are best in harmony with the ecology of these forests.

The circumstances that provided this "natural experiment" have allowed the author to demonstrate certain limitations to direct transposition of methods widely used in other areas of the United States, or even the Pacific Northwest, when description and analysis in closest feasible parallel to the nature of the patterns of vegetational distribution found in this area are attempted.

This finding catalyzed the development of a method incorporating cluster analysis of matrices of relative parameter-weighted coefficients of association into a means of making very objective synecological delimitations. The dendrograms derived from this analysis allow a "sliding scale" of stratification to be made in this vegetation of most realistically intermediate, yet of more continuously variable than unit-association nature.

AN ANALYSIS OF MONTANE FOREST VEGETATION ON THE EAST FLANK OF THE CENTRAL OREGON CASCADES

by

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INTRODUCTION

The manner of study and interpretation of data in plant sociology, synecology, or vegetation science is in very large measure influenced by the researcher's own synecological context. Whittaker's (147) scholarly review of the historical development of approaches to the classification of biological communities over the world aptly illustrates this influence. This review also intimates that inertia from tradition has profoundly canalized the diversity of approaches and heightened disagreement on how to analyze and facilitate generalizations about the distributional nature of vegetation.

Synecological study in the Pacific Northwest has in turn been strongly affected by the characteristics of the vegetation and by traditional precedents established after effective means have been developed to study important portions of the region.

Nearly all authors of synecological studies in the Pacific Northwest have concluded that relatively discrete communities could be described following reconnaissance of a given area. Purposive sampling for quantitative data describing modal stands of associations of "habitat-types" have been used quite successfully for stratification purposes in both pure and applied ecological research and nonarable land resource management. (See Daubenmire, 38 and 42; Poulton, 99; Driscoll, 47; Dyrness, 49; Eckert, 52 Tueller, 116; and Volland, 128 for best examples of this approach.)

Several workers have followed a well established tradition, whose chief exponent is J. Braun-Blanquet in Central Europe, and have classified the vegetation in the areas studied into associations without stress of interpreted successional status (Roach, 103; Brayshaw, 14). The de-emphasis on vegetation dynamics shown in these studies contrasts sharply with the degree to which stability is stressed as a criterion for defining classificatory units by the advocates of the habitat-type concept.

On the other hand, a few areas of the Pacific Northwest have been examined by researchers who described their vegetational distributions in terms of phytosociological and underlying environmental gradients, and who sub-divided the vegetation into admittedly arbitrary units for discussion purposes. (c. f. Whittaker, 146; Swedberg, 112; and Thilenius, 115).

The diversity of approach and emphasis in studies of the vegetation in the different areas of the Pacific Northwest illustrate the apparent controversy between synecologists as to the interpreted relative discreteness to continuously variable nature of vegetational distribution. In Whittaker's terms (147) we basically have those workers of "individualistic dissent" differing in their conclusions from the proponents of the "unit-association hypothesis".

It is this author's contention that the quasi-controversy is heightened principally by differences in the types of vegetation that the proponents of both points of view work with, and by the degrees of environmental variation and consequent magnitudes of vegetational change within a given geographical area.

Assertions such as that made by Daubenmire (41, p. 105) that, "We are faced with the choice of either a continuum or a classification; the two viewpoints are strictly incompatible," is believed to be posed as a false dilemma. It is the author's aim to demonstrate that the two approaches have inherent strengths and weaknesses, but to show in addition that the advantages of these two principal approaches of American synecology can be complementarily welded into functional schema.

An eclectic attitude is the goal of the logic and synthesis illustrated by the analysis, described in the following presentation, of the montane forest vegetation on the east flank of the central Oregon Cascades.

In essence, this is an attempt to describe and interpret phytosociological variation for this forest region. Conditions for a "natural experiment" in vegetational distribution have been capitalized upon. No manipulation of the vegetation itself has been attempted. Such studies of species complexes or plant communities are believed to be necessary prerequisites to etiological definitions of plant distribution. In addition, they provide the most sensitive natural context for stratification of autecological investigations of the component species, and they greatly contribute to clarifying plant-environmental-temporal inter-relationships.

Guided by these considerations, the study has been designed to describe the floristic composition and structure of plant communities where *Pinus ponderosa* exists as an arboreal dominant or co-dominant, and to relate the variation in vegetation, including its successional status, to gradients of the physical environment.

In addition, methodology not hitherto applied either to synecology, to this type of vegetation, or to this region of the world has been introduced. The result has been the development of means of quite objectively characterizing this vegetation. This methodology may also be adaptable to other areas and problems of plant synecological study.

THE STUDY AREA

Geographical Location

The areas selected for this study are in part within the boundaries of the Warm Springs Indian Reservation in northwestern Jefferson County, Oregon, and in part in the Deschutes National Forest, Metolius and Sister Ranger Districts, in southwestern Jefferson County and northwestern Deschutes County.

Figure 1 shows the distribution of ponderosa pine, major tree component of the montane forest zone, with the circle indicating the general location of the study area in relation to the geography of the Western United States. Figures 2 and 3 show in more detail the location of transects and stands. These photographic copies of maps made from portions of adjoining quadrangles of United States Geological Survey topographic maps, illustrate the topography to be described in a following section.

The Warm Springs stands are deemed to be representative of forests from latitudes approximately 44 degrees, 40 minutes north to 44 degrees, 50 minutes north, and between longitudes 121 degrees, 25 minutes west to 121 degrees, 35 minutes west. The legal locations of all stands are to be found in Appendix 1.

The Deschutes series of stands are found at approximately 44 degrees, 7 minutes north to 44 degrees, 26 minutes north in latitude

Figure 1. -- Botanical range of ponderosa pine
(from Curtis and Lynch, 1957 frontpiece)
Circle denotes study area

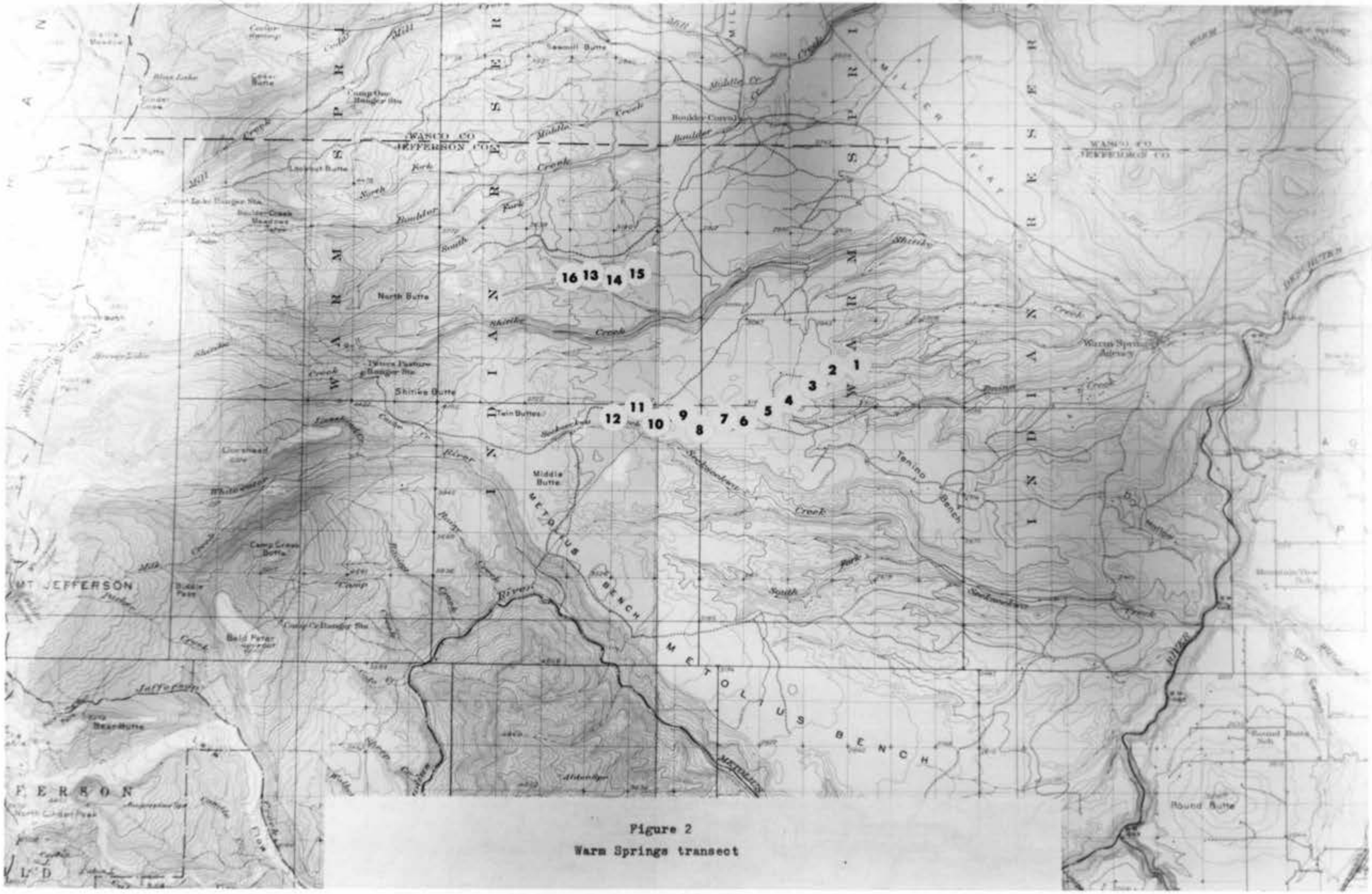

Figure 2
Warm Springs transect

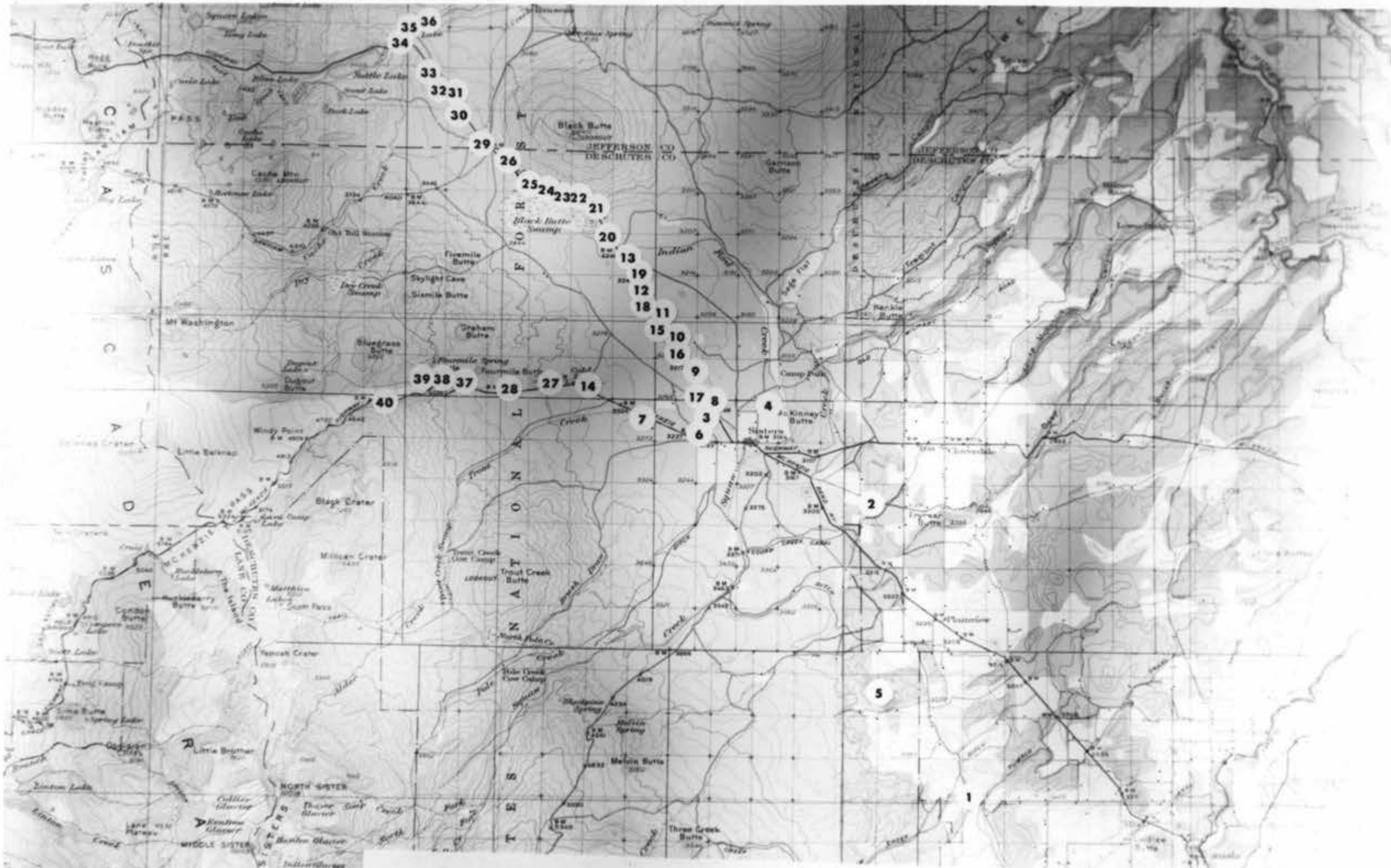

Figure 3
Deschutes transect

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and from longitude 121 degrees, 25 minutes west to 121 degrees, 45 minutes west. The data and results from the Deschutes transect apply most adequately to its particular geographical location. The edaphic and physiographic substratifications and considerations necessary to extrapolate the results of this study are found in the conclusions.

Geology and Physiography

The study area is located within the Middle Cascades subprovince of Fenneman's Sierra-Cascades physiographic province (55, p. 332-333). The Middle Cascades of Oregon consist almost exclusively of volcanic rock and owe their present height and configuration to vulcanism in and since the lower Tertiary period (6, p. 51). This is a relatively new area, geologically speaking, since prior to the Eocene Epoch most of the present land area of western and central Oregon was covered by the sea (148, p. 10).

The Oregon Cascades can be differentiated into two rather distinct cross-sectional sub-divisions. These are the "old" or Western Cascades of Eocene to Miocene origin, and the "new" or High Cascades of Pliocene-Pleistocene development. The Western Cascades form the broad basal foundation of the range with the High Cascades imposed on its eastern flank. Overall, the range is characterized as a broad, well-drained western slope, with a relatively short slope on the east. It is this latter slope that will be described in more detail.

Williams (149, p. 34-35) believes that the volcanoes of the High Cascades began activity in the lower Pliocene. The early eruptions were mostly outpourings from broad shield volcanoes with little explosive activity. The first buildup was formed of gray olivine basalt and olivine-bearing basaltic andesites. Later eruptions in many of the presently existing peaks were explosive, capping the mountains with fragmental ejecta. Many parasitic cones were formed at the bases of the larger peaks during this time.

Pleistocene glaciation has altered the High Cascades to some extent, obliterating many of the parasitic cones and cutting wide valleys separated by steep ridges around the major peaks. Glacial gouging and deposition of morainal material has created basins holding Suttle Lake and the numerous smaller lakes to the west.

A number of volcanic cones, both near crest line and a few miles to the east, appear to be unaffected by glaciation. Thus, one can conclude that they must have developed after the general recession of the Pleistocene glaciers. These many possible sources of pumice and ash make interpretation of volcanic history in the study area very difficult compared to the area near Crater Lake.

Due to the recent orogeny of the High Cascades and the less abundant precipitation on the leeward slope, the east flank of the Cascade Range is less dissected than the western slope. Pleistocene glaciers and the increased runoff associated with them augmented the development of some canyons. The general area is gently inclined eastward with few southern, northern, or western slopes exposed.

The relatively simple geological substratum of this region is characterized in Figure 4 and the maps by Williams (150) and Hodge (75).

The Deschutes transect study area is physiographically a plain sloping very gently eastward from the Santiam Pass-Suttle Lake crest region. The majority of the area has been covered with lavas of olivine basalt and basaltic andesite but with much of it having been reworked by activity of glaciers and their attendant melt waters. Ridges of little-weathered lava, with its thinner soil covering, rise 50 to 100 feet above the heavy gravel substrata of the glacial outwash plain, the landform of greatest areal extent. Numerous small cinder cones pock the plain area. The transect skirts the southern flank of a 6,436 foot high cone, Black Butte. For the stands located in and adjacent to Deschutes National Forest, the elevational difference between the most westerly and highest stand, at 4,300 feet, to the most easterly and the lowest stand, at 3,200 feet, is 1,100 feet. All but seven of these stands occur at elevations between 3,200 and 3,400 feet above sea level. The horizontal distance between the most westerly and most easterly placed stand is slightly over ten and one-half miles.

The topography of the area on which the Warm Springs

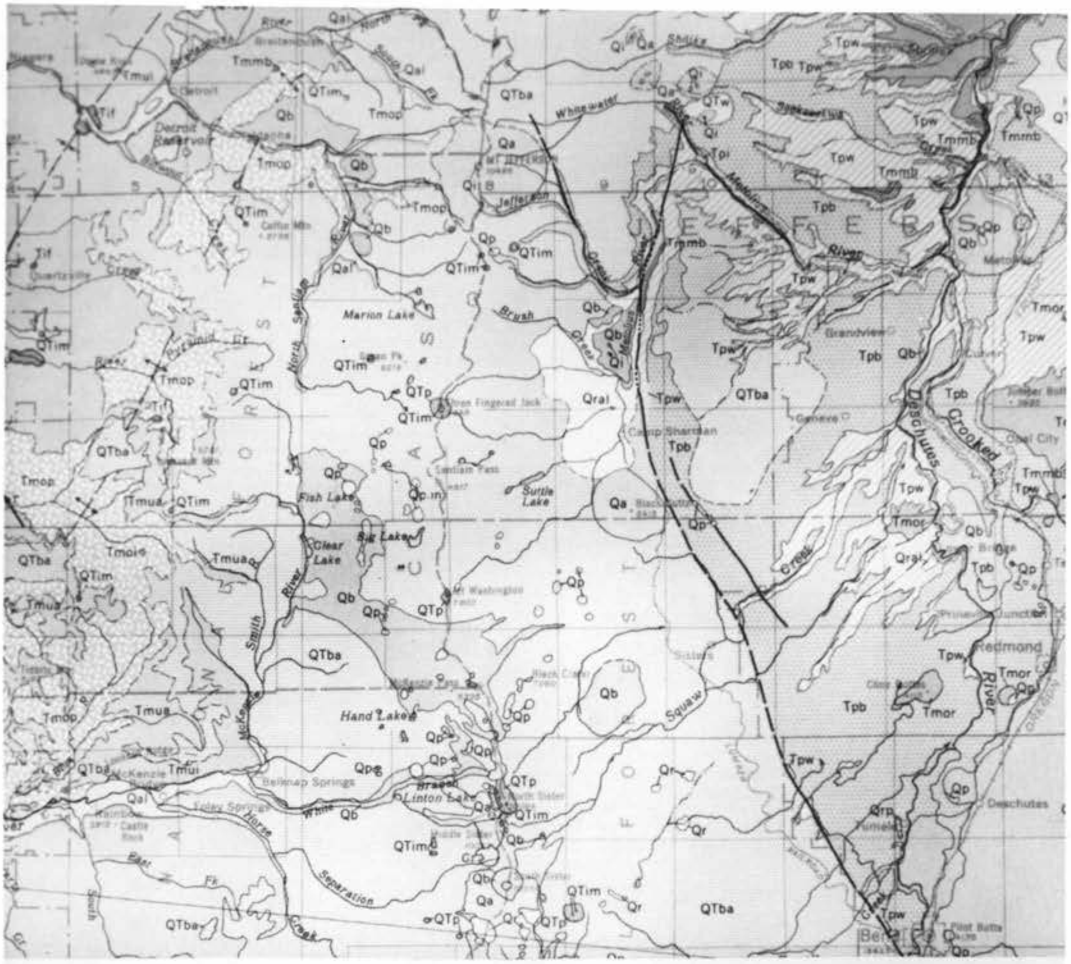

Figure 4

Geological Map
(from U.S.G.S. Miscellaneous Investigations Map I-325, 1961)

	Qral	alluvium; rudely andesitic bouldery gravel, pyroclastic sand, gravel and debris
Upper Pleistocene to Recent	Qa	light gray pyroxene andesite and olivine-bearing andesite in flows and composite cones as pyroclastic rock
	Qb	light to dark-gray, dense to open-textured olivine basalt and andesite domes
Pliocene to Pleistocene	QTba	gray open-textured olivine basalt and olivine bearing andesite
	QTw	medial, water-laid volcanic deposits
Pliocene	Tpw	water-laid volcanic rocks of the Dalles formation
	Tpb	gray open-textured olivine basalt flows, in part intercalated with the Dalles formation
	Qi Tpi Tmmb	All mafic intrusive rock of various Cenozoic age, medium to dark gray, fine-grained andesite porphory and olivine dibase plugs, dikes and vent breccia
Miocene	Tmor	rhyolite of the John Day formation

transect was taken can be characterized as benchlands separated by the deep canyons of Shitike and Tenino Creeks and the Metolius River. These benches are formed from lavas of basic olivine basalt and basaltic andesite of the Dalles Formation. Toward the west, these benches are overlain with increasing amounts of glacial outwash and ejecta of the Cascan Formation (Hodge, 76). The gradient in elevation from the most westerly to the most easterly stand, a distance of six and one-half miles, is from approximately 3,400 to 2,900 feet, on a long, nearly level slope, giving a difference of but 500 feet.

The study areas are characterized by a minimum of variation in geology and physiography. The associated relative uniformity of elevation and slope exposure makes for much less confounded analysis, with a statistical connotation, of plant distribution in relation to synecological context and the primary physical gradient of moisture. It thus, in a sense, adds "control" to a "natural experiment".

Climate

Climatic History

The fossil record reveals the significant change from the humid regimes of Eocene-Miocene times to a relatively arid climate in the Pliocene epoch (20, p. 187). This change resulted when the bulk of the Cascade mountain mass formed during the Miocene and produced an orographic rain shadow to its lee. The period of aridity was followed by the coolness of the Pleistocene with periodic growth and recession of mountain glaciation in the Cascades (114, p. 20).

Interpretations of post Pleistocene paleoclimate through analyses of fossil pollen indicate that certain changes in the vegetation concomitant with climatic changes have occurred in the Cascades. Hansen (67, p. 113) records a period of increasing warmth and dryness from 15, 000 to 8, 000 years ago. This trend was reflected in an expansion of yellow pine, as indicated by increased pollen of this species in the profiles from the Cascades. About 10, 000 years ago the temperature is thought to have been similar to that of today. The "thermal interval" of 8, 000 to 4, 000 years ago was a period of maximum warmth and dryness that gave a yellow pine maximum. Following this period there was a return to a relatively cooler, moister climate similar to the present. These conditions resulted in a slightly decreased prevalence of yellow pine over that of 4, 000 years ago.

With a relatively stable climate in the Pacific Northwest throughout the past 4, 000 years (72), it would seem, a priori, that there has been adequate time for plant species to become adapted to present climatic conditions, to invade, become established and sort themselves according to the local effective environment. This stability reflected in terms of plant distribution has been indexed by Witty (153, p. 39) though analysis of grass opal deposition in a forest-grassland boundary several miles north of the Warm Springs transect. His study showed that a sampled forest-grassland boundary has persisted in approximately its present position for perhaps 4,500 to 7,000 years.

The preceding statements are only generalizations for there have been climatic trends from century to century and from year to year. Mountain glaciers were reborn during the "little ice age" of 1650 to 1850 A.D. (46, p. 357). Reviews of glacial retreat on the near-by peaks within the last few decades are to be found in Van Vechten (127, p. 13-15) and Voth (129, p. 66-68). The climatic trend for temperate North America the last few centuries, as shown by tree rings, seems to be toward increasing dryness (1, p. 36), and warmness, as evidenced in poor growth of southern outlying populations of tree species (109, p. 223).

More detail for this region is provided by Keen (81, p. 188) through samples of ponderosa pine growth rings collected from several central Oregon locations. He indicated that despite minor fluctuations growing conditions, reflected by these rings, have not changed greatly during the past 650 years for which they span. Since soil moisture is generally the limiting factor in growth of ponderosa pine, these variations, outside of local defoliation and fire, largely reflect fluctuations in amount of precipitation. On this assumption, Keen ascertained that a fairly severe drought occurred during the 1840's to early 1850's which was followed by 40 years of above average precipitation. Average growth for the period from 1900 to 1917 was equal to the general average for the entire record of 650 years. Beginning in 1917, however, a severe drought occurred in central Oregon, with the smallest amount of growth noted in the rings corresponding to the years 1924 and 1931. Following this second low, the more recent trend has been toward a more rapid rate of growth.

Present Climate

The Cascade Mountain Range separates Oregon into two substantially different climatic zones. West of the mountain crest a humid micro-thermal or maritime climate prevails in general, while the east side has essentially a continental climate with reduced precipitation and greater extremes of temperature.

Oregon lies in the belt of prevailing westerly winds, with air moving generally inland from the Pacific Ocean. As winter storms advance over the land, the air is cooled adiabatically with the Coast Range and Cascades acting as orographic instruments, and heavy precipitation the result. The low Coast Range has less marked effects, but the height of the Cascades is adequate to remove a high percentage of moisture from the air masses. In descending the short east slope of the Cascades, the air is warmed katabatically, and its moisture-holding capacity is increased; the result is the "rain shadow" extending over considerable expanses to the east (43, p. 23).

Cyclonic westerlies account for about 90 percent of the precipitation in the state, with higher percentages of non-cyclic precipitation occuring toward the interior. Summer rainfall contributes only five percent of the total annual precipitation west of the Cascades, whereas, summer showers, mostly convectional, account for 12 percent of the total in eastern Oregon (141, p. 1086). Precipitation that does occur during the summer is generally of the very light and sporadic type from convectional storms, and thus is generally ineffective for perennial plant growth. Approximately 75 percent of the yearly precipitation in the study area falls in the form of snow during the late fall, winter, and early spring months. From east to west in the study area the snowpack becomes progressively deeper and persists later into the spring (88). Figure 5 is a generalized, extrapolated isohyetal map characterizing total average annual precipitation on and near the study area.

The temperature regimes of the study area are closely affiliated with those of eastern Oregon proper, with lows of zero degrees F. and highs of 95 degrees F. not uncommon.

Due to the absence of meterological stations on the sampled sites, statements other than the above generalization must be quite limited. In Baker's (5, p. 238) treatise, the climate of the leeward mountain slope in central Oregon was not described because of the

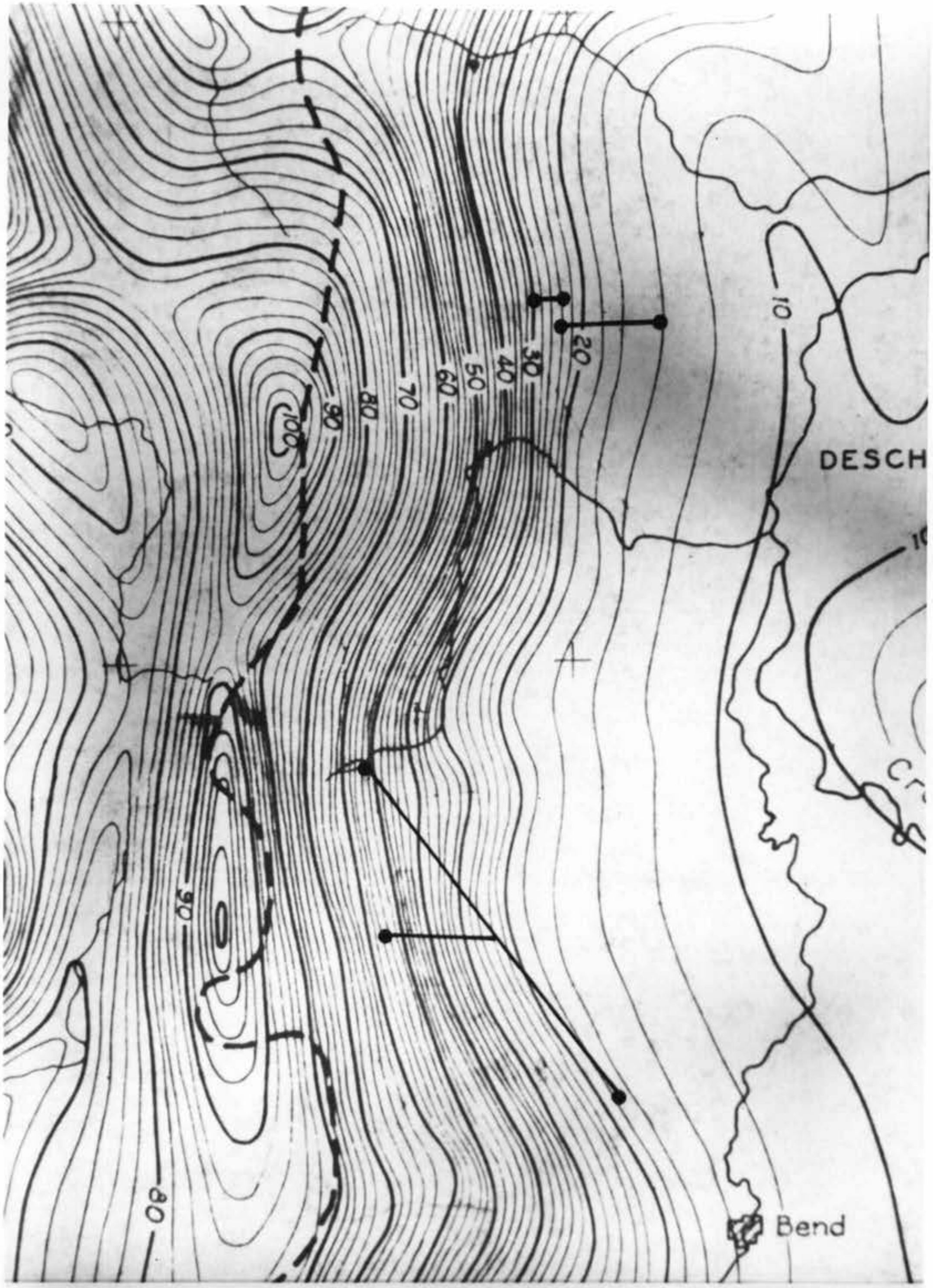

Figure 5
Extrapolated isohyetal map- total annual precipitation
(in inches, from U.S. Corps of Engineers map
of the Willamette Drainage District, 1942)

absence of data collection points.

No short-term meterological data were collected in conjunction with this study, nor were any mathematical correlations of vegetational attributes with climatic factors *per se* attempted. However, data from three sources, discussed below, can be consulted for at least partially relevant meterological information.

Table I gives a summary of the limited climatological data available for Sisters, Oregon. This small town is within a radius of approximately one mile from four of the sampled stands of vegetation.

The possible climatic bias included in the vegetational data at the time of collection needs to be considered in an ecological study. In arid to semi-arid regions where moisture is a major limiting factor, pattern, kinds, and amounts of precipitation need closest scrutiny. The most readily determined and single best reflection of the moisture regime is a comparison of the total annual precipitation for the years during which vegetational data were collected with the median value for a given station (40, p. 141). This is done in Table I where these comparisons are made for the Sisters station, the only source of fairly long-term precipitation data. During 1959 and 1960 the general area experienced one of the severest periods of drought on record. This climatic sequence undoubtedly influenced the growth of plants, particularly herbaceous species, and their consequent recovery. There is no conceivable way to make adjustments for the

TABLE I. CLIMATOLOGICAL DATA FOR SISTERS, OREGON

13 Year Record---1921-1934---Average precipitation in inches (No available temperature record was kept for this period)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann.
2.64	1.94	1.16	.85	1.09	.68	.68	.32	.86	1.05	3.24	2.14	16.65

Recent Records (No recent records were kept until September, 1958.)

Average precipitation in inches

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann.	deviation from Median
1958	----	----	----	----	----	----	----	----	.28	.36	2.09	1.07	----	----
1959	2.57	1.84	.75	.12	.46	.34	.05	.11	.53	.81	.45	.59	8.62	-7.45
1960	1.55	2.22	3.31	1.02	.54	.02	.05	.17	.19	.66	4.55	1.80	16.08	- .01
1961	.84	3.78	1.43	.66	.84	.68	.04	.06	.55	1.44	4.64	3.20	18.16	+2.09
1962	1.87	1.50	1.63	.65	1.09	.04	.01	.48	.35	2.30	2.03	1.90	13.85	-2.22

Average temperature (F.)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann.	Extremes High	Extremes Low
1958	----	----	----	----	----	----	----	----	54.4	47.8	38.9	38.0	----	-------	-------
1959	33.7	32.8	38.7	43.7	45.8	56.7	63.8	58.8	53.0	47.5	38.4	31.4	45.4	100 7/22	-11 1/4
1960	26.0	31.3	38.8	43.3	46.9	57.3	66.0	59.1	56.0	47.5	35.4	31.1	44.9	99 7/18	-12 2/27
1961	34.5	39.4	38.3	43.4	48.2	60.9	63.3	66.1	50.6	45.5	34.3	31.5	46.3	98 7/12	- 8 12/11
1962	29.7	33.4	36.7	46.4	46.2	55.1	60.7	59.4	55.6	46.1	40.1	35.3	45.4	95 7/23	-28 1/22

lag in recovery of plant growth reflected in the vegetational data collected during 1961 and 1962, more "normal" years in terms of precipitation.

Low temperatures can also affect seasonal expression of vegetation and its component species as well as its distributional pattern. A notable example observed in this study was the effect of low temperatures (-28 degrees F. recorded at Sisters, January 28, 1962) on the leaf area of evergreen shrubs, particularly Ceanothus velutinus, exposed above the snow. This die-back probably affected cover values collected the following summer for these species to a relatively small, though then indeterminable degree.

In addition to the data for Sisters, two growing seasons of climatological data are given by Wagg and Hermann (130, p. 9-20) for a site approximately one mile southwest of the most xeric stand sampled on the Deschutes transect. These data include maximal and minimal air temperatures, ground surface temperatures for bare and littered conditions and trends of soil moisture depletion.

Roach (102, p. 37-49) gives temperature, relative humidity, snowpack and total annual precipitation data collected near an Oregon State Highway Department maintenance station at the junction of U. S. Highway 20 and Oregon State Highway 222, the South and North Santiam highways, respectively. The fact that this area is in a slight "rain shadow" trough at 3,800 feet in elevation between the "old" and "new" Cascades is reflected in the average annual precipitation of approximately 50 inches.

There is a total absence of meterological records from near the Warm Springs transect. What little data that exist from the proximity of this study area have been collected at stations located at the bottoms of canyons, a micro-climatic situation far different from that of the benches.

Soils

Knox (83, p. 26-27) includes the study area in a region where, under the existing climatic regime, the zonal soils would be expected to belong to the "Western Brown Forest" Great Soil Group. However, all the soils of the study area are of fairly recent, though indeterminate age, having been derived from basic igneous rock of one form or another. Thus, they are genetically very similar. The principal common denominator is the relatively short period of time since geologic deposition in which they have had to develop distinctive profiles reflecting the pedogenic factors.

These soils contain some cinders and pumice of aeolian and alluvial origin. The parent materials have usually been more or less transported as glacial outwash. The general sorting of particles with an increased proportion of larger stones to the west in the study area supports the interpretation of glacial outwash origin.

In general, the soils along both transects are quite uniform considering the climatic gradient through which they are found. At any rate, the soils do not exhibit gradients of differences approaching the magnitude of those shown by the vegetation.

There are no published soils maps for the area under consideration. There is, however, a map for the nearby agricultural lands (85). Youngberg (154) prepared a land use and soil management report from a soil survey completed by Bureau of Indian Affairs soil scientists on the present and potential agricultural lands of the Warm Springs Indian Reservation. He recommended a survey of the forest soils to be implemented with increased intensity of management. Youngberg did, however, find occasion to examine soils very close to stands sampled during this study, but did not record data for mapping them. Pertinent information was conveyed to the author through oral discussion with and final review of the soils interpretation in this manuscript by Dr. Youngberg.

Discussion of specific soils and vegetational relationships found will follow in a concluding section of this paper. Appendix 6 contains a set of selected profile descriptions.

Vegetation

General Description

The vegetation of the area studied is best typified by the presence of *Pinus ponderosa*, western yellow or ponderosa pine,[1/] as the dominant or co-dominant species in the overstory. This species is the key component of the montane forest zone as described by Oosting (93, p. 309), Gordon (62, p. 21), and Bratz (11, p. 34), and of the *Pinus-Pseudotsuga* Formation of Weaver and Clements (139, p. 481). Other common tree species found in the immediate study areas are *Juniperus occidentalis*, western juniper; *Libocedrus decurrens*, incense cedar; *Abies grandis*, grand fir; *Pseudotsuga menziesii*, Douglas-fir.

The three most typical and conspicuous shrub components of this montane forest are *Purshia tridentata*, antelope bitterbrush, *Ceanothus velutinus*, and *Arctostaphylos parryana* Lem var. *pinetorum* (Rollins) Wiesl. & Schr. The grasses *Festuca idahoensis*, Idaho fescue; *Sitanion hystrix*, bottle-brush squirreltail; *Calamagrostis rubescens*, pine grass, and *Stipa* spp., needlegrasses are the

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1/ Both scientific and common names are those of Peck (94, 936 p.) except where the authority for a name is given. A complete listing of scientific names for the vascular flora encountered on all sample sites appears as part of Appendix 2.

herbaceous species most likely to be encountered.

Forb species are found in considerable variety but contribute relatively little in terms of biomass to this vegetation. None could be said to be distinctive to the total range of variation in the montane forest considered here. The itemization included in later presented "association" tables best represents their respective occurrences.

The limits of the area under study here are defined by the presence of ponderosa pine in slightly less than 50 percent crown codominance with western juniper for the most easterly and xeric stands, through nearly pure stands of ponderosa pine to its admixture with Douglas-fir and grand fir in the most mesic and westerly situated stands. In a sense, a macro-community characterized by the presence of _Pinus ponderosa_ is dealt with.

Paleoecology

Because the nature of plant distribution cannot always be explained by present circumstances, a review of the paleoecology of the area is deemed in order.

Less than 100 miles to the northwest of the study area occurs perhaps the richest Cenozoic paleo-flora in western North America, intensively studied by Chaney (21). The excellent fossil record indicates that what is now north-central Oregon was occupied by subtropical rain forest in the Eocene epoch. Temperate hardwood-conifer forest covered this landscape from Oligocene through Miocene times. The late Tertiary trees that were likely dominants in the area were very similar to modern day species of Sequoia and various genera of present day hardwoods of the eastern United States.

By the end of the Miocene, however, the Cascade Range built up to significant height, causing an orographic rainfall pattern to develop. A differentiation of climate and topography similar to that of today was well expressed in the Pliocene. A cooling trend and full expression of seasonal precipitation differences, with wet winters and dry summers, came also during this latter epoch. In response to the climatic changes from Miocene to Pliocene, most of the deciduous, broad-leafed taxa became extinct in western North America, with certain broad-leafed and coniferous evergreens surviving. Fossil records indicate that even within Miocene time, species of the genera Pinus, Pseudotsuga, Cercocarpus, and Arbutus had displaced the temperate mesophytic forest dominated by Metasequoia for as far north as central Idaho (37, p. 21). The Madro-tertiary pattern of vegetation, similar to that of today, moved into areas and niches left vacant by deciduous species of the Arcto-tertiary Geoflora as the general zonation moving generally south or down slope with the cooling temperatures and elevating topography in the Miocene to Pliocene transition period. The Pleistocene epoch brought no major changes in vegetation types or zonation, only an additional migration to the south or lower elevations and a possible loss of taxa which did not adapt or move with the changing environment.

Peck (95, p. 22) contends that, "While a relatively small part of the two states (Oregon and Washington) were glaciated, subarctic conditions must have prevailed especially inland, as far south as Central Oregon, and in the Cascades much farther." A synopsis of the post-Pleistocene trends in terms of climate and probable vegetation has been given in an aforegoing section on climate.

The present vegetation studied has elements derived principally from the Madro-tertiary Geoflora (4, p. 483-484; 89, p. 208). However, a few species such as those of the genus *Abies* are derivatives from the Arcto-tertiary Geoflora.

Influence of Man

Man began to influence his biotic milieu at least 6,000 to 7,000, or perhaps as much as 20,000 years ago, in this area (68, p. 17-19). The most efficacious instrument for modification of the vegetation by these pre-Columbian natives was probably the use of fire. Late-day Amerinds told of very open grass-carpeted montane forests. A generally park-like forest with lack of heavy brush or sapling thickets was known to persist until around 1915 (136, p. 16).

Grazing History. The advent of white men to the region resulted in a much increased expression of the anthropoeic factor.

Prior to 1865 the area between the Deschutes River and the Cascades was little traversed by white men. Thereafter, the region was utilized by cattlemen and sheepmen who began to drive stock over the Old Santiam Toll Road from the Willamette Valley. Quite a few stockmen who had used this road after its opening in 1865 began to settle in the central Oregon area. By 1880, big flocks of sheep from the interior ranches were driven past Sisters enroute to their summer pastures in the Cascades (15, p. 141). By 1908, the period of heavy sheep traffic through to the Santiam and McKenzie summer ranges had greatly diminished, as grazing allotments were severely reduced due to the establishment of United States Forest Service administration for the Cascade Forest Reserve.

No grazing is currently permitted on the National Forest lands studied on the Deschutes transect, although some of the stands are located so that they are near the path of infrequent livestock drives between parcels of enclosed private lands. A few of the most easterly xeric stands are on private lands, but lack the proximity of water and fencing, sometimes resulting in a combined effect, which has generally limited past and present usage by livestock. However, this relative freedom from disturbance can change quickly, as evidenced by the results of the movement of a water wagon that allowed cattle to graze heavily the most xeric stand a few weeks after the author had collected his data from it.

A similar pattern of early use took place on the Warm Springs Indian Reservation. Frequenting these ranges around the turn of the century were bands of sheep and herds of cattle from home ranches near Redmond and Prineville. Von Wernsted reported in 1906 (136, p. 16) that the Indians carried 1, 500 head of cattle and 5, 600 horses on ranges that were then in quite noticeably poor condition. Heavy grazing by Indian-owned livestock has persisted from times of reservation establishment down to the present on this reservation (104, p. 11 and 114; 48, p. 43-46). Particularly damaging to the vegetation have been the large herds of semi-feral horses that have roamed these ranges. Despite its depredative effects on the vegetation, this population had been little controlled until very recent years.

Fire and Fire Exclusion. Fire has played a very important role in the history of the vegetation of the montane forest region. This influence is recorded in the fire scars at the base of nearly every living tree or stump of western yellow pine and large Douglas-fir in the area. Keen (81, p. 181), working on Watkins Butte of the southern Deschutes National Forest, found that frequent fires had swept through that area in the past. He found one ponderosa pine tree that had been scarred 25 times between the years 1481 and 1936. Weaver (136, p. 16) has dated fire scars on stumps taken from the Twin Buttes area near the mesic terminus of the author's transect on the Warm Springs Indian Reservation (refer to Figure 2). These scars indicated that 15 fires had occurred between 1667 and 1906, with an average interval of 16 years between fires. Weaver in his papers extensively reviews reports by Indians, ranchers, and early forest examiners on the characteristics of this forest when it received such periodic fires. Plummer, et al. (96, p. 18) in 1903, reporting on conditions in yellow pine forest in the "Central Portion of the Cascade Range Forest Reserve", stated, "Its forests are generally open without much litter or undergrowth, and for these reasons are almost immune to fire. In the yellow pine region bordering the timberless areas of eastern Oregon the forest is often as clean as if it had been cleared, and one may ride or even drive without hindrance."

Prehistorical fires are believed to have been only light periodic ground fires set by lightning and Indians. However, Brogan records (15, p. 248) that occasionally when the sheep flocks came out of the mountains at the end of the grazing season in the fall, fires were set by the herders on the timbered lands. These flocksmen believed that fire would provide more accessible grass in future years. On the contrary, the heat produced by fires may have been responsible for hastening the germination of Ceanothus seeds long buried in the duff (63).

Protection of the forest from fire was one of the main aims outlined in the early stewardship policies of the United States Forest Service. One of the first official guard stations in central Oregon was established near the study area at the pioneer Allingham homestead on the Metolius River (15, p. 249).

The United States Forest Service Office at Sisters, Oregon, has no records of extensive fires occurring on or adjacent to the immediate stands sampled on the Deschutes transect. The length of their records vary, with the Black Butte area having the longest continuous records, kept since 1922.

The Bureau of Indian Affairs developed its fire protection program somewhat later and less intensively than the United States Forest Service. Recent fire effects were limited in the Warm Springs transect to that of a light ground fire in 1938 passing over the east end of Tenino Bench where the four most xeric stands are located. However, this has an advantage in that by comparing stands from adjacent burned and unburned areas one can contrast the likely structure and composition of the vegetation before and after the advent of fire prevention policies.

The effects of the exclusion of fire in terms of probable vegetational changes following this period are to be described in considerable detail in the conclusions and discussion of the following text.

Logging. The Indians and early settlers made very little direct use of the dominant trees in this forest zone. Large scale logging operations did not start at Bend, Oregon, the milling center of the region, until 1916 (15, p. 260-261). At the present time nearly all the highly productive land and easily accessible tracts have been at least lightly logged by the selective cutting methods employed in this forest type (73).

Previous Research. The considerable economic importance of the wood products from the yellow pine forest is reflected in the fact that nearly all the vegetation studies in this area have been conducted by the United States Forest Service and aimed at answering silviculturally important questions. The results are discussed in general as they are deemed applicable to the entire montane forest zone in eastern Oregon (e.g., 117, 118, and 119). Because Pringle Falls Experimental Forest is in the region of pumice soils, results from research there apply most directly to forests developed on such a mantle.

Dyrness (49) implemented the use of synecological information in Oregon forest management in the geographically wider and topographically more diverse montane forest on the very young Mazama and Newberry pumice-derived soils 50 to 100 miles south and slightly east of the author's area of consideration. Dyrness' treatment of vegetation and soils by reconnaissance and latter classification into habitat types, in sensu Daubenmire, (39) was later extended south by Volland (128) into the Winema National Forest of northern Klamath County.

Vegetational studies made elsewhere within similar montane forest include Willits' (152) survey of the silvicultural problems of what he called the "ponderosa pine - Douglas-fir transition zone" in the Lake Wenatchee area of the eastern Washington Cascades. He was concerned almost solely with the tree species and potential silvicultural practices to be carried out on sites with varying successional rates.

A very thorough phytosociological study was carried out by Brayshaw (14) in the southern interior of British Columbia. Through selection of and data treatment for 121 stands in the fashion of the Zurich-Montpellier school of phytosociology, he arrived at a classification comprising seven associations.

Swedberg (112 and 113) concentrated his efforts on describing the coniferous ecotone from the crestline of the Cascades to the juniper woodland 16 miles to the east. Due to the overlapping of species ranges in the area, he encountered 19 coniferous species on an elevational east-west transect situated approximately half-way in a north-south direction between the study areas used in the research reported here. Swedberg was primarily interested in the autecology of the coniferous species as reflected by their environmental position and synecological context. Subjective and incomplete data were taken for the understory species.

Johnson's (80) report on Black Butte, a volcanic cone near the Deschutes transect, comprises a compilation of the vascular flora and an acknowledgedly cursory and tentative classification of the vegetation into habitat types patterned after Daubenmire (38).

The paucity of synecological information for the montane forest studied is paralleled by a lack of autecological literature for component species other than the coniferous dominants. For the latter trees, the information has been appropriately reviewed by Berry (8), Brayshaw (14), and Swedberg (112). Research on the autecology of the associated and understory species is meager, except for a few studies of the principal shrub components (Stanton, 110), (McKell, 92), (Goodwin, 61).

METHODOLOGY

Background of Ecological Concepts and Terminology

Since no general agreement on how to analyze and describe vegetation exists (69, p. 66), it hardly seems a propos here to attempt an exhaustive review of the methods and philosophies of vegetation science. It suffices to say at this point in the text that these human processes depend each in part on the purpose and level of classification desired or needed; characteristics of vegetation measured and stressed; the abilities of men preparing and using the information; and hopefully, most of all, the nature and uses of the vegetation itself (142). A somewhat intangible influence is that of human inertia developed at certain points with vectors being geographical, linguistic, academic, and vegetational in nature.

Pertinent references on concepts and methods will be cited in context as they relate to this particular study. Much more will be said of synecological theory and practice in the results and discussion chapter of this dissertation.

Basic terminology follows that of Greig-Smith (65, p. 322-324) except where otherwise defined, modified, or elaborated upon.

Some important terms and associated concepts extensively employed here but not found in the above reference are cited by Whittaker (145, p. 5-6 and 146, p. 308). Quoting the latter paper, "An ecocline may be conceived as a gradation in characteristics of ecosystems along an environmental gradient, a gradation that may be underlain or caused by a particular environmental gradient but usually expressed in all aspects of ecosystems." In the former paper, Whittaker first coined the term, complex-gradient, a succinct means for connoting the gradient of environmental complexes, which can be thought of as the sum of the factor gradients and their manifold interactions and compensations. In the more recent monograph, coenocline was used to denote the gradient of natural communities in an ecocline. The coenocline and complex-gradient together constitute the ecosystemic gradient or total ecocline. These terms are used frequently in the following text to most concisely describe the gradients of the physical environment and associated vegetation.

The distribution of vegetation cannot be interpreted as an effect to any specific cause or environmental factor or factor group. The factors of the "organismo-environmental complex" (9, p. 481) act collectively; and any action of one factor is necessarily qualified by the other factors and hence cannot be considered as being a limiting factor in itself. In other words the environment is holocoenotic (17, p. 18). Quantitative environmental data can only serve to illustrate expression of primary, secondary, etc. degrees of cause or control of slowly interacting and ever changing actions, reactions, and coactions that contribute to a selective complex upon vegetation in its temporal transition toward higher efficiencies in the long-term utilization of the resources of the effective environment.

Vegetation is a phytometer-complex, a sort of biological assay, integrating the factors of the environmental complex and reflecting the net or effective environment by their presence, absence, rate of growth, and stature. That plants as vegetation can measure and assess the present and potential productivity of a given portion of the landscape is the raison d'être of phytosociological investigations.

Reconnaissance

A point that has been stressed by several noteworthy ecologists (64, p. 19; 19, p. 3) is the subjective necessity that one must first inevitably be able to recognize apparent gross consistencies in the nature of vegetation, be they repeatability of rather discrete units or gradients for study.

Initial familiarity with floristic and environmental variation in this montane forest region was gained in accompaniment with Swedberg in the summer of 1960. Later visitation with Johnson at his study site, Black Butte, in the summer of 1961 also allowed the author to again view the complexities faced in studying the nature of this vegetational distribution. It was apparent that moisture, the primary factor of the complex gradient, is modified by major interactions with elevation, topography and associated slope.

Although it was recognized that environments are complexes of almost innumerable factors and all possible interactions, coenoclines can be found that are due to overriding or dominant factors which are superimposed on a relative uniformity of concomitant environmental influences.

Such a situation seemed possible in the montane forest zone on the east slope of the Cascades, for conditions of rather uniform geology and resultant soils lie on generally gentle topography unconfounded by the alterne effects of slope exposure. The major gradient is the decrease of total precipitation in the "rain-shadow" produced by the Cascades orographically extracting precipitation from the prevailing westerly winds. Thus, if an area could be located with stable vegetation expressing the primarily climatic potential, it could be analyzed by the field ecologist as nearly an ideal "natural experiment" with "controls" of essentially all variables but one. The resultant pattern of vegetation, with its component species populations, could be examined for its inherent nature.

In search of the closest possible approximation of this ideal set of circumstances, the author covered approximately 2, 000 miles in late August and early September of 1960 on reconnaissance through the montane forest zone for its whole north-south length on the east flank of the Oregon Cascades.

Several expanses of gentle topography and relatively uniform soils were located across the zone, but vegetational distribution patterns were generally confounded by lack of vegetational stability due to logging or grazing, or both.

However, in almost every synecological study, the researcher is forced to make certain compromises in regard to the alternative choice of confounding factors involved. Over most of the United States one is forced to locate disjunct, relict stands that commonly occur on a wide variety of sites in respect to soils and topography, in order to get a high degree of stability in the vegetation studied. The stable stand is so hard to locate in Europe, that little consideration is made for the dynamics of vegetation in the classification schemes, *per se*.

A compromise made in this study was to collect data from the unlogged, although partially grazed, forest vegetation on the Tenino and North Butte benches of the Warm Springs Indian Reservation (*c. f.*, Figure 2). The more open, xeric stands and other locations that happened to be near water available to livestock were especially overutilized by cattle. The remainder, excluding all but the few stands having the most dense conifer canopies, had seen grazing by the semiferal horses. However, the topographic and edaphic uniformity found was near the best to be expected for minimization of environmental factor compensation for the greatest expression of the primary effects of total precipitation pattern. The unlogged stretches of forest then available allowed the author to assess both the macro- and micro-patterns of conifer size-age class distribution along this primary gradient. Because of heavy logging on the west end of Tenino Bench, the four most mesic stands were located on North Butte bench, an area very comparable in all terms, topography, elevation, soils, etc., to that of the western end of Tenino Bench (c. f., Figure 2).

The other area of data collection was what is termed here the Deschutes transect (Figure 3). The actual sampling locations included a few relict stands, most xeric in character, which occur outside the National Forest boundaries. The bulk of the stands are located along the Santiam (U. S. 20) and McKenzie (Oregon 137) Highways within the scenic protection strips left along these routes heavily used by vacationists.

Reconnaissance in the area had quickly revealed that nearly all the forest land more than 500 feet away from these two main highways had been at least lightly selectively logged. However, within the protection strip only occasional very light salvage cutting of diseased or insect-ridden trees had been done in the past. If skid trails away from the highway were noticeable in the composition and density of the understory, the particular area was not sampled.

Some of the most xeric stands were located fortuitously quite distant from permanent water during the grazing season. Fencing excluded domestic animal usage from stands on several quarter sections which were owned by Deschutes County for quarry purposes. In both xeric stand situations, the timber was of very low density and commercial value so that evidence of harvesting was negligible.

No attempt was made to assess the effects of pathogenic organisms, big game, rodents, insects, and other animals on the vegetation studied. The intensity of effect of these organisms undoubtedly varied between species and stands, but no readily apparent unbalances or uncommon biotic disturbances were evident. Mule deer (Dama hemionus hemiona Raf.) were the most frequently encountered herbivores in the area.

Collection of Vegetation Data

Once the general areas of sampling concentration had been chosen, detailed types and methods of allocation of samples were planned. Time available, size of area with stable vegetation, and the kind and amounts of data desired were the factors that most dictated the number of stands (macro-plots) that could be sampled. Also to be taken into account for all aspects of the collection of vegetation data was the fact that the work was carried out singlehandedly.

Techniques for determining appropriate quadrat sizes and number are less objective than one might desire, because synecological interests commonly include all the species. The situation is further compounded in this study because of the particular interest in and consideration of the size-age class patterning of the tree species, particularly ponderosa pine (28).

Sampling efficiency equations can help determine the most appropriate quadrat size for sampling a single species in various stands, however, the problem is both statistically and ecologically complicated when all species in a community or layer thereof are to be sampled with a single quadrat size (78, p. 741). Some concessions are necessary because any quadrat size will sample some species or size-age class pattern of that species more adequately than others. Thus, satisfactory sample precision for a maximum number of species while retaining precision and normality in the frequency data for the most common species was striven for in this study.

A guaranteed assessment of the variation within a specific study area is best accomplished by a method of systematic sampling fitted to include the range of readily observable differences, especially when sample size is necessarily small. Even though sampling error and confidence limits cannot be determined for other than random samples (64, p. 20), the assurance of uniform coverage provided by systematic or stratified sampling overrides the value of estimates of sample precision in this study.

Hutchinson and Knapp (77, p. 47-48) aptly point out that strictly random sampling cannot occur in practice for biological problems because of the inexorable time variable. Furthermore, "The pattern of selective sampling takes account of ecological contours and recognizes causal, in contrast to random, distribution. Random sampling has value where there is one or two simple variables but is not practicable where multiple, variable ecological factors are operative."

This compromise was much preferred over selection of sites considered typical of vegetation studied. The bias introduced would be dependent on the observer's preconceived ideas of the character of the vegetation and clearly inappropriate for quantitative synecological investigations (64, p. 20).

With this multitude of considerations weighing upon the author's mind, the following decisions were reached.

It was decided to locate the stands (macro-plots) of the Warm Springs transect in a systematic fashion. Sixteen stands were positioned near the centers of the benches, as near as could be readily determined to the north-south section or quarter section lines. The specific macro-plot location was the highest and best drained point of micro-topography along these legal boundaries. Thus, the successive stand locations were not in a direct east-west line because they shifted with micro-relief, and where necessary, roads and trails were avoided by displacing the stand at least half its width east or west of the track (see Figure 2).

Following the above resolution of stand placement was determination of appropriate macro-plot size. The size-age class patterning of Pinus ponderosa, the principal tree, and bench mark species determining the range of vegetation variability included, was of prime consideration for decisions made in this regard. But also considered was the shape of the species area curve for understory species obtained from stratified random subsampling within the tree macro-plots.

The first consideration was satisfied by judging the middle four miles of the proposed transect as the area of maximum expression of the mosaic of size-age class patterning in these ponderosa pine-dominated forests. The north-south and east-west axial dimensions were paced off for 40 of the generally elliptically-shaped groupings of sapling and pole size reproduction, as these groupings occurred within one-half mile (but with a boundary of such groups not closer than 100 feet of the roadway) along both sides of the main Tenino Bench road. The mean of the north-south and east-west semi-axes of the young growth patches averaged 178.7 and 220.4 feet, with 56.7 and 66.5 being their respective standard deviations.

In discussing the problem of appropriate quadrat sizes, Curtis and McIntosh (33, p. 453) concluded that a quadrat should be at least one to two times as large as the mean area of the individuals of the most common species. In the present study, attention was paid to the mean area of the even size-age class clusters of young ponderosa pine. Curtis and McIntosh further state that all randomly distributed species should have quadrat sizes one to two times the mean area per individual. However, ponderosa pine individuals, considered by size-age class in this sampled area, were obviously not randomly dispersed, at least at the scale they were being measured. Thus, the lack of the criterion of randomness negated the use of plotless methods of tree data collection in this forest type (64, p. 48).

It was deemed necessary to have the macro-plot exceed by several times the dimensions of these "reproduction thickets", as they are termed by Weaver (136, p. 15). The rationale was to insure sampling of all size classes of trees and include variation in kind and density of understory vegetation beneath the different heights and degrees of tree canopy. In this way a broader characterization of the forest in given specific areas, but including the micro-pattern, could be made. The 600 by 200 foot macro-plot finally chosen was approximately three and three quarters the mean area of this size-age grouping for a locality of maximum observed expression.

Placement of the macro-plots on an east-west axis was predicated on the finding by a t-test that the east-west dimensions of the "reproduction thickets" were significantly greater at the 0.5 percent plus level than the north-south dimension. The probable cause of this orientation will be commented on later.

In practice, these macro-plots or stands were located as mentioned above, with due consideration being made for topographic and vegetational homogeneity within the confines of the systematic layout. That is, stands were moved north or south along the judged legal boundary until the highest level area was found that did not include roads, trails, or inordinate amounts of rock out-crop. The use of legal boundaries was greatly facilitated by the intensive surveying and marking used on the Indian reservation as a result of the inclusion of valuable private Indian allotments within the tribally-owned lands. Use was made of timber type and sales maps, odometer readings, and legal markers, in that order, to establish close approximations of legal boundaries. Roads commonly followed or paralleled the high parts of the topography so that sampling was usually conducted in close proximity to narrow forest roads. (See Appendix 1 for descriptions of legal locations of all stands sampled.)

The third set of sampling design decisions concerned the inventory of understory vegetation. Maximum area was limited by the size of the macro-plot, so that efficiency of sub-sampling needed to characterize the understory vegetation became an important factor. Since it was necessary to sub-divide the macro-plot for collection of data on tree size-age class frequency and density, a procedure that would integrate well with these tree sub-quadrats and yet yield sufficient data on the understory was striven for. A scheme was tried, and the resultant species-area curves for several first-sampled stands near the center of the transect were drawn. Species-area curves gave much more than the adjudged minimal 1:1 tangent to a slope between the percentage rate of increase in number of species and percentage increase of sub-quadrat area sampled (19, p. 172). Since the procedure fitted well into the total sampling routine, even though it was more than substantial by the above criterion, it was continued.

With respect to variance alone, the most efficient type of sampling is random placement of each quadrat. However, because this procedure is very time-consuming in practice, a stratified random sub-quadrat placement, described below, was used.

It is recognized that a comprehensive analysis for determination of the best stand size, stand number, stand placement, and similar considerations for the sub-quadrats would be an extremely detailed and time consuming undertaking. A great many parameters were being considered across a wide range of variability. Because of the exigencies of time available to work in the area, certain decisions are more the result of straight judgment and experience than prior analysis.

It may be best to summarize the basic sampling within a stand by outlining the procedure for collecting field data at a typical stand (follow Figure 6 with text).

The site for a stand was usually located in the late afternoon,

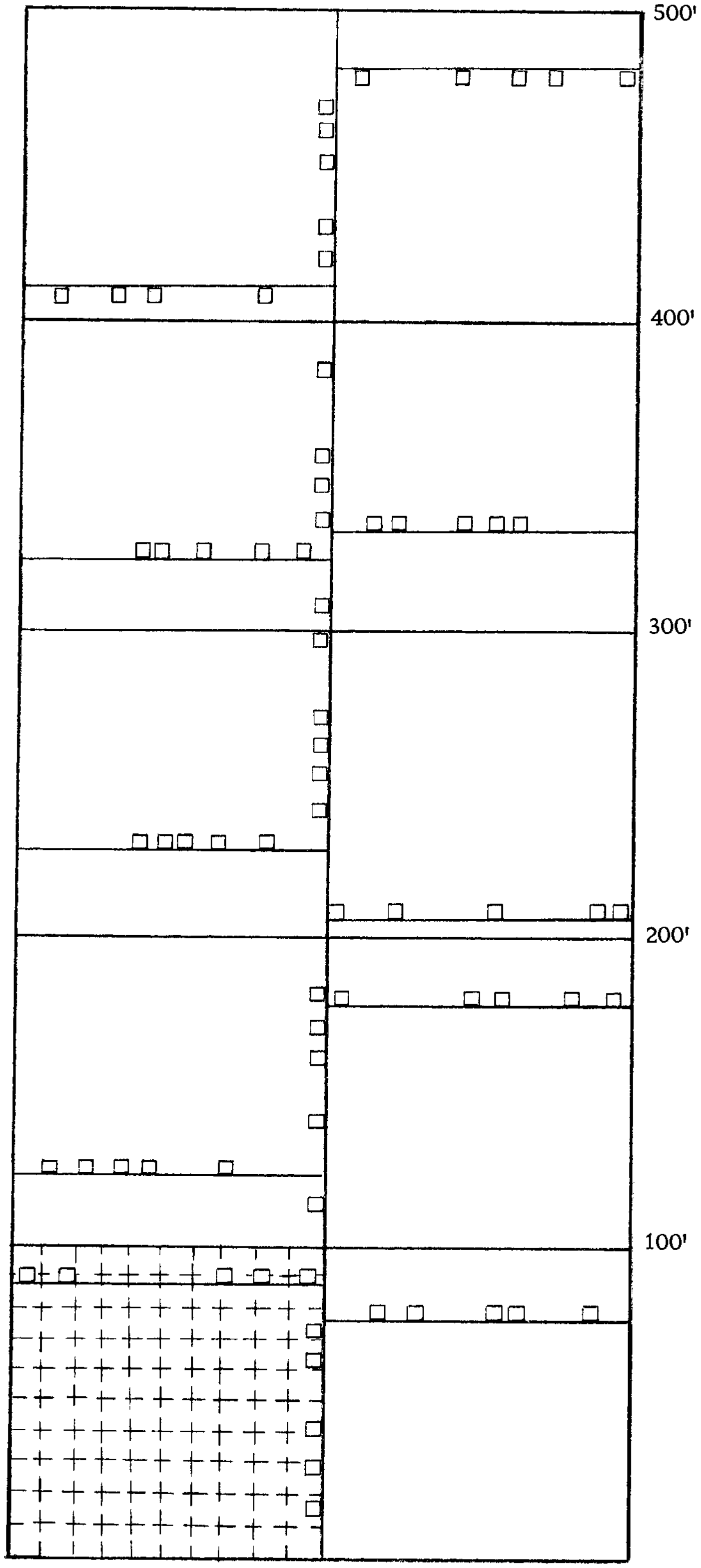


FIGURE 6. Schematic Plan of Macro-Plot

following mental and physical tiring of the author in collecting data from another stand. Once the legal markers and approximate boundary had been located, the stand was positioned in accord with the previously mentioned criteria. A long wooden stake was first driven in the ground at the center eastern end point. A metal foil stand marker with stand number and date written upon it was stapled to the nearest young but vigorous pole-sized tree around this point. The location of this marker in terms of species diameter, breast height (d. b. h.), distance and direction of this marked tree from the stake was sketched on the first of the data sheets for the stand. Positions of two more non-sapling size class trees close to this stake were also indicated in order to aid possible relocation for later study. A metal pin was then placed in the ground at the base of the stake and a cloth tape was reeled off on a compass line for its full length of 100 feet to the west. Another stake was driven and five more such 100 foot moves were made to the west. Care was taken to bring the tape level over the shrubs or course it straight through dense stands of saplings. A similar marking and position recording procedure to that initially done at the eastern starting point was done at this western terminus of the stand.

Most commonly, the author returned to the stand early the next morning, and relaid the tape along the center of the first section. A pin was placed in the ground at the foot mark designated by a number previously chosen from a random number table. Another 100 foot cloth was unwound in a northerly direction perpendicular to the center line. A piece of plastic flagging was then tied as near as possible to what were estimated to be the other corners and center of this north edge of the first section of the macro-plot. This 100 foot by 100 foot section was subdivided into ten by ten foot squares, for which tree frequency data was recorded. Frequent checks were made back to the perpendicular tapes as the area of ground was mentally subdivided into the smallest sub-plots. By utilizing a different colored pencil, to designate each species, the position of each tree was plotted on the data sheet. Trees over six feet high were recorded by a circle and a number designating their d. b. h. to the nearest inch. Saplings between six feet and one foot high were recorded as a dot in their respective color. The area was covered systematically with frequent checks to the tapes to obtain relative distances as correctly as possible.

Next came the recording of understory data for this half of the section. A convenient size for these sub-quadrats was found to be one with dimensions of three feet by three feet. Five such sub-samples were laid down along the north-lying tape with their southwest corners situated at the foot marker of the tape corresponding to a random number between zero and 97. No overlap was allowed, however, with these plots being at least one foot apart. These quadrats were marked by laying down a one inch-wide aluminum stake perpendicular to the stretched-out tape. The inside boundary was formed by the tape and the outside corners were marked by vegetation or scratches on the soil surface.

The first step during this part of the procedure was to take shrub data. A shrub was "counted in" for frequency (i. e., rooted frequency) if more than one-half of its basal stems were inside the sub-quadrat. A "cover" measure was recorded by the use of corner "points". That is, a "hit" was recorded for that species if living foliage was within three inches of a column projected upward from each of the four corners of this sub-quadrat. This is recognizably another measure of frequency. Even with the use of pointed pins the data can be recorded as cover or frequency (78, p. 741). Only a randomized placement of infinitesimally small points can theoretically give an unbiased measure of cover. Increasing the "point" size increases the "cover" bias in a different fashion for each species (59).

Since it would be a rather involved study to estimate this bias itself, the data are presented only as a pragmatic, yet objective assessment of "cover". Analyses including this data are done separately from those including frequency and density.

Once the shrub data had been recorded on a separate sheet, the herbaceous layer was recorded within the same sub-quadrat. Total counts were made of all individuals. Shrub and tree seedling (to one foot high) data were also collected from these square yard micro-plots.

The problem of differentiating individuals varied with species and life form, but counts were made in regard to how many separate plants would be seen from above, with no checks for root connections. "Cover" in the case of the herbaceous vegetation was a portion of a herb which was closest to the center of a one-inch circumference from the corners of the micro-plot. Herbaceous plant cover data were not recorded for the Warm Springs transect because of the time involved to obtain information likely confounded by grazing. Also recorded under this heading were the ground surface conditions of rock outcrop, gravel or loose stone, bare soil or litter, if a living plant part did not intersect this projection.

Once all these data had been collected for the north half of the first macro-plot section, the tape was drawn perpendicularly out from a random number along the base line to the south. The same set of procedures and data followed for this and remaining sections of the macro-plot.

For the Deschutes transect expressing much more stable understory vegetation, an additional five randomized subquadrats were placed on the untrampled side of the center tape before proceeding with the data collection to each side. Thus, five square yard understory samples per line add up to ten per section and 60 per stand for the Warm Springs transect and 15 per section and 75 per stand (because of shortened macro-plot length) for the Deschutes transect. Species density and frequency tallies are computed on the basis of these quadrat numbers. "Cover" is calculated from the 240 and 300 respective "points" at the corners of these quadrats. Tree frequency by the nearest one-inch d. b. h. interval class is tallied for the ten by ten foot sub-quadrats.

For the Warm Springs stands, increment cores from five dominant or co-dominant mature and thrifty ponderosa pines and five dominant saplings of this species within "reproduction thickets" were taken from their south sides at waist height, in order to make limited assessment of age and growth of this species at the various stands.

Any decidedly new or the least questionable possibility for taxonomic addition or change to the data was backed up by appropriate notes and collection of voucher specimens at the time they were encountered. Collected and listed as traces were any species occurring outside the understory micro-plots but within the macro-plot proper. All voucher specimens are on file at the Oregon State University Herbarium.

Finally, at least two color and two black-and-white photographs were taken of a representative view of the stands.

A total of 16 such stands were established and examined for the Warm Springs transect from June 27 to July 15, 1961.

The above text describes the field procedure developed during the summer of 1961 on the Warm Springs transect. The following considers the modifications necessary in field methodology during the following summer for the Deschutes transect.

The necessitated positioning of some stands in relict areas but primarily along the highways within the protection strips has already been discussed. In addition, it should be noted that the area has nearly level topography and thus understandably has a great profusion of roads leading away from the highway toward sites of timber harvesting and recreational use. This condition plus the fact that legal markers were not as readily available negated the objective use of legal locations as was done for the Warm Springs transect. It was thus necessary to place the stands where they would fit, to meet the criteria of no intersection with roads and trails and relative freedom from disturbance (see Figure 3).

The author felt he was fortunate even to find the most xeric stands in acceptable vegetative conditions and topographic situations, let alone be concerned about their geographical dispersion. However, once sampling moved to federally-owned land within the national forest boundary, more objective rules for stand placement could be adopted. For this bulk of the area considered, an attempt was made to place two stands per each mile of highway for the Santiam route and one per each mile along the McKenzie Pass route.

This difference in sampling intensity was deemed appropriate for two reasons. First, freedom from salvage logging disturbance was harder to find along the latter route and secondly this highway is almost due west, with the montane forest zone being traversed in a shorter road distance than along the northwest bearing stretch of U. S. Highway 20. In both cases, however, at least one stand is found in each legal section that is intersected by these main roads.

A total of 40 stands were examined for this transect between June 10 and August 15, 1962. They were examined in an approximate sequence from most xeric to most mesic in order to capitalize upon the change in the flowering phenology for the bulk of the herbaceous understory.

Since the size of macro-plot used the first summer on the Warm Springs transect had frequently taken a day and a half to collect data from, it was decided that a reduction in size of 100 feet in length to a 200 by 500 foot macro-plot and the foregoing of extraction of increment cores was necessary to complete vegetation data collection from a stand during one long summer day, and to allow all stands to be sampled before the herbaceous vegetation had withered significantly on the most mesic stands. This reduction in total size also allowed somewhat easier positioning of stands in the scenic protection strip vegetation between the frequent side roads. These stands were centered as far as possible away from road and surrounding disturbed vegetation. Otherwise, the procedure and data taken are exactly like those described for the Warm Springs transect.

It may well be mentioned at this time that every opportunity was taken to travel through surrounding vegetation when coming and going from stands and areas, in order to assess the representativeness of the specific stands studied in comparison to the forest of the general area.

Analysis of Vegetation Data

Raw field data were tallied on marginal punch cards in order to facilitate manual sorting by key items of information. From the absolute values of parameters for individual species or size classes thereof, the data were all converted with the aid of a desk calculator into relative measures and indices. That is, the measurements for one species or species group were compared to the total for all species in one of the three strata of a stand. These percentage or relative assessments were (31, p. 67):

Relative Frequency - number of occurrences of one species as a percentage of the total number of occurrences of all species.

Relative Density - number of individuals of one species as a percentage of the total number of individuals of all species.

Relative Dominance - for trees, total basal area of one species as a percentage of the total basal area of all tree species. Use was made of a table in Bruce and Schumacher (16, p. 460) for conversion of d. b. h. measurements to the

nearest inch into basal area in square feet.
For understory species, "cover" values were used as a measure of dominance.

Indices computed from the above relative parameters were:

Importance Value (IV) - sum of relative density, relative frequency and relative dominance.

Relative Importance Value (RIV) - importance value, as above, divided by three, in order to bring the maximum plotted values down from a possible high of 300 to a high of 100 (10, p. 681).

DF - sum of relative density and relative frequency for understory species.

Relative DF - sum of relative density and relative frequency values for understory species, divided by two.

These relative indices were further stratified by life form. The definitions of the modified Raunkier life form classes and the status of each species are given in Appendix 2. Life form indices were calculated by summation of the contributions of all species of a life form class and finding the class' percentage contribution to a particular set of parameters. Furthermore, these relative indices for herbaceous species were calculated as a percentage of the numerical contribution of only the perennial herbaceous species, in addition to a calculation based on an all species, perennials plus annuals, basis.

After the necessary calculations were recorded on marginal punch cards, a series of "spread sheets" or "association tables" using various single and combined measurements were constructed for all species and all stands by transect. Selected series of these appear in Appendix 4.

These spread sheets were ordered in various ways along their two margins (54, p. 45-67; 82, p. 24-31). For a main set of these organizations of data, the vertical margin listing species was first ordered by life form, secondly by percentage presence, thirdly by magnitude of measurement, and fourthly by degree of judged indication of xeric to mesic conditions. The position of the stands along the upper horizontal margin was thus determined by the placement of its component species for this phytosociological ordering. The order of the stands and the species varied with the parameter or combination of parameters considered. These variations, however, were of prominent interest in this study.

Some spread sheets were based on an ordering of stands by their geographic position, that is, either by direct distance east to west by legal location or direct westerly distance from the crest line of the Cascades for the particular stands.

In order to study the promise of electronic data processing (EDP) in the extensive employment of formulae of comparison on different data bases and also the variation in final ordering to be achieved by inspection versus machine procedures, selected association table data were transferred to EDP punch cards.

Matrices of a index of similarity between stands were computed, using a program modified from that called INDIXSM supplied by Robert R. Ream (101, p. 98) of the Plant Ecology Laboratory, University of Wisconsin.

The locally available IBM 1620 computor in Oregon State University's Statistics Department Computor Laboratory was utilized for the smaller set of data from the Warm Springs transect. However, the larger computor memory required for the manipulation of the Deschutes transect data necessitated telephone transmission to an IBM 7090 computor at the Western Data Processing Center at the University of California, Los Angeles.

Because of the financial limitation, not all the desired computor runs could be undertaken. However, enough large scale electronic computation was employed to give an example of its empirical value in this study and its further potential in aiding synecological assessments in general.

The formula of the particular coefficient of association used for comparing the selected quantitative data of each stand with that of every other stand is symbolized as:

$$\frac{2W}{A + B} \times 100$$

where A is the sum of all measures for one stand, B is the sum of all measures for another stand and W is the sum of the lower values for each measure, or the amount which the two stands have in common. (If a species occurs in only one of two stands, its lower value is zero.

Trace species cannot be weighted; thus, they are necessarily excluded from the computations). This matching coefficient or index of similarity may vary from zero for two stands which have no measurements in common to 100 percent for two quantitatively identical stands (30, p. 83).

This is a coefficient of association in which the negative matches are excluded from the numerator and matched pairs carry twice the weight of unmatched pairs (107, p. 129). This particular coefficient was originated by Dice (45, p. 298) and expounded by Sorenson (108). It is commonly known in synecological literature as "Sorenson's K". The context in which it is used here is more similar to that of Clausen (22, p. 640) than that of Sorenson, because the latter author used only presence data. This index can be more simply thought of as the proportion of species and their measurements in common between two stands.

The runs and combinations of quantitative characteristics of the stands included in the computor analyses are as follows:

For the Warm Springs transect: data including

all trees one inch d. b. h. and greater - RIV's

all shrubs - RIV's

all perennial herbs (except geophytes) - relative DF's

For the Deschutes transect: data including

all trees four inches d. b. h. and greater - RIV's all shrub species - relative frequencies

all herbs - relative frequencies (all species basis)

Tables II and III are matrices of index of similarity values computed from the above selected sets of the total data available.

Once the index of similarity matrices had been formed, a means of objectively finding structure, *i. e.* degree of affinity and relative hiatus points between groups of stands, was sought. Various combinations of mathematical and graphical techniques can and have been used in illustrating phytosociological relationships.

In addition to coefficients of association and correlation, coefficients of distance remain as a third alternative method of computation of resemblance between entities. This last named method has usually been termed "taxonomic distance". Construction of schemes employing combinations of line length, direction and thickness can be found in the literature to illustrate species (44), quadrat (60) and community associations (90). Maycock and Curtis (91) have constructed three-dimensional models showing ordinations of stands and species in relation to three environmental gradients. Formulae are available for describing *p*-variate populations in *n*-dimensional hyperspaces (53).

However, two strictly mathematical techniques can be applied to analyzing matrices; factor analysis for coefficients of correlation and cluster analysis for coefficients of association. It is the latter

TABLE II. COEFFICIENT OF SIMILARITY MATRIX , WARM SPRINGS TRANSECT

Stand Numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	----	55.3	50.5	48.6	33.9	27.3	22.6	28.1	24.2	31.6	28.1	11.4	4.5	12.5	22.2	4.8
2		----	66.6	67.5	48.9	47.7	33.6	32.3	30.7	38.9	36.4	18.4	8.3	20.7	30.1	7.8
3			----	72.9	65.7	56.1	47.0	47.4	36.1	41.2	39.2	23.8	11.5	22.9	34.1	10.8
4				----	57.2	59.2	46.2	41.5	37.5	41.9	45.4	22.4	12.9	25.0	29.4	11.8
5					----	59.3	58.7	44.3	30.7	33.0	39.7	29.9	10.9	23.2	31.1	10.3
6						----	61.3	43.3	38.9	38.1	45.8	24.3	15.9	26.0	29.0	14.4
7							----	44.8	43.9	32.3	48.3	22.6	9.5	21.3	25.1	8.6
8								----	36.3	33.9	39.3	23.6	16.6	27.0	30.6	8.8
9									----	61.1	51.1	35.5	22.7	37.8	40.4	26.0
10										----	53.6	37.7	18.6	28.6	35.5	20.7
11											----	37.7	21.1	27.0	31.6	14.7
12												----	30.5	26.9	30.1	34.8
13													----	40.9	30.0	57.8
14														----	51.0	47.0
15															----	28.9
16																----

TABLE III. MATRIX OF INDICES OF SIMILARITY, DESCHUTES TRANSECT

Stands	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Stand
1		48.7	31.4	44.0	52.5	36.4	23.7	29.1	33.0	26.8	20.6	21.8	22.3	16.9	17.9	27.5	30.1	19.3	17.4	18.3	14.7	12.5	10.4	8.4	8.5	13.9	17.3	9.6	16.1	7.6	11.8	7.3	4.9	1.7	1.1	5.1	10.3	10.8	6.8	2.0	1
2			39.3	54.2	44.3	49.9	29.0	41.0	34.7	34.6	27.0	30.5	24.4	23.4	27.5	32.7	39.5	27.6	22.8	23.6	18.9	18.0	12.4	9.7	9.8	15.6	21.9	14.1	16.6	8.3	11.7	7.6	4.8	1.5	1.1	5.0	7.9	9.1	5.3	2.1	2
3				47.6	33.9	56.6	44.0	59.1	43.8	55.1	41.5	47.7	44.8	40.8	45.4	44.7	68.5	35.6	36.0	37.3	34.5	36.7	32.9	27.3	24.9	38.6	47.5	35.3	44.8	16.8	19.4	14.0	7.1	2.2	1.4	7.2	21.7	21.0	11.1	2.7	3
4					43.4	64.1	48.8	52.7	49.5	55.1	42.4	42.4	37.8	29.4	43.1	52.8	53.0	33.3	27.1	28.0	22.2	21.9	16.5	12.8	12.6	20.3	24.6	18.7	26.4	12.6	14.6	11.1	7.0	2.9	1.2	5.8	12.9	13.0	6.1	2.2	4
5						39.0	26.4	40.9	31.6	38.5	30.1	29.3	25.9	27.8	25.6	27.7	36.3	24.0	22.4	20.3	19.8	21.7	11.1	9.1	9.2	18.0	21.2	18.4	20.5	11.4	13.1	10.3	3.8	1.4	1.1	4.4	9.6	10.6	5.5	2.0	5
6							44.8	58.2	58.6	58.5	48.5	52.5	41.1	39.5	43.1	53.7	62.4	39.9	34.9	34.7	28.9	27.9	21.8	17.6	16.2	27.9	37.9	23.9	32.2	13.9	20.6	13.1	7.2	2.6	1.3	6.7	17.4	17.2	9.7	2.5	6
7								38.1	35.4	58.9	49.3	45.8	38.5	44.7	59.6	68.8	54.6	45.1	46.6	35.3	41.9	40.2	33.4	28.4	23.8	35.8	41.0	36.1	46.1	19.3	28.3	17.1	8.7	3.3	1.3	6.9	22.5	21.8	9.5	2.6	7
8									39.5	57.1	39.9	47.4	37.4	36.7	42.0	41.3	63.9	34.6	31.0	30.3	28.3	31.0	27.0	21.2	21.9	29.9	36.3	28.7	33.0	15.7	16.2	12.2	6.5	1.8	1.4	6.7	15.2	15.3	8.2	2.7	8
9										51.7	47.2	45.6	38.9	32.9	34.9	48.9	51.4	38.8	30.3	39.3	27.3	22.3	14.6	11.2	12.3	22.9	33.6	18.3	28.4	12.4	16.2	11.5	7.3	3.3	1.3	6.8	13.4	10.7	8.2	2.5	9
10											65.2	65.3	52.7	49.4	65.2	57.5	66.6	58.0	51.8	44.9	34.8	40.2	27.0	22.7	19.8	35.3	39.9	36.9	42.4	23.8	34.3	24.1	8.7	3.3	1.3	6.9	22.3	23.0	10.5	2.5	10
11												70.4	66.5	54.5	53.0	51.6	51.2	62.6	51.1	53.4	34.9	32.3	21.8	17.1	15.8	34.7	43.4	23.9	44.9	18.1	27.5	16.2	9.1	3.5	1.4	7.2	22.2	20.3	10.2	2.7	11
12													65.7	59.4	53.7	49.6	58.3	64.1	61.7	54.7	45.2	37.6	31.6	26.8	21.6	39.0	46.7	34.0	44.6	24.6	32.1	19.0	9.0	3.4	1.4	7.2	26.1	24.7	11.3	3.3	12
13														49.5	48.2	38.3	48.2	57.2	49.9	48.6	39.4	32.6	25.8	18.9	16.7	29.8	38.0	25.4	39.6	15.6	24.2	16.1	8.8	3.2	1.5	7.1	21.4	19.2	10.7	3.1	13
14															47.7	40.2	50.8	47.3	57.9	44.9	43.7	45.4	34.7	29.7	23.7	43.4	50.8	42.8	50.0	29.5	36.4	24.3	10.9	5.0	4.0	9.2	28.4	27.9	13.4	7.7	14
15																61.4	58.6	56.6	49.8	40.2	32.8	34.2	24.4	20.4	17.9	26.5	31.1	31.6	35.8	19.8	28.3	19.2	8.0	3.1	1.2	5.5	16.5	16.8	7.7	2.3	15
16																	57.7	51.6	42.9	34.3	31.8	29.4	20.1	15.9	15.8	26.6	35.2	22.0	35.2	16.4	21.6	13.1	7.5	3.1	1.2	6.1	16.1	16.4	6.9	2.3	16
17																		48.2	44.1	41.0	36.6	37.8	33.1	28.6	23.5	37.0	46.8	34.7	46.8	21.0	28.5	19.1	9.6	3.6	1.5	7.7	24.2	25.1	12.5	2.8	17
18																			66.7	46.1	37.7	35.2	21.8	17.2	21.1	34.8	35.3	26.0	41.8	24.6	34.5	22.8	7.6	3.6	3.1	5.9	17.9	18.3	9.3	2.3	18
19																				50.8	48.9	46.0	33.4	24.9	24.2	41.8	43.7	37.1	49.4	30.6	39.3	27.8	9.4	3.1	2.5	7.9	26.1	25.3	12.9	3.6	19
20																					39.4	36.8	29.3	22.1	20.5	33.5	36.2	28.4	37.2	26.7	27.3	21.7	7.6	2.9	1.4	6.1	22.1	21.3	14.1	2.9	20
21																						59.2	50.0	40.7	43.7	47.1	48.8	51.9	41.4	40.0	40.5	28.7	13.3	3.3	5.3	19.5	37.1	32.0	24.7	6.5	21
22																							58.0	46.1	53.9	58.8	50.8	66.9	50.4	40.3	44.7	29.6	10.7	2.0	10.0	21.8	32.3	30.7	21.6	6.8	22
23																								66.8	62.0	54.8	43.6	59.7	42.4	46.7	41.8	33.6	18.8	6.7	8.2	26.7	40.2	39.5	29.6	7.5	23
24																									59.7	44.4	40.9	53.6	38.3	41.6	38.2	33.7	19.3	7.7	11.6	21.3	32.5	38.9	24.5	7.4	24
25																										39.4	33.4	51.1	32.2	47.8	38.5	37.7	14.0	5.4	5.7	28.9	27.6	30.2	24.9	7.4	25
26																											53.2	57.4	65.4	38.7	44.2	28.1	19.4	3.0	2.6	13.7	45.1	38.0	25.6	7.9	26
27																												49.2	61.6	27.4	30.0	15.4	9.5	4.2	3.9	16.0	36.4	30.1	17.3	3.5	27
28																													47.7	38.5	37.7	28.7	8.8	2.0	1.6	13.9	31.7	28.9	22.9	6.5	28
29																														26.5	35.5	20.7	10.2	3.8	1.5	8.3	33.4	34.3	14.8	3.5	29
30																															63.7	48.3	28.1	8.3	6.2	28.2	36.5	35.1	25.4	6.6	30
31																																63.0	31.2	8.4	10.0	28.5	40.0	42.4	34.2	6.7	31
32																																	32.3	19.6	18.6	24.6	31.1	34.3	26.3	5.9	32
33																																		40.8	44.6	48.4	24.0	21.5	18.0	9.2	33
34																																			46.7	31.7	5.9	12.9	8.3	20.4	34
35																																				41.5	8.0	13.2	13.0	19.7	35
36																																					21.4	23.1	29.7	5.3	36
37																																						46.0	45.7	10.6	37
38																																							49.0	11.7	38
39																																								18.9	39
40																																									40

that will be of primary concern in this study.

Cluster analysis may be described as more of less automatic methods for establishing and defining clusters of mutally high similarity coefficients among entities in the resemblance matrix. The simplest treatment of such matrices is that of differential shading of elements of the matrix corresponding to the range of values within a shading category. This method was used by Gilbert (57, p. 192) for showing selected species associations from the understory of the upland forest in the prairie-forest border region of Wisconsin.

Much more sophisticated methods, presumably more closely paralleling the full complexity of phytosociological phenomena, are available through various means of mathematically clustering the values within a matrix. From such analyses dendrograms can be constructed showing the levels of affinity at which connections emerge.

This technique was first minimally used by Sorenson (108), who had to choose arbitrary values at which to draw his clusters. However, recent burgeoning of the field of numerical taxonomy has produced mathematically much more rigorous, and thus more objective, types of cluster analysis. The prerequisite development of electronic computors has allowed this quite objective and repeatable approach to undergo research usage in a wide array of problems in biological classification.

An attempt has been made here to extend a recently described technique of Sokal and Sneath (107, p. 305-311) to this example of a phytosociological problem. Financial limitations for the present study forced the adoption of but one selected means of analysis from the many mathematically possible ones. The comparative value of the different possible methods of weighting and performing cluster analysis programs remains as yet unexplored for plant synecology.

The particular type of cluster analysis chosen was that of average linkage through the weighted pair-group method (107, p. 309). An outline of the procedure is as follows:

1) Computation of a full symetrical matrix (except diagonal) of indices of similarity.
2) Search for mutually highest correlations and establishment of central points of the clusters to be formed (for a column or, in this case, a stand).
3) New relationships among clusters are calculated as arithmetic averages of all the coefficients involved in the correlations of any two clusters.
4) Only the two most highly correlated stems join at each clustering cycle.

A Fortran II program for an IBM 1620 computor was written by the staff of the Computor Laboratory, Statistics Department, Oregon State University. Funding available allowed only the two matrices given here to be analyzed. The resulting dendrograms are Figures 7 and 8.

Soils Data

The examination of soil profiles was delayed until late August and September because of the time consumed in and the exigencies of collecting vegetation data as near as possible to the peak of its growth and flowering. Each stand was then returned to and a pit was dug as near as possible to the geometrical center of the stand. The pedon examined was displaced if large tree roots or a rock outcrop negated this central position. For approximately one-fourth of the most xeric stands a probing procedure in which for 50 regularly spaced positions a three-eighths inch by five foot steel rod was driven into the soil until rock impedances were struck. Data on depth to rock was collected in order to estimate the influence of soil depth in accentuating the change in forest characteristics at these ends of the transects.

A three foot wide face was exposed at a pit that was dug as deep as possible, commonly three to four feet. Field data sheets included information on horizonation, including depths to lower boundaries, their topography and distinctness; manual judgment of texture; structural type, grade and class; hardness or firmness; pore type, size and abundance; estimated cross-sectional area of exposed gravel, cobbles or stone; and finally notes on rooting, pans, and

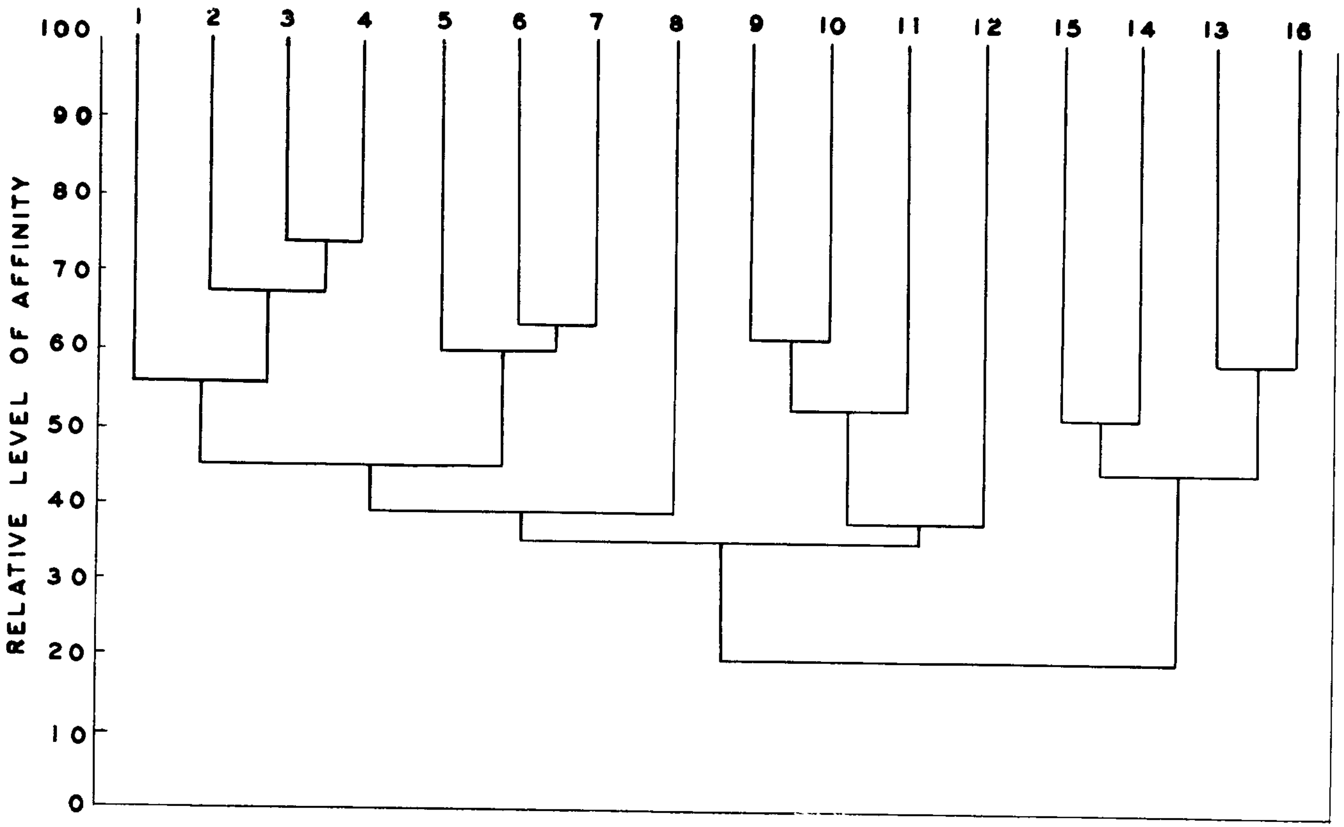


Figure 7. Dendrogram for Warm Spring Transect
Indices of Similarity Weighted by: RIV (1" d. b. h. +) - trees; RIV - shrubs; Rel. D. F. - herbs (perennial species basis)

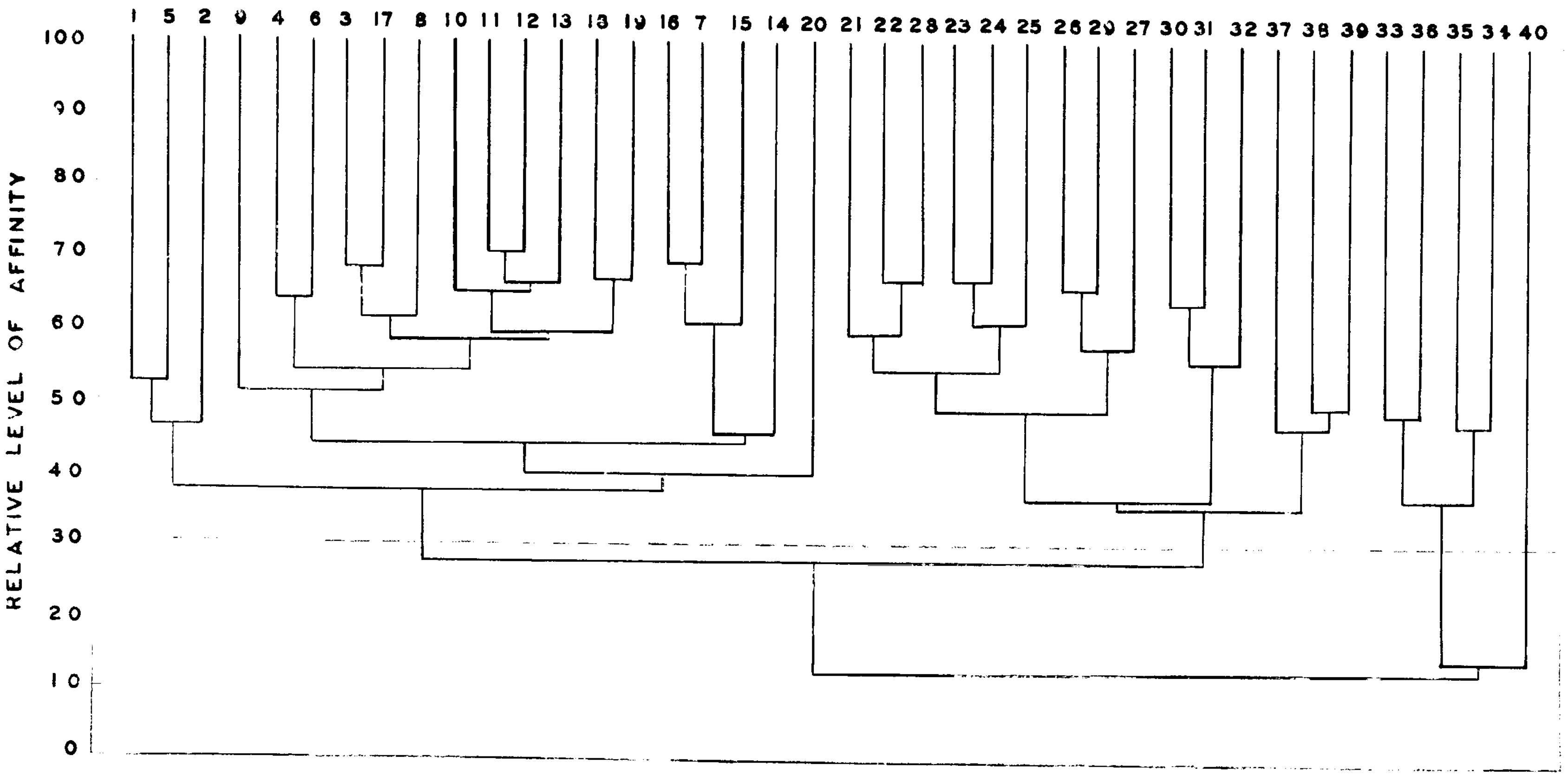


Figure 8. Dendrogram for Deschutes Transect.
Indices of Similarity Weighted by: RIV (4" d.b.h.+) - trees; Rel. freq. - shrubs; Rel. freq. - herbs; (all species)

silicate deposits.

Descriptions followed the terminology included in Soil Classification, A Comprehensive System, 7th Approximation, Soil Conservation Service, 1960.

Approximately 500 grams from each horizon was collected into paper bags nested into a larger one for each stand. These samples were brought to the laboratory for later examinations for the properties of both moist and dry hue, value and chroma, determined with the aid of Munsell color charts under uniform lighting conditions. Also determined in the laboratory were pH, consistence, and a re-examination of texture.

RESULTS AND DISCUSSION

The scientific contributions of this study have two complementary dimensions. These are a detailed analysis, description and interpretation of the montane forest vegetation of the area considered; and the refinement of certain methodology of plant synecology that allows closer scrutiny for assessment of vegetation distribution theory and classificatory practices in relation to this and other vegetation types. The following text attempts to untangle somewhat the intertwined threads of these two respective types of research and thought. The order of presentation is not meant to imply order of deemed importance, for the relative values can best be decided in the light of the reader's particular background and interests.

Theory and Methodology

One of the principal objectives of this study was to examine how the nature of the area, its physical and biological aspects, as well as the methods of study, affected the resultant interpretations of the vegetation. Hence, the study was designed to minimize the apparent sources of confounding environmental and biological variation and to maximize objectivity during the collection and analysis of data. This goal was limited by the author's available time and fiscal resources. The ideal reached for was symbolic representation by words and numbers in as close as possible, yet practicable, parallel to the nature of the vegetation studied.

Variables Influencing Vegetational Classification

Since students of synecology inevitably draw upon a heritage of theory and information, it is wise first to consider carefully the premises and to acknowledge the influences of these previously developed ideas in relation to the study at hand.

Of very great relevance to this study is the apparent dispute over the "naturalness" of "association-units" of vegetation countered by those who judge vegetation to be continuously variable in nature. Discussion of the lines of evidence and argument around this question add to quite a sizeable synecological literature. The history of this quasi-controversy between those of individualistic dissent and advocates of the unit-association hypothesis has been thoroughly traced by Whittaker (147) in a review of synecological theory and practice.

The author has found it expedient to summarize here this contentious topic of synecology by modifying and expanding an outline, first given by Spurr (109, p. 189), of factors that contribute to the two basic types of vegetational interpretation. This outline (Table 4) should be referred to during the following discussion.

Among ecologists there is a spectrum of interpretations and associated degrees of adherence to the individualistic and unit-

TABLE IV. INFLUENCES ON VEGETATIONAL SYSTEMATIZATION

Variables	Vegetational Interpretation Favored: Unit - Association	Vegetational Interpretation Favored: Individualistic
Area Attributes		
Size of area studied	The smaller the area (region to sample) the better the chance of homogeneity	The larger the area (region to sample) the less the chance of homegeneity
Ecotope		
Topography	Dissected topography	Gentle topography
Aspect	Steep, multiplicity of slope exposures	Lack of or minor expression of slope aspect
Edaphic		
Soil parent materials	Abrupt changes in parent materials	Uniformity or gradual changes in parent materials
Pedogenesis	Mature (zonal) soils	Immature (azonal or intrazonal) soils
Soil moisture and drainage	Abrupt changes in soil moisture and/or drainage	Gradual changes in soil moisture and/or drainage
Climate	Abrupt changes in climate (frost pockets, etc.)	Gradual changes in climate
Biota		
Flora		
Diversity	Small floras, more depauperate and endemic floras, genetic and phenetic distinctness of taxa	Rich floras, taxa with wide geographical distribution and ecological amplitudes. Introgressive hybridization, etc.
Vegetation	Stable, successionally in equilibrium with site	Disturbed, confounded by successional changes
Fauna	Uneven use patterns (water, fences, salt, herding, etc.)	Relatively even use patterns
Natural Catastrophy	Localized occurrences e.g. fire patterns	Broad sweeping occurrence

TABLE IV. Continued.

Variables	Vegetational Interpretation Favored: Unit - Association	Vegetational Interpretation Favored: Individualistic
Human Attributes		
Uses of Vegetation	Abrupt changes, differential use	Little or no use, or else uniform utilization
Sampling (Data Collection)	Selected species studied Purposive selection of stands after reconnaissance (circuitous reasoning) Small size and number of samples Disjunction of samples Many variables considered at a time, but difficulty in quantification and objective analysis, Dominance measures stressed	All species taken into account Objective (random, stratified random or regular placement of stands) Large size and number of samples Contiguity of samples Consideration of single or a few variables at a time e.g. frequency, populations Numbers, species populations stressed
Analysis	Subjective	Mathematical and statistical
Synthesis of Data	Categorization	Expression of relative differences or similarity
Purpose of Synecological Evaluation Classifier User	Practical, to stratify management practices	Academic, theoretical, research
Training Classifier User	 Traditional taxonomy and soils Wild land resource management and applied research	 Modern taxonomy, statistics Allied pure research
Traditional and Political Influence	intangible but very important facet	

association theories. The difference of opinion is often aggravated by semantic encumbrances and misunderstandings. At one end of the scale was Gleason (58), who viewed vegetation as assemblages of individuals that have similar tolerances but have no specific effects on one another. At the other extreme were those who held to the organismic interpretation of communities, best exemplified by Clements (24), who analogized the relationship between individuals in a community to cells in an organism. Most contemporary synecologists are not as extreme in their views, but nevertheless they are far from equivocation or sometimes even tolerance of the different means of studying vegetation.

No matter how desirable the unit-association idea is from a practical standpoint, there has been mounting evidence, particularly within the last decade, that indicates the continuum concept as representing more fully the variation in vegetation as it is found over large sections of the world (64, p. 172). However, Webb (140) points out, "The fact is that the pattern of variation shown by the distribution of species among quadrats of the earth's surface chosen at random hovers in a tantalizing manner between the continuous and discontinuous."

Grieg-Smith (64, p. 119) states, "The reality or otherwise of distinctive units of vegetation in the field remains an open question and one likely to remain a matter of considerable interest for its bearing on differing concepts of the plant community." He also mentions that, "Transects which include a transition between clearly distinct types of vegetation commonly illustrate the difficulties of delineating the boundaries of communities."

With this in mind, the selection of a study area in which the vegetation has been described as "ecotonal" (112, p. 5) and whose major physical factors of the environment express gradients that are noticeably gentle (elevation, aspect), relatively minorly expressed in a differential fashion (soils) or apparently continuously variable in nature (precipitation) seems to predicate the analysis and description of this vegetation as a continuum.

Results of Some Previous Studies in the Pacific Northwest

Other studies of the montane forest vegetation of the Pacific Northwest have been cited in which there has been derivation of plant association-units. The authors of these studies have mostly followed Daubenmire (38) in using the "habitat-type" concept. That approach employs reconnaissance and consequent selection of a few stands for quantitative analysis and representation as "modal" examples of abstract plant associations that are interpreted to repeat in more or less taxonomically identifiable fashion across the landscape. Disregarding the ability to represent the nature and extent of variation of patterns of vegetation by this approach, the principal advantage of describing habitat-types is the relatively economical way in which classification is reached and the consequent ease of communication, especially when transposed to applied ecology. The author considered these relative merits for striving toward this type of classification, but judged a lack of harmony with this approach to the particular area and its vegetation to exist in light of the questions asked.

In addition, this approach has an important logical fallacy in common with traditional taxonomic schemes in general. This criticism has been best expressed by Sokal and Sneath (107, p. 7). This chief weakness is, "the self-reinforcing circular arguments used to establish categories, which on repeated application invest the latter with the appearance of possessing objective and definable reality."

Nevertheless, such subjective treatments have served the causes of ecology well as first approximations. Such initial utilitarian, although perhaps over-simplified, schemes have been especially valuable for implementing the use of stratification by synecological context for forest and range management. (see Dyrness, 49; Driscoll, 47 and Volland, 128).

But, in addition to stress upon ultimate management application of synecological information in the Pacific Northwest, steepness of topographic, and consequent micro-climatic and edaphic gradients have considerably influenced the conclusions reached in other studies in the western-most portions of the Montane Forest Zone (e. g. 14

and 80).

Brayshaw (14) in the establishment of his association scheme for the southern interior of British Columbia regarded vegetational stability with somewhat less importance than would have been stressed by habitat-type advocates. Yet, it is quite interesting to note that several associations and their sub-divisions were quite similar in some respects to Daubenmire's (38) associations and unions in eastern Washington and northeastern Idaho. Even so, between Brayshaw's Arctostaphylos, Arctostaphylos-Calamagrostis, and Calamagrostis associations, the author states (14, p. 96), ". . . no sharp boundaries can be drawn on the basis of edaphic, floristic or tree growth characteristics, but the three communities seem to intergrade indistinguishably, as though parts of a continuum". Quite detailed soils descriptions were made in conjunction with this study. All species, including lichens and mosses, were noted and used in classificatory decisions. But, again this was a study done in an area of glaciated and moderately diverse topography, with wide differences in altitude, aspects, and slope and thus expectedly considerable variation among stands and within associations.

Johnson (80, p. 13) self-acknowledges his classification of the vegetation of Black Butte in central Oregon as being quite tentative, arbitrary, and secondary to the bulk of his work, the vascular plant taxonomy of this mountain. However, the considerable elevational and slope exposure variation encountered on this volcanic cone undoubtedly influenced his approximations.

Willits (152) attempted no synecological classification of an area of montane forest on diverse topography on the east flank of the central Washington Cascades. He pointed out, however, silvicultural changes similar to those observed in the study area under consideration here. Unfortunately, the lack of understory vegetation data from his study doesn't allow an estimate of the range of full synecological context considered.

Swedberg (112, p. 25) in his analysis of the conifer distribution patterns from the sub-alpine forest at the Cascade crest to juniper woodland for a transect located between the two specific areas of data collection considered here, concluded that, "a continuum interpretation would most closely fit the situation encountered". He attempted no classification scheme per se because he judged too excessive a degree of arbitrariness would be involved. Since only incomplete and subjective assessment of the understory was attempted by Swedberg, the author was encouraged by him to analyze in detail the concomitant changes in understory vegetation relative to qualitative and quantitative changes in the arborescent vegetation. Ponderosa pine was found to occur over a 5600 to 3800 foot altitudinal range on this transect. The topography of Swedberg's transect was complicated by the occurrence, in its center, of a high, faulted ridge.

Theoretical and Methodological Results of the Present Study

An attempt has been made in the present study to minimize the topographic and elevational variation and thus presumable accentuated environmental factor compensations, by the stand placement in the selected study areas as previously described.

Factors Influencing Stand Order. Since a continuum interpretation is amplified by inclusion of unstable vegetation, only the least disturbed montane forest vegetation that could be found on the east flank of the Oregon Cascades was assessed. Contrary to the case in many studies when continuum interpretations are reached, the author has included and analyzed the data for trees by different size classes so that successional status in terms of the arboreal component reproduction and replacement can be interpreted (Appendix 5, Parts A and B).

The sampling procedure was as objective as humanly feasible and physical and biological conditions permitted, and yet assured through the type of allocation employed, a systematic, equable measure of the range of variation encountered. The total amount of detailed and objective data taken was much greater than could be expected had reconnaissance-based methods been employed. The time consumed to obtain this data could presently be justified only for research purposes, to attempt to answer the questions posed.

The results of any synecological study should best be considered in the light of the following reflections most aptly put by Grieg-Smith (64, p. 142-143),

> There are two distinct aspects of classification, or ordination, of a set of stands. Firstly, we have to decide whether or not they can be considered as falling into more than one class. Since variation is continuous this must ultimately depend on subjective judgement (as in all biological classification), but it is, at least, possible to determine objectively whether there is any tendency for clustering of points in the multidimensional system or grouping into noda. Secondly, if we accept such a grouping, the criteria on which further stands are assigned to the appropriate cluster or nodum must be determined. A variety of techniques is available to carry out these processes. They may be applied whether the original stands were selected subjectively or were random samples. If they were selected, it must be remembered that a bias may have been introduced in the selection and the resulting data may indicate a more clear-cut distinction into groups than actually exists.

Accordingly, these considerations have been incorporated into the approach presented here.

Since stress on species populations, instead of species groups strengthens a continuum interpretation, "association tables" were constructed in the fashion of European phytosociologists and North American adherents of the unit-association idea. However, use of relative measurements as well as absolute values and combinations of measurements thereof were put in this tabular form. See Appendix A, Parts A and B for examples of such data.

Dyrness (49, p. 65-67) states that consideration of dominance and species groups, instead of stress on frequency data of individual species is necessary for plant communities to be delineated. However, this former stress was made in the present study, yet no associations were readily derived. The differences are believed to be due to reasoning best expressed by Grieg-Smith (64, p. 141).

> Classification of stands on a basis of presence or absence of species tends to give either too broad or too narrow a classification for practical purposes. It is therefore, necessary to consider the quantity of the more prominent species, with the result that classification becomes dependent on continuous variables. It is difficult to delimit a boundary between classes at some value of a single continuous variable but it is quite impracticable to do so on subjective criteria if a number of such variables have to be taken into account.

Dyrness further states (49, p. 66) that intergrade areas or transition zones should not be sampled. But, what of the case where such zones are large and economically important, such as the study area under consideration here?

Researchers favoring the unit-association concept have commonly used reasoning along the lines given by Grieg-Smith (64, p. 120) that, "The fact that an area is recognized subjectively as distinctive is evidence that it represents a significant portion of the total vegetation of a region." This consideration could apply equally well to large, recognizable transition zones.

Driscoll (47, p. 100) points out that the vegetation of the adjacent juniper woodland zone in central Oregon could have been classified using the continuum concept, if single species were considered independently. The result he felt would have been a pattern of complex curves illustrating the diversity of vegetation, but having no practical value from the land management point of view.

The relatively small number of species involved in Dyrness' and Driscoll's study area has undoubtedly affected their conclusions, in addition to the more diverse physical environments involved and their needs to develop classification schemes readily implementing management applications.

It is particularly hoped that the present study presents an acceptable means of bridging this gap in theory and practice. Methodology accounting for the inherent variation found and yet deriving practical units reflecting differentially productive site potential is suggested.

Stand order derived from purely phytosociological considerations was closely allied with the gross changes from xeric to mesic conditions. However, the large number of overlapping and sporadic species made it very difficult to determine by mere inspection of the data the most logical positions of stands or groupings of stands representing what the author would consider to be even highly arbitrary "associations" on an all species basis. Consequently a mathematical technique, cluster analysis of matrices or relative parameter-weighted coefficient of similarity, was introduced with the level of relationships between stands and their consequent order being decided after electronic processing of data from all species.

These most highly sophisticated phytosociological ordinations were compared with other stand orders based on; distance from the crest line of the Cascades, east to west position by legal location, and orderings by relative IV curves of the major tree species, ponderosa pine, and secondarily by the judged xerism to mesism of the other tree components (with and without inclusion of the smaller tree size classes). The orders are summarized as Tables V and VI for the Warm Springs and Deschutes transects, respectively.

Comparison of these orders derived from different bases sheds light on the assumptions involved and how use of them may effect the interpretation of vegetation in areas with more complicated topographic and edaphic influences.

Since the crest line is somewhat sinuous, order I is effected by the exact north to south position of the stands related to the direct easterly map distance, with fractions of a mile making the difference in order many times, especially so for the more diagonally placed stands on the Deschutes transect.

Because the general crest of the Cascades in this part of Oregon is aligned on a north-south axis, column II, order from distance east to west by legal location, probably follows the major factor

TABLE V. STAND ORDER BY DIFFERENT BASES OF COMPARISON WARM SPRINGS TRANSECT.

	I	II	III	IV	V
xeric					
↓	1	1	1	1	1
	2	2	2	2	2
	3	3	3	3	3
	4	4	5	5	4
	5	5	4	4	5
	6	6	6	6	6
	7	7	7	7	7
	8	8	11	11	8
	9	9	8	8	9
	15	10	9	9	10
	10	11 >	10	12	11
	11	15	12	10	12
	14	12 >	15	15	15
	12	14	13	14	14
	13	13	14	13	13
	16	16	16	16	16
mesic					

I decreasing direct easterly distance from Cascade crest line
II distance, east to west by Legal location
III relative I.V. curve of *Pinus ponderosa*, secondly xerism to mesism of other tree components (4" d.b.h.+ size class)
IV same as III, except 1" d.b.h. + size classes included
V phytosociological, by cluster analysis of RIV weighted coefficients of similarity.

> indicates equivalent position

TABLE VI. STAND ORDER BY DIFFERENT BASES OF COMPARISON DESCHUTES TRANSECT.

I	II	III	IV	V
1	1	5	5	1
2	5	2	2	5
5	2	1	1	2
4	4	4	4	9
8	8	6	6	4
3	3	8	8	6
6	6	3	3	3
17	17	19	22	17
9	9	16	9	8
16	16	10	12	10
10	10	21	20	11
15	15	17	16	12
11	11	9	17	13
18	18	13	19	18
12	7	20	21	19
7	12	11	10	16
19	19	15	7	7
13	13	18	13	15
20	20	7	11	14
21	21	12	18	20
14	14	14	14	21
22	22	27	15	22
23	23	24	27	28
24	27	25	24	23
27	24	26	25	24
25	25	28	20	25
26	26	29	26	26
28	28	23	30	29
29	29	22	29	27
27	30	30	23	30
30	37	31	31	31
31	31	37	32	32
32	32	32	37	37
33	38	38	33	38
36	33	39	39	39
35	36	33	36	33
34	39	36	38	36
38	35	40	40	35
39	34	34	35	34
40	40	35	34	40

Same legend as Table V.

gradient of increasing total precipitation more closely than does the order of column I. Consequently, column II is considered the prime order or "control" for purposes of comparison. The differences between the stand order of Column II with several bases of ordering discussed below are illustrated by Tables VII and VIII, graphical comparisons of selected orders from the Warm Springs and Deschutes transects.

Both the Warm Springs and the Deschutes transects encompass a very similar range of vegetational variation and change. The shorter overall distance of the Warm Springs transect reflecting this variation is probably due chiefly to it being to the general orographic lee of the large peak, Mount Jefferson, whereas the Deschutes transect is to the lee of the much lower Santiam Pass region with probably slightly greater amounts of moisture passing over the latter area and somewhat broadening the rain shadow gradient.

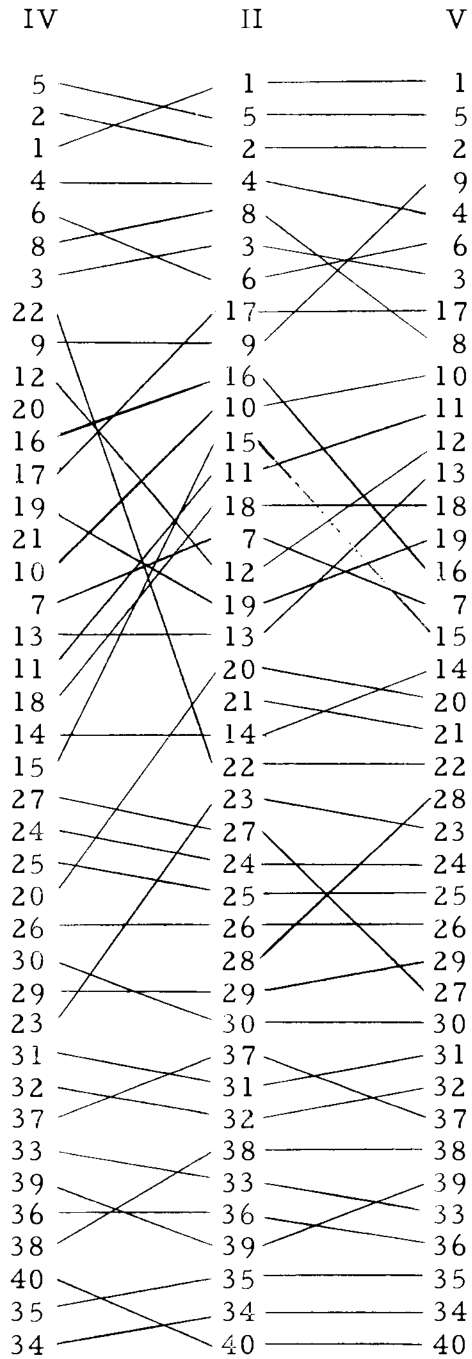
The order of stands determined by the relative importance value of primarily one tree species, ponderosa pine, produced a decidedly different order from that of column II. (e. g. compare positions of stand 11, Table 3 and stands 12, 19 and 22, Table 4 in columns II, III and IV) For this ordering process, first the RIV of ponderosa pine was noted, then inspection of the other tree components indicated which side of the center, xeric or mesic, the stand belonged. For example, a value of 90 for ponderosa pine in

TABLE VII. GRAPHICAL COMPARISON OF STAND ORDERS, WARM SPRINGS TRANSECT.

IV	II	V
1	1	1
2	2	2
3	3	3
5	4	4
4	5	5
6	6	6
7	7	7
11	8	8
8	9	9
9	10	10
12	11	11
10	15	12
15	12	15
14	14	14
13	13	13
16	16	16

Same Legend as Table V.

TABLE VIII. GRAPHICAL COMPARISON OF STAND ORDERS, DESCHUTES TRANSECT.



Same legend as Table V.

association with an RIV of 10 for western juniper would indicate a more xeric placement of the stand than one where Douglas-fir gave an RIV of 10 and a hypothetical value of 90 for Pinus ponderosa.

With only tree species determining the critical placement of the stand, greater effects from sampling error, chance dispersal, and fire history must be expected. Variationin order due to this method is particularly evident as more tree species are encountered and values of ponderosa pine more closely approach 100. 0. Then, differences in magnitude of but a few tenths of a unit on the 100 unit scale determine placement, hence the greater variability in stand position near the centers of columns III and IV.

The inclusion of the one to four inch d. b. h. size class into the computation of relative tree parameters changes the values for the trees, reflecting an included assessment of their effective regeneration patterns along the complex gradient (see Appendix 4 and Appendix 5, Section 1 of Parts A and B). Again, but small differences greatly affect exact stand placement, principally as the values for ponderosa pine change.

These results pose questions of the plausibility of the basis of ordination on the values of a few tree species as have been extensively employed by Curtis (30), his students and colleagues. First, it is doubtful that such stress on especially one tree species should be made and data from all concomitant species ordered in relation to its curve of values, for it is a well established generalization of synecology that combinations of species and their degree of expression at a given site best integrates the total and long-term factor interactions and hence assesses the biological productivity and potential of that site. Secondly, it is shown that by calculating relative tree parameters by inclusion or exclusion of various size class intervals, significant changes in the species values and consequent stand placement are affected.

Basing synecological schemes on the population curves of one or a few dominant species is an extension of mono-climax theory. The author will subsequently show that there are gradients of successional potential and probable climax status. Thus, it seemed unjustifiable to attempt to extend the ideas of "continuum index" as done by Curtis (30). Grieg-Smith (64, p. 157-158) has emphasized that subjective elements distastefully enter the analysis through selection of "climax adaptation numbers" and some distortion of the curves inevitably results.

Similar considerations apply to the selection of stands to base consequent ordinations of other stands and their species. The author must conclude with Clausen (23, p. 268) that Bray and Curtis' (13) method of comparing and placing stands on the basis of terminal reference stands, essentially a distance method, is not as logically or empirically sound as comparing each stand with every other stand by way of full matrices of coefficients of association. Curtis (30, p. 483) also points out that the actual placement of a stand can be influenced greatly by the particular pairs of stands that come to occupy the ends of the axes that are derived.

The most important comparisons from Tables V and VI are probably between columns II and V. An inspection of these respective orders indicates that there are no major differences between the geographical and phytosociological orderings, when all vascular species are included. That is, stands are rarely more than a few positions different.

The harmony between these two orders substantiates the assumption of uniformity of change for the complex-gradient, since a selective complex is believed to operate in a smoothly differential fashion, allowing component species populations of communities to have variable expression. Differential factor compensations are thus deemed to be minimally and smoothly variable for the transect areas.

It must be remembered in interpreting the graphs that follow, that direct comparisons of relative indices on the ordinate in relation to the abcissa (coenocline) can be misleading in illustrating changes in physiognomy and absolute density, since the derived values depend on their comparisons with the changing absolute values for density, frequency and basal area. The particular species and total number of them contributing to this base form the initial computational entities. It should also be stressed that no running averages were calculated to smooth the data for curves, such as the employment of the formula (a + 2b + c/4) for five stands as was done by Curtis and McIntosh (34, p. 487). Scattergram points are simply plotted as derived from a single stand basis of computation. Free hand interpolative curves are drawn only for the tree data, and then merely to help illustrate the successional shifts.

Unfortunately, not enough funds were available to use the computor-aided cluster analysis ordinations for all available absolute or relative parameters, singly or in combination. At least minor differences in the order and level of relationship in the schema could be expected with the use of different sets of data. The only published results of comparison of stand orders with various data taken from the same set of stands that the author is aware of is that of Clausen (23) for vegetation from a wide range of habitats, from sand dunes to shallow, warm lakes, of the Jutlands in Denmark. Her findings will be discussed later in connection with the results of the present study.

Inspection of the association tables for which a computor analysis was not capable of being carried out leads to the following incompletely checked conclusions.

Consideration of Data Categorized by Life Form. The life forms and number of species included in the totals from which the relative parameters were calculated had considerable effects on the derived values for the herbaceous species. (e. g. compare the values for Lupinus lepidus at stand P-W-I, Appendix 4, Part A, Section 1 with its value at the same stand in Section 3 of this part of the Appendix.) This and many other cases indicate that the inclusion of annuals greatly skew the relative frequency and relative density figures. This factor isn't accounted for in Curtis' and Greene's (32) analysis of the relic Wisconsin prairies by the species-presence method. A consideration of when to include annuals has practical effects for the ephemeral nature of annuals in this habitat lends toward a fluctuating computing base depending on the period of data collection. Perennials on the other hand maintain a much more constant population and degree of cover throughout the growing season. Annuals exert but a generally minor and short-lived dominance (change in micro-climate) in this area. It is acknowledged however that they often wield a decidedly critical influence on the establishment of perennial seedlings in other forest types.

The annuals found in this study were either native ephemerals or weedy adventives, both with generally wide ecological amplitudes. The latter were more indicative of disturbance than long term site potential of the economically important perennials. Annuals in these forests are little noticed, much less identified by wild land resource managers. Thus in any practical extensions of the results, annuals should best be considered somewhat apart from the perennial components.

Categorization by life form allowed the change in adaptations by perennating structures to be studied in relation to the coenocline. Since specific taxonomic placement is often difficult for biotic resource managers, it was hoped that significant differences in life form spectra could be found and used to place stands along a phytosociological scale and consequently a scale of silvicultural and range production potentials and problems.

Ordinary (percentage) life form spectra (36, p. 70) were calculated for all stands (Appendix 4, Part A, Section 4; Part B, Section 6), but differences were too minor and variable between stands for their critical use. As suggested by Cain (18, p. 29) some measure of abundance weighting life forms can yield more information for stand to stand comparisons. Accordingly, the component species were weighted by their relative DF's in an attempt to accentuate the differences. These latter values for the ground layer of vegetation are plotted in Figures 9 and 10. Again, gross differences between widely separated stands along the coenocline readily appear, but the stand to stand values are too erratic to make this means sufficiently critical to assess small differences in site potential.

A gradient of herbaceous pattern exists in relation to the density of the tree canopy and brush cover along the coenocline. There is also micro-variation within the stand itself due to the size-age

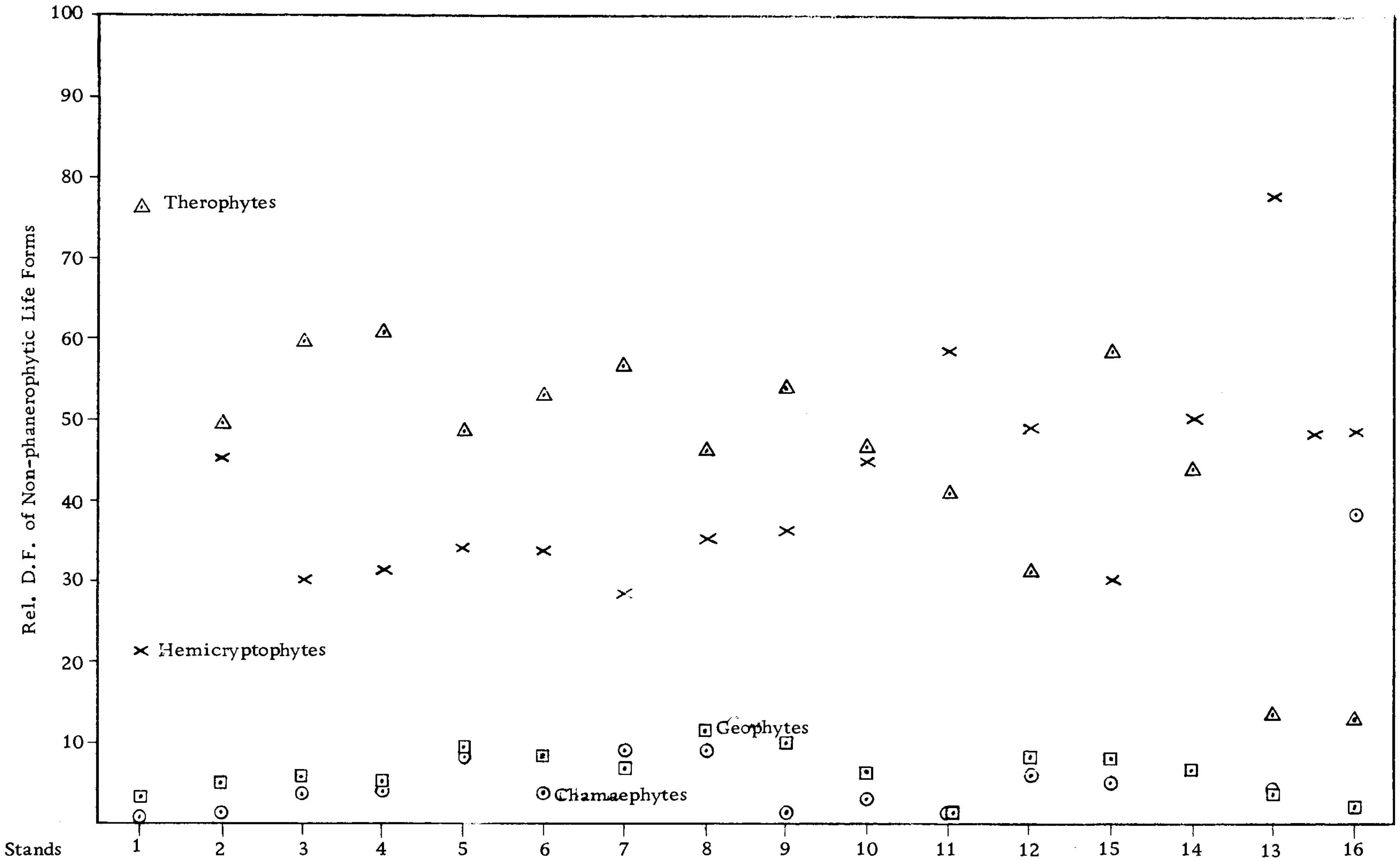


FIGURE 9. Non-phanerophytic Life Form Spectra weighted by Rel. DF's of constituent species

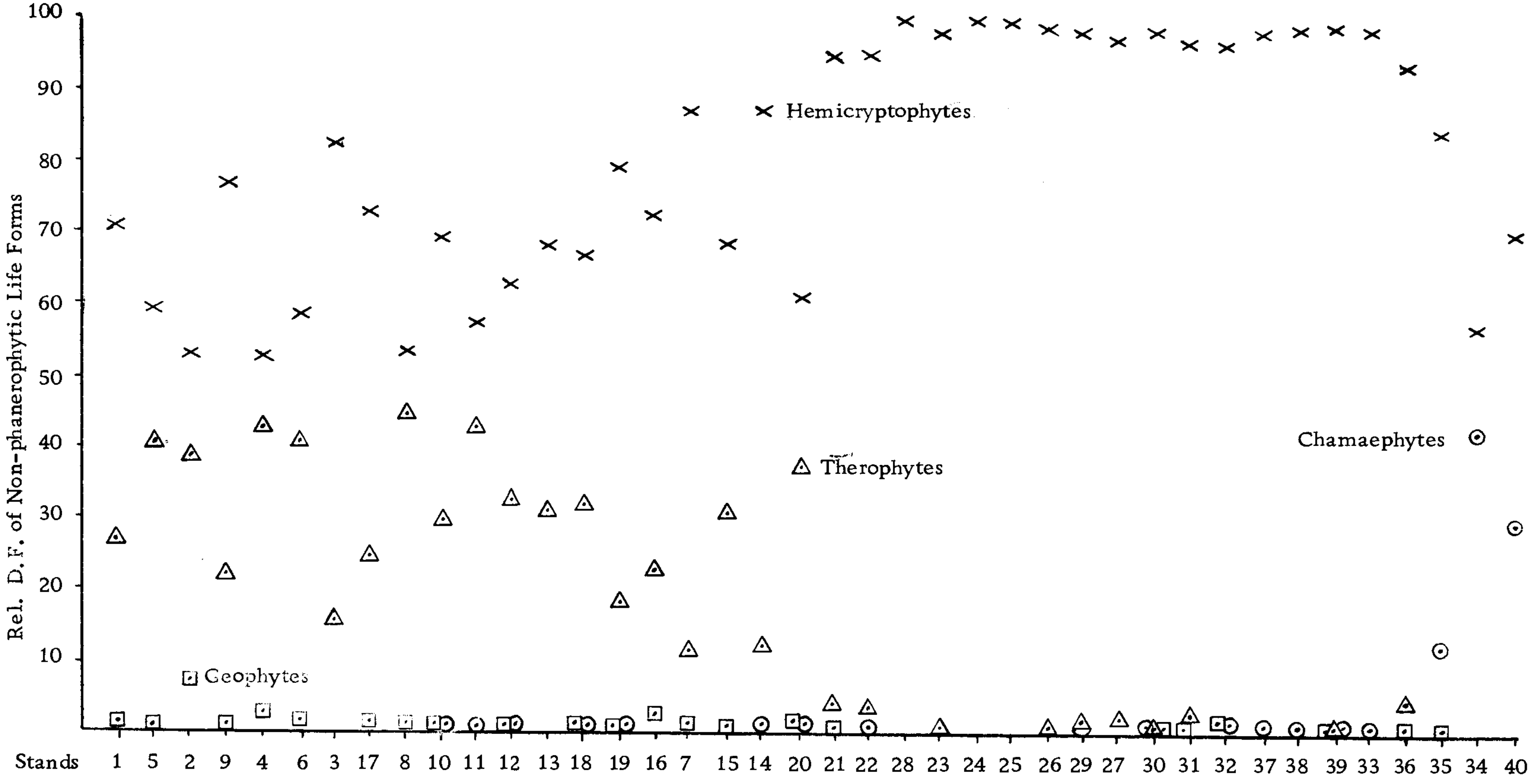


FIGURE 10. Non-phanerophytic Life Form Spectra weighted by Rel. D.F.'s of constituent species

class mosaic of ponderosa pine. The stratified random placement of sub-quadrats has integrated data from under the dense woody cover with the lighter, warmer, and drier micro-sites from openings in the canopy.

Variation in fire history and sampling error from including varying proportions of different micro-sites at a given stand affect the species and their values recorded. Disturbance by logging, grazing, or fire would greatly increase the annuals at the expense of the calculated values for the perennials. Such analyses of life forms are more likely to succeed for very large scale geographic comparisons, particularly where taxonomic problems are ponderous. Hence, this technique may be more appropriate for application by tropical forest ecologists.

Considerations of Species and Stand Indices. From consideration of overall pattern, the discussion will turn to other points of the methodology, as related to other studies and their adaptation to this particular vegetation.

The use of combined measures of species "importance" and stand similarity as used here should be viewed with some degree of discretion. As Anderson (2, p. 404) aptly points out, there are always limitations to the precise meanings that can be given to such indices. However, individual measures such as density, cover and frequency taken by themselves are inadequate to assess the performance of the plants concerned. Thus, a compromising judgement must be exercised to give simple, yet meaningful estimates of the effective contribution of each species to the vegetation found at the various sites.

Spurr (109, p. 205-206) suggests correlation of these indices with environmental factors for more reliable usage. This has been done by Curtis and McIntosh (33), and others for the edaphic factors associated with certain portions of the vegetation of Wisconsin. Loucks (87) has used environmental scalars and ordinated the physical environment with its vegetation in northwestern New Brunswick. Similar sorts of comparisons would be highly adaptable to the ecosystemic gradient of the study area considered here. However, it should be kept in mind that correlation does not invariably indicate causation.

Coefficients of association have been used in numerous synecological studies. However, little comparison of formulae in synecological application is available. Curtis (30, p. 485) does mention that actual stand placement is influenced greatly by the particular index of similarity used and by the species used to compute the index. However, he hasn't illustrated or elaborated on this point. Bray and Curtis (13, p. 329) reviewed the formulae of coefficients of association found in phytosociological literature and concluded that the one used here appears to be the best approximation yet available to a linear measure of relationship.

The particular coefficient of similarity formula used is but one of the 14 mathematically possible such coefficients of association listed by Sokal and Sneath (107, p. 129-130). This particular formula in which positive matches count double to the total number of possible matches was first used by Sorenson (108), later Dahl (35), Clausen (22 and 23), Curtis (30), Looman and Campbell (86) and others to establish order to plant synecological samples.

Sorenson (108) used only species presence data. This is understandable because of the ponderous amount of calculation involved for any other parameter or their combination for many stands without the aid of a computor. Clausen (22, p. 643) gave a 16 by 16 matrix of similarity indices using relative frequencies for samples of understory vegetation from the conifer swamps of Wisconsin. For the west coast of Denmark, Clausen (23) presented matrices of coefficients of community for each of three measures: presence, frequency, and relative frequency. A major conclusion of this latter paper was that large numbers of very high frequencies render a coefficient of community insensitive (23, p. 258).

Hanson and Dahl (70, p. 255) weighted species values by cover or abundance estimates before final computation of the values for "Sorenson's K".

The rationale followed in the present study is that weighting of species by values representing their "importance" in the community is a logical extension of the previous use of the formula. A weighting procedure using values reflecting abundance instead of only presence is critical as Grieg-Smith (64, p. 122-123) points out, data on mere occurrence will invariably reduce the expected values of the coefficients due to the inclusion of rare species having equal numerical contributions with the more common species. Thus, in this study relative measures of frequency, density, and dominance, first singly then in combination, were used to weight species presence. It should be noted that all vascular species are included in the calculations. This contrasts with work such as Bray and Curtis (13, p. 328) for which only tree species with greater than 33 percent presence were considered and 14 shrub and herb species of intermediate presence were selected for the computations. Loucks (87, p. 141) used in his analysis only those shrub and herb species for which he obtained at minimum an average of 15 percent frequency in at least three samples.

The computational methodology used to analyze the data from the montane forest of the present study blends the Anglo-American point of view in which dominance is the assessment strived for in defining classification schemes with the Zurich-Montpellier School, where reliance on the use of characteristic species of high "fidelity", even though they may make a small numerical or physiognomic contribution to the vegetation, is made. However, it must be acknowledged that with the procedure followed here arithmetic stress is unarbitrarily proportional to the degree of abundance or dominance of the species involved.

There is some evidence that combinations of infrequent, though highly indicative species groups could conceivably be used as a basis of comparison along the transects studied. But, in addition to the problem of low presence, these species are generally in genera in which taxonomic determinations of species are very difficult to make, even when flowers or fruit are present, e. g. Castilleja, Penstemon, and Pyrola. Because of these limitations, it isn't likely that this approach could be relied on for this vegetation.

Combinations of geophytes of this area are also indicative of relative position on the gradient of vegetational change, but their short-lived conspicuousness makes reliance on them risky. This is why they have been excluded from the calculations of relative parameters for the perennial basis.

Plotting of absolute data understandably gave much more erratic patterns to the distribution curves. Interpretation was aided by plotting of relative values calculated from the totals of a given stand and bringing the scale to a zero to 100 point range of damped variation. The matrix data presented here is doubly "normalized" in the sense that the particular computor program used also computes a score as a percentage of the maximum value attained by that species or measure thereof in any of the stands. These transformed values thus indicate in comparable units the behavior of each quantitative measure in relation to its optimum behavior for the entire transect. Furthermore, since all measures are put on a relative basis, the species receive importance in relation to their degree of numerical contribution to the numerator and denominator of the formula.

Critique of Other Possible Methods of Analysis. Something should be said in defense of the choice of a coefficient of association approach over the alternatives of coefficients of correlation and distance. Numerous pieces of literature have illustrated the use of the latter two methods. An outstanding example of their combination is DeVries' (44) diagrams showing species distances inversely related to a coefficient of correlation based on presence (above a certain frequency) and absence for 1000 stands of Dutch grassland.

An important difference of coefficient of association formulae from product-moment correlation coefficients is the avoidance in the former of accentuated weighting of higher valued species much more than species with small values due to the squaring of all terms in the formula of the latter (13, p. 328). Anyway, as Cole (25, p. 412) has pointed out, ". . . the frequency distributions of organisms in samples commonly differ so widely from random distribution that the validity of applying ordinary correlation methods to such data become highly questionable."

Even though the distribution functions of indices of association are not yet known for common tests of statistical significance to be performed, the use of them in synecology now has an empirical and pragmatic basis, and non-parmetric tests could conceivably be developed for large sample sizes.

A serious limitation of traditional statistical analysis, such as analysis of variance and discriminant functions, is the assumption that well-defined populations or sets exist and they can be segregated or blocked off for tests of significant differences or lack thereof (null hypothesis). But in synecological problems the hierarchy of relationships and separation of sets from the frame should ideally be objectively and inductively approached from the outset, rather than being initially subjectively delineated as the literature commonly attests. Once objectively delimited entities are described for stratification purposes, it is much more valid and logical that we can proceed to the use of more conventional statistical analysis. Sorenson (108, p. 5) pointed these limitations out in rather a rambling fashion, but with logic that is still sound today. He wrote,

> One feature still seems to be common to hitherto known statistical methods of treatment: that a statistical treatment is made of already defined groups of populations arranged according to subjective points of view. Hence these methods provide no satisfactory answer to the questions outlined above concerning the equal amplitude of the units. So long as the basis of an objective appreciation of the interdependence of a number of populations that have been included in one

> group does not exist, any comparison between individual groups made on a statistical basis must in reality become deceptive to a certain extent.

This author further states (Loc. cit., p. 14) that he had to choose arbitrary levels of similarities at which to form successive clusters, but the smaller the interval chosen the better is the guarantee of uniformity among groups established.

The mathematically more sophisticated techniques of factor analysis for obtaining structure from matrices was not tested here. Primary considerations were current limitations of time and cost of computor analysis. However, it is doubtful that they would divulge more than similar phytosociological factors and the gradient of precipitation as the main variables. Grieg-Smith (64, p. 163) advises, if one environmental factor is of greatest importance, results can be obtained more readily by continuum analysis than the more precise and less subjective, but extremely more computationally laborious factor analysis. Curtis (30, p. 482) bypassed this method because of the extremely heavy computational load and the doubt that extracted factors are independent. He felt that there is, "no sound basis for concluding the entities are real." Being that coefficients of correlation (r) are required for factor analysis, presumably the same reservations about the use of r's would apply here.

Williams and Lambert (151) have admitted that their extensive use of multivariate analysis does not necessarily provide information useful to the ecologist nor extract factors that show operative implications.

Poore (98, p. 39) concludes that only two or three factor complexes can be abstracted by these methods. Thus, the heavier computational manipulations may be too sophisticated for initial synecological approximations.

The author agrees with Ashby's (3, p. 225) warning to synecologists that statistics do little to remove subjective judgements connected with community delimitation. However, we can forestall subjectivity until the very final phases of synthesis. It should be recognized however, that the recognition of a problem, choice of a study, area, a working hypothesis and the methods of searching for an answer are initially and inevitably subjective.

Application of Cluster Analysis. The cluster analysis technique used here allows subjective decisions concerning the pragmatic fragmentation of the phytosociological order to be foregone until this judgement remains as the last decision. The inherent weaknesses of earlier subjective choices of the levels of affinity used shows up in the limited value of differentially shaded matrices due to the choice of the range of values to be included within each shade. The same subjective proviso negated the use of mathematically simpler cluster analysis techniques than the particular one that was used.

As was briefly mentioned before, the choice of the particular method of cluster analysis was ruled by logic in the face of lack of sufficient funds to explore all the possible techniques outlined by Sokal and Sneath (107, p. 176-188). The rationale of the choice of the specific cluster analysis method employed, clustering by average linkage (weighted pair-group method), is that it will show less distortion of the original similarity coefficient matrix and be devoid of an arbitrary criterion of group formation required by other less arithmetically complicated methods. This allows the subjective choice of levels at which to form clusters that Sorenson and later Clausen employed to be bypassed. By devising the method in such a way as to avoid overlapping clusters, the data are in fact being biased to yield discrete, definable clusters. "Such biases are deliberately introduced as a matter of a regular function of the system because of the nature of the classification we are trying to construct," (107, p. 141).

The cluster analysis program used by the author has given a hierarchial representation of stand relationships (see Figures 7 and 8). The sequential clusters formed by the program determine the basic form of the dendrogram through the levels of similarity at which bifurcations of diagramed relationships are indicated. These computations thus guide the derivation of stand order given on the horizontal axis, here representing xeric to mesic vegetation from left to right, and the level of similarity of each stand with every other stand as indicated on the vertical axis. The dendrogram condenses into two dimensions a representation of vegetation affected by n-dimensional factors and their innumerable interactions. These figures convey in linear fashion the relationships of the values given in the matrices of coefficients of similarity (Tables II and III) which in turn represent integrations of voluminous data on combinations of plant species and their measured expressions. It should be recognized that there are inevitable distortions from such two dimensional symbolizations of essentially multi-dimensional relationships.

Such dendrograms communicate vegetational relationships of interest to both pure and applied biologists.

First, the levels of relationship for the successive clusters formed along the transect indicate the degrees of relative vegetational homogeneity to distinctness. In this study there appears to be some evidence by the way the levels of similarity decrease comparatively more for the most xeric and most mesic stands than those in the intermediate positions that the degree of homogeneity is less in these former types of vegetation than for the bulk of the central transect area represented.

Since it is known how the samples have been distributed across the landscape and their number, it is possible to estimate the areal extent of the vegetation of various levels of similarity. In this case, we could conclude that the vegetation in the middle of the transects is comparatively more similar and covers larger area than the more rapidly transitional and less extensive type of vegetation found near either the mesic or xeric ends of the transect. These conclusions are more founded in the Deschutes data than that from the Warm Springs transect. The fact that slightly more stands of medial than near terminal position have been sampled in the former transect may have influenced this difference.

Poore (98, p. 55) emphasizes that continuously variable samples of vegetation must occupy comparable areas of the landscape to fully substantiate the continuum interpretation of vegetation. This criterion has been met in the present study, but a somewhat intermediate interpretation could be reached. That is, the species population scattergrams do not yield the smoothy contoured bell-shaped curves of species distribution shown in the papers of authors illustrating continuum interpretations in other parts of the United States. It is possible, however, that such curves could be drawn after smoothing with running average formulae.

But, neither do species distributions weighted by their abundances coincide enough to make derivation of "associations" in sensu Daubenmire (38) other than excessively arbitrary. Thus, the present methodology applied seems the most "natural", yet operational manner to organize the synecological data collected in highest consonance with the complexity of the vegetation allowing the communication of generalizations of utility to those involved in applied ecology programs in this forest type.

The dendrograms used here differ from the "dendrite" diagrams of Matuskiewiez and Borowik (90, p. 728) illustrating the affinities of 18 Polish oak woodland communities. These workers computed Sorenson's K from Zurich-Montpellier type of reconnaissance data and used the results to show the connections at the highest levels of association between the community types. These diagrams, however, fail to indicate the level of similarity at which the community samples are related to the one most similar and every other entity.

Obviation of older, imprecise terms with their semantic and emotional encumbrances seems desirable here to describe the pragmatic derivations from such a procedure in plant synecological investigations. I have chosen to term these empirically established groupings as <u>operational</u> <u>synecological</u> <u>units</u> (O. S. U. 's) or more concisely <u>coenons</u>.

Coenons are always defined by the level of similarity being considered. That is, we may speak of a 30 percent level coenon for a certain studied vegetation type. Since the numerical levels are determined by the data from which they are computed, knowledge of the data involved in their derivation is necessary for communication with such a term.

Since no mathematical or statistical tests to find hiatus points are presently developed, empirical groupings can be made with their relative breadth of inclusion secondarily dependent on the interests of the user. The chief advantage of this scheme is that stratification can be objectively made at any level, from specific stands to the complete range of vegetation over which the samples are deemed to be representative.

Possible Practical Application

The adaptability of the methodology introduced here may best be illustrated by some plausible examples of application. Similar considerations would apply to the use of this methodology in other types of vegetation.

Suppose a range conservationist with the United States Forest Service needed to evaluate the productivity or carrying capacity for the area possessing the diversity of vegetation illustrated in Figure 8, the dendrogram for the Deschutes transect. His ideal would be to gear his sampling and consequent management recommendations with the inherent ecological differences of the area considered. Of course, economic considerations would necessarily modify any policy; but for maintenance of sustained productivities these policies should be in as close as possible harmony with the ecosystems into which they are put in application.

First, such a dendrogram in combination with the original data and a knowledge of the distribution of the samples gives the range conservationist an idea of the total variability and the areal extent of the various degrees of variability to be encountered in the field. (The present data are from stable vegetation, knowledge of the modifications from disturbance relevant to the qualitites assessed would be necessary to most adequately extend the particular schema presented here.) He could then allocate his samples in proportion to the synecology of the landscape and his estimated importance of the various areas and its vegetation for his purposes. If he deemed eight subdivisions of this transect feasible for his sampling, he would move a ruler down the vertical scale of the dendrogram until eight cluster stems were bi-sected. This procedure would yield eight, 38 percent coenons. He would then go to the original data to note the variability of the vegetation for the stands clustered within these coenons. In the field he would sample within the defined ranges of these operational synecological units. Comparison could then be made between data stratified by these coenons. If after analyzing his data in relation to these 38 percent coenons, he found that only four larger divisions were significantly different for his practical purposes, he could bring the level of similarity down to around 30 percent to where the stems of four more inclusive coenons are found. By going back to the original synecological data and his range productivity data he could judge the variation in the vegetation within these coenons. By knowing the distribution of the samples yielding the coenons, he could estimate the area involved in each, _e.g._ the first 30 percent coenon to the left side of Figure 8 is derived from 20 stands over an east-west distance of approximately five miles, whereas the fourth such coenon to the right is represented by only one stand reflecting the vegetation for approximately one-half mile of the most mesic end of the complex-gradient and its concomitant coenocline. By multiplying productivity times area he could compute carrying capacity of that portion of the range. In the most practical sense, such an analysis may help the range manager to decide where a fence should best be put to compartmentalize the range on the basis of its inherent ecology. Certainly topography, water, property lines, etc., would modify the final position of such boundaries of management units, but the ecology of the landscape could be considered first.

Analogous capitalization upon the synecological information of this study could be made by the timber cruiser, tax appraiser, and foresters in charge of silvicultural planning. The practical number of modifications of policies along this gradient could be readily stratified by the synecological similarities shown and the division lines estimated from combination of field checking with aerial photo interpretation.

A chief merit of this approach is that the sophistication in congruence of management with the inherent vegetational variability can be continuously ameliorated as the economic value of the vegetational resource increases.

The present study has been designed to scrutinize theory in light of its data, thus the observations taken were very detailed and as objectively collected as possible. However, estimates of species expression could be more easily and rapidly collected, transformed with scalars, and entered into the described sorts of formulae and computations to yield sound, practical synecological schemes.

A principal conclusion is that use of the EDP programs allowed a maximization of objectivity or stand order and consequent derivation of operational synecological units, for it integrates all the vascular plant species as they quantitatively express the biological productivity and potential of the gradient of sites. Electronic data processing allows the investigator to use enormous amounts of data, after assimilation, yielding single expressions for a stand determining its placement and consequently a predictive measure of the biotic resource status that can be derived from parallel observations. The laborious manipulation of data into association tables can be bypassed if desired, with order and hierarchy being derived from the computor analysis.

Description and Interpretation of the Vegetation Patterns

Now that the implications of the methodology employed has been duly discussed, one can more logically proceed to the nature of the patterns of vegetation revealed by the methods used.

The gross changes from the xeric, easterly stands through to the mesic, westerly limits of the study area can readily be noted by inspection of the "association tables" of Appendix 4 and tree data summaries of Appendix 5. The principal generalizations derived thereof can be outlined as:

1) The change from open, western juniper-ponderosa pine woodland on the eastern fringe of the study area through increasingly denser forest dominated by Pinus ponderosa and increasing amounts of conifers expressing primarily the increase of effective moisture, until dense-canopied grand fir-Douglas-fir-ponderosa pine dominated forests at the western ends of the transects are encountered. Compare Figures 11, 12, 13, and 14.
2) The change in and interpretation of relative amounts, species composition, and micro-pattern of tree regeneration along this coenocline.
3) The gradient of change in the concomitant understory vegetation in terms of life form and specific components, their single and collective values of number and cover.

Each of these generalizations will be discussed in the detail allowed by the analysis and interpretation of the particular data taken; and in reference to previously published literature concerning the area and this type of vegetation.

FIGURE 11. Photographic View of Stand P-D-1

FIGURE 12. Photographic View of Stand P-W-6

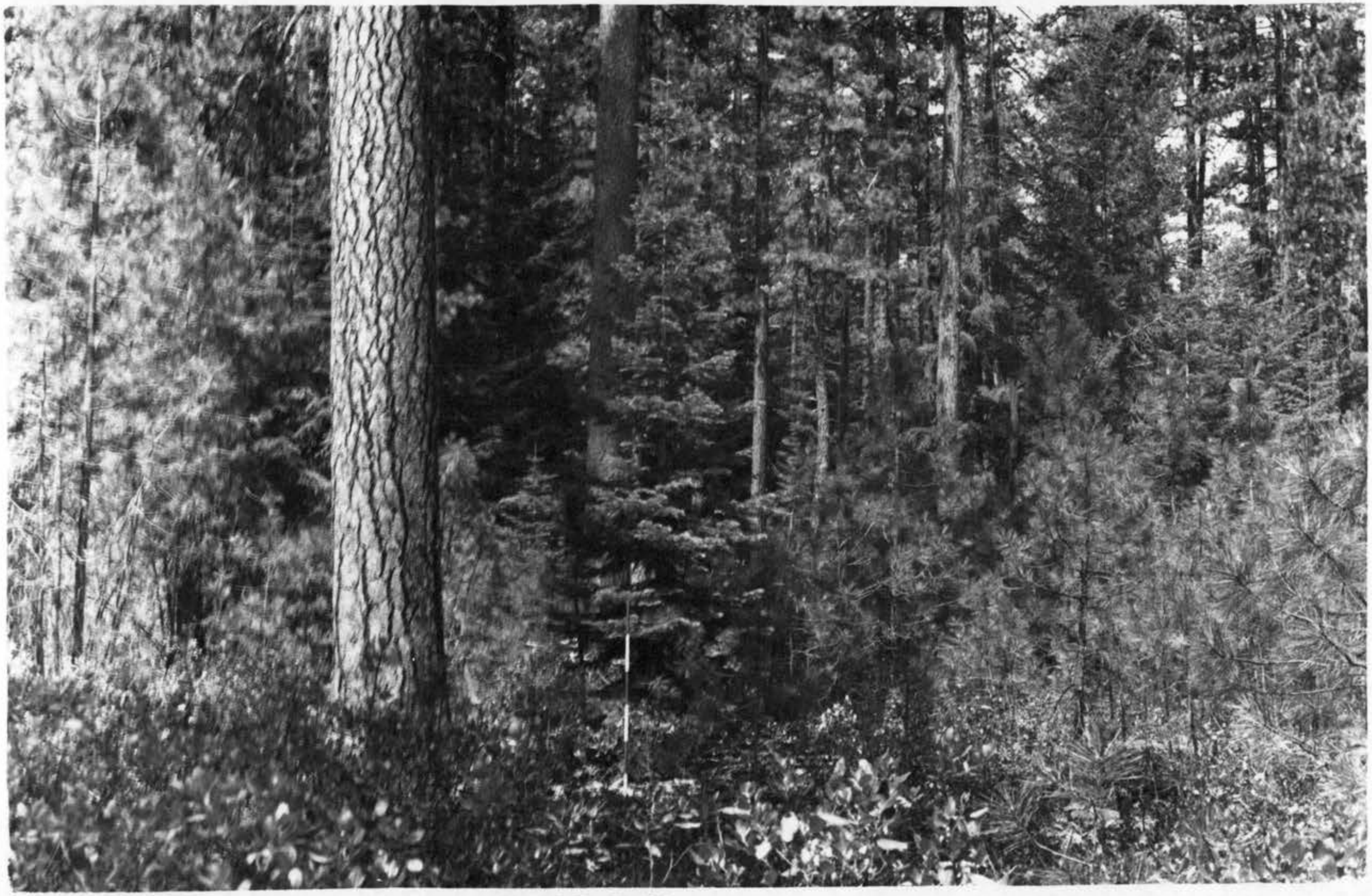


FIGURE 13. Photographic View of Stand P-D-31

FIGURE 14. Photographic View of Stand P-D-34

Changes in Tree Species Composition

The change in tree species composition and expression is illustrated by Figures 15, 16, and 17 showing the RIV's of the component species along both transects. An example of the concomitant gradient of conifer productivity per unit area is given as Figures 18 and 19, scattergrams of the total basal area of the conifers per unit area of land surface for the Deschutes series of stands.

The differences between the free-hand curves of Figures 15, 16 and 17 when the one to four inch d. b. h. size class is included and considered separately in the basis of calculation is to assess and illustrate part of generalization 2 on the change in species composition of conifer regeneration. These curves would be even more accentuated in difference by the inclusion of data from Section 2 of Parts A and B, Appendix 5, on seedling and sapling data. However, this latter set of data would yield no relative dominance values, and hence they have necessarily been excluded from the calculations of relative IV's.

This easterly shift in the comparative proportion of smaller size classes of the mesic species and the westerly shift of young juniper is believed to be principally due to the exclusion of light, periodic ground fires known to influence the nature of the pristine forest, before the general advent of white men to the area. The subsequent

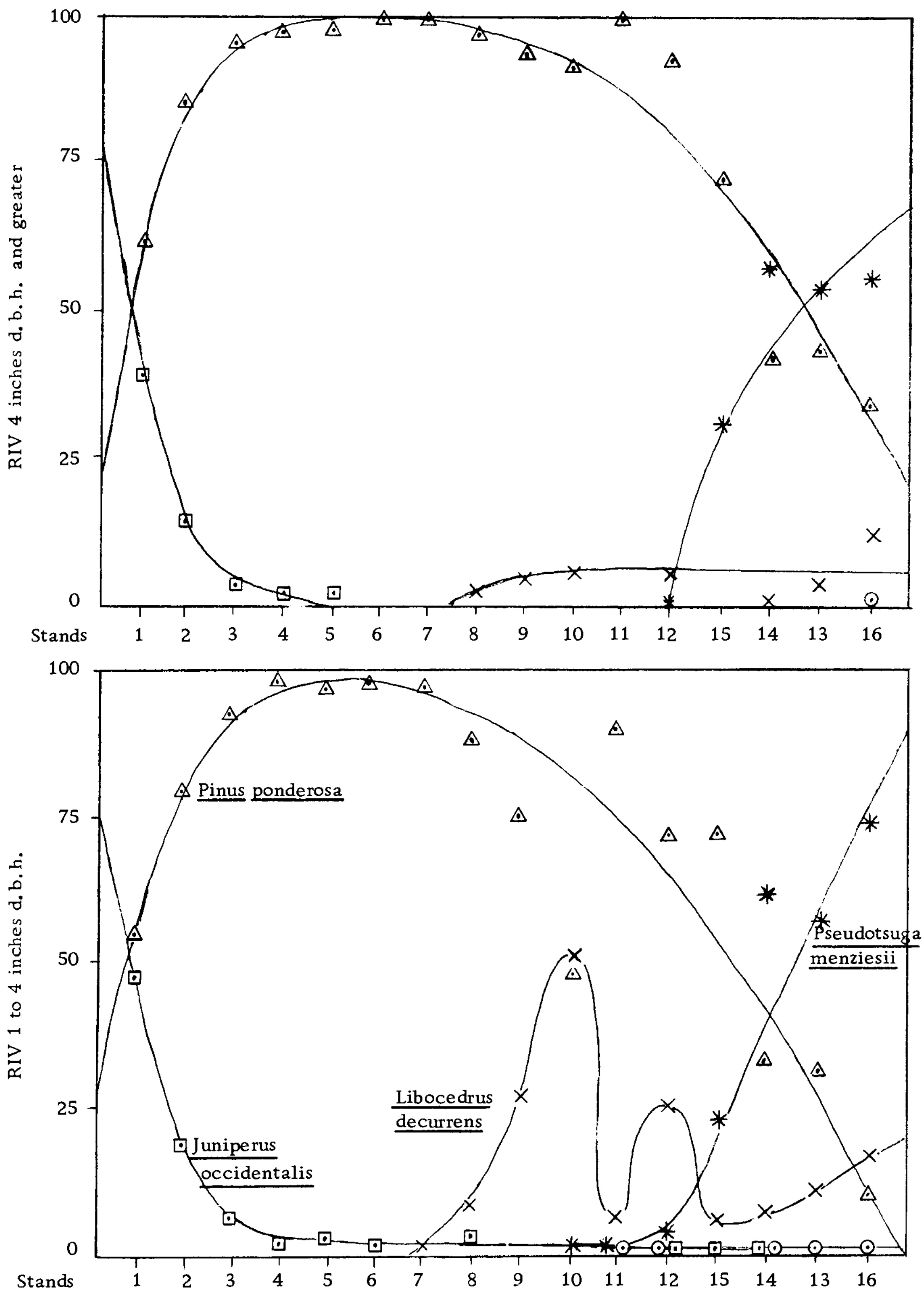


FIGURE 15. Successional Indications by Tree Size Class Shifts, Warm Springs Transect
⊙ = Abies grandis

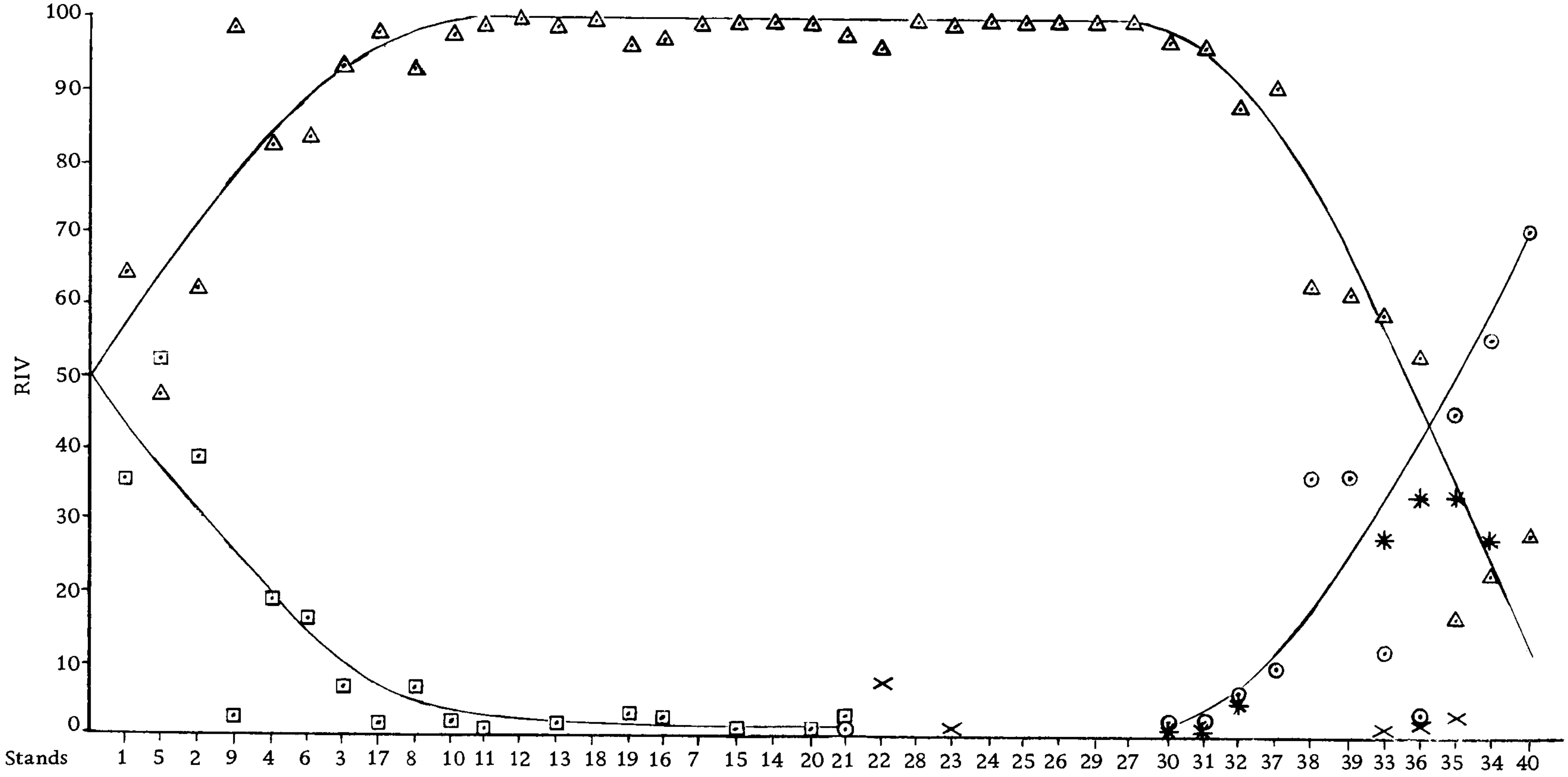


FIGURE 16. Tree RIV's (4 inch d.b.h. and greater), Deschutes Transect.

△ Pinus ponderosa ⊡ Juniperus occidentalis ✳ Pseudotsuga menziesii

× Libocedrus decurrens ⊙ Abies grandis

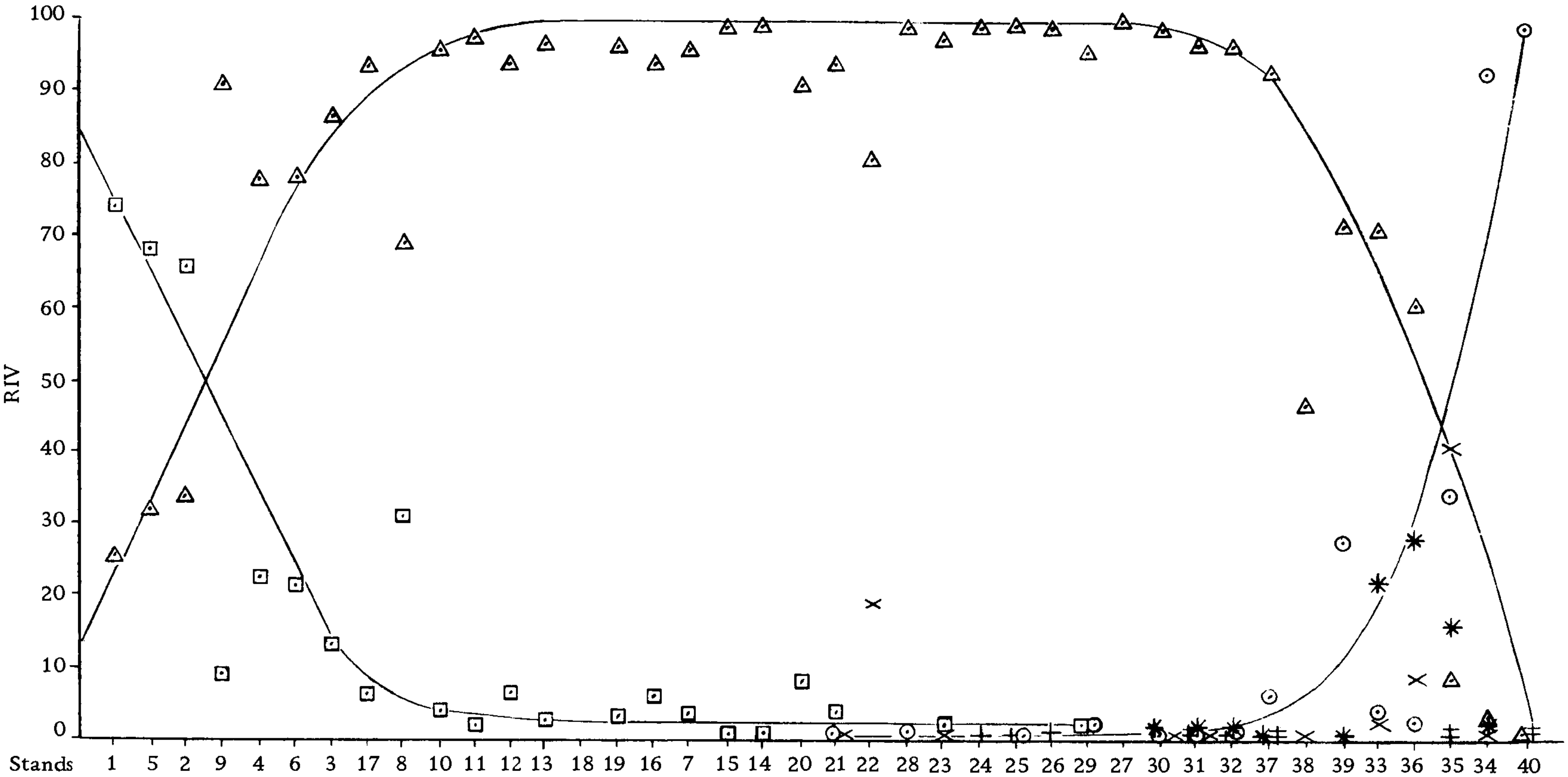


FIGURE 17. Tree RIV's (1 to 4 inch d. b. h.), Deschutes Transect

△ Pinus ponderosa ⊡ Juniperus occidentalis ✳ Pseudotsuga menziesii

× Libocedrus decurrens ⊙ Abies grandis + Pinus contorta ‡ Pinus monticola

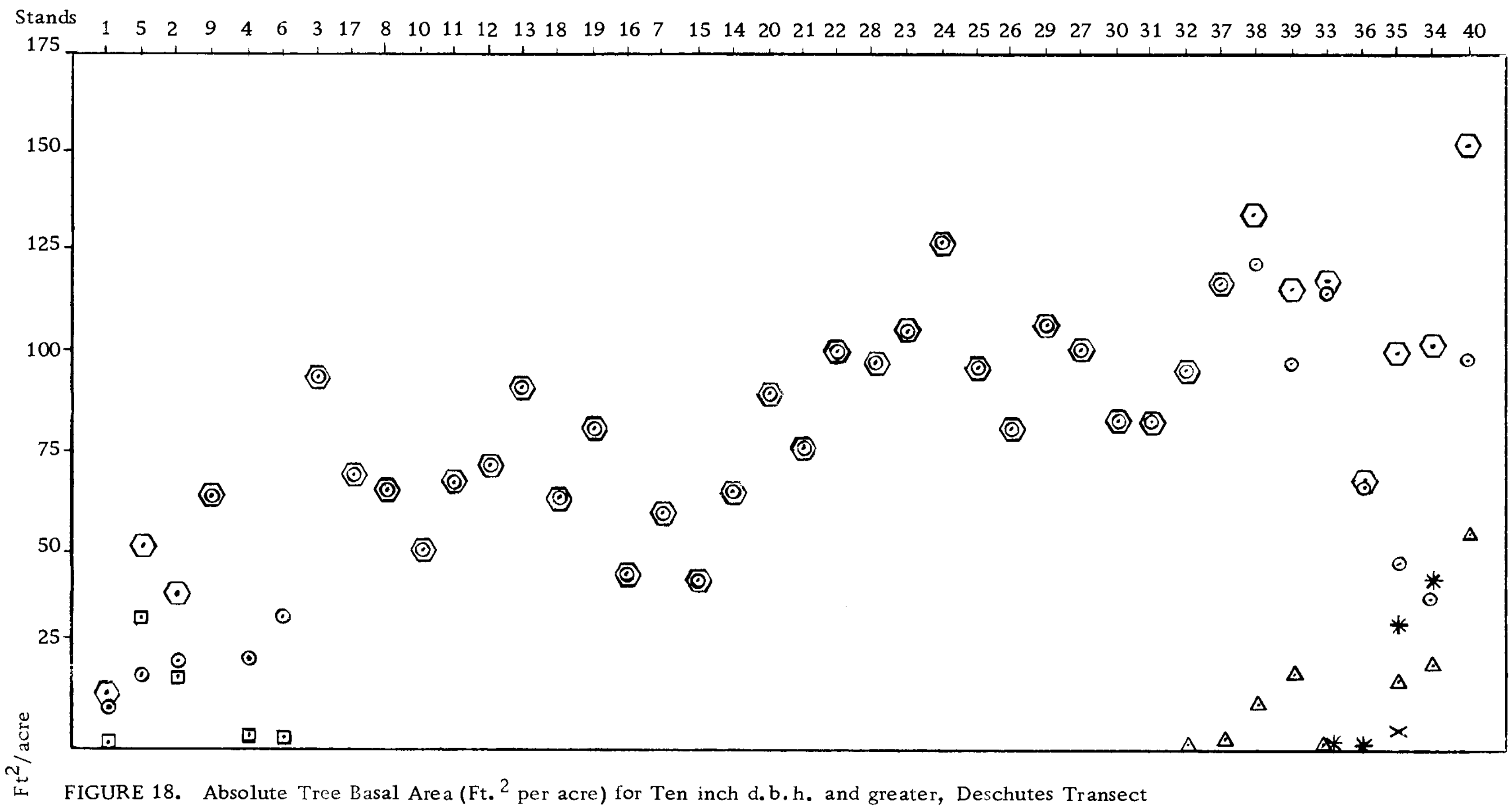


FIGURE 18. Absolute Tree Basal Area (Ft.^{2} per acre) for Ten inch d.b.h. and greater, Deschutes Transect

⊙ Pinus ponderosa ⊡ Juniperus occidentalis △ Abies grandis

✳ Pseudotsuga menziesii ✕ Libocedrus decurrens ⬡ Total

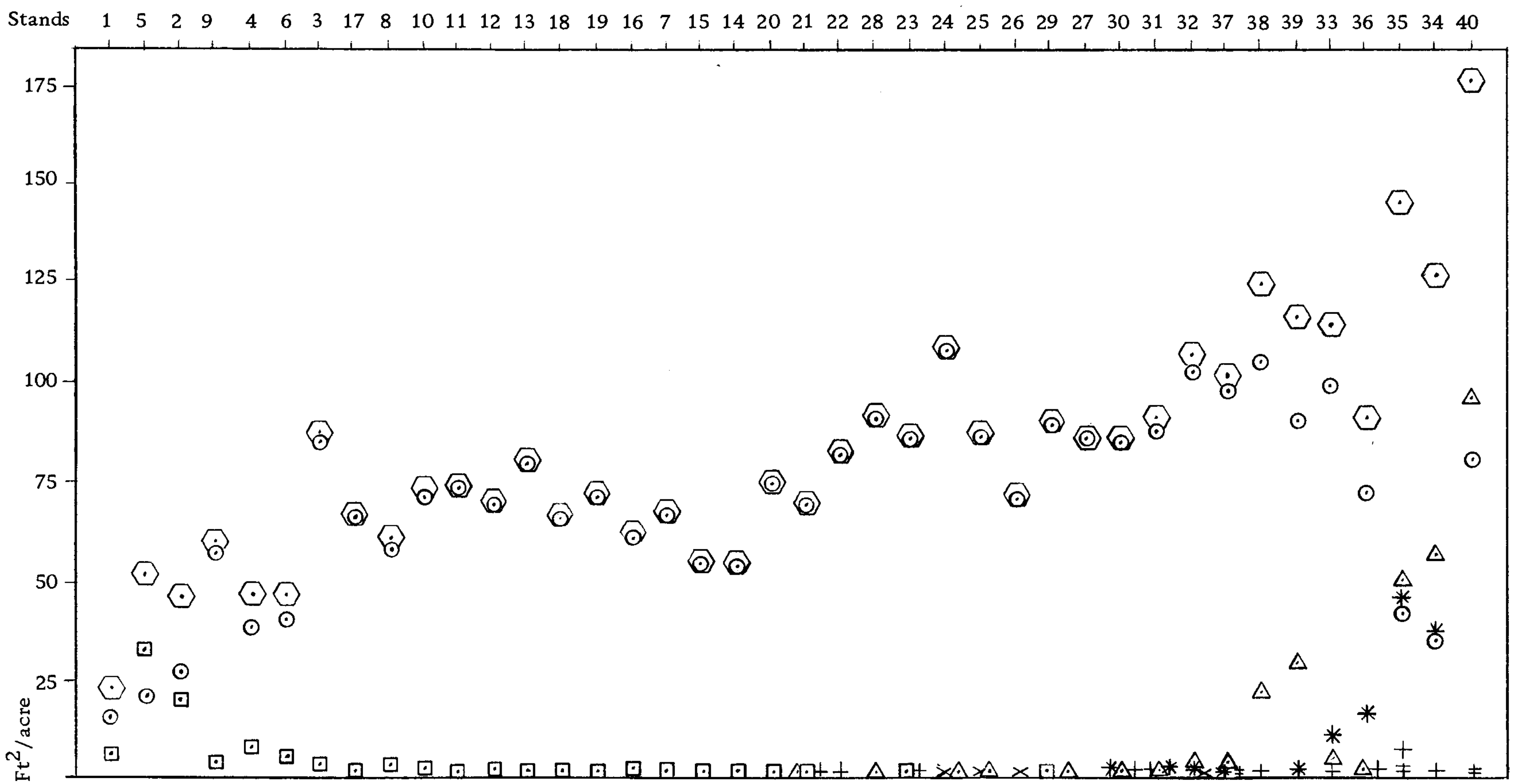


FIGURE 19. Tree Basal Area (ft^2 per acre) for one inch d.b.h. and greater, Deschutes Transect

⊙ Pinus ponderosa ⊡ Juniperus occidentalis △ Abies grandis ✳ Pseudotsuga menziesii

+ Libocedrus decurrens × Pinus contorta ‡ Pinus monticola ⬡ Total changes in ponderosa pine forest, especially the silvicultural implications, has been repeatedly emphasized by Weaver (136 and 137). This situation is also believed to be similar to the changes in ponderosa pine forests studied in detail in the southwestern United States by Cooper (27).

The data from this study constitute the first known detailed record of this phenomenon that allows the analysis of species contributions by size class along a moisture-controlled gradient. Thus a spectrum of silvicultural implications are shown to exist along this gradient with Weaver's warnings holding true only at a very general level. Hence the critical need for the use of the full synecological context is stratifying research and management practices through the montane forest belt of north-central Oregon.

In successional terms, we go from areas of maintenance of open-forested western juniper-ponderosa pine dominated vegetation at the driest, most eastern situated stands to the imminent conversion of the most mesic sites on the western portions of the transects to grand fir dominated area. In between these extremes we find serious threats to ponderosa pine maintenance through very heavy reproduction of particularly incense cedar and Douglas-fir. The threat of the former species has aroused foresters to plea for experimentation on its control (79, p. 255).

The changes in the character of these forests are being greatly accelerated by selective cutting of large ponderosa pine without the concomitant removal of mature competing conifer species. Thus the best sites in terms of rate and total ponderosa pine growth are and will continue to be lost if the present cutting practices are reliance on natural regeneration are to continue as management policy. The presently less commercially desirable species are over-occupying the more mesic sites, resulting in stagnation of growth in varying degrees for the site, a species, and individuals.

Ponderosa pine will naturally maintain itself in "climax" (Daubenmire's definition, 30, p. 302) only on the eastern half of the transect areas studied. But even on the relatively better of these sites, stagnation of growth has or will occur when too many stems per unit area of ponderosa pine must compete for the inherent supplies of moisture and nutrients.

Willits (152) brief reconnaissance records at least recognition of some similar silvicultural trends and implications for management for comparable forests on the eastern slopes of the central Washington Cascades.

Fortunately, extensive research is underway on the optimum stocking levels in connection with mechanical thinning of these "jungled-up" stands of reproduction (118, p. 67-68; 7). Research on means of holding ponderosa pine on the more mesic sites has also been carried out, at least in one reported case (119, p. 38).

The data presented indicate that in addition to determination of areal extent, the rate of change of this alteration of forest character in terms of its commercially important conifers is also highly correlated with the postulated coenocline. Fortunately, these successional trends parallel the coenocline and do not seriously confound interpretations of similarity of potential as would be the case in a region of more homogeneous climate, in all respects, (*c.f.* 115, p. 117). Where disjunct stands must be sampled and no breakdown of data by size classes are given, it is impossible for the reader to differentiate variation due to site from that due to successional status. Successional intermediates accentuate the continuum interpretation. However, in this study with contiguous stable areas allowing a check on interpolation, it is possible to conclude that succession only skews the curves, for consideration of only the larger size classes would still produce intergradation of tree composition and dominance reflecting the nature of the gradient under earlier conditions as it affected establishment (*c.f.* Figures 18 and 19).

Changes in Tree Size-Age Class Patterning

Another silviculturally important facet of the change in forest character in the wake of fire exclusion is the modification of the characteristic size-age class mosaic of ponderosa pine. In general, the regeneration clusters are best expressed, in terms of size and distinctness, near the centers of the transects. The distinctness is progressively lost as the more open canopies develop with increasing xerism, as well as, when heavy crown density with more shade-tolerant conifer species gradually reduce the size and distinctness of ponderosa pine size-age class groupings.

The theory of the development of this species patterning through the differential effects of litter fall coupled with periodic ground fire under probable pristine conditions as outlined by Weaver (132) is generally substantiated by observations during this study. Weaver's frequent and enthusiastic support of prescribed burning (133, 134, 135, 136 and 138) in the ponderosa pine region is a logical development of interpretated changes due to the general exclusion of this very important ecological factor.

The same sample areas as reported by this Bureau of Indian Affairs forester in his 1959 paper were found in the course of the field work and stand data was taken nearby. Stands P-W-1, 2, 3, and 4 occur on areas lightly burned by the 1938 fire, whereas Stand P-W-5 is just west, across the fire line. Since Weaver's evaluations stress tree rings and fire scars, the detailed quantitative data on relative arboreal composition and understory vegetation here should define variation to bring in sharper focus his generalities on gross and practical changes, having occurred and to be expected. Descriptions of his selected areas have gone without mention of synecological context. The data presented in this thesis show that the degree and resolution of the silvicultural problems parallel the inherent variability of the coenocline.

It must be granted that Weaver's arguments for prescribed burning contain sound ecological reasoning, yet practically speaking these forests are generally beyond the point of no return for application of fire as a management tool. The risk of crown fire is presently too high with the current heavy backlog of debris, density of understory vegetation, and limbiness of younger trees. Weaver's publications have understandably stressed situations that strengthened his arguments. However, the author has seen three cases of application of prescribed burning on the Warm Springs Reservation, which if studied would probably show prescribed burning to be a crude tool of questionable value in inducing desirable silvicultural changes, under present conditions in the forest region studied.

Decidedly more predictable, albeit more expensive, results can be obtained for releasing stagnated reproduction through mechanical thinning. When optimum densities of stocking and concomitant change of size-age class micro-pattern can be correlated with the coenocline, best reflected by its synecology, and economic limitations begin to allow sufficient sophistication of management to simulate the effects of periodic fire in the thinning, pruning and harvest phases, we will have capitalized upon the ecological features of these forests to adjust our uses to the long-term biotic potential of the gradient of conditions. This is essentially a problem of successive approximation to capitalize upon the long-term efficiencies that the process of evolution selectively yields.

An additional note of interest in regard to the size-age class patterning of ponderosa pine was the finding that the longest dimension of the reproduction clusters was in an east-west direction. This is probably due to the prevailing westerly winds blowing down a large share of the dead, over-mature, insect-killed trees in an easterly direction and thus opening up an oval to elliptically-shaped spot in the forest to the invasion of relatively shade-intolerant ponderosa pine seedlings. The average area of the clusters described in the methodology section is 0.71 acre. This value compares to Cooper's finding (28, p. 498) of approximately one-fifth acre as the most frequently encountered size of reproduction thickets for the virgin ponderosa pine stands studied in east-central Arizona.

Unfortunately, time for only a very limited, exploratory collection of tree growth and age class data for ponderosa pine was available during the present study. It would have been highly desirable to have made mensurational analyses similar to those that Cooper (27) carried out in the ponderosa pine forests of his study area in Arizona. It was quickly realized that adequate synecological stratification would be necessary for any such mensurational studies as growth rates, age class patterning and density varied greatly, yet with noticeable orderliness along the basic vegetational gradient. This need for establishing synecological contexts would be much more critical over such a region of rapidly, but smoothly changing effective environments than over the relatively larger and more homogeneous areas encompassed by Cooper's study.

In light of the above conclusions, silvicultural research should develop logging practices consonant with the pattern of variation in the ecology of this forest type for maximum sustained productivity to be maintained. Present practices of cutting up to 60 percent of the volume contributed by the mature size classes of ponderosa pine at one time is drastically altering the forest structure and thus the small scale patterns of regeneration. Several harvest cycles of selective cutting coupled with salvage-sanitation logging will bring the regeneration patterns into less distinct, smaller, irregularly-spaced patches with closer age and size similarities between clusters. The application of "unit-area control" in the ponderosa-jefferey pine forests on the east flank of the Sierras (66) is a big step toward gearing forest harvest procedure with the silvicultural features of this forest type.

Patterns of Understory Vegetation

Fire exclusion has also undoubtedly changed the pattern of understory vegetation along these transects. The reports of early forest examiners, ranchers, and Indians have already been reviewed. The details of these changes can, of course, never be known since there are no comprehensive assessments of this vegetation available except for the present decade. It can generally be surmised, however, that brush species have increased in density at the expense of the herbaceous species. Both types of understory vegetation have probably declined in abundance with the increase of canopy coverage of tree species for the more mesic part of the study area. These trends most likely started around the turn of the century. The early heavy grazing undoubtedly accelerated the prodigous regeneration of conifers by initial reduction of understory competition for seedlings (105). The differential effects of kind of livestock are difficult to assess at this late date, but the difference in understory vegetation between the Warm Springs and Deschutes transects is probably due in no minor degree to the differences in grazing histories between the two areas.

An attempted assessment of the effect of understory competition on the growth of ponderosa pine across the fireline area studied by Weaver has been reported by Van Sickle and Hickman (126). They measured the presence of four conditions; namely, trees, brush, grasses or barren ground at points on 40 foot radii around 20 yellow pine trees of Keen's 2B class in each area. They found a significant difference in diameter growth and vegetation density between the burned and unburned area. They expected to find a definite correlation between the tree growth rate in the first decade after burning and vegetation density (their wording, more correctly cover). A covariance analysis was made to test this relationship, however, adjusted growth rate and number of bare spots were used as the two variables. It is puzzling that no mention is made of testing tree diameter growth directly with understory vegetative cover. When their regression analysis proved non-significant, they reasoned that there was too much variation from a consistent relationship among the individual trees. They further conclude (126, p. 852-853) that, "This does not prove that there is no such relation but indicates that there are so many other unmeasured and uncontrollable factors affecting growth that the possible relation is obscured."

In general, present variation in shrub and herbaceous cover from stand to stand hints that variation in the history of fires, even up to 60 years ago, may be very important in having influenced the character of the total vegetation at specific sites.

The data representing the patterns of present day vegetational distribution composes Appendices 4 and 5. Some scattergrams of

RIV data for principal understory species in relation to the coenocline are given as Figures 20, 21, 22 and 23.

It should be repeated that the Warm Springs transect understory data are depreciated in indicator value by a history of heavy and non-uniform livestock use, from around the turn of the century to the present time. Consequently, the data on perennial species alone are of comparatively more value than that with the inclusion of annuals for the phytosociological assessment of site differences and potential.

The Deschutes transect understory data are nearly free from variable effects due to recent livestock use and thus believed to be vegetation in closer balance with the physical factors of the environment and with utilization limited to native fauna. Granted that the area had a history of heavy use up until about 1908, but since that time the limitation of grazing almost solely to fenced meadows has allowed the vegetation to more or less uniformly return toward stability with its natural milieu. Accordingly, more data are given for the understory vegetation of the Deschutes transect. Also the inclusion of values for "cover" and from annuals should more closely represent stable native vegetation. Nevertheless, density and frequency of perennial species as a basis of computation is stressed since they are more evident features to be noticed more readily throughout the year.

An advantage of selective logging practices is that a large

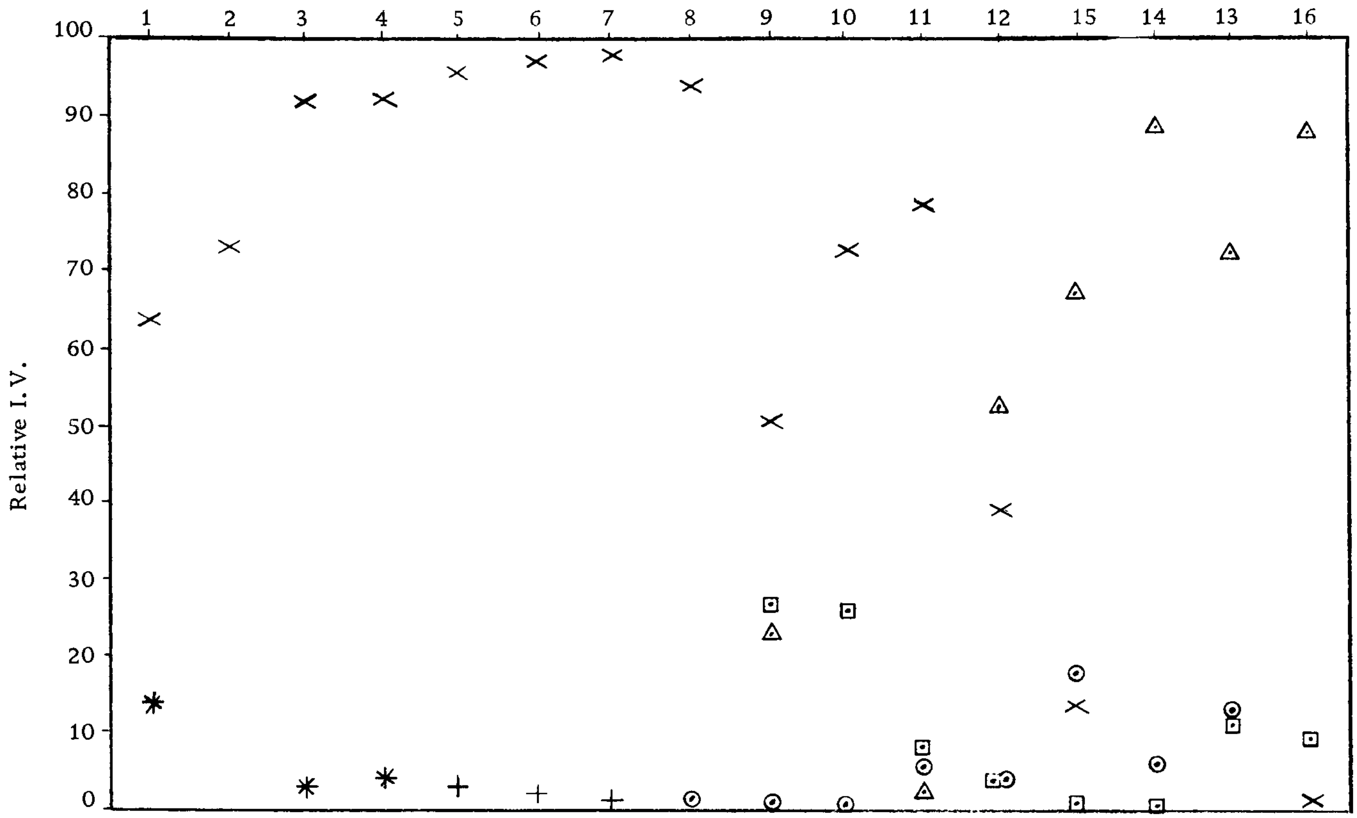


FIGURE 20. Selected Shrub Species RIV's, Warm Springs Transect

× Purshia tridentata   □ Ceanothus velutinus   ✳ Chrysothamnus viscidiflorus

⊙ Arctostaphylos parryana   + Haplopappus bloomeri   △ Ceanothus prostratus

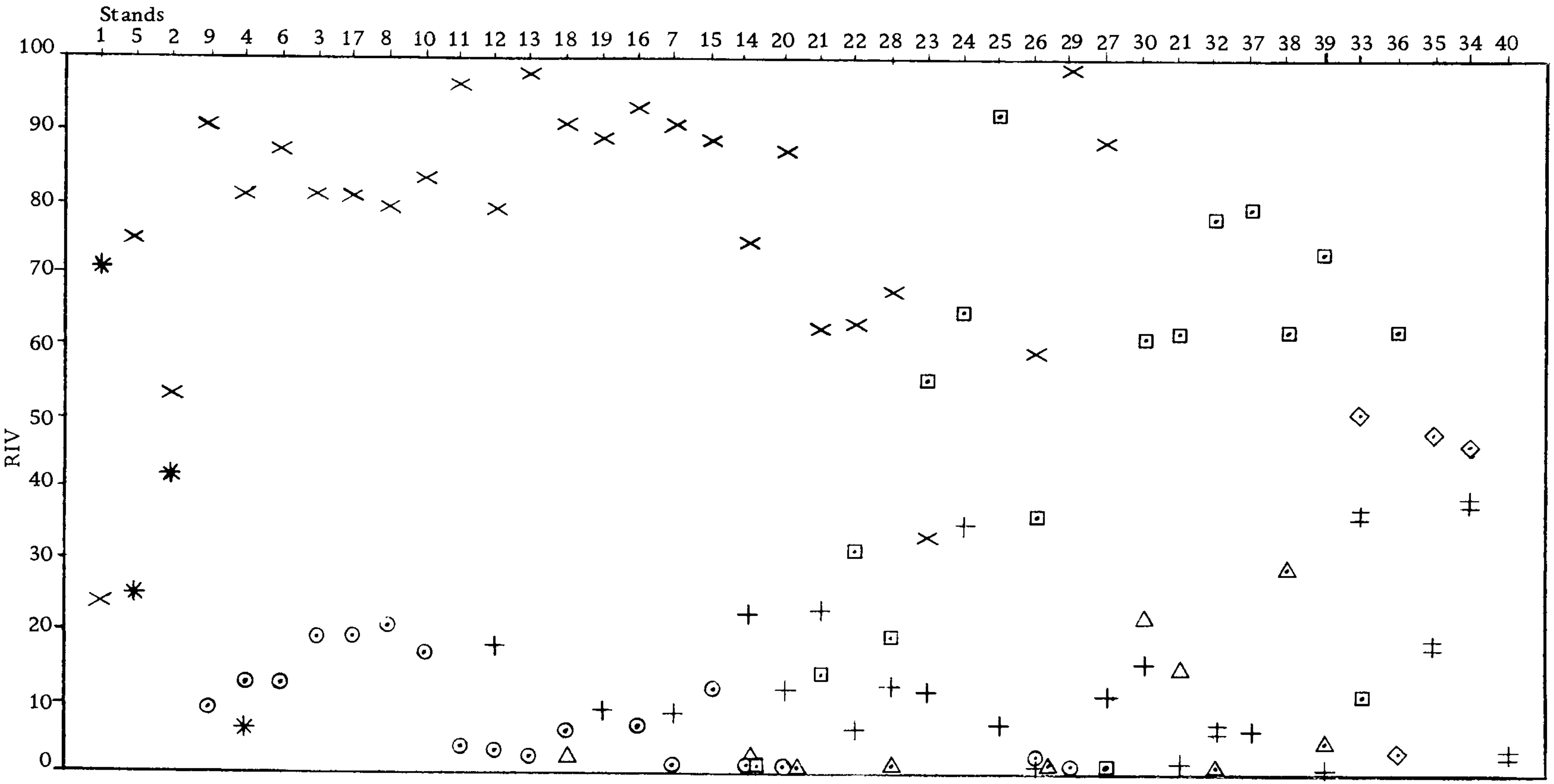


FIGURE 21. Selected Shrub Species RIV's, Deschutes Transect

× Purshia tridentata   ⊡ Ceanothus velutinus   ✳ Artemisia tridentata   ⊙ Chyrsothamnus viscidiflorus

+ Arctostaphylos parryana   △ Haplopappus bloomeri   ‡ Rubus vitifolius   ◇ Castanopsis chrysophylla

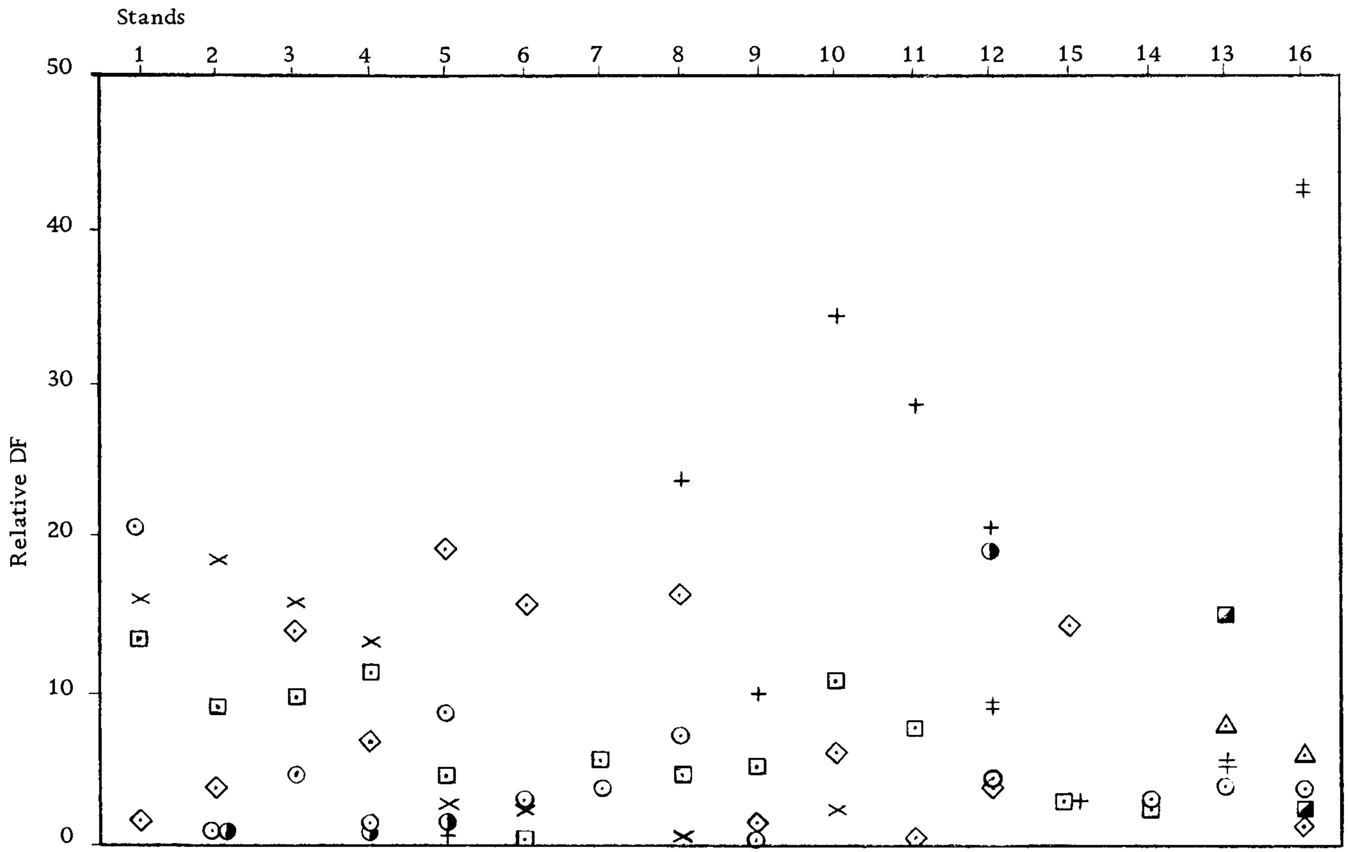


FIGURE 22. Selected Herbaceous Species Relative DF's (perennial species basis), Warm Springs Transect

⊙ Festuca idahoensis | ⊡ Sitanion hystrix | + Lathyrus lanswertii | △ Arnica latifolia
ǂ Chimaphila umbellata | × Poa secunda | ◑ Trifolium eriocephalum | ◇ Antennaria geyeri
◪ Fragaria virginiana

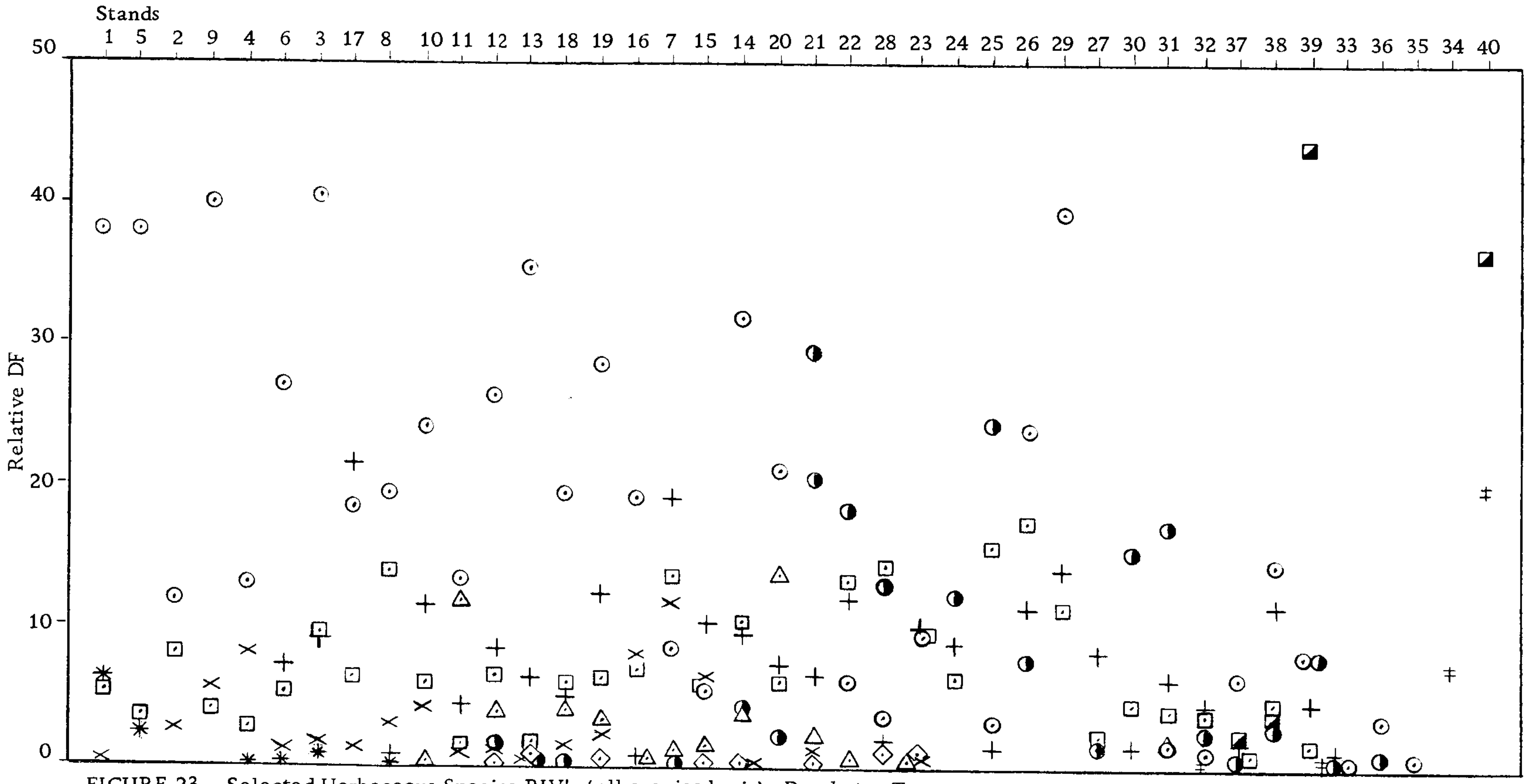


FIGURE 23. Selected Herbaceous Species RIV's (all species basis), Deschutes Transect

⊙ Festuca idahoensis ⊡ Sitanion hystrix + Lathyrus lanswertii △ Clarkia rhomboidea

◑ Kellogia galiodes × Penstemon cinereus ◇ Penstemon speciosus ✳ Koelaria cristata

‡ Chimaphila menziesii ◪ Calamagrostis rubenscens

portion of the vegetation remains untrampled after logging activity. This situation allows indicator species of more stable conditions to remain undisturbed, but for the possible changes in light reaching them due to partial removal of the canopy. This happenstance allows greater use of phytosociological information in forest evaluation, than is the case where clear-cutting and slash-burning is carried out.

Correlation of Vegetation with Some Environmental Patterns

Actual measurements of physical factors of the enviroment were not undertaken, yet some generalizations can be inferred about relationships of observed patterns of vegetation to soils and climate, chiefly precipitation.

The author would like to stress the point made by Whittaker (144) that statements about the relationship of plants to environments are statements of probability, not of strict necessity, and hence are a statistical conception. However, it is assumed that vegetation best integrates and expresses the interactions of the environmental complex. Discussion of vegetation in relation to certain factors are considered as only partial correlations or coincidences.

Soils and their Vegetational Relationships

More information on soils was desired in this study than had been included in those of Johnson (80) and Swedberg (112). However, the degree of soils-vegetation correlation is not that employed by Dyrness (49), Driscoll (47), or Volland (128), partly due to difference in training and partly due to lack of direct organizational requests for application of the information.

A detailed description of the soil morphology from a pedon exposed at each stand allowed the author to conclude that the soils are surprisingly uniform throughout the transects. Selected profile descriptions compose Appendix 6.

All the soil profiles studied along the Deschutes transect could be classified in the Entisol (Azonal) Order, Ustent Suborder, and Psammustent Great Group.[1/] Most of these soils are moderately well to well drained, for the sites of the macro-plots, at least. The surface textures vary from sandy to sandy loams. This horizon is soft when dry, non-plastic when wet, and very friable when moist. The pH of the various profiles and their horizons vary slightly to each side of neutrality. The upper 18 to 25 inches is generally very porous and nearly structureless. Organic material on the surface varies from a trace to nearly two inches in depth and is decomposed slowly.

[1/] Terminology and classification follows that of the Seventh Approximation of Soil Classification, United States Soil Conservation Service (120), with the closest equivalent in the older nomenclature within parentheses.

The specific soils of the Deschutes transect area have a range of variability from aeolian pumicy sands over gravelly to stony outwash layers in the main plain area, and from a regosol-colluvial mixture over pyroxene andesite at the base of Black Butte to regosolic sandy loams over a paleosol near Suttle Lake.

Soils of the Warm Springs transect show evidence of a greater degree of development in place than those of the Deschutes transect. There is also less evidence of glacial outwash influence, especially at the most xeric end of the transect. The soil surfaces are much harder and more finely textured. They are darker in color at all depths with the cambic B (AC) horizon being typically more structured and occupied by a higher percentage of angular, less water-worked rock than that of the Deschutes transect soils. Thus, all the profiles taken at the Warm Springs stands fit into the Inceptisol (Intrazonal) Order, Ochrept (Braunerde - Brown Forest) Suborder, and Dystrocrept Great Group.

The most important conclusion concerning soils of the area, is that they have not had time to express the pedogenic functions nearly to the degree in which the vegetation reflects the effective environment. Thus, soils information is of comparatively much less value in stratifying predictions of forest and range productivity in this study area than is phytosociological context. Similar conclusions were reached by Dyrness (49) and Volland (128) in their studies of forest vegetation on comparatively recent pumice-mantled soils around 100 miles south and slightly east of the study area considered here.

Analysis of the probing procedure data indicates that increasingly shallow soils contribute to a minor accentuation of the change to more open, depauperate forest for the three most xeric stands on the Warm Springs transect. There is no evidence of this influence for the most xeric stands of the Deschutes transect, however.

More careful study would be necessary to substantiate the hypothesis that problems of heavy increases of incense cedar regeneration at the detriment of the more commercially valuable conifers is associated with either the more heavily textured soils of the Warm Springs benches or areas where a finer textured buried profile exists on the Deschutes transect (see tree data and soil profile for Stands P-W-10 and P-D-35). Of course, an abundant seed source and other adequate conditions reflected by synecological context are prerequisites for the development of these conditions.

Another interesting observation was that small, localized areas with a buried pumice gravel profile found near the middle of the Warm Springs transect, reflected no unexpected changes in the vegetation found there as compared to that on the surrounding, more frequent type of soil. This observation demonstrates the importance of seed pressure in maintaining uniformity of vegetation, even when small enclosed areas show minor edaphic differences from the surrounding, more generally occurring combinations of vegetation and soils.

Precipitation-Vegetation Relationships

The main contributing factor of the complex environmental gradient operating in this study area is the decreasing amount of total annual precipitation in this orographic rain shadow. Quantitative evidence that effective soil moisture can be recognized as the most important limiting factor for tree and understory growth in the ponderosa pine regions of the Pacific Northwest has been presented by Dyrness (49, p. 144). A comparison of the isohyetal map, Figure 5, with the species curves, Figures 15, 16 and 17, and the "association" tables of Appendix 4 can give estimations of the degree of influence this major variable has on understory species and forest character in general. Of course, effective soil moisture is tempered by other variables of the factor complex operating, with these changes in vegetation attributable only in large part to this major climatic gradient.

Autecological Considerations

Since Swedberg (112, p. 72-102) has thoroughly reviewed the autecological literature and interpreted it in the light of the conifer species responses along his transect, it remains only to be said that this study generally substantiates his findings and conclusions in this regard.

This study defines the synecological context from which many interesting autecological, genecological, or ectotypic variation studies could readily be related. Especially noticeable differences in morphology and phenology were observed in relation to the coenocline for the native ephemerals (*e. g.* *Clarkia rhomboidea*, *Collomia grandiflora* and *Gayophytum nuttallii*). It is to be expected that all species would show a genetic cline in relation to the environmental coenocline.

GENERAL DISCUSSION AND CONCLUSIONS

It is only logical that the schematic representation of nature that most closely parallels the natural phenomenon itself will yield the highest degree of predictability about the phenomenon and hence its pragmatic manipulation by man. However, in field biological problems so many dimensions can be attributed to the stochastic systems of mutually interdependent variables that, "We are forced to compromise between the degrees of conformity our symbols have with natural phenomena in their full complexity and yet maximize the information value at the highest level that can be communicated with facility among ourselves" (142).

In trying to form communicable approximations on natural processes and circumstances, a facade of impersonal language has often masked personal and subjective conclusions that have been time-honored and over-generalized. This has particularly been the case in systematics and ecology.

A "natural" classification is one intended for use by all scientists for many purposes, as opposed to a special, artificial, or arbitrary classification for limited purposes. Consideration of but one or a few characteristics carries much greater risks of misclassification if natural groups are desired. For if a sample lacks that or those basic features used, it will be placed elsewhere even though it is identical in other respects. This is why a polythetic (107, p. 13) or many character-derived classification has a better possibility of being "natural" and thus of greatest and longest use. But, it should be emphasized that polythetic classifications can never be perfect for all purposes; since this is a consequence of the way in which we strive for natural groupings.

Artificial groups established on the basis of one or a few characteristics are of lower predictive value and reliability than those involving many substratifications, because fewer influences, their interactions or compensations, are accounted for. This is the reason why a total synecological classification is of much more basic value than a cover-type or tree "site-type" map. Classifications based on productivity alone are also too broad for much practical use in land management as Waring and Major (131, p. 171) have pointed out. This is so because dissimilar environments may have similar productivities, such as very dry and very wet sites. At any rate, other features of the vegetation are very important to consider. For example, information on shrub composition and density as related to forage quality and grazing capacity or to tree regeneration is commonly needed by range managers and foresters.

A major question that synecologists have been trying to answer to their mutual satisfaction is, whether described units or ordinations of vegetation are as distinct in nature as they appear in the schema.

The answer is inevitably negative in the ideal, because of the semantic impossibility of symbols being physical reality (Korzybski's Law of Non-identity; 84, p. 417). No is the answer in the less ideal when it is not possible by inspection to delineate the boundaries dividing different communities because of intergradation between them. But, on a lower plane of abstraction and practicality, especially when the situation is promoted by the conditions to the left side of Table IV, an affirmative answer can be given for we can recognize the existence of a utilitarian, if not strictly natural, order of more or less homogeneous examples of vegetation repeating across the landscape.

Grieg-Smith (64, p. 118) has offered some sound philosophical reflections to synecologists:

> Reference has been made to systems of classification because their erection carries implications of the existence of discrete communities on the ground. A clear distinction must be made between the abstract concept of vegetation units of different grades, embodied in a system of classification, and the actual existence in the field of communities with defined boundaries between them. The real existence of the classificatory units implies the real existence of communities in the field. The converse is not necessarily true; communities might be clearly distinguishable in the field, but the communities so distinguished might form a continuum not susceptible of classification except by drawing arbitrary boundaries.

Even with this in mind exigencies of application of ecological information forces us to make practical compromises.

Thus, an "association" in the traditional sense could be represented by a cluster of stands whose species composition do not fully overlap, but possess centers of greater density representing the most typical form, a modal community or "nodum" (98, p. 56) of the abstract association. Such points of reference for supposedly discrete, non-overlapping classes of vegetation may be highly desirable from a practical viewpoint, but is has been shown here and elsewhere (143 and 30) that they have more conceptual than empirical validity upon more objective analysis of vegetational variation.

The adjustment of concept to reality is an ever continuing process; "successive approximation" as it has aptly been termed by Poore (98, p. 38). He further states (loc. cit., p. 98), "The erection of points of reference or of classes cannot be avoided if the data are to be presented in a comprehensible and useful form, irrespective of whether the classes are arbitrary or natural." Congruency of nature with symbolization improves as human methods become more sophisticated with the increase of knowledge.

The association or habitat-type usage may be regarded as a functional early approximation. It is essentially a taxonomic scheme based on over-generalized properties useful for remembering and understanding relationships among the entities classified. Nevertheless, the cognizance of such units of relatively similar vegetation reflecting similarities in inherent site potential has been put to increasingly valuable use in research and management of the biotic resources of non-arable lands (e. g. 42 and 50).

A proviso for this application of synecology to land management has generally been some means of categorization, mostly for purposes of discursive communication and highly generalized management decisions. The judgements for these delimitations, however, can be taken from a sliding scale when it is demonstrated that the variation is more realistically gradual in nature. This approach has been taken in evaluating range condition and trend (51 and 100).

The aim here is not to denigrate subjective classifications, when they are the only feasible alternative. Under some conditions and for some uses, highly arbitrary groupings are simply unavoidable at the time. It is not to be intimated that the methodology presented here is a panacea. All of the outlined variables of Table IV contribute to the particular choice of synecological approaches employed in any vegetation. The truisms of Fosberg (56) that there is no one way to study vegetation, of Cain and Castro (19, p. 2-3) that the most appropriate methods and systems should be adapted to fit the vegetation before adoption, and Conard's (26, p. 3) belief that one should work with vegetation as it is now, are all heartily supported by this author.

Proponents of the various views of synecology are not blind to how their favored abstractions color their interpretations and consequent writing. Particularly relevant examples of this acknowledgement are cited in the following.

Daubenmire intimates that his classification of the forest vegetation of eastern Washington and northern Idaho is not unrealistically rigid for this area of study, when he states (38, p. 319-320), . . . "there are broad pieces of vegetation characterized by a relatively low degree of variation or gradient that are separated by narrow areas of sharp gradients wherein the relative dominants of species-groups change rapidly." His adjacent associations may be quite distinct or involve only the relative abundance of a single species. Later, (39) he generalizes that, "Plant communities exhibit variability and intergradation, so units of plant sociology must be described in terms of norms, and actual pieces of vegetation in the field to be classified according to the norms to which they most closely conform. Each stand has its own parameters and hence must be treated as a statistical unit."

Spurr (109, p. 184) surmised that the forest vegetation of northern Idaho is neither a continuum with strong gradients extending in all directions, nor a group of discretely defined associations separated by sharp discontinuities.

Neither have those of the individualistic dissent unreservedly defended their abstractions as all encompassing. Curtis states in his book (30, p. 51-53), after accepting Gleason's (58) individualistic concept, It must not be assumed, however, that the vegetation of Wisconsin is a chaotic mixture of communities, each composed of a random assortment of species, each independently adapted to a particular set of external environmental factors. Rather, there is a certain pattern to the vegetation, with more or less similar groups of species recurring from place to place. The main reason for this is the great potentiality for dominance possessed by a relatively small group of species. These are plants that are well adapted to the over-all climate and soil groups of the province and which have the ability to exert a controlling influence on the communities where they occur because of their size or their high population densities . . . The interactions of this tiny group of plants with the general climate and the regional soil groups produce a series of microenvironments which differ according to the biological characteristics of the dominants. Most of the remaining species of the flora must grow in these modified conditions and they tend to be sorted out in groups aligned with the particular dominant concerned. The groups are not discrete and separate from one another but gradually shift in composition because the dominants themselves rarely grow in pure stands but occur rather in mixtures of varying proportions. The mixtures of dominants vary according to a pattern commonly associated with a soil-moisture gradient . . . The entire series of communities whose floristic composition gradually changes along an environmental gradient has been termed a "vegetational continuum" to emphasize the fact that there are no discrete divisions, entities, or other natural discontinuities present.

It must not be assumed that this gradual blending of one community into another or one vegetation type into another is always expressed in the field. On the contrary, there are many examples of abrupt shifts that may be crossed in a single step . . .

Usually there abrupt boundaries between dissimilar communities are associated with equally abrupt changes in the habitat, mostly due to topographic features . . . Thus, communities largely or totally different in composition may exist side by side yet they cannot be categorized because more remote examples

> of each of the locally distinct types will differ slightly from the initial stands and further examples can be found which will show much less differentiation, and finally culminate in stands which are intermediate between the original pair . . .
>
> This situation means that it is not possible to erect a classification scheme which will place the plant communities of any large portion of the earth's surface into a series of discrete pigeonholes, each with recognizable and describable characteristics and boundary limitations. The plant communities, although composed of plant species, are not capable of being taxonomically classified as are the species themselves. The communities are the result of chance happenings, accidents of migration, and partial catastrophic destructions, with no two stands ever of the same composition.

Review of the literature and the results of this study lead the author to conclude that the two concepts of vegetation, unit-association and continuum, are equally valid and essential mental constructs for studying vegetation. It is deceiving to place the word versus between the two ideas, for the quasi-opposition becomes disspelled as one examines the situation more carefully. The essential difference is the relative stress of variation and homogeneity, or the difference in what the worker considers is significant variation within or among samples. In the simplest terms, it depends on which examples the worker judges are more alike than different.

Classification of units which represent modal points of vegetational variability involves a search for hiatuses at a relatively high level of extraction. Classification <u>per se</u> into such abstract entities is bypassed through continuum analysis and characterization of vegetational change in relation to gradients. The spectrum of variation over the total vegetation is interpolated and emphasized in the latter approach, whereas modal examples are interpreted and presented as the key points of reference in derivations of unit-associations. Although continuum, gradient, or factor analysis is not in the strictest sense a classification scheme, such an analysis can serve as a basis for deriving less subjectively, but still ultimately arbitrary units of a known degree of similarity. This is the principal demonstration of this study.

Thus, the whole apparent issue can be condensed to a contrast of what the synecologist interprets as the truer symbolization of the vegetation in relation to his purposes, modes or gradients. Often both representations are essential to understanding the circumstances, regardless of the preference of the investigator. There is no logical conflict between cognizance of plant cover as continuous and the construction of association-units as useful abstractions (97).

Of course, the two schools of thought have evolved in human, biotic, and physical environmental frameworks in which each concept is best reflected. For example, in areas of dissected topography with its concomitantly abrupt changes in micro-climate, soil, etc., the corresponding vegetation is relatively easily parceled into quite discrete and repeatably similar units. On the other hand, in regions of nearly level topography and its relatively gradual changes in effective environment, species distributions seem more continuously variable over the wide, gradual range of conditions.

The two schools of phytosociology have developed sampling methods and ways of treating data which amplify their conceptions of vegetation and make even more of an apparent controversy. Additional elaborations, illustrations, and concrete examples could be readily given for all of the counterpoints outlined in Table IV, but most of the variance of viewpoint pivots around rates and magnitudes of difference and change.

Some of the wisdom of the Russian ecologist, Ramenskii, seems appropriate to quote with the concluding remarks. Ramenskii's (100, p. 3) second rule seems particularly applicable here. This rule states,

> Do not disregard all manner of intermediate or transition conditions and coenoses, but to study them, establishing a series of sequences in space. Disregard of intermediate conditions and mixed coenoses, of all that is not 'typical' leads to formalism, to subjective conditional theories, to misunderstanding and distortion of the natural correlations.

He goes on in this final, "capping" paper to say (Loc. cit., p. 23)

> To master the laws governing the plant cover (in order to direct its development) we must forsake all metaphysical methods of reasoning, of thinking of individual arbitrarily selected units which logically exclude each other; instead we must adopt consecutive thinking in systems of regular series, a method of thinking which has long been adopted by the more advanced natural and technological sciences.

(*loc. cit.*, p. 25-26)

> Generalized units are necessary, but not as a method of initial classification of coenoses in accordance with a few arbitrarily chosen external characteristics (as is customary), but rather as a secondary act of generalization following through preliminary analysis, including identification by ecological tables, etc. . .
>
> The investigator must put the contents and boundaries of the association that he establishes on the firmest possible basis . . .

It is readily acknowledged that vegetation may exhibit a continuous nature, but on the other hand, relatively similar stands can be grouped into higher order units of vegetation. This dualistic viewpoint is possible simply because we can see and study from both points of departure.

Gradient analysis is especially valuable in interpreting causation in vegetation distribution, but such ordinations can also be used as the basis of characterization of similarity and difference needed to make decisions on synecological units usually necessary for transposal of ecological knowledge to land management.

Knowledge of the relative strengths and weaknesses of continuum analysis and in the establishment of association units is essential in the critical reading of synecological literature. Once the apparent barrier of conflict of ideas has been logically destructed, one has at his command the strengths of both concepts to synthesize methodology most adaptable to his needs and circumstances.

SUMMARY

The montane forest vegetation as it occurs on the east flank of the central Oregon Cascades has provided excellent conditions for a "natural experiment" in the use of various methodologies in studying vegetational distribution which has reflected on some theory and practice for the discipline of plant synecology. In addition, detailed descriptions, analysis, and interpretation of the data document present conditions in relation to the past and allow prognostication of future changes of silvicultural importance for a portion of this forest type extensively found on the east flank of the Sierra Nevada-Cascades mountain chain.

A major objective of this study was to determine the relative merits and deficiencies of attempting to transpose to this vegetation the methods of analyzing vegetation based on the individualistic or continuum philosophy of phytosociology that has developed and been practiced principally in the north-central United States. These attempts have been contrasted to strengths and short-comings of poly-climax theory, the most widely used basis of vegetational classification in the Pacific Northwest, in relation to the analysis of this and other vegetation types. The influences on and of these variant interpretations have been outlined and presented in tabular form.

The study area is nearly ideal for posing these questions because edaphic and topographic factor complexes remain surprisingly uniform, with the vegetation superimposed in apparent primary response to the condensed gradient of total precipitation wrought by the orographic "rain shadow" effect due to a major mountain range, the Cascades, intervening in a region of prevailing westerly winds. The stability of the vegetation concomitant with this nearly ideal set of "naturally controlled" physical conditions, minimized variation of successional status, except that due to fire exclusion. This latter variation, however, paralleled the coenocline studied, and in fact allowed silviculturally important interpretations to be made. Stable vegetation occurring in general contiguity allowed systematic stand placement, leaving little doubt concerning the validity of interpolation between stands.

Another main objective of the study was to obtain and analyze data to substantiate the hypothesized influence of light periodic ground fires in initiating and maintaining the characteristic mosaic of size-age class distribution of ponderosa pine. The data also yielded a quantitative indication of the shift in species composition and dominance that is in largest measure due to the continued exclusion of fire by man for approximately the past 50 years. From this data the future appearance of the forest can be surmised and silvicultural manipulation best in harmony with the ecology of these forests suggested.

The transitional nature of much of the montane forest, as well as its differentially variable nature along the coenocline studied, negates the use of traditional classification schemes. However, the need for using synecological contexts for silvicultural and wild land use research and management programs encouraged the development of objective, yet pragmatic means of schema beyond ordination of stands. The result was the introduction of methods of cluster analysis of matrices of relative parameter-weighted coefficients of similarity as a means of giving a very objective basis to synecological delimitations believed to most closely parallel the nature of the vegetation and thus the concomitant present and future problems of research and management of the vegetational resources of this area. This method can serve the detailed needs of researchers as well as provide information for divisions limited more by economics than desire for sophistication that must be constantly made by the forest administrator. The dendrograms derived from this analysis allow a "sliding scale" of stratification to be made in this vegetation of intermediate, but more characteristically continuum than unit-association nature. Modifications of the methodology are suggested when more subjective synecological examinations are necessitated.

The value of such synecological information is enhanced by the very uniform nature of the weakly differentiated soil profiles which negates heavy reliance on edaphic information for research or management stratification.

It should be emphasized that man has become the synecological dominant in this ecosystem. This anthropeic factor can be expected to become increasingly determinant of the future development of the montane forest within certain inherent limits of the biota in its physical framework of climate and soil.

Particularly noticeable is how present timber harvesting practices are accelerating the modifications initiated by fire exclusion policies. The result is a projected drastic alteration of the size-age class patterning of ponderosa pine. Nevertheless, these selective cutting practices leave patches of undisturbed understory vegetation which facilitates the use of their indicator significance in combination with the conifers to evaluate silvicultural problems and aid decisions for predicting productivity and potential and thus determining the policies of forest use most commensurate with its inherent ecology.

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APPENDICES

Appendix 1. Legal Location of Stands Warm Springs Transect

Stand	Legal Location
P-W-1	Range 11 East, Willamette Meridian, Township 9 South, Columbia (Portland) Base line, section 27, southeast boundary of southeast quarter of southwest quarter section.
P-W-2	R. 11 E., T. 9 S., section 33, center of N.E. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-W-3	R. 11 E., T. 9 S., section 33, N.E. boundary, N.E. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-W-4	R. 11 E., T. 9 S., section 32, center of S.E. $\frac{1}{4}$ of S.E. $\frac{1}{4}$
P-W-5	R. 11 E., T. 10 S., section 5, center of N.E. $\frac{1}{4}$ of N.W. $\frac{1}{4}$
P-W-6	R. 11 E., T. 10 S., section 6, center of S.E. $\frac{1}{4}$ of N.E. $\frac{1}{4}$
P-W-7	R. 11 E., T. 10 S., section 6, center of S.E. $\frac{1}{4}$ of N.W. $\frac{1}{4}$
P-W-8	R. 10 E., T. 10 S., section 1, N.E. boundary of N.W. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-W-9	R. 10 E., T. 10 S., section 1, S.E. boundary of N.E. $\frac{1}{4}$ of N.W. $\frac{1}{4}$
P-W-10	R. 10 E., T. 10 S., section 2, center of S.E. $\frac{1}{4}$ of N.W. $\frac{1}{4}$
P-W-11	R. 10 E., T. 10 S., section 2, N.E. boundary of N.E. $\frac{1}{4}$ of N.W. $\frac{1}{4}$
P-W-12	R. 10 E., T. 10 S., section 3, S.E. boundary of N.E. $\frac{1}{4}$ of N.E. $\frac{1}{4}$
P-W-13	R. 10 E., T. 9 S., section 22, center of N.E. $\frac{1}{4}$ of N.W. $\frac{1}{4}$
P-W-14	R. 10 E., T. 9 S., section 22, center of N.E. $\frac{1}{4}$ of N.E. $\frac{1}{4}$
P-W-15	R. 10 E., T. 9 S., section 14, S.E. boundary of S.E. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-W-16	R. 10 E., T. 9 S., section 21, center N.W. $\frac{1}{4}$ of N.W. $\frac{1}{4}$

Appendix 1 (continued) Legal Location of Stands
Deschutes Transect

Stand	Legal Location
P-D-1	R. 11 E., T. 16 S., section 20, S.W. boundary S.W. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-D-2	R. 10 E., T. 15 S., section 13, S.W. boundary of S.W. $\frac{1}{4}$ of N.W. $\frac{1}{4}$
P-D-3	R. 10 E., T. 15 S., section 5, center of N.W. quarter section
P-D-4	R. 10 E., T. 15 S., section 4, N.W. $\frac{1}{4}$ of N.W. $\frac{1}{4}$ of N.E. $\frac{1}{4}$
P-D-5	R. 10 E., T. 16 S., section 12, N.W. boundary of N.W. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-D-6	R. 10 E., T. 15 S., section 5, W. center boundary of S.W. $\frac{1}{4}$
P-D-7	R. 9 E., T. 15 S., section 1, S. boundary of S.W. $\frac{1}{4}$ of N.E. $\frac{1}{4}$
P-D-8	R. 10 E., T. 15 S., section 5, N.E. $\frac{1}{4}$ of N.E. $\frac{1}{4}$ of N.W. $\frac{1}{4}$
P-D-9	R. 10 E., T. 14 S., section 31, N.E. $\frac{1}{4}$ of N.E. $\frac{1}{4}$ of S.E. $\frac{1}{4}$
P-D-10	R. 10 E., T. 14 S., section 30, at center of section
P-D-11	R. 10 E., T. 14 S., section 19, S.W. $\frac{1}{4}$ of S.W. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-D-12	R. 9 E., T. 14 S., section 24, center S.W. $\frac{1}{4}$ of N.E. $\frac{1}{4}$
P-D-13	R. 9 E., T. 14 S., section 13, center N.E. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-D-14	R. 9 E., T. 14 S., section 35, center N. boundary of S.E. $\frac{1}{4}$ of S.W. $\frac{1}{4}$

Appendix 1 (continued) Legal Location of Stands
Deschutes Transect

Stand	Legal Location
P-D-15	R. 10 E., T. 14 S., section 30, N.E. $\frac{1}{4}$ of S.E. $\frac{1}{4}$ of N.W. $\frac{1}{4}$
P-D-16	R. 10 E., T. 14 S., section 30, N.E. $\frac{1}{4}$ of N.E. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-D-17	R. 10 E., T. 14 S., section 32, center S.W. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-D-18	R. 9 E., T. 14 S., section 24, center of N $\frac{1}{2}$ of S.E. $\frac{1}{4}$ of S.E. $\frac{1}{4}$
P-D-19	R. 9 E., T. 14 S., section 24, N.W. $\frac{1}{4}$ of N.W. $\frac{1}{4}$ of N.W. $\frac{1}{4}$
P-D-20	R. 9 E., T. 14 S., section 14, center of N.E. $\frac{1}{4}$ of N.E. $\frac{1}{4}$
P-D-21	R. 9 E., T. 14 S., section 11, N.E. $\frac{1}{4}$ of N.W. $\frac{1}{4}$ of S.E. $\frac{1}{4}$
P-D-22	R. 9 E., T. 14 S., section 11, S.E. boundary of N.W. $\frac{1}{4}$ of N.W. $\frac{1}{4}$
P-D-23	R. 9 E., T. 14 S., section 10, N.W. $\frac{1}{4}$ of N.E. $\frac{1}{4}$ of N.E. $\frac{1}{4}$
P-D-24	R. 9 E., T. 14 S., section 3, center of E $\frac{1}{2}$ of S.E. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-D-25	R. 9 E., T. 14 S., section 4, N.E. $\frac{1}{4}$ of S.E. $\frac{1}{4}$ of S.E. $\frac{1}{4}$
P-D-26	R. 9 E., T. 14 S., section 4, center S.W. $\frac{1}{4}$ of N.E. $\frac{1}{4}$
P-D-27	R. 9 E., T. 14 S., section 34, center S $\frac{1}{2}$ of section
P-D-28	R. 9 E., T. 14 S., section 33, center E $\frac{1}{2}$ of S.W. $\frac{1}{4}$ of S.E. $\frac{1}{4}$
P-D-29	R. 9 E., T. 13 S., section 32, center W $\frac{1}{2}$ of section
P-D-30	R. 9 E., T. 13 S., section 32, center N.W. $\frac{1}{4}$ of section

Appendix 1 (continued) Legal Location of Stands
Deschutes Transect

Stand	Legal Location
P-D-31	R. 9 E., T. 13 S., section 29, N.W. $\frac{1}{4}$ of S.W. $\frac{1}{4}$
P-D-32	R. 9 E., T. 13 S., section 30, center N. $\frac{1}{2}$ of S.E. $\frac{1}{4}$
P-D-33	R. 9 E., T. 13 S., section 30, center N. $\frac{1}{2}$ of section
P-D-34	R. 8 E., T. 13 S., section 24, center E. $\frac{1}{2}$ of section
P-D-35	R. 8 E., T. 13 S., section 24, center E. $\frac{1}{2}$ of N.E. $\frac{1}{4}$
P-D-36	R. 9 E., T. 13 S., section 18, center S.W. $\frac{1}{4}$
P-D-37	R. 9 E., T. 14 S., section 32, S. E. boundary N.E. $\frac{1}{4}$ of S. W. $\frac{1}{4}$
P-D-38	R. 9 E., T. 14 S., section 31, center W. $\frac{1}{2}$ of N.W. $\frac{1}{4}$ of S.E. $\frac{1}{4}$
P-D-39	R. 9 E., T. 14 S., section 31, center S.W. quarter section
P-D-40	R. 8 E., T. 15 S., section 1, center N. $\frac{1}{2}$ of section

Appendix 2. Scientific names, authorities, and life forms of species and species groups cited in tables and text.

Life forms are modified from those defined by Braun-Blanquet (12, p. 289-296). Designations apply to mature, average-statured examples of the species.

Symbol	Life Form Description
P	Phanerophytes: woody plants with perennating buds over 8 inches (2 dm.) above ground level.
C	Chamaephytes: perennating buds above the ground level but less than 8 inches (2 dm.) above it; prostrate shrubs, semi-shrubs, some stoloniferous and caespitose herbs.
H	Hemicrytophytes: perennating buds at ground level; includes most perennial and biennial herbs.
G	Geophytes: perennating organs (rhizomes or bulbs) beneath the ground surface; includes liliaceous plants, root parasites, etc.
T	Therophytes: annuals, perennating only as seeds.

Life Form Symbol	Scientific Names and Authorities
P	Abies grandis Lindl. - Abies concolor Lindl. complex
P	Acer circinatum Pursh
H	Achillea millefolium L. var. lanulosa (Nutt.) Piper
G	Agoseris glauca (Pursh) Raf.
G	Agoseris retrorsa (Benth.) Greene
H	Agropyron spicatum (Pursh) Scribn. & Smith
P	Amelanchier florida Lindl.
T	Amsinckia retrorsa Suksd.
H	Antennaria dimorpha (Nutt.) T. & G.
C	Antennaria geyeri A. Gray - A. argentea Benth. - A. rosea Greene
T	Apera spica-venti L. var. interrupta Hook.

Appendix 2 (Continued)

Life Form Symbol	Scientific Names and Authorities
H	*Apocynum pumilum* (Gray) Greene
H	*Aquilegia formosa* Fisch.
H	*Arabis holboellii* Hornem. var. *retrofracta* (Grah.) Rydb.
C	*Arctostaphylos nevadensis* Gray
P	*Arctostaphylos parryana* Lem. var. *pinetorum* (Rollins) Wiesl. & Schr.
H	*Arnica cordifolia* Hook. - *A. latifolia* Bong.
P	*Artemisia tridentata* Nutt.
H	*Aster canescens* Pursh
H	*Astragalus* sp.
H	*Balsamorhiza careyana* Gray
C	*Berberis nervosa* Pursh
C	*Berberis repens* Lindl.
T	*Blepharipappus scaber* Hook.
H	*Bromus carinatus* H. & A. - *B. marginatus* Nees. - *B. polyanthus* Scribn.
H	*Bromus orcuttianus* Vas.
T	*Bromus racemosus* L.
T	*Bromus tectorum* L.
H	*Calamagrostis rubescens* Buckl.
G	*Calochortus elegans* Pursh
G	*Calochortus macrocarpus* Dougl.
H	*Campanula scouleri* Hook.
H	*Carex* sp.
H	*Carex inops* Bailey
P	*Castanopsis chrysophylla* (Dougl.) A. DC.
H	*Castilleja miniata* Dougl. - *C. hispida* Benth.
C	*Ceanothus prostratus* Benth.
P	*Ceanothus velutinus* Dougl.
H	*Chaenactis douglasii* (Hook.) Hook. & Arn.
C	*Chimaphila menziesii* (R. Br.) Spreng
C	*Chimaphila umbellata* (L.) Nutt. var. *occidentalis* (Rydb.) Blake
P	*Chrysothamnus nauseosus* (Pall.) Britt.
P	*Chrysothamnus viscidiflorus* (Hook.) Nutt.
H	*Cirsium centaurea* (Rydb.) Schum.
T	*Clarkia rhomboidea* Dougl.
T	*Collomia grandiflora* Dougl.
T	*Collinsia parviflora* Dougl.
H	*Comandra pallida* A. DC.

Appendix 2 (Continued)

Life Form Symbol	Scientific Names and Authorities
T	Convolvulus polymorphus Greene
P	Corylus cornuta Marsh var. californica (A. DC.) Sharp
T	Cryptantha ambigua (A. Gray) Greene
T	Cryptantha circumscissa (H. & A.) Johnst.
H	Cynoglossum occidentale A. Gray
G	Delphinium nuttallianum Pritz
T	Deschampsia danthonioides (Trin.) Munro
H	Deschampsia elongata (Hook.) Munro
T	Draba verna L.
H	Elymus glaucus Buckl.
H	Epilobium angustifolium L.
T	Epilobium minutum Lindl.
T	Epilobium paniculatum Nutt.
H	Erigeron filifolius Nutt.
H	Erigeron inornatus A. Gray
H	Erigeron peregrinus (Pursh) Greene
T	Eriogonum baileyi S. Wats.
H	Eriogonum ovalifolium Nutt.
H	Eriogonum umbellatum Torr.
H	Eriophyllum lanatum (Pursh) Forbes
T	Erodium cicutarium (L.) L'Her.
H	Erysimum sp.
G	Erythronium sp.
T	Euphorbia serpyllifolia Pers.
T	Festuca dertonensis (All.) A. & G. - F. octoflora Walt. - F. megalura Nutt.
H	Festuca idahoensis Elmer
H	Fragaria virginiana Druck. ssp. platypetala (Rydb.) Staudt
G	Fritillaria atropurpurea Nutt.
T	Gayophytum lasiospermum Greene
T	Gayophytum nuttallii T. & G.
H	Geum ciliatum Pursh
H	Gilia aggregata (Pursh) Spreng
H	Goodyera oblongifolia Raf.
G	Habenaria hyperborea (L.) R. Br.
G	Habenaria unalaschensis (Spreng.) Wats. var. elata (Jeps.) Corr.
H	Hackelia floribunda (Lehm.) I. M. Johnston
P	Haplopappus bloomeri A. Gray

Appendix 2 (Continued)

Life Form Symbol	Scientific Names and Authorities
H	Haplopappus carthamoides (Hook.) Gray
H	Hieracium albiflorum Hook. - H. albertinum Farr. - H. scouleri Hook. - H. cynoglossoides Arv. - Touv.
P	Holodiscus discolor (Pursh) Maxim.
P	Holodiscus glabrescens (Greene) Hel.
T	Hordeum depressum (Scribn. & Smith) Rydb.
H	Horkelia fusca Lindl.
P	Juniperus occidentalis Hook.
H	Kelloggia galioides Torr.
H	Koeleria cristata (L.) Pers.
T	Lagophylla ramisisssima Nutt.
H	Lathyrus lanswertii Kell. ssp aridus (Piper) Brads.
H	Leptodactylon pungens (Torr.) Nutt.
G	Leucocrinum montanum Nutt.
P	Libocedrus decurrens Torr.
G	Lilium washingtonianum Kell.
T	Linanthus septentrionalis H. L. Mason
C	Linnaea borealis L. var. americana (Forbes) Rehder
H	Linum lewisii Pursh
T	Linum micranthum
H	Lithospermum ruderale Dougl.
G	Lomatium dissectum (Nutt.) Math. & Const.
G	Lomatium nudicaule (Pursh) Coult. & Rose
G	Lomatium simplex (Nutt.) J. F. Macbride
G	Lomatium triternatum (Pursh) Coult. & Rose
H	Lotus douglasii Greene
H	Lotus crassifolius (Benth.) Greene
H	Lupinus caudatus Kell.
H	Lupinus lepidus Dougl.
H	Lupinus leucophyllus Dougl.
T	Madia gracilis (Smith) Keck
T	Madia minima (A. Gray) Keck
T	Mentzelia albicaulis Dougl.
H	Microseris nutans (Geyer) Schultz-Bip.
T	Mimulus nanus H. & A.
T	Montia perfoliata (Donn.) Howell var. depressa (Gray) Jeps.
T	Nama densum Lem.
T	Narvarretia breweri (Gray) Greene
G	Orobanche fasciculata Nutt.

Appendix 2 (Continued)

Life Form Symbol	Scientific Names and Authorities
T	Orthocarpus hispidus Benth.
H	Osmorhiza chilensis Hook. & Arn.
H	Osmorhiza obtusa (C. & R.) Fern.
C	Pachistima myrsinites (Pursh) Raf.
H	Paeonia brownii Dougl.
H	Penstemon cinereus Piper
H	Penstemon speciosus Dougl.
H	Phacelia heterophylla Pursh
T	Phacelia linearis (Pursh) Holz.
H	Phacelia mutabilis Greene
H	Phlox diffusa Benth.
T	Phlox gracilis (Hook.) Greene ssp. humilis (Greene) Mas.
P	Pinus contorta Dougl. var. murrayana (Balf.) Engelm.
P	Pinus ponderosa Dougl.
P	Pinus monticola Dougl.
T	Plectritis congesta (Lindl.) DC.
H	Poa secunda Presl
T	Polygonum douglasii Greene
H	Potentilla glandulosa Lindl.
H	Prunella vulgaris L. ssp. lanceolata (Barton) Hulten
P	Prunus emarginata (Dougl.) Walp.
P	Pseudotsuga menziesii (Mirb.) Franco
H	Pteridium aquilinum (L.) Kuhn var. pubescens Underw.
G	Pterospora andromeda Nutt.
P	Purshia tridentata (Pursh) DC.
H	Pyrola aphylla Smith
H	Pyrola chlorantha Smith
H	Pyrola dentata Smith
H	Pyrola picta Smith
H	Ranunculus occidentalis Nutt.
P	Rhamnus purshiana DC.
P	Ribes cereum Dougl.
T	Rigiopappus leptocladus Gray
P	Rosa gymnocarpa Nutt.
T	Rumex acetosella L.
P	Rubus parviflorus Nutt.
C	Rubus vitifolius C. & S.
P	Salix sp.
C	Satureja douglasii (Benth.) Briq.
H	Scutellaria nana Gray

Appendix 2 (Continued)

Life Form Symbol	Scientific Names and Authorities
H	Senecio canus Hook.
H	Senecio integerrimus Nutt.
H	Senecio pseudoaureus Rydb.
H	Silene sp.
H	Sitanion hystrix (Nutt.) Smith - S. hanseni (Scribn.) Smith
H	Smilacina amplexicaulis Nutt.
P	Sorbus sitchensis M. Rhoem.
H	Stephanomeria lactucina A. Gray
H	Stipa occidentalis Thurb. - S. thurberiana Piper - S. elmeri Piper & Brodie
P	Symphoricarpos albus (L.) Blake
P	Tetradymia canescens DC.
P	Tetradymia glabrata A. Gray
H	Townsendia florifer (Hook.) Gray
H	Tragopogon dubius Scop.
H	Trientalis latifolia Hook.
H	Trifolium eriocephalum Nutt.
G	Trillium ovatum Pursh
H	Trisetum canescens Buckl.
P	Tsuga mertensiana (Bong.) Sarg.
H	Verbascum thapsus L.
H	Vicia sp.
H	Viola purpurea Kell.
H	Wyethia amplexicaulis Nutt.
G	Zygadenus paniculatus (Nutt.) S. Wats.

Appendix 3. Related Taxonomic Problems

The quality of synecological interpretation is understandably correlated with the investigator's efforts to make as correct taxonomic differentiations as possible. However, the synecologist is not always able to observe or remeasure individuals in his studies at times when the phenology of all species gives him the maximum number of attributes to use for taxonomic placement. Commonly, flowers or fruits absolutely required for the use of the key to place the individual of some groups at the specific level are not to be found at the particular time the area is analyzed by the ecologist and consequently, vegetative characters must be relied on. Also, the synecologist likes to know the identity of every individual encountered. Thus with the presence of close taxa, not all individuals may have needed fruits or flowers in his sample areas. He is concerned with quantities, after and addition to the initial knowledge he must gain of the floristics of his chosen area. Because of these considered exigencies, the logical and pragmatic approach is to collect vouchers frequently as time permits and variation of the flora requires and request the assistance of competent plant systematists for verification or correction of the worker's field determinations.

However, when certain problems of taxonomic determination arise, it is felt that due explanation of the manner in which they are dealt with should be entailed. These problems involve either single indeterminate species or species groups.

The following text describes the reasons for and dispositions of such difficulties of species groups associated with this particular study. They are listed in alphabetical order as they arise in the list of Appendix 2.

The single indeterminant species consistently lacked characteristics essential for taxonomic placement. There seems to be no real need to list the details of these particular deficiencies, thus they are found in the species list and tables with a generic name followed by

The species groups are found in the tables listed under the binomial of the principal species.

The order of the names in specific groups indicates the estimated order of importance in composition of that grouping over the study area as a whole.

Abies grandis Lindl. - A. concolor Lindl.

In the text and tables this species group is designated by the former latin binomial, for grand fir. However, some of the individuals of this genus in the area studied have morphological features used to key out white fir (Abies concolor). Since the ranges for these two species overlap in the vicinity (112, p. 64), hybridization is likely. Scheplitz (106, p. 73-74) found that F-1 hybrids between grand and white fir had some morphological features of each parent, showing Mendelian ratios in several characters that indicate heterozygosity in the parent stock.

Antennaria geyeri A. Gray - A. rosea Greene - A. argentea Benth.

This group too frequently lacked heads to make consistent differentiation. Differences in pubescence was too variable to employ.

Arnica cordifolia Hook - A. latifolia Hook.

Only very slight amounts of the latter species was present. However, the usual absence of heads and variable leaf development under various degrees of shade made grouping necessary.

Bromus carinatus H. & A. - B. marginatus Nees. - B. polyanthus Scribn.

Since Peck (94, p. 84) lists these taxa as synonyms, this was a much more practical grouping than making splits by length of awns and pubescence of sheaths as done in Hitchcock (74, p. 32).

Castilleja miniata Dougl. - C. hispida Benth.

For this difficult group I can only note that C. hispida was encountered most frequently on the Warm Springs area whereas C. miniata was the predominant paintbrush of the Deschutes transect.

C. Peckianna was expected to be found in the latter area, but no vouchers were noted from the frequent specimens taken.

Festuca dertonesis (All.) A. & G. - *F. octoflora* Walt. - *F. megalura* Nutt.

Since these annual fescues were deemed evidence of disturbance, at least locally in a microserule, the effort was not expended to separate them by number of florets per spiklet and length of glume.

Hieracium albiflorum Hook. - *H. albertinum* Farr. - *H. scouleri* *H. cynoglossoides* Arv. Touv.

The frequent lack of heads encountered and extremely small differences in this apomictic genus (111, p. 236) made use of vegetative features well nie impossible for headless individuals of this very difficult group.

Sitanion hystrix (Nutt.) Smith - *S. hanseni* (Scribn.) Smith

The first species is by far the most frequently encountered of the two. Some of the individuals lacked an inflorescence, thus negating the use of glume characteristics for the needed species identification.

Stipa occidentalis Thurb. - *S. californica* Merr. & Davy - *S. elmeri* Piper & Brodie - *S. thurberiana* Piper.

The very common lack of inflorescences on individuals of these species made for only partial and unreliable differentiation of the total populations of different species. Variation in the stage of maturity of the vegetative portions, seriously handicapped, in the absence of culms, the use of sheaths and ligules.

Special comment is necessary on the nomenclatural disposition of the taxon termed here, *Arctostaphylos parryana* var. *pinetorum* (Rollins) Wiesl. & Schreib. The problem is best described by quoting Hayes and Garrison (71, p. 180)

> L. R. Abrams (*Illustrated Flora of the Pacific States* 3:314. 1951.) and J. E. Adams (A Systematic Study of the Genus *Arctostaphylos* Adans. *Elisha Mitchell Sci. Soc. Jour.* 56:1-62. 1940.) regard both *Arctostaphylos parryana* var. *pinetorum* (Rollins) Wiesl. & Schreib. (1939) and *A. obtusifolia* Piper (1902) as synonyms of *A. patula* Greene (1891). However, for the present at least, it seems preferable to keep the non-sprouting pine manzanita separate from the crown-sprouting greenleaf manzanita (*A. patula*). Recent Forest Service field studies of large patches of manzanita plants (apparently typical *Arctostaphylos obtusifolia*) have proved these plants to be non-sprouting and without burls. Moreover, this material was compared with Cusick's type specimen of *A. obtusifolia* (in the Herbarium of the University of Oregon at Eugene) and both seemed to be identical with the nonsprouting pine manzanita. If indeed *A. pinetorum* Rollins (1937) and *A. obtusifolia* Piper (1902) prove to be synonymous, the latter name (having 35 years' priority) should stand for both. It would not be surprising if further field studies prove that the crown-sprouting greenleaf manzanita is rare (if present at all) in this Oregon area, and that the correct scientific name of the common nonsprouting manzanita there is *A. obtusifolia* Piper.

Clearly, this is a systematic problem deserving intensive study, particularly because of the taxa's variable response to fire and consequent differences in degree of competition with conifer reproduction. The variability appears to be correlated with distribution, which is best defined by the synecological context of the species.

Appendix 4, Part A, Section 1 - Warm Springs Transect

Basis of Order: Stands - geographical east to west; Species - life form, alphabetical

Values given: Trees - Rel. I. V. 4" d.b.h. +; Shrubs - Rel. Freq.; Herbs - Rel. Freq. (all species)

	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Abies grandis											T	T		T	T	0.4
Juniperus occidentalis	38.8	15.0	3.4	2.0	2.3	T		T	T			T	T	T		
Libocedrus decurrens							T	2.5	5.8	4.7	T	5.7	T	0.7	3.7	12.4
Pinus ponderosa	61.2	85.0	96.6	98.0	97.7	100.0	100.0	97.5	94.2	94.2	100.0	93.6	69.4	41.7	43.0	32.8
Pseudotsuga menziesii									T	T	T	0.7	30.6	57.6	53.2	54.5
Amelanchier florida	T	T	T			T	T	2.9				T		3.4		T
Arctostaphylos parryana		T		T	T	T	T	2.9			5.9	3.3	13.6	3.4	10.5	
Ceanothus velutinus									15.4	17.3		1.6	1.7		5.3	6.1
Chrysothamnus nauseosus	13.0	33.3	8.7	5.3	2.7						8.8					
Chrysothamnus viscidiflorus	13.0	T	4.3	5.3												
Haplopappus bloomeri					5.4	2.4	2.9						T			
Holodiscus discolor																T
Pachistima myrsinites														3.4		
Purshia tridentata	69.6	67.7	87.0	89.5	91.9	97.6	97.1	91.4	59.3	82.6	82.4	46.0	18.6	T		3.0
Ribes cereum	T	T														
Rosa gymnocarpa	T							T								
Tetradymia canescens	4.4	T														
Tetradymia glabrata								T		T						
Berberis repens								2.9							5.3	
Ceanothus prostratus									25.9		2.9	49.2	66.1	89.7	78.9	90.9
Antennaria geyeri	0.8	1.2	3.9	3.0	15.5	5.5	8.3	5.8	0.7	3.3	0.4	2.7	5.6			1.2
Chimaphila menziesii																T
Chimaphila umbellata							T		T			3.8			1.9	26.8

Appendix 4, Part A, Section 1 (Cont'd.)

	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Achillea millefolium	5.8	4.3	6.5	6.0	12.9	4.9	2.2	5.8	8.9	5.1	4.5	4.4	13.3	10.1	3.7	
Apocynum pumilum	0.8	0.4	T	0.6		0.6			0.3	0.9	3.6	T	0.5	4.5	20.4	9.3
Arnica cordifolia															3.7	7.0
Balsamorhiza careyana	1.2	15.3	8.8	12.8	12.0	13.5	5.8	6.9	3.7	7.5	9.8	4.4	3.6	9.0	9.3	3.5
Bromus carinatus								T				2.7				
Calamagrostis rubescens												1.4		T		
Carex sp.					0.3							0.5				
Castilleja miniata				0.3	T	T	T	0.3	0.3		1.8	0.5		T		
Chaenactis douglasii						0.6										
Comandra pallida															3.7	3.5
Cynoglossum occidentale																T
Deschampsia elongata								T								
Epilobium angustifloium							T	1.6			0.9		1.5			
Erigeron filifolius	T	1.6	1.0	0.9	2.8	0.9	T	0.5								
Erigeron inornatus												0.5				T
Eriogonum ovalifolium	0.4	0.4	0.8	0.3	2.1							T	0.5			
Eriogonum umbellatum	0.8	0.4	3.9	1.2	7.5	0.3										
Eriophyllum lanatum					T	0.6	0.7			T	0.4		T			
Festuca idahoensis		0.4	1.8	1.2	7.0	1.5	1.8	3.9	0.3			2.2		2.3	3.7	3.5
Fragaria virginiana								T				7.1			7.4	2.3
Geum ciliatum								T								
Gilia aggregata					1.3	T	1.1									
Haplopappus carthamoides								0.8								
Hieracium albiflorum			0.3	0.3	T	3.7	2.0	0.5	5.8	4.7	4.9	5.4	7.7	14.6	9.3	18.6
Lathyrus lanswertii					0.3	T			2.7	14.0	14.7	10.9				
Linum lewisii			0.5	0.9	1.4	1.2	1.4	1.1		0.5	2.2					
Lithospermum ruderale	0.4	0.4	0.3	0.3	0.4	0.6	0.7	0.3	T		0.4					
Lotus douglasii					0.3		3.6	3.9	4.4	1.4	4.5	0.5	0.5	2.3		
Lotus crassifolius							T		0.3		0.9				T	
Lupinus caudatus		0.8	1.3	0.3	2.7	4.6			1.7	0.5		T		3.4	13.0	5.8
Lupinus leucophyllus		T	0.3	1.2	0.7	0.6	3.6		1.7		0.9					

Appendix 4, Part A, Section 1 (Cont'd.)

	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Microseris nutans								T								
Osmorhiza obtusa								T						T		
Paeonia brownii	0.4	T	T			0.6	T	0.3		1.4	0.4	T				T
Phacelia heterophylla	T				T											
Poa secunda	4.3	5.5	7.0	6.0	1.4	1.5		0.3	0.3	1.4			1.5			
Potentilla glandulosa								T								
Prunella vulgaris							T									
Pyrola chlorantha												T			7.4	
Ranunculus occidentalis								0.3								
Senecio pseudoaureus								T	T	T	T	1.1	T		T	1.2
Scutellaria nana	T															
Sitanion hystrix	5.8	4.3	5.7	5.4	2.7	0.3	2.2	2.6	3.1	6.1	4.5		1.5	2.3		
Stipa occidentalis	0.4	2.4	1.6		4.4	4.0	9.1	2.9	5.8	2.8	5.4	4.9	3.6	4.5		1.2
Townsendia florifer		T														
Tragopogon dubius		T	0.5	T		0.6	0.4	1.3	0.7							
Trifolium eriocephalum	4.3	0.4		0.6	0.3		T	8.2								
Vicia sp.										0.5	1.3	2.2				
Wyethia amplexicaulis								0.5								
Agoseris glauca	1.2	T	0.5	0.3	0.4	0.9	0.4	0.8		0.5			0.5			
Agoseris retrorsa	0.4	T	0.5	T	1.3	0.9	T	0.5	0.7		0.9			1.1		
Calochortus elegans						T	T									
Erythronium sp.						T		T				0.5	T			1.2
Fritillaria atropurpurea						T										
Habenaria hyperborea							T	0.5	T	0.9		T	0.5	1.1	T	1.2
Habenaria unalaschensis						T										
Lomatium nudicaule	1.6		1.3					5.5								
Lomatium triternatum	0.4	3.5	3.9	7.2	16.0	8.6	8.7	3.7	9.5	6.1	4.9	14.7	8.2	4.5	5.6	1.2
Pterospora andromeda		T					T		T	T		T		T	T	T
Zygadenus paniculatus	T	1.2	2.3			0.3	T	2.9					T			

Appendix 4, Part A, Section 1 (Cont'd.)

	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Amsinckia retrorsa	T															
Blepharipappus scaber	2.8	2.0	1.3		1.0											
Bromus racemosus	2.8		0.8													
Bromus tectorum	17.8	20.0	6.5	1.5	3.8	T										
Clarkia rhomboidea		1.2	2.6	2.4	4.0	5.5	10.5	3.4	10.9	10.7	9.4	6.0	15.8	12.4	1.9	1.2
Collomia grandiflora	10.5	9.4	7.7	10.7	20.2	10.5	12.6	5.3	15.0	11.6	11.2	7.6	13.3	14.6	3.7	2.3
Collinsia parviflora		0.4	2.1	1.2	5.5	2.5	3.3	3.7	7.1	9.3	6.7	10.3	9.7	7.9	1.9	5.8
Convolvulus polymorphus	T															
Deschampsia danthonioides								T								
Epilobium paniculatum	5.1	3.9	7.0	7.2	7.7	3.4	4.3	5.8	2.4	1.9						
Erodium cicutarium	0.4															
Festuca dertonensis	12.8	14.9	10.1	16.1	39.6	15.1	8.3	10.0	7.8	2.3	2.7		4.1			
Hordeum depressum	1.9															
Lagophylla ramisissima	4.3	2.0	1.8	0.9												
Linum micranthum				0.9	0.8	1.2	0.4	2.0	1.0	1.4			2.6			
Madia gracilis	8.6	3.9	6.7	7.7	5.1	2.8	8.0	7.1	0.3				2.1	2.3		
Montia perfoliata			0.3	T		0.3	0.7	0.3	1.7	1.9	2.7	0.5	1.0	1.1		
Narvarretia breweri	0.4		0.3													
Orthocarpus hispidus								2.6	1.4							
Phlox gracilis						1.5	0.8	1.1		3.7		4.9	2.6	2.3	3.7	3.5
Polygonum douglasii	3.5	T	0.3		0.3											
Rigiopappus leptocladus	T	T	0.5	T												

Appendix 4, Part A, Section 2 - Warm Springs Transect

Basis of Order: Stands - geographical, east to west; Species - Life Form sociological

Values Given: Trees - Rel. I.V. 1" d.b.h.+; Shrubs - Rel. D.F.; Herbs - Rel. D.F. (all species)

	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Pinus ponderosa	59.2	82.4	93.9	97.9	97.7	99.7	99.4	93.9	85.9	76.1	98.1	84.3	74.7	42.7	29.4	21.3
Juniperus occidentalis	40.8	17.6	6.1	2.1	2.3	0.3		1.9	T			0.1	0.3	T		
Libocedrus decurrens							0.6	4.3	14.1	23.7	1.4	13.9	3.3	4.7	9.7	14.4
Pseudotsuga menziesii										0.2	0.3	1.6	21.7	52.4	61.1	64.2
Abies grandis											0.3	0.1		T	0.4	0.1
Purshia tridentata	69.6	63.9	87.9	88.5	92.8	98.3	97.9	90.8	62.5	81.3	85.4	47.2	16.0	T		2.5
Arctostaphylos parryana		T		T	T	T	T	2.4	T	T	4.9	2.8	11.1	2.8	12.7	
Amelanchier florida	T	T	T			T	T	2.4	T			T		2.8		T
Ceanothus velutinus									14.8	18.7	T	1.4	1.3	T	4.5	4.5
Chrysothamnus nauseosus	13.0	36.1	8.0	4.7	2.4						7.3					
Chrysothamnus viscidiflorus	13.0	T	4.0	6.8												
Haplopappus bloomeri					4.8	1.7	2.1									
Tetradymia canescens	4.3	T														
Rosa gymnacarpa	T							T								
Ribes cereum	T	T														
Tetradymia glabrata								T		T		T				
Pachistima myrsinites														2.8		
Holodiscus discolor																T
Ceanothus prostratus									23.0		2.4	48.7	71.6	91.7	78.4	92.6
Berberis repens								4.4							4.5	
Antennaria geyeri	0.5	0.8	4.4	2.2	7.8	5.6	9.3	6.7	0.6	3.0	0.8	2.3	5.0			1.3
Chimaphila umbellata							T		T			5.2			4.2	36.7
Chimaphila menziesii																T

Appendix 4, Part A, Section 2 (Cont'd.)

	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Achillea millefolium	3.6	3.4	5.8	5.8	6.5	4.1	1.6	4.6	9.5	6.1	4.0	4.2	13.6	12.2	3.1	T
Balsamorhiza careyana	0.6	10.9	6.5	9.9	6.0	12.2	4.9	5.5	3.3	6.2	7.9	3.2	2.4	7.5	7.9	2.5
Stipa occidentalis	0.3	1.4	0.9	T	3.3	3.5	7.3	2.0	4.6	2.3	4.7	3.8	2.8	4.7		1.5
Apocynum pumilum	0.5	0.3	T	0.5		0.4			0.3	0.7	2.4	T	0.4	3.3	10.9	7.0
Sitanion hystrix	3.4	2.7	3.7	3.8	2.0	0.2	2.0	2.1	2.0	5.1	4.5	1.1		1.6		
Festuca idahoensis		0.3	1.6	0.8	3.5	1.1	1.4	3.2	0.2			2.4		1.6	3.1	2.7
Hieracium albiflorum			0.2	0.2	T	2.8	1.0	0.4	4.5	4.0	4.3	5.2	6.6	14.2	8.7	18.2
Lupinus caudatus		0.5	2.0	0.6	7.8	3.3			1.0	0.3		T		3.4	11.4	4.7
Poa secunda	3.2	4.4	6.0	4.5	1.1	1.1	0.2	0.3	1.1				1.1			
Lithospermum ruderale	0.2	0.3	1.6	0.2	0.2	0.4	0.5	0.2	T		0.3					
Lotus douglasii					0.3		3.9	3.1	3.7	1.3	3.6	0.5	0.5	1.9		
Lupinus leucophyllus		T	0.2	0.9	0.5	0.4	2.5		2.3		0.6					
Linum lewisii			0.4	0.6	1.2	0.8	1.1	0.7		0.3	1.5					
Paeonia brownii	0.2	T	T			0.4	T	0.2	0.5	1.0	0.3	T				
Lathyrus lanswertii					0.3	T			3.4	16.3	16.0	11.4				
Tragopogon dubius		T	0.4	T	0.4		0.4	0.9	0.5							
Trifolium eriocephalum	3.7	0.3		0.4	0.5		T	9.7								
Castilleja miniata				0.2	T	T	T	0.2	0.3		1.6	0.5		T		
Eriogonum ovalifolium	0.1	0.3	0.9	0.2	1.1							T	0.5			
Eriogonum umbellatum	1.6	0.3	2.5	0.9	3.8	0.3										
Erigeron filifolius	T	1.0	0.8	0.6	1.4	0.8	T	0.5								
Eriophyllum lanatum					T	0.4	0.5			T	0.4		T			
Epilobium angustiflolium							T	1.6			0.6		1.9			
Vicia sp.										0.3	1.0	2.2				
Fragaria virginiana								T				10.7			12.2	2.1
Senecio pseudoaureus								T	T	T	T	0.7	T		T	0.8
Carex sp.				0.2	T	T	T	0.2	0.3		1.6	0.5		T		
Gilia aggregata					0.7	T	0.8									
Lotus crassifolius							T		0.2		0.6					
Arnica cordifolia															6.4	5.3

Appendix 4, Part A, Section 2 (Cont'd.)

	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Comandra pallida															3.1	2.5
Pyrola chlorantha												T			5.3	
Chaenactis douglasii						0.4										
Haplopappus carthamoides								0.6								
Ranunculus occidentalis								0.3								
Wyethia amplexicaulis								0.4								
Bromus carinatus								T				2.0				
Erigeron inornatus												0.9				
Calamagrostis rubescens												0.9		T		
Osmorhiza obtusa								T						T		
Phacelia heterophylla	T				T											
Cynoglossum occidentale																T
Geum ciliatum								T								
Deschampsia elongata								T								
Microseris nutans								T								
Potentilla glandulosa								T								
Prunella vulgaria							T									
Scutellaria nana	T															
Townsendia florifer		T														
Lomatium triternatum	0.4	2.3	2.3	5.3	8.0	6.9	7.1	3.7	8.8	5.5	4.3	12.9	6.7	4.0	4.0	0.8
Agoseris glauca	0.6	T	0.4	0.2	0.2	0.6	0.3	0.7		0.3			0.5			
Agoseris retrorsa	0.2	T	0.3	T	0.7	0.6	T	0.4	0.5		0.6			0.8		
Haberaria hyperborea							T	0.4	T	0.7		T	0.5	0.8	T	0.8
Zygadenus paniculatus	T	0.8	1.6			0.2	T	2.1					T			
Erythronium sp.						T		T	0.5			0.4	T			0.8
Lomatium nudicaule	1.0		2.2					5.0								
Pterospora andromeda		T					T		T	T		T		T	T	T
Calochortus elegans						T	T									
Fritillaria atropurpurea						T										
Habenaria unalaschensis						T										

Appendix 4, Part A, Section 2 (Cont'd.)

	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Collomia grandiflora	6.5	6.6	6.1	8.9	10.1	10.0	13.3	4.1	15.2	10.6	9.7	7.3	14.6	12.7	2.7	2.6
Collinsia parviflora		0.3	2.1	1.2	2.8	2.4	3.3	3.0	7.2	10.0	7.5	11.4	10.9	12.5	3.4	5.7
Clarkia rhomboidea		0.8	2.0	2.3	2.0	5.0	11.4	3.3	10.6	11.9	7.1	5.1	17.9	13.1	4.2	
Festuca dertonensis	9.4	41.5	16.4	27.8	19.8	26.7	14.1	17.2	15.6	4.6	14.1		6.1			
Madia gracilis	9.8	4.7	10.5	12.4	7.3	3.8	8.6	7.8	0.4				2.3	3.4		
Epilobium paniculatum	3.3	2.3	5.4	5.5	3.9	2.9	3.7	4.8	2.0	1.7						
Montia perfoliata			0.2	T		0.3	1.0	0.2	1.6	2.0	2.3	0.4	0.9	0.8		
Phlox gracilis						1.4	0.7	1.2	1.1	3.9		6.7	1.9	1.6	3.9	2.9
Linum micranthus			0.8		0.4	1.3	0.3	1.7	0.7	1.5			2.5			
Bromus tectorum	28.8	30.1	12.3	1.9	T											
Lagophylla ramisissima	3.0	1.6	1.5	0.6												
Polygonum douglasii	2.3	T	0.2		0.2											
Blepharipappus scaber	2.3	1.5	1.5		1.0											
Bromus racemosus	2.5		1.1													
Orthocarpus hispidus								3.5								
Hordeum depressum	1.3															
Narvarretia breweri	0.3															
Erodium cicutarium	0.2															
Rigiopappus leptocladus	T	T		T												
Deschampsia danthonioides								T								
Convolvulus polymorphus	T															
Amsinckia retrorsa	T															

Appendix 4, Part A, Section 3 - Warm Springs Transect

Basis of Order: Stands - geographical, east to west; Understory Species - Life Form, sociological;

Values Given: Shrubs - Rel. I.V., Herbs - Rel. D.F., perennial species (except geophytes)

Species	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Purshia tridentata	64.3	72.7	91.9	92.3	95.2	97.5	98.3	93.9	50.3	72.7	79.5	39.4	14.0	T		1.7
Arctostaphylos parryana		T		T	T	T	T	1.3	1.1	1.2	5.7	3.9	17.7	5.9	13.3	
Amelanchier florida	T	T	T			T	T	1.3	T			T		1.8		T
Ceanothus velutinus									26.0	25.7	7.4	3.9	0.9	0.7	11.1	10.0
Chrysothamnus nauseosus	16.8	27.3	5.4	3.1	1.6						4.9					
Chrysothamnus viscidiflorus	14.4		2.7	4.5												
Haplopappus bloomeri					3.2	2.5	1.7						T			
Tetradymia canescens	4.5		T													
Rosa gymnocarpa	T							T								
Ribes cereum	T		T													
Tetradymia glabrata								T		T		T				
Pachistima myrsinites														1.8		
Holodiscus discolor																T
Ceanothus prostratus									22.8		2.6	52.8	67.4	89.7	72.6	88.4
Berberis repens								2.6							3.0	
Antennaria geyeri	1.8	3.0	14.0	6.6	19.3	15.3	26.2	16.3	1.6	6.2	0.5	4.0	14.3			1.5
Chimaphila umbellata							T		T			9.2			5.1	42.7
Chimaphila menziesii																T
Achillea millefolium	15.4	13.9	17.7	18.8	16.1	10.6	4.1	10.6	28.1	12.9	6.8	7.2	39.2	22.2	3.7	T
Balsamorhiza careyana	2.6	41.3	18.6	29.8	14.4	32.8	13.4	12.8	8.9	12.8	13.3	5.6	6.5	13.2	9.6	2.9
Stipa occidentalis	1.3	4.6	2.4	T	7.5	9.1	19.6	4.6	12.3	4.8	8.0	6.8	7.6	8.5		1.8
Apocynum pumilum	1.6	0.8	T	1.4		0.9			0.7	0.8	4.0	T	0.9	5.7	20.7	8.2
Sitanion hystrix	13.3	8.9	9.9	11.1	4.7	0.5	5.6	4.9	5.1	10.5	7.7		3.1	2.8		
Festuca idahoensis		0.8	4.7	1.9	8.3	2.7	3.7	7.4	0.6			4.2		2.9	3.7	3.2
Hieracium albiflorum			0.6	0.7	T	6.9	2.6	0.8	12.1	8.4	7.2	9.0	18.6	25.5	10.6	21.3
Lupinus caudatus		1.6	2.0	5.7	3.9	8.3			3.3	0.7		T		6.2	13.8	5.3

Appendix 4, Part A, Section 3 (Cont'd.)

Species	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Poa secunda	16.1	18.4	15.9	13.5	2.5	2.6		0.4	0.7	2.3			3.1			
Lithospermum ruderale	0.8	0.8	0.4	0.7	0.5	0.9	1.2	0.4	T		0.5					
Lotus douglasii					0.8		10.8	7.0	10.2	2.7	6.1	0.8	1.2	3.3		
Lupinus leucophyllus		T	0.6	2.4	1.2	0.9	6.3		3.4		0.9					
Linum lewisii			0.9	1.8	2.8	2.0	2.9	1.5		0.7	2.5	0.8				
Paeonia brownii	0.8	T	T			0.9	T	0.4	1.1	2.0	0.5	T				
Lathyrus lanswertii					0.6	T			9.8	34.4	27.9	20.2				
Tragopogon dubius		T	1.0	T		0.9	1.0	2.1	1.1							
Trifolium eriocephalum	20.9	0.8		1.2	1.1		T	23.3								
Castilleja miniata				0.5	T	T	T	0.4	0.7		2.6	0.8		T		
Eriogonum ovalifolium	2.0	0.8	2.8	0.5	2.5							T	0.9			
Eriogonum umbellatum	23.6	1.0	6.7	2.5	8.7	0.6										
Erigeron filifolius	T	3.6	2.1	1.6	3.4	2.2	T	1.2								
Eriophyllum lanatum					T	0.9	1.2			T	0.6		T			
Epilobium angustiflolium							T	3.8			0.9		5.5			
Vicia sp.										0.7	1.5	3.8				
Fragaria virginiana								T				19.0			15.0	2.5
Senecio pseudoaureus								T	T	T	T	1.3	T		T	1.0
Carex sp.					0.8							0.7				
Gilia aggregata					1.6	T	2.0									
Lotus crassifolius							T		0.6		0.9				T	
Arnica cordifolia															7.7	6.0
Comandra pallida															3.7	6.6
Pyrola chlorantha												T			6.5	
Chaenactis douglasii						0.9										
Haplopappus carthamoides								1.4								
Ranunculus occidentalis								0.4								
Wyethia amplexicaulis								1.0								
Bromus carinatus								T				3.6				

Appendix 4, Part A, Section 3 (Cont'd.)

Species	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Erigeron inornatus												1.5				
Calamagrostis rubescens												1.9		T		
Osmorhiza obtusa								T						T		
Phacelia heterophylla	T				T											
Cynoglossum occidentale																T
Geum ciliatum								T								
Deschampsia elongata								T								
Microseris nutans								T								
Potentilla glandulosa								T								
Prunella vulgaris								T								
Scutellaria nana	T															
Townsendia florifer		T														

Appendix 4, Part A, Section 4 - Warm Springs Transect
Non-phanerophytic Life Form Spectra weighted by Rel. D.F.'s of constituent species
Stand Order - geographical, east to west

Life Form	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Chamaephytes	0.4	1.4	4.4	3.8	7.8	5.6	9.3	6.6	1.2	3.0	0.8	7.5	5.0	T	4.2	37.8
Hemicryptophytes	20.6	44.9	30.1	31.4	34.1	32.7	27.6	35.4	36.2	44.7	58.1	48.8	30.2	50.0	77.9	47.6
Geophytes	2.9	4.9	6.1	5.5	8.9	8.3	7.4	12.0	10.7	6.5	0.6	13.2	7.5	5.6	4.0	1.6
Therophytes	76.3	48.9	60.4	61.0	49.2	53.4	55.9	46.0	54.9	46.0	40.6	30.6	57.3	44.1	14.0	13.0

Non-phanerophytic Life Form Spectra

Percentage of Total Species at Each Stand Within Life Form Categories

	P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Chamaephytes	3.6	4.0	2.9	3.6	3.1	3.1	4.0	2.8	3.4	4.0	4.0	8.0	4.5	T	6.3	12.5
Hemicryptophytes	39.3	52.8	42.9	57.1	56.3	56.3	52.0	52.8	55.2	52.0	72.0	64.0	45.5	50.0	62.5	50.0
Geophytes	14.3	8.0	14.3	7.1	9.4	12.5	8.0	12.6	10.3	12.0	4.0	8.0	13.6	17.0	6.3	12.5
Therophytes	42.9	36.0	40.0	32.1	31.3	28.1	36.0	27.8	31.0	32.0	20.0	20.0	36.4	33.0	25.0	25.0

Appendix 4, Part B, Section 1 - Deschutes Transect

Basis of Order: Stands - legal position, east to west; Species - life form, alphabetical;

Values Given: Trees - Rel. I.V. 4" d.b.h. +; Shrubs - Rel. Freq; Herbs - Rel. Freq. (all species)

Species	P-D-1	P-D-5	P-D-2	P-D-4	P-D-8	P-D-3	P-D-6	P-D-17	P-D-9	P-D-16	P-D-10	P-D-15	P-D-11	P-D-18	P-D-7	P-D-12
Juniperus occidentalis	35.1	52.3	38.7	18.8	6.9	6.8	16.3	1.5	1.3	2.5	1.9	0.4	0.7	T	T	T
Pinus ponderosa	64.9	47.7	61.3	81.2	93.1	93.2	83.7	98.5	98.7	97.5	98.1	99.6	99.3	100.0	100.0	100.0
~~Arctostaphylos parryana~~													T		6.6	13.9
Artemisia tridentata	69.8	26.3	42.3	7.5												
Ceanothus velutinus													T			
Chrysothamnus nauseosus		T														
Chrysothamnus viscidiflorus	5.7	T	7.7	20.0	1.7	28.6	18.8	26.9	15.2	8.7	22.9	18.8	6.3	9.6	1.6	4.7
Haplopappus bloomeri		T							T			T		3.8		T
Holodiscus glabrescens													T			
Purshia tridentata	24.5	73.7	50.0	72.5	98.3	71.4	81.2	73.1	84.8	91.3	77.1	81.2	93.7	86.5	91.8	81.4
Ribes cereum	T	T		T												
Antennaria geyeri									T		0.6		0.6	2.2		0.5
Achillea millefolium	0.7	T		3.2		0.5	1.4	5.2	2.7	4.5	6.2	7.9	10.0	8.5	6.4	7.4
Agropyron spicatum	T	1.5	T		T		T									
Antennaria dimorpha	0.2	T														
Arabis holboellii	0.2	T	1.5	0.3		T										
Aster canescens						T		T		1.2		2.9		1.0		2.3
Astragalus sp.	0.2															
Carex sp.	2.7	1.9	8.8	3.4	4.4	5.5	8.1	5.9	6.0	7.5	3.0	3.1	3.6	4.5	2.8	3.8
Castilleja miniata											0.3	0.8	T	0.7	0.4	0.3
Chaenactis douglasii										0.6		0.3			0.4	
Erigeron filifolius	0.7	1.2	T													
Eriogonum umbellatum	1.0	1.2		2.7	0.4		1.0	1.3	1.7	4.8	2.7	2.4	1.9	6.0	0.8	2.3
Eriophyllum lanatum	0.5	1.2		2.4		T	0.3	1.0	1.3	3.9	2.7	6.3	1.9	0.7	2.4	0.5
Erysimum sp.	0.2	0.4	T													
Festuca idahoensis	14.7	18.5	3.1	6.1	8.0	20.5	12.8	11.4	22.1	7.8	12.2	0.3	15.5	10.0	5.2	14.0
Kelloggia galioides														0.2	0.4	2.3
Koeleria cristata	5.3	3.8	1.5	0.8	0.4	2.5	0.3									
Lathyrus lanswertii				T	0.7	8.5	4.7	9.8		0.3	7.4	6.3	4.5	3.7	14.4	7.6
Leptodactylon pungens	0.5	1.2	0.4	0.5												

Appendix 4, Part B, Section 1 (Cont'd.)

Species	P-D-1	P-D-5	P-D-2	P-D-4	P-D-8	P-D-3	P-D-6	P-D-17	P-D-9	P-D-16	P-D-10	P-D-15	P-D-11	P-D-18	P-D-7	P-D-12
Linum lewisii				T	T		T	0.7	T	0.3	0.3	1.3	T	2.0	T	0.3
Lithospermum ruderale		0.4							T		0.6	0.3		0.2		T
Lotus douglasii													0.6			0.3
Lupinus caudatus		0.4			T				9.1	1.2	T				0.8	
Lupinus lepidus	1.0															
Penstemon cinereus	0.2	T	0.8	8.5	4.7	3.0	2.0	1.6		8.7	7.1	6.8	1.3	1.5	10.4	2.5
Penstemon speciosus												0.5				
Phacelia mutabilis	1.7	T	1.9	T		T	0.7	0.3	0.3	0.3	0.6	0.3		1.0	0.8	0.3
Poa secunda	6.8	6.9	6.1	1.3	0.7	1.5	1.7				0.6		1.0		0.8	
Senecio canus	1.2	1.2		1.9				0.7	0.3	2.1	T				1.6	
Scutellaria nana			0.8				T			0.6		0.5		0.7	2.0	
Silene sp.	0.2		1.5													
Sitanion hystrix	4.1	6.2	5.7	5.6	9.5	11.5	5.1	6.5		7.5	7.7	7.9	1.9	6.7	11.2	6.9
Stephanomeria lactucina								1.0	1.7	T	T		6.0			
Stipa occidentalis	6.8	9.6	6.9	10.6	16.4	19.5	10.5	14.0		10.5	11.9	12.3	6.1	8.7	12.8	8.1
Townsendia florifer			T	0.8	T	T	0.7	T	0.3	0.3	0.3	T	0.3	T	0.4	
Tragopogon dubius								T								
Viola purpurea			1.9	4.0	1.8	10.5	3.4	9.1		7.5	2.4	5.8	1.3	1.2	6.8	1.5
Agoseris glauca	0.7	T														
Calochortus macrocarpus		T														
Delphinium nuttallianum	0.2	T					0.3		0.3	0.3						
Fritillaria atropurpurea			T						0.3							
Leucocrinum montanum	0.5		9.5	7.2	1.5	T	1.5	1.2	0.3	3.3	0.3	0.8			3.2	
Lomatium dissectum	0.5	0.4														
Lomatium simplex		0.2							0.3							
Lomatium triternatum														0.2		0.3
Orobanche fasciculata												0.3				
Pterospora andromeda											T		T			T

Appendix 4, Part B, Section 1 (Cont'd.)

Species	P-D-1	P-D-5	P-D-2	P-D-4	P-D-8	P-D-3	P-D-6	P-D-17	P-D-9	P-D-16	P-D-10	P-D-15	P-D-11	P-D-18	P-D-7	P-D-12
Bromus tectorum	1.2	10.8	5.7	5.6	1.1	0.5	4.1	0.7	2.0	0.9	3.0		2.3	T		1.0
Clarkia rhomboidea									T	1.2	0.9	5.2	10.4	5.5	1.2	4.6
Collomia grandiflora		0.8					0.7	1.3	1.0	10.5	5.0	10.5	11.3	9.2	8.0	0.5
Collinsia parviflora	1.0	0.4	1.5	1.3	0.4	1.5	1.0	1.0	2.7	1.8	3.9	1.8	6.1	4.2		5.6
Cryptantha ambigua	3.6	8.1	11.8	2.4	5.1	1.5	3.0	1.0	2.3		0.9	1.0	1.0	1.2		1.5
Cryptantha circumscissa	0.7	0.8	0.4		1.1	0.3		0.3	0.3		0.6					
Draba verna			T													
Epilobium minutum	0.7	0.8	1.1	1.5			2.0		0.7		T				0.4	
Epilobium paniculatum								T						T		
Eriogonum baileyi	1.0	T	1.1	1.1												
Euphorbia serpyllifolia						T										
Festuca dertonensis			0.8						0.3		T					
Gayophytum lasiospermum	0.2															
Gayophytum nattallii	3.9	8.5	8.0	7.7	14.6	5.5	9.1	9.4	4.7	5.1	6.8	7.1	7.4	2.0	3.6	9.6
Linanthus septentrionalis		T														
Madia minima	0.2	8.5	4.2	10.3	12.8	3.0	14.2	5.9	8.1	2.7	9.8	4.2	8.1	8.5	2.4	12.4
Mentzelia albicaulis	0.2	T	T	0.3					0.3							
Mimulus nanus	6.8	4.2	8.4	9.3	13.1	3.5	7.4	8.1	1.3	4.2	1.2	2.9	0.3			0.3
Nama densum		0.4		0.3	1.1											
Phacelia linearis		T														
Phlox gracilis	0.7	0.8	2.3	1.9	0.7	4.5	3.0	0.7	2.3	0.6	1.2		1.0	1.2	0.4	2.0
Plectritis congesta	0.7		T	0.5		1.5										
Polygonum douglasii													1.3	2.0		1.0

Appendix 4, Part B, Section 1 (Cont'd.)

Species	P-D-19	P-D-13	P-D-20	P-D-21	P-D-14	P-D-22	P-D-23	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-30	P-D-37	P-D-31
Abies grandis				0.7			T	T		T	T	T	T	2.2	9.9	2.6
Juniperus occidentalis	3.6	1.1	0.8	1.4	T	T	T		T		T		T		T	
Libocedrus decurrens				T		3.8	0.7							T		T
Pinus contorta							T		T	T	T			T		
Pinus monticola															T	T
Pinus ponderosa	96.4	98.9	99.2	97.9	100.0	96.2	99.3	100.0	100.0	100.0	100.0	100.0	100.0	97.3	90.3	96.4
Pseudotsuga menziesii											T			0.6	T	1.0
Amelanchier florida			T			T	T							T		
Arctostaphylos parryana	8.3	T	10.3	16.9	14.1	3.6	11.1	11.7	38.5	7.7	T	12.2	T	14.3	9.1	T
Castanopsis chrysophylla														T		7.2
Ceanothus velutinus				12.3		21.4	44.4	T	61.5	92.3	22.9	14.3	T	57.1	72.7	50.0
Chrysothamnus viscidiflorus	T	3.4	T	T	1.4		T				2.9		2.0			
Haplopappus bloomeri	1.7	T	1.7	T	2.8		T		T		2.9	2.0	T	25.7	T	21.4
Prunus emarginata														T		21.4
Purshia tridentata	90.0	96.6	87.9	70.8	81.7	75.0	44.4	88.3			71.4	71.4	98.0	T		
Rhamnus purshiana				T												
Rosa gymnocarpa							T				T				9.1	
Sorbus sitchensis															9.1	
Symphoricarpos albus															T	T
Arctostaphylos nevadensis														2.9	T	
Antennaria geyeri	2.0	T	0.7	0.3	1.1	0.4	T	0.7			1.3		1.3	0.4	0.3	0.8
Chimaphila umbellata											1.3			0.4	1.3	0.4
Archillea millefolium	10.1	10.5	5.4	1.7	11.9								10.2	3.6	3.8	7.7
Apocynum pumilum				0.3			3.0				2.3			5.8		
Aquilegia formosa															T	
Arabis holboellii		0.3														
Aster canescens	1.7	0.3		0.3												
Balsamorhiza careyana			0.7											0.4		
Bromus carinatus							0.4		T	T	T				0.9	

Appendix 4, Part B, Section 1 (Cont'd.)

Species	P-D-19	P-D-13	P-D-20	P-D-21	P-D-14	P-D-22	P-D-23	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-30	P-D-37	P-D-31
Bromus orcuttianus														T		
Calamagrostis rubescens															6.0	
Carex sp.	3.2	4.1	0.5	2.1	6.8			6.8								
Carex inops				6.3		3.4	7.8		5.0	2.4	9.9	22.5	4.7	6.3	8.8	2.8
Castilleja miniata	1.7	0.9	T		T			T								
Cirsium centaurea								2.0							0.9	
Comandra pallida				2.8		3.8	T	2.0	0.7	5.8		2.3			1.3	0.8
Cynoglossum occidentale				T		1.1	0.4			5.8				9.0	T	0.4
Elymus glaucus															0.3	
Epilobium angustifloium							0.4				1.3			7.2	1.6	6.5
Erigeron peregrinus															4.4	
Eriogonum umbellatum	T	2.0			1.4							T				1.2
Eriophyllum lanatum		0.3		0.3	0.7								T			
Festuca idahoensis	14.1	15.7	11.3	17.4	13.3	6.5	6.9	34.5		2.4	16.6	1.7	23.7		16.7	0.8
Fragaria virginiana				1.0			4.8				10.9			14.8	11.7	12.9
Gilia aggregata			T													
Hieracium albiflorum	3.4	0.6	0.7	8.3	4.3	0.8	0.4			1.0				5.4	9.5	10.9
Horkelia fusca													0.4			
Kelloggia galioides	2.9	1.2	2.0	17.4	2.5	13.4	19.0	0.7	15.6	26.0	8.3	14.5	T	15.2	1.9	13.3
Lathyrus lanswertii	12.4	6.7	9.3	6.9	12.6	16.5	13.9	12.8	13.5	2.9	18.3	16.8	13.6	2.2	11.0	7.7
Linum lewisii	0.3	0.3			T											
Lithospermum ruderale	0.3	T			0.4	0.4	T	T	T			0.6	T	0.4	T	0.4
Lotus douglasii					3.6											
Lotus crassifolius											0.4					
Lupinus caudatus		T	6.6	0.7												
Lupinus lepidus								1.4					0.8		3.5	
Paeonia brownii	0.3	1.2	0.5	0.7		0.4	0.4		T			T	T			
Penstemon cinereus	3.2	0.2		1.4	0.4	T	1.3		T					0.4		
Penstemon speciosus	0.6	0.2		0.7	0.4	T	0.4					2.3				
Phacelia mutabilis	0.6	T			T		T						T			0.8
Pteridium aquilinum							6.9		37.6	13.9	T			T		5.2

Appendix 4, Part B, Section 1 (Cont'd.)

Species	P-D-19	P-D-13	P-D-20	P-D-21	P-D-14	P-D-22	P-D-23	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-30	P-D-37	P-D-31
Pyrola aphylla											T	T				
Pyrola dentata														1.3		2.4
Senecio canus													0.4			
Senecio integerrimus		4.1	0.7													
Scutellaria nana	0.3			2.1		0.4										
Sitanion hystrix	6.0	2.6	7.8	7.6	10.1	15.3	12.6	3.4	7.1	16.8	18.3	15.0	14.8	6.3	2.5	4.8
Stephanomeria lactucina	4.9		2.5	4.2		3.4	1.7	T	0.7	5.3	T	1.7		5.4		3.6
Stipa occidentalis	8.3	10.2	8.8	9.7	9.0	11.5	16.5	31.8	19.9	17.8	7.4	19.1	25.0	14.3	11.0	12.5
Trientalis latifolia															T	
Trisetum canescens															1.9	
Viola purpurea	1.7	0.9	1.0	0.7	0.7	1.1	1.3	0.7			0.4	1.2	3.0	T	0.6	0.8
Agoseris glauca			1.0										T			
Agoseris retrorsa			0.2													
Fritillaria atropurpurea		T														
Lilium washingtonianum																T
Lomatium simplex	0.9	T	2.0	0.7										0.4	T	0.4
Pterospora andromeda		T		T	16.1			T		T	T	T	T		T	T
Apera spica-venti			0.2													
Bromus tectorum	1.1		0.5													
Clarkia rhomboidea	3.7	9.0	9.3	2.4	5.0	1.1					T					1.2
Collomia grandiflora	5.2	0.9	3.7		2.2											0.4
Collinsia parviflora	1.1	5.2	6.4		0.4	0.4							0.4			
Cryptantha ambigua	0.3	2.0	1.2		T											
Epilobium paniculatum	2.3		1.2	0.7							T					
Festuca dertonensis			0.2													
Gayophytum nuttallii	2.9	7.0	5.9	1.7	10.1	3.1		3.4			0.9	T	1.3	0.4		1.2
Madia minima	4.0	9.9	5.9	1.0	2.9	0.8							0.4			
Montia perfoliata			0.5													
Phlox gracilis		0.3	2.7													
Plectritis congesta		1.2														
Polygonum douglasii	0.6	2.0	0.5		0.4											
Rumex acetosella																T

Appendix 4, Part B, Section 1 (Cont'd.)

Species	P-D-32	P-D-38	P-D-33	P-D-36	P-D-39	P-D-35	P-D-34	P-D-40
Abies grandis	6.0	36.7	11.7	3.0	37.1	45.5	55.7	70.8
Juniperus occidentalis	T				T			
Libocedrus decurrens		T	0.6	1.2		3.4	T	
Pinus contorta	T							
Pinus monticola	T		T			T	T	T
Pinus ponderosa	88.5	63.3	59.9	54.5	62.9	17.0	23.5	29.2
Pseudotsuga menziesii	5.4		27.7	34.3	T	34.1	20.8	
Tsuga mertensiana								T
Acer circinatum							T	
Amelanchier florida	T		T	T	13.3		T	
Arctostaphylos parryana		T			T			
Castanopsis chrysophylla	7.4		25.4	T		13.3	25.7	T
Ceanothus velutinus	70.4	44.4	9.5	59.1	66.7			
Corylus cornuta						13.3	1.4	
Haplopappus bloomeri	T	44.4			6.7			
Holodiscus discolor				T			1.4	
Pachistima myrsinites	3.7						4.3	
Prunus emarginata	18.5	11.1	1.6	2.3	13.3		2.9	T
Rhamnus purshiana			T		T		T	T
Rosa gymnocarpa			1.6	2.3		3.3	2.9	61.1
Rubus parviflorus						T	7.1	
Salix sp.							T	T
Symphoricarpos albus		T				T	T	38.9
Arctostaphylos nevadensis					T			
Berberis nervosa	T		T			3.3	T	
Rubus vitifolius			61.9	36.4		66.7	54.3	

Appendix 4, Part B, Section 1 (Cont'd.)

Species	P-D-32	P-D-38	P-D-33	P-D-36	P-D-39	P-D-35	P-D-34	P-D-40
Antennaria geyeri		0.3						
Chimaphila menziesii	0.3		0.5			2.6	5.0	22.3
Chimaphila umbellata	0.7	0.6	1.1		1.1	12.8	20.0	7.4
Linnaea borealis							3.3	
Satureja douglasii				T				
Achillea millefolium	6.3	4.1	3.2	0.7	2.6			
Apocynum pumilum			1.1	10.2		2.6	10.0	
Balsamorhiza careyana	T		T					
Bromus carinatus	T	2.5			2.3			
Calamagrostis rubescens		3.1		T	22.2			20.2
Campanula scouleri	0.3		1.6					
Carex inops	1.7	9.1		T	10.2			1.1
Cirsium centaurea		T			2.6			
Comandra pallida		T		3.6	1.5			
Cynoglossum occidentale	1.4		T		T			
Elymus glaucus					0.4			
Epilobium angustifloium			6.8	10.9	4.9		T	
Festuca idahoensis		12.5	0.5	3.6	9.8		T	
Fragaria virginiana	11.8	0.6	15.3	0.7	0.4			
Gilia aggregata					T			
Goodyera oblongifolia								2.1
Hackelia floribunda								T
Hieracium albiflorum	9.0	6.6	6.3	19.7	14.3			1.1
Kelloggia galioides	2.8	2.2	0.5	0.7	8.6			7.4
Lathyrus lanswertii	3.5	11.3	1.1		6.0			
Lithospermum ruderale	0.7		T					
Lotus crassifolius	T							
Lupinus lepidus		10.0			3.0			
Lupinus leucophyllus			0.5					
Osmorhiza chilensis					T			14.9

Appendix 4, Part B, Section 1 (Cont'd.)

Species	P-D-32	P-D-38	P-D-33	P-D-36	P-D-39	P-D-35	P-D-34	P-D-40
Penstemon cinereus		T			T			
Phlox diffusa		2.5			0.8			
Pteridium aquilinum	18.8	16.3	29.5	12.4		35.9	21.7	
Pyrola aphylla		T	T					T
Pyrola dentata	2.1							
Pyrola picta		T	T	2.9		10.3	5.0	3.2
Sitanion hystrix	5.2	6.3			1.5			
Smilacina amplexicaulis	T	0.3		0.7	T	5.1	T	20.2
Stephanomeria lactucina	8.3	T			1.1			
Stipa occidentalis	6.6	11.9	1.6					
Tragopogon dubius		T						
Trientalis latifolia	1.7		30.5	22.6	5.6	28.2	35.0	
Trisetum canescens	T				0.4			
Agoseris retrorsa					0.4			
Lilium washingtonianum	1.4		T		2.6			
Pterospora andromeda		T	T	T		T	T	T
Trillium ovatum						T	T	T
Clarkia rhomboidea	T							
Gayophytum nuttallii					0.4			

Appendix 4, Part B, Section 2 - Deschutes Transect

Basis of Order: Stands - Rel. tree I.V. 4" d.b.h. +; Species - life form, sociological

Values given: Trees - Rel. I.V. 1" d.b.h. +; Shrubs - Rel. D.F.; Herbs - Rel. D.F. (all species)

Species	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-19	P-D-16	P-D-10	P-D-17	P-D-21	P-D-9	P-D-13	P-D-20	P-D-11
Pinus ponderosa	39.4	51.5	58.2	80.4	82.6	91.3	91.3	96.9	96.5	97.4	96.7	97.0	95.1	98.2	96.4	98.9
Juniperus occidentalis	60.6	48.5	41.8	19.6	17.4	8.7	8.7	3.1	3.5	2.6	3.3	2.4	4.9	1.8	3.6	1.1
Abies grandis												0.4				
Libocedrus decurrens												0.2				
Purshia tridentata	73.7	49.6	24.8	74.3	82.9	69.5	71.4	92.6	92.1	78.6	75.0	73.5	86.6	97.3	89.5	94.8
Chrysothamnus viscidiflorus	T	7.0	6.4	18.7	17.2	30.6	28.6	T	7.9	21.5	25.0	T	13.5	2.7	T	5.2
Arctostaphylos parryana								7.0				15.4		T	9.0	T
Ceanothus velutinus												11.2				T
Haplopappus bloomeri	T							1.4				T	T	T	1.5	
Artemisia tridentata	26.3	43.4	68.1	7.0												
Amelanchier florida															T	
Chrysothamnus nauseosus	T															
Holodiscus glabrescens																T
Rhamnus purshiana												T				
Ribes cereum	T		T	T												
Antennaria geyeri								1.5		0.4		0.2	T	T	0.5	0.4
Festuca idahoensis	20.4	3.7	22.7	5.5	26.6	7.1	24.4	19.4	9.9	12.6	10.9	21.5	27.2	18.6	13.3	17.4
Stipa occidentalis	6.9	5.3	6.8	8.7	16.0	13.1	19.5	7.7	9.6	11.1	11.8	8.3	8.1	8.8	7.2	4.8
Sitanion hystrix	4.4	5.1	4.4	4.0	6.7	7.1	9.4	5.1	6.4	6.0	5.0	6.5	4.3	1.9	6.0	1.3
Lathyrus lanswertii				T	5.6	0.6	9.0	13.3	0.2	9.6	15.0	7.0		5.7	8.5	4.1
Achillea millefolium	T		0.7	2.7	2.1			9.8	4.7	6.1	4.9	1.5	2.6	8.8	4.9	9.7
Viola purpurea		1.3		2.7	5.1	1.2	6.7	1.2	6.8	1.6	7.5	0.6	0.4	0.5	0.7	1.0
Kelloggia galioides								3.1				20.8		0.7	1.9	
Carex sp.	1.2	6.8	2.4	2.5	10.7	2.8	4.1	2.3	5.7	2.0	4.3	2.1	4.2	3.0	0.4	2.5
Penstemon cinereus	T	1.1	0.2	7.1	2.7	3.4	2.2	2.7	8.2	5.6	1.0	1.2	7.4	0.2		0.8
Hieracium albiflorum								2.9				7.0		0.4	0.6	
Eriogonum umbellatum	0.8		1.1	1.9	1.4	0.4		T	3.7	1.8	0.9		1.3	1.6		1.7
Eriophyllum lanatum	0.8	3.1	0.7	1.7	0.4		T		3.2	1.8	0.6	0.2	1.0	0.2		1.3
Stephanomeria lactucina								4.3	T	T	1.0	3.1	1.5		2.0	

Appendix 4, Part B, Section 2 (Cont'd.)

Species	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-19	P-D-16	P-D-10	P-D-17	P-D-21	P-D-9	P-D-13	P-D-20	P-D-11
Carex inops												6.1				
Phacelia mutabilis	T	13.2	2.0	T	0.9		T	0.4	0.2	0.3	0.2		0.2	T		
Lithospermum ruderale	0.2							0.2		0.4			T	T		
Fragaria virginiana												1.2				
Poa secunda	4.5	4.6	6.8	1.1	2.2	0.5	1.1			0.3			0.9			0.6
Pteridium aquilinum																
Comandra pallida												1.9				
Senecio canus	0.9		1.5	1.2					2.1	T	0.4		0.2			
Scutellaria nana		1.2			T			0.2	0.5			1.6				
Linum lewisii				T	T	T		0.2	0.3	0.2	0.4		T	0.3		T
Penstemon speciosus								0.4				0.5		0.2		
Epilobium angustiflolium																
Apocynum pumilum												0.2				
Koeleria cristata	2.5	1.1	6.4	0.5	0.4	0.2	1.6									
Townsendia florifer		T		0.6	0.8	T	T		0.3	0.2	T		0.2			0.2
Aster canescens							T	1.3	0.9		T	0.2		0.2		
Castilleja miniata								1.3		0.4				0.5	T	T
Cynoglossum occidentale												T				
Lupinus caudatus	0.2					T		.	0.9	T	.	0.5	9.0	T	5.1	
Lupinus lepidus			0.8													
Paeonia brownii	T							0.2				0.5		1.3	0.3	
Trientalis latifolia																
Leptodactylon pungens		0.8	0.3	0.4	0.5											
Arabis holboellii	T	1.0	0.2	0.2			T									
Bromus carinatus												0.4				
Chaenactis douglasii									0.4							
Lotus douglasii																0.4
Erigeron filifolius	0.8	T	0.9													
Erysimum sp.	0.2	T	0.2													
Silene sp.		1.1	0.2													
Balsamorhiza careyana															0.6	

Appendix 4, Part B, Section 2 (Cont'd.)

Species	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-19	P-D-16	P-D-10	P-D-17	P-D-21	P-D-9	P-D-13	P-D-20	P-D-11
Senecio integerrimus														3.5	0.6	
Agropyron spicatum	0.9	T	T		T	T	0.4									
Antennaria dimorpha	T		0.2													
Astragalus sp.			0.2													
Tragopogon dubius											T					
Gilia aggregata															T	
Leucocrinum montanum		8.0	0.4	5.3	2.1	1.0	T		2.7	0.2	1.2					
Lomatium simplex	0.2							0.7				0.5	0.2	T	1.3	
Delphinium nuttallianum	T		0.2		0.4				0.2				0.2			
Agoseris glauca	T		0.8												0.7	
Lomatium dissectum	0.2		0.4													
Agoseris retrorsa															0.2	
Fritillaria atropurpurea		T											0.3	T		
Calochortus macrocarpus	T															
Pterospora andromeda										T		T		T		T
Gayophytum nuttallii	7.3	6.3	3.7	6.3	14.6	12.6	5.0	2.6	4.7	7.2	9.1	2.3	3.9	6.7	6.5	7.9
Madia minima	12.7	7.4	0.2	15.2	53.7	21.0	4.8	2.5	3.6	15.4	6.5	0.8	9.9	15.9	7.7	9.8
Collinsia parviflora	0.3	1.1	1.2	1.8	1.3	0.3	1.1	1.1	2.4	3.3	0.9		2.1	5.4	6.8	5.3
Cryptantha ambigua	8.1	14.5	4.8	3.9	5.3	3.9	1.0	0.3		0.8	0.7		2.3	1.7	1.0	1.3
Phlox gracilis	0.6	1.9	0.7	1.6	4.8	0.6	3.5		0.4	0.9	0.4		2.0	0.2	2.2	0.8
Collomia grandiflora	0.5				1.3			4.2	10.6	3.7	0.8		1.0	0.5	7.9	3.1
Bromus tectorum	19.6	8.9	1.6	10.9	13.3	2.2	0.7	4.5	2.5	5.9	1.3		6.6		6.6	0.8
Mimulus nanus	3.3	12.0	8.6	12.5	17.3	19.7	5.6		6.1	1.3	13.9		1.4			0.5
Clarkia rhomboidea								4.1	0.8	0.8		3.1	T	11.6	14.4	12.9
Cryptantha circumscissa	0.5	0.3	0.6	0.2		0.9				0.4	0.2		0.3			
Epilobium minutum	0.6	0.8	0.7		2.9	1.0				T			0.4			
Plectritis congesta		T	1.7	0.6			2.4							0.7		
Polygonum douglasii								0.5					0.8	1.3	0.4	0.8

Appendix 4, Part B, Section 2 (Cont'd.)

Species	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-19	P-D-16	P-D-10	P-D-17	P-D-21	P-D-9	P-D-13	P-D-20	P-D-11
Eriogonum baileyi	T	0.8	1.5	0.8												
Nama densum	0.3			0.2		0.7										
Festuca dertonensis		1.0								T			0.3		0.8	
Mentzelia albicaulis	T	T	0.2	0.3									0.2			
Epilobium paniculatum								1.9			T	0.5			1.1	
Montia perfoliata															0.4	
Gayophytum lasiospermum			0.3													
Apera spica - venti															0.5	
Draba verna		T														
Linanthus septentrionalis	T															
Phacelia linearis	T															
Euphorbia serpyllifolia							T									

Appendix 4, Part B, Section 2 (Cont'd.)

Species	P-D-15	P-D-18	P-D-7	P-D-12	P-D-14	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-23	P-D-22	P-D-30	P-D-31	P-D-36
Pinus ponderosa	99.7	99.4	98.1	97.7	99.7	100.0	99.9	99.8	99.4	99.7	99.1	98.7	91.5	99.2	97.6	67.6
Juniperus occidentalis	0.3	0.6	1.9	2.3	0.3		T		T		0.5	0.8	8.5			
Abies grandis						T		0.1	T	0.3	0.5	T		0.5	1.3	2.1
Libocedrus decurrens												0.5	T	0.1	0.1	6.0
Pseudotsuga menziesii									T					0.3	1.0	26.2
Pinus monticola															0.1	
Pinus contorta							0.1	0.1	0.6			T		T		
Purshia tridentata	83.9	87.7	93.2	82.6	83.4	90.2	38.5		73.2	75.3	98.5	44.4	75.5	T		
Chrysothamnus viscidiflorus	16.1	8.8	1.4	4.4	1.3				2.7		1.6	T				
Arctostaphylos parryana			5.5	13.1	12.4	9.8		7.7	T	10.6	T	11.1	3.5	12.9	T	
Ceanothus velutinus					T	T	61.5	92.3	22.5	12.4	T	44.4	21.1	53.6	50.0	50.1
Haplopappus bloomeri	T	3.5		T	3.0		T		2.7	1.8	T	T		31.1	21.4	
Prunus emarginata														T	21.4	1.9
Rosa gymnacarpa									T			T				1.9
Castanopsis chrysophylla														T	7.2	T
Rubus vitifolius																46.3
Amelanchier florida												T	T	T		T
Holodiscus discolor																T
Arctostaphylos nevadensis														2.6		
Symphoricarpos albus															T	
Antennaria geyeri		1.5		0.4	0.7	0.5			0.9		0.9	T	0.3	0.3	0.5	
Chimaphila umbellata									0.9					0.3	0.4	
Satureja douglasii																T
Festuca idahoensis	0.2	19.4	4.7	16.5	16.7	43.1		3.4	21.3	2.1	30.4	8.1	6.8		0.7	3.0
Stipa occidentalis	12.7	7.7	10.6	6.2	9.2	29.2	21.7	15.9	11.0	17.4	23.5	13.3	10.6	23.5	11.0	2.1
Sitanion hystrix	6.5	5.1	9.5	5.1	9.9	2.4	8.9	14.3	16.4	11.9	11.5	10.8	14.2	4.5	3.6	
Lathyrus lanswertii	6.8	13.3	18.8	7.6	11.7	10.4	11.1	2.3	14.2	19.2	15.4	14.3	14.8	1.5	7.0	
Achillea millefolium	8.4	9.8	8.5	6.8	12.5						9.8			3.2	8.0	0.5
Viola purpurea	5.1	1.2	7.0	1.0	0.5	0.8			0.4	0.8	2.1	1.0	0.9		0.7	

Appendix 4, Part B, Section 2 (Cont'd.)

Species	P-D-15	P-D-18	P-D-7	P-D-12	P-D-14	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-23	P-D-22	P-D-30	P-D-31	P-D-36
Kelloggia galioides		3.1	0.3	1.7	4.3	1.2	14.9	36.9	7.7	13.5	T	25.1	17.2	14.6	15.4	0.9
Carex sp.	2.3	2.3	2.2	2.5	6.0	7.0										
Penstemon cinereus	5.8	2.7	9.1	1.9	0.2		T						T			
Hieracium albiflorum		2.9			4.4			0.8				0.3	0.8	3.8	8.1	16.9
Eriogonum umbellatum	2.0		0.7	1.5	1.0					T					1.0	
Eriophyllum lanatum	5.6		2.3	0.3	0.6						T					
Stephanomeria lactucina		4.3				T	0.6	4.1	T	1.3		1.3	3.1	4.1	2.8	
Carex inops							5.2	2.1	8.0	28.8	3.5	8.4	4.5	6.7	3.2	T
Phacelia mutabilis	0.2	0.4	0.7	0.2	T						T	T			0.5	
Lithospermum ruderale	0.2	0.2		T	0.2	T	T			0.4	T	T	0.3	0.3	0.3	
Fragaria virginiana									15.1			6.6		27.5	19.4	0.5
Poa secunda			0.6													
Pteridium aquilinum							37.0	11.8	T			5.4	16.2	T	5.1	10.4
Comandra pallida						1.6		4.3		1.5		T	3.3		0.9	4.7
Senecio canus			1.4								0.3					
Scutellaria nana	0.4	0.2	2.6										0.3			
Linum lewisii	0.9	0.2	T	0.2	T											
Penstemon speciosus	0.4	0.4		0.4	0.2					1.5		0.3	T			
Epilobium angustifolium									1.0			0.3		5.9	5.8	9.3
Apocynum pumilum										1.7		2.0		4.8		8.3
Townsendia florifer	T	T	0.4													
Aster canescens	2.4	1.3		1.8												
Castilleja miniata	0.6	1.3	0.3	0.2	T	T										
Cynoglossum occidentale							0.5	4.0				0.3	0.8	6.6	0.3	
Lupinus caudatus			0.6													
Lupinus lepidus						1.1					0.5					
Paeonia brownii		0.2					T			T	T	0.3	0.3			
Trientalis latifolia																32.0
Bromus carinatus							T	T	T			0.3			T	
Calamagrostis rubescens																T

Appendix 4, Part B, Section 2 (Cont'd.)

Species	P-D-15	P-D-18	P-D-7	P-D-12	P-D-14	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-23	P-D-22	P-D-30	P-D-31	P-D-36
Pyrola picta																2.3
Smilacina amplexicaulis																0.5
Chaenactis douglasii	0.2		0.3													
Lotus douglasii				0.2	2.7											
Pyrola dentata														0.8	1.8	
Balsamorhiza careyana														0.4		
Trisetum canescens														T		
Horkelia fusca											0.3					
Lotus crassifolius									0.3							
Bromus orcuttianus														T		
Pyrola aphylla									T	T						
Leucocrinum montanum	0.2		2.4													
Lomatium simplex		0.7		0.2										0.3	0.3	1.1
Agoseris glauca											T					
Lilium washingtonianum															T	
Orobanche fasciculata	0.2															
Pterospora andromeda				T		T		T	T	T	T				T	T
Gayophytum nuttallii	6.8	2.6	3.4	9.2	8.5	2.7			0.7	T	0.9	0.3	3.6	0.4	1.3	0.5
Madia minima	5.0	2.5	3.2	21.0	2.9						0.3		0.7			
Collinsia parviflora	1.9	1.1		4.6	0.2						0.4		0.3			5.5
Cryptantha ambigua	0.9	0.3		1.2	T											
Phlox gracilis			0.3	1.4												
Collomia grandiflora	12.5	4.2	8.1	0.4	1.7										0.3	
Bromus tectorum		T		1.9												
Mimulus nanus	5.5			0.4												
Clarkia rhomboidea	5.7	4.1	1.4	4.8	5.6				T			0.3	1.3		1.9	1.6
Epilobium minutum			0.3													
Polygonum douglasii		0.5		0.6	0.2											
Epilobium paniculatum		T							T							
Montia perfoliata	0.2															

Appendix 4, Part B, Section 2 (Cont'd.)

Species	P-D-32	P-D-37	P-D-33	P-D-39	P-D-38	P-D-35	P-D-34	P-D-40
Pinus ponderosa	95.8	93.4	73.1	60.8	71.4	15.2	12.8	19.4
Juniperus occidentalis	T	T			T			
Abies grandis	2.3	6.2	6.0	39.1	28.5	36.6	74.7	80.6
Libocedrus decurrens		T	3.0	0.1		23.3	0.1	
Pseudotsuga menziesii	1.8	0.3	18.9		0.1	24.8	12.4	
Pinus monticola	T	0.1	T			0.1	T	T
Pinus contorta	T							
Tsuga mertensiana								T
Arctostaphylos parryana		8.7		T	T	T		
Ceanothus velutinus	70.4	69.7	7.7	44.4	66.7			
Haplopappus bloomeri	T	T		44.4	6.7			
Prunus emarginata	18.5		1.3	11.1	13.3		2.2	T
Rosa gymnocarpa		12.9	1.3			3.2	1.7	67.3
Castanopsis chrysophylla	7.4		20.4			12.7	20.0	T
Rubus vitifolius			69.4			68.2	61.5	
Amelanchier florida	T		T	T	13.3		T	
Corylus cornuta						12.7	1.1	
Pachistima myrsinites	3.7						5.9	
Holodiscus discolor							1.5	
Arctostaphylos nevadensis		T			T			
Rubus parviflorus							5.8	
Berberis nervosa	T		T			3.2	T	
Sorbus sitchensis		8.7						
Symphoricarpos albus		T		T		T	T	32.7
Acer circinatum							T	
Rhamnus purshiana			T		T		T	T
Salix sp.							T	T

Appendix 4. Part B, Section 2 (Cont'd.)

Species	P-D-32	P-D-37	P-D-33	P-D-39	P-D-38	P-D-35	P-D-34	P-D-40
Antennaria geyeri		0.2			0.3			
Chimaphila umbellata	0.6	1.6	0.8	0.8	0.4	14.9	27.3	6.5
Chimaphila menziesii	0.3		0.4			1.9	6.9	20.2
Linnaea borealis							3.1	
Festuca idahoesis	1.5	18.4	0.4	8.5	15.2		T	
Stipa occidentalis	6.8	10.2	1.2	4.7	11.4			
Sitanion hystrix	4.2	1.8		1.2	4.7			
Lathyrus lanswertii	3.9	12.3	0.8	5.9	13.3			
Achillea millefolium	6.5	3.0	2.3	2.0	4.3			
Kelloggia galioides	2.8	1.4	0.4	8.7	2.9			
Penstemon cinereus				T	T			
Hieracium albiflorum	7.3	7.1	4.7	11.3	6.1			1.4
Stephanomeria lactucina	7.1			0.8	T			
Carex inops	1.6	10.7		11.2	10.8			1.0
Lithospermum ruderale	0.5	T	T					
Fragaria virginiana	19.4	12.3	18.0	0.2	0.5			
Pteridium aquilinum	17.0		25.6		14.5	34.2	17.5	
Comandra pallida		0.8		1.0	T			
Epilobium angustiflolium	11.0	1.1	5.2	3.1			T	
Apocynum pumilum			0.7			1.9	7.2	
Cynoglossum occidentale	1.0	T	T	T				
Lupinus lepidus		2.5		2.0	8.3			
Trientalis latifolia	3.3	T	37.6			31.0	34.4	
Bromus carinatus	T	0.8		1.5	2.0			
Calamagrostis rubescens		7.0		34.1	3.0			
Pyrola picta			T		T	10.3	3.6	2.2
Smilacina amplexicaulis	T			T	0.2	3.9	T	17.9
Pyrola dentata	1.6							
Balsamorhiza careyana	T		T					
Elymus glaucus		0.2		0.3				

Appendix 4, Part B, Section 2 (Cont'd.)

Species	P-D-32	P-D-37	P-D-33	P-D-39	P-D-38	P-D-35	P-D-34	P-D-40
Phlox diffusa				0.6	2.2			
Trisetum canescens	T	2.0		0.3				
Campanula scouleri	0.6		1.6					
Cirsium centaurea		0.7		1.7	T			
Lotus crassifolius	T							
Erigeron peregrinus		5.4						
Lupinus leucophyllus			0.4					
Aquilegia formosa		T						
Goodyera oblongifolia								1.9
Gilia aggregata				T				
Pyrola aphylla			T		T			T
Osmorhiza chilensis				T				14.1
Hackelia floribunda								T

Appendix 4, Part B, Section 3 - Deschutes Transect

Basis of Order: Stands - Rel. tree I.V. 4" d.b.h. +; Understory species - life form, sociological

Values Given: Shrubs - Rel. I.V.; Herbs - Rel. I.V. (all species)

Species	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-19	P-D-16	P-D-10	P-D-17	P-D-21	P-D-9	P-D-13	P-D-20	P-D-11
Purshia tridentata	74.9	53.1	23.7	81.1	87.6	79.1	80.9	89.4	93.4	83.1	80.9	62.1	90.2	97.8	87.0	96.1
Chrysothamnus viscidiflorus	T	5.3	5.4	12.9	12.4	20.9	19.1	T	6.6	16.9	19.1	T	9.8	1.8	0.2	3.9
Arctostaphylos parryana								9.6				23.1		0.4	11.7	T
Ceanothus velutinus												14.8				
Haplopappus bloomeri	T							0.9				T	T	T	1.0	T
Artemisia tridentata	25.1	41.6	70.9	5.6												
Amelanchier florida															T	
Chrysothamnus nauseosus	T			0.4												
Holodiscus glabrescens																T
Rhamnus purshiana												T				
Ribes cereum	T		T	T												
Antennaria geyeri								1.6		0.4		0.2	T	T	0.7	0.3
Festuca idahoensis	8.1	12.1	38.6	13.1	27.3	19.4	41.0	28.3	19.0	24.0	18.5	29.3	40.0	35.3	21.0	13.4
Stipa occidentalis	5.3	7.0	5.6	9.6	7.7	14.4	14.1	6.1	9.2	10.1	9.1	9.2	6.9	6.8	7.5	4.3
Sitanion hystrix	3.6	7.8	5.4	2.7	5.2	13.7	9.7	6.6	7.1	5.9	6.4	6.1	4.1	1.9	6.3	1.2
Lathyrus lanswertii				T	7.2	0.4	8.9	12.4	0.7	11.5	21.8	6.5		6.4	9.4	4.2
Achillea millefolium	0.4		0.5	1.8	0.7			7.8	3.7	5.6	3.7	1.4	2.2	6.2	4.6	7.6
Viola purpurea		1.8		1.8	1.7	0.8	4.5	0.8	4.5	0.2	5.4	0.8	0.3	0.4	0.5	0.7
Kelloggia galioides								3.3				20.1		0.5	2.3	
Carex sp.	1.2	8.9	1.9	6.7	4.2	1.9	3.3	1.5	7.8	2.1	5.0	1.8	3.8	2.6	0.2	3.1
Penstemon cinereus	T	2.5	0.1	7.9	0.9	3.0	1.5	2.4	7.7	4.2	1.1	1.2	5.6	0.1		0.6
Hieracium albiflorum								2.9				5.4		0.3	0.7	
Eriogonum umbellatum	0.5		1.1	1.3	1.0	0.2		T	4.7	1.6	1.5		1.1	2.4		2.6
Eriophyllum lanatum	0.5	3.1	0.5	1.8	0.1		T		3.3	1.2	0.4	0.2	1.2	0.4		0.8
Stephanomeria lactucina								4.2	T	T	0.7	2.0	1.0		1.0	
Carex inops												5.6				
Phacelia mutabilis	T	0.9	1.3	T	0.3		T	0.3	0.1	0.2	0.1		0.1	T		
Lithospermum ruderale	0.2							0.1		0.3		0.4	T	T		
Fragaria virginiana												1.2				

Appendix 4, Part B, Section 3 (Cont'd.)

Species	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-19	P-D-16	P-D-10	P-D-17	P-D-21	P-D-9	P-D-13	P-D-20	P-D-11
Poa secunda	4.0	5.7	5.6	1.3	0.7	0.3	0.7			0.2			0.6			0.4
Comandra pallida												1.3				
Senecio canus	0.6		1.0	1.4					1.4	T	0.7		0.1			
Scutellaria nana		0.8			T			0.4	0.3			1.0				
Linum lewisii				T	T	T		0.1	0.7	0.1	0.3		T	0.2		T
Penstemon speciosus								0.3				0.3		0.4		
Apocynum pumilum												0.2				
Koeleria cristata	2.4	1.6	6.4	0.3	0.1	0.2	1.1									
Townsendia florifer		T		0.4	0.3	T	T		0.2	0.1	T		0.1			0.1
Aster canescens							T	1.2	0.6		T	0.2		0.1		
Castilleja miniata								0.9		0.3				0.4	T	T
Cynoglossum occidentale												T				
Lupinus caudatus	0.2					T			0.6	T		0.3	9.7	T	6.1	
Paeonia brownii	T							0.1				0.3		0.5	0.2	
Leptodactylon pungens	0.9	1.0	0.6	2.8												
Arabis holboellii	T	0.7	0.1	0.1			T							0.1		
Bromus carinatus												0.6				
Chaenactis douglasii									0.3							
Lotus douglasii																0.3
Erigeron filifolius	0.9	T	0.6													
Erysimum sp.	0.2	T	0.1													
Silene sp.		0.7	0.1													
Balsamorhiza careyana															1.4	
Senecio integerrimus														3.0	0.7	
Agropyron spicatum	0.6	T	T		T	T	0.8									
Antennaria dimorpha	T		0.5													
Astragalus sp.			0.1													
Tragopogon dubius											T					
Gilia aggregata															T	

Appendix 4, Part B, Section 3 (Cont'd.)

Species	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-19	P-D-16	P-D-10	P-D-17	P-D-21	P-D-9	P-D-13	P-D-20	P-D-11
Leucocrinum montanum		7.9	0.3	3.6	1.3	0.6	T		2.9	0.1	0.8		0.1			
Lomatium simplex	0.2							0.4				0.3	0.1	T	1.0	
Delphinium nuttallianum	T		0.1		0.1				0.1				0.1			
Agoseris glauca	T		0.9												0.5	
Lomatium dissectum	0.2		0.3													
Agoseris retrorsa															0.1	
Fritillaria atropurpurea		T											0.2	T		
Calochortus macrocarpus	T															
Pterospora andromeda										T		T		T		T
Gayophytum nuttallii	4.8	5.1	2.5	4.2	4.9	8.4	3.3	2.4	3.1	5.6	6.9	1.5	2.9	4.8	5.0	5.6
Madia minima	9.2	4.9	0.1	11.4	19.1	15.6	3.2	1.7	2.4	11.8	4.4	0.5	6.6	10.6	5.1	6.5
Collinsia parviflora	0.2	0.8	0.8	8.7	0.4	1.0	0.8	0.8	1.6	2.2	0.6		1.4	3.6	5.5	3.5
Cryptantha ambigua	5.4	10.6	3.2	2.6	1.8	2.6	0.7	0.2		0.5	0.5		1.5	1.8	0.7	0.9
Phlox gracilis	0.4		0.4	1.1	1.6	0.4	2.3		0.3	0.6	0.3		1.6	0.1	2.2	0.5
Collomia grandiflora	0.4	1.3			0.4			2.8	7.6	2.4	0.5		0.9	0.4	2.1	6.5
Bromus tectorum	16.6	5.9	1.4	13.6	5.0	1.5	0.5	4.9	2.8	5.1	0.9		5.9		0.9	7.0
Mimulus nanus	2.2	8.0	5.8	8.4	6.4	13.9	3.7		5.2	0.9	10.6		0.9			0.4
Clarkia rhomboidea								3.3	0.5	0.5		2.0	T	9.3	13.3	12.3
Cryptantha circumscissa	0.3	0.2	0.8	0.1		0.6				0.3	0.2		0.2			
Epilobium minutum	0.4	0.5	0.4		1.0	0.7				T			0.3			
Plectritis congesta		T	1.1	0.4			1.6							0.5		
Polygonum douglasii								0.7						0.9	0.2	0.6
Eriogonum baileyi	T	0.5	1.0	0.5												
Nama densum	0.2			0.1		0.5										
Festuca dertonensis		0.7								T			0.2		0.5	
Mentzelia albicaulis	T	T	0.1	0.2									0.1			
Epilobium paniculatum								1.2			T	0.3			1.0	
Montia perfoliata															0.2	
Gayophytum lasiospermum			0.2													
Apera spica - venti															0.3	
Draba verna		T														
Linanthus septentrionalis	T															
Phacelia linearis	T															

Appendix 4, Part B, Section 3 (Cont'd.)

Species	P-D-15	P-D-18	P-D-7	P-D-12	P-D-14	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-23	P-D-22	P-D-30	P-D-31	P-D-36
Purshia tridentata	88.1	91.2	90.3	79.3	74.4	88.5			59.7	67.5	98.7	32.9	62.7	T		
Chrysothamnus viscidiflorus	11.9	6.3	0.9	2.9	0.8				1.8		1.3	T				
Arctostaphylos parryana			8.8	17.8	22.6	10.7	35.0	7.5	0.4	12.5	T	11.1	6.1	15.1	1.5	
Ceanothus velutinus					0.2	0.8	65.0	92.5	36.4	18.7	T	55.5	31.2	60.6	62.1	61.9
Haplopappus bloomeri	T	2.3		T	2.0		T		2.2	1.2	T	T		22.4	15.0	
Prunus emarginata														T	15.0	1.2
Rosa gymnocarpa									T			0.4				1.2
Castanopsis chrysophylla														T	6.3	T
Rubus vitifolius																3.6
Amelanchier florida												T	T	T		T
Holodiscus discolor																T
Arctostaphylos nevadensis														2.0		
Symphoricarpos albus															T	
Antennaria geyeri		1.0		0.9	0.5	0.8			0.8		0.6	T	0.2	0.2	0.4	
Chimaphila umbellata						0.6								0.2	0.3	
Satureja douglasii																T
Festuca idahoensis	1.5	19.7	8.5	26.6	32.1	52.3		2.9	24.0	3.4	39.4	9.3	5.9		1.1	3.5
Stipa occidentalis	10.5	7.7	12.5	5.7	8.4	19.5	1.8	13.6	11.8	14.0	20.9	10.2	8.5	13.1	8.8	1.4
Sitanion hystrix	5.7	5.8	13.6	6.5	10.0	2.1	6.6	15.3	17.2	14.2	11.3	9.5	13.1	4.5	3.7	
Lathyrus lanswertii	10.0	4.8	18.8	7.9	9.5	8.0	8.7	1.5	11.3	2.0	13.9	9.5	11.9	1.3	6.2	
Achillea millefolium	9.0	6.7	6.6	4.8	8.9						7.5			2.7	7.2	0.4
Viola purpurea	3.4	0.5	4.6	0.7	0.3	0.6			0.3	0.5	1.7	1.0	0.6		0.5	
Kelloggia galioides		0.1	0.2	1.5	4.0	1.3	12.3	24.6	7.5	12.9		9.2	17.9	15.1	17.2	0.6
Carex sp.	2.9	5.4	3.3	2.3	4.0	5.2										
Penstemon cinereus	6.6	1.2	11.5	1.6	0.2		T					0.6	T	0.2		
Hieracium albiflorum					3.5			0.5				0.2	0.8	3.1	6.3	15.0
Eriogonum umbellatum	5.4	5.1	0.4	1.9	0.7					T					1.3	
Eriophyllum lanatum	6.4	0.3	1.8	0.5	0.9						T					
Stephanomeria lactucina		5.3				T	0.7	3.0	0.3	2.0		0.9	2.3	3.3	2.2	
Carex inops							3.5	1.4	7.7	29.0	2.8	7.6	4.7	5.7	2.7	T

Appendix 4, Part B, Section 3 (Cont'd.)

Species	P-D-15	P-D-18	P-D-7	P-D-12	P-D-14	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-23	P-D-22	P-D-30	P-D-31	P-D-36
Phacelia mutabilis	0.1	0.7	0.4	0.1	T						T	T			0.4	
Lithospermum ruderale	0.1	0.1		T	0.2	T	T			0.2	T	T	0.2	0.5	0.5	
Fragaria virginiana									15.1			8.6		31.3	20.2	0.4
Poa secunda			0.4													
Pteridium aquilinum							49.9	15.1	T			8.5	26.1	T	9.7	19.8
Comandra pallida						1.1		3.2		1.0		T	2.2		0.6	3.1
Senecio canus			0.6								0.2					
Scutellaria nana	0.3	0.4	1.7										0.2			
Linum lewisii	0.6	1.3	T	0.2	T											
Penstemon speciosus	0.2			0.2	0.2					1.4		0.9	T			
Epilobium angustiflolium									1.2			0.2		5.7	6.4	8.5
Apocynum pumilum										1.1		2.6		5.6		9.3
Townsendia florifer	T	T	0.3													
Aster canescens	5.0	0.4		2.1												
Castilleja miniata	0.4	1.0	0.2	0.4	T	T										
Cynoglossum occidentale							0.3	3.6			0.9	0.5	5.9	0.2		
Lupinus lepidus						0.7					0.4					
Paeonia brownii							T			T	T	0.2	0.2			
Trientalis latifolia																30.4
Bromus carinatus							T	T	T			0.2			T	
Calamagrostis rubescens																T
Pyrola picta																1.5
Smilacina amplexicaulis																0.4
Chaenactis douglasii	0.1		0.2													
Lotus douglasii					0.1	2.9										
Pyrola dentata														0.6	1.2	
Balsamorhiza careyana														0.5		
Trisetum canescens														T		
Horkelia fusca											0.4					
Lotus crassifolius									0.2							
Bromus orcuttianus														T		
Pyrola aphylla									T	T						

Appendix 4, Part B, Section 3 (Cont'd.)

Species	P-D-15	P-D-18	P-D-7	P-D-12	P-D-14	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-23	P-D-22	P-D-30	P-D-31	P-D-36
Leucocrinum montanum	1.1		1.6													
Lomatium simplex		0.1		0.1										0.2	0.2	0.4
Agoseris glauca											T					
Lilium washingtonianum															T	
Orobanche fasciculata	0.1															
Pterospora andromeda				T		T		T	T	T	T				T	T
Gayophytum nuttallii	5.2	1.5	2.3	7.4	5.7	1.8			0.5	T	0.6	0.9	3.2	0.2	0.9	0.4
Madia minima	3.3	14.2	2.1	16.9	2.5						0.2		0.5			
Collinsia parviflora	1.3	5.3		3.1	0.2						0.3		0.2			3.7
Cryptantha ambigua	0.6	1.0		7.8	T											
Phlox gracilis		0.9	0.2	0.9												
Collomia grandiflora	9.7	5.3	6.3	0.3	1.1										0.2	
Bromus tectorum		T		1.3												
Mimulus nanus	4.4			0.3												
Clarkia rhomboidea	5.8	4.0	0.9	3.8	3.7				T			0.2	0.5		1.6	0.7
Epilobium minutum			0.2													
Polygonum douglasii		1.4		0.4	0.2											
Epilobium paniculatum		T							T							
Montia perfoliata	0.1															

Appendix 4, Part B, Section 3 (Cont'd.)

Species	P-D-32	P-D-37	P-D-33	P-D-39	P-D-38	P-D-35	P-D-34	P-D-40
Arctostaphylos parryana		5.8		1.4	T	T		
Ceanothus velutinus	77.9	79.8	10.6	73.5	61.9			
Haplopappus bloomeri	0.4	T		4.5	29.6			
Prunus emarginata	12.7		0.4	8.9	8.5		1.5	2.8
Rosa gymnocarpa		8.6	0.9			2.1	1.5	64.3
Castanopsis chrysophylla	6.5		36.6			18.5	38.7	2.8
Rubus vitifolius			50.5			48.1	45.1	
Amelanchier florida	T		0.2	11.8			T	
Corylus cornuta						29.1	2.0	
Pachistima myrsinites	2.5						5.5	
Holodiscus discolor							2.0	
Arctostaphylos nevadensis		T			T			
Rubus parviflorus							3.9	
Berberis nervosa	T		T			2.1	T	
Sorbus sitchensis		5.8						
Symphoricarpos albus		T					T	30.1
Acer circinatum							T	
Rhamnus purshiana			T		T		T	T
Salix sp.							T	T
Antennaria geyeri		0.1			0.2			
Chimaphila umbellata	0.9	0.5	0.8	0.7	0.5	13.0	32.3	5.7
Chimaphila menziesii	0.2		0.2			1.3	7.2	24.1
Linnaea borealis							3.4	
Festuca idahoensis	0.9	6.1	0.2	7.7	14.3		T	
Stipa occidentalis	4.5	3.4	1.0	4.3	12.2			
Sitanion hystrix	3.5	0.6		1.3	4.4			
Lathyrus lanswertii	4.3	4.1	0.5	4.8	11.6			
Achillea millefolium	6.1	1.0	1.5	1.7	3.0			
Viola purpurea		0.1						
Kelloggia galioides	2.4	0.5	0.6	7.7	2.7			

Appendix 4, Part B, Section 3 (Cont'd.)

Species	P-D-32	P-D-37	P-D-33	P-D-39	P-D-38	P-D-35	P-D-34	P-D-40
Penstemon cinereus				T	T			
Hieracium albiflorum	5.4	2.4	3.4	8.6	4.4			0.9
Stephanomeria lactucina	6.2			0.5	T			
Carex inops	1.1	3.6		10.9	9.5			0.6
Lithospermum ruderale	0.6	T	T					
Fragaria virginiana	19.0	4.1	15.8	0.1	0.5			
Pteridium aquilinum	27.1		40.2		23.4	45.8	21.9	
Comandra pallida		0.3		0.6	T			
Epilobium angustifolium	10.4	0.4	4.0	2.4			T	
Apocynum pumilum			0.7			2.8	6.1	
Cynoglossum occidentale	0.7	T	T	T				
Lupinus lepidus		0.8		1.3	6.5			
Trientalis latifolia	2.7	T	29.4			22.5	25.5	
Bromus carinatus	T	0.3		1.2	1.7			
Calamagrostis rubescens		2.3		44.0	3.3			36.8
Pyrola picta			T		T	11.4	3.7	1.5
Smilacina amplexicaulis	T			T	0.1	2.6	T	13.2
Pyrola dentata	1.3		0.3					
Balsamorhiza careyana	T		T					
Elymus glaucus		0.1		0.3				
Phlox diffusa				0.4	1.7			
Trisetum canescens	T	0.7		0.2				
Campanula scouleri	0.6		1.0					
Cirsium centaurea		0.2		1.1	T			
Lotus crassifolius	T							
Erigeron peregrinus		1.8						
Lupinus leucophyllus			0.2					1.3
Aquilegia formosa		T						
Gilia aggregata				T				
Pyrola aphylla			T		T			T
Osmorhiza chilensis				T				9.4
Hackelia floribunda								T
Lomatium simplex	1.5							
Agoseris retrorsa				0.1				
Lilium washingtonianum	0.7					0.6		
Gayophytum nuttallii				0.2				

Appendix 4, Part B, Section 4 - Deschutes Transect
Basis of Order: Stands - Rel. tree I.V. 4" d.b.h. +; Species - life form, sociological
Values given: Rel. D.F. - perennial species (except geophytes)

Species	P-D-5	P-D 2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-19	P D-16	P-D-10	P D-17	P-D-21	P-D-9	P-D-13	P-D-20	P-D-11
Antennaria geyeri								2.0		0.6		0.3	T	T	0.9	0.9
Festuca idahoensis	48.0	10.0	37.5	14.2	35.6	20.8	32.4	25.0	15.1	21.2	16.6	23.1	39.2	34.2	26.2	38.5
Stipa occidentalis	4.6	14.0	11.9	21.6	19.2	36.5	25.7	10.0	14.5	18.4	18.3	8.7	11.7	15.5	13.6	10.2
Sitanion hystrix	9.2	14.2	7.6	9.5	7.6	19.3	12.3	6.5	9.6	9.8	7.8	7.0	6.2	3.2	11.1	2.6
Lathyrus lanswertii				T	5.9	1.5	11.9	17.1	0.3	16.5	24.2	7.6		10.2	16.4	8.8
Achillea millefolium	T		1.3	6.9	2.6			12.7	7.1	10.2	7.6	1.6	3.8	15.5	9.4	21.1
Viola purpurea		3.4		6.2	6.1	2.9	5.5	1.6	10.3	2.6	11.6	0.6	0.6	0.9	1.2	2.1
Kelloggia galioides								4.0				22.3		1.2	3.7	
Carex sp.	2.5	18.2	4.2	5.8	12.1	7.1	5.3	3.0	8.5	3.1	6.6	2.3	6.0	5.2	0.7	5.2
Penstemon cinereus	T	3.2	0.4	17.7	3.1	8.9	2.9	3.4	12.4	9.2	1.6	1.3	10.6	0.4		1.7
Hieracium albiflorum								3.8						0.8	1.1	
Eriogonum umbellatum	1.5		1.4	4.5	1.5	1.1		T	5.5	2.9	1.4	7.5	1.9	2.7		3.7
Eriophyllum lanatum	1.5	8.3	0.9	4.0	0.5		T		4.9	2.8	0.9	0.3	1.5	0.3		2.6
Stephanomeria lactucina								5.6	T	T	1.6	3.3	2.2		3.7	
Carex inops												6.6				
Phacelia mutabilis	T	3.4	3.4	T	1.1		T	0.5	0.3	0.6	0.3		0.3	T		
Lithospermum ruderale	0.5							0.2		0.6		T		T		
Fragaria virginiana												1.3				
Poa secunda	9.1	12.1	11.9	2.6	2.5	1.2	1.4			0.6			1.2			1.3
Comandra pallida												2.1				
Senecio canus	1.9		2.5	2.6					3.2	T	0.6		0.3			
Scutellaria nana		3.8			T			0.2	0.7			1.6				
Linum lewisii				T	T	T		0.2	0.4	0.3	0.6		T	0.5		T
Penstemon speciosus								0.5				0.5		0.3		
Apocynum pumilum												0.3				
Koeleria cristata	5.2	2.8	11.0	1.1	0.5	0.6	2.1									
Townsendia florifer		T		1.4	0.9	T	T		0.5	0.3	T		0.3			0.4
Aster canescens							T	1.7	1.3		T	0.3		0.4		
Castilleja miniata								1.7		0.4				0.9	T	T

Appendix 4, Part B, Section 4 (Cont'd.)

Species	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-19	P-D-16	P-D-10	P-D-17	P-D-21	P-D-9	P-D-13	P-D-20	P-D-11
Cynoglossum occidentale												T				
Lupinus caudatus	0.5					T			1.3	T		0.5	13.2	T	9.4	
Lupinus lepidus			1.4													
Paeonia brownii	T							0.2				0.5		1.2	0.6	
Leptodactylon pungens	1.8	0.6	0.7	1.3										0.3		
Arabis holboellii	T	2.5	0.4	0.5												
Bromus carinatus												0.5				
Chaenactis douglasii									0.6							
Lotus douglasii																0.9
Erigeron filifolius	1.5	T	1.5													
Erysimum sp.	0.5	T	0.4													
Silene sp.		2.8	0.4													
Balsamorhiza careyana															1.0	
Senecio integerrimus														7.0	1.0	
Agropyron spicatum	1.9	T	T		T	T	0.5									
Antennaria dimorpha	T		0.4													
Astragalus sp.			0.4													
Tragopogon dubius												T				
Gilia aggregata															T	

Appendix 4, Part B, Section 4 (Cont'd.)

Species	P-D-15	P-D-18	P-D-7	P-D-12	P-D-14	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-23	P-D-22	P-D-30	P-D-31	P-D-36
Antennaria geyeri		2.5		0.6	0.9	0.5			0.9		0.9	T	0.3	0.3	0.6	
Chimaphila umbellata									0.9					0.3	0.4	
Satureja douglasii																T
Festuca idahoensis	0.3	19.6	5.8	59.3	20.6	44.2		3.4	21.4	2.1	30.9	8.2	7.2		0.7	3.3
Stipa occidentalis	21.2	12.7	13.1	11.2	11.3	13.9	21.7	15.9	15.5	17.4	23.9	13.5	11.3	13.6	11.4	2.3
Sitanion hystrix	10.6	8.5	11.8	9.0	12.3	2.5	8.9	14.5	16.5	11.9	11.7	11.0	15.0	4.5	3.8	
Lathyrus lanswertii	11.4	7.1	23.2	14.2	14.5	10.7	11.1	2.3	14.3	19.2	15.6	14.5	15.7	1.5	7.2	
Achillea millefolium	14.0	14.1	10.5	12.6	15.4						10.0			3.2	8.3	0.7
Viola purpurea	8.5	1.3	8.6	1.8	0.6	2.3			0.4	0.8	2.2	0.9	0.9		0.8	
Kelloggia galioides		0.3	0.4	3.1	5.3	1.2	14.9	36.9	7.8	13.5		25.4	18.2	14.7	16.0	1.0
Carex sp.	3.7	5.1	2.3	4.4	7.4	7.2										
Penstemon cinereus	9.4	1.5	11.3	3.5	0.3		T					0.8	T	0.3		
Hieracium albiflorum					5.5			0.8				0.3	0.8	3.9	8.4	18.4
Eriogonum umbellatum	3.2	7.4	0.8	2.5	1.2					T					1.1	
Eriophyllum lanatum	9.2	0.8	3.4	0.5	0.7						T					
Stephanomeria lactucina		12.5				T	0.6	4.1	T	1.3		1.3	3.3	4.2	2.9	
Carex inops							5.2	2.1	5.9	28.8	3.6	8.5	4.8	8.5	3.3	T
Phacelia mutabilis	0.3	1.0	0.8	0.4	T						T	T			0.6	
Lithospermum ruderale	2.9	0.3		T	0.3	T	T			0.4	T	T	0.4	0.3	0.3	
Fragaria virginiana									15.2			6.7		27.7	20.2	0.6
Poa secunda			0.7													
Pteridium aquilinum							37.0	11.8	T			5.4	17.2	T	5.3	11.3
Comandra pallida						1.7		4.3		1.5		T	3.5		1.0	5.1
Senecio canus			1.7								0.3					
Scutellaria nana	0.7	0.9	3.2										0.3			
Linum lewisii	1.5	2.5	T	0.3	T											
Penstemon speciosus	0.6			0.6	0.3					1.5		0.3	T			
Epilobium angustiflolium									1.0			0.3		5.9	6.0	10.2
Apocynum pumilum										1.7		2.0		4.9		9.1

Appendix 4, Part B, Section 4 (Cont'd.)

Species	P-D-15	P-D-18	P-D-7	P-D-12	P-D-14	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-23	P-D-22	P-D-30	P-D-31	P-D-36
Townsendia florifer	T	T	0.5													
Aster canescens	4.0	1.0		3.2												
Castilleja miniata	0.9	1.0	0.4	0.3	T	T										
Cynoglossum occidentale							0.5	4.0				0.3	0.8	6.7	0.3	
Lupinus caudatus			0.7													
Lupinus lepidus						1.1					0.6					
Paeonia brownii							T			T	T	0.3	0.3			
Trientalis latifolia																35.1
Bromus carinatus							T	T	T			0.3			T	
Calamagrostis rubescens																T
Pyrola picta																2.5
Smilacina amplexicaulis																0.6
Chaenactis douglasii	0.3		3.6													
Lotus douglasii				0.3	3.3											
Pyrola dentata														0.9	1.8	
Balsamorhiza careyana														0.4		
Campanula scouleri														T		
Horkelia fusca											0.3					
Lotus crassifolius									0.3							
Pyrola aphylla									T	T						

Appendix 4, Part B, Section 4 (Cont'd.)

Species	P-D-32	P-D-37	P-D-33	P-D-39	P-D-38	P-D-35	P-D-34	P-D-40
Antennaria geyeri		0.2			0.3			
Chimaphila umbellata	0.6	1.6	0.8	1.5	0.4	15.1	54.6	6.5
Chimaphila menziesii	0.3		0.4			2.0	13.8	20.2
Linnaea borealis							6.3	
Festuca idahoensis	1.4	18.4	0.4	16.9	15.2		T	
Stipa occidentalis	7.0	10.2	1.2	9.3	11.4			
Sitanion hystrix	4.3	1.8		2.3	4.7			
Lathyrus lanswertii	4.0	12.3	0.8	11.7	13.3			
Achillea millefolium	6.7	3.0	2.3	4.0	4.3			
Viola purpurea		0.4						
Kelloggia galioides	2.9	1.4	0.4	17.3	2.9			7.6
Penstemon cinereus				T	T			
Hieracium albiflorum	7.6	7.1	4.7	22.7	6.1			1.4
Stephanomeria lactucina	7.4			1.6	T			
Carex inops	1.7	10.7		22.3	10.8			1.0
Lithospermum ruderale	0.5	T	T					
Fragaria virginiana	20.0	12.3	18.0	0.4	0.5			
Pteridium aquilinum	17.6		25.6		14.5	34.9	34.9	
Comandra pallida		0.8		1.9	T			
Epilobium angustiflolium	11.4	1.1	5.2	6.2			T	
Apocynum pumilum			0.7			2.0	14.4	
Cynoglossum occidentale	1.0	T	T	T				
Lupinus lepidus		2.5		4.0	8.3			
Trientalis latifolia	3.3	T	37.6			31.6	68.8	
Bromus carinatus	T	0.8		3.0	2.0			
Calamagrostis rubescens		7.0		68.3	3.0			27.1
Pyrola picta			T		T	10.5	7.2	2.2
Smilacina amplexicaulis	T			T	0.2	4.0	T	17.9
Pyrola dentata	1.6		T					

Appendix 4, Part B, Section 4 (Cont'd.)

Species	P-D-32	P-D-37	P-D-33	P-D-39	P-D-38	P-D-35	P-D-34	P-D-40
Balsamorhiza careyana	T		T					
Elymus glaucus		0.2		0.5				
Phlox diffusa				1.1	2.2			
Trisetum canescens	T	2.0		0.5				
Campanula scouleri	0.6		1.6					
Cirsium centaurea		0.7		3.4	T			
Lotus crassifolius	T							
Erigeron peregrinus		5.4						
Lupinus leucophyllus			0.4					
Goodyera oblongifolia								1.9
Aquilegia formosa		T						
Gilia aggregata				T				
Pyrola aphylla			T		T			T
Osmorhiza chilensis				T				14.1
Hackelia floribunda								T

Appendix 4, Part B, Section 5 - Deschutes Transect

Basis of Order: Stands - Rel. tree I.V. 4" d.b.h. +; Species - life form, sociological

Values Given: Rel. I.V. - perennial species (except geophytes)

Species	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-19	P-D-16	P-D-10	P-D-17	P-D-21	P-D-9	P-D-13	P-D-20	P-D-11
Antennaria geyeri								2.0		0.4		0.2	T	T	1.0	0.6
Festuca idahoensis	60.1	18.3	49.5	21.7	44.0	30.0	46.7	33.9	24.2	31.6	23.4	30.3	49.5	47.6	32.6	49.8
Stipa occidentalis	10.6	20.0	9.0	19.3	15.4	30.6	18.3	7.7	12.9	15.4	13.6	9.5	9.4	11.4	12.4	8.2
Sitanion hystrix	7.0	14.5	7.6	6.4	8.3	22.8	11.6	7.9	9.6	8.7	8.4	6.5	5.4	2.8	10.3	2.2
Lathyrus lanswertii					9.8	1.0	10.8	1.5	0.8	16.7	27.7	6.9		1.0	13.0	78.0
Achillea millefolium	0.4		0.9	4.6	1.7			7.8	5.3	8.5	5.5	1.4	3.1	10.7	7.9	15.5
Viola purpurea		3.3		4.1	4.1	1.9	3.7	1.1	6.9	2.6	8.2	0.8	0.4	0.6	0.8	1.4
Kelloggia galioides								4.1				21.2		0.8	3.7	
Carex sp.	2.0	17.2	3.2	10.4	8.7	4.8	3.1	2.0	10.2	3.0	6.7	1.9	5.0	4.2	0.4	5.4
Penstemon cinereus	T	4.1	0.2	15.9	2.1	6.8	1.9	4.7	10.5	6.6	1.5	1.2	7.9	0.3		1.2
Hieracium albiflorum								3.6				5.7		0.5	1.2	
Eriogonum umbellatum	1.0		1.6	3.0	1.7	0.8		T	5.9	2.4	1.9		1.5	3.2		4.4
Eriophyllum lanatum	1.0	5.5	0.6	3.5	0.3		T		4.5	1.9	0.6	0.2	1.5	0.6		1.7
Stephanomeria lactucina								5.2	T	T	1.0	2.2	1.5		3.3	
Carex inops												5.9				
Phacelia mutabilis	T	5.3	2.6	T	0.7		T	0.4	0.3	0.4	0.2		0.3	T		
Lithospermum ruderale	0.3							0.2		0.4		0.4		T		
Fragaria virginiana												1.2				
Poa secunda	7.3	8.1	9.0	2.6	1.6	0.8	0.9			0.4			0.8			0.9
Comandra pallida												1.4				
Senecio canus	1.3		1.7	2.6					2.1	T	0.9		0.2			
Scutellaria nana		2.5			T			0.5	0.5			1.1				
Linum lewisii				T	T	T		0.2	0.9	0.2	0.4		T	0.3		T
Penstemon speciosus								0.3				0.3		0.6		
Apocynum pumilum												0.2				
Koeleria cristata	4.3	2.8	9.5	0.8	0.3	0.4	1.4									
Townsendia florifer				0.9	0.6	T	T		0.3	0.3	T		0.2			0.3
Aster canescens							T	1.2	0.9		T	0.2		0.3		
Castilleja miniata								1.1		0.7				0.6	T	T
Cynoglossum occidentale												T				

Appendix 4, Part B, Section 5 (Cont'd.)

Species	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-19	P-D-16	P-D-10	P-D-17	P-D-21	P-D-9	P-D-13	P-D-20	P-D-11
Lupinus caudatus	0.3					T			0.9	T		0.3	12.7	T	9.7	
Lupinus lepidus			1.0													
Paeonia brownii	T							0.2				0.3		0.8	0.4	
Leptodactylon pungens	1.6	1.4	0.5	4.1												
Arabis holboellii	T	1.7	0.2	0.3			T							0.2		
Bromus carinatus												0.7				
Chaenactis douglasii									0.4							
Lotus douglasii																0.6
Erigeron filifolius	1.4	T	1.0													
Erysimum sp.	0.3	T	0.2													
Silene sp.		1.8	0.2													
Balsamorhiza careyana															1.9	
Senecio integerrimus														5.4	1.1	
Agropyron spicatum	1.2	T	T		T	T	0.9									
Antennaria dimorpha	T		0.6													
Astragalus sp.			0.2													
Tragopogon dubius												T				

Appendix 4, Part B, Section 5 (Cont'd.)

Species	P-D-15	P-D-18	P-D-7	P-D-12	P-D-14	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-23	P-D-22	P-D-30	P-D-31	P-D-36
Antennaria geyeri		1.7		1.2	0.6	0.8			0.8		0.6	T	0.2	0.2	0.4	
Chimaphila umbellata									0.6					0.2	0.3	
Satureja douglasii																T
Festuca idahoensis	1.8	27.2	9.4	39.5	35.0	53.1		2.9	24.2	3.4	39.7	9.4	6.2		1.1	3.7
Stipa occidentalis	16.5	11.6	14.3	9.3	9.8	15.9	21.7	13.6	14.9	14.0	21.1	10.3	9.0	13.2	8.5	1.5
Sitanion hystrix	8.7	8.5	15.3	9.8	11.6	2.2	8.9	15.3	17.4	14.2	11.4	9.6	13.8	4.5	3.8	
Lathyrus lanswertii	14.1	7.2	22.0	12.9	11.4	8.2	11.1	1.5	11.4	2.0	14.0	12.9	12.5	1.3	0.6	
Achillea millefolium	13.4	10.8	7.9	8.8	10.9						7.6			2.7	7.4	0.4
Viola purpurea	5.6	0.9	5.7	1.2	0.4	1.5			0.3	0.5	1.7	1.0	0.6		0.5	
Kelloggia galioides		0.2	0.2	2.4	4.7	1.3	14.9	24.6	7.6	12.9		25.2	18.8	15.1	17.7	0.6
Carex sp.	4.1	7.3	3.7	3.7	4.9	5.3										
Penstemon cinereus	9.5	1.7	13.1	2.7	0.2		T					0.6	T	0.2		
Hieracium albiflorum					4.2			0.5				0.2	0.8	3.2	6.5	16.1
Eriogonum umbellatum	7.0	7.4	0.6	2.8	0.8					T					1.3	
Eriophyllum lanatum	9.3	0.5	2.3	0.7	1.0						T					
Stephanomeria lactucina		9.1				T	0.6	3.0	0.3	2.0		0.9	2.5	3.4	2.2	
Carex inops							5.2	1.4	6.3	29.0	2.8	7.6	4.9	5.7	2.8	T
Phacelia mutabilis	0.2	1.0	0.6	0.3	T						T	T			0.4	
Lithospermum ruderale	0.2	0.2		T	0.2	T	T			0.2	T	T	0.2	0.5	0.5	
Fragaria virginiana									15.2			8.7		31.4	20.8	0.4
Poa secunda			0.5													
Pteridium aquilinum							37.0	15.1	T			8.6	27.1	T	9.9	20.4
Comandra pallida						1.1		3.2		1.0		T	2.4		0.7	3.4
Senecio canus			1.1								0.2					
Scutellaria nana	0.5	0.6	2.1										0.2			
Linum lewisii	1.0	2.0	T	0.2												
Penstemon speciosus	0.4			0.4	0.2					1.4		0.9	T			
Epilobium angustiflolium									1.2			0.2		5.7	6.6	9.1
Apocynum pumilum										1.1		2.7		5.6		9.8
Townsendia florifer	T	T	0.3													

Appendix 4, Part B, Section 5 (Cont'd.)

Species	P-D-15	P-D-18	P-D-7	P-D-12	P-D-14	P-D-27	P-D-24	P-D-25	P-D-26	P-D-28	P-D-29	P-D-23	P-D-22	P-D-30	P-D-31	P-D-36
Aster canescens	6.7	0.7		3.3												
Castilleja miniata	0.6	1.4	0.2	0.6		T										
Cynoglossum occidentale							0.5	3.6				0.9	0.6	5.9	0.2	
Lupinus caudatus			0.5													
Lupinus lepidus						0.7					0.4					
Paeonia brownii							T			T	T	0.2	0.2			
Trientalis latifolia																32.5
Bromus carinatus							T	T	T			0.2			T	
Calamagrostis rubescens																T
Pyrola picta																1.7
Smilacina amplexicaulis																0.4
Chaenactis douglasii	0.2		0.2													
Lotus douglasii				0.2	3.4											
Pyrola dentata														0.6	1.2	
Balsamorhiza careyana														0.5		
Campanula scouleri														T		
Horkelia fusca											0.4					
Lotus crassifolius									0.2							
Pyrola aphylla									T	T						

Appendix 4, Part B, Section 5 (Cont'd.)

Species	P-D-32	P-D-37	P-D-33	P-D-39	P-D-38	P-D-35	P-D-34	P-D-40
Antennaria geyeri		0.1			0.2			
Chimaphila umbellata	0.9	0.5	0.8	0.7	0.5	13.0	32.3	5.7
Chimaphila menziesii	0.2		0.4			1.3	7.2	24.1
Linnaea borealis							3.4	
Festuca idahoensis	0.9	6.1	0.4	7.7	14.3		T	
Stipa occidentalis	4.7	3.4	1.2	4.3	12.2			
Sitanion hystrix	3.6	0.6		1.3	4.4			
Lathyrus lanswertii	4.4	4.1	0.8	4.8	11.6			
Achillea millefolium	6.2	1.0	2.3	1.7	3.0			
Viola purpurea		0.1						
Kelloggia galioides	2.4	0.5	0.4	7.7	2.7			6.4
Penstemon cinereus				T	T			
Hieracium albiflorum	5.5	2.4	4.7	8.6	4.4			0.9
Stephanomeria lactucina	6.4			0.5	T			
Carex inops	1.1	3.6		10.9	9.5			0.6
Lithospermum ruderale	0.6	T	T					
Fragaria virginiana	19.4	4.1	18.0	0.1	0.5			
Pteridium aquilinum	27.5		25.6		23.4	46.4	21.9	
Comandra pallida		0.3		0.6	T			
Epilobium angustiflolium	10.6	0.4	5.2	2.4			T	
Apocynum pumilum			0.7			2.8	6.1	
Cynoglossum occidentale	0.7	T	T	T				
Lupinus lepidus		0.8		1.3	6.5			
Trientalis latifolia	2.7	T	37.6			22.5	25.5	
Bromus carinatus	T	0.3		1.2	1.7			
Calamagrostis rubescens		2.3		44.0	3.3			36.8
Pyrola picta			T		T	11.4	3.7	1.5
Smilacina amplexicaulis	T			T	0.1	2.6	T	13.2
Pyrola dentata	1.3		T					

Appendix 4, Part B, Section 5 (Cont'd.)

Species	P-D-32	P-D-37	P-D-33	P-D-39	P-D-38	P-D-35	P-D-34	P-D-40
Balsamorhiza careyana	T		T					
Elymus glaucus		0.1		0.3				
Phlox diffusa				0.4	1.7			
Trisetum canescens	T	0.7		0.2				
Campanula scouleri	0.6		1.6					
Cirsium centaurea		0.2		1.1	T			
Lotus crassifolius	T							
Erigeron peregrinus		1.8						
Lupinus leucophyllus			0.4					
Goodyera oblongifolia								1.3
Aquilegia formosa		T						
Gilia aggregata				T				
Pyrola aphylla			T		T			T
Osmorhiza chilensis				T				9.4
Hackelia floribunda								T

Appendix 4, Part B, Section 6 - Deschutes Transect

Non-phanerophytic Life Form Spectra weighted by Rel. D.F.'s of constituent species

Stand Order - geographical, east to west

Life Form	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-22	P-D-9	P-D-12	P-D-20	P-D-16	P-D-17	P-D-19	P-D-21	P-D-10
Chamaephytes								0.3	T	0.4	0.5			1.5	0.2	0.4
Hemicryptophytes	45.6	36.9	58.6	40.9	41.5	36.3	75.9	93.9	68.8	54.0	51.8	66.0	63.9	76.1	92.7	59.8
Geophytes	0.5	7.9	1.8	5.4	1.2	1.0			1.0	0.2	2.1	2.9	1.2	0.7	0.5	0.2
Therophytes	5.4	55.1	39.6	53.8	57.3	62.8	24.1	5.8	30.4	45.5	45.6	31.1	33.9	21.7	6.6	36.9

Non-phanerophytic Life Form Spectra weighted by Rel. I.V.'s of constituent species

Life Form	P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-22	P-D-9	P-D-12	P-D-20	P-D-16	P-D-17	P-D-19	P-D-21	P-D-10
Chamaephytes								0.2	T	0.9	0.7			1.7	0.2	0.3
Hemicryptophytes	59.5	53.6	71.0	53.1	58.0	54.2	83.9	95.1	77.0	63.4	60.1	73.6	74.3	79.9	95.1	69.6
Geophytes	0.3	7.9	1.5	3.6	1.4	0.6			0.7	0.1	1.4	3.0	1.5	0.4	0.2	0.1
Therophytes	40.2	38.5	27.4	43.4	40.5	45.2	16.1	4.7	22.3	35.8	37.2	23.4	24.3	17.9	4.4	30.0

Appendix 4, Part B, Section 6 (Cont'd.)

Life Form	P-D-7	P-D-13	P-D-11	P-D-18	P-D-14	P-D-15	P-D-27	P-D-24	P-D-25	P-D-28	P-D-26	P-D-30	P-D-29	P-D-23	P-D-31	P-D-32
Chamaephytes		T	0.4	1.5	0.7		0.5				1.8	0.6	0.9	T	0.4	0.8
Hemicryptophytes	80.8	56.1	45.8	57.3	80.2	60.7	96.9	100.0	100.0	100.0	97.5	98.7	97.5	98.8	95.4	95.9
Geophytes	2.4	T	T	0.2		0.8	T		T	T	T	0.3	T		0.2	3.3
Therophytes	16.8	43.9	53.8	41.2	19.1	38.5	2.7				0.7	0.4	1.6	1.2	3.4	T

Life Form	P-D-7	P-D-13	P-D-11	P-D-18	P-D-14	P-D-15	P-D-27	P-D-24	P-D-25	P-D-28	P-D-26	P-D-30	P-D-29	P-D-23	P-D-31	P-D-32
Chamaephytes		T	0.3	1.0	0.5		0.8				1.4	0.4	0.6	T	0.6	1.0
Hemicryptophytes	86.4	68.1	56.1	66.8	86.4	68.4	97.6	100.0	100.0	100.0	98.1	99.1	98.4	99.1	96.6	70.1
Geophytes	1.6	T	T	0.1		1.2	T		T	T	T	0.2	T		0.2	2.2
Therophytes	12.0	31.9	43.6	32.0	13.3	30.4	1.8				0.5	0.2	1.1	0.9	2.9	T

Appendix 4, Part B, Section 6 (Cont'd.)

Life Form	P-D-37	P-D-39	P-D-33	P-D-36	P-D-38	P-D-40	P-D-35	P-D-34
Chamaephytes	1.8	1.1	0.8		0.7	26.7	16.8	37.3
Hemicryptophytes	98.2	98.9	98.8	91.3	99.3	73.3	81.3	62.7
Geophytes	T		0.2	1.1	T	T	1.9	T
Therophytes			0.3	7.6				

Life Form	P-D-37	P-D-39	P-D-33	P-D-36	P-D-38	P-D-40	P-D-35	P-D-34
Chamaephytes	1.6	1.0	0.7		0.6	29.8	14.1	42.8
Hemicryptophytes	98.4	99.0	99.0	94.2	99.4	70.2	84.6	57.2
Geophytes	T		0.1	0.7	T	T	1.3	T
Therophytes			0.2	5.1				

Appendix 5, Part A, Section 1

Tree Data Summary - by size-class intervals - Warm Springs Transect

Basis of Order: Stands - geographical, east to west; Species - sociological

Species	Size Class	Stand P-W-1			Stand P-W-2			Stand P-W-3			Stand P-W-4		
		Den-sity	Fre-quency	Basal (ft.^{2}) Area	Den-sity	Fre-quency	Basal Area	Den-sity	Fre-quency	Basal Area	Den-sity	Fre-quency	Basal Area
	1-4" d.b.h.	45	42	1.65	96	91	3.18	239	206	9.53	158	129	3.48
	5-11" d.b.h.	18	18	5.27	35	33	7.72	77	74	19.67	26	26	11.49
Pinus	12-21" d.b.h.	7	7	10.48	8	8	11.91	20	20	26.81	50	50	70.11
ponderosa	21-30" d.b.h.	1	1	3.14	7	7	23.95	13	13	48.70	14	14	48.12
	31" + d.b.h.							1	1	5.94	2	2	12.24
	Sum 4" +	26	26	18.89	50	48	43.58	111	108	101.12	92	92	141.96
	Sum 1" +	71	68	20.54	146	139	46.76	350	314	110.65	250	221	145.44
	1-4" d.b.h.	40	38	1.20	25	21	0.75	23	22	0.78	2	2	0.06
	5-11" d.b.h.	20	18	6.64	3	3	1.13	2	2	0.69			
Juniperus	12-21" d.b.h.	1	1	1.23	4	4	4.33	2	2	2.56			
occidentalis	21-30" d.b.h.				1	1	3.41				1	1	5.59
	31" + d.b.h.												
	Sum 4" +	21	19	7.87	8	8	8.87	4	4	3.25	1	1	5.59
	Sum 1" +	61	57	9.07	33	29	9.62	27	26	4.03	3	3	5.65

Divide all values by 2.75 to obtain units per acre.

Appendix 5, Part A, Section 1 (Cont'd.)

Species	Size Class	Stand P-W-5			Stand P-W-6			Stand P-W-7			Stand P-W-8		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pinus ponderosa	1-4" d.b.h.	427	321	10.26	65	47	1.29	421	181	5.91	901	359	14.38
	5-11" d.b.h.	45	45	14.56	39	38	15.65	33	33	14.70	36	33	13.63
	12-21" d.b.h.	37	36	52.52	80	79	117.03	96	96	142.77	69	69	112.36
	21-30" d.b.h.	21	21	68.50	23	23	76.84	31	30	103.64	28	28	100.38
	31" + d.b.h.	1	1	13.77	1	1	5.59	1	1	7.07	4	4	28.43
	Sum 4" +	104	103	149.35	143	141	215.11	161	160	268.18	137	134	254.80
	Sum 1" +	531	424	159.61	208	188	216.40	582	341	274.09	1038	493	269.18
Juniperus occidentalis	1-4" d.b.h.	13	12	0.29	1	1	0.01				38	38	1.76
	5-11" d.b.h.	2	2	0.34							5	5	1.30
	12-21" d.b.h.	1	1	1.58									
	21-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +	3	3	1.92							5	5	1.30
	Sum 1" +	16	15	2.21	1	1	0.01				43	43	3.06
Libocedrus decurrens	1-4" d.b.h.							4	4	0.04	20	20	0.40
	5-11" d.b.h.												
	12-21" d.b.h.												
	21-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +												
	Sum 1" +							4	4	0.04	20	20	0.40

Divide all values by 2.75 to obtain units per acre.

Appendix 5, Part A, Section 1 (Cont'd.)

Species	Size Class	Stand P-W-9			Stand P-W-10			Stand P-W-11			Stand P-W-12		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pinus ponderosa	1-4" d.b.h.	232	137	3.94	246	43	2.85	89	50	1.59	507	214	7.62
	5-11" d.b.h.	19	19	7.87	23	23	8.30	55	55	22.15	68	67	25.59
	12-21" d.b.h.	55	54	93.30	62	61	100.13	75	75	112.66	76	76	121.23
	22-30" d.b.h.	37	37	121.49	48	48	164.65	34	34	105.96	35	34	123.53
	31" + d.b.h.	6	6	35.07	4	4	23.10	7	7	43.94	6	4	42.31
	Sum 4" +	117	116	257.73	137	136	296.18	171	171	284.71	195	181	312.66
	Sum 1" +	349	253	261.67	383	179	299.03	260	221	286.30	691	395	320.28
Juniperus occidentalis	1-4" d.b.h.										1	1	0.01
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" d.b.h.												
	Sum 4" +												
	Sum 1" +										1	1	0.01
Libocedrus decurrens	1-4" d.b.h.	66	58	1.30	120	98	2.92	5	5	0.05	115	106	2.67
	5-11" d.b.h.	4	4	0.95	1	1	0.14				15	15	3.97
	12-21" d.b.h.	1	1	1.97	1	1	2.41						
	22-30" d.b.h.	2	2	7.97	3	3	10.51				1	1	3.69
	31" + d.b.h.				1	1	16.50						
	Sum 4" +	7	7	10.89	6	6	29.56				16	16	7.66
	Sum 1" +	73	65	12.19	126	104	32.48	5	5	0.05	130	121	10.33
Pseudotsuga menziesii	1-4" d.b.h.				1	1	0.01	1	1	0.01	13	12	0.44
	5-11" d.b.h.										2	2	0.41
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +										2	2	0.41
	Sum 1" +				1	1	0.01	1	1	0.01	15	14	0.85
Abies grandis	1-4" d.b.h.							1	1	0.02	1	1	0.01
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" d.b.h.												
	Sum 1" d.b.h.							1	1	0.02	1	1	0.01

Divide all values by 2.75 to obtain units per acre.

Appendix 5, Part A, Section 1 (Cont'd.)

Species	Size Class	Stand P-W-15			Stand P-W-14			Stand P-W-13			Stand P-W-16		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pinus ponderosa	1-4" d.b.h.	684	349	9.78	565	264	6.32	315	213	6.38	158	104	1.86
	5-11" d.b.h.	41	40	14.72	16	16	5.55	38	34	11.07	10	9	5.37
	12-21" d.b.h.	56	56	84.06	40	39	63.22	26	26	39.45	24	24	40.71
	22-30" d.b.h.	9	8	29.35	23	23	77.37	27	27	92.12	24	24	85.55
	31" + d.b.h.	1	1	5.59	3	3	19.48	6	6	38.02	7	5	51.84
	Sum 4" +	107	105	133.72	82	81	165.62	97	93	180.66	65	62	183.47
	Sum 1" +	791	454	143.50	647	345	171.94	412	306	187.04	223	166	185.33
Juniperus occidentalis	1-4" d.b.h.	4	4	0.04	1	1	0.01						
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +												
	Sum 1" +	4	4	0.04	1	1	0.01						
Libocedrus decurrens	1-4" d.b.h.	43	37	0.62	86	79	1.19	237	170	3.91	249	197	4.06
	5-11" d.b.h.				1	1	0.14	5	5	0.97	10	10	2.85
	12-21" d.b.h.				2	1	3.54	1	1	2.41	8	8	12.84
	22-30" d.b.h.							2	1	5.78	10	10	35.21
	31" + d.b.h.							1	1	5.59			
	Sum 4" +				1	1	3.68	9	8	14.75	28	28	50.90
	Sum 1" +	43	37	0.62	87	80	4.87	246	178	18.66	277	225	54.96
Pseudotsuga menziesii	1-4" d.b.h.	137	120	4.08	663	540	19.90	1378	751	33.78	1161	663	21.36
	5-11" d.b.h.	48	48	13.98	145	137	37.96	119	101	27.03	60	58	14.25
	12-21" d.b.h.	11	11	3.54	15	15	17.45	10	10	12.99	29	29	45.31
	22-30" d.b.h.	3	3	11.98	10	9	32.29	10	10	38.00	20	16	68.53
	31" + d.b.h.				2	2	19.84	9	9	83.01	13	13	113.61
	Sum 4" +	62	62	29.50	172	163	107.54	148	130	161.03	123	116	241.70
	Sum 1" +	199	182	33.58	835	703	127.44	1526	881	194.81	1284	779	263.06
Abies grandis	1-4" d.b.h.				1	1	0.01	1	1	0.01	2	2	0.10
	5-11" d.b.h.												
	12-21" d.b.h.										1	1	0.79
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" d.b.h.										1	1	0.79
	Sum 1" d.b.h.				1	1	0.01	1	1	0.01	3	3	0.89

Divide all values by 2.75 to obtain units per acre.

Appendix 5, Part A, Section 2

Tree Sapling (1' to 6' high) and Seedling (to 1' high) Data Summary - Warm Springs Transect

Basis of Order: Stands - geographical, east to west; Species - sociological

Species	Size Class	Stand															
		P-W-1	P-W-2	P-W-3	P-W-4	P-W-5	P-W-6	P-W-7	P-W-8	P-W-9	P-W-10	P-W-11	P-W-12	P-W-15	P-W-14	P-W-13	P-W-16
Pinus	Seedlings		1		3		5	16	10	16	2	23	4	1	2	1	1
ponderosa	Saplings	15	115	117	363	1102	1204	1504	714	403	1699	917	1982	429	817	456	411
Juniperus	Seedlings	2															
occidentalis	Saplings	123	58	56	4	30	4	2	14		1	5	3	2	2		1
Libocedrus	Seedlings										9		1			3	11
decurrens	Saplings						4	12	14	297	1494	23	793	145	226	902	840
Pseudotsuga	Seedlings										1			2	4	9	6
menziesii	Saplings									1	1	1	12	65	326	545	599
Abies	Seedlings																
grandis	Saplings										2	1	2		1		

Multiply seedling values by 80.67 to obtain a random estimate of plants per acre (data from 60 randomized 3'x3' sub-plots within the macro-plot).

Divide sapling values by 2.75 to obtain number of stems per acre.

Appendix 5, Part B, Section 1

Tree Data Summary - by size-class intervals - Deschutes Transect

Basis of Order: Stands - Rel. I. V. (1" d. b. h. +) curve of Pinus ponderosa, secondly by xerism to misism of other tree components.
Species - sociological

Species	Size Class	Stand P-D-5 Density	Stand P-D-5 Frequency	Stand P-D-5 Basal Area	Stand P-D-2 Density	Stand P-D-2 Frequency	Stand P-D-2 Basal Area	Stand P-D-1 Density	Stand P-D-1 Frequency	Stand P-D-1 Basal Area	Stand P-D-4 Density	Stand P-D-4 Frequency	Stand P-D-4 Basal Area
Pinus ponderosa	1-4" d. b. h.	64	57	2.07	50	44	2.54	11	11	0.50	171	145	7.29
	5-11" d. b. h.	53	52	14.17	66	64	23.32	43	42	15.08	166	155	49.73
	12-21" d. b. h.	6	6	7.96	47	45	43.08	22	20	25.94	43	43	52.30
	22-30" d. b. h.	8	8	28.29	2	2	6.33						
	31" + d. b. h.	1	1	5.59									
	Sum 4" +	68	67	56.01	115	111	72.73	65	62	41.02	209	198	102.03
	Sum 1" +	132	124	58.08	165	155	75.27	76	73	41.52	380	343	109.32
Juniperus occidentalis	1-4" d. b. h.	148	119	4.32	106	97	4.11	36	32	1.33	53	39	2.05
	5-11" d. b. h.	35	34	10.77	47	43	12.35	38	37	11.23	48	45	15.48
	12-21" d. b. h.	17	17	25.47	17	17	22.87	3	3	2.94	4	4	4.77
	22-30" d. b. h.	9	9	36.14	5	5	17.12						
	31" + d. b. h.	2	2	14.14									
	Sum 4" +	63	62	86.52	69	65	52.34	41	40	14.17	52	49	20.25
	Sum 1" +	211	181	90.84	175	162	56.45	77	72	15.50	105	88	22.30

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 1 (Cont'd.)

Species	Size Class	Stand P-D-6			Stand P-D-8			Stand P-D-3			Stand P-D-22		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pinus ponderosa	1-4" d.b.h.	165	127	5.02	42	36	1.68	58	55	2.89	109	63	2.35
	5-11" d.b.h.	101	89	30.03	47	45	18.35	72	71	24.01	3	3	1.43
	12-21" d.b.h.	21	20	30.15	40	40	51.23	63	60	87.51	38	37	67.76
	22-30" d.b.h.	11	11	31.38	24	24	81.82	37	37	122.13	39	39	131.63
	31" + d.b.h.	3	3	16.77	1	1	14.73	1	1	5.94	6	6	30.16
	Sum 4" +	136	123	108.33	112	110	166.13	173	169	239.59	86	85	230.98
	Sum 1" +	301	250	113.35	154	146	167.81	231	224	242.48	195	148	233.33
Juniperus occidentalis	1-4" d.b.h.	41	35	1.49	9	9	0.21	14	13	0.42			
	5-11" d.b.h.	26	26	9.24	10	10	3.35	17	17	5.68			
	12-21" d.b.h.	2	2	2.14	1	1	1.07						
	22-30" d.b.h.	1	1	3.69									
	31" + d.b.h.												
	Sum 4" +	29	29	15.07	11	11	4.42	17	17	5.68			
	Sum 1" +	70	64	16.56	20	20	4.63	31	30	6.10			
Libocedrus decurrens	1-4" d.b.h.										19	19	0.54
	5-11" d.b.h.										5	5	0.74
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +										5	5	0.74
	Sum 1" +										24	24	1.28

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 1 (Cont'd.)

Species	Size Class	Stand P-D-9			Stand P-D-12			Stand P-D-20			Stand P-D-16		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pinus ponderosa	1-4" d.b.h.	431	251	6.93	180	128	5.95	223	100	3.51	456	354	14.02
	5-11" d.b.h.	55	51	16.79	93	90	29.39	9	9	3.45	563	188	59.12
	12-21" d.b.h.	45	42	68.56	45	44	58.35	39	38	65.06	54	52	68.46
	22-30" d.b.h.	22	22	73.70	14	13	50.77	36	36	121.53	6	6	20.03
	31" + d.b.h.				7	7	52.81	3	3	19.69	2	2	12.27
	Sum 4" +	122	115	159.05	159	154	191.32	87	86	209.73	625	248	159.88
	Sum 1" +	653	366	165.98	339	282	197.27	310	186	213.24	1081	602	173.90
Juniperus occidentalis	1-4" d.b.h.	33	32	0.85	11	11	0.23	12	12	0.37	24	23	0.87
	5-11" d.b.h.	2	2	0.82				1	1	0.14	11	11	2.81
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +	2	2	0.82				1	1	0.14	11	11	2.81
	Sum 1" +	35	34	1.67	11	11	0.23	13	13	0.51	35	34	3.68

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 1 (Cont'd.)

Species	Size Class	Stand P-D-17			Stand P-D-19			Stand P-D-21			Stand P-D-10		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pinus ponderosa	1-4" d.b.h.	187	149	6.39	720	468	12.43	354	210	7.81	204	156	7.12
	5-11" d.b.h.	81	74	21.87	29	27	6.85	39	35	11.26	217	201	73.79
	12-21" d.b.h.	34	33	50.50	30	30	48.61	34	33	53.99	61	58	70.74
	22-30" d.b.h.	25	25	83.41	31	30	109.50	18	17	68.71	12	12	34.93
	31" + d.b.h.	4	4	26.03	4	4	23.84	10	10	55.25	2	2	12.24
	Sum 4" +	144	136	180.81	94	91	188.80	101	95	189.21	292	273	191.70
	Sum 1" +	331	285	187.20	814	559	201.23	455	305	197.02	496	429	200.82
Juniperus occidentalis	1-4" d.b.h.	12	12	0.28	25	25	0.35	12	10	0.50	8	8	0.35
	5-11" d.b.h.	3	3	0.54	5	5	0.95	2	2	0.28	3	3	0.99
	12-21" d.b.h.										2	2	3.17
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +	3	3	0.54	5	5	0.95	2	2	0.28	5	5	4.16
	Sum 1" +	15	15	0.82	30	30	1.30	14	12	0.78	13	13	4.51
Abies grandis	1-4" d.b.h.							1	1	0.05			
	5-11" d.b.h.							1	1	0.35			
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +							1	1	0.35			
	Sum 1" +							2	2	0.40			
Libocedrus decurrens	1-4" d.b.h.							1	1	0.02			
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +												
	Sum 1" +							1	1	0.02			

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 1 (Cont'd.)

Species	Size Class	Stand P-D-7			Stand P-D-13			Stand P-D-11			Stand P-D-18		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
	1-4" d.b.h.	430	261	10.84	169	103	2.93	149	108	5.61	384	229	9.69
	5-11" d.b.h.	141	124	42.99	40	39	14.05	144	136	48.64	92	87	31.54
	12-21" d.b.h.	71	70	97.39	44	44	69.50	69	67	89.39	31	31	45.47
Pinus ponderosa	22-30" d.b.h.	13	13	41.00	39	39	120.78	16	16	53.07	21	21	78.40
	31" + d.b.h.				6	5	19.77	2	2	13.37	5	5	20.04
	Sum 4" +	225	207	181.38	129	127	224.10	231	221	204.47	149	144	175.45
	Sum 1" +	655	468	192.22	298	230	227.03	380	329	210.08	533	373	185.14
	1-4" d.b.h.	16	15	0.37	5	5	0.06	5	3	0.05	4	4	0.18
	5-11" d.b.h.				2	2	0.34	2	2	0.82			
Juniperus occidentalis	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +				2	2	0.34	2	2	0.82			
	Sum 1" +	16	15	0.37	7	7	0.40	7	5	0.87	4	4	0.18

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 1 (Cont'd.)

Species	Size Class	Stand P-D-14			Stand P-D-15			Stand P-D-27			Stand P-D-24		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pinus ponderosa	1-4" d.b.h.	211	126	3.60	417	287	11.78	300	131	6.12	928	597	13.60
	5-11" d.b.h.	13	13	5.70	147	135	43.86	16	16	6.84	7	6	2.10
	12-21" d.b.h.	41	39	63.26	36	35	48.16	60	60	102.04	30	29	54.54
	22-30" d.b.h.	15	15	51.56	13	12	45.35	32	32	112.47	52	48	196.15
	31" + d.b.h.	4	4	32.27	1	1	6.30	3	3	18.61	7	7	42.46
	Sum 4" +	73	71	152.79	197	183	143.67	111	111	239.96	96	90	295.25
	Sum 1" +	284	197	156.39	614	470	155.45	411	242	246.08	1024	687	308.85
Juniperus occidentalis	1-4" d.b.h.	1	1	0.01	1	1	0.01						
	5-11" d.b.h.				1	1	0.20						
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +				1	1	0.20						
	Sum 1" +	1	1	0.01	2	2	0.21						
Pinus contorta	1-4" d.b.h.										1	1	0.01
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +												
	Sum 1" +										1	1	0.01

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 1 (Cont'd.)

Species	Size Class	Stand P-D-25			Stand P-D-28			Stand P-D-26			Stand P-D-30		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pinus ponderosa	1-4" d.b.h.	1573	1113	25.74	832	352	12.12	324	183	6.12	1753	923	27.92
	5-11" d.b.h.	4	4	1.24	73	70	23.35	30	30	10.97	76	68	22.70
	12-21" d.b.h.	17	17	31.67	60	59	94.11	52	50	80.15	14	14	23.78
	22-30" d.b.h.	40	40	146.08	31	31	107.90	33	32	89.97	24	24	96.87
	31" + d.b.h.	7	7	43.76	3	3	23.59	3	3	15.72	13	13	71.72
	Sum 4" +	68	68	222.75	167	163	248.95	118	115	196.81	127	119	215.07
	Sum 1" +	1641	1249	248.49	999	515	261.07	442	298	202.93	1880	1042	242.99
Abies grandis	1-4" d.b.h.	1	1	0.01	3	3	0.11				4	4	0.20
	5-11" d.b.h.										4	4	0.68
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +										4	4	0.68
	Sum 1" +	1	1	0.01	3	3	0.11				8	8	0.88
Libocedrus decurrens	1-4" d.b.h.										1	1	0.05
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +												
	Sum 1" +										1	1	0.05

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 1 (Cont'd.)

Species	Size Class	Stand P-D-25			Stand P-D-28			Stand P-D-26			Stand P-D-30		
		Den-sity	Fre-quency	Basal Area	Den-sity	Fre-quency	Basal Area	Den-sity	Fre-quency	Basal Area	Den-sity	Fre-quency	Basal Area
Pseudotsuga menziesii	1-4" d.b.h.										4	4	0.09
	5-11" d.b.h.										1	1	0.20
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +										1	1	0.20
	Sum 1" +										5	5	0.29
Pinus monticola	1-4" d.b.h.							3	3	0.08			
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +												
	Sum 1"+							3	3	0.08			
Pinus contorta	1-4" d.b.h.	3	3	0.06									
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +												
	Sum 1" +	3	3	0.06									

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 1 (Cont'd.)

Species	Size Class	Stand P-D-29			Stand P-D-23			Stand P-D-31			Stand P-D-32		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pinus ponderosa	1-4" d.b.h.	42	30	0.79	238	107	3.38	1225	810	28.91	1527	1068	38.09
	5-11" d.b.h.	26	26	11.03	7	7	2.57	117	111	30.01	164	141	34.74
	12-21" d.b.h.	50	49	93.39	32	31	54.73	41	40	63.05	14	14	21.33
	22-30" d.b.h.	23	22	89.06	51	49	155.60	34	34	110.87	25	25	97.04
	31" + d.b.h.	10	10	62.37	9	9	29.88	5	5	18.96	16	16	101.56
Juniperus occidentalis	1-4" d.b.h.	1	1	0.01	3	3	0.03						
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +												
	Sum 1" +	1	1	0.01	3	3	0.03						
Abies grandis	1-4" d.b.h.	1	1	0.01				10	10	0.47	16	15	0.86
	5-11" d.b.h.							7	7	2.17	17	17	4.84
	12-21" d.b.h.										2	2	1.86
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +							7	7	2.17	19	19	6.70
	Sum 1" +	1	1	0.01				17	17	2.64	35	34	7.56
Libocedrus decurrens	1-4" d.b.h.				1	1	0.01	1	1	0.05			
	5-11" d.b.h.				1	1	0.20						
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +				1	1	0.20						
	Sum 1" +				2	2	0.21	1	1	0.05			

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 1 (Cont'd.)

Species	Size Class	Stand P-D-29			Stand P-D-23			Stand P-D-31			Stand P-D-32		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pseudotsuga menziesii	1-4" d.b.h.							13	12	0.59	28	27	1.49
	5-11" d.b.h.							3	3	0.28	18	18	4.00
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +							3	3	0.28	18	18	4.00
	Sum 1" +							16	15	0.87	28	27	5.49
Pinus monticola	1-4" d.b.h.							1	1	0.01			
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" d.b.h.												
	Sum 4" +												
	Sum 1" +							1	1	0.01			
Pinus contorta	1-4" d.b.h.										1	1	0.01
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" d.b.h.												
	Sum 4" +												
	Sum 1" +										1	1	0.01

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 1 (Cont'd.)

Species	Size Class	Stand P-D-37			Stand P-D-33			Stand P-D-39			Stand P-D-36		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pinus ponderosa	1-4" d.b.h.	584	366	10.20	538	364	11.00	611	420	15.31	1009	583	21.18
	5-11" d.b.h.	12	12	4.07	20	19	6.85	85	84	19.19	117	107	30.96
	12-21" d.b.h.	43	43	77.18	51	51	80.37	22	22	38.83	20	20	30.73
	22-30" d.b.h.	31	31	116.87	42	37	154.01	25	25	88.43	18	17	64.40
	31" + d.b.h.	11	11	72.96	6	6	32.11	15	15	94.93	10	10	57.95
	Sum 4" +	97	97	271.08	119	113	273.34	147	146	241.38	165	154	184.04
	Sum 1" +	681	463	281.28	657	477	284.34	758	566	256.69	1174	737	205.22
Abies grandis	1-4" d.b.h.	33	31	0.68	20	19	1.07	183	171	7.13	24	24	1.29
	5-11" d.b.h.	13	13	3.60	40	38	10.30	104	101	29.93	12	12	2.71
	12-21" d.b.h.	1	1	1.77	1	1	0.92	13	13	42.20			
	22-30" d.b.h.	1	1	2.89									
	31" + d.b.h.												
	Sum 4" +	15	15	8.26	41	39	11.22	117	114	72.13	12	12	2.71
	Sum 1" +	48	46	8.94	61	58	12.29	300	285	79.26	36	36	4.00
Libocedrus decurrens	1-4" d.b.h.				23	21	0.66				126	111	2.98
	5-11" d.b.h.				2	2	0.62				5	5	1.09
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +				2	2	0.62				5	5	1.09
	Sum 1" +				25	23	1.28				131	116	4.09
Pseudotsuga menziesii	1-4" d.b.h.	3	2	0.03	110	101	5.23	1	1	0.01	349	280	12.20
	5-11" d.b.h.				95	94	23.63				139	130	35.87
	12-21" d.b.h.				1	1	0.79				1	1	0.79
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +				96	95	24.42				140	131	36.66
	Sum 1" +	3	3	0.03	206	196	29.65	1	1	0.01	489	411	48.86
Pinus monticola	1-4" d.b.h.	1	1	0.01									
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +												
	Sum 1" +	1	1	0.01									

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 1 (Cont'd.)

Species	Size Class	Stand P-D-38			Stand P-D-40			Stand P-D-35			Stand P-D-34		
		Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area	Density	Frequency	Basal Area
Pinus ponderosa	1-4" d.b.h.	306	177	7.53	6	6	0.46	92	83	4.11	78	62	2.44
	5-11" d.b.h.	48	44	11.64	14	14	5.94	37	36	8.15	33	30	12.01
	12-21" d.b.h.	34	34	54.69	59	58	97.32	3	3	4.60	12	12	18.20
	22-30" d.b.h.	40	39	139.55	27	27	91.18	10	9	34.53	7	7	24.53
	31" + d.b.h.	13	13	86.08	6	6	36.10	10	10	67.85	7	7	42.18
	Sum 4" +	135	130	291.96	106	105	230.54	60	58	115.13	59	56	96.92
	Sum 1" +	441	307	299.49	112	111	231.00	152	141	119.24	137	118	99.36
Abies grandis	1-4" d.b.h.	285	219	9.18	1482	990	50.31	395	310	16.55	2284	1484	66.33
	5-11" d.b.h.	105	101	25.22	402	365	101.05	271	244	85.81	179	167	44.78
	12-21" d.b.h.	14	14	19.10	71	70	87.00	41	40	40.02	28	27	37.59
	22-30" d.b.h.	1	1	2.89	9	9	30.22				5	5	14.50
	31" + d.b.h.	1	1	5.59	1	1	7.88						
	Sum 4" +	121	117	52.80	483	445	226.15	312	284	125.83	212	199	96.87
	Sum 1" +	406	336	61.98	1965	1435	276.46	707	594	142.38	2496	1683	163.20
Libocedrus decurrens	1-4" d.b.h.	1	1	0.01				639	443	12.00	4	4	0.09
	5-11" d.b.h.							21	20	5.30			
	12-21" d.b.h.							2	2	2.81			
	22-30" d.b.h.												
	31" + d.b.h.							1	1	8.30			
	Sum 4" +							24	23	16.41			
	Sum 1" +	1	1	0.01				663	466	28.41	4	4	0.09
Pseudotsuga menziesii	1-4" d.b.h.							173	152	6.68	61	55	1.95
	5-11" d.b.h.							167	162	57.38	11	10	3.06
	12-21" d.b.h.							24	24	30.71	18	18	28.42
	22-30" d.b.h.							4	4	14.35	9	9	36.28
	31" + d.b.h.							3	3	27.66	5	5	34.51
	Sum 4" +							198	193	130.10	43	42	102.27
	Sum 1" +							371	345	136.78	104	97	104.22
Pinus monticola	1-4" d.b.h.				1	1	0.01	2	2	0.11			
	5-11" d.b.h.												
	12-21" d.b.h.												
	22-30" d.b.h.												
	31" + d.b.h.												
	Sum 4" +												
	Sum 1" +				1	1	0.01	2	2	0.11			

Divide all values by 2.30 to obtain units per acre.

Appendix 5, Part B, Section 2

Tree Sapling (1' to 6' high) and Seedling (to 1' high) Data Summary - Deschutes Transect

Basis of Order: Stands - Rel.I.V. (1" d.b.h.+ curve of *Pinus ponderosa*, secondly by xerism to mesism of other tree components

Species - Sociological

Species	Size Class	Stand															
		P-D-5	P-D-2	P-D-1	P-D-4	P-D-6	P-D-8	P-D-3	P-D-22	P-D-9	P-D-12	P-D-20	P-D-16	P-D-17	P-D-19	P-D-21	P-D-10
Pinus	Seedlings						1		3		2				9	3	1
ponderosa	Saplings	18	11	10	51	72	15	3	595	908	252	226	310	273	903	460	190
Juniperus	Seedlings					2				1					1		
occidentalis	Saplings	100	84	20	33	21	23	20	3	23	14	3	6	11	8	8	11
Abies	Seedlings																
grandis	Saplings															5	
Libocerdrus	Seedlings																
decurrens	Saplings								8								
Pseudotsuga	Seedlings																
menziesii	Saplings																
Pinus	Seedlings																
contorta	Saplings																
Tsuga	Seedlings																
mertensiana	Saplings																

Divide sapling values by 2.30 to obtain units per acre.

Multiply seedling values by 64.53 to obtain an estimate of individuals per acre.

Appendix 5, Part B, Section 2 (Cont'd.)

Species	Size Class	Stand															
		P-D-7	P-D-13	P-D-11	P-D-18	P-D-14	P-D-15	P-D-27	P-D-24	P-D-25	P-D-28	P-D-26	P-D-30	P-D-29	P-D-23	P-D-31	P-D-32
Pinus	Seedlings	6	2		8	2	3	5	3	2	1	1	1	6	5	11	3
ponderosa	Saplings	330	465	66	866	590	362	630	1212	1093	1576	762	1198	756	1606	662	599
Juniperus	Seedlings																
occidentalis	Saplings	4	10	3	1	2	2		1			2		1	13		1
Abies	Seedlings												1				
grandis	Saplings							1			1	2	4	1	1	5	2
Libocedrus	Seedlings																
decurrens	Saplings														5		
Pseudotsuga	Seedlings																
menziesii	Saplings											2				5	3
Pinus	Seedlings																
menticola	Saplings															1	3
Pinus	Seedlings																
contorta	Saplings											14	1		2		
Tsuga	Seedlings																
mertensiana	Saplings																

Divide sapling values by 2.30 to obtain units per acre.

Multiply seedling values by 64.53 to obtain an estimate of individuals per acre.

Appendix 5, Part B, Section 2 (Cont'd.)

Species	Size Class	Stand							
		P-D-37	P-D-33	P-D-39	P-D-36	P-D-38	P-D-40	P-D-35	P-D-34
Pinus	Seedings	6	2	1	4	7			
ponderosa	Saplings	587	320	542	949	884		1	18
Juniperus	Seedlings								
occidentalis	Saplings	1		1					
Abies	Seedlings			9		6	2	3	5
grandis	Saplings	152	6	142	8	197	689	126	564
Libocedrus	Seedlings								
decurrens	Saplings		8		70			403	1
Pseudotsuga	Seedlings	1							
menziesii	Saplings		13	2	90			26	14
Pinus	Seedlings								
menticola	Saplings		1						2
Pinus	Seedlings								
contorta	Saplings								
Tsuga	Seedlings								
mertensiana	Saplings						2		

Divide sapling values by 2.30 to obtain units per acre.

Multiply seedling values by 64.53 to obtain an estimate of individuals per acre.

Appendix 6. Selected Soil Profile Descriptions.

Part A. Warm Springs Transect

All soil profiles examined for the Warm Springs Transect can be classified under the Inceptisol Order, Ochrept Suborder, and Dystrochrept Great Group.

Stand P-W-1

Horizon	Depth	Description
0	1/4-0"	
A1	0-1"	Light brown (7.5YR 6/4 dry), dark brown (7.5YR 3/3 moist) loam; strong, medium, subangular blocky; slightly hard, slightly sticky, slightly plastic, many fine vesicular pores; many fine roots; pH 6.8; boundary clear, wavy.
A3	1-3"	Brown (7.5YR 5/4 dry), dark brown (7.5YR 3/2 moist) silt loam; moderate, fine, subangular blocky, slightly hard, slightly sticky, slightly plastic; many fine tubular pores; many roots; pH 7.1; boundary gradual, smooth.
B1	3-10"	Brown (7.5YR 5/4 dry), dark brown (7.5YR 3/2 moist) clay loam; strong, coarse, subangular blocky; hard, sticky, slightly plastic; many medium tubular pores; occasional shrub roots; pH 7.7; boundary diffuse, smooth; 2% slightly rounded gravel.
B2	10-15"	Brown (7.5YR 5/4 dry), dark brown (7.5YR 4/2 moist) cobbly(30%) clay loam; strong, coarse, subangular blocky; hard, sticky, slightly plastic, many fine tubular pores; occasional shrub roots; pH 7.8; boundary abrupt, smooth.
Csim	15-16"	Light brown (7.5YR 6/5 dry), dark brown (7.5YR 4/4 moist) silicate duripan; massive; extremely hard; boundary capping tops of unconsolidated rocks below.
C	16"+	Unconsolidated, partially decomposed stones making nearly 100% by volume of the profile.

Stand P-W-6

Horizon	Depth	Description
0	1/4-0"	
A1	0-3"	Brown (7.5YR 5/4 dry), dark brown (7.5YR 3/2 moist) sandy loam; weak, medium, subangular blocky breaking to fine granular; slightly hard, slightly sticky; slightly plastic; many fine vesicular pores; many fine roots; pH 7.5; boundary clear, smooth.
A3	3-9"	Light brown (7.5YR 6/4 dry), brown (7.5YR 4/4 moist) sandy loam; moderate, medium, subangular blocky breaking into moderate, fine, subangular blocky; slightly hard, slightly sticky, slightly plastic; many fine tubular pores; abundant roots; pH 7.2; boundary gradual, smooth.
B1	9-19"	Brown (7.5YR 5/4 dry), dark brown (7.5YR 4/3 moist) loam (5% cobbles); moderate, medium blocky; hard, slightly sticky, slightly plastic; abundant, fine tubular pores; occasional roots; pH 7.2; boundary gradual, smooth.
B3	19-42"	Light brown (7.5YR 6/5 dry), dark brown (7.5YR 4/4 moist) loam; strong coarse subangular blocky; hard sticky, plastic; many fine tubular pores; few roots pH 7.2; boundary clear, irregular.
Csim	25-42"	Very pale brown (10YR 7/4 dry), dark yellowish brown (10YR 4/4 moist) with numerous black flecks silicate fragipan; massive, extremely hard; Csim concretion starts at 25" and increase in volume and consolidation to 42".
C	42"+	Unconsolidated, partially decomposed stones with capping and tongues of Csim.

Stand P-W-15

0	1-0"	Mull type humus - loose needles and shrub litter.

Horizon	Depth	Description
A1	0-4"	Pale brown (10YR 6/3 dry), brown (10YR 4/3 moist) sandy loam; weak, medium, subangular blocky, breaking to medium, granular; slightly hard, slightly sticky, slightly plastic, common and abundant roots; pH 7.5; boundary gradual, regular.
B1	4-12"	Pale brown (10YR 6/3 dry), brown (10YR 4/3 moist) sandy loam; strong, medium, angular breaking to medium granular; hard, slightly sticky, slightly plastic; roots common, pH 7.4; boundary gradual, regular.
B2	12-18"	Very pale brown (10YR 7/3 dry), yellowish brown (10YR 5/4 moist) sandy loam; strong, coarse, angular breaking into medium subangular; hard, slightly sticky, slightly plastic; few roots; pH 7.1; boundary diffuse, irregular.
Csim	18-26"	Pinkish gray (7.5YR 7/2 dry), reddish yellow (7.5YR 6/6 moist) with black flecks,silicate fragipan; massive, extremely hard; concretions start at 12", increase in frequency until they form a continuous, consolidated layer above the C horizon.
C	26"+	Semi-consolidated pumicy sands and gravels, pumice gravel starts at 18", but not forming a continuous horizon until 26".

Stand P-W-16

0	1-0"	Mull type humus - loose needles and shrub litter.
A1	0-3"	Yellowish red (5YR 5/6 dry), dark reddish brown (5YR 3/3 moist) sandy loam; weak, medium to coarse subangular blocky breaking to medium crumb; slightly hard, nonsticky, non-plastic; roots common and abundant; pH 7.3; boundary gradual, smooth.
A3	3-10"	Yellowish red (5YR 5/6 dry), (5YR 4/6 moist) loam; moderate, coarse, subangular blocky breaking to medium crumb, slightly hard, non-sticky, non-plastic; roots common; pH 7.5; boundary gradual, smooth.

Horizon	Depth	Description
B2	10-16"	Reddish yellow (5YR 6/6 dry), yellowish red (5YR 4/6 moist) loam; strong, medium to coarse, subangular blocky breaking into fine, subangular, blocky; very hard, slightly sticky, slightly plastic; very few roots; pH 6.9; boundary diffuse, smooth.
B3	16-48"	Yellowish red (5YR 5/6), (5YR 4/6 moist) loam; strong, coarse blocky; extremely hard, slightly sticky, slightly plastic; root uncommon; pH 7.1; boundary diffuse, irregular.
Csim	48"+	Very pale brown (10YR 7/3 dry), light brownish gray (10YR 6/2 moist) silicate fragipan; massive, extremely hard; concretions start at 16" increase in frequency until they form a continuous, consolidated layer at 48"; large vesicular pores, no roots noted.

Appendix 6. Continued.

Part B. Deschutes Transect

All soil profiles examined for the Deschutes Transect can be classified under the Entisol Order, Ustent Suborder, and Psammustant Great Group.

Stand P-D-1

Horizon	Depth	Description
A1	0-3"	Light gray (10YR 7/2 dry), dark brown (10YR 3/3 moist) pumicy sand; structureless to weak, medium, subangular blocky breaking to single grain; soft to loose, nonsticky, nonplastic; pH 7.5; boundary gradual, smooth.
A3	3-8"	Light brownish gray (10YR 6/2 dry), very dark grayish brown (10YR 3/2 moist) pumicy sand; weak, medium, subangular blocky breaking to medium crumb and single grain; soft, nonsticky, nonplastic; pH 7.9; boundary gradual, smooth.
AC	8-17"	Light gray (10YR 7/2 dry), brown (10YR 4/3 moist) cobbly (30%) pumicy sand; moderate, medium to coarse subangular blocky breaking to medium crumb and single grain; slightly hard, nonsticky, nonplastic; pH 8.6; boundary abrupt, smooth.
Csim	17-20"	Pale brown (10YR 6/3 dry), dark yellowish brown (10YR 4/4 moist) silicate-cemented sandy fragipan; massive; very hard; coating upper surface of stone of the R horizon.
R	20"+	Basalt coated with layer of Csim material.

Stand P-D-4

A1	0-4"	Pale brown (10YR 6/3 dry), dark brown (10YR 3/3 moist) gravelly (20%) pumicy sand; mostly structureless, small proportion of weak, medium, subangular blocky; loose to soft, nonsticky, nonplastic; pH 7.9; boundary gradual, smooth.

Horizon	Depth	Description
AC	4-16"	Yellowish brown (10YR 5/4 dry), brown (10YR 4/3 moist) gravelly (30-40%) pumicy sand; mostly structureless, some moderately weak, medium, subangular blocky easily breaking to single grain; loose to soft, nonsticky, nonplastic; pH 8.0; boundary gradual, smooth.
C	16"+	Alluvium, 95% well-rounded pebbles, 5% well-washed cobbles.

Stand P-D-11

Horizon	Depth	Description
A1	0-4"	Brown (7.5YR 5/4 dry), very dark grayish brown (7.5YR 3/2 moist) pumicy loamy sand, (10% gravel); weak, medium, subangular blocky easily breaking to single grain; soft, nonstocky, nonplastic; pH 7.5; boundary gradual, smooth.
AC	4-16"	Yellowish brown (10YR 5/6 dry), brown (10YR 4/3 moist) coarse pumicy sand, (10% gravel); weak, coarse, subangular blocky readily breaking to single grain; soft, nonsticky, nonplastic; pH 7.5; boundary gradual, smooth.
Csim	16"+	Yellowish brown (10YR 5/6 dry), dark yellowish brown (10YR 4/4 moist) silicate-cemented pumicy sand fragipan; nearly massive with fragments of very strong, coarse, subangular blocky; common, medium-sized vesicular pores.
C	16-48"+	Alluvium, 20% moderately well-rounded pebbles, 10% moderately well-washed cobbles; all cemented together by extensions of Csim material.

Stand P-D-19

Horizon	Depth	Description
A1	0-3"	Yellowish brown (10YR 5/4 dry), dark yellowish brown (10YR 4/4 wet) loamy sand; weak, medium, subangular blocky readily breaking to single grain; soft, nonsticky, nonplastic; pH 7.4; boundary gradual, smooth.

Horizon	Depth	Description
AC	3-15"	Yellowish brown (10YR 5/6 dry), brown (10YR 4/3 moist) pumicy loamy sand; moderate, fine, subangular blocky breaking to single grain; slightly hard, nonsticky, nonplastic; pH 7.6; boundary gradual, smooth.
Csim	15-40"+	Yellowish brown (10YR 5/6 dry), brown (10YR 4/3 moist) silicate-cemented pumicy sand duripan, (10% moderately well-rounded pebbles); nearly massive breaking with difficulty into fragments of strong, coarse, subangular blocky; few, small vesicular pores.

Stand P-D-23

A1	0-4"	Dark reddish gray (5YR 4/2 dry), dark reddish brown (5YR 2/2 moist) loamy sand, (5% moderately well-rounded pebbles); very weak, medium to fine, subangular blocky breaking readily to single grain; soft, non-sticky, non-plastic; pH 7.4; boundary gradual, smooth.
AC	4-18"	Yellowish brown (10YR 5/4 dry), brown (10YR 4/3 moist) pumicy sand (1% moderately well-rounded pebbles); weak, medium, subangular blocky readily breaking to single grain; soft, non-sticky, non-plastic; pH 7.9; boundary abrupt, smooth.
IIAC	18-36"+	Strong brown (7.5YR 5/6 dry), dark brown 7.5YR 4/4 moist) gravelly (30%) pumicy coarse sand, (5% little washed cobbles); weak, fine to medium, subangular blocky breaking to single grain; soft, non-sticky, non-plastic; pH 7.8; profile includes fragments of appearance described for Csim from previous profiles, but a continuous duripan not encountered in the profile sampled here.

Stand P-D-28

0	2-0"	Mull type humus chiefly from conifer needles and shrub litter.

Horizon	Depth	Description
A1	0-4"	Dark brown (7.5YR 4/4 dry), (7.5YR 3/2 moist) pumicy loamy sand (1% slightly rounded pumice pebbles); net-like structure due to root masses, readily breaking into single grain; soft, non-sticky, non-plastic; pH 7.3; boundary gradual, smooth.
AC1	4-20"	Strong brown (7.5YR 5/6 dry), dark brown (7.5YR 4/4 moist) pumicy sand, (2% slightly rounded fine pumicy pebbles); weak, medium to fine subangular blocky breaking readily to single grain; soft, non-sticky, non-plastic; pH 8.0; boundary clear, smooth.
AC2	20-52"+	Brownish yellow (10YR 6/6 dry), dark yellowish brown (10YR 4/4 moist) pumicy sand, (5% slightly rounded pumicy pebbles); weak, medium to coarse, subangular blocky breaking to single grain; soft, non-sticky, non-plastic; pH 7.7; (increasing size and density of gravel with depth).

Stand P-D-35

0	2-0"	Mull type humus, primarily from conifer needles.
A1	0-3"	Brown (7.5YR 5/4 dry), dark brown (7.5YR 3/2 moist) fine slightly washed gravelly (60%) coarse pumicy sand; single grain; loose, non-sticky, non-plastic; pH 6 8; boundary gradual, smooth.
C1	3-15"	Alluvium, light yellowish brown (10YR 6/4 dry), brown (10YR 4/3 moist) fine slightly washed gravel; single grain; loose, non-sticky, non-plastic; pH 6.9; boundary clear, smooth.
C2	15-26"	Alluvium, 90% fine slightly rounded pyroclastic pebbles 3/4 of gravel very dark grey (7.5YR 3/0 dry), 1/4 reddish yellow (7.5YR 6/6 dry) gravel; single grain; loose, non-sticky, non-plastic; pH 6.9; boundary abrupt, smooth.

Horizon	Depth	Description
IIC	26-54"+	Light yellowish brown (10YR 6/4 dry), very dark grayish brown (10YR 3/2 moist) fine pumicy sand; weak, medium to fine angular and subangular blocky readily breaking to single grain; soft, non-sticky, non-plastic; pH 7.3; (increasing amounts of larger reddish-hued gravel as bottom of pit approached).

Stand P-D-40

Horizon	Depth	Description
0	2-0"	Mull type humus, primarily derived from conifer needles.
A1	0-4"	Dark brown (10YR 4/3 dry), very dark grayish brown (10YR 3/2 moist) loamy pumicy sand, (5% fine, slightly rounded pumicy pebbles); weak, medium, subangular blocky structure due to profuse fine roots; loose, nonsticky, non-plastic; pH 6.6; boundary gradual, smooth.
AC1	4-28"	Brown (10YR 5/3 dry), dark brown (10YR 3/3 moist) pumicy sand, (10% fine, slightly rounded pumicy gravel); weak, medium to coarse, sub-angular blocky breaking readily to single grain; loose, nonsticky, nonplastic; pH 7.3; boundary gradual, smooth.
AC2	28-40"+	Light yellowish brown (10YR 6/4 dry), brown (10YR 4/3 moist) cobbly (40% moderately washed basalt) pumicy sand, (5% fine, lightly washed pumicy gravel, 10% moderately rounded basalt pebbles); weak, angular to subangular blocky breaking to structureless; loose, non-sticky, nonplastic; pH 7.5; (increasingly larger rock with depth).