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Abbott Creek Natural Area is a 2600 acre research area of the Mixed-Conifer forest type. This study delineated plant association units within the area, and demonstrates the use of the computer program SIMORD as a tool in the definition of such associations. One hundred fourteen sites were sampled by a reconnaissance plot technique and were used, by SIMORD, in the construction of a two-dimensional ordination. On this ordination high, moderate, moist, dry, and Arctostaphylos/Ceanothus plant associations were defined. For each association, tables were constructed of the overstory, shrub and understory vegetation. Where it was meaningful, associations were compared to topographic features of the area, and to similar associations elsewhere.

An Analysis of the Vegetation of Abbott Creek Natural Area, Oregon

by

Roderic Jamie Mitchell

A THESIS

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Most of all, I would like to acknowledge the encouragement and perseverance of my wife Marilyn, son Todd and daughter Erin, that has made this undertaking possible and worthwhile.

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AN ANALYSIS OF THE VEGETATION OF ABBOTT CREEK NATURAL AREA, OREGON

INTRODUCTION

The basic principle involved in phytosociological analysis is that of ordination, in which vegetation samples are arranged along an axis on the basis of their composition. Ordination was originally used (Curtis and McIntosh, 1951; Brown and Curtis, 1952) to support the view that the forests of Wisconsin formed a vegetational continuum. "Continuum" implies a gradual change in the vegetation as one moves from one area to another, as opposed to a classification system which implies a discontinuity of composition and which divides vegetation into associations with distinctive characters and discrete boundaries.

This paper is not intended as a vehicle for discussion of the relative merits of the continuum as opposed to the discrete approach to vegetation analysis. Rather, it is the author's intent to use the original ordination principle, coupled with the tools of computer analysis, to characterize the vegetational composition of Abbott Creek Natural Area.

There are two contributions that might be made by this work. The first is a description of the vegetation with some comments upon its relation to topography and successional patterns. The second contribution is in the area of technique. An attempt is made to integrate reconnaissance plots with computer manipulations to provide a viable method of vegetation analysis which is both simple and quick. Further, an attempt is made to justify the use of non-measured reconnaissance plots (Franklin, Dyrness, and Moir, 1970) as preferable to the more traditional Daubenmire plots (Daubenmire, 1959) which involve precise measurements and considerably more labor.

In the following, an attempt is also made to carry the reader through a specific problem in which the computer analysis technique is used in making decisions about how different stands of vegetation in the area are related. The major emphasis intends to show that the computer is a tool which can serve as an adjunct to the investigator's own judgment in making decisions about vegetation analysis.

The computer program used was developed by William Moir (Dick-Peddie and Moir, 1970) and involves the development of a two-dimensional ordination, upon which are placed the 120 stands considered in this study. The plot reconnaissance technique was developed by Jerry F. Franklin and C. T. Dyrness (Franklin, Dyrness, and Moir, 1970) in their study of the H. J. Andrews Experimental Forest in Oregon.

STUDY AREA

Geographic Location

Abbott Creek Natural Area is located 12 statute miles west of Crater Lake National Park, in the Rogue River National Forest of southern Oregon (Figures 1 and 2). Its boundaries include parts of Douglas and Jackson counties. The total area comprises 2660 acres in one continuous location.

The western border of the natural area is defined by the main branch of Abbott Creek and is the location of easiest access to major portions of the area. An unmaintained logging road parallels the more southerly half. This road is easily accessible from U.S. Highway 26 via forest road 3047. The northern border is defined by a ridge which divides the Rogue and Umpque river drainages. The main access to this border is via Abbott Butte fire lookout, which is serviced by forest road 2923, and the remnants of a trail which follows this ridge. The eastern edge of the area follows the Golden Stairs Trail, for the most part, which is accessible at its southern end by forest road 3017 and which can be reached from forest road 3016 with little difficulty at a more northerly point. The southern border is not long, and access to it can be gained from forest road 3047. There are no trails or roads within the area, the major topographic features of which are shown in Figure 3.

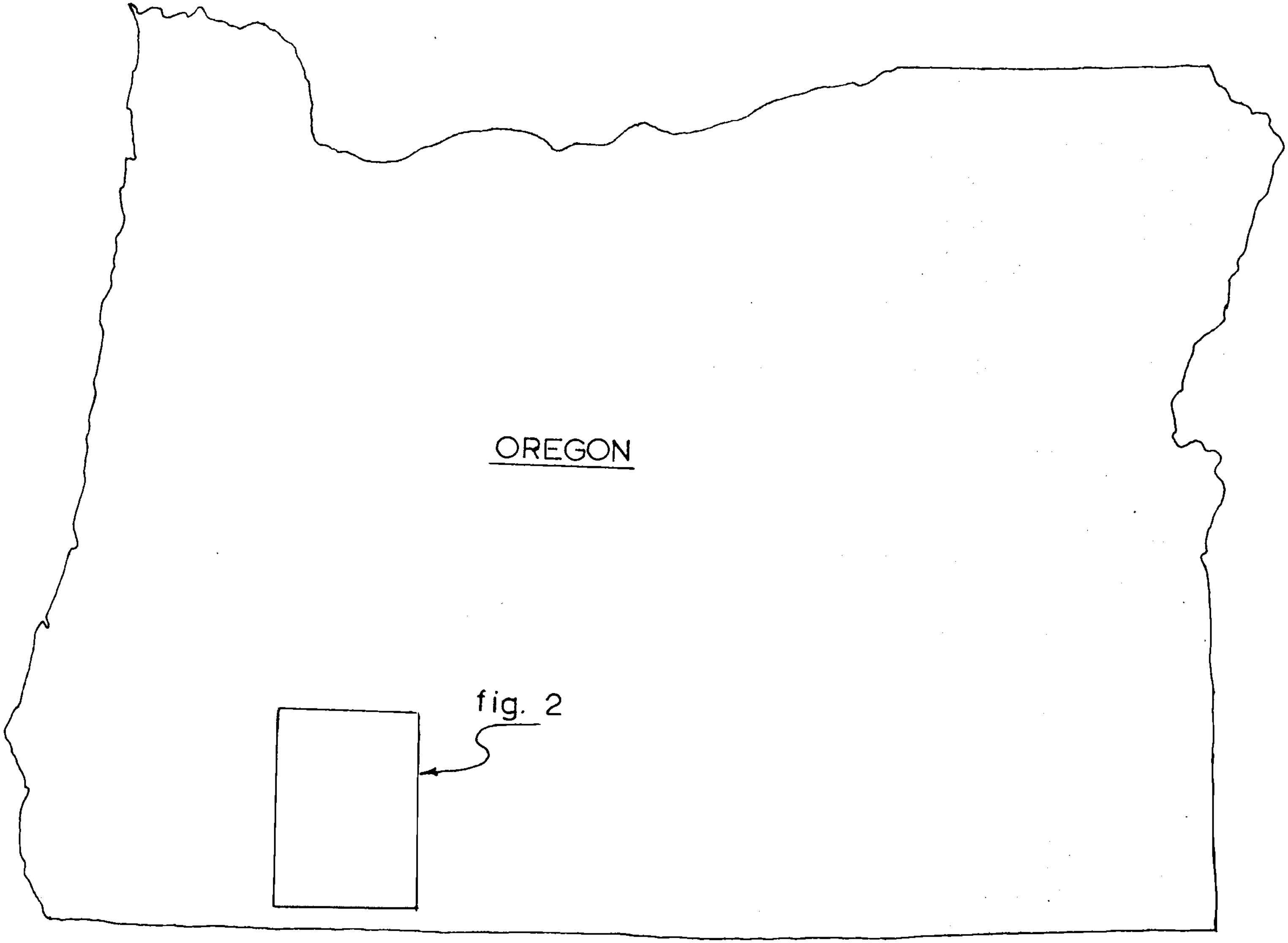


Figure 1. Map of Oregon, insert represents Figure 2.

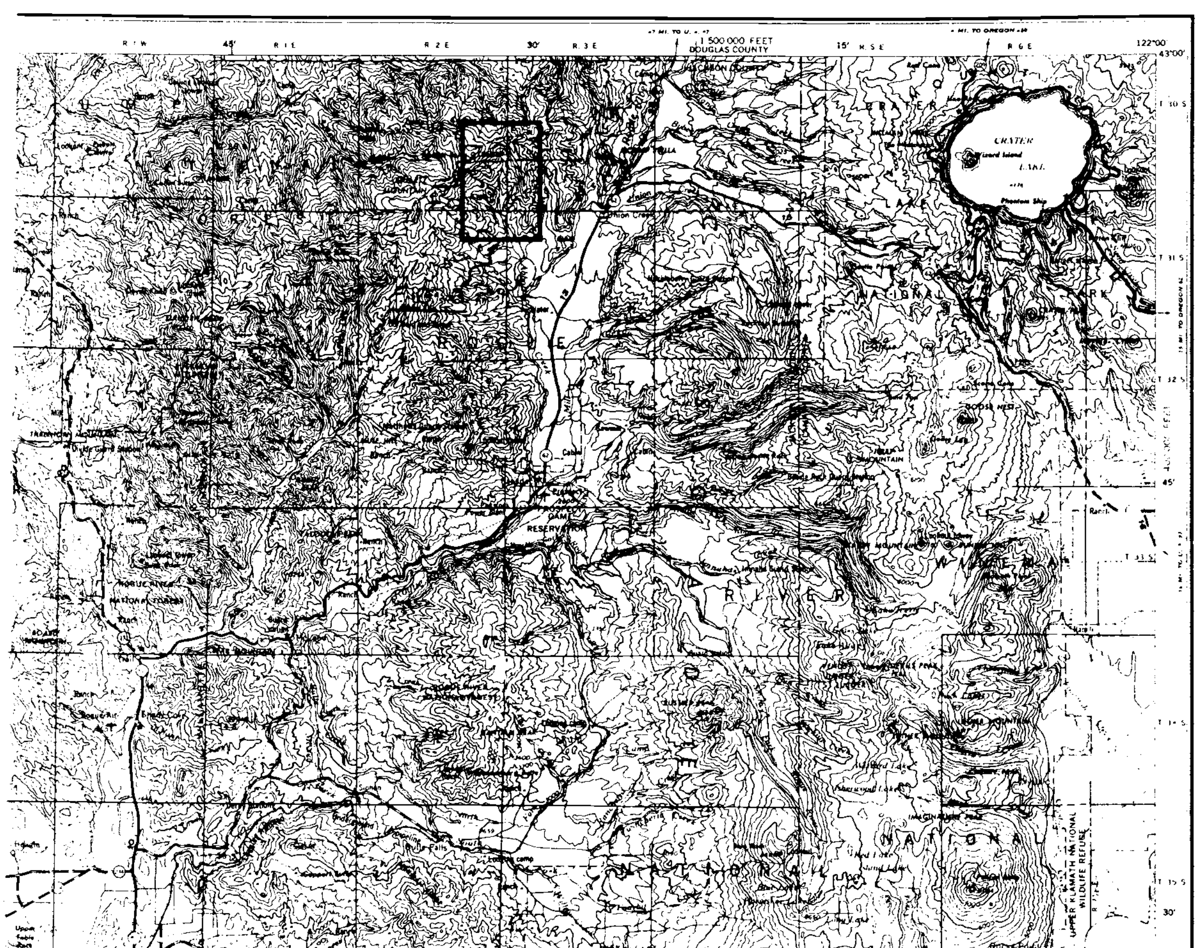


Figure 2. Map of southwestern Oregon, insert represents study area as seen in Figure 3.

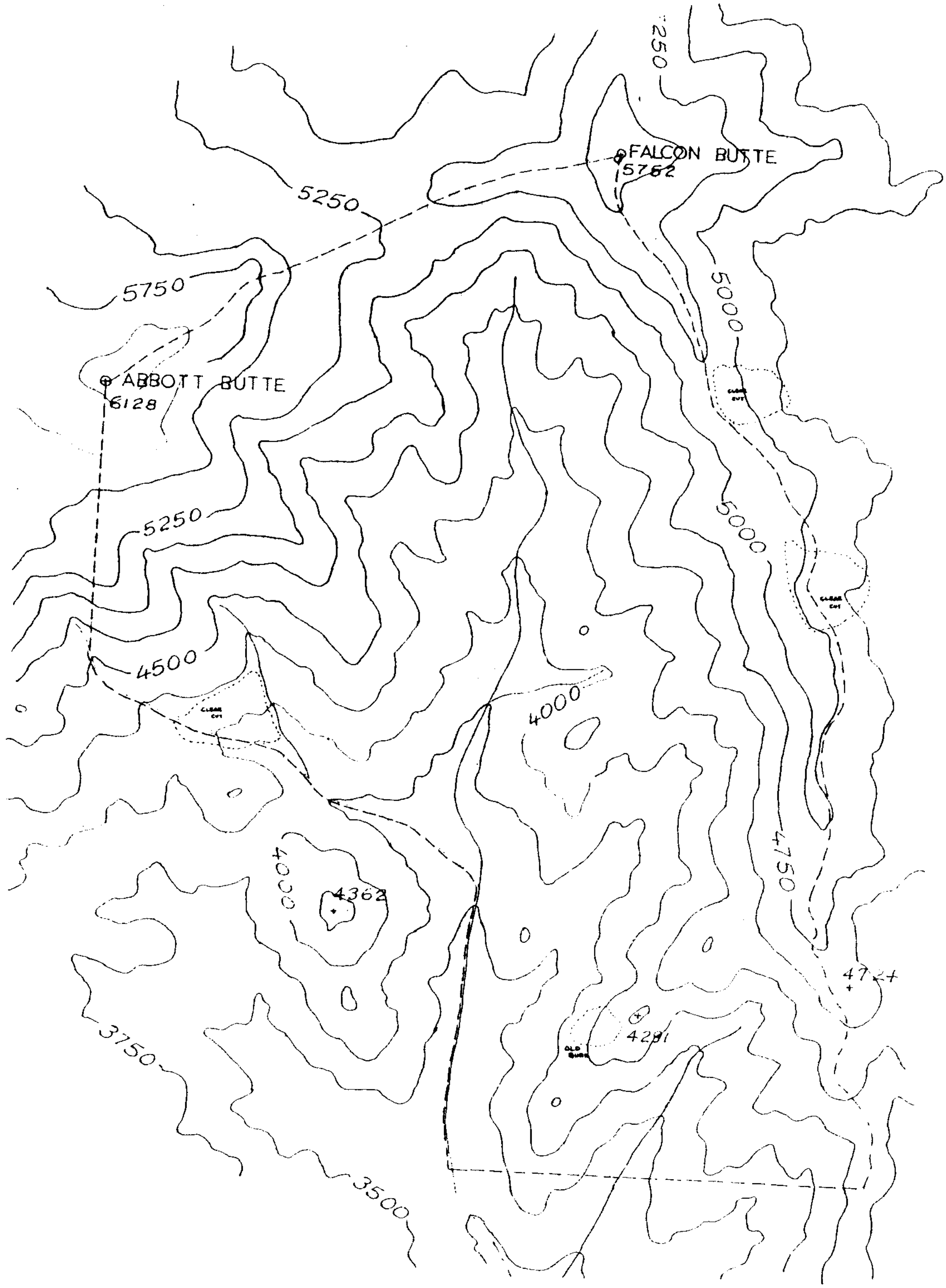


Figure 3. Topographic map of study area.

Physiography and Geology

Three drainages make up the major portion of the area, with the northernmost containing almost half of the total acreage. The general topography is quite rugged, with much of the area consisting of slopes of 25 percent or more. There are some portions of gentle to almost flat relief along the western edge of the area near Abbott Creek, and some benches at high elevations below Abbott Butte. Many of the ridges between and along the borders of drainages contain rock outcroppings with little vegetation.

The highest point in the area is Abbott Butte, elevation 6131 feet, located in the northwestern corner. The crest of the ridge that parallels the northern border and much of the crest of the ridge paralleling the eastern border are above 5000 feet. The southwestern corner is the lowest point, at about 3300 feet.

Geologically, the entire area is volcanic in origin. It belongs to the "old" or Western Cascades of upper Eocene to late Miocene origin (Williams, 1942). This formation flanks the western edge of the High Cascades, ranging from Mount Hood to as far south as Mount Shasta. The older origin of the Abbott Creek region permitted the rocks of this area to become folded and deeply eroded before the High Cascades began to erupt. In some locations, the rock of this formation accumulated to thicknesses of 7,000 to 10,000 feet.

In the natural area, bedrock at the higher elevations has been described as belonging to the Sardine formation of middle and upper Miocene andesite flows. The lower elevations contain lower Miocene pyroclastic rocks and may include tuffs, breccias, and conglomerates (Franklin, 1971). The summit of Abbott Butte itself is mapped as basalt of Pliocene or Pleistocene age (Peck and Wells, 1961).

Soils

The soil of the natural area is described as belonging to the Freezener-Coyata soil series (Power and Simonson, 1969), which is typically found in moderately steep to very steep forested uplands. These soils are used mainly for forest production, and, to a limited extent, for pasturage in locations of moderate slope. In the Rogue drainage basin, a mapping unit of 186,600 acres of Freezener-Coyata series exists. About 70 percent of the series is Freezener; the remaining 30 percent is Coyata. Typically these soils are deep and well drained with dark reddish-brown, friable, loam surface layers and clay loam, moderately blocky subsoils. Rock fragments range in abundance from 0 to 30 percent or more by volume. The soils are moderately acid in reaction.

Climate

The climate in the natural area is characterized as "modified maritime" in nature. Most of the precipitation is a result of low pressure systems which move eastward across western Oregon from the Pacific Ocean. During the summer, this dominant climatic feature is modified by high pressure systems which shift fronts northward, resulting in clear, dry weather. The overall outcome of such a weather pattern is a climate of cool, wet winters and warm, dry summers.

The climatic data from the United States Weather Bureau station at Prospect, Oregon (Table 1) support such a conclusion. However, the general climatic features in the area reflect the elevational gradient of some 2800 feet, as well as the fact that the Prospect station is located to the south and at a lower elevation than any part of the area. It would therefore be expected that the natural area experiences a wetter and cooler climatic scheme than that found at Prospect, and that this would be especially true at higher elevations. It is not uncommon, for example, to find snow packs at the higher elevations as late as early August.

Table 1. United States Weather Bureau statistical data from the Prospect Weather Station, Prospect, Oregon. Data collected from 1905-1960.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Years Observed
Average Precipitation (inches)	6.60	4.94	4.55	2.90	2.73	1.80	0.33	0.30	1.06	3.95	5.67	6.86	41.69	56
Average Snow (inches)	20.8	13.7	9.6	2.3	0.3	T	0.0	T	T	0.3	4.1	12.5	63.6	52
Days of Rain 0.1 inch	13	10	12	7	6	4	1	1	3	7	9	11	84	7
Days of Rain 0.5 inch	5	3	4	1	2	1	+	+	1	3	4	6	30	10
Mean Temperature °F	35.4	38.5	40.0	47.8	53.9	59.2	66.2	65.0	60.4	51.3	42.2	37.4	49.9	53
Mean Daily Maximum °F	44.4	49.4	55.2	62.4	69.3	75.8	86.1	85.5	78.4	66.9	53.9	45.8	64.4	53
Mean Daily Minimum °F	26.1	27.6	29.2	32.6	37.2	42.0	45.8	44.3	39.8	34.6	30.5	27.6	34.8	53
Highest Temperature °F	70	74	88	90	98	101	106	104	106	96	82	68	106	53
Lowest Temperature °F	-12	-2	7	17	21	27	30	27	20	12	2	-3	-12	53
Mean Days Above 90 °F	0	0	0	0	1	3	14	11	8	1	0	0	38	10
Mean Days Below 32 °F	24	21	25	17	8	2	+	1	4	11	20	24	157	10

Vegetation

Almost all of the natural area is forested. Typically, it can be described as belonging to the Mixed-Conifer Forest group described by Franklin and Dyrness (1969). The overstory is characterized by *Pseudotsuga menziesii*, *Pinus lambertiana*, *Libocedrus decurrens* and *Abies concolor*. At several locations in the higher elevations the Mixed-Conifer forest type gives way to *Abies magnifica* and *Abies concolor* zones. Along the streams a more mesic forest exists containing *Tsuga heterophylla*, *Pinus monticola* and *Taxus brevifolia*.

Some locations are nonforested. At higher elevations, some meadows are dominated by various grasses and sedges, while rock outcroppings can be found at various locations throughout the area. These are typically very exposed, and are very xeric habitats. Other nonforested locations are represented by an association of various evergreen shrubs, *Castanopsis chrysophylla*, *Garrya fremontii*, *Arctostaphylos patula* and *Ceanothus velutinus*. These shrubs are also found in some of the drier forested locations.

It is difficult to generalize about the understory species, but some that have a wide range in the area are *Achlys triphylla*, *Berberis nervosa*, *Chimaphila umbellata*, *Iris chrysophylla*, *Linnaea borealis*, *Rubus ursinus*, *Trientalis latifolia*, and *Whipplea modesta*.

Influence of Man

Human disturbance within the natural area has been minimal. There is a small clearcut of about 30 acres, just north of the west branch of Abbott Creek, which is the only obvious human disturbance. However, traces of caterpillar trails just inside the western border indicate that some selective logging may have been carried out there at one time. There is also an area of about five acres within the eastern border in section 30, which is the upper extension of an old logging operation which extended down the ridge marking the eastern border of the natural area. There are two more extensive clearcuts on the east side of this ridge, but outside the natural area border. These clearcuts influence the area's vegetation, as cattle are grazed in them during the summer, and they often stray into the natural area. There is also limited grazing by cattle in some of the meadows at high elevations.

A fire lookout is maintained on a limited basis during the summer months on Abbott Butte. However, this, as well as the occasional hiker or hunter, has little, if any, influence upon the vegetation of the area.

There is evidence that fires have been a part of the natural development of the area. Fire scars are found on many of the older trees, and one location in section 31 exhibits a stand of young

Pseudotsuga menziesii of almost identical size. This stand encompasses 30 acres or more and is the result of a recent fire.

Due to the relatively rugged topography and lack of logging operations, the natural area has remained quite pristine and is an ideal location for plant community studies.

The regulations governing the management of natural areas have, as a guiding principle, the prevention of any unnatural encroachment by man. Any activity which might directly or indirectly modify the area's natural ecological processes is discouraged. Logging and uncontrolled grazing of cattle are not allowed. Roads, trails, fences, and buildings are prohibited. Public use of the land which might contribute to a modification of its value for research is discouraged; such activities as camping, picknicking, and gathering of berries, nuts, or plants is therefore prohibited. However, hunting, fishing, and trapping are subject only to state regulations.

Abbott Creek Natural Area was established on November 18, 1946 and, until the time of this study, no research had been done in the area.

METHODOLOGY

During the late summer of 1970, a reconnaissance of the area's topography and vegetation was conducted. At that time, many plant specimens were collected for identification, and some preliminary data were gathered concerning the age structures and species compositions of certain stands. The major purpose of this preliminary study was to familiarize the author with the area, and to establish a plan for data collection procedures in the summer of 1971.

Data Collecting Technique

The data for this study were collected during the months of June, July, August, and September, 1971. One hundred and twenty stands* were selected throughout the study area (Figure 4), with no attempt made to cover all of the natural area in either a uniform or random manner. An attempt was made to sample all of the various types of stands which had mature trees. Young stands represented by many small and even aged trees, and nonforested areas, were not selected for study. For the most part, stands at lower elevations were examined first, with higher elevations examined after the snow packs had melted.

* A, "stand", as used in the following, is defined as a fairly uniform unit of vegetation, the species of which can be assumed to have had a common history of development.

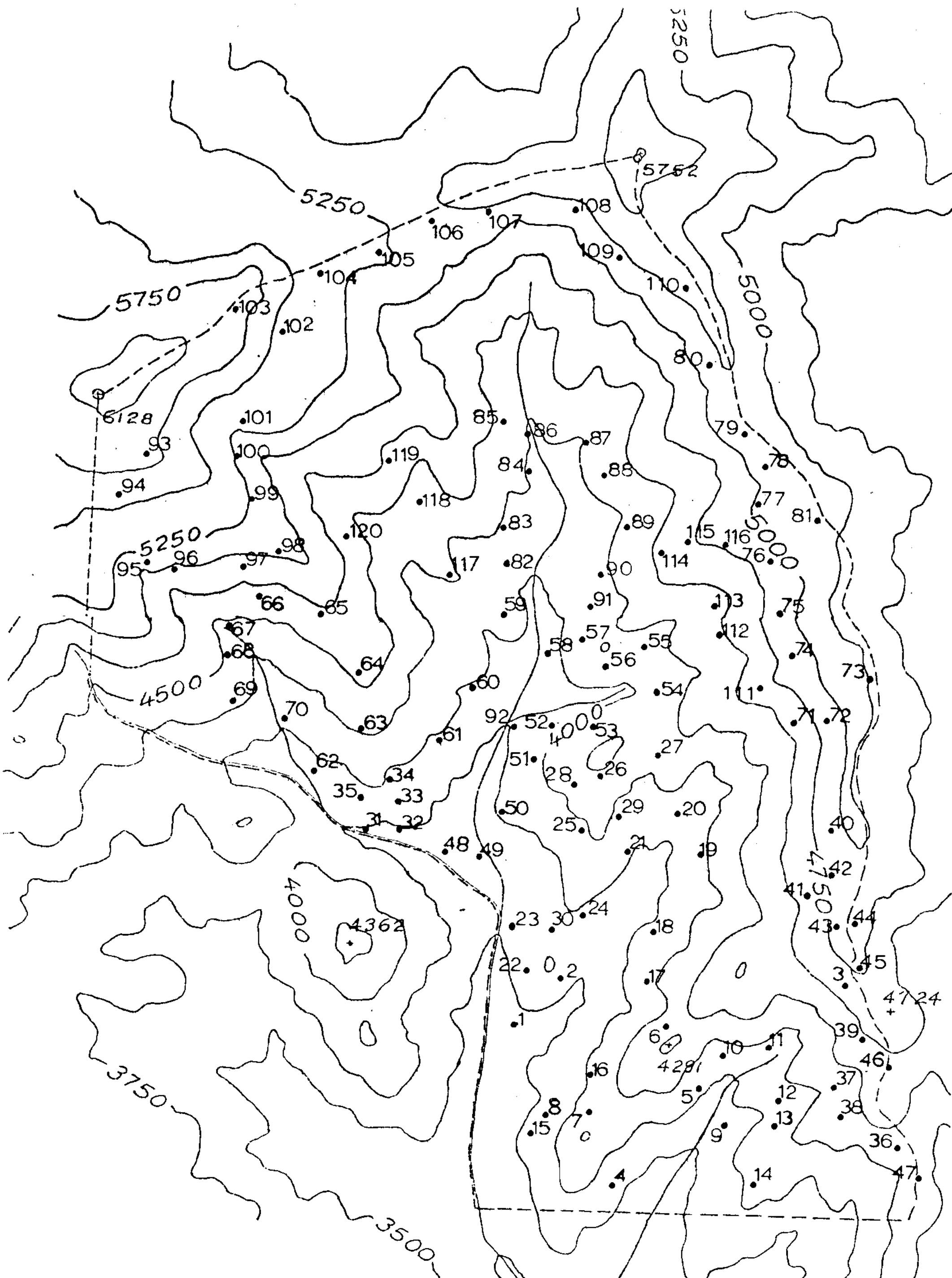


Figure 4. Map of study area with plot locations.

At each sampling location, a "reconnaissance" plot was established at a point which seemed representative of the vegetation which the plot was intended to characterize. A reconnaissance plot, described in detail below, does not require the staking out of borders and other detailed measuring techniques. This allows the establishment of more plots per unit of time than would be feasible using more traditional vegetation analysis techniques. It is the author's opinion that the small amount of precision that is lost is more than compensated by the doubling or tripling of the number of plots which can be established in a given time period.

A field data sheet was developed (Figure 5) which defines the three categories of data collected at each plot; species and size classes of the trees, frequency and cover estimates of the understory species, and topographic and geological features of the site.

The data collection procedure was usually conducted in the following manner. A site was selected well within the confines of a stand as a location for collecting data which would be representative of that stand. The center of a circular plot ranging from 50 to 100 feet in diameter was established, and the species and size classes of the trees within the plot were recorded. The size of the plot was determined by the density of the trees in the stand; for denser stands, smaller plots are needed to obtain a representative sample of the trees. From 10 to 20 mature trees were considered to constitute a

Date: ______________ Plot Number: ______________

Elevation: __________ Slope: __________ Aspect: __________

Topography & Landform: ______________________________

____

Soil Texture: __________ Percent Rock: ______________

Soil Remarks: __________________________________

____

TREE DATA

Species Diameter at breast height

	0-10 cm dbh			10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 & Ov.
	Under 5 cm		Over 5 cm								
	Und. 1m	Ov. 1m									
Duog. Fir											
I. Cedar											
Red Fir											
W. Hemlock											
White Fir											
Sugar Pine											
White Pine											
Big Leaf Maple											
Chinkopin											
Pacific Yew											
Madron											
White Oak											
P. Pine											
Dogwood											

Plot No. __________

UNDERSTORY PLANTS

Species	Abundance	Coverage
Shrub Layer:		
Herb Layer:		

Abundance 1 = Rare; 6 = Abundant
Coverage: 1=0-5%; 2=5-25%; 3=25-45%; 4=45-65%; 5=65-85%; 6=85-100%

Figure 5. Data sheet used for collection in the field.

representative sample. Because this study does not involve a quantitative comparison of tree species abundance on different sites, there is no necessity to adhere to a specific plot size. The important criterion in establishing the plot size is that it be large enough to obtain a sample which will represent the proportional composition of the tree species within the stand. Once the plot size was determined, the tree data defined in Figure 5 were taken.

The plot was thoroughly examined to determine which plant species other than trees were present. Any species which could not be identified were collected for future identiciation. A frequency number ranging from 1 to 6 (1 = rare, 6 = abundant) and percent cover designations ranging from 1 to 6 (1 = 0-5%; 2 = 5-25%; 3 = 25-45%; 4 = 45-65%; 5 = 65-85%; 6 = 85-100%) were recorded for each species.

After the vegetation observations were completed, the elevation, slope and aspect of the site were recorded. These were determined through the use of a topographic map, an Abney level and a compass. These measurements were followed by a brief description of the topography and landform of the site. A shallow soil pit was dug, and the thickness of the humus, the soil texture and percent rock content, the sizes and shapes of rocks and the soil color were recorded.

Analysis Technique

Upon completion of all of the field work, the data were coded (see Appendices 1 and 2) and transferred to computer cards. All of the data from one plot could be assembled on five 80-column cards.

When all of the data were collected from all of the sites which comprised this investigation, the plots were subjectively divided by the investigator into groups based upon their vegetational composition (Table 2). Each group was defined as those sites having a number of species in common and an absence of certain other species (Table 3). Some plots were not easily fitted into specific groups and were considered separately. Four plots were eliminated from the analysis because their vegetation was considered aberrant from that of the rest of the area.

The computer analysis was conducted at the Oregon State University Computer Center using a Control Data Corporation 3300 computer system. The method of analysis was adapted from the original program, SIMORD, written by W. H. Moir (1970) and used in the vegetation analysis of the Organ Mountains of New Mexico. This program was designed to ordinate plots on a two dimensional plane. The distribution of plots on the plane can be analyzed to assist in refining judgements previously made concerning plot relationships.

Initially, the program involved the establishment of a matrix of similarity values based upon comparisons of each plot with all

Table 2. A list of the plots initially placed in vegetational associations by the author.

Series Name	Plot Numbers
High Altitude Series	93, 94, 95, 97, 98, 99, 100, 101, 104, 105, 106, 107, 109
Moist Series	1, 15, 22, 23, 31, 32, 35, 48, 49, 50, 58, 59, 62, 67, 68, 82, 85, 86, 87, 88, 89, 90, 91, 119.
Moderate Series	9, 11, 12, 18, 20, 21, 26, 29, 30, 34, 43, 51, 52, 53, 54, 55, 56, 57, 60, 61 63, 65, 69, 70, 73, 76, 77, 81, 83, 84, 96, 108, 111, 115, 116, 118, 120.
Dry Series	4, 5, 7, 8, 14, 37, 39, 44, 64, 66, 71, 72, 74, 75, 78, 79, 113.
Arctostaphylos/Ceanothus Series	2, 6, 10, 17, 19, 24, 25, 27, 28, 33, 38, 40, 41, 42, 45, 80, 112, 114.
Odd & Intermediate Series	3, 13, 46, 47, 102, 110, 117.

Plots rejected because species composition is far divergent from the rest of the plots 16, 36, 92, 103.

Table 3. A list of the species used as criteria for placing plots initially into different vegetational associations.

Group Species	Number of plots in which each species is found
Dry Group:	
Pseudotsuga menziesii	16
Libocedrus decurrens	16
Abies concolor	15
Berberis nervosa	13
Chimaphila umbellata	14
Collomia heterophylla	10
Hieracium albiflorum	14
Trientalis latifolia	12
Whipplea modesta	14
Rubus ursinus	14
High Group:	
Abies magnifica	11
Libocedrus decurrens	11
Abies concolor	13
Achlys triphylla	8
Adenocaulon bicolor	9
Arenaria macrophylla	13
Circaea alpina	9
Erigeron aliceae	7
Galium aparine	9
Montia sibirica	6
Osmorhiza chilensis	9
Pteridium aquilinum	10
Ribes lacustre	8
Ribes viscosissimum	7
Smilacina sessilifolia	12
Trientalis latifolia	8
Vicia americana	10
Vancouveria hexandra	8
Arctostaphylos/Ceanothus Group:	
Pseudotsuga menziesii	16
Libocedrus decurrens	16
Abies concolor	16
Pinus lambertiana	14
Arctostaphylos nevadensis	14
Arenaria macrophylla	13
Berberis nervosa	12
Ceanothus prostratus	14
Chimaphila umbellata	14
Collomia heterophylla	11
Garrya fremontii	10
Hieracium albiflorum	16
Trientalis latifolia	13
Whipplea modesta	13
Castanopsis chrysophylla	11

Group Species	Number of plots in which each species is found
Moist Group:	
Pseudotsuga menziesii	23
Libocedrus decurrens	18
Abies concolor	20
Tsuga heterophylla	18
Taxus brevifolia	18
Acer circinatum	18
Achlys triphylla	19
Anemone deltoidea	16
Berberis nervosa	19
Chimaphila umbellata	18
Clintonia uniflora	18
Corylus cornuta	19
Linnaea borealis	21
Pachystima myrsinites	20
Rosa gymnocarpa	14
Trientalis latifolia	19
Trillium ovatum	12
Vaccinium membranaceum	20
Viola sempervirens	14
Whipplea modesta	16
Vancouveria hexandra	13
Moderate Group:	
Pseudotsuga menziesii	32
Libocedrus decurrens	26
Abies concolor	32
Tsuga heterophylla	18
Pinus lambertiana	18
Achlys triphylla	28
Asarum caudatum	14
Berberis nervosa	27
Chimaphila umbellata	30
Corylus cornuta	24
Hieracium albiflorum	24
Linnaea borealis	27
Pachystima myrsinites	18
Rosa gymnocarpa	18
Trientalis latifolia	21
Whipplea modesta	28
Vancouveria hexandra	22

other plots. Each similarity value defines, numerically, a measure of the similarity between two plots. The computation of the similarity values between pairs of plots was, in the original Moir program, based upon up to 50 characteristics of the plots being compared. The similarity matrix is a table of all the similarity values.

Only vegetation characteristics were used to make comparisons in this study, since the author wished to develop a model totally based upon vegetation. The topographic and soil data were used for interpretation of and comparison with the vegetation model. However, under different objectives, topographic and soil characteristics could be used in the development of similarity values.

Five different categories of vegetative characteristics were available for use in developing site similarity values: frequency of young trees, middle aged trees, and older trees, frequency of understory species, and cover of understory species. With a limit of 50 characteristics, due to computer storage capacity, and with over 100 understory species occurring in the natural area, it is obvious that not all of the vegetative characters of the sites could be used. It was therefore necessary to select 50 characters that best represented the vegetative similarities and differences between the stands involved.

In the selection of the 50 species characters, several criteria were considered. A character found in all the plots was of little value because it tended simply to raise the similarity values of the entire matrix. A characteristic found in few stands would have the opposite effect of lowering most of the matrix values. However, a character found in several stands would establish a criterion for discrimination, hopefully isolating the stands into groups by lowering the similarity values of certain stands while raising those of others.

Of the 50 characters used (Table 4) those species which were felt to be poor discriminators were avoided. Both understory and overstory species were used. Because of the magnitude of the size differences between different understory species, the frequency data were not used in the comparisons. It was also felt that the reproductive age classes of trees were a better monitor of recent site characteristics than were older age classes, in that they represented the species the site will perpetuate.

The similarity between two stands, I and J, was computed as:

$$\mathrm{SIM}(I, J) = \frac{1}{n'} \sum_{k=1}^{50} \left(\frac{2\mathrm{minimum}\ (a_{ik},\ a_{jk})}{a_{ik} + a_{jk}} \right)$$

where a_{ik} and a_{jk} are the frequency or cover measurements of the kth species in stands I and J. The summation was performed only for those n' species which appear in one or both stands.

Once the similarity matrix is produced, the end stands R1 and R2 for the first or X axis in the ordination plane can be identified. The initial end stand R1 is derived by summing the column similarity

Table 4. A list of the 50 species characteristics initially used in the production of the similarity matrix of the plots.

Reproducing *Pseudotsuga menziesii*	*Erigeron aliceae*
Reproducing *Libocedrus decurrens*	*Galium aparine*
Reproducing *Abies magnifica*	*Garrya fremontii*
Mature *Abies magnifica*	*Hieracium albiflorum*
Reproducing *Tsuga heterophylla*	*Linnaea borealis*
Mature *Tsuga heterophylla*	*Lupinus andersonii*
Reproducing *Abies concolor*	*Montia sibirica*
Mature *Pinus lambertiana*	*Osmorhiza chilensis*
Reproducing *Pinus monticola*	*Pachystima myrsinites*
Castanopsis chrysophylla	*Pedicularis racemosa*
Taxus brevifolia	*Pteridium aquilinum*
Acer circinatum	*Ribes lacustre*
Achlys triphylla	*Ribes viscosissimum*
Adenocaulon bicolor	*Rosa gymnocarpa*
Anemone deltoidea	*Smilacina sessilifolia*
Arctostaphylos nevadensis	*Symphoricarpos mollis*
Arenaria macrophylla	*Trientalis latifolia*
Asarum caudatum	*Trillium ovatum*
Berberis nervosa	*Vaccinium membranaceum*
Ceanothus prostratus	*Vicia americana*
Chimaphila umbellata	*Vicia californica*
Circaea alpina	*Viola sempervirens*
Clintonia uniflora	*Whipplea modesta*
Collomia heterophylla	*Vancouveria hexandra*
Corylus cornuta	

values, from the similarity matrix. The stand with the lowest total was designated as R1. Therefore R1 is the most divergent of all of the stands considered. R2 is that stand which is least similar to R1. If two or more stands tie for this distinction, that stand least similar to all other stands in the matrix, as determined by summation, is designated R2.

Next, all of the stands are ordinated on the X axis, which is divided into 100 units between R1 and R2. The location of each stand on this axis is determined by its respective similarity value to R1 and R2. This axis represents the greatest expanse of variability within the stands because its endpoints are represented by the stand least similar to all other stands at one end and the stand least similar to it at the other. However, there may have been other sources of variability in the population of stands. Therefore, quite often in vegetation data there would be a number of stands that were not very similar to either R1 or R2. These stands would cluster near the middle of the X axis. However, there could be considerable variability among these stands, so that two stands located near one another on the X axis in this central region might, in fact, be quite dissimilar. To discriminate between these central stands, a second Y axis is produced, the end stands R3 and R4 being derived from the central cluster of stands located between values 40 and 60 on the X axis.

R3 is derived by finding the stand in the central cluster with the lowest total similarity to all other stands in the central cluster, much the same as R1 was determined from the total number of stands. R4 is that stand in the central cluster with the lowest similarity to R3.

Once R3 and R4 have been established, all stands are positioned on the Y axis relative to their similarity values to R3 and R4. The length of the Y axis is determined by the similarity value of R3 to R4 and is on the same scale as the X axis.

The result of the X and Y axis formation is a two dimensional ordination, in which the position of each stand is determined by its X and Y coordinates.

At this point the stands can be plotted on an X, Y plane and the positions of the subjective groups that were originally determined by the investigator noted. The ordination may now be used to reaffirm the investigator's original judgement in assigning the plots to vegetation associations. The members of subjective groups may be found occurring in clusters on the X, Y ordination. If this is not the case, either the original subjective grouping by the investigator was poorly conducted or the end stands picked by the computer were so widely divergent from the majority of the stands that they did not represent the ends of vegetation gradients, but were simply odd stands. A stand which is completely atypical, and therefore greatly different from all of the others, will be selected as an end stand by the program. However, it is of little value to the classification of the rest of the stands, and is best eliminated. Often such stands can be subjectively eliminated before the initial run of the program is made.

Plotting the stands can often serve to re-constitute the subjective grouping of plots. A plot which is initially placed in one group may, upon plotting, fall into another group. When this happens the investigator should look at the total vegetational composition of the plot again and determine whether it should remain in the original group or be placed in the group suggested by the ordination technique.

Another option that is available is the pre-selection of end plots. After an initial run, it may become apparent that a group of plots is projected toward one end of an axis. However, the actual end plot may not be representative of this group. It would better serve the overall position of the plots within the group to select a more representative member of the group as an end plot. This would also be a better plot to use for the determination of the position of all the plots on that particular axis. Again, this is because it is a better representative of the vegetation at that end of the gradient.

Repeated modifications of the computer analysis may be necessary before a viable ordination is developed. If this ordination involves the clustering of certain plots into groups, the basis of a community classification system may be developing. The homogeneity of the groups can be checked by comparing the similarity values of the plots in the group to those outside the group.

Once the investigator feels he has produced a viable ordination which is representative of the relative vegetation composition of the plots, the non-vegetation data can enter the analysis. The objective here was to determine if there was any relation between the position of the stands on the ordination and the soil, slope, etc. This could give insight into the reasons for the distribution pattern found in the area of study. For example, it might be found that one end of the axis represented stands of high elevations while the other those of low. This might indicate that elevation, or the result thereof, was a major factor in determining the vegetation distribution of the area.

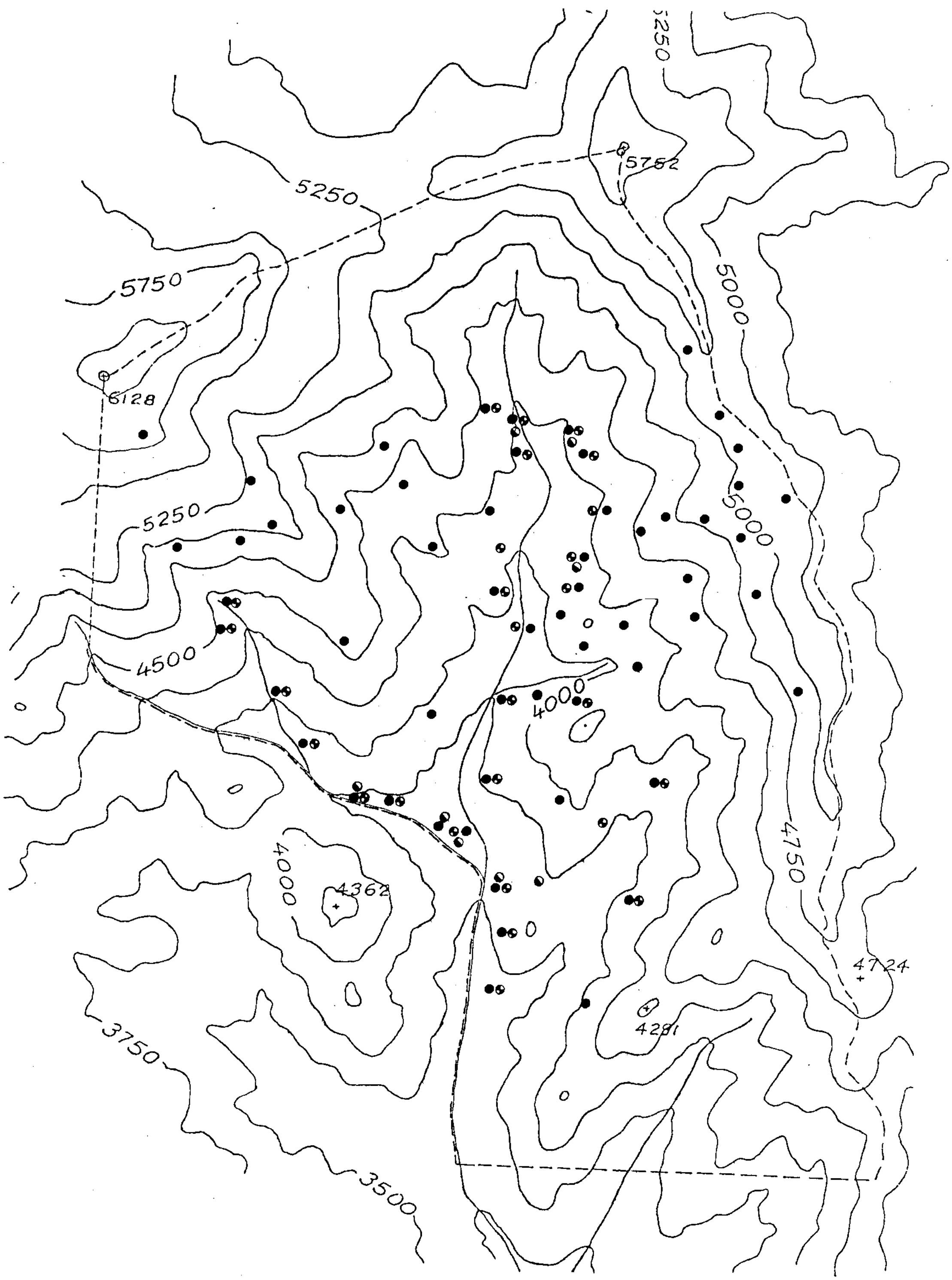
RESULTS

Species Distribution

Almost all of the 120 locations sampled in the study area can be described as belonging to the Mixed-Conifer Forest group (Franklin and Dyrness, 1969). The dominant overstory species were Abies concolor, Pseudotsuga menziesii and Libocedrus decurrens occurring, respectively, in 116, 103, and 87 of the 120 sample locations. Pinus lambertiana was also widely distributed, but occurred in only 47 of the stands sampled. Other overstory species were not so ubiquitous in their distribution. Tsuga heterophylla, Taxus brevifolia, and Pinus monticola, were found in the moister locations, especially along stream beds (Figure 6). Abies magnifica was confined in its distribution to higher elevations (Figure 7).

The understory vegetation also contained species of wide distribution, such as Trientalis latifolia, Chimaphila umbellata and Iris chrysophylla which occurred, respectively, in 81, 84, and 86 of the plots sampled. Other species, such as Clintonia uniflora and Vaccinium membranaceum were confined to moist areas. Erigeron aliceae and Montia sibirica represented species confined to higher elevations.

Pseudotsuga menziesii and Pinus lambertiana were the predominant species of largest size in the stands that were sampled (Figure 8). This could be partially due to the normally large size of



● Tsuga heterophylla
◕ Taxus brevifolia
◔ Pinus monticola

Figure 6. Location of three overstory discriminators.

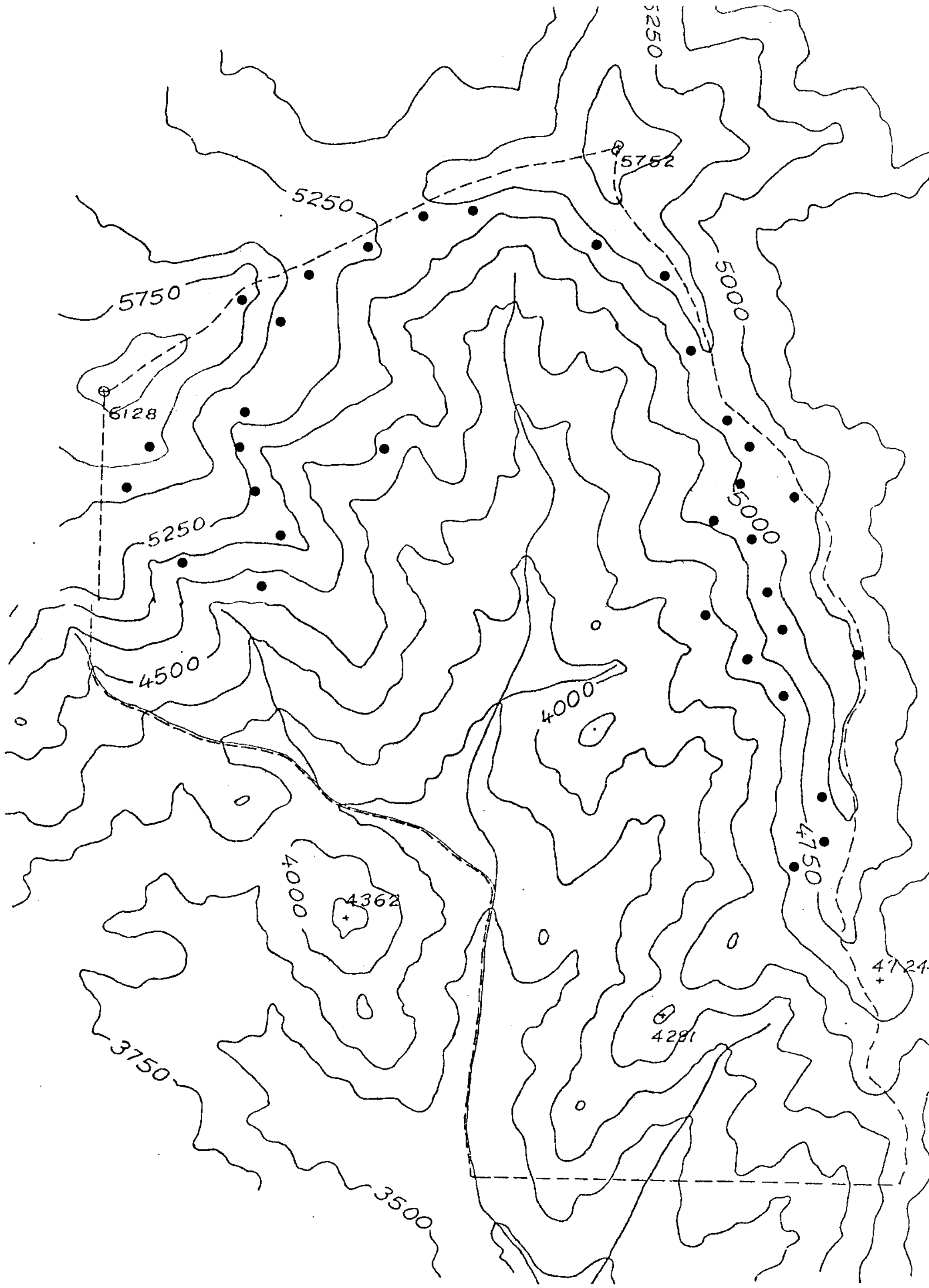
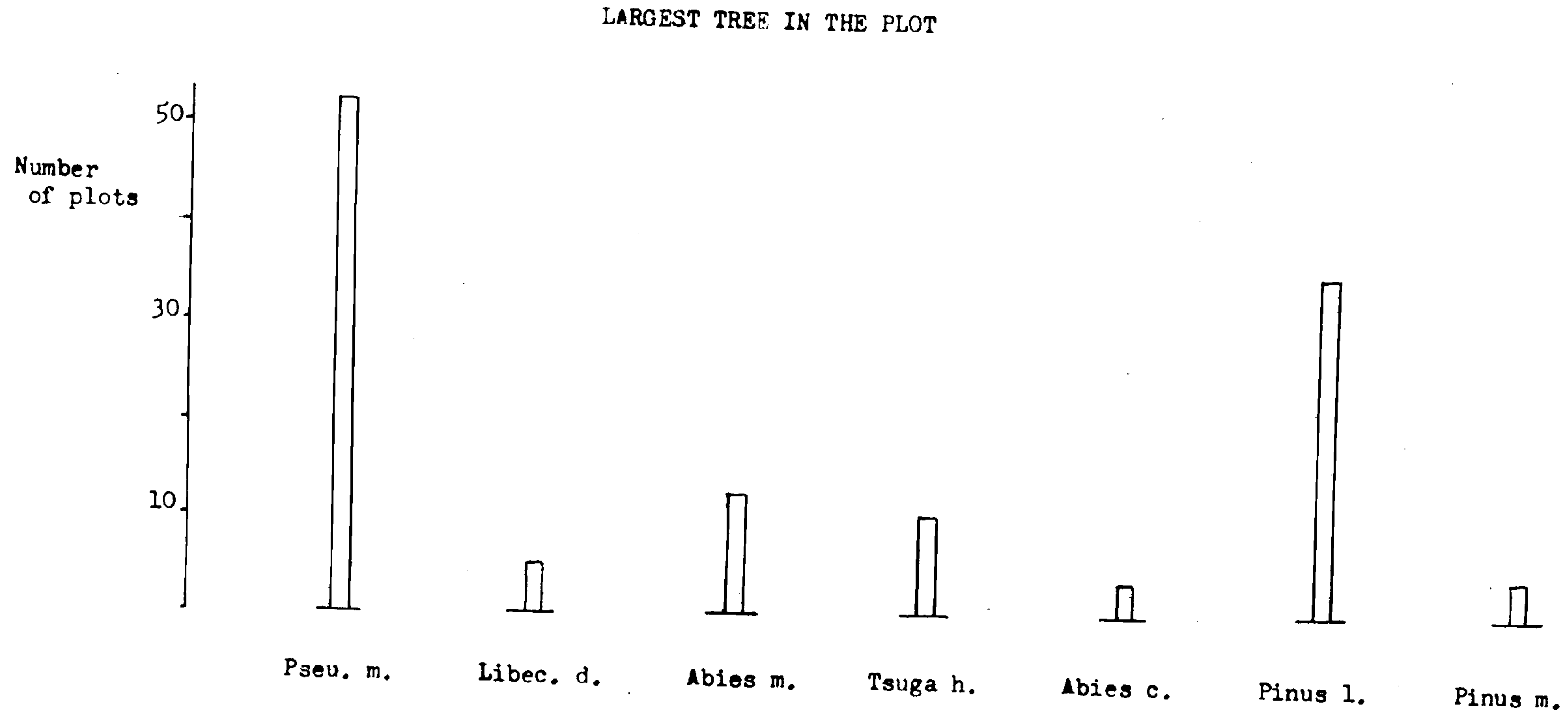


Figure 7. Location of Abies magnifica as an overstory indicator of high elevation.



	Pseu. m.	Libec. d.	Abies m.	Tsuga h.	Abies c.	Pinus l.	Pinus m.
Mean diameter in inches	49.48	45.40	48.33	49.80	40.66	51.91	43.33
Standard deviation of mean diameter	7.54	8.38	8.95	6.28	0.57	5.77	18.14

Figure 8. Species breakdown of largest trees in plots.

mature individuals of these two species, in comparison with that of other overstory species. In the case of *Pinus lambertiana*, this may in fact be the case, since plots which contained this species usually contained only a few very old individuals. With respect to *Pseudotsuga menziesii*, this was not the case, as the overstory of most of the natural area was dominated by this species.

When the age structure of the overstory species was evaluated (Figure 9), *Pseudotsuga menziesii* was unique in that a majority of the stands contained old dominant individuals, but in most cases, no younger individuals. In essence, *Pseudotsuga menziesii* is not reproducing itself in older stands (probably due to its relatively low shade tolerance) and represents a earl ? late seral stage species. *Abies concolor* and *Libocedrus decurrens*, by contrast, were represented by all age classes in the stands in which they occur, and might be considered dominant climax species. However, a climax situation in an area such as Abbott Creek may not be a real situation. Due to the periodic fires which occur, and the opening of the forest by fallen trees, *Pseudotsuga menziesii* may be able to compete successfully and remain the permanent dominant overstory species.

Plant Community Types

From the visual evaluation of the individual species distributions and groups of species, and from insight acquired in the field, the

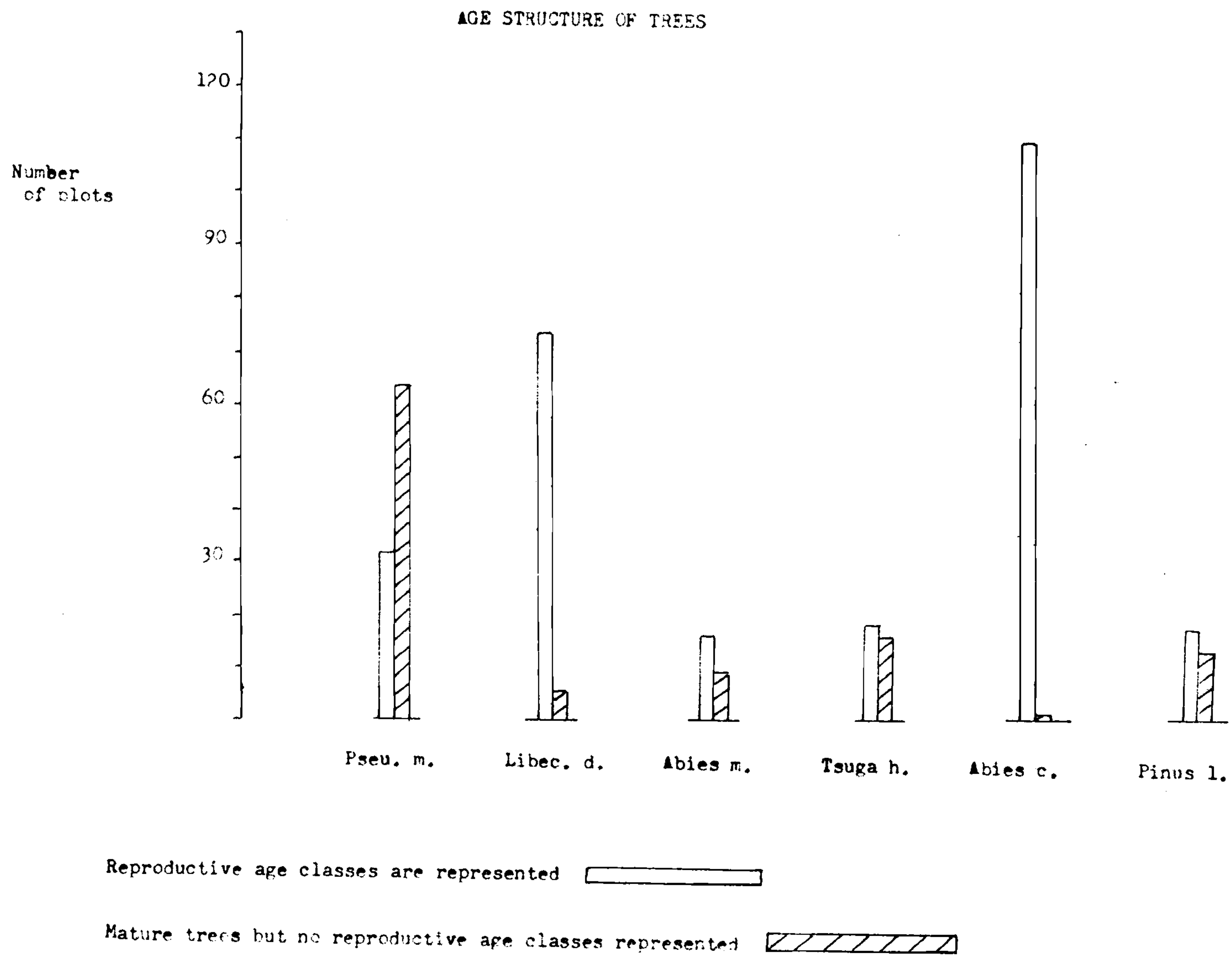


Figure 9. Reproductive and mature age classes of selected tree species.

author initially divided the various sample plots into five groups, or community types, within the Mixed-Conifer Forest group (Table 2). Each group is represented by several species which most of the individual plots have in common (Table 3). Many species were found in more than one of the groups and few were exclusive to one group. It was the combinations of species which constituted the identity of a specific group. This initial subjective grouping of the plots was used as a basis for comparison with distributions generated by the computer. Subsequently, certain plots were placed in a different series when their relative positions on an X, Y ordination initiated a re-evaluation of the vegetation composition which resulted in the decision that the initial designation of the group was incorrect.

The results of the initial run (Table 5) produced a two dimensional ordination, with plots 46 and 104 selected as end plots of the X axis and plots 40 and 87 as end plots on the Y axis.

When the plots were located on the two dimensional field produced by the X and Y axis (Figure 10) there seemed to be a good correlation between the locations of the plots with those in the preselected plot groups. The high elevation and moist groups were especially distinct. However, the separation of the plots along the X axis was reduced greatly due to the fact that plot 46, which was one of the end plots, had a very low similarity value to all the other plots with the exception of plot 47. These two plots were on the east side

Table 5. A list of the plots by vegetational association groups and their X, Y coordinates (first ordination).

	X	Y		X	Y		X	Y
High:			Moderate:			Dry:		
93	31.7	57.5	9	73.9	58.5	4	72.4	57.7
94	28.6	65.2	11	71.1	56.9	5	58.5	61.4
95	41.3	44.7	12	59.7	51.8	7	79.9	60.9
97	42.6	42.3	18	61.2	35.9	8	57.1	60.3
98	41.6	45.2	20	63.8	25.9	14	68.7	48.7
99	23.7	55.8	21	65.3	43.9	37	77.8	59.1
100	16.5	53.3	26	59.0	59.0	39	77.8	68.8
101	21.3	58.7	29	67.7	55.9	44	70.9	66.4
104	0.0	54.5	30	69.0	46.3	64	70.3	55.1
105	17.6	47.8	34	59.3	39.5	66	64.5	55.6
106	24.2	54.5	43	57.7	79.3	71	56.8	46.7
107	33.0	46.7	51	64.1	47.1	72	53.8	57.3
109	24.1	52.0	52	69.0	37.3	74	42.0	63.1
			53	66.5	28.2	75	48.3	55.9
Moist:			54	59.2	44.4	78	54.3	60.6
1	58.3	29.6	55	65.2	43.9	79	44.1	51.0
15	64.3	43.7	56	61.4	54.8	113	64.3	52.2
22	49.6	22.3	57	55.9	65.8			
23	56.9	12.6	60	68.5	37.5	Arctostaphylos/Ceanothus:		
31	52.3	25.5	61	65.2	40.0	2	70.0	67.3
32	55.0	24.3	63	69.3	37.8	6	69.5	59.7
35	59.1	51.5	65	56.3	42.8	10	65.2	62.9
48	54.6	22.1	69	64.3	42.5	17	66.8	67.4
49	49.2	26.9	70	59.9	22.4	19	70.7	81.6
50	50.0	36.8	73	40.1	52.8	24	70.2	55.6
58	54.9	18.5	76	45.2	57.7	25	75.7	79.9
59	59.3	26.6	77	45.6	55.9	27	62.0	83.3
62	61.6	23.7	81	39.1	50.2	28	71.5	64.9
67	54.8	38.3	83	63.5	52.5	33	67.2	71.2
68	61.4	20.9	84	65.9	36.9	38	69.9	65.1
82	60.6	26.7	96	52.8	47.3	40	55.7	92.9
85	51.3	17.9	108	33.0	45.5	41	60.8	89.4
86	49.1	28.9	111	42.7	45.7	42	56.4	76.5
87	55.8	7.1	115	57.6	54.2	45	78.3	72.8
88	55.9	20.7	116	48.6	53.0	80	45.3	61.9
89	60.7	24.6	118	55.4	34.3	112	61.5	55.5
90	63.1	19.4	120	48.5	41.8	114	59.2	59.1
91	53.1	19.0						
119	53.4	35.0				Odd:		
						3	78.0	51.7
						13	68.2	60.6
						46	100.0	54.5
						47	93.3	53.3
						102	30.5	59.8
						110	34.8	52.5
						117	52.0	51.5

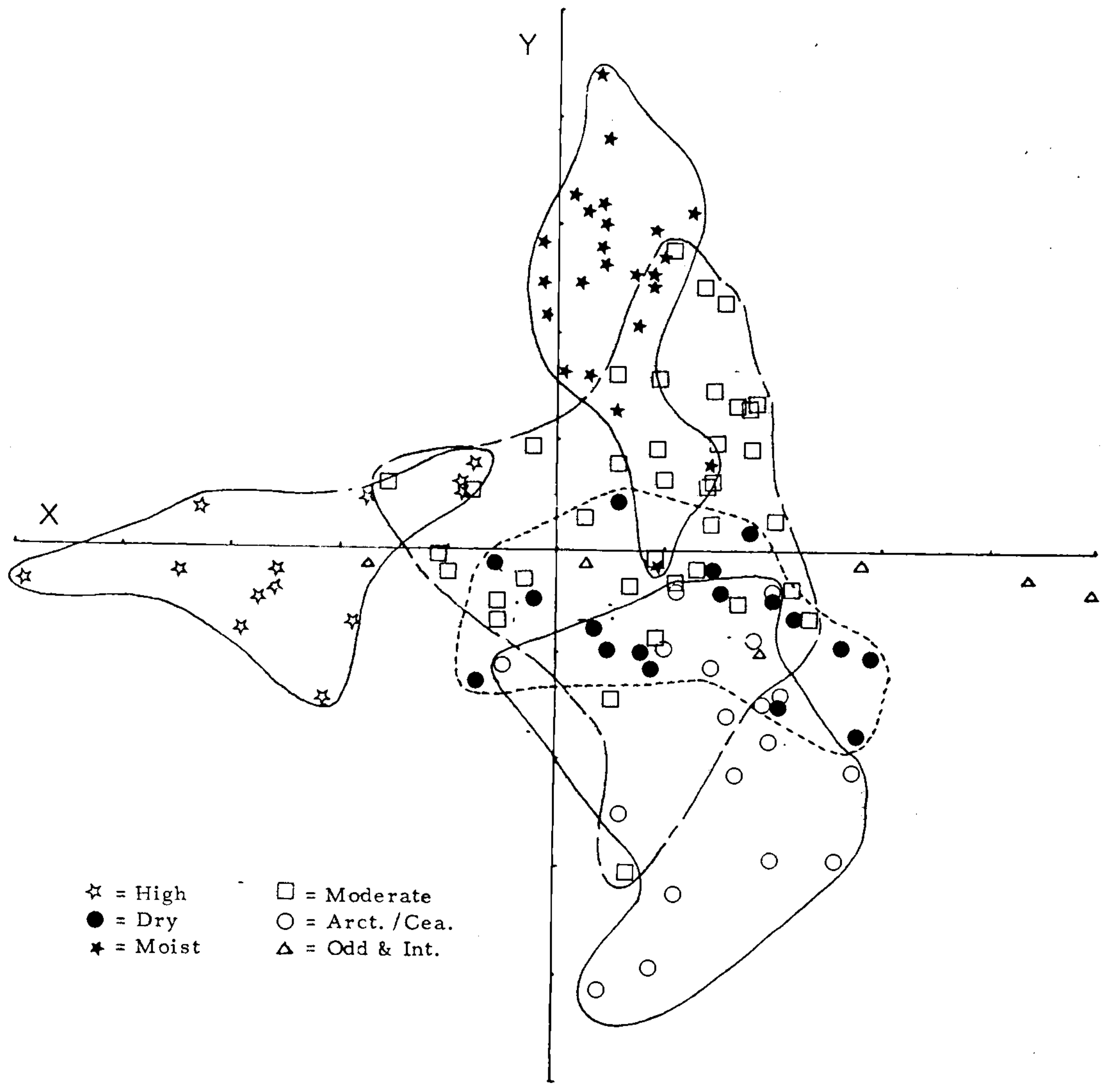


Figure 10. First ordination of 116 plots and no pre-selected end points is plotted on a two dimensional axis.

of the crest which runs up the eastern side of the area, and were quite distinct from the other plots in their vegetation. They had not initially been placed in any of the five major groups. It is therefore not difficult to see why plot 46 was selected as one of the end plots, and it is also quite possible that it did not represent an end point of a naturally occurring gradient running through all of the plots. It was probably an odd plot not related to the predominant pattern in the area. Therefore, plots 46 and 47 were eliminated from subsequent runs in the hope of developing a new set of end plots which would better demonstrate any major trend in the vegetation composition of the plots involved.

On the second run with 114 plots and the same 50 characters, plots 38 and 104 became the end plots of the X axis and plots 43 and 87 the end plots of the Y (Table 6). When the different community groups were plotted, the moist and high elevation groups remained distinct (Figure 11). However, the dry and Arctostaphylos/Ceanothus groups showed considerable overlap.

Upon close scrutiny of the dry and Arctostaphylos/Ceanothus plot locations, it could be seen that, even though plot 38 was the end plot on the X axis, most of the dry plots were positioned toward the bottom end of the Y axis. Plot 43, which represented the end plot at the bottom of this axis, was a preliminary member of the moderate group. However, upon closer examination of the vegetational

Table 6. A list of the plots by vegetational association groups and their X, Y coordinates (second ordination).

	X	Y		X	Y		X	Y
High:			Moderate:			Dry:		
93	42.0	66.2	9	75.2	55.0	4	85.0	54.0
94	35.1	74.7	11	73.9	55.3	5	69.9	58.5
95	52.0	48.9	12	61.6	57.5	7	87.5	54.3
97	44.9	50.4	18	62.6	35.5	8	72.4	56.8
98	47.1	51.5	20	66.7	25.5	14	62.6	54.2
99	34.0	59.9	21	66.6	37.9	37	82.7	70.8
100	26.0	56.2	26	61.8	54.5	39	76.8	74.1
101	23.3	69.7	29	76.6	54.5	44	61.4	70.9
104	0.0	64.3	30	69.4	47.4	64	81.6	56.4
105	20.8	43.4	34	70.3	36.7	66	67.4	62.9
106	26.1	67.0	43	53.3	92.9	71	66.5	55.7
107	39.9	54.6	51	68.2	51.6	72	63.8	62.3
109	29.7	55.8	52	66.7	36.0	74	55.6	64.7
			53	65.1	28.2	75	59.8	58.2
Moist:			54	63.4	45.0	78	60.5	64.3
1	57.1	35.6	55	68.6	47.4	79	53.6	54.0
15	70.1	37.3	56	61.6	56.8	113	68.3	45.7
22	54.8	22.3	57	62.7	58.9			
23	53.2	14.8	60	66.3	40.5	Arctostaphylos/Ceanothus:		
31	54.9	28.5	61	62.1	43.3	2	69.0	62.7
32	59.0	26.6	63	63.4	37.2	6	75.0	53.4
35	73.7	50.2	65	63.5	39.8	10	65.0	64.1
48	59.1	26.2	69	65.9	41.3	17	66.0	69.3
49	48.0	32.5	70	61.6	19.9	19	70.2	67.1
50	56.4	37.9	73	52.8	50.1	24	76.8	44.9
58	52.5	25.7	76	61.7	63.1	25	76.7	71.9
59	62.7	20.8	77	57.0	58.4	27	71.4	67.2
62	60.2	26.1	81	48.3	49.4	28	77.1	55.1
67	62.1	44.9	83	74.0	49.2	33	77.0	62.3
82	60.0	29.5	84	62.0	40.0	38	100.0	63.2
85	52.8	15.4	96	63.2	54.8	40	65.1	79.3
86	55.1	35.1	108	44.1	45.5	41	68.0	76.9
87	54.5	7.1	111	48.7	50.7	42	69.4	72.0
88	51.2	20.7	115	63.6	53.7	45	75.6	74.8
89	54.2	27.3	116	60.6	54.7	80	53.9	64.8
90	57.2	22.1	118	56.9	34.3	112	69.3	55.5
91	48.5	17.8	120	55.4	37.7	114	60.9	53.8
119	58.4	42.0						
						Odd:		
						3	71.1	59.7
						13	71.0	64.9
						102	34.4	47.5
						110	42.4	48.3
						117	57.2	47.8

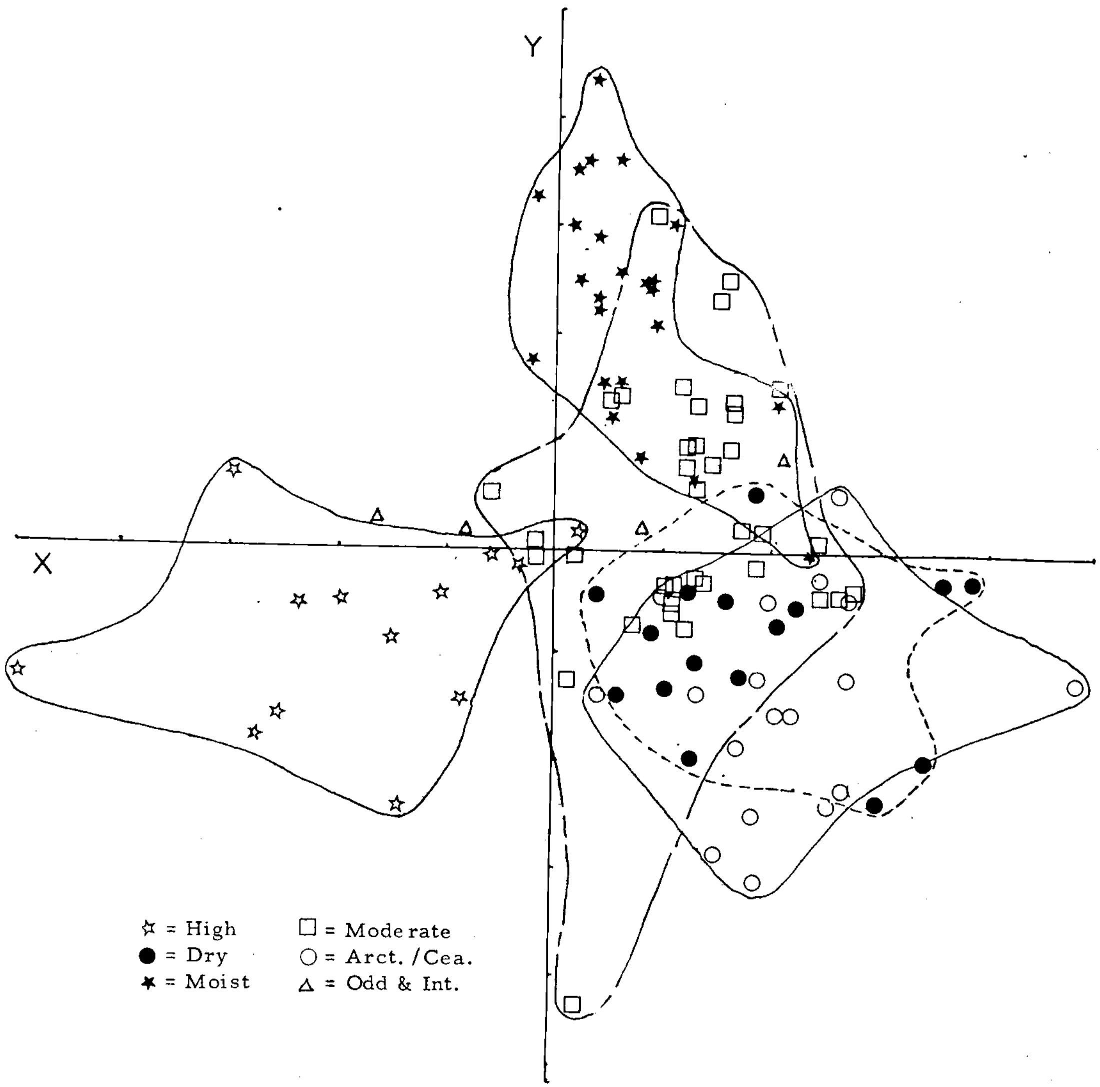


Figure 11. Second ordination of 114 plots and no pre-selected end points is plotted on a two dimensional axis.

composition of plot 43, it became apparent that it had been misclassified and that it should have occupied a position about mid-way between the dry group and the Arctostaphylos/Ceanothus group. The overall species composition is very similar to that used to define the Arctostaphylos/Ceanothus group. However, the plot did not contain Ceanothus prostratus or Arctostaphylos nevadensis.

Because of the position of the pre-selected moist plots 15, 35, and 67, their species compositions were investigated more closely. Plots 15 and 35 were re-classified to "moderate" because they did not have any Tsuga heterophylla, Taxus brevifolia, Acer circinatum or other key species of the moist group. However, 67 was left as a moist group plot, even though some key species were absent.

At this point no other attempts were made to re-classify plots, even though there was considerable overlap of groups, especially the dry and Arctostaphylos/Ceanothus groups.

The next step was to select new end plots which would better represent the overall distribution of plots on each axis. One end of the X axis was dominated by the high elevation group. Therefore, plot 99 was selected as an end plot in that it seemed to best represent this group of plots due to its more central location among the plots on the ordination and species composition. For the other end of the X axis, plot 64, a typical dry plot, was selected. This was a difficult decision, since the dry and the Arctostaphylos/Ceanothus plots overlapped in their distribution. However, the dry plots seemed to be closer to the center of the Y axis and farther to the right on the X axis than did the Arctostaphylos/Ceanothus group.

For the end plots on the Y axis, plot 87 was retained as it seemed representative of the moist group at one end. Plot 17 was selected as a good representative of the Arctostaphylos/Ceanothus group and was designated the second end plot on the Y axis.

From the X and Y designations (Table 7) the plots were positioned on a two dimensional ordination (Figure 12).

The general positioning of the groups remained similar to that found in Figure 11. However, there was a much better separation of the dry from the Arctostaphylos/Ceanothus group. The dry, high and Arctostaphylos/Ceanothus groups, all of which had one plot pre-selected as an end plot for one of the axes, were more compact than in the previous distribution. This indicated that the selected end plots were better indicators of the total groups vegetation composition than were the original end plots.

With the exception of the high elevation group, there was little separation on the X axis. The major axis of separation of groups remained the Y axis.

There were also a few plots whose vegetational composition was re-evaluated, since the computer evaluation consistently placed them in groups other than those in which they were originally classified.

Table 7. A list of the plots by vegetational association groups and their X, Y coordinates (third ordination).

	X	Y		X	Y		X	Y
High:			Moderate:			Dry:		
93	34.5	53.5	9	73.4	60.0	4	76.6	63.2
94	31.0	67.1	11	70.8	60.9	5	62.9	66.4
95	43.0	45.7	12	64.6	62.3	7	70.6	68.8
97	39.6	41.1	15	60.6	47.3	8	61.4	65.6
98	45.7	41.0	18	58.0	40.6	14	57.3	55.3
99	23.7	51.4	20	57.6	28.8	37	64.5	67.6
100	28.8	44.1	21	63.5	52.5	39	66.1	64.7
101	27.4	58.4	26	67.3	66.7	44	61.3	65.0
104	25.6	52.4	29	56.8	62.5	64	76.3	58.5
105	34.5	46.9	30	62.6	45.7	66	54.5	66.1
106	29.9	58.3	34	65.2	40.0	71	59.5	42.9
107	40.8	48.3	35	57.1	48.9	72	69.4	60.6
			51	60.7	49.0	74	44.7	55.9
Moist:			52	67.1	41.8	75	53.6	54.1
1	57.3	35.5	53	67.2	39.7	78	57.0	58.8
22	57.3	27.8	54	68.8	46.0	79	56.0	49.2
23	59.4	19.9	55	65.0	39.8	113	70.0	51.6
31	57.1	31.5	56	75.8	62.5			
32	59.9	26.2	57	59.3	64.7	Arctostaphylos/Ceanothus:		
48	59.6	34.6	60	63.5	38.0	2	64.2	71.8
49	52.3	35.9	61	67.8	44.7	6	63.4	70.8
50	68.6	40.9	63	70.8	45.2	10	60.9	75.4
58	55.2	19.7	65	71.2	44.2	17	63.7	86.7
59	62.5	24 2	69	69.7	45.7	19	62.7	80.2
62	55.2	27.7	70	58.7	22.5	24	66.2	61.2
67	49.1	39.0	73	57.7	48.4	25	67.5	82.5
68	67.2	26.2	76	50.6	53.8	27	58.6	79.5
82	62.4	34.9	77	56.2	56.2	28	74.7	70.8
85	65.1	21.9	81	52.0	40.6	33	68.1	79.3
86	58.6	37.1	83	63.0	49.7	38	67.8	66.7
87	56.6	13.3	84	64.5	45.1	40	55.5	70.7
88	62.5	23.5	96	51.3	52.8	41	56.5	76.4
89	68.3	31.9	108	44.4	45.4	42	54.0	73.2
90	63.1	25.5	109	45.1	49.0	45	69.0	82.5
91	56.8	24.6	111	44.8	49.8	80	57.2	58.2
119	55.5	41.3	115	63.3	53.9	112	54 5	75.2
			116	48.6	54.9	114	66.6	71.1
			118	63.2	32.2			
			120	57.0	35.5	Odd:		
						3	60.5	57.8
						13	65.9	58.7
						43	52.9	72.4
						102	44.3	48.2
						110	45.1	41.6
						117	58.2	44.8

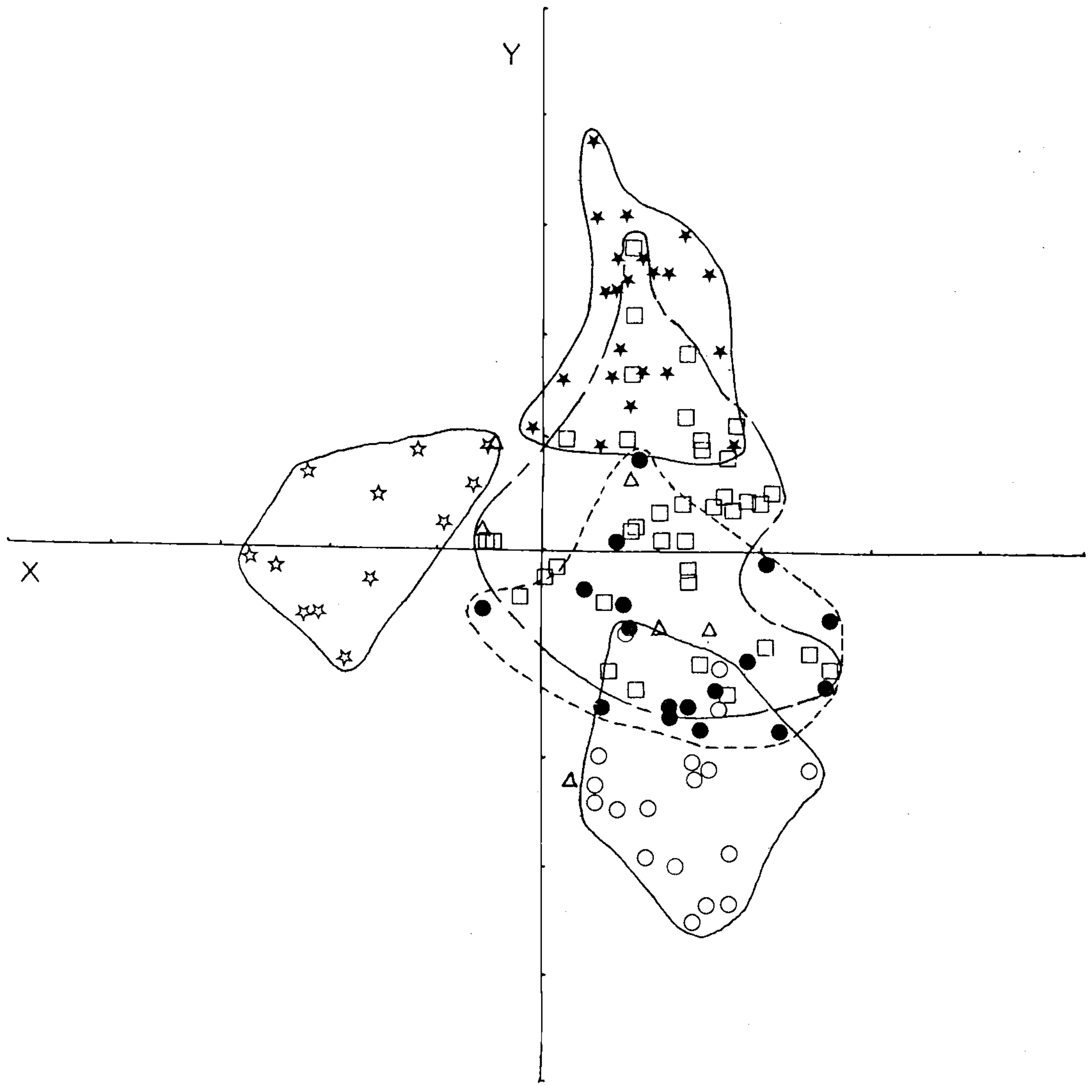


Figure 12. Third ordination of 114 plots and all four end points pre-selected is plotted on a two dimensional axis.

Plots 24 and 80 were changed from Arctostaphylos/Ceanothus to the moderate group. Plot 24 had an overall composition similar to the Arctostaphylos/Ceanothus group. However, the presence of Linnaea borealis and Vaccinium membranaceum as major components of its understory rationalized its re-classification to the moderate group. Plot 80 contained several species which were found only infrequently in the Arctostaphylos/Ceanothus group, but which were often found in the moist group plots. If only one or two of these species had been present I would not have re-classified the plot. However, with eight species in this category I re-classified it to moderate also.

From a closer analysis of plot 71, it appeared that it was not a typical dry plot. However, it didn't fall clearly into any other group. It could best be placed somewhere between the dry and moderate groups. I therefore re-classified it to the odd or intermediate series.

Plots 20 and 70 were re-classified from moderate to moist, as the three most abundant understory species were Vaccinium membranaceum, Linnaea borealis and Corylus cornuta. Plot 70 also contained Calypso bulbosa, a species with a distinctly moist distribution.

Plots 108 and 111 were re-examined on the basis of their position on the X, Y ordination and found to contain many of the species of the high elevation group as well as of the moderate group. Neither plot seemed to fall clearly into either category. Plot 108 lacked seven of the high elevation indicators, and six of the moderate indicators, while plot 111 lacked five of each. I therefore re-classified these two plots to the odd and intermediate series.

After the above re-classification of plots, the five classification groups were re-constituted (Figure 13). The result is a fairly distinct separation of the dry, high, moist, and Arctostaphylos/Ceanothus groups. The moderate group overlapped both the dry and moist groups.

There seemed to be a distinct gradient running along the Y axis. The X axis seemed to have initially separated out the high altitude group, which appeared to be a somewhat distinct flora from the rest.

For the next step in the analysis, the members of the 50 characters used in the initial similarity matrix construction were re-examined. Certain species were found to occur in all five groups in approximately equal proportions. These species tend to increase the similarity values of all plots, and therefore condense the positions of the plots on the ordination. It was the author's desire to separate the groups, if there were distinct differences in their vegetative composition. Therefore, ten species were eliminated (Table 8) from the next run on the basis of their fairly ubiquitous distribution.

From the results of the final run (Table 9) of the 114 plots and 40 species characters, a two dimensional ordination was constructed using the same pre-selected end plots (Figure 14). Slight condensation of the groups, with the exception of the dry group, seems to result, At the same time the Y axis was lengthened.

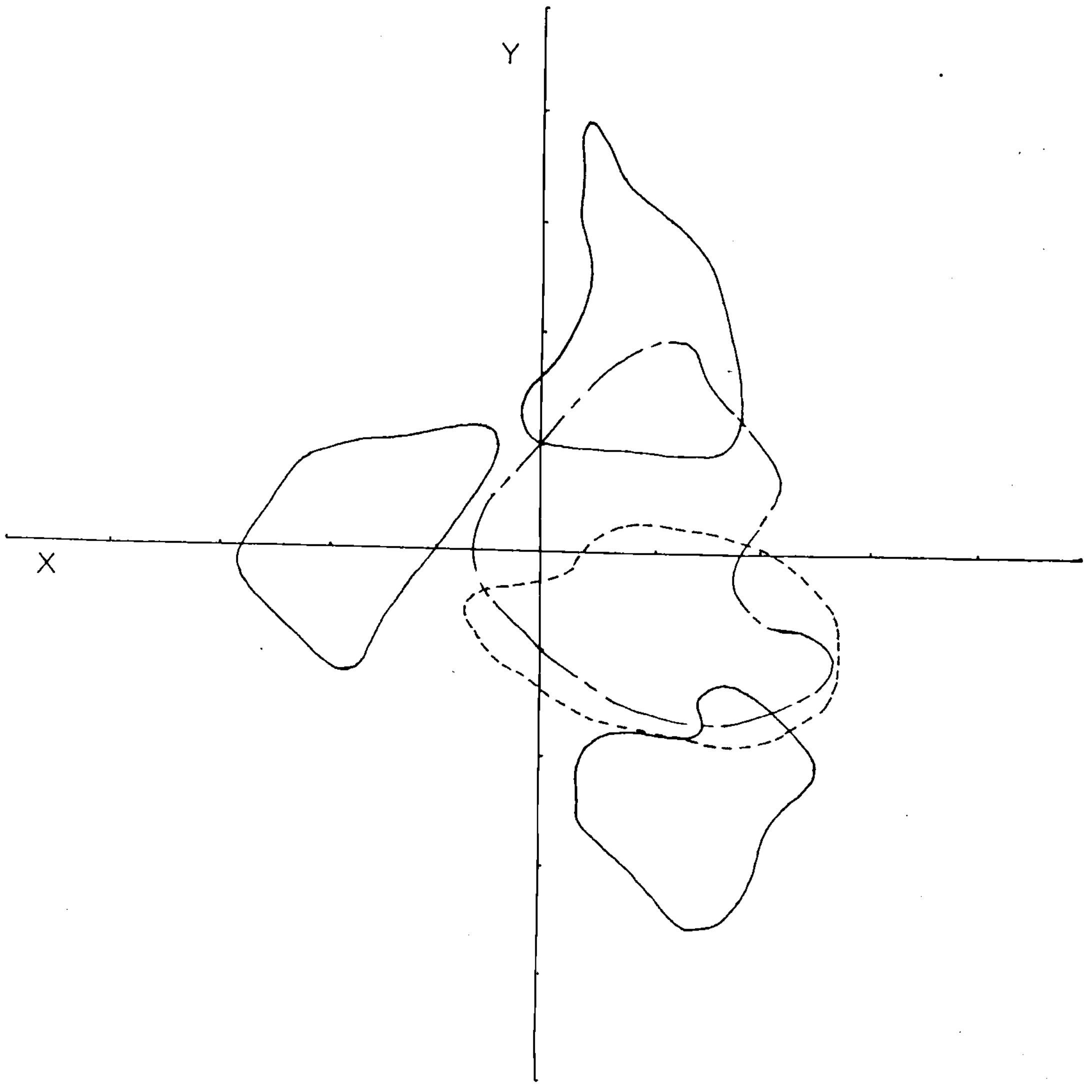


Figure 13. Spacial arrangement of third ordination of 114 plots with five plots re-classified.

Table 8. The ten species characteristics eliminated from the matrix construction in the final ordination.

1.	Reproductive *Libocedrus decurrens*
2.	Reproductive *Abies concolor*
3.	Reproductive *Pinus monticola*
4.	*Asarum caudatum*
5.	*Berberis nervosa*
6.	*Chimaphila umbellata*
7.	*Rosa gymnocarpa*
8.	*Symphoricarpos mollis*
9.	*Trientalies latifolia*
10.	*Whipplea modesta*

Table 9. A list of the plots by vegetational association groups and their X, Y coordinates (final ordination).

	X	Y		X	Y		X	Y
High:			Moderate:			Dry:		
93	30.2	53.9	9	71.6	59.5	4	75.3	62.8
94	25.1	63.9	11	66.1	59.6	5	58.9	74.6
95	39.2	48.6	12	60.1	64.8	7	61.4	68.5
97	36.3	41.3	15	51.5	38.5	8	58.3	67.1
98	37.7	38.1	18	52.1	33.8	14	40.0	51.9
99	19.3	52.0	21	56.5	51.1	37	52.8	66.5
100	26.5	46.4	24	57.6	57.5	39	64.4	75.5
101	18.6	63.9	26	57.1	66.5	44	57.5	61.8
104	18.4	52.6	29	47.9	61.3	64	80.2	56.0
105	26.3	46.3	30	55.3	42.3	66	44.2	63.3
106	15.7	60.0	34	64.7	34.7	72	62.7	65.3
107	30.4	50.8	35	52.4	48.7	74	40.3	60.6
			51	51.3	41.4	75	49.4	58.2
Moist:			52	58.8	29.1	78	50.3	61.3
1	49.0	23.0	53	60.9	26.2	79	45.8	47.0
20	50.1	17.7	54	62.3	41.2	113	69.5	43.4
22	54.0	19.6	55	67.5	32.5			
23	52.2	8.5	56	68.6	61.2	Arctostaphylos/Ceanothus:		
31	47.3	22.4	57	56.8	64.0	2	54.6	75.3
32	52.1	14.8	60	56.4	28.9	6	55.1	74.3
48	51.8	27.6	61	59.0	37.8	10	52.5	79.1
49	43.3	28.4	63	61.9	37.1	17	57.1	96.9
50	62.2	35.5	65	68.2	40.5	19	59.7	87.1
58	51.1	10.7	69	59.7	34.3	25	59.6	93.2
59	59.3	16.0	73	55.0	50.8	27	59.7	86.9
62	47.2	15.4	76	44.6	55.1	28	71.6	73.7
67	44.6	33.3	77	42.4	53.7	33	60.7	88.4
68	59.5	12.3	80	50.1	60.2	38	67.3	65.3
70	54.8	13.6	81	47.1	40.6	40	58.9	78.8
82	54.4	21.6	83	60.0	47.3	41	55.3	86.0
85	58.9	9.8	84	56.3	34.2	42	48.0	79.8
86	49.9	27.2	96	47.4	52.3	45	64.1	89.1
87	53.2	3.1	109	43.6	53.2	112	46 6	78.8
88	51.8	8.3	115	56.9	53.6	114	57.2	75.0
89	55.6	15.0	116	43.3	54.9			
90	55.2	11.1	118	56.2	26.0	Odd:		
91	51.6	8.5	120	55.1	31.4	3	48.4	55.4
119	42.6	32.0				13	60.5	61.6
						43	45.3	76.4
						71	56.5	38.9
						102	45.3	47.6
						108	41.9	46.9
						110	46.3	42.7
						111	36.4	52.1
						117	50.1	45.1

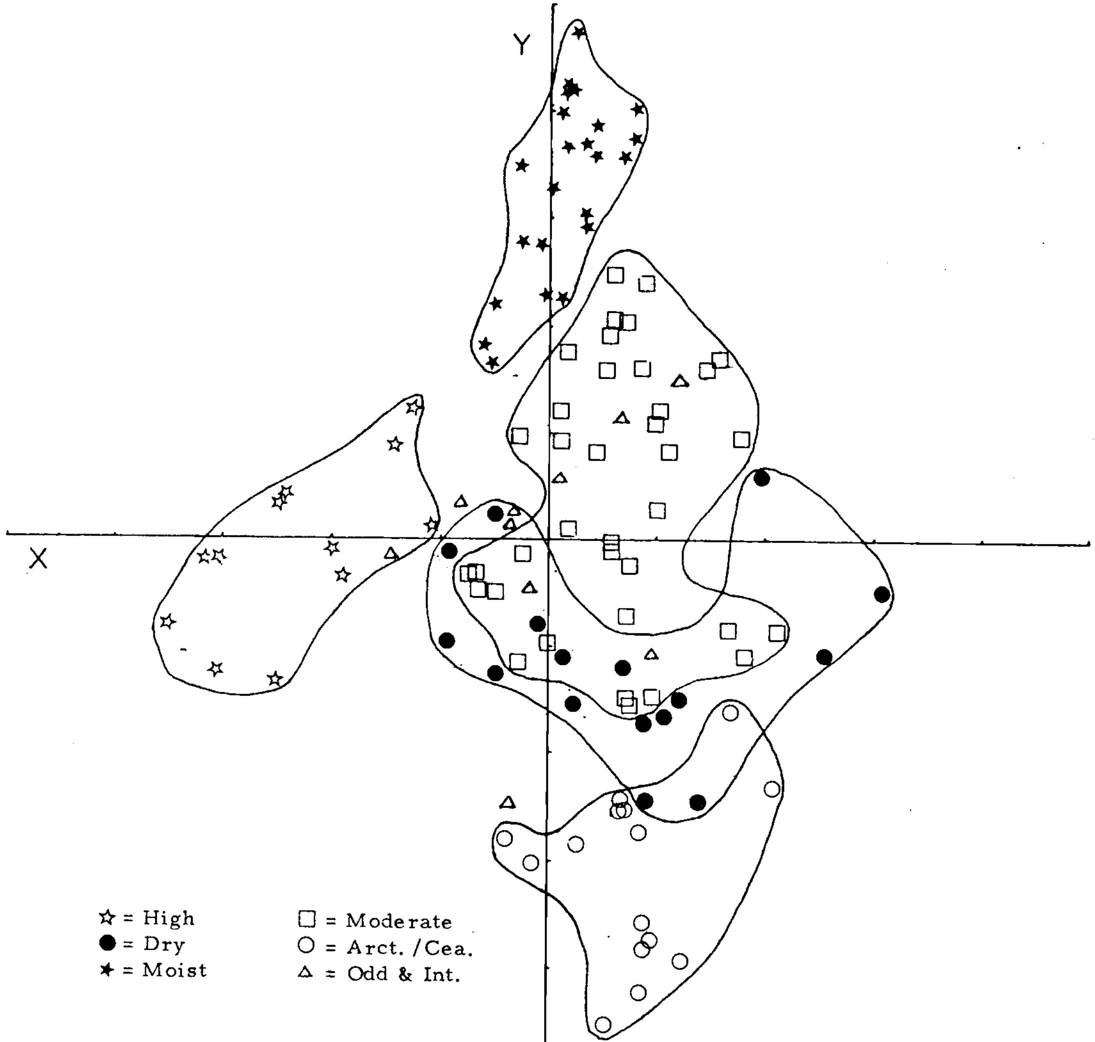


Figure 14. Final ordination of 114 plots and all four end points pre-selected. (Forty species characteristics were used in the similarity matrix construction rather than the original fifty.)

The vegetation of several plots was re-examined. However, plot 50 was the only one reclassified. It went from the moist to the odd and intermediate group. It contained all the species of the moist group except three and all of those were of the moderate group. A complete re-classification could not be justified to moderate because some of the species such as the Pacific Yew, although not abundant in the plot, are quite specific to the moist plots.

At this point, manipulation of the plots was terminated as there seemed to be a consensus between the arrangement of the plots on the X, Y ordination by the computer and the subjective evaluation of the author.

An evaluation of the plot group patterns would reaffirm the previous evaluation that the X axis seemed to separate the high elevation group as a distinct floral series while the Y axis represents a gradient from moist to dry within a second vegetation series. The Arctostaphylos/Ceanothus group occurs at the dry end of the moisture gradient in that it is vegetatively quite similar to the drier end of the dry group. However, it also contained Ceanothus prostratus and Arctostaphylos nevadensis almost exclusively. Thus, there was a compounding effect of a dry as well as a partially distinct vegetation series that positioned this group at the extreme end of the Y axis.

Vegetation Units

High Elevation Unit

This unit is the most distinct of the five communities identified in this study. As can be seen from Figure 15, it occupies the higher elevations of the study area. It is characteristic of most of the area in the northwest corner of the natural area below Abbott Butte and Elephant Head. Some of the area below Falcon Butte and along the ridge between Falcon Butte and Elephant Head also contained this community type.

In most locations, the moderate vegetation series borders this group. The moderate series also occupies an adjacent location on the ordination.

The overstory (Table 10) is characterized by *Libocedrus decurrens*, *Abies magnifica* and *Abies concolor*, with all age classes represented. Among the vegetation units studied, it is unique in the absence of *Pseudotsuga menziesii*, which is the dominant overstory species of the older age classes for most of the natural area. The strong presence of *Abies magnifica* is also specific to this community type.

From Table 11, it can be seen that the shrub component is not extensive, averaging less than 5% cover. It is characterized by *Ribes lacustre* and *Ribes viscosissimum*, both of which occur only to

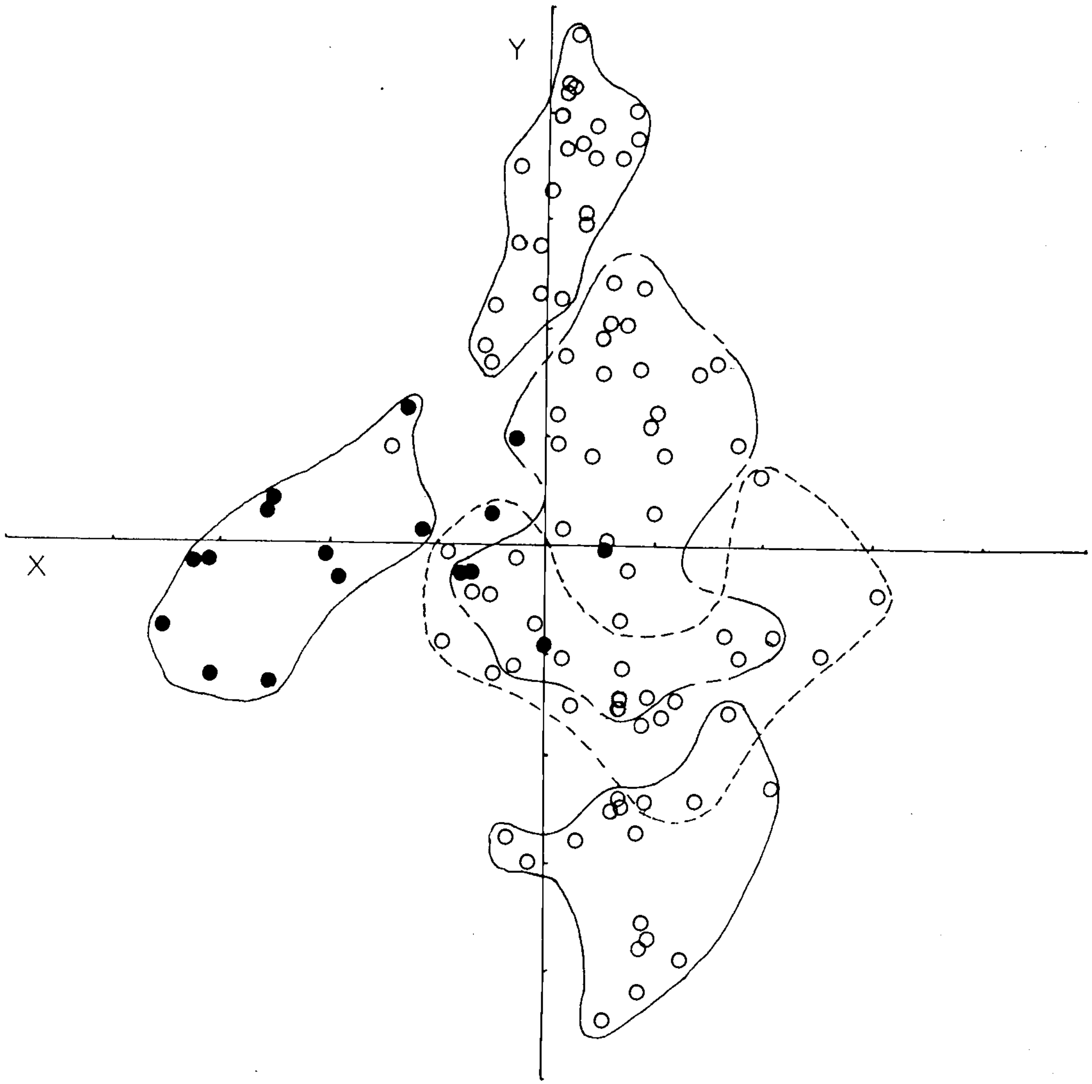


Figure 15. The darkened circles indicate the plots with an elevation of over 5, 000 feet.

Table 10. Overstory species distribution of the high community type.

	Diameter at breast height									
	Under 5 cm.	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80 & over
Pseudotsuga menziesii										
abundance				*		*	*	*		.2
consistency				*		*	*	*		.2
Libocedrus decurrens										
abundance	2.1	1.0	.7	1.1	.8	.9	.4	.5	1.5	2.7
consistency	.7	.7	.5	.4	.3	.5	.3	.3	.6	.8
Abies magnifica										
abundance	1.3	1.1	.6	.3	.8	.3	.2	.4	.9	3.1
consistency	.4	.5	.4	.3	.4	.3	.2	.4	.9	3.1
Tsuga heterophylla										
abundance	*	*	.2	*	*	*	.3		*	.6
consistency	*	*	.2	*	*	*	.2		*	.4
Abies concolor										
abundance	5.8	3.5	1.8	2.2	.6	.5	.8	.9	1.5	2.3
consistency	.9	.9	.7	.6	.4	.4	.3	.6	.7	.9
Pinus lambertiana										
abundance										
consistency										
Pinus monticola										
abundance										
consistency										
Taxus brevifolia										
abundance										
consistency										

Table 11. Distribution of the shrub species component in the five community types (consistency, abundance and percent cover).

	High			Moist			Moderate			Dry			Arct. /Cea.		
	con.	ab.	% co.	con.	ab.	% co.	con.	ab.	% co.	con.	ab.	% co.	con.	ab.	% co.
Ribes l.	.7	2.0	1.7				*	*	*	.1	..4	.7			
Ribes v.	.5	1.3	1.7				.1	..3	.3	.3	.7	.6			
Acer c.	.3	.5	.6	.7	2.5	14.6									
Corylus c.	.3	.3	.6	.9	2.7	6.0	.7	1.5	2.3	.6	2.2	1.6	.2	.4	.4
Rosa g.	.5	1.4	1.3	.7	1.7	1.7	.5	1.2	1.4	.4	1.2	1.3			
Vac. mem.				1.0	2.7	3.4	.4	1.0	1.0						
Cast. cry.				.8	1.9	4.5	.8	1.9	3.1	.6	1.6	5.6	.6	1.6	2.8
Arcto. nev.							.1	.4	.8				.9	3.9	9.7
Cea. pro.				*	*	*	*	*	*				.9	3.4	4.5
Garria f.							.1	.1	.3	.2	.4	1.4	.6	1.0	1.8

con = consistency

ab = abundance

% co = percent cover

limited extents in some of the dry and moderate stands. Acer circinatum, Corylus cornuta and Rosa gymnocarpa are also components of the shrub layer.

The understory is quite extensive, with cover values averaging well over 80%. There are several species that are quite specific in their distribution to this community type, such as Erigeron aliceae, Montia sibirica, Galium aparine and Osmorhiza chilensis, as well as some less abundant species (Table 12). Pteridium aquilinum, Smilacina sessilifolia, Vancouveria hexandra, Achlys triphylla and Vicia americana comprised the major component of the understory.

Moist Unit

This community type is almost exclusively located in or near the bottoms of drainages, usually those containing running water throughout the year. From Figures 16 and 17, it can also be seen that this moist end of the Y axis is also associated with the plots that contain the least slope and the deepest humus layers. These two factors tend to occur together in the study area, in that a majority of the plot locations were on slopes of 25 degrees or more. It would appear that the severity of the slopes in these locations is a major factor in preventing humus accumulation.

The overstory (Table 13) is characterized by mature Pseudotsuga menziesii, Pinus lambertiana and Pinus monticola, while all age

Table 12. Distribution of the understory species component in the five community types (consistency, abundance and percent cover).

	High			Moist			Moderate			Dry			Arc. /Cea.		
	con.	ab.	% co.	con.	ab.	% co.	con.	ab.	% co.	con.	ab.	% co.	con.	ab.	% co.
Erigeron a.	.5	1.5	1.3												
Montia s.	.5	1.9	1.3												
Galium a.	.7	2.2	1.7	*	*	*	.1	.3	.4						
Osmer. ch.	.7	2.1	1.7	*	*	*									
Trillium o.	.4	.8	1.0	.7	1.4	1.6									
Anemone d.	.2	.4	.4	.7	2.1	1.9	.3	.8	.7				*	*	*
Clint. un.	.2	.5	.4	.8	2.3	2.0	.2	.5	.5						
Pter. aq.	.8	2.4	3.2	.1	.3	.3	.2	.6	.8				*	*	*
Smil. se.	.9	3.2	5.2	*	*	*	.1	.2	.3						
Van. hex.	.6	1.7	2.9	.7	1.6	1.6	.7	1.5	1.7	.2	.4	.4			
Coll. he.	.5	1.0	1.0				.2	.6	.5	.4	.9	1.6	.6	1.0	1.8
Achlys t.	.6	2.3	4.0	.9	3.2	4.6	.9	3.0	3.2	.4	1.3	2.1	.2	.5	.5
Adeno. bi.	.7	1.8	1.7	.2	.5	.6	.4	1.2	1.0	.4	1.1	1.1	.2	.5	.5
Arenaria m.	1.0	3.8	2.5	*	*	*	.4	1.4	1.0	.5	1.9	1.3	.8	2.8	2.1
Asarum c.	.3	1.0	.8	.5	1.0	.9	.4	1.2	1.0	.3	.6	.6	*	*	*
Circaea a.	.8	4.7	1.9	.3	1.0	.7	.2	.8	.6	.4	1.6	1.1	.3	.8	.6
Hier. al.	.3	.8	.8	.4	.8	1.0	.8	2.0	2.0	.9	2.4	2.2	1.0	2.7	2.5
Pach. m.	.3	.5	.6	1.0	2.2	2.0	.5	1.2	1.4	.4	1.0	.9	*	*	*
Sym. mo.	.2	.3	.4	.2	.7	.6	.3	.6	.8	.2	.4	.4			
Tri. l.	.9	2.3	1.9	.9	2.5	2.2	.9	2.7	2.2	.8	2.0	1.9	.8	2.4	2.3
Vicia a.	.8	2.4	3.8	.4	1.2	2.0	.4	1.3	1.9	.4	1.3	3.2	.2	.5	.4
Vicia c.	.4	1.0	1.0	*	*	*	.1	.4	.4	.4	1.4	1.2	*	*	*
Chim. um.	.3	1.2	.8	.9	2.6	2.2	1.0	3.0	2.4	.9	2.7	3.2	.9	2.8	2.8
Whipplea m.	.1	.4	1.3	.8	2.4	2.6	.8	3.0	4.3	.9	3.8	8.8	.8	2.9	4.2
Ped. rac.				.4	.7	.7	.4	.8	.3	*	*	*			
Viola s.				.7	2.0	1.7	.2	.5	.5	.2	.2	.3			
Berb. n.				.9	3.0	2.6	.8	2.4	2.1	.8	2.5	2.8	.7	1.6	2.1
Linnaea b.				1.0	4.6	10.0	.8	3.6	8.8				.1	.4	.5
Lupinus a.							*	*	*	.3	.9	.8	.2	.3	.4

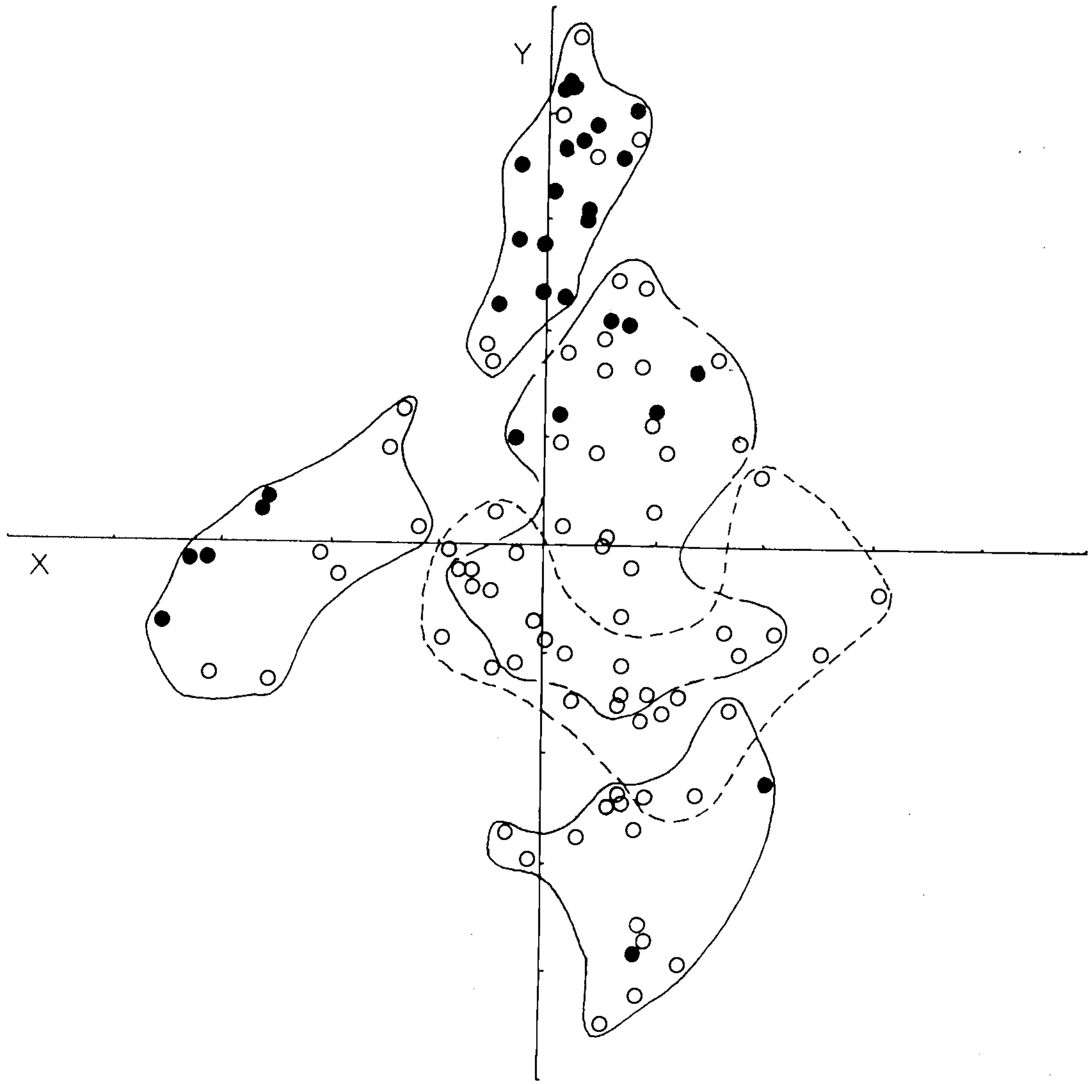


Figure 16. The darkened circles indicate the plots with a slope of less than 25 degrees.

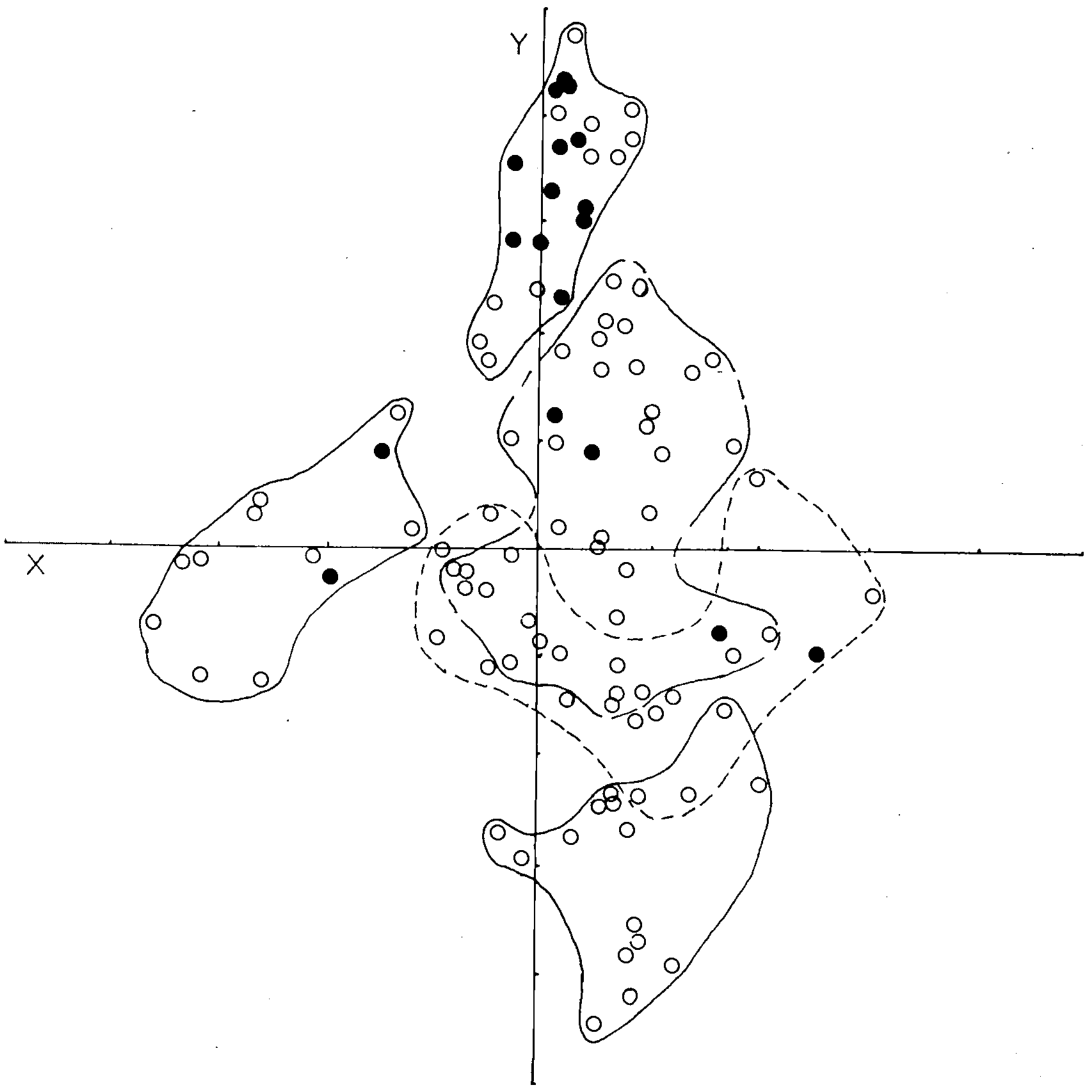


Figure 17. The darkened circles indicate the plots with a humus layer of more than 1.5 inches.

Table 13. Overstory species distribution of the moist community type.

	Diameter at breast height									
	Under 5 cm.	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80 & over
Pseudotsuga menziesii										
abundance	.3	*	*		.1	*	*	.3	.9	3.0
consistency	.1	*	*		.1	*	*	.2	.4	1.0
Libocedrus decurrens										
abundance	2.1	.3	.3	*	.4	.2	.2	.2	.4	.4
consistency	.5	.3	.2	*	.3	.2	.1	.2	.2	.4
Abies magnifica										
abundance										
consistency										
Tsuga heterophylla										
abundance	1.6	1.3	1.1	.4	.6	.8	.4	.4	.5	1.2
consistency	.5	.4	.6	.4	.2	.5	.3	.3	.4	.7
Abies concolor										
abundance	8.3	4.1	2.5	1.4	1.3	.6	.5	.8	.4	.7
consistency	.9	.9	.7	.4	.5	.3	.4	.5	.4	.5
Pinus lambertiana										
abundance										.4
consistency										.3
Pinus monticola										
abundance			*		*				*	.4
consistency			*		*				*	.4
Taxus brevifolia										
abundance	2.2	1.5	.9	.5	*					
consistency	.7	.7	.6	.3	*					

classes of *Abies concolor*, *Libocedrus decurrens*, *Tsuga heterophylla* and *Taxus brevifolia* are found. *Taxus brevifolia* and *Pinus monticola* are quite specific to this community type. *Pseudotsuga menziesii* is the biggest component of the overstory, but shows very little ability to reproduce itself there, since younger age classes are almost completely absent. The significant presence of *Tsuga heterophylla* is, perhaps, the most apparent characteristic of the overstory. Although this species does occur in other community types, it has by far its greatest concentration in this series and is a definite indicator.

The shrub layer is quite extensive and is dominated by *Acer circinatum*, which has a distribution that is quite specific to this community type. *Corylus cornuta*, *Castanopsis chrysophylla* and *Vaccinium membranaceum* are also abundant there.

The understory of this group is quite extensive, often reaching 90% cover. There is also a wide variety of species, most of which are not restricted to this community type. The most important understory species is *Linnaea borealis*, appearing in all of the plots and accounting for an average of 10% of the understory cover. Some other important members of the understory are *Achlys triphylla*, *Whipplea modesta*, *Berberis nervosa* and *Pachystima myrsinites*.

Moderate Unit

The moderate community type is the most common and accounts for a majority of the area under study. With the exception of the southeastern corner and the area occupied by the high elevation community type in the north, most of the rest of the study area is occupied by this community type. It is especially prevalent on the slopes of the major drainages, which contribute the most frequent feature of the land area.

The overstory is dominated by Pseudotsuga menziesii, Libocedrus decurrens and Abies concolor (Table 14). Abies magnifica, Tsuga heterophylla and Pinus lambertiana are also present. Pseudotsuga menziesii is by far the most dominant old growth species, but its representation in younger age classes is much less. On the basis of this evidence, one could consider Pseudotsuga menziesii to be a late successional species, ultimately replaced by Libocedrus decurrens and Abies concolor.

The shrub layer is not extensive, and is dominated by Castanopsis chrysophylla and Corylus cornuta.

The species composition of the understory does not differ greatly from that found in the moist community type. However, neither the cover nor the variety within plots is as extensive as in the moist community. Linnaea borealis, Whipplea modesta, Achlys

Table 14. Overstory species distribution of the moderate community type.

	Diameter at breast height									
	Under 5 cm.	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80 & over
Pseudotsuga menziesii										
abundance	1.6	1.1	.4	.4	*	.2	*	.2	.8	2.7
consistency	.4	.3	.2	.2	*	.1	*	.2	.4	.9
Libocedrus decurrens										
abundance	3.7	1.4	.6	.4	.4	.3	*	.4	1.0	.9
consistency	.9	.6	.3	.3	.3	.2	*	.3	.6	.5
Abies magnifica										
abundance	.7	.5	.4	*	.1		*	*	.2	.3
consistency	.1	.1	.1	*	.1		*	*	.1	.2
Tsuta heterophylla										
abundance	.9	.2	.2	.2	.1	.2	*	.4	.6	1.3
consistency	.2	.1	.1	.2	.1	.2	*	.3	.3	.5
Abies concolor										
abundance	10.0	6.3	3.2	2.1	1.0	.4	.5	.6	.5	1.0
consistency	1.0	1.0	.9	.7	.6	.3	.4	.4	.4	.7
Pinus lambertiana										
abundance	.8	*			*	*	*		*	.9
consistency	.3	*			*	*	*		*	.5
Pinus monticola										
abundance										
consistency										
Taxus brevifolia										
abundance										
consistency										

triphylla, *Chimaphila umbellata* and *Trientalis latifolia* are the most representative species.

Dry Unit

The dry community type is confined in its distribution to the southern end of the study area, where the elevation is lowest, and to the ridge running along the eastern border of the study area. Most of this area has a southwestern exposure, and becomes free of snow early in the year.

The overstory is much the same as was found in the moderate community type (Table 15). *Pseudotsuga menziesii* again dominated the older age classes, but it is not reproducing nearly as well as is *Abies concolor* and *Libocedrus decurrens*. *Abies magnifica* is found only sparingly at some of the high elevation locations. *Tsuga heterophylla* is almost absent, and only a few large older *Pinus lambertiana* individuals are found.

The shrub layer is quite sparse, with *Castanopsis chrysophylla* being the most important species of this component. The understory also is not extensive. Several species found in the moderate and moist community types are not found in this unit. The best understory indicator is *Whipplea modesta*. *Chimaphila umbellata*, *Berberis nervosa* and *Hieracium albiflorum* are also found in abundance.

Table 15. Overstory species distribution of the dry community type.

	Diameter at breast height									
	Under 5 cm.	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80 & over
<u>Pseudotsuga menziesii</u>										
abundance	2.4	1.5	.4	.6	.2	.4	.8	.9	1.1	2.3
consistency	.4	.4	.1	.3	.1	.2	.3	.6	.5	.8
<u>Libocedrus decurrens</u>										
abundance	5.1	2.4	.4	.4	.7	.7	.7	.6	1.4	1.2
consistency	.9	.8	.3	.3	.4	.3	.5	.3	.5	.8
<u>Abies magnifica</u>										
abundance	.6	.2	*	*	*	.1	.1	.3	.1	.1
consistency	.3	.1	*	*	*	.1	.1	.1	.1	.1
<u>Tsuga heterophylla</u>										
abundance	*	.2		.1	*		.2	.1	.2	1.4
consistency	*	.1		.1	*		.1	.1	.2	.4
<u>Abies concolor</u>										
abundance	13.4	10.4	4.7	1.0	.5	.4	.3	.2	.6	.4
consistency	.9	.9	.8	.4	.3	.4	.2	.1	.1	.3
<u>Pinus lambertiana</u>										
abundance	1.9	.6	*	*		*			*	.8
consistency	.3	.1	*	*		*			*	.4
<u>Pinus monticola</u>										
abundance										
consistency										
<u>Taxus brevifolia</u>										
abundance										
consistency										

Arctostaphylos/Ceanothus Unit

This community type is widely distributed throughout the study area, but does not comprise a major component of the total area. This community type is commonly found along ridges. Rock outcroppings are often associated with this unit. However, plots were not placed on these outcroppings as they contain a distinct flora.

The overstory of this community type is open, and dominated by Pseudotsuga menziesii (Table 16). In contrast to the previously discussed units, Pseudotsuga menziesii is represented here by all age classes, and seems to be reproducing itself on such sites. This must be attributed, in part, to the generally more open nature of the forest canopy. Abies concolor and Libocedrus decurrens are also quite abundant. However, Abies concolor had few representatives in the older age classes. As in the dry community series, Pinus lambertiana is consistently present in the form of a few old large trees.

The shrub layer of this community type is quite distinct and extensive. It is dominated by Arctostaphylos nevadensis and Ceanothus prostratus, from which the group is named. Garrya fremontii and Castanopsis chrysophylla also comprised a major portion of this component.

Because of the extensive nature of the shrub layer, coupled with the fact that Ceanothus prostratus and Arctostaphylos nevadensis are

Table 16. Overstory species distribution of the Arct. /Cea. community type.

	Diameter at breast height									
	Under 5 cm.	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80 & over
Pseudotsuga menziesii										
abundance	6.4	3.5	2.2	.8	.3	.3	.5	.7	1.3	2.6
consistency	.8	.8	.4	.4	.3	.1	.3	.3	.4	.8
Libocedrus decurrens										
abundance	3.8	1.3	1.0	.2	*	.6	.3	.6	.9	.5
consistency	.8	.6	.3	.2	*	.5	.1	.4	.6	.3
Abies magnifica										
abundance	1.1	.6	.2		*	*	*	*		*
consistency	.2	.2	.1		*	*	*	*		*
Tsuga heterophylla										
abundance	.3	.4			.1		*	*	.1	.4
consistency	.1	.1			.1		*	*	.1	.1
Abies concolor										
abundance	7.5	3.0	1.3	.8	.5	.4	.5	.1	.1	.2
consistency	.8	.8	.7	.4	.3	.3	.3	.1	.1	.1
Pinus lambertiana										
abundance	1.8	.2		.1	.1			*	.3	1.3
consistency	.8	.1		.1	.1			*	.3	.8
Pinus monticola										
abundance										
consistency										
Taxus brevifolia										
abundance										
consistency										

very low in stature, the understory herbaceous layer is rather meager. Very seldom does this layer exceed 10% cover. The most common species of the understory are *Whipplea modesta*, *Hieracium albiflorum*, *Arenaria macrophylla* and *Chimaphila umbellata*.

DISCUSSION

This study is an attempt to characterize the vegetation of Abbott Creek Natural Area. The outcome resulted in the identification of five plant association units, based upon the presence or absence of species, and the relative cover represented by each.

The Technique

Initial efforts to classify vegetation into plant association units were influenced by the work of Braun-Blanquet (Poore, 1955). The general procedure involved the construction of tables similar to those in Tables 11 and 12. They were the result of the laborious trial and error grouping of plots with one another, until a concensus of sub-sets of species was developed.

There are two major criticisms that might be presented with respect to the Braun-Blanquet technique (Braun-Blanquet, 1932) of association formation. First, it is quite easy to separate the vegetation if there is a great deal of diversity involved, i.e., several species that are found in only one of the associations. However, if this is not the case, it can be very difficult to separate out the associations that might exist. Another criticism regards the difficulty in determining criteria for separation of the vegetation into associations.

To try and illuminate these two difficulties, the classification in this study was conducted by using an ordination technique to place plots on a two dimensional field. From the pattern of plots on the field, associations were delineated.

Ordination involves the placement of plots, or species, on a line defined by two end points. The position on the line of individuals or plots is determined by their relative similarity to the end points that define the line. To construct a two dimensional plane, plots representing two perpendicular ordinations, or axes, are selected. The original work on this technique of vegetation classification was done by Curtis and McIntosh (1951) and Brown and Curtis (1952). However, due to the infancy of computer technology when these studies were conducted, the methods of selecting end points for the ordination met with some criticism (Orloci, 1966).

With the widespread use and availability of computers, it is now possible to move to a matrix of comparative values of all plots, from which techniques similar to those used in this study can be used to select end points on which to base ordinations (Beal, 1965; Loucks, 1966; Frydman and Whittaker, 1968; Knight and Loucks, 1969; Franklin, Dyrness and Moir, 1970). Once the two dimensions of the ordination are established and the plots are located on the ordination, the investigator can look for clusters of plots that might represent associations. However, it should always be kept in mind that the validity of the ordination distribution represented is dependent upon how well the end points selected represent major trends in the actual vegetation. There is always danger involved when one reduces vegetation analysis to a series of numerical values, that some of what is seen represents a residual commodity which is the result of the numerical transfer never being able to truly represent the biological situation.

In this study, there is a second danger in that the investigator must decide which aspects of the vegetation should be used in making the initial comparisons of the plots from which the ordination is developed. Because certain species have wider ranges of distribution, or are more representative of a climax stage than others, there is a hierarchy in the choices available. In this study, no more than 50 characters can be selected, but ultimately the investigator must decide, subjectively, how many and which characters will be used. The first choices will be those of greatest validity, and subsequent choices will decrease in importance down to the investigator's cutoff point.

It is therefore felt that programs such as SIMORD simplify the necessary manipulations of plots in assembling associations, if they exist.

The question of the selection of criteria by which associations are defined remains a difficult one. Ultimately the investigator must look at both the relative position of plots on the ordination, and the tables such as Tables 11 and 12 to determine whether or not distinct units have been delineated, or whether the vegetation simply represents a vegetative continuum. This determination may not be obvious, but by using the ordination technique with the tables, the investigator is armed with a new tool that previous investigators following the traditional Braun-Blanquet methods did not have.

Successional Patterns

It is difficult to analyze the successional patterns in this study area because a conscious attempt was made to sample only stands which contained a mature overstory. However, one intriguing successional problem does exist. By far the most abundant overstory species in the moist, moderate, dry, and Arctostaphylos/Ceanothus vegetation units is *Pseudotsuga menziesii*. Yet, due to the shade intolerance of this species (Bates, 1917; Hoffmann, 1920) only in very few open stands is it reproducing itself. Usually a study of the age classes of the trees reveals that *Abies concolor* and *Libocedrus decurrens* will eventually replace *Pseudotsuga menziesii*. Yet at no location in the study area did the author encounter stands dominated by old growth *Abies concolor* or *Libocedrus decurrens*. This would indicate that something has prevented the overstory from reaching this final stage of development. Several possibilities exist and are supported by observations in the study area.

At numerous locations over the entire study area, old fallen trees can be found which have opened large gaps in the forest canopy. Quite often, at these locations, younger age classes of Pseudotsuga menziesii are present. Abbott Creek Natural Area is also located in the worst forest fire climatic zone in southern Oregon, with a 300% greater fire potential than forested areas along the coast (Hayes and Hallin, 1959). There is evidence of fire at several locations, both in the form of fire scars on older trees, and in the existence of equal sized young Pseudotsuga menziesii trees over extensive areas. Again, fire could open the canopy or destroy the shrub layer enough to allow young Pseudotsuga menziesii saplings to establish themselves. A third possibility is that the canopy trees may become infected with insect parasites to such an extent that they die, which would again open the canopy and allow young Pseudotsuga menziesii to establish themselves. This was observed in two locations.

There seems to be a dynamic equilibrium in existence, which, as a result of these disturbances, maintains the Pseudotsuga menziesii as the dominant species of the overstory.

Vegetation Association Units

Five vegetation associations have resulted from this investigation of Abbott Creek Natural Area (Figure 18). The X axis of the

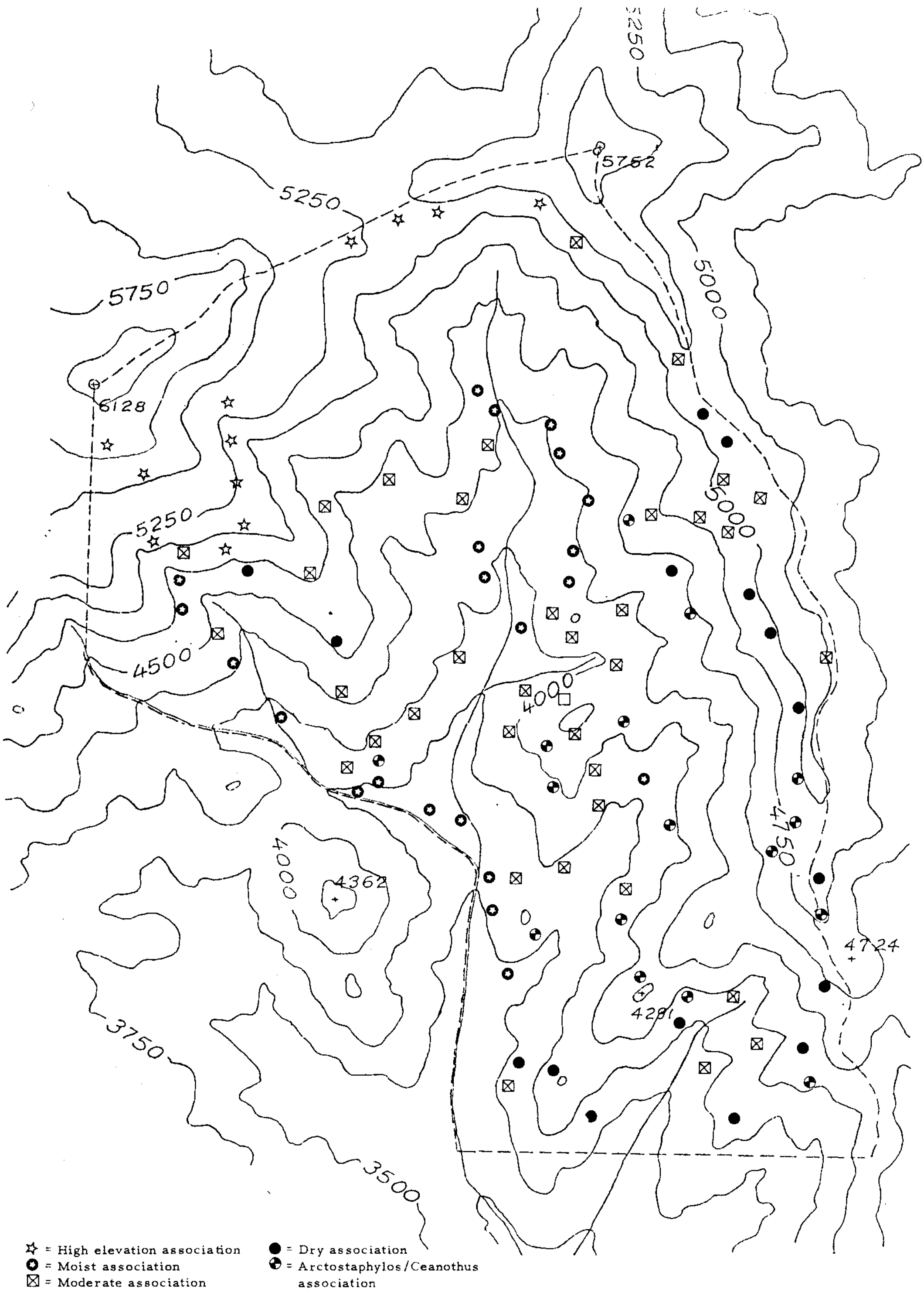


Figure 18. Map of study area with the locations of plots comprising the five plant associations designated.

ordination divides these units into two groups. The first is associated with the Abies magnifica var. shastensis zone (Dennis, 1959; Whittaker, 1960; Franklin and Dyrness, 1969) and consists of the high vegetation unit. The second is associated with the Mixed-Conifer zone (Dennis, 1959; Waring, 1969; Franklin and Dyrness, 1969) and consists of the moist, moderate, dry and Arctostaphylos/Ceanothus vegetation units.

The Y axis tends to separate the four vegetation units associated with the Mixed-Conifer zone along a moisture gradient. A similar moisture gradient has been described in other Mixed-Conifer or Montane type forested areas of southwestern Oregon (Waring, 1969; Whittaker, 1960; West, 1966). These gradients have been designated as "topographic moisture gradients" with the more mesic sites being found in ravines and sheltered areas while the more xeric are found on open southwest facing slopes. The site locations along the gradient associated with the Y axis have a similar distribution.

An attempt has been made to correlate the vegetation units in this study with those found in similar studies of the Southern Cascades and adjacent areas in Oregon (Waring, 1969; Dennis, 1959; Applegate, 1939; Whittaker, 1960). However, the data is rather limited considering the extent and diversity of the flora.

The high elevation unit has similar characteristics to the Shasta Red Fir community type as described by Waring (1969), Franklin and

Dyrness (1969), and Dennis (1959). All contain Abies magnifica as a dominant indicator species. Typically the growing season is short, not beginning until July. Elevations for this association vary depending on the locations, but all are above 5000 feet. The Abbott Creek study area contains examples at the lowest elevations.

Ribes viscosissimum and Arctostaphylos patula are the two most dominant shrubs in the related studies. In the Abbott Creek area, Ribes viscosissimum is one of the more dominant species of the shrub layer, but Arctostaphylos patula is absent.

The understory at Abbott Creek appears to be denser, but contains species similar to those at Mt. Ashland (Dennis, 1959) and the Siskiyous (Waring, 1969; and Whittaker, 1960).

The moist vegetation unit shows a high similarity to Waring's (1969) Yew vegetation type. He describes this group as being associated with locations where water is available throughout the growing season, either through a sheltered topography where transpiration is low, or as a result of small streams. Acer circinatum, Cornus nuttallii and an overstudy dominated by Pseudotsuga menziesii are associated with this community type. In the Abbott Creek area, a similar situation exists in that Taxus brevifolia is found exclusively in the moist area, with Acer circinatum and Pseudotsuga menziesii dominating the understory and overstory, respectively.

It is difficult to separate the moderate and dry units when trying to compare them to descriptions of vegetation on Mt. Ashland or the Siskiyous. Many of the elements of Waring's White Fir and Mixed-Conifer types are found in these two units. However, stands dominated by Abies concolor do not exist in the Abbott Creek area. The overstory of the moderate and dry units is dominated by Pseudotsuga menziesii, Libocedrus decurrens, Pinus lambertiana and Abies concolor. The same is true of Waring's and Franklin and Dyrness' Mixed-Conifer zones, except that Pinus ponderosa is also a major component in their designations. This is not the case at Abbott Creek, but seems to be true in locations just to the south and at lower elevations than occur in the natural area.

Castanopsis chrysophylla, Symphoricarpos mollis, Rubus ursinus, Rosa gymnocarpa, Adenocaulon bicolor, Corylus cornuta, and Berberis nervosa are common to the study areas of Waring, Franklin and Dyrness and Abbott Creek.

The Arctostaphylos/Ceanothus unit is described by Franklin and Dyrness as a plant association which occupies rocky openings in the Mixed-Conifer zone and which is dominated by Arctostaphylos nevadensis and Ceanothus prostratus. There also seems to be a correspondence between this association and Waring's Jeffrey Pine vegetation type. He describes it as occurring at various elevations with an overstory of Abies concolor, Pseudotsuga menziesii, or

Libocedrus decurrens. The common feature of these locations is an infertile, rocky, dry soil. The same description can be used for the Arctostaphylos/Ceanothus unit in Abbott Creek.

The above attempt to relate the vegetation units defined in this study to those defined in other studies (Waring, 1969; Dennis, 1959; Whittaker, 1960) is simply intended to show that there are vegetation associations of comparable composition in other locations in southern Oregon. However, the vegetation of Abbott Creek is quite indistinct, and such comparisons can only be made on a superficial basis which considers a few of the more prominent species. To my knowledge, there are no community vegetation studies on an area of similar composition to that of Abbott Creek.

Another aspect of this study that must be examined is the fact that during the course of the field work I began to assume that distinct vegetation associations exist. This assumption supports a discrete school of plant associations (Daubenmire, 1942, 1943, 1953, 1966) as does all of the vegetation analysis work on communities in southwestern Oregon (Dennis, 1959; Whittaker, 1960; Waring, 1969; Franklin and Dyrness, 1969). It was the author's view that vegetation is distributed in associations, and associations were sought in the analysis. The author feels the association assumption was verified by the ordination procedure, in that discrete groups of plots were delineated from the overall distribution. He also feels that the consistency, abundance, and cover values from Tables 10, 11, 12, 13, 14, 15 and 16 support this assumption.

However, if an investigator were to subscribe to a school of vegetation analysis which does not look for discrete associations and whose mental image of vegetation is that it is distributed along a continuum (Curtis and McIntosh, 1951; Brown and Curtis, 1952; Curtis, 1955; Bray and Curtis, 1959; McIntosh and Cottam, 1966; Swan, 1970), perhaps there could have been a different interpretation of the results. On the basis of the final ordination pattern, Figure 14, there is the possibility that the "topgraphic moisture gradient" defined along the Y axis could be interpreted as being associated with a vegetational continuum rather than four discrete vegetational association units.

This again supports the thesis that, ultimately, it is the judgement of the individual investigator which must be relied upon in making decisions concerning vegetation analysis. The techniques of ordination analysis and computer processing of data are simply tools to extend the analytical abilities of the investigator, but they cannot define the vegetation.

SUMMARY

The major objectives of this study were to determine whether or not different vegetational associations exist in Abbott Creek Natural Area and to see how the computer program SIMORD (Dick-Peddie and Moir, 1970) can assist in the delineation of such communities if they exist.

The data were collected by use of a reconnaissance plot technique (Franklin, Dyrness and Moir, 1970) which afforded the investigator the opportunity to collect data from two to three times as many locations as would have been possible using the traditional construction techniques (Daubenmire, 1959).

Upon completion of the data collection, it was the author's opinion that there were distinct vegetation associations in the area. The plots were divided into high, moist, moderate, dry, Arctostaphylos/Ceanothus and odd groups. The plots which composed each of these groups were subjectively assigned, based upon a set of criteria which described each group by the presence of a series of species.

Verification of the composition and existence of these vegetation associations was done, in part, by the use of the computer program SIMORD. This involved the selection of 50 characters of the vegetation, which were used in the construction of a matrix of similarity

values equating each plot to all others. From this matrix of similarity values, a two dimensional ordination was constructed. The relative position of the plots on this ordination equates the proximity of their vegetation composition.

After a series of plot re-classifications, it was determined that the five vegetation associations originally designated by the author did exist. These vegetational groups were associated on the ordination so that the high group was initially separated from the other groups on the first or X axis. The other groups separated on the Y axis along what appeared to be a moisture gradient, ranging from the moist to the Arctostaphylos/Ceanothus groups.

Further verification of the associations was accomplished by the construction of tables which depicted the vegetational composition of the overstory, shrub and understory of each association as having distinct characteristics. Associations of similar composition have also been found in other locations in southern Oregon (Waring, 1969; Whittaker, 1960; Dennis, 1959; Franklin and Dyrness, 1969).

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APPENDICES

APPENDIX 1

The code used to transfer the data from field observations to 80 column computer cards is listed below by card and column.

CARD 1

Column		Code
1 - 3		Plot number (on all cards)
4		Card number (on all cards)
5 - 8		Elevation
9 - 10		Slope in degrees
11 - 12	Aspect	01 = NNN
		02 = NNE
		03 = NE
		04 = NEE
		05 = EEE
		06 = EES
		07 = ES
		08 = ESS
		09 = SSS
		10 = SSW
		11 = SW
		12 = SWW
		13 = WWW
		14 = WWN
		15 = WN
		16 = WNN
13	Landform	1 = Bench
		2 = Ridgetop
		3 = Toe of slope
		4 = Stream terrace
		5 = Upper 1/3 of slope
		6 = Middle 1/3 of slope
		7 = Lower 1/3 of slope
14	Rock percent	1 = Few - 5 = Many

Column		Code
15	Soil color	1 = Brown 2 = Light Brown 3 = Dark Brown 4 = Gray/Brown 5 = Red/Brown
16	Humus depth	1 = 1/2 inch 2 = 1 inch 3 = 1-1/2 inches 4 = 2 inches
17	Rock	1 = Small rounded 2 = Small angular 3 = Large rounded 4 = Large angular 5 = Large and small rounded 6 = Large and small angular
18	Largest tree	1 = Douglas fir 2 = Incense cedar 3 = Red fir 4 = Western hemlock 5 = White fir 6 = Sugar pine 7 = White pine 8 = Ponderosa pine
19 - 20		Diameter of largest tree in inches

21 - 62 Take all 14 tree species in modules of three and categorize as follows:

(A) Module column number 1 = 0-10 cm dbh

1 = Rare = 4 or less
2 = Occasional = 5-9
3 = Common = 10-24
4 = Abundant = 25 or more

(B) Module column number 2 = 10-70 cm dbh

1 = 1-2
2 = 3-4
3 = 4-6
4 = 7-9
5 = 10-12

Column		Code
21 - 62	(Cont.)	6 = 13-16
		7 = 17-21
		8 = 22-26
		9 = 27 or more
	(C) Module column number 3 = 70 cm dbh or more	
		1 = 1
		2 = 2
		3 = 3
		4 = 4
		5 = 5
		6 = 6
		7 = 7
		8 = 8
		9 = 9 or more
63 - 64		Percent shrub layer
65 - 66		Percent herb layer

67 - 80 and 1 - 80 on future cards as far as necessary in modules of 2.

(A) Module column number 1 = Abundance

1 = Rare - 6 = Abundant

(B) Module column number 2 = Coverage

1 = 0-5%
2 = 5-25%
3 = 25-45%
4 = 45-65%
5 = 65-85%
6 = 85-100%

(Species names of all plants from Peck, 1961)

67 - 68	Acer circinatum
69 - 70	Achlys triphylla
71 - 72	Adenocaulon bicolor
73 - 74	Anemone deltoidea
75 - 76	Arctostaphylos nevadensis
77 - 78	Arctostaphylos patula
79 - 80	Arenaria macrophylla

CARD 2

5 - 6	Asarum caudatum
7 - 8	Berberis nervosa
9 - 10	Carex inops
11 - 12	Castanopsis chrysophylla
13 - 14	Ceanothus prostratus
15 - 16	Chimaphila umbellata
17 - 18	Circaea alpina
19 - 20	Clintonia uniflora
21 - 22	Collomia heterophylla
23 - 24	Corylus cornuta
25 - 26	Disporum hookeri
27 - 28	Erigeron aliceae
29 - 30	Fragaria californica
31 - 32	Galium aparine
33 - 34	Garrya fremontii
35 - 36	Goodyera oblongifolia
37 - 38	Hieracium albiflorum
39 - 40	Holodiscus discolor
41 - 42	Iris chrysophylla
43 - 44	Linnaea borealis
45 - 46	Lupinus andersonii
47 - 48	Melica subulata
49 - 50	Montia perfoliata
51 - 52	Montia sibirica
53 - 54	Osmorhiza chilensis
55 - 56	Pachystima myrsinites
57 - 58	Pedicularis racemosa
59 - 60	Polystichum munitum
61 - 62	Pteridium aquilinum
63 - 64	Pyrola picta
65 - 66	Ribes lacustre
67 - 68	Ribes viscosissimum
69 - 70	Rosa gymnocarpa
71 - 72	Rubus parviflorus
73 - 74	Rubus ursinus
75 - 76	Smilacina sessilifolia
77 - 78	Symphoricarpos mollis
79 - 80	Synthyris reniformis

CARD 3

5 - 6	Trientali~~e~~s latifolia
7 - 8	Trillium ovatum

9 - 10	Vaccinium membranaceum
11 - 12	Vicia americana
13 - 14	Vicia californica
15 - 16	Viola sempervirens
17 - 18	Viola sheltonii
19 - 20	Whipplea modesta
21 - 22	Acer glabrum
23 - 24	Actaea arguta
25 - 26	Agastache urticifolia
27 - 28	Agoseris aurantiaca
29 - 30	Amelanchier florida
31 - 32	Antennaria racemosa
33 - 34	Apocynum androsaemifolium
35 - 36	Arnica cordifolia
37 - 38	Brodiaea pulchella
39 - 40	Calypso bulbosa
41 - 42	Castilleja sp.
43 - 44	Ceanothus integerrimus
45 - 46	Ceanothus velutinus
47 - 48	Cheilanthes siliquosa
49 - 50	Clarkia rhomboidea
51 - 52	Collinsia linearis
53 - 54	Collinsia parviflora
55 - 56	Collomia grandiflora
57 - 58	Collomia tinctoria
59 - 60	Convolvulus arvensis
61 - 62	Corallorhiza striata
63 - 64	Cornus glabrata
65 - 66	Cystopteris fragilis
67 - 68	Delphinium depauperatum
69 - 70	Delphinium scopulorum
71 - 72	Dicentra formosa
73 - 74	Eriophyllum lanatum
75 - 76	Erythronium oregonum
77 - 78	Festuca occidentalis
79 - 80	Gaultheria ovatifolia

CARD 4

5 - 6	Gilia aggregata
7 - 8	Gilia capitata
9 - 10	Hackelia californica
11 - 12	Lathyrus nevadensis
13 - 14	Ligusticum apiifolium
15 - 16	Lillium washingtonianum

17 - 18	Lianthus ciliatus
19 - 20	Lotus micranthus
21 - 22	Lupinus latifolius
23 - 24	Madia gracilis
25 - 26	Marah oregana
27 - 28	Melica aristata
29 - 30	Melica hartfordii
31 - 32	Mertensia paniculata
33 - 34	Nemophila parviflora
35 - 36	Orthocarpus hispidus
37 - 38	Perideridia gairdneri
39 - 40	Phacelia leucophylla
41 - 42	Prunus emarginata
43 - 44	Pyrola bracteata
45 - 46	Pyrola dentata
47 - 48	Pyrola minor
49 - 50	Rhododendron macrophyllum
51 - 52	Ribes cereum
53 - 54	Ribes sanguineum
55 - 56	Rubus nivalis
57 - 58	Sedum spathulifolium
59 - 60	Silene campanulata
61 - 62	Smilacima racemosa
63 - 64	Sorbus sitchensis
65 - 66	Swertia umpquaensis
67 - 68	Trifolium longipes
69 - 70	Valeriana sitchensis
71 - 72	Vancouveria hexandra
73 - 74	Luina nardosmia
75 - 76	Berberis aquifolium
77 - 78	Unidentified (no. 125)
79 - 80	Unidentified (no. 129)

Appendix 2 includes all the data from the 120 plots of the Abbott Creek study. The data are arranged on computer coding forms using the outline in Appendix 1.

APPENDIX 2.

FORTRAN CODING FORM

PROGRAM	NAME ROD MITCHELL	
ROUTINE	DATE	PAGE OF 1

STATEMENT NO.	6–10	0 = ZERO Ø = ALPHA O (11–20)	21–30	1 = ONE I = ALPHA I (31–40)	41–50	51–60	2 = TWO Z = ALPHA Z (61–70)	71–72	SERIAL NUMBER
1134	75 0	1112335160	812 1	31	11		35253231		21
12	4121	432141 31		1121	1141	113121	21		21 21
1331	32	21 21	21	21					
14								11	
15									
2136	0032	864316128	39 12	1 11		1	2015 31		3143 31
22	3121	323141	21	112141	21		21		
2331		42				31			21
24									21
25									
3150	0031	1523266 31	15 13	22 1			2550	21	
32	32			3132	52				31
3331		1142	21						
34			21	41			21		31
35									

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ROUTINE

NAME ROD MITCHELL

DATE

PAGE 2 OF

STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER
413	6	0029	563431662	37 2 1	3 2	3		1540		
42		42	32 42	3111	2131					
433	1		21 52							21
44										21
45										
513	3	0033	564414653	244	2 4	32	11	6520 42		
52			43 31	31	42 31					
532	1		42					21 21		21
54										31
55						31				
614		0032	152326131	1572	111	111				
62		3121	322131		21			2510		213221
63			21 31	21				21		111
64										21
65										

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PROGRAM

ROUTINE

NAME ROD MITCHELL

DATE

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FORTRAN STATEMENT

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER
713	9	0028	1352221654	4 411	47 322	32		1515		
72		31	32 41		2131					
733	1		31							
74										
75						21				
813	6	5020	1463126653	15 34	46 2	1		1045 21	21	
82		31	31 3121	31	31	21				
83			21 21 53							
84										
85										
913	6	0030	1023526616	1121 1 1	33 42 2	1				
92		21	21 31	2121 21	112121	2121		545		21
933	1		53				21			11 21
94				21						
95										

NAME ROD MITCHELL

ROUTINE

DATE

PAGE 4 OF

TYPE	STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER 73–80
				0= ZERO Ø= ALPHA O		1= ONE I= ALPHA I			2= TWO Z= ALPHA Z		
	1013	8	5033	5644146623	31432	1 4	3	13	1045 31		21
	102		31	42 41	21	21 31	31		21		11
	1034	2		52							
	104				21		11				
	105										
	1113	9	3026	664336155	133133	33 2 1	1	11 1	840 41		
	112		3131	31 31	2122	211121	2152	21			21 41
	1134	1		31 52							
	114					21	21				
	115										
	1213	8	5031	853326541	12211	351 1	2		1040 21		21
	122		42	32 4131	2121		2142				21 21
	1233	1		21 52							
	124					31				31	
	125										

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FORTRAN CODING FORM

PROGRAM		NAME	ROD MITCHELL
ROUTINE		DATE	PAGE of 5

STATEMENT NO. (2–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
1313	9	0033	1675326146	3513 2	23		1	579		2131
132		31		4121 31	31	21 41	31 31	21		21 42
1332	1		21 1153	11	42		11			
134				31			42			
135										
1413	9	0029	1262325860	18213	34		1	1070 42		21
142		42	32 31			2131				21 41
1433	1		43 42							
144				21						
145										
1513	6	5024	1663336659	322421	453 5	2		1570 42		2121
152		3131	31 31 31		21	2153				11 41
1534	1	1132	21 21	11	21					
154						21			31	
155										

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

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FORTRAN CODING FORM

PROGRAM		NAME	ROD MITCHELL
ROUTINE		DATE	PAGE OF 6

FORTRAN STATEMENT — 0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

TYPE	STATEMENT NO. (2–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
	1613	7	5026	1562521158	13 1 2	312			70 5		
	162		31				31	21			11
	1633	1	21								
	164						41 55				
	165										
	1713	9	0030	1362216648	13 1	362 1	2		840		53 31
	172		3121	32424221	31	11 31	11		11		31
	1733	1		31							
	174										
	175										
	1813	9	0029	1672511159	2122 1 1	2343	21 1		560 52		31 31
	182		3141	21 31 21	1111	2131	52		21		1141
	1834	1		42 31 21							
	184							41		21	
	185										

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FORTRAN CODING FORM

PROGRAM	NAME ROD MITCHELL
ROUTINE	DATE / PAGE OF 7

TYPE	STATEMENT NO. (2–5)	CONT. (6)	7–10	11–20 (0= ZERO, Ø= ALPHA O)	21–30	31–40 (1= ONE, I= ALPHA I)	41–50	51–60	61–70 (2= TWO, Z= ALPHA Z)	71–72	SERIAL NUMBER (73–80)
	1914	0	0032	1374114656	21621	3 1 2			1040		42 31
	192		3141	213131	41	112121	2142				
	193			41							
	194						21				
	195										
	2013	9	50 8	632331160	2 53	245	1 11 11	1	4060 31		31
	202		2131	21 31 31	3221	2121	2152	32	21		21 41
	2033	1	2132	32 31 21							
	204									21	
	205										
	2113	8	0028	663122646	21321	4611 1	2 1		1565 31		11
	212		3141	324231	21		2153		11 11		21 21
	2134	1	21	21 21							
	214									21	
	215										

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FORTRAN CODING FORM

PROGRAM

ROUTINE

NAME ROD MITCHELL

DATE

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Statement No.	Cont.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	Serial Number
2213	5	50 3	9123356558	6 1	3133 2	1 15	1	30603231		41
222		3131	21 313121	2111	2121	2152	21	11		21 31
223		2131	31 42		11					
224									21	
225										
2313	5	00 4	912345149	2 2	31312 1	3 21	1	25653252		31
232		41	21 31 41	2111		1141	2131	21 31		21 31
2333	1	2131	41 21		11					
234										
235										
2413	7	0029	3534166473	3171 1	34 1 2	1		1035 21		52
242		3131	32 31		31	2152				
2433	1	21	31							
244						21				
245										

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FORTRAN CODING FORM

PROGRAM

ROUTINE

NAME ROD MITCHELL

DATE

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FORTRAN STATEMENT

0 = ZERO Ø = ALPHA O 1 = ONE I = ALPHA I 2 = TWO Z = ALPHA Z

STATEMENT NO.	CONT	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER
2514	2	2034	1253416142	2 12 1	1 33 3			1530		523231
252		2121	315231	41	31 31					
2533	1		2142							
254				21						
255										
2614	2	2034	753416142	3 1 7	31 1 1	1	1	515 31		21
2623	1	3121	31	21	111131	2131	21	11		21
2633	1		41							
264										21
265										
2714		0030	053416655	3137 3	32 1 2			830		523131
272		31	315231	41	11231	2151				21
273			41							
274						21				
275										

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FORTRAN CODING FORM

PROGRAM		NAME ROD MITCHELL	
ROUTINE		DATE	PAGE OF 10

STATEMENT NO. (1–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
2814	1	0024	1354216646	2 2111	4131 2	2		515		52
282		2121	325221	3121	21	21	21			
2833	1		41							
284										
285										
2913	9	5029	553412150	325211	4311	21	1	1525 31		
292		31	322131		2121	2152				21
2933	1		52 41							
294										
295										
3013	6	5032	562236138	812	21	5		530 31	21	3141
302		31	21 31	11	11 31	2152	21	21		21 21
3033	1	31	31 52		11 11					
304								21	21	
305										

0= ZERO, Ø= ALPHA O; 1= ONE, I= ALPHA I; 2= TWO, Z= ALPHA Z

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FORTRAN CODING FORM

PROGRAM

ROUTINE

NAME ROD MITCHELL

DATE

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STATEMENT NO. (1–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
311	0	20 9	332541654	41 2	433 1	2 1 1		6060434 1		41
3122	1	31	51312 1	3221 21	31	41	21	21 21		21 31
3134		2131	21 31 31					21		
314										
315									31	
3213	7	5015	673135156	41 1	11335	1	1	1 1070 1153	1 1	31
3223	1	42	1 31 31	3231	3121	1 152	21	21		21 21
3222	1	212	21 31 21							
324										
325									51	
3313	9	0023	9654144650	3461	22 2 2	1		660		53 51
332		211	324231	51	51	21				
3333	1		52							
334						31				
335										21

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FORTRAN CODING FORM

PROGRAM		NAME ROD MITCHELL
ROUTINE	DATE	PAGE OF 12

FORTRAN STATEMENT: 0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

STATEMENT NO.	CONT	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER 73–80
3413	4	5020	253426653	5121	46 1 1	1		540 3 1	31	
342		2121	31 31	2131	2121	42	31	21		31 21
343		31	31 31 42		21					
344						21			31	
345										
3513	5	0026	1064126651	1 5211	3221 1			555 42		
352			21 31 31	11	2131	4142		11 21		11 21
3533	1		42 42		11					
354										
355									11	
3614	1	0026	1053216824	3 3			2 12	2060		42
362		31	42	31	31					
363			21		21	2111 31	3121213131			51
364		51	6221	31 53	21241	21		21		
365										

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FORTRAN CODING FORM

PROGRAM		NAME ROD MITCHELL	
ROUTINE		DATE	PAGE OF 13

FORTRAN STATEMENT

0 = ZERO
Ø = ALPHA O

1 = ONE
I = ALPHA I

2 = TWO
Z = ALPHA Z

STATEMENT NO. (1–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
5714	1	5033	14531 1856	4241	431			120	21	31
372		2141		21	31	31				21
3732	1		52 42							21
374										21
575										41
3914	1	0030	85322 647	463333	21		3	220	21	
392			21 52	21	31	21				21
3833	1		11 52							
384										
385										21
3214	4	5028	3542 16146	25237	21			310		
392		31	11	21 4	21 21	31 31		21		31
3933	1		3152							
394										
395										21

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FORTRAN CODING FORM

PROGRAM	NAME ROD MITCHELL
ROUTINE	DATE · PAGE OF 14

STATEMENT NO.	CONT.	FORTRAN STATEMENT 7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER
		0= ZERO Ø= ALPHA O			1= ONE I= ALPHA I			2= TWO Z= ALPHA Z		
4014	9	0022	1354416656	65322222	32 2			1 2 5		52 41
402			21	51	21 31	21 21	11 11			
403			21							
404										
405										
4114	7	0023	1254416658	31924222	31 2			1025		52341
412		31	4131	41	11 31	21 11		11		
4133	1		21							
414										
415										
4214	3	503	2535161512	521231	33 1			1225	31	52 51
422		131	31314	51	21	31 21				
4232	1		3141 41							
424					31		21			
425										

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FORTRAN CODING FORM

PROGRAM	NAME ROD MITCHELL
ROUTINE	DATE	PAGE OF 15

FORTRAN STATEMENT — 0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER
4314	5	5029	10533 14150	2425	33			520		41
432			31	41	311131	31 31	4121 31			21
4333	1		52			21	31			21
434				41	21		31	21		41 11
435										
4414	3	0039	45311 6143	5233	32			520		51
442		2141		51 21 31	4121	31 31	11 21			21
443			215141		31			21		
444				31		11				31
445										
4514	7	5028	92411 14646	11734				610		41
452		1121	21	41	32 31		31			
4535	1		31	21						
454							21			
455										

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PROGRAM		NAME	ROD MITCHELL
ROUTINE		DATE	PAGE OF 16

FORTRAN STATEMENT

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

C	STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
	4614	5	5031	45441 5142	25246	21			410		
	462		21		31	31	21	21			
	4633	1		3141							31
	464										31
	465										
	4714	5	5024	55332 5149	15346	32		1	15		
	472		3141		21	2121		21			11
	4733	1		3141							
	474				41	41					
	475										
	4815		50 9	633335657	22	211 3	22		6575433 1	3 1	31
	482		31	32 3141	3211	31	52	21	21 21		21 51
	4833	1	3121	21 42		21					
	484								11		
	485										

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FORTRAN CODING FORM

PROGRAM

ROUTINE

NAME ROD MITCHELL

DATE

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FORTRAN STATEMENT

0 = ZERO
Ø = ALPHA O

1 = ONE
I = ALPHA I

2 = TWO
Z = ALPHA Z

STATEMENT NO. (1–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
4913	6	50 8	6433156 50	15	3111 2	2 1		5050 4341		31
492		21	11 31 41 41	3221	11	2141	3131	31		41 31
4933	1	31	42 41		21					
494										
4951										
5013	9	5033	1 3753 16 149	18	1221 1	1		1055 21 21		21 31
5023	1	31	32 31	21 21	1131	42	21 21	31		21 31
5033	1	31	42		21					
504								21	21	
5053	1									
5113	9	5035	1363 316 649	9211	312 2			340 52		
512		31	31 2141	11	2121	2141	21			21 31
5133	1	31	31 21 52							
514										
515									21	

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FORTRAN CODING FORM

PROGRAM	NAME ROD MITCHELL
ROUTINE	DATE	PAGE OF 18

FORTRAN STATEMENT

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

STATEMENT NO. (1–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
5214		0023	1663126650	4422 2	25413 2			375 41		21
522		3121	21 41 21		31	1164		11		11 31
5233	1	31	31		11					
524									21	
525		11								
5314		0028	1663226656	2 3	35313 1	11		520 31		
532		3111	21 31	31		52				21 41
5333	1	31	31 21							11
534									21	
535		21								
5414		0033	15642 6654	11	16252 2			530 31		
5422		31	32 3121	11	21	52	21 21	21 11	21	21
5433	1	31	31							
544									31	
545										

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FORTRAN CODING FORM

PROGRAM

ROUTINE

NAME ROO MITCHELL

DATE

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STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER
5514	1	5030	57311 5150	132 1	2333			1050 52		
552			32 31	2121 31	2131	1163	31	21		21
5532	1		41		11					
554										
555									11	
5614		5032	56441 6448	212242	11232 11			315 21		41
5623	1	31	2141	4121		2141				
5633	1		52							31
564										
565										
5714		5029	3653 146	2 7231	1134 21			535 21		41 51
572		21	31 3151	31 21	2131	1151	21 21			21 41
573		31	51				11			
574							51			31
575										

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

[illegible] FORTRAN CODING FORM

PROGRAM

ROUTINE

NAME ROD MITCHELL

DATE

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STATEMENT NO. (1–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
			C = ZERO Ø = ALPHA 0		1 = ONE I = ALPHA 1			2 = TWO Z = ALPHA Z		
5913	9	0010	1043335158	41111 2	44211	21		40404341		31
592		31	31	31 21	11	51	2121	31		31 31
5933	1	2131	41		21					
594										
595							21		11	
5914		0021	773325161	224121 1	2 241 1	2		56021		21
592		31	21 31 31	2121	11	63	21	31		21
5933	1	21	41 31		21					
594										
595									21	
6014	0	0016	663226153	7211	452			560 41		31
602		4131	21 31 21	2121	11 2121	2152	21	21		21 31
6033	1	31	52 21		11					
604										
605									31	

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FORTRAN CODING FORM

PROGRAM		NAME ROD MITCHELL
ROUTINE	DATE	PAGE OF 21

FORTRAN STATEMENT

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

STATEMENT NO. (1–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
61139	5	020	963215154	7212	1 352			1 645 41		
61221		31	31 31	2121	2121	2152		31 21		21 41
61331		31	41							
614										
615									21	
62139	5	021	934333154	13221	1231	11 1 21	2	1 2080 42		21
622		3121	21 41 21	2131 21	21	3152	31	2121 31		21 21
62331	1	2131	3121 41		21			21		
624						21				
625									21	
63142	5	026	1263216653	13232	381 3	14		310		
63321		3121	21 31 11	21	21			2121 11		21
63321			31							
634						21			11	
635										

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FORTRAN CODING FORM

PROGRAM		NAME	ROD MITCHELL
ROUTINE		DATE	PAGE OF 22

FORTRAN STATEMENT — 0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

TYPE	STATEMENT NO. (2–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
	6414	C	5030	1154415156	4212	245 1 1			230	21	
	6422	1	3111	21 41	2121	31	11	21			31
	6432	1		52							
	644									21	
	645										
	6514	7	0033	1064416142	141	11451 1	21		2040 21		21
	6522	1	41	22 31	32	31	2121	21	21 21	31	31
	653			42		21					
	654			21						21	
	655										
	6614	7	0020	963412147	41 3	358	3		1017		
	662		41	32 4231	11	1121		21	31		21
	663			11 52							
	664										
	665										

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FORTRAN STATEMENT

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

STATEMENT NO. (1–5)	6–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
67165	0029	933126157	4211	1361	1	1	880 31	21	31
672		21 314151	3221 21	2131	2163	21	31		21 31
67331	3131	21 41			41				
674								41	
675									
69144	5029	863416142	21 1 1	31341 1	1		560 21		31
68231	41	31	3121	21	52	21	21		31
68331	3121	31 31		11			11		
684					21			31	
685									
69142	5026	693425650	4112	4311 2	11	1	550 31	31	31
69231	4121	21 31	21	21	2152	21	21		31 21
69331	21	41		21					
694								31	
695									

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FORTRAN STATEMENT

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

TYPE	STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER 73–80
	7014	0	5021	1074335148	43 2 1	21341 1	1	1	2570 41		31
	702		31	21 31 31	3221 31	31	2152	21	21 31		
	7033	1	2132	31 31		31 21			21		
	704									31	
	705										
	7114	6	2034	1053416143	24341 1	134		1	630	21	21
	712				31 31	11	21 31	31	21 21	21	31 31
	7133	1		3121 42							
	714										
	715										
	7214	5	5023	1334115451	12111	1333 121	1		1040 21		41
	7223	1	3121	32 2141	3132	31	21 3121	31 21	21		21
	7233	1		31 52							
	724										21
	725										

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PROGRAM		NAME ROD MITCHELL	
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FORTRAN STATEMENT

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

STATEMENT NO. (1–5)	CONT (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
7315	0	026	553121250	22 6 2	1331 11	1		1565 52	31	31 31
7323	1		21 31	2121	213	21 5231	31	12 3242		3121
7334	1									
734			21		11					
735										
7416	0	033	1353512143	1 6322 11	342			230 41	31	31
742		31	3151	41 21 41		31 31	31	21423142		
7433	1		231 21							
744										
745										
7516	0	037	2541 16446	1213221111	531			1055	31	2151
752		3121	21 3151	513221	3121	21 3121		3131		21 21
7533	1		4241 31							
754					31					
755										

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PROGRAM	NAME ROD MITCHELL
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FORTRAN STATEMENT — 0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER 73–80
7614	3	0022	1353116448	111311	735			340 31	31	2141
762		31	4131	21 41	4132	21	21	21 3131		21 21
763			31 4152							
764										
765									21	
7715	0	0031	1453116459	11 2 2143	17351			340 31	31	41
7723	1	3131	31	3221 21	3131	21	21	212131		21
7733	1		4231 42							
774										
775										
7815		0027	1253416445	1122 4231	3233	11		1545 21	21	51
782		3121	3141	5131	11 3132	21 21	21	21 3131		21
7832	1		4231 4152							
784										
785										

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FORTRAN STATEMENT

0= ZERO, Ø= ALPHA O — 1= ONE, I= ALPHA I — 2= TWO, Z= ALPHA Z

STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER
7915	1	5031	1154416449	1113422321	17352			535 31	31	31
7923	1	31	3131	2111 31	2121	31	31 31	21212131		21 21
7933	1		41 41							
794					21				21	
795										
8015	2	0034	1254122443	1132325	3634 1			1045 31	31	3241
8023	1	31	21 4131	412121	3111	21 2121	31	21		21 11
8033	1		3131 41							
804										
805										
8115		0026	553321241	224443	2 346			565 41	31	31
8123	1		31	2131	21 2131	2152 31	21	4221 31		422111
8133	1									
814							31		21	
815										

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STATEMENT NO. (1–5)	CONT (6–10)	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
52141	0016	673535157	9 1	461	1 3		15703241		
522	3131	32 31 41	3231	3121	2152	3111	31		21 31
52341	32	31 21					21		
524								21	
525									
53142	5030	764416654	26522	134 1			545 31		31
532	3121	31	21 31	3141	2152 52	21	21		31
53331		3131 21		31					
534								21	
535									
54142	5024	563416150	2212	1134 2	1		1570 41		31
542	31	32 412141	3221		2141	42	21		
54331		31		41					
544									
545									

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PROGRAM	NAME ROD MITCHELL
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FORTRAN STATEMENT — 0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

STATEMENT NO. (1–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
5514	4	0024	673125162	14 2	3131 1	12		1535323 1		31
5522		3111	21 31 21	3121		141	21	21		21 31
5533		12131	31							
554									31	
555										
5614	2	5012	844325159	2 11	21 1	22 1		706065411	31	31
5624	1		21	31		41 21	2121			31 41 21
5633	1	31	2131 21		21					
564					111					
565										
5714	2	5026	473325153	3 1	1238 11	111 2		304542		
572		52	21 31 31	3221		31	41	31		21
5732	1	1131	31		31					
574										
575									21	

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STATEMENT NO. (2–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
8914	3	5024	1273342243	3	53342	21		25304221		
8923	1	41	32 31 31	32	21	41	21			21 31
8932	1	11						11		
884										
885										
8914	3	0029	1273115443	2231	23431			15453131		31
8923	1	31	31 31 31	4221	11	1152	21	21		31
8933	1	31	31		31					
894										
895										
9014	2	5024	1073425151	21	33331	21		25553231		21
902		31	31 31	42		1142	21	21 31		31
9033	1	21	31 31		21			21		
904										
905										

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PROGRAM	NAME ROD MITCHELL
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STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER 73–80
9114	2	0025	1163212151	14 2	32322	32		25604241		
912		31	41 31 21	42		1152	21	31		21 31
913		42	21 31		21					
914										
915										
9213	[illegible]	5020	433425146	3 1	612	1 21		851542		31
922		31	21 31	3131	21	41	21	21		21 31
9233	1				21					
924						54				
925										
9315	[illegible]	0037	852134257	1691132	143			90	21	41
932				31 21	31 2121	21 31	4131	312		2111
9333		21	4241 31							
934				11					11	
935		21	11						52	

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

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FORTRAN CODING FORM

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FORTRAN STATEMENT

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER
9415	5	5028	S71111358	213124	353			90	31	41
942				31 31	31 31	21 31	4131	42 31		63
9434	1		31						21	
944				21						
945										
9515	1	0030	863122540	122	147			570 31	31	21 41
952			41431	2141 31	21	21		21		2141
9534	1		5221 21							
954									21	
955										
9614	9	0023	863216235	125 12	26221			525	21	31
962				3121 31	21 212131	31		21		5121
9633	1		31 2131							
964										
965										

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FORTRAN CODING FORM

PROGRAM	NAME ROD MITCHELL
ROUTINE	DATE	PAGE OF 33

FORTRAN STATEMENT — 0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

STATEMENT NO. (1–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
9714	3	0029	862134541	2114	11249	1		318 31	21	31
972			41	2121 21	31 21	21	31 11 21	31 31		21
9733	1	31	31							21
974				21					31	
975		21								
9915	0	0026	852213461	22323	13461			5702121	31	31 41
982			4141	21 21	21 31	41	31	31 31		314121
9933	1	21	21 52							
984									31	
985		31								
9915	2	0014	513116256	244 25	22337			260	31	41
992			3131	31	31 3131	21 42	31	31 31		2142
993		21	42 31							
994									21	
995										

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TYPE	STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER 73–80
			0 = ZERO Ø = ALPHA O			1 = ONE I = ALPHA I			2 = TWO Z = ALPHA Z		
1	0015	1	5025	263122347	151329	1317			5802162	21	41
1	002			3131	3131	41 21	21 31	2121	3131	31	21
1	003		21								
1	004								21	21	
1	005		31	21							
1	0115	3	0023	8641115347	222249	313			380		31
1	012			31	31 31	31	21	31	21 3121 31	53	31
1	0132	1		3121			21				
1	014				31				21 31		
1	015										
1	0215	4	5032	4542153 30	11 227	133			5253231		42 31
1	022			31			21		21	21	21 3121
1	023									11	
1	024									31	
1	025										

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FORTRAN CODING FORM

PROGRAM		NAME ROD MITCHELL
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FORTRAN STATEMENT

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

TYPE (1)	STATEMENT NO. (2–5)	CONT. (6)	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
1	0315	9	00 3	4121112338	13	7911			1		11
1	032								21		
1	033										
1	034										
1	035										
1	0415	4	0018	4144123558	128	22			5952142		41
1	0423	1		51	31	51	31	51	42 4121		31
1	043				52					21	
1	044				31	21			21 21	31	
1	045										
1	0515	3	00 8	5221111340	1 14	153			890 52		31 51
1	0524	1		51 31			31		42 2142		41
1	053		21		52						
1	054					31			31		
1	055										

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NAME ROD MITCHELL

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TYPE	STATEMENT NO.	CONT.	FORTRAN STATEMENT 7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER 73–80
1	02615		0015	7521111242	229 12	3 1			399		41
1	0262	1		41	31		41	5131	31 4131		21
1	0263	1		3121	31						
1	024		31		31	42			21		
1	265		31	31							
1	02715		0026	7631211352	2112511	241			520 41	31	21
1	0272	1			32		41	3131	31 31 31	31	41
1	0273	1		3121	21						
1	074				21	31 21					
1	075										
1	02615		5033	1063114166	12	146			56011	31	31 31
1	262		21	31 21	311121	31 41	21 21	21	2121	42	21 31
	263			3121		21					
1	264					21			11	31	
1	265										

0 = ZERO, 0 = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

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FORTRAN CODING FORM

PROGRAM		NAME	ROD MITCHELL
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FORTRAN STATEMENT

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

TYPE	STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER (73–80)
1	0915	2	0031	1163114344	11113 2	2224			560 21	31	21 41
1	0923	1		21 3151	312121 21	31 21	21	3121 21	11 3121	52	31
1	093			21							
1	094									31	
1	095										
1	1015	3	00 6	1123121353	24211 2	331			504521		32
1	102			32	3221 2131	3131	21 21	31	21 2131		2141
1	103					21	43				
1	1042	1					1				
1	105										
1	1114	7	0024	1253422146	53211 2	34211	1		315 3	31	21
1	112		31	11 3121	11 21	21	21		31 21		31 21
1	1132	1		2121							
1	114									31	
1	115										

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PROGRAM		NAME ROD MITCHELL	
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TYPE	STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER 73–80
1	1214	5	2034	1364415453	35 12	1634 21			525	31	52 21
1	122		21	21523121		21	21	21			21
1	1232	1		3121 41							
1	124										21
1	125										
1	1314	5	5026	1363116650	34446 1	2635 2	1		2 8		
1	1322	1	3121	31	11	1121					31
1	133			21 31							
1	134									21	
1	135										
1	1414	5	5026	1364116651	23112 2	2325 112	1		240 21		52 31
1	1432	1	31	215221	31	21	21		11		21
1	1432	1		21 41							
1	144										
1	145										

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FORTRAN CODING FORM

PROGRAM		NAME	ROD MITCHELL
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FORTRAN STATEMENT

0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

TYPE	STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER 73–80
1	1514	7	0030	1263116150	225216	1345 11			635 31	31	41
1	1522	1	31	21 31	313221 21	21	21		3121 21		21 21
1	1533	1		21 41							
1	154									21	
1	155										
1	1614	7	5031	1253416356	119121 12	243521			430 41	31	21
1	162		31	21 4131	21	21 112121	21		11		31 21
1	1633	1		3121							
1	164									21	
1	165										
1	1714	3	0024	763115154	245463	124			430 31		31
1	1722	1	31	31	2121	1121	21	31	21 21		21
1	1733	1		31							
1	174									21	
1	175										

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FORTRAN CODING FORM

PROGRAM	NAME ROD MITCHELL
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TYPE	STATEMENT NO.	CONT.	7–10	11–20	21–30	31–40	41–50	51–60	61–70	71–72	SERIAL NUMBER 73–80
			FORTRAN STATEMENT 0= ZERO Ø= ALPHA O			1= ONE I= ALPHA I			2= TWO Z= ALPHA Z		
1	1814	4	2028	664326146	3311 3	25222			1060 42		
1	1823	1	21	31	3231 31	1121	2152	21	3121 31		21
1	1834	1	31			21					
1	184									31	
1	185										
1	1814	7	5037	663114148	14235 11	23451		21	875 41	21	
1	1922	1	31	2141	3211 31	31 1121	1142	11			31
1	1933	1	2131	21 52							
1	194									31	
1	195										
1	2014	6	0037	463115143	12313 2	44362			460	31	31
1	2023	1	21	21	3111	31 2121	41	31 21	21 21		21 31
1	203			21							
1	204									31	
1	205										

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