AN ABSTRACT OF THE THESIS OF

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Title EARLY STAGES IN PLANT SUCCESSION ON DOUGLAS FIR CLEARCUTS ON THE MARY'S PEAK WATERSHED NEAR CORVALLIS, OREGON.

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This study has been concerned with the patterns of vegetative changes which occur during the first five years following logging and burning on Douglas-fir clear cuts. Knowledge of the successional sequence in the coastal forests of western Oregon is of primary importance to those concerned with the management of this resource. From the more theoretical point of view, there are many unique features associated with this type of vegetation of special interest to the ecologist. Published accounts of studies in Oregon and Washington have been of a generalized nature. None have approached a localized area with the degree of intensity attempted in this study.

Due to its close proximity to Oregon State University and the cutting and burning history of the area, the Mary's Peak Watershed has been especially suitable for this study.

Mary's Peak is the highest point of the Oregon Coast range having an elevation of 4,097 feet. The Corvallis watershed is located on the eastern slope of the peak and includes both the Rock Creek and Griffith Creek drainages. The area is about five miles long east and west by four miles north and south. The area is managed as a unit by the United States Forest Service.

Due to the marine influence, the area has a humid climate averaging approximately 65 inches of precipitation annually with an annual mean temperature of approximately 52°F. Soils are basaltic in origin and are primarily clay loam in texture.

In 1950, an epidemic of Douglas fir bark beetles made necessary a program of development which included cutting of dead and infected trees and establishing a road system. Cutting was restricted to small clear cuts.

The vegetation in the study area is a Douglas fir-vine maple association. Gaultheria shallon and Berberis nervosa dominate the forest floor with traces of Castanopsis, Corylus, and Cornus.

Study plots were located on nine clear cut and burned areas ranging in elevation from 1,300 to 2,800 feet and including north, south, and east exposures.

Nineteen study plots, which were 100 x 100 feet, were established in uniform vegetative areas. Plots were also established in the undisturbed areas adjacent to the clear cuts for comparative purposes.

Vegetative sampling was done using a device called an ocular point frame which provided a reliable indication of vegetative cover. Sampling was done in both the spring and fall on the second, third, fourth, and fifth years following burning. The stable undisturbed vegetation was sampled only once.

Results of the five-year study showed a general increase in total number of plant species. The average total vegetative cover rose abruptly the third, fourth, and fifth years. An analysis indicated that south exposed plots had the greatest vegetative cover the first five years after burning. East plots ranked second and north plots third. By the fourth year, average cover values on clear cut areas exceeded the cover values of understory vegetation on the adjacent uncut forest.

Analysis of data regarding seasonal variation indicated sharp decreases in total cover from spring to fall during the first three years. Increasing amounts of perennial vegetation during the fourth and fifth years reduced this seasonal variation markedly.

In terms of mean cover trends, the annual herb, Senecio sylvaticus, dominated the second year; Lotus stipularis and Circium vulgare, the third; Lotus and Holcus lanatus, the fourth and fifth. All plant species indicated a wide range of cover values on the plots sampled. Some consistent trends in the sequence of cover dominance are noted.

EARLY STAGES IN PLANT SUCCESSION ON DOUGLAS FIR CLEARCUTS ON THE MARY'S PEAK WATERSHED NEAR CORVALLIS, OREGON

by

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INTRODUCTION

This study is concerned with the patterns of vegetative changes which occur during the first five years following logging and burning on Douglas-fir clear cuts on the Mary's Peak watershed in the Oregon Coast Range.

The Mary's Peak watershed is especially suitable for a study of this type, because of its close proximity to Oregon State University, and the cutting and burning history of the area. Salvage operations, as a result of a severe Douglas-fir bark beetle infestation in 1952, resulted in a series of clear cuts beginning in 1953. New clear cuts each year for a number of years provide an excellent opportunity to follow plant succession of this vegetation type.

Knowledge of the successional sequence in the coastal forests of western Oregon is of primary importance to those concerned with the management of this resource. There are also many unique features associated with this type of vegetation of special interest to the ecologist from the more theoretical point of view.

Published accounts of plant succession on Douglas-fir clear cuts in Oregon and Washington have been of a generalized nature. None have approached a localized area with the degree of intensity attempted

in this study.

The first data in connection with this study was taken in the fall of 1957 and continued with both spring and fall sampling until the spring of 1959, with new clear cuts being sampled as they appeared. The work has been continued and expanded by Dr. W. W. Chilcote of the Department of Botany, Oregon State University, and his students.

Many of the trends noted by the author have been confirmed as much additional data have been accumulated. The material covered in this thesis pertains to findings connected to the first years of this continuing study.

REVIEW OF LITERATURE

Ecological succession is the orderly process of community change. It is the sequence of communities which replace one another in a given area. Ecological succession is also directional. In areas where the processes are well known, the stage present at any given time may be recognized and future changes predicted.

Probably the most influential early American ecologist was Frederic E. Clements, whose pioneer studies in the early 1900's established the basic principle that every plant is a product of the conditions under which it grows and is, therefore, a measure of these conditions (3, p. 234). An appreciation of this has lead to the application of ecological principles where the management of wild land vegetation is concerned.

In range management the principle of plant succession has received much emphasis where matters of interpreting range conditions and trends are important. The interaction between the tree species from a successional point of view has also received much attention in forestry. Although major emphasis has been placed upon the successional status of the commercial tree species, changes in the composition of the lesser plants growing beneath the tree canopy and following cutting and burning attracts special attention where problems of forest tree regeneration are involved. Observations by Isaac (4, p. 5) concerning the reproduction of

Douglas-fir focused attention on the changes from herbaceous to brushy cover following logging and burning. A number of plants characteristic of the original ground cover persisted. However, beginning with the second year after cutting and burning, a herbaceous stage including Epilobium angustifolium, Senecio vulgaris and Anaphalis margaritacea develops. This herbaceous stage is later replaced by native shrub species.

Kienholz, studying the revegetation after logging and burning in western Washington, also noted the presence of native and invading plant species after burning. He observed that native shrubby species in the virgin timber showed a slower start than the invading species. However, in a few years, the native shrubby species were in control of the site, and remained so until finally shaded out by Douglas-fir (5, p. 103). He indicated that the density of the total vegetative cover on recently burned plots was low and that the cover rose rapidly as the plots became older. Of special interest was the observation that a reciprocal relationship existed between Senecio vulgaris and Epilobium angustifolium. When there was a high relative density of Senecio, there was a low relative density of Epilobium (5, p. 104). No difference was noted in total vegetative cover on north slopes as compared to south slopes.

Morris (6) in a more recent study in western Washington and Oregon on the effects of slash burning on regeneration

used paired plots to determine differences between burned and unburned areas. He noted that the herbaceous cover was equal on burned and unburned plots by the fourth season. The amount of brush cover on unburned plots was generally higher than on burned plots. He concluded that burning did not decisively reduce or increase the number of post-logging seedlings (13, p. 45).

One of the most thorough studies of early plant succession on Douglas-fir clear cuts has been reported by Yerkes. This study was part of a regeneration experiment in the H. J. Andrews Experimental Forest in the central Oregon Cascades. Yerkes followed vegetative trends on 14 clear cut and burned areas over a six-year period. The species present and trends in total cover as well as trends in woody, herbaceous, annual, and perennial cover classes are reported. The results of the study indicated that herbaceous vegetation constituted the major part of total cover for the first five years. The annuals dropped out early and were replaced by perennial species. Although lower in total cover value, woody vegetation showed a gradual increase over the five-year period. Seventy-three different plant species were recorded on the clear cut for the five-year period with fewer species present on south slopes than north. Two to four species dominated each class of vegetation providing 50 percent of the cover of the class. Minor species followed the trend of the class as a whole. The herbaceous vegetation

was dominated by Epilobium angustifolium, Senecio sylvaticus, and Epilobium minutum. Woody vegetation was dominated by Linnaea borealis, Whipplea modesta, and Rubus vitifolius. Epilobium angustifolium, Rubus vitifolium, Linnaea borealis, and Whipplea modesta dominated the perennial class. Annuals were dominated by Senecio sylvaticus and Epilobium minutum. During the first two years, Senecio sylvaticus and Epilobium minutum were the only species to exhibit a consistant difference between burned and unburned areas. In general, differences between burned and unburned areas were not evident. Yerkes recommended that future studies use a more refined method for determining plant cover so that differences due to elevation, burning, exposure, etc., could be analyzed with more confidence.

DESCRIPTION OF THE GENERAL AREA

PHYSICAL FEATURES

The Corvallis watershed includes both the Rock Creek and Griffith Creek drainages on the eastern slope of Mary's Peak. It is located near the western margin of Benton County in west central Oregon and is included within the western part of range 6W southwest and most of range 7W in township 12S Willamette meridian. The area is approximately two miles south and nine miles west of Philomath, Oregon. Elevations within the watershed range from 450 feet where Griffith and Rock Creeks meet to 4,097 feet at the summit of Mary's Peak. There are about 8,500 acres within these boundaries, three-quarters of which are owned by the Forest Service. The rest is owned by the city of Corvallis with exception of a few acres privately owned and in public domain on the very top.

HISTORY

The primary use of the Rock Creek and Griffith Creek drainages is for water production. In 1920, 1,720 acres of Federal land were transferred from the Bureau of Land Management to the U.S. Forest Service for management as a watershed. This stopped logging operations that were taking place in the northwest corner of the watershed. The Forest Service and the city entered into a cooperative arrangement in 1922. In

1940, the Forest Service acquired 5,021 acres by purchase under the Week's Law of 1911. This completed government control over all but a small amount of the drainage area. In 1950, the overmature Douglas-fir trees were attacked by the Douglas fir bark beetle (Dendroctonus pseudotsugae). In order to protect the watershed from fire and to prevent beetle damage from spreading, a program of development was initiated which included cutting of dead and infected trees and the establishment of a road system for log removal and fire patrol. This plan was put into effect by 1953. From 1953 to 1957 when this study was initiated, some 22 areas ranging from 20 to 40 acres in size had been cut and burned (Fig. 1). There will be eventually about 30 miles of surfaced roads and over 60 million board feet of timber salvaged. About 5 million board feet will be harvested annually. Cutting will be in small clear cuts with every effort made to assure regeneration.

GEOLOGY AND SOILS

Mary's Peak is the highest point of the Oregon Coast Range north of the Umpqua River. It is the result of resistance of a sill of igneous rock intruded conformably into weak sedimentary rocks of the Burpee formation of the Eocene Age. The sandstones and siltstones of the Burpee formation lie unconformably on basalts of the Siletz River volcanic series. The igneous rock cap is thought to be remnant of a more

Figure 1. Clear cut areas in the Mary's Peak Watershed.

extensive body. Near the summit of the peak a ridge extends to the north. On the southeast of the main body of the peak is Griffith Peak (3,100 feet). A saddle is formed by a ridge which connects the two peaks. Most of the slopes are steep. There is a drop of 1,500 feet from the summit in a half-mile linear distance on the south side of the peak while on the east side, there is a drop of 2,000 feet in one mile. The drop in elevation along the ridges is more gentle, but their sides are also steep.

Soils of the watershed may be grouped generally into Aiken and Olympic clay loam with soils of the Aiken series more common below 1,300 feet in elevation.

CLIMATE

Precipitation records for three stations in the vicinity of Mary's Peak are as follows:

	Elevation	Average Annual Rainfall	Average Annual Snowfall	Average Number of Days Receiving .01"
Watershed	450'	67"	-------	-------
Summit	750'	60"	15.1"	160
Corvallis	220'	39"	7.4"	140

Temperature records for the watershed are not available. They tend to be somewhat cooler than at Corvallis which is seven miles to the east.

Corvallis temperature records are as follows: annual average 52°F., January average 39°F., July average 66°F., average number of days between freezing temperature 195, highest temperature recorded 107°F, in 1946, the lowest recorded -14°F. in 1919.

FLORAL DESCRIPTION

Comparative studies and sampling analysis of the undisturbed vegetation adjacent to the clear cuts indicates that vegetation in the study area (Fig. 2) is typically a Douglas fir-vine maple association (1). Cover estimates for Douglas fir on all north, south, and east aspects, averaged approximately 55 percent. North aspects at higher elevations show high cover values for Tsuga heterophyla with reduced reduced amounts of vegetation on the forest floor.

The major understory tree species is Acer circinatum with average cover of 30 percent. The highest cover readings (36 percent) were found on east exposures. Readings were less on north aspects which had low light values and were frequently free from understory vegetation.

On the forest floor Gaultheria shallon (2.1 percent cover) and Berberis nervosa (1.2 percent cover) dominate with Gaultheria generally the more common. Polystichum munitum is seen frequently, but total cover percentages are very low (.27 percent). Traces of tree species such as Castanopsis chrysophyla, Corylus cornuta, and Cornus

Figure 2. Undisturbed vegetation adjacent to clear cuts in the Douglas fir-vine maple association.

nuttallii are found especially on south and east aspects with the Corylus cornuta and Cornus nuttallii more common on south exposures.

Other plant species frequently encountered include Oxalis oregana, Galium triflorum, Anemone lyallii, Vancouveria hexandra, Viola sempervirens, Trientalis latifolia, and Achlys triphylla. For a complete species list, the reader is referred to Appendix I, page 55.

METHODS OF SAMPLING

LOCATION OF STUDY AREAS

All plots were located on nine clear cut and burned areas. These are shown on the map in Figure 3. The areas ranged from 1,300 feet to 2,800 feet in elevation and included north, south, and east exposures. Table 1 lists the elevation of each clear cut, history of logging and burning, number of plots on each clear cut and the general aspects.

SELECTION OF CLEAR CUTS AND PLOT LOCATION

Study plots were 100' x 100' and were established in areas of uniform vegetation and conspicuously marked by corner stakes. In this way, 19 study areas were located; six, cut and burned in 1954; seven, cut and burned in 1955; and six, cut and burned in 1956. For each of these years two north, south, and east exposures were selected (Table 1). Plots were also established in the stable undisturbed areas adjacent to the clear cuts (Fig. 2) for the purpose of establishing an idea of what the vegetation was like before logging and burning. Care was taken to locate the plots on similar aspects and topography. Paired plots were also 100' x 100' in size and were marked with white cloth strips at five-foot intervals.

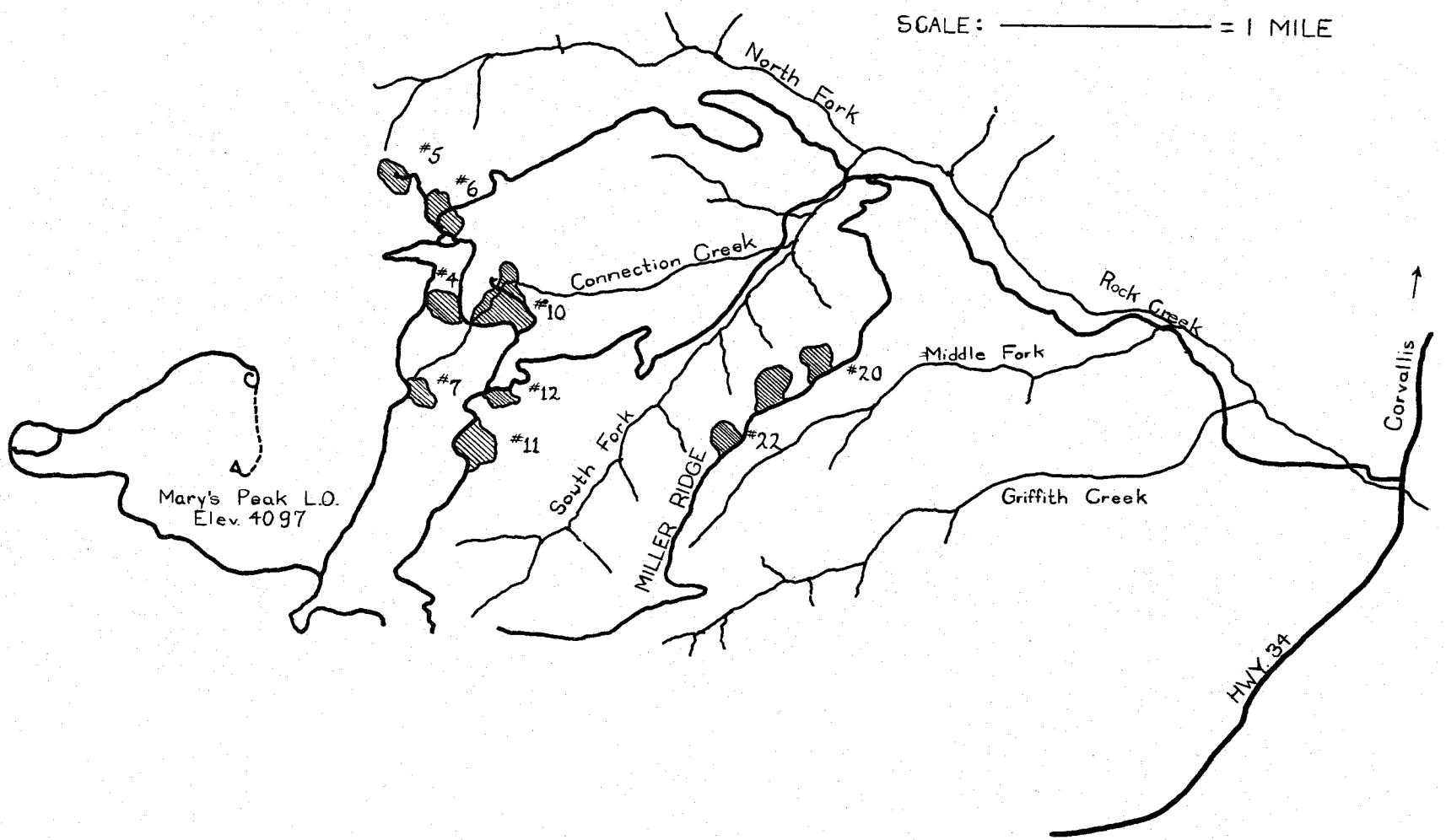

Figure 3. Map of the Mary's Peak Watershed showing the location of the clear cuts studied.

Table 1.

Clear Cuts in the Study Area

Clear Cut Number	Cut and Burned	Elevation	Number of Plots	Aspects
4	1954	2000'	1	East
5	1954	2350'	1	North
6	1954	2400'	3	N, S, E.
7	1954	2800'	1	South
10	1955	1850'	2	N, S.
11	1955	1720'	2	S, E.
12	1955	1700'	3	N, S, E.
20	1956	1300'	3	N, S, E.
22	1956	1500'	3	N, S, E.

SAMPLING PROCEDURES

Prior to sampling the plots, a complete floristic list was prepared. No attempt was made to identify individual species of cryptograms. During sampling they were referred to simply as mosses or lichens. Notes dealing with the development of the vegetation, such as flowering, germination of seedlings, leaf fall, etc., were maintained throughout the sampling period.

Vegetative sampling was done using a device called the ocular point frame, developed by Dr. W. W. Chilcote and students, for use in plant ecology classes at Oregon State University. This instrument is a modification of the standard point frame which supports a vertical row of metal pins as a sampling unit. When the points were lowered over the vegetation, it provided a method for the determination of cover values and relative abundance of species. In contrast, the ocular point frame consists of a grid arrangement of two sets of cross hairs forming a square with 25 intersecting points at approximately three-inch spacing. The two sets are attached to the frame with the points vertically aligned. The frame is supported by four steel legs and is adjustable for convenient heights and capable of measuring vegetation up to four feet high. When sampling vegetation which measured in excess of four feet as encountered in the undisturbed paired plots, a vertical estimate was made to determine cover values. It should be noted that the legs are removable

which made it a compact unit, sufficiently rugged for field use.

In using the ocular point frame, the observer sights through the frame and lines up the double cross hairs. By extending this line of sight, a hit is made either on a particular plant species or on the ground surface. This hit is recorded on a sampling data form. Prior to sampling, the following conditions were established to insure sampling uniformity of non-living materials:

1. A hit on loose soil with no associated materials was recorded as bare ground.
2. A hit on rock material smaller than three-fourths of one inch was recorded as gravel.
3. A hit on rock material larger than three-fourths of one inch was recorded as stone.
4. A hit on dead vegetative material smaller than three-fourths of one inch would be recorded as litter.
5. A hit on wood larger than three-fourths of one inch would be recorded as wood.

In sampling the study plots, five sampling lines were established at regular paced intervals. Sightings of 25 points per frame were taken eight times along each line resulting in 200 points for each line or 1,000 points for the five-line plot. It was found that on plots 100' x 100' in area the use of the ocular point frame provided a reliable indication of

vegetative cover.

YEAR AND SEASON OF SAMPLING

All clear cut plots were sampled for the first time in the fall of 1957, with the exception of the 1956 plots, which were barren of vegetation due to fall cutting and burning. The plots were sampled again in the spring and fall of 1958 and in the spring of 1959. By sampling the 1956 plots in 1958 and 1959, a two-year succession could be studied. By sampling the 1955 plots in 1957, 1958, and 1959, plant succession for two, three, and four years could be observed. The 1954 plots sampled over the same three-year period provided data for the third, fourth, and fifth year (Fig. 4).

Due to the stable nature of the vegetation on the undisturbed paired plots, they were only sampled once in the spring of 1959.

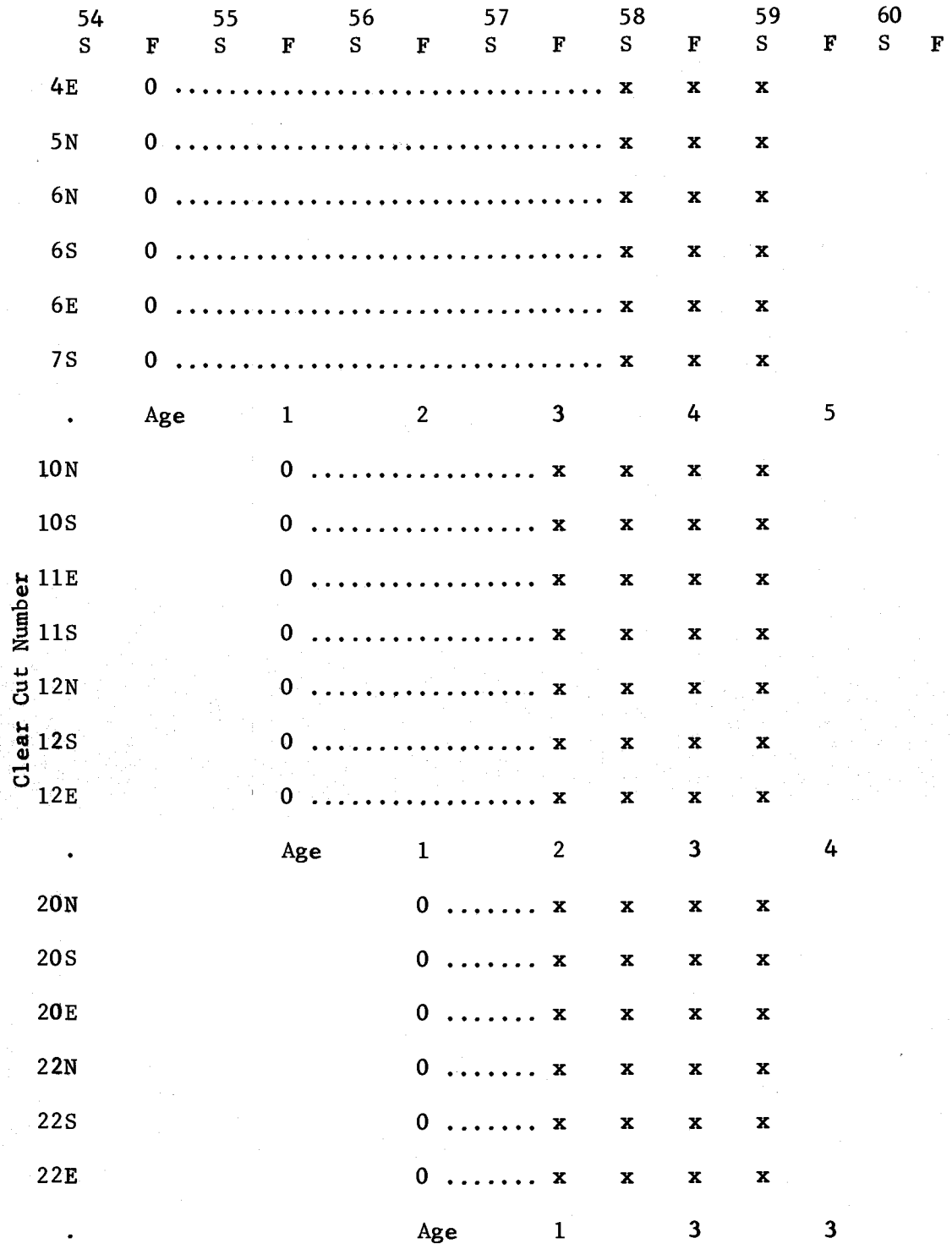

Figure 4. Cutting and study sequences on clearcuts.

0 Year cut and burned.
x Years and season cover data taken.

PRESENTATION OF DATA

MEAN TOTAL VEGETATIVE COVER BY YEAR AND EXPOSURE

In terms of average total cover, vegetation appeared to remain about the same the second and third year on north exposed plots, but declined slightly on south and east exposed plots. There was an abrupt rise the fourth and fifth years. This is shown in Figure 5.

Cover analysis indicated that south exposed plots had more vegetative cover the first five years following burning. Cover readings averaged 71 percent the second year and by the fifth year were up to 93 percent. East plots ranked second in terms of average total cover with 69 percent the second year and rising to 87 percent. North plots generally showed the lowest cover indicating 63 percent the second year and 86 percent the fifth year.

Analysis of paired plots in adjacent undisturbed forest areas on north, south, and east exposures, showed that the highest average cover of 78 percent was on north exposed plots (Fig. 6). South plots averaged 71 percent total cover while east plots averaged 64 percent. In comparing cut and uncut areas, this appears to be a reverse trend, until it is understood that on uncut north plots the cover is mainly in the overstory vegetation. The understory vegetation tends to be sparse. This tendency is reflected after logging and burning by the low amount of

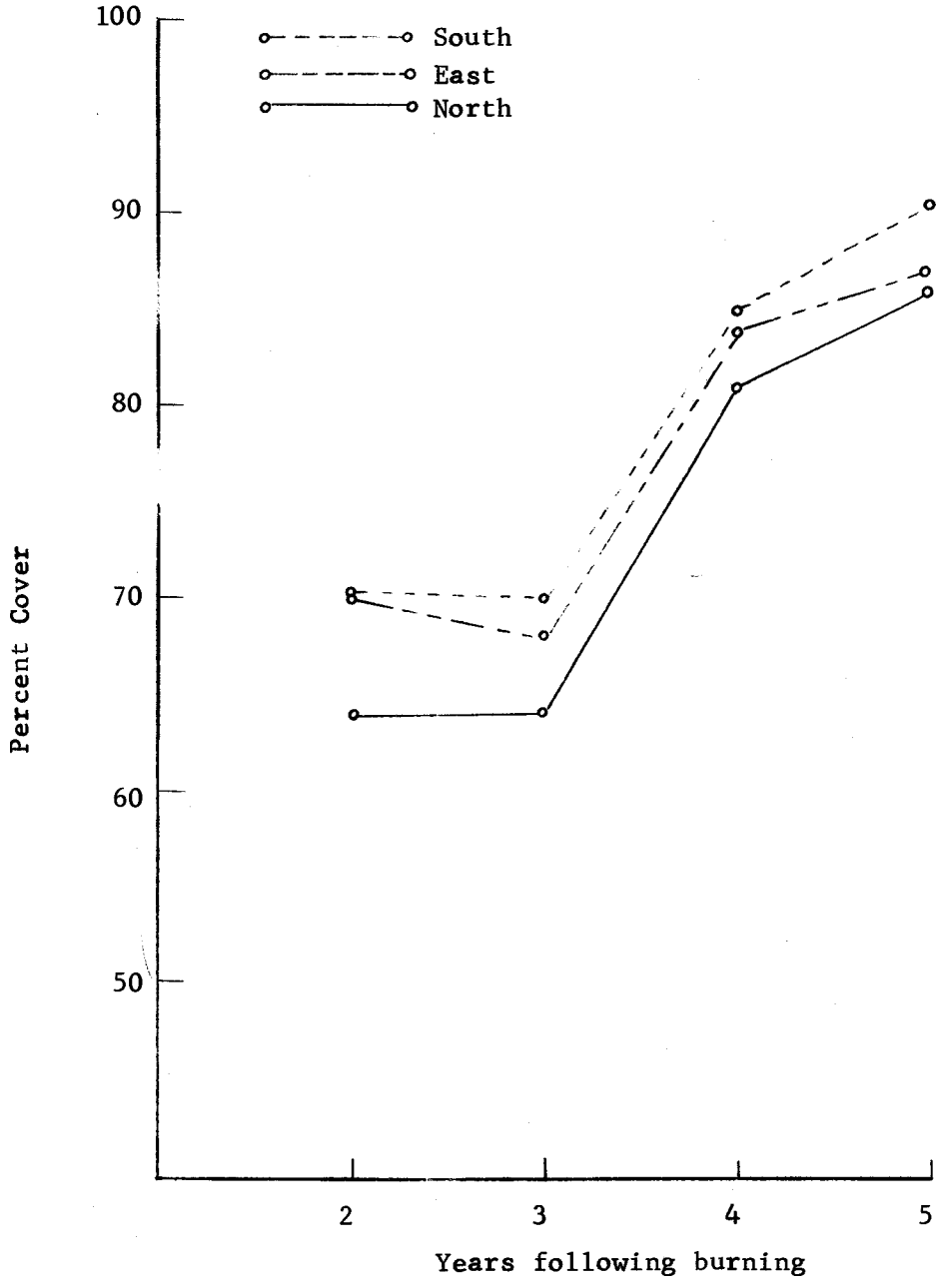

Figure 5. Mean total vegetative cover by year and aspect.

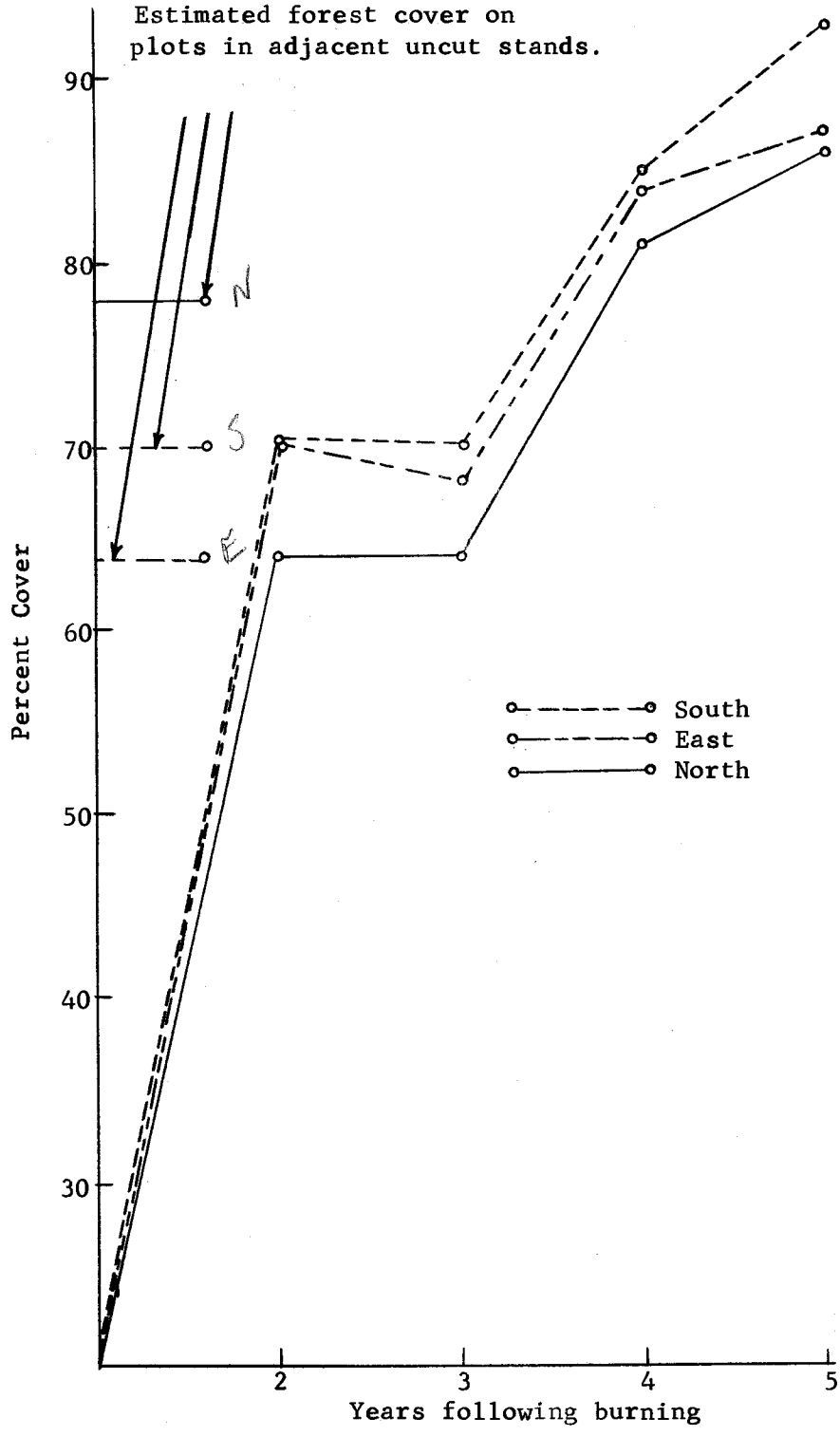

Figure 6. Average total vegetative cover on cut and uncut plots by year and exposure.

cover contributed by resprouting of the residual plants. It was noted that by the second year following burning, vegetation on south and east aspects had equaled in terms of total cover, the average total cover of 71 percent which existed prior to logging and burning. North plots averaged 7 percent below average. By the fourth and fifth years all exposures were 17 percent above the estimated unburned average.

AVERAGE TOTAL VEGETATIVE COVER BY EXPOSURE AS AFFECTED BY SEASONAL VARIATION

Analysis of data regarding seasonal variation (Fig. 7) indicated a sharp decrease in total cover on all exposures from the spring (sampled in mid-June) to the fall (sampled in mid-September). The first three years, when annuals and biennials were dominant, the seasonal variations averaged 20 percent. With the coming of the perennial vegetation during the fourth and fifth years, the seasonal fluctuations were present, but did not exceed 5 percent. In general, south plots showed the greatest seasonal variation. East plots were next, while the north exposed plots showed the least variation.

MEAN TOTAL COVER OF THE PRINCIPLE PLANT SPECIES COMPARED WITH TOTAL VEGETATIVE COVER

In the years following logging and burning a large number of plant species were involved in the succession. Table 2 lists the most

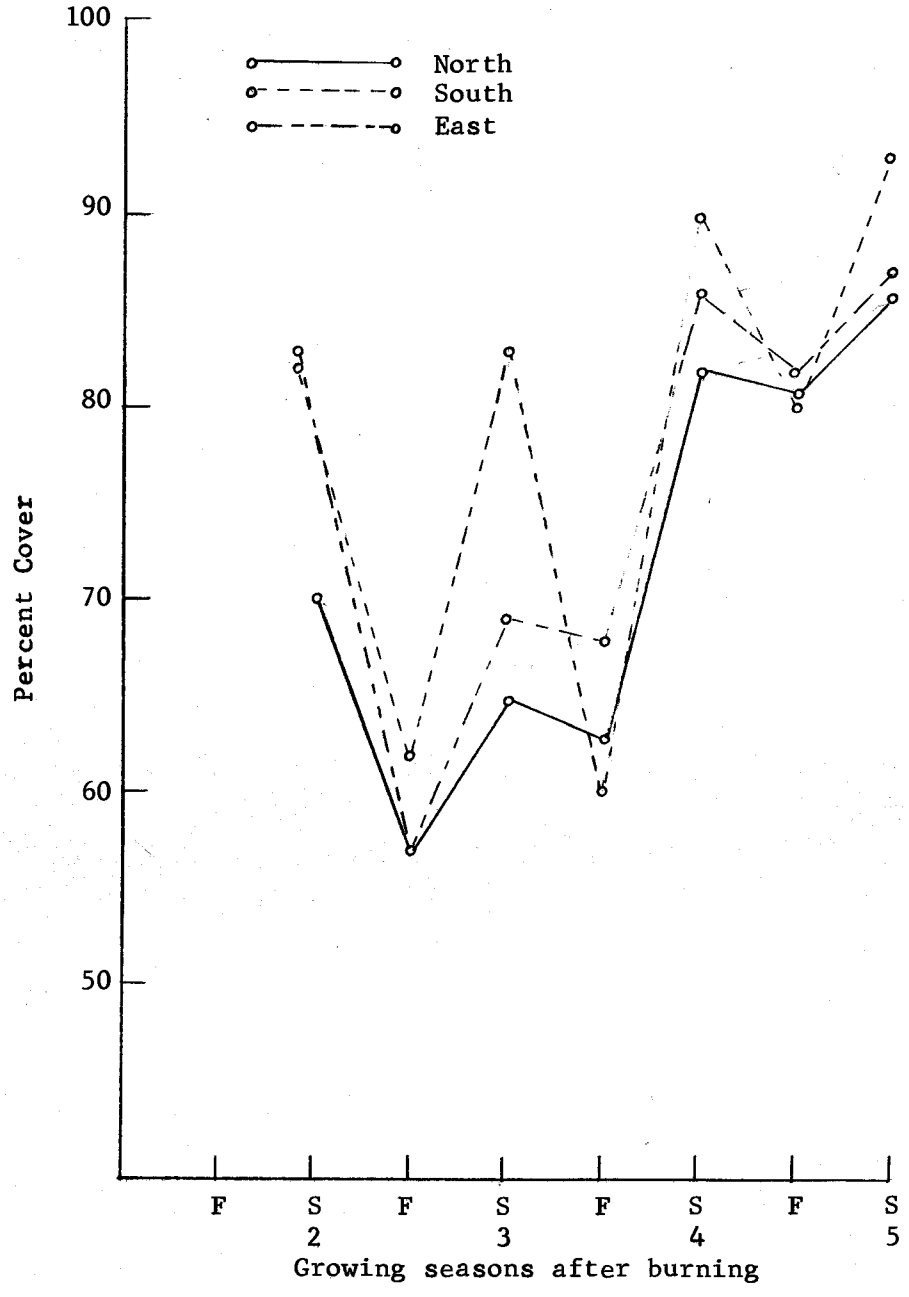

Figure 7. Mean total vegetative cover by exposure as affected by seasonal variation.

Second Year		Third Year		Fourth Year		Fifth Year	
Sesy	65.0	Lost	27.4	Lost	28.0	Bene	20.0
Lost	15.	Civu	24.9	Civu	23.5	Lost	11.4
Civu	7.7	Bene	7.6	Bene	18.0	Hola	10.4
Bene	5.5	Sesy	6.5	Acci	10.3	Civu	10.0
Gash	1.8	Acci	4.2	Hola	7.4	Acci	7.2
Acci	1.2	Cafe	2.9	Cafe	6.5	Epan	4.7
Pomu	1.07	Gash	2.8	Gash	5.8	Epad	4.4
Anma	.4	Deel	1.5	Epad	4.2	Cafe	4.0
Casc	.39	Hola	1.4	Epmi	2.6	Pomu	2.4
Ruma	.39	Epad	1.0	Deel	1.9	Gash	2.3
Deel	.35	Ruma	1.0	Irte	1.8	Irte	2.26
Luca	.3	Pomu	.9	Ruma	1.5	Ruma	1.0
Cafe	.2	Epmi	.86	Pomu	1.4	Deel	1.0
Cach	.14	Luca	.6	Luca	1.1	Casc	.8
Psme	.069	Anma	.44	Epan	.86	Sesy	.63
Epad	.061	Cach	.35	Sesy	.58	Anma	.4
Epmi	.053	Irte	.31	Anma	.58	Psme	.36
Hola	.023	Casc	.28	Casc	.53	Hyra	.33
Rupa	.015	Psme	.16	Psme	.49	Rupa	.3
Treu	.007	Treu	.15	Treu	.40	Treu	.23
Epan	0.	Rupa	.12	Cach	.30	Luca	.20
Hyra	0.	Epan	.12	Rupa	.16	Epmi	.03
Irte	0.	Hyra	.12	Hyra	.15	Cach	0.

Table 2. Average cover values contributed by the more prominent plant species involved in secondary succession during five years following logging and burning.

prominent of these plants. Examination shows that these plants all change their relative positions in time, but that some are more dominant than others in terms of the amount of cover contributed. By combining the four most dominant species for each year, we arrive at a value expressed as the mean total cover of the dominant species. When this amount is compared with the total vegetative cover of all species by year, it is possible to see the overall trend and the contribution of the lesser species toward the trend.

Figure 8 indicates that by the second year following burning, the mean total cover contributed by the four most dominant plant species was 66 percent. Other plants contributed only two percent. In the third year, the annual vegetation was replaced by biennial and perennial species and the total mean of the four main species dropped to 51 percent. The other plant species were contributing 16 percent of the total vegetative cover. This general trend continued as perennial vegetation assumed a more primant role in the succession. By the fourth year 48 percent of the cover was contributed by the four main species while 35 percent was contributed by the other species. Fifth year data indicated the mean total cover of the main species down to 34 percent of total cover.

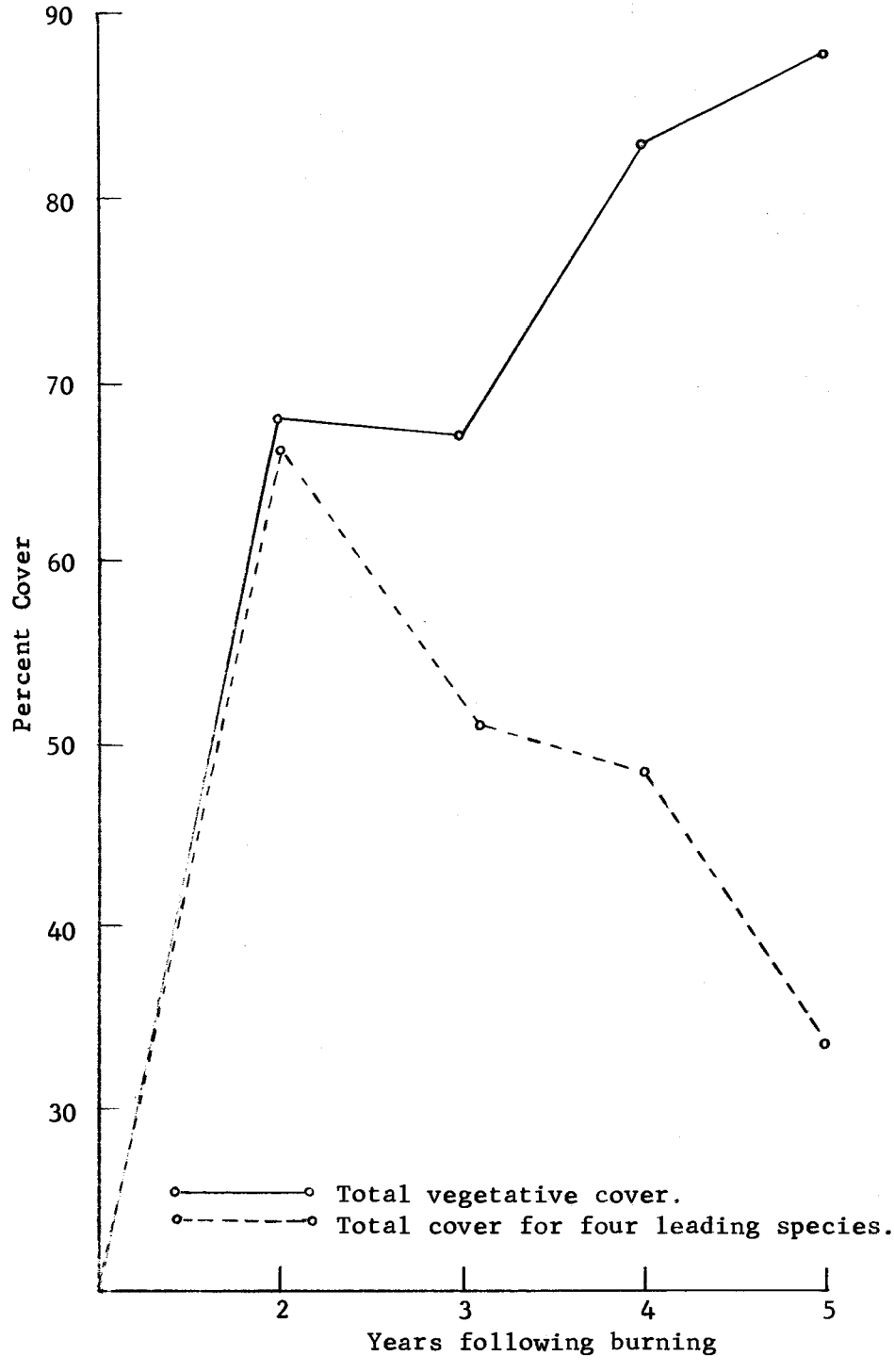

Figure 8. Mean total cover of the four most important plant species compared with total vegetative cover.

MEAN COVER TRENDS OF THE PRINCIPLE PLANT SPECIES

With the general trend in mind, it is possible to examine the principle plant species as they change their relative positions in time. These trends have been shown in Table 2 and graphically illustrated in Figures 9 and 10.

The data indicates that the second year following burning the dominant plant was Senecio sylvaticus with a mean total cover of 65 percent (Table 2). The third year found a dramatic vegetative shift as Senecio sylvaticus dropped to 6.5 percent and was replaced by the co-dominants Lotus stipularis, 27 percent, and Circium vulgare with 25 percent. The woody perennial, Berberis nervosa, increased and showed a total mean cover of 7.6 percent. Fourth year data showed that Lotus stipularis had increased in cover to 28 percent. Circium vulgare was on the decline. Its total mean cover dropped to 23 percent. Berberis nervosa built up having moved into third place position with 18 percent cover. Two other plant species became prominant the fourth year. These were the woody perennial, Acer circinatum, with 10.3 percent cover, and the perennial grass, Holcus lanatus, with 7.4 percent mean total cover. The dominant plant species the fifth year was Berberis nervosa with 20 percent cover, followed by Lotus stipularis, with 11.4 percent cover and Holcus lanatus with 10.4 percent cover.

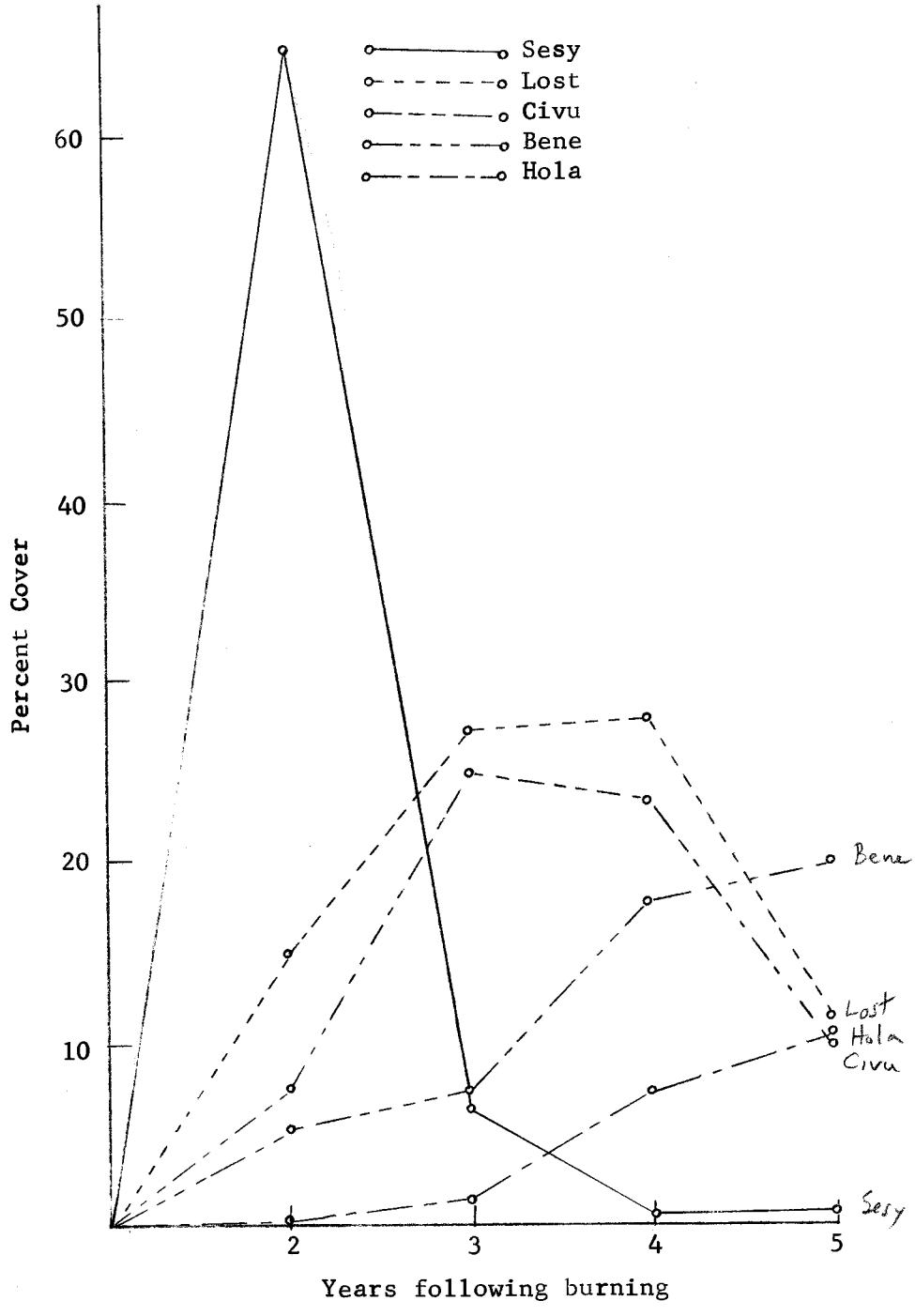

Figure 9. Mean cover trends of the more prominent plant species.

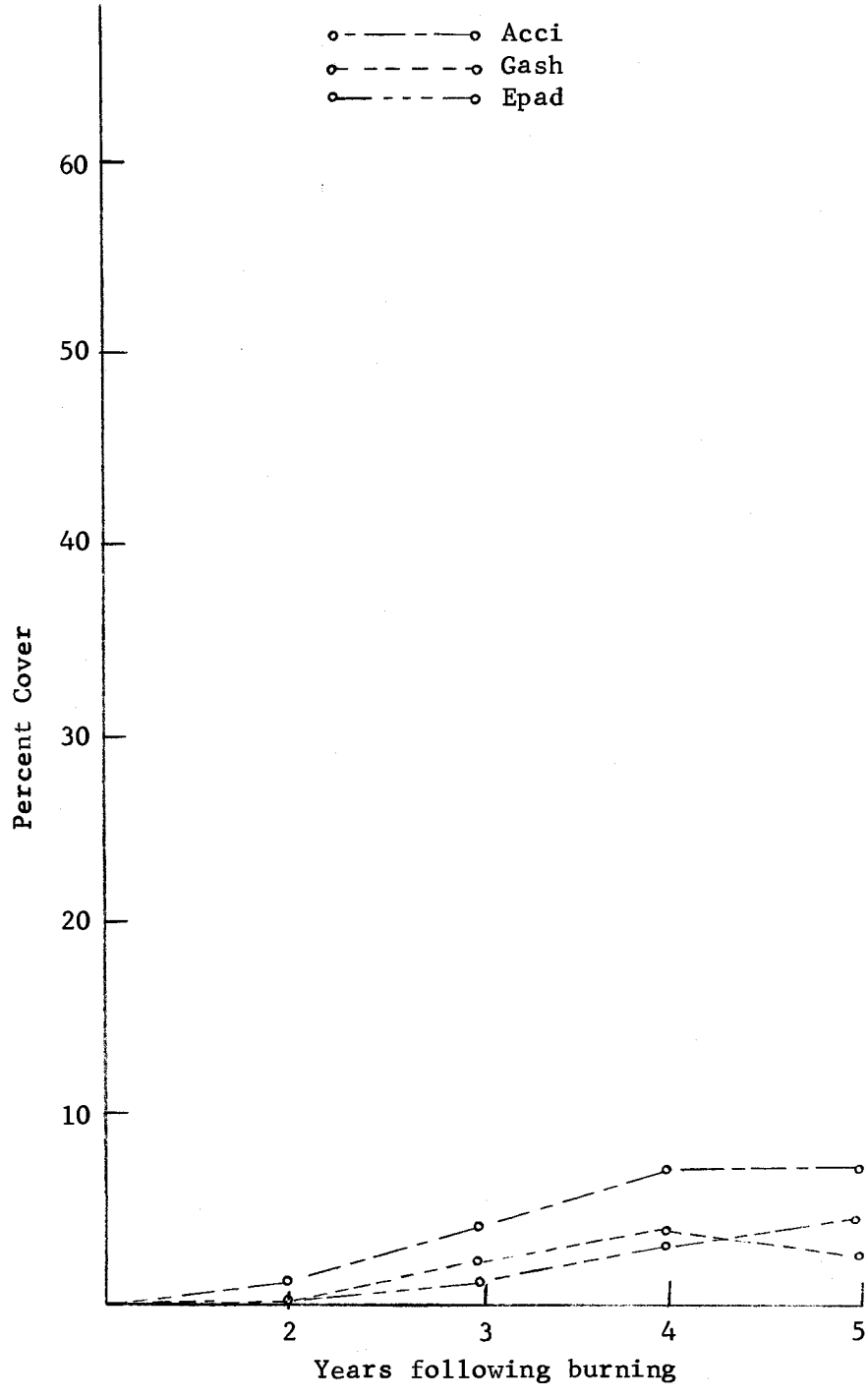

Figure 10. Mean cover trends of the more prominent plant species.

Total cover trends for other plant species as seen in Table 2 indicate that some plants such as Iris tenax and species of Epilobium indicate a gradual increase in cover during the five-year period while others like Luzula campestris and Campanula scouleri gradually decrease. The extremely low cover readings of these species prevents accurate analysis of any real trends which may be present.

SUCCESSIONAL TRENDS OF THE PROMINENT PLANT SPECIES

An analysis of cover data not only emphasized yearly successional trends, but provided insight into the range of cover values and aspect preferences of the more prominent species.

Senecio sylvaticus (Fig. 11), which appeared to peak the second year after burning, indicated a wide range of cover values on the plots sampled. These ranged from 72 percent to 29 percent. Mean cover value for the second year was 54 percent. Some difference in aspect preference is suggested (Fig. 13) with east slopes showing the highest cover values. There was also an indication that north aspects were preferred over scuth slopes.

Circium vulgare showed a great deal of variation in amounts of cover from one site to another. As seen in Figure 11, Circium ranged from a high of 65 percent cover to a low of 5.4 percent. In general, the peak cover values appeared the third year following burning. Mean

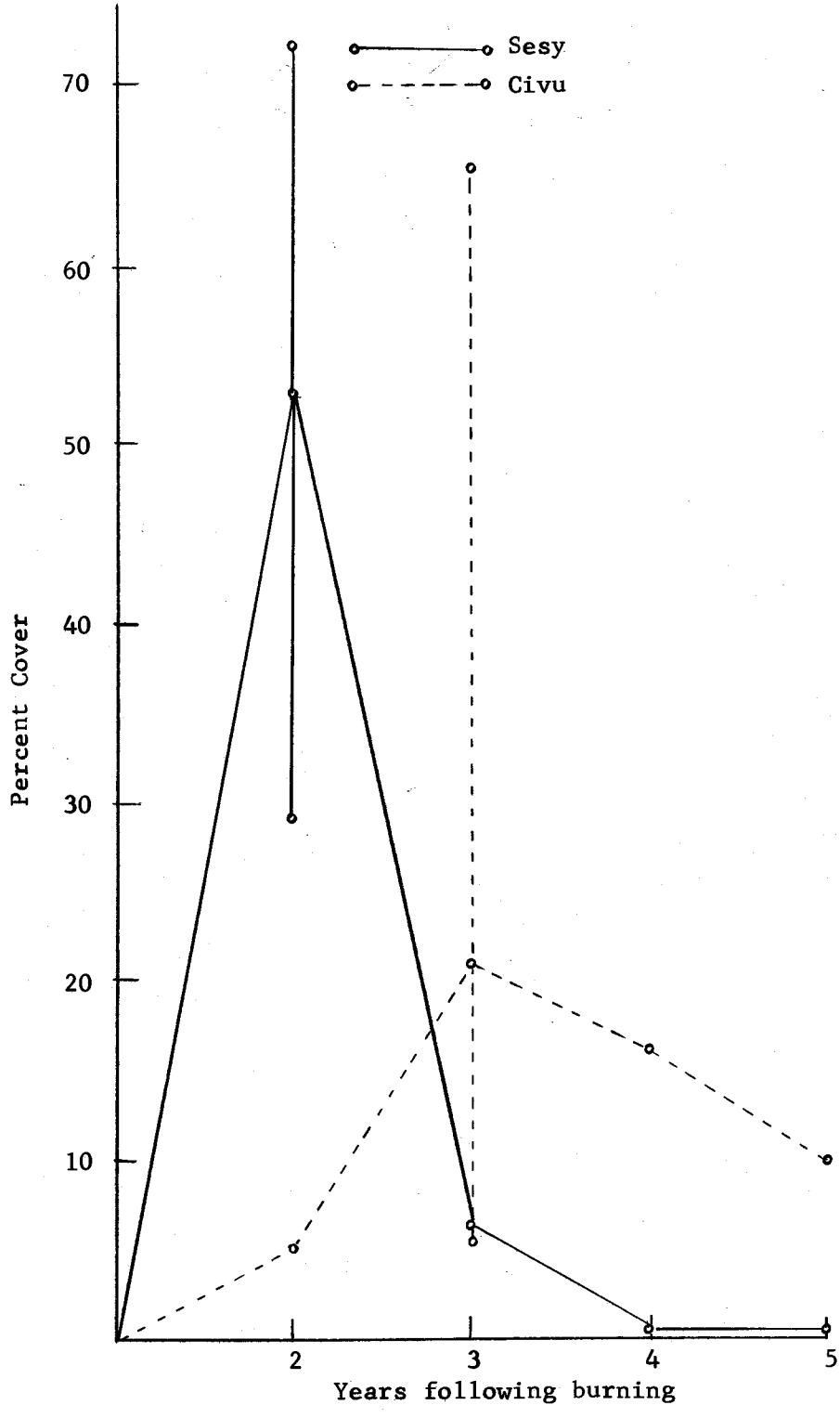

Figure 11. Maximum, minimum, and average cover values for Senecio sylvaticus and Circium vulgare.

cover value for the third year was 24 percent. In the case of the plots burned in 1954 and located at higher elevations, the peak cover value appeared in the fourth year rather than the third. Average cover values for Circium indicated an aspect preference up to the third year peak period, preferring south aspects over north and east exposures. After the third year, east aspects seemed favored over both north and east exposures (Fig. 14).

The cover trends of Lotus stipularis (Fig. 12) suggest a peak during the fourth year when a cover value of 26 percent was reached. Cover values fluctuated greatly ranging from 76 percent on some plots to 17 percent on others. This seems to indicate a wide variation in site preference. When cover values were plotted with regard to aspect preference, no definite aspect appeared to be favored (Fig. 15). Preferences fluctuated from east aspects the second year to south aspects the third and fourth. North aspects were highest in the fifth year.

No peak in cover values could be determined for Holcus lanatus (Fig. 12). Up to the fifth year the maximum cover was 28 percent. Minimum cover went as low as 1 percent with mean total cover of 10 percent for the corresponding period. Some indication of a preference for south facing slopes are suggested until the fourth year (Fig. 16).

Figure 17 shows the graphed cover trends for Berberis nervosa for the first five years. There was no indication that this understory

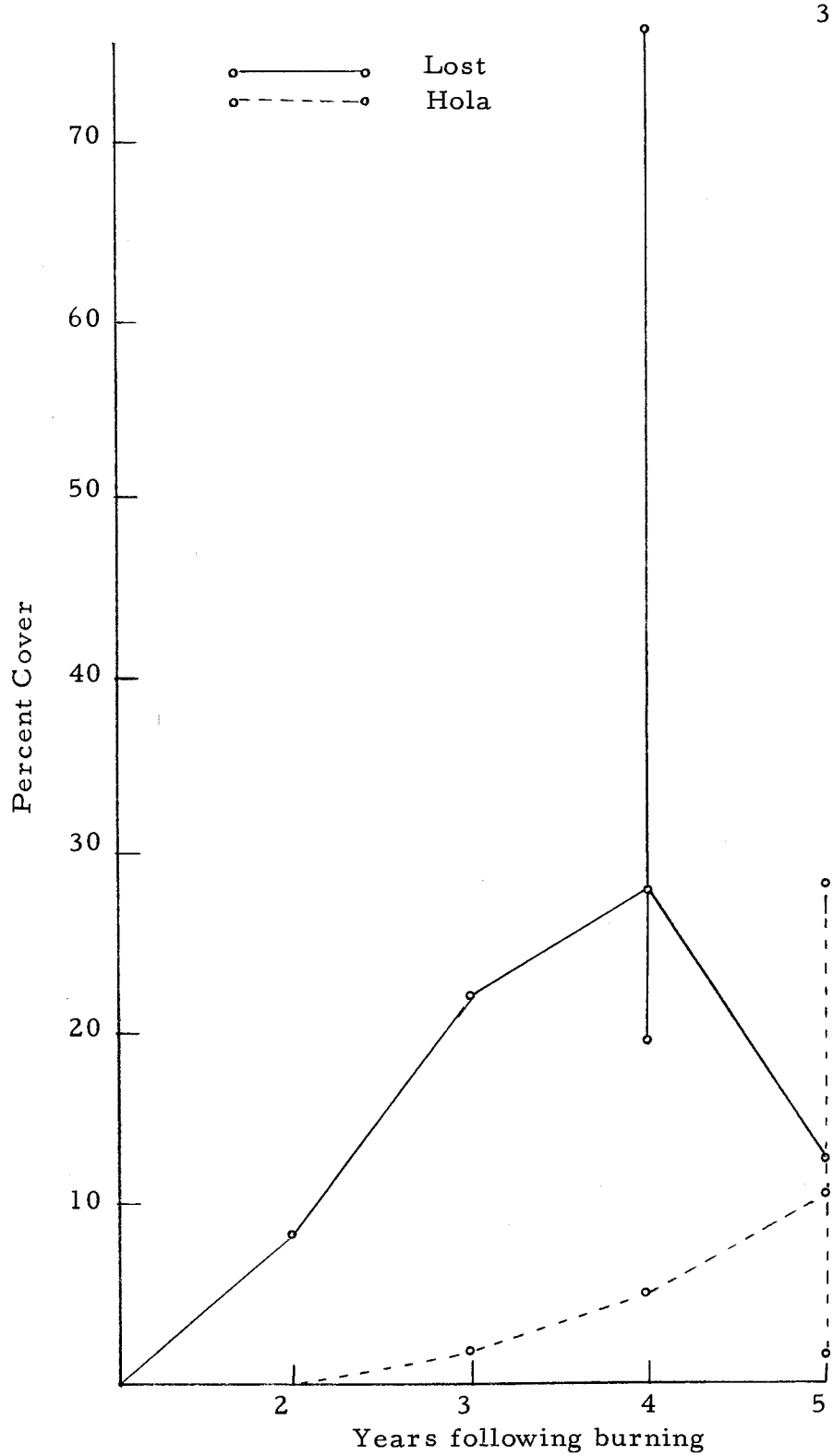

Figure 12. Maximum, minimum, and average cover values for Lotus stipularis and Holcus lanatus.

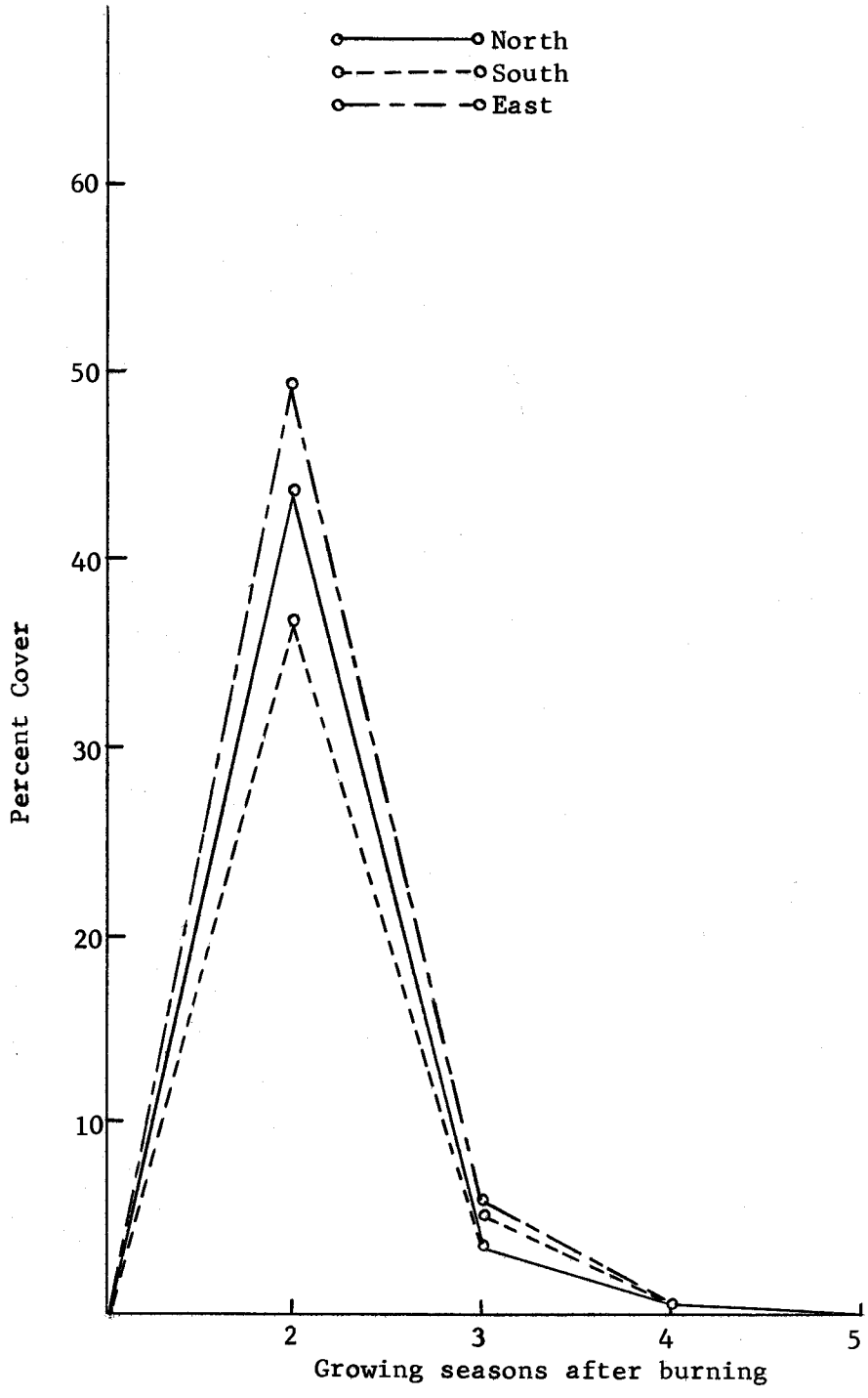

Figure 13. North, south, and east slope cover trends for Senecio sylvaticus.

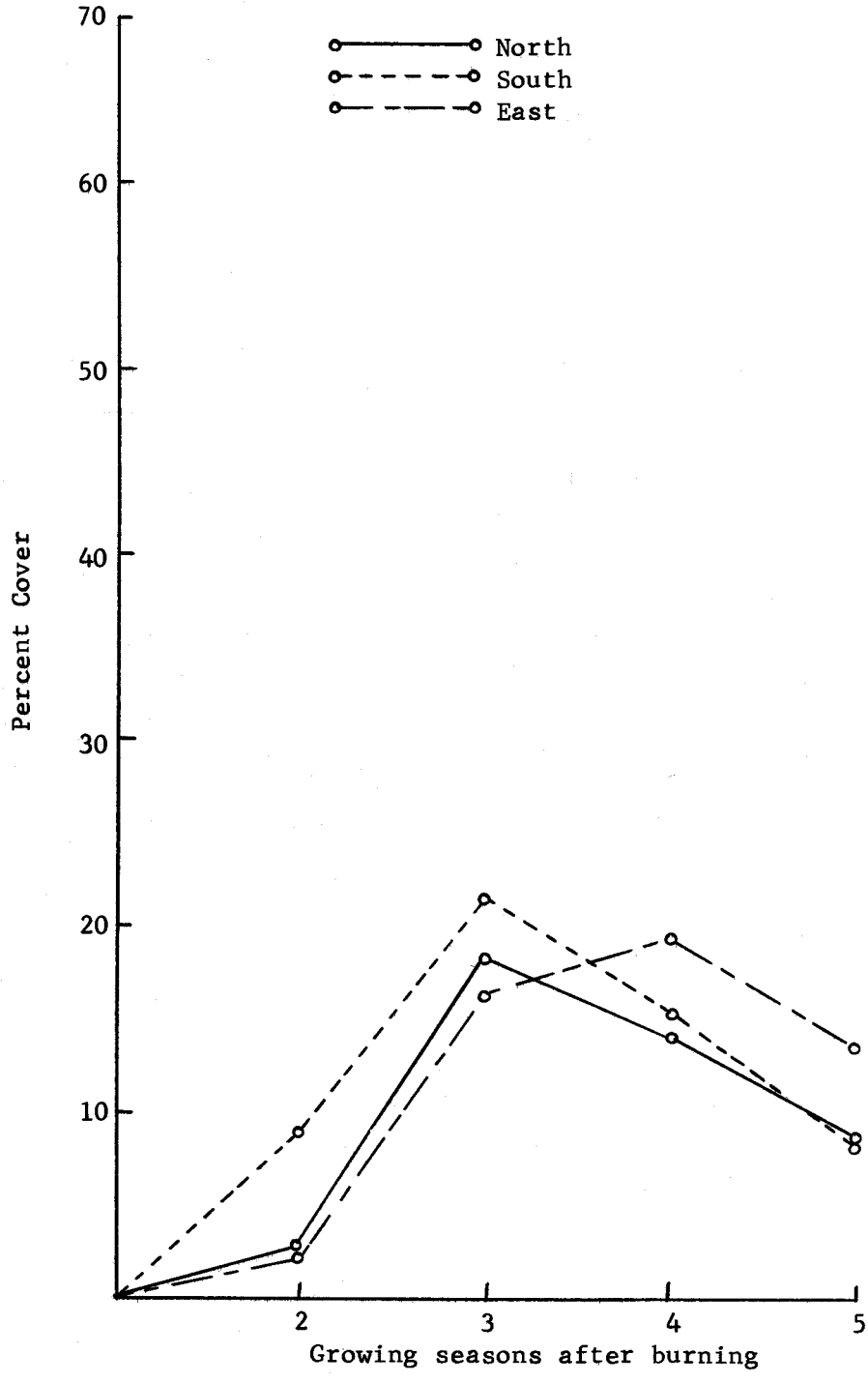

Figure 14. North, south, and east slope cover trends for Circium vulgare.

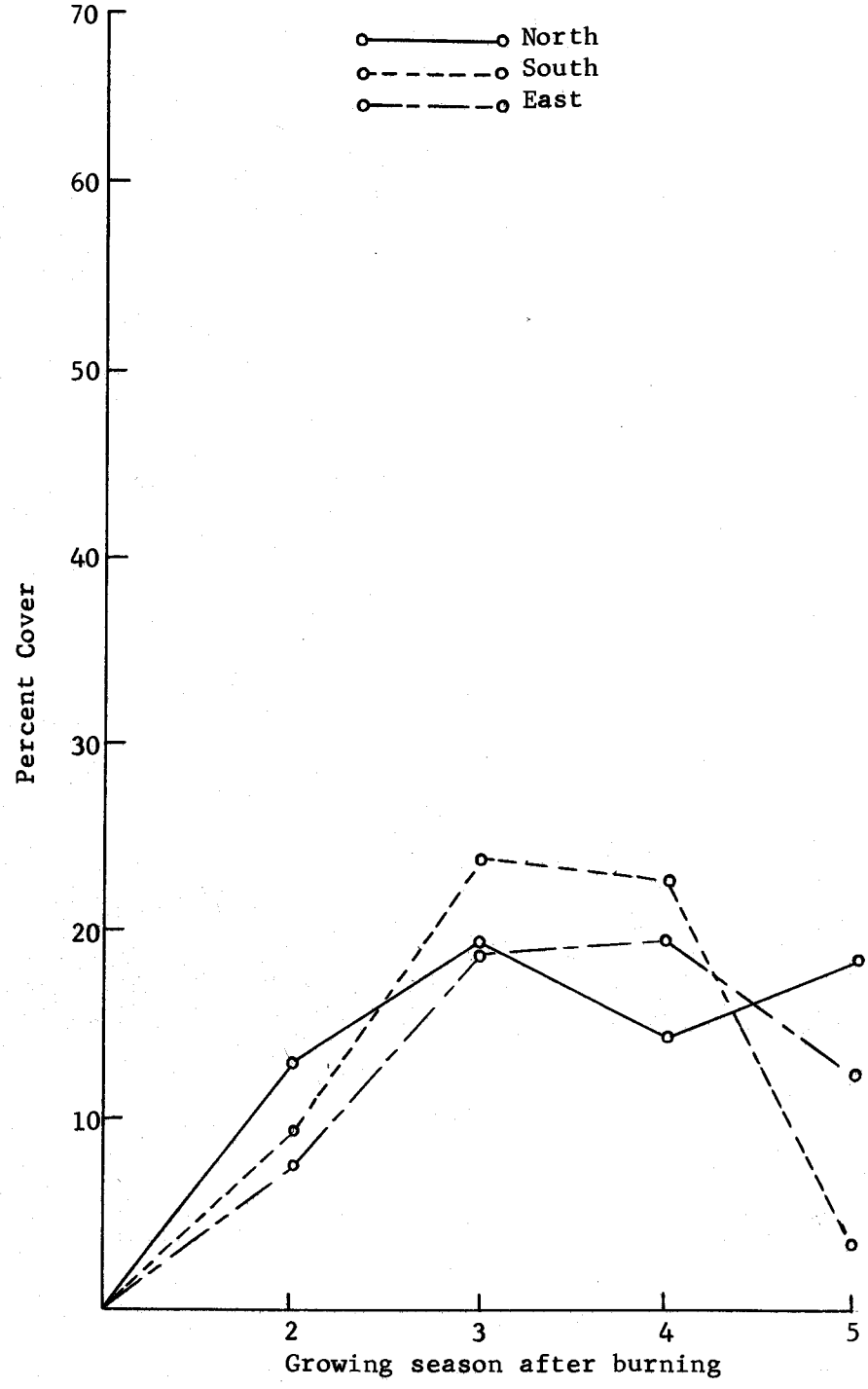

Figure 15. North, south, and east slope cover trends for Lotus stipularis.

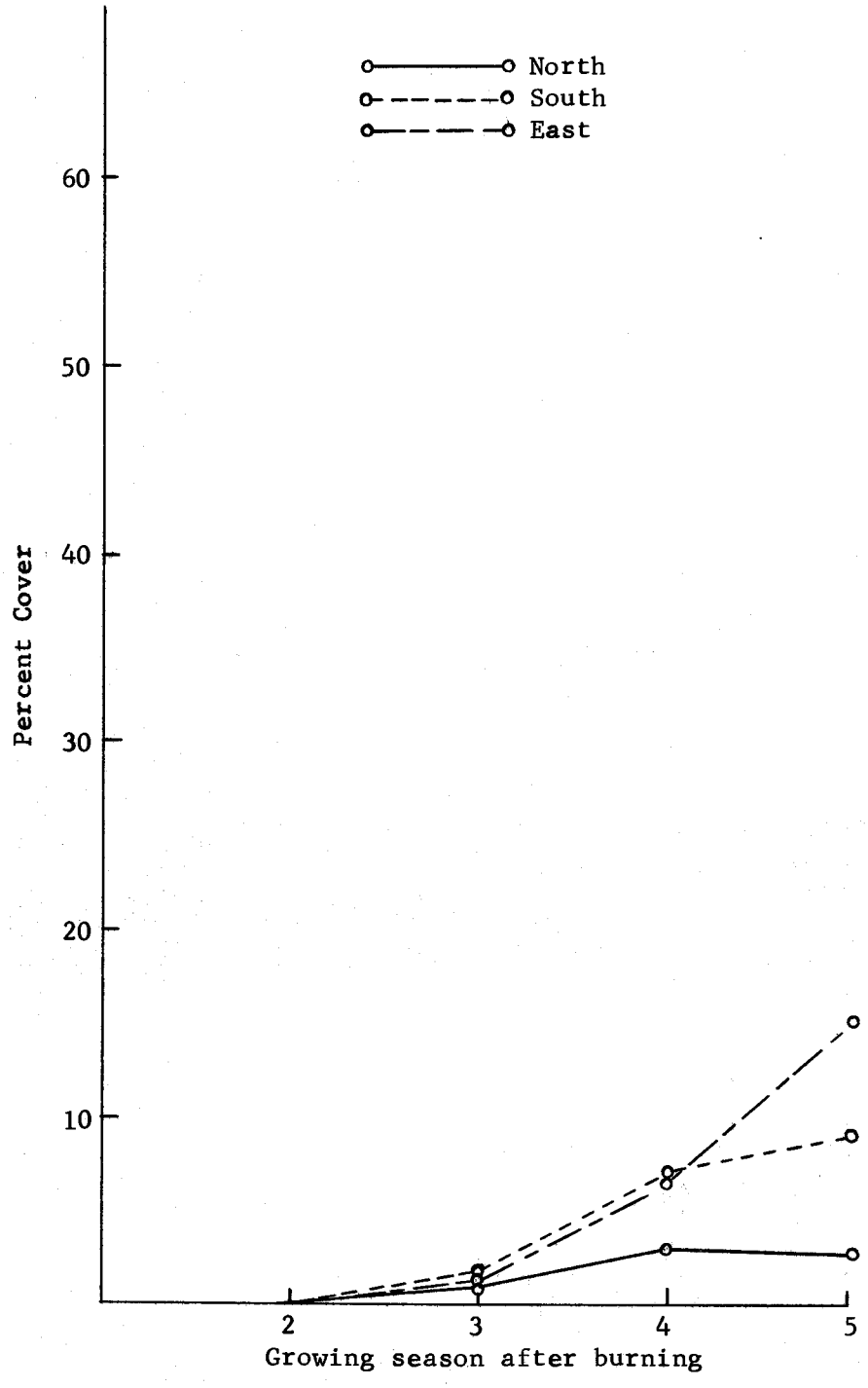

Figure 16. North, south, and east slope cover trends for Holcus lanatus.

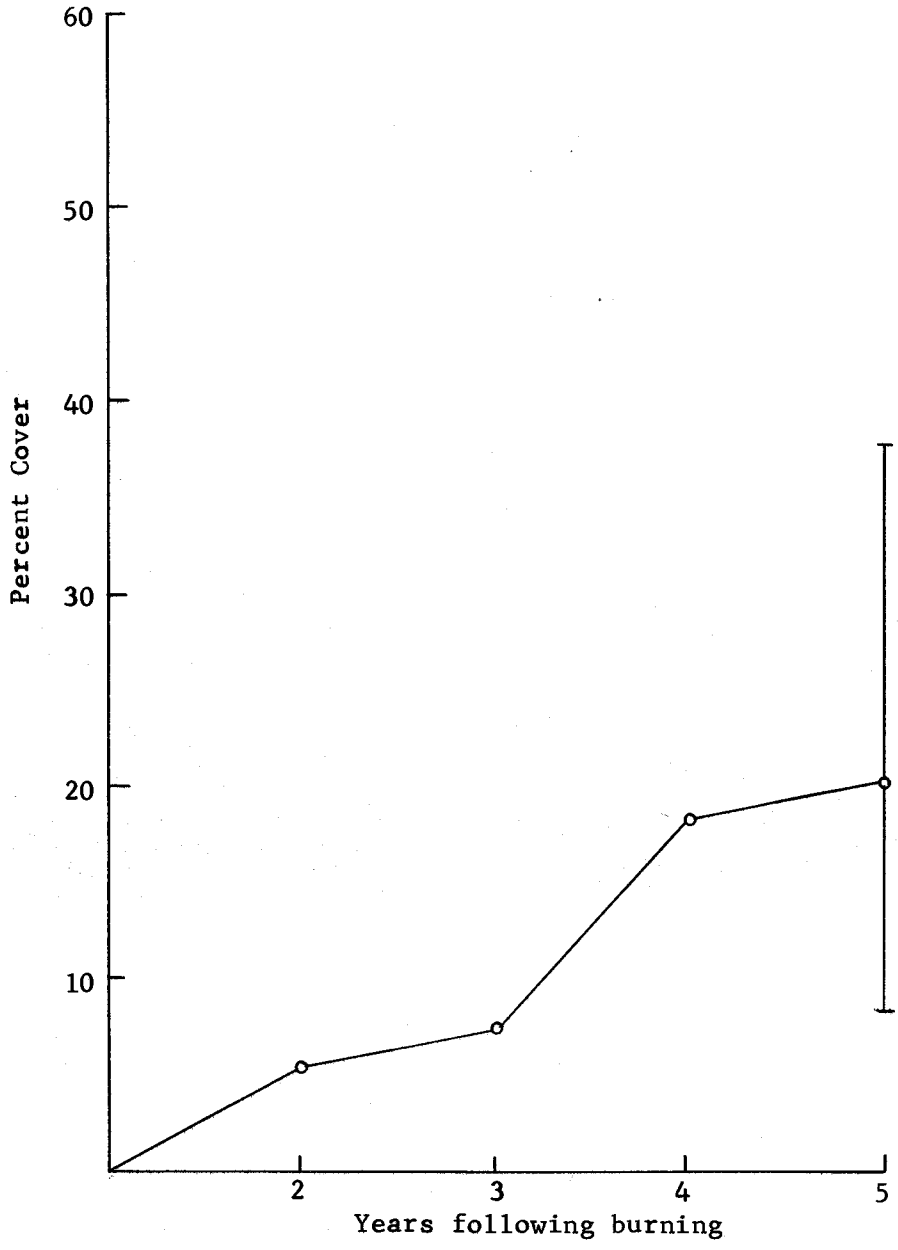

Figure 17. Maximum, minimum, and average cover values for Berberis nervosa.

species had reached any peak in cover. Cover values for the fifth year ranged from 38 percent down to 8.5 percent. Mean cover for the fifth year was 20 percent. Berberis nervosa did not appear to exhibit any exposure preference (Fig. 18). If we assume greater vegetational stability as the succession progresses, then it would be possible to state that in terms of cover, Berberis indicates a preference for south aspects over north and north over east aspects.

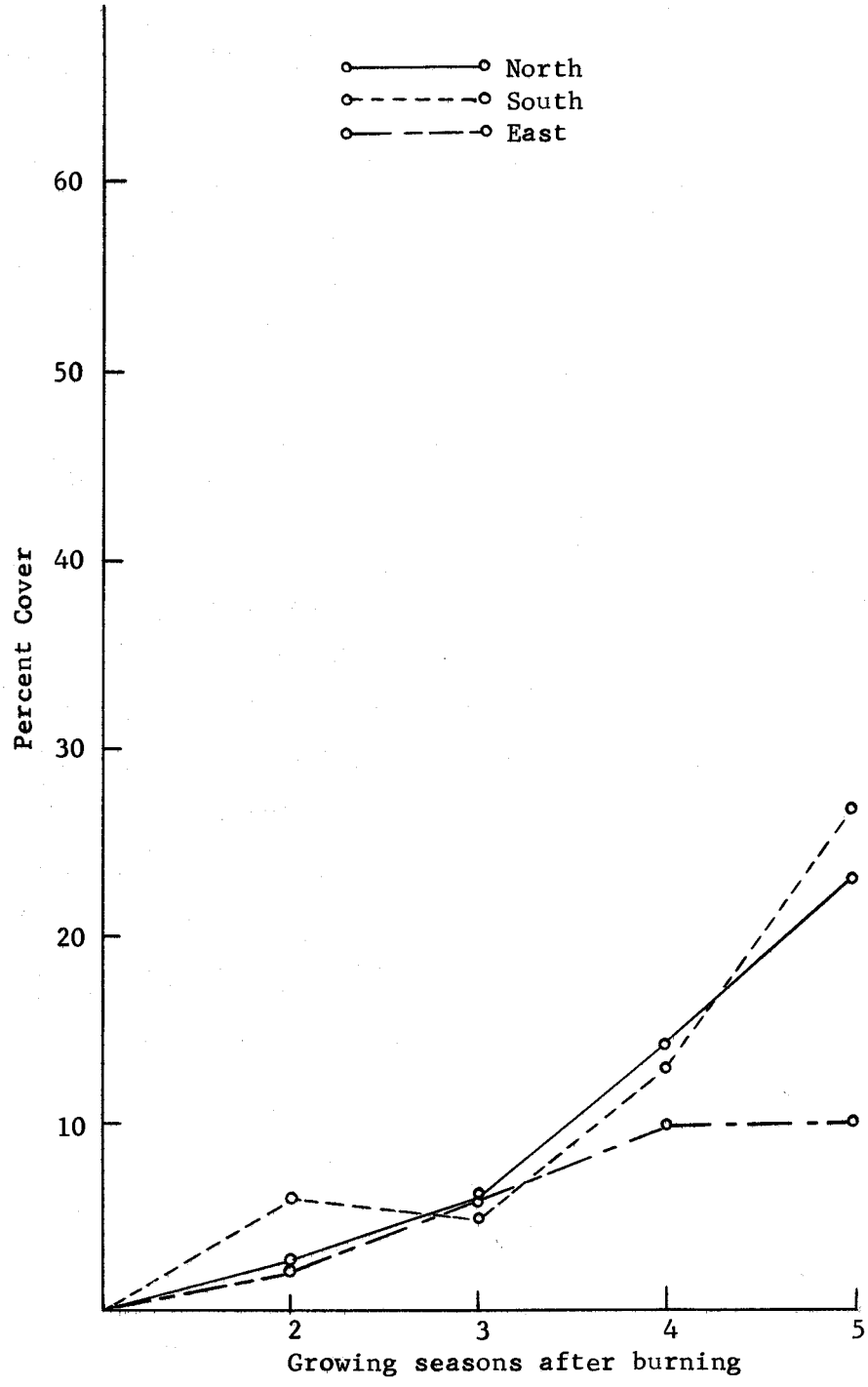

Figure 18. North, south, and east slope cover trends for Berberis nervosa.

Figure 19. Clear cut area two years after burning showing the dominant annual Senecio sylvaticus.

Figure 20. Clear cut area two years after burning showing the dominant biennial Circium vulgare.

Figure 21. Clear cut area four years after cutting and burning showing Lotus stipularis and Holcus lanatus as co-dominants.

Figure 22. Clear cut area five years after cutting and burning showing Lotus stipularis and Holcus lanatus still dominating with woody perennials becoming prominent.

DISCUSSION

The general pattern of secondary succession of annuals to perennial species has been observed by many ecologists. Successional studies on Douglas fir clear cuts substantiate this tendency, but vary considerably in terms of a consistent pattern. This may be expected in view of the limited studies and the wide variation of environmental conditions encountered.

Yerkes (7) and the other forest ecologists (4, 5, 6) noted an increase in total number of species present the first five years after burning. This was supported by the present study. With this increase in numbers of species, both Kienholz (5) and Morris (6) found that initially the total vegetative cover was low, but rose rapidly as plots became older. In contrast, Yerkes' study indicated a general decline in vegetative cover in some instances (7). He suggested that this may be due to the result of a transition from short-lived to long-lived perennials or plausibly due to examination error. The results of this study show a rapid increase for the first five years after burning with a slight depression in total cover during the third year.

Kienholz (5) did not note any difference in total vegetative cover on north and south aspects. Yerkes (7), however, noted that the total cover on south aspects was less than that on north slopes. He explained this by pointing out that south slopes support fewer plant species due to more xeric conditions. These observations were made without the benefit of comparative plots in undisturbed vegetation. When studies were made of the undisturbed vegetation on the Mary's Peak watershed, it was

found that north aspects did have the highest percentage of total cover. This cover was centered mainly in the overstory composed of Douglas fir and some hemlock. The understory vegetation, however, was very scant. This lack of understory vegetation was reflected after logging and burning with north plots ranking lowest in total vegetative cover. South and East plots had the highest total vegetative cover. This appears understandable using the above reasoning since uncut timber adjacent to south and east plots showed higher cover values for understory vegetation than uncut timber adjacent to north plots.

There are interesting differences to be found regarding seasonal variation in total vegetative cover. Yerkes examined his plots between July 22 and October 1, but found no evidence of difference in cover to the time of year examined. The author examined units on Mary's Peak in the spring and fall and found a significant decrease in total cover on all exposures. The fluctuations were striking the first three years and tended to be less as the succession progressed. This was due to the sensitive nature of the annual and biennial herbaceous plant species which dominate the clear cuts the first three years. Later as the more hardy herbaceous and woody perennials assume dominance, the seasonal effects are not reflected so strongly.

As mentioned before, the general successional trend from annuals to perennials is widely recognized. The plant species involved in this trend vary from one area to another. Yerkes (7) noted that in the H. J. Andrews Experimental forest, Epilobium angustifolium and Senecio sylvaticus were dominant the first two years. Results of this study, which was conducted eighty miles northeast of the aforementioned area,

showed Senecio sylvaticus dominant the second year and Circium vulgare and Lotus stipularis dominant the third year.

During the fourth, fifth, and sixth years, Yerkes (7) indicated that Epilobium munitum replaced Senecio sylvaticus and that Epilobium angustifolium became dominant. Other species, especially woody perennials, were found to be erratic in expressed cover trends. Berberis nervosa and Gaultheria shallon indicated a trend upward with a fairly high occurance. This study indicated that Lotus stipularis, Berberis nervosa, and Holcus lanatus were dominant during the fourth, fifth, and sixth years. The erratic nature of the woody perennials noted by Yerkes (7) was not detected in terms of mean cover in the Mary's Peak study.

Trends of the prominent plant species over the range of five years have shown a definite and consistent pattern following cutting and burning. Probably the most striking change is found in Senecio sylvaticus, which was hardly noticeable the first year and completely dominant the second year. Senecio has disappeared by the third year. The disappearance may be due to soil nutrient levels, leaf and root derived substances, climate conditions, or combinations of these. After viewing the green fields of Senecio the second year, it is always a dramatic change to find only dead litter remaining and Circium vulgare predominating the third year (Fig. 20). Circium is a biennial and tends to hang on through the fourth year. It is replaced by the legume, Lotus stipularis, and the grass, Holcus lanatus, the fourth and fifth years (Fig. 21 and 22). Material presented since this data was collected indicates that the Holcus introduced by man as a part of a road bank

stabilization competes rather strongly with Lotus until the sixth year when it begins to lose ground to the more vigorous Lotus and the woody perennials (2, p. 58).

This study had time as its major limiting factor. Succession tends to move at slow rates thus making a prolonged study beyond the scope of a thesis project. Also limiting was the fact that nature does not always provide the ideal setting for a statistically designed study. At the time this study was begun, there were only clear cut units available for 18 plots in the Mary's Peak watershed. It was recognized that a larger series of units would have been beneficial.

Having had close contact with the research project from its inception to the present time, it has been gratifying to know that the studies initiated in 1957 have been continued and broadened to include some 30 Douglas fir clear cuts covering a secondary succession of eight years (2, p. 58). It has also been satisfying to note that the successional sequence indicated from data collected during the course of this study has been substantiated to some degree by the more recent work.

SUMMARY

This study has been concerned with the patterns of vegetative changes which occur during the first five years following logging and burning on Douglas fir clear cuts. Knowledge of the successional sequence in the coastal forests of western Oregon is of primary importance to those concerned with the management of this resource. From the more theoretical point of view, there are many unique features associated with this type of vegetation of special interest to the ecologist. Published accounts of studies in Oregon and Washington have been of a generalized nature. None have approached a localized area with the degree of intensity attempted in this study.

Due to its close proximity to Oregon State University and the cutting and burning history of the area, Mary's Peak has been especially suitable for this study.

Mary's Peak is the highest point of the Oregon Coast range having an elevation of 4,097 feet. The Corvallis watershed is located on the eastern slope of the peak and includes both the Rock Creek and Griffith Creek drainages. The area is about five miles long east and west by four miles north and south. The area is managed as a unit by the United States Forest Service.

Due to the marine influence, the area has a humid climate averaging approximately 65 inches of precipitation annually with an annual

mean temperature of approximately 52°F. Soils are basaltic in origin and are primarily clay loam in texture.

In 1950, an epidemic of Douglas fir bark beetles made necessary a program of development which included cutting of dead and infected trees and establishing a road system. Cutting was restricted to small clear cuts.

The vegetation in the study area is a Douglas fir-vine maple association. Gaultheria shallon and Berberis nervosa dominate the forest floor with traces of Castanopsis, Corylus, and Cornus.

Study plots were located on nine clear cut and burned areas ranging in elevation from 1,300 to 2,800 feet and including north, south, and east exposures.

Nineteen study plots, which were 100 x 100 feet, were established in uniform vegetative areas. Plots were also established in the undisturbed areas adjacent to the clear cuts for comparative purposes. Vegetative sampling was done using a device called an ocular point frame which provided a reliable indication of vegetative cover. Sampling was done in both the spring and the fall on the second, third, fourth, and fifth years following burning. The stable undisturbed vegetation was sampled only once.

Results of the five-year study showed a general increase in total number of plant species. The average total vegetative cover rose

abruptly the third, fourth, and fifth years. An analysis indicated that south exposed plots had the greatest vegetative cover the first five years after burning. East plots ranked second and north plots third. By the fourth year, average cover values on clear cut areas exceeded the cover values of understory vegetation on the adjacent uncut forest.

Analysis of data regarding seasonal variation indicated sharp decreases in total cover from spring to fall during the first three years. Increasing amounts of perennial vegetation during the fourth and fifth year reduced this seasonal variation markedly.

In terms of mean cover trends, the annual herb, Senecio sylvaticus, dominated the second year; Lotus stipularis and Circium vulgare, the third; Lotus and Holcus lanatus, the fourth and fifth. All plant species indicated a wide range of cover values on the plots sampled. Some consistent trends in the sequence of cover dominance are noted.

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APPENDIX

APPENDIX I

Flowering Plant Species Encountered in the Plots of the Mary's Peak Succession Study

Plant Symbol	Scientific Name	Common Name
Trees:		
Tabr	Taxus brevifolia Nutt.	Western Yew
Tshe	Tsuga heterophylla (Raf.) Sarg.	Western Hemlock
Psme	Pseudotsuga menziesii (Mirb.) Franco	Douglas Fir
Cach	Castanopsis chrysophylla (Dougl.) A. DC.	Chinquapin
Acci	Acer circinatum Pursh.	Vine Maple
Acma	Acer macrophyllum Pursh.	Oregon Maple
Conu	Cornus nuttallii Aud.	Western Flowering Dogwood
Shrubs:		
Coco	Corylus cornuta Marsh. var. californica (A. DC.) Sharp.	Western Hazel
Bene	Berberis nervosa Pursh.	Long-leaved Oregon Grape
Rilo	Ribes lobbii Gray.	Pioneer Gooseberry
Hodi	Holodiscus discolor (Pursh) Maxim.	Ocean Spray
Rogy	Rosa gymnocarpa Nutt.	Little Wild Rose

Rule	Rubus leucodermis Dougl.	Western Blackcap
Ruma	Rubus macropetalus	
Rupa	Rubus parviflorus Nutt.	Thimble Berry
Osce	Osmaronia cerasiformis (T. and G.) Greene.	Indian Plum
Prem	Prunus emarginata Var. mollis (Dougl.) Brew	Bitter Cherry
Cesa	Ceanothus sanguineus Pursh.	Oregon Tea Tree
Ceve	Ceanothus velutinus Dougl. var. laevigatus T. and G.	Sticky Laurel
Gash	Gaultheria shallon Pursh.	Salal
Vasc	Vaccinium scoparium Leiberg.	Small-leaved Huckleberry
Saca	Sambucus callicarpa Greene.	Red Elderberry
Sagl	Sambucus glauca Nutt.	Blue Elderberry

Forbs:

Polo	Polystichum lonchitis (L.) Roth	Holly Fern
Pomu	Polystichum munitum (Kaulf.) Presl.	Western Sword Fern
Ptaq	Pteridium aquilinium (L.) Kuhn. var. pubescens Underw.	Western Brake Fern
Equar	Equisetum arvense L.	Common Horsetail
Lico	Lilium columbianum Hans.	Columbia Lily
Trov	Trillium ovatum Pursh.	Western Trillium

Dism	Disporum smithii (Hook.) Piper	Large-flowered Fairy Bell
Irte	Iris tenax Dougl.	Oregon Iris
Goob	Goodyera oblongifolia Raf.	Rattlesnake Plantain
Ruac	Rumax acetosella L.	Red Sorrel
Mosi	Montia sibirica (L.) How.	Western Spring Beauty
Mope	Montia perfoliata (Donn) How.	Miner's Lettuce
Spar	Spergula arvensis L.	Corn Spurry
Cegl	Cerastium glomeratum Thuill.	Sticky Mouse-Ear
Anly	Anemone lyallii Britt.	Little Mountain Anemone
Vahe	Vancouveria hexandra (Hooke.) Morr. and Dene.	Inside-out Flower
Actr	Achlys triphylla (J. E. Sm.) DC.	Vanilla-leaf
Difo	Dicentra formosa (Andr.) Walp.	Western Bleeding Heart
Lula	Lupinus latifolium Ag. var. columbianus (Hel.) C. P. Sm.	Broad-leaved Lupine
Loab	Lotus aboriginus Jeps.	Thicket Lotus
Lomi	Lotus micranthus Benth.	Small-Flowered Lotus
LOST	LOTUS STIPULARIS	
Oxor	Oxalis oregana Nutt.	Oregon Oxalis
Gedi	Geranium dissectum L.	Cut-leaved Geranium
Gemo	Geranium molle L.	Dove's Foot Geranium

Vise	Viola sempervirens Greene.	Evergreen Violet
Epan	Epilobium augustifolium L.	Fireweed
Epad	Epilobium adenocaulon Haussk.	Common Western Willow-herb
Epca	Epilobium californicum Haussk.	California Willow-herb
Epmi	Epilobium minutum Lindl.	Small-flowered Willow-herb
Daca	Daucus carota L.	Wild Carrot
Pyap	Pyrola aphylla J. E. Sm.	Leafless Pyrola
Trla	Trientalis latifolia Hooke.	Broad-leaved Star-flower
Cohe	Collomia heterophylla Hooke.	Varied-leaved Phacelia
Dipu	Digitalis purpurea L.	Foxglove
Orpi	Orobanche pinorum Geyer.	Pine Broom-Rape
Gatr	Galium triflorum Michx.	Fragrant Bedstraw
Libo	Linnea borealis L. var. americana (Forbes) Rehd.	American Twin-Flower
Casc	Campanula scouleri Hook.	Scouler's Campanula
Anma	Anaphalis margaritacea (L.) B. & H.	Pearly Everlasting
Anne	Antennaris neglecta Greene var. Howellii Cron.	Howell's Everlasting
Maex	Madia exigua (J. E. Sm.) Gray	Little Tarweed

Acmi	Achillea millefolium L.	Yarrow
Chle	Chrysanthemum leucanthemum L.	Ox-eyed Daisy
Erpr	Erechtitis prenenthoides DC.	Australian Fireweed
Sesy	Senecio sylvaticus L.	Wood Groundsel
Seja	Senecio jacobaea L.	Tansy Ragwort
Sein	Senecio integerrimus Nutt. var. exaltatus (Nutt.) Cron	Tall Western Senecio
Civu	Cirsium vulgare (Savi) Airy-Shaw	Common Thistle
Cibr	Cirsium brevistylum Cron.	Indian Thistle
Ciar	Cirsium arvense (L.) Scop.	Canada Thistle
Hyra	Hypochoeris radicata L.	Hairy Cat's Ears
Lele	Leontodon leysseri (Wallr.) Beck	Rough Hawkbit
Lasc	Lactuca scariola L. var. integrata Gren. & Godr.	Prickly Lettuce
Soas	Sonchus asper (L.) Hill	Prickly Sow Thistle
Taof	Taraxacum officinale Weber	Dandelion
Aggr	Agoseris grandiflora (Nutt.) Greene	Large-flowered Agoseris
Hial	Hieracium albiflorum Hook.	White-flowered Hawkweed
Hial	Hieracium albertinum Farr.	Western Hawkweed
Crca	Crepis capillaris (L.) Wallr.	Smooth Hawksbeard

Crse	Crepis setosa Hal. F.	Bristly Hawksbeard

Grasses and Sedges:

Brca	Bromus carinatus H. & A.	California Brome Grass
Brsi	Bromus sitchensis Trin.	Alaska Brome Grass
Feme	Festuca megalura Nutt.	Western Six-weeks Fescue
Fesu	Festuca subuliflora Scribn.	Coast Range Fescue
Fesu	Festuca subulata Trin.	Nodding Fescue
Feel	Festuca elatior L. Var. arundinacea (Schrad.) Weinn	Meadow Fescue
Feru	Festuca rubra L.	Red Fescue
Cyec	Cynosurus echinatus L.	Bristly Dog's tail Grass
Elca	Elymus glaucus Buckl.	Western Rye-Grass
Lope	Lolium perenne L.	English Rye-Grass
Trca	Trisetum canescens Buckl.	Tall Trisetum
Deel	Deschampsia elongata (Hook.) Munro	Slender Hair-Grass
Aica	Aira caryophyllea L.	Silvery Hair-Grass
Hola	Holcus lanatus L.	Velvet Grass
Agex	Agrostis exarata Trin.	Western Bent-grass

Cafe	Carex festivella Mack.	Mountain Meadow Sedge
Lumu	Luzula multiflora (Retz.) Lej.	Commod Wood Rush