SUCCESSIONAL TRENDS OF LESSER VEGETATION FOLLOWING CLEARCUTTING IN OLD-GROWTH DOUGLAS-FIR STANDS

by

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A THESIS

submitted to

OREGON STATE COLLEGE

in partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE

June 1958

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ACKNOWLEDGMENT

Acknowledgment is made to the many groups and individuals for guidance and assistance in preparation of this paper. Special thanks go to the Oregon State College School of Forestry for the award of the Weyerhaeuser Fellowship; to personnel of the Pacific Northwest Forest and Range Experiment Station for data, photographs, and assistance; and to Dr. J. Richard Dilworth, Dr. W. K. Ferrell, and Dr. William W. Chilcote for personal guidance and assistance.

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INTRODUCTION

The use of plants, other than commercial tree species, as indicators for management of forest lands has in the past been seriously limited. This resulted primarily from a lack of knowledge about these species, the reason for their presence or absence, and the causes of the variation of distributional patterns that exist on different areas. Not until more is learned about the forest community's lesser vegetation and its ecological requirements, can it be used to fullest advantage by foresters, game managers, ecologists, and watershed managers (31, p. 461). Lesser vegetation undoubtedly reflects site quality and production potential for commercial crops of trees. This vegetation also indicates the future cover that can be expected, its amount and type, and the future value that can be placed on an area whether it be for timber production, water production, or game production. It is the job of land and resource managers to learn more about the lesser vegetation so the information presently unrecognized can be used to its best advantage.

The purpose of this study on logged and burned areas originally covered by old-growth Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) stands was to add to basic knowledge with regard to secondary succession over a six-year period and the variations of successional trends as affected by slope, burning, aspect, and elevation.

This study, initiated in 1953 by Roy Silen of the Pacific Northwest Forest and Range Experiment Station, was concerned with 400-year-old Douglas-fir stands in the central Oregon Cascades. The successional trends were followed by recording the frequency of occurrence and the percent of cover contributed by individual species on three separate examinations: 1953, 1956, and 1957.

REVIEW OF LITERATURE

The role of lesser vegetation in natural regeneration of conifers is well known. A small amount of ground cover is beneficial for natural reproduction of conifer seedlings, while heavy cover is harmful (21, p. 18; 2, p. 34; 14, p. 43). A ground cover of between 0-25 percent increases the amount of coniferous reproduction while ground cover of between 25-85 percent is increasingly detrimental and cover of more than 85 percent practically eliminates conifer seedling establishment (15, p. 720). When ground cover is between 60-75 percent, conifer seedlings are found only in the more open areas where root and crown competition are less. After the seedlings are established, however, they can withstand much heavier ground cover satisfactorily (16, p. 59).

Different types of vegetation and shade produce different effects on conifer seedling establishment. Because of the competition that accompanies live shade, dead shade is more beneficial to seedling establishment (14, p. 43). A combination of heavy weed and light evergreen ground cover is detrimental whereas light-weed ground cover is beneficial to seedling establishment (2, p. 34). Both heavy, woody and heavy, herbaceous ground cover are detrimental to conifer seedling establishment (21, p. 27), (2, p. 34). The lesser vegetation present on an area also alters the site and in a normal pattern of succession provides for cooler more moist conditions for invasion of conifers (11, p. 44).

Serious attempts to study the secondary successional patterns of the lesser vegetation in the Pacific Northwest were started in 1928, by Kienholz (18), who established a study of Douglas-fir clearcut and burned areas in western Washington. He studied a series of logged and burned areas with known histories covering a span of two years after burning. He found that the average density of cover increased with age. He also found that moderately burned plots had the highest density of cover with heavy burn second, light burn third, and with the least cover existing on unburned plots. He found that light burned and unburned areas had been heavily disturbed or had a heavy cover of duff or debris and vegetation on these would normally have been light. In reference to burning and its effect on vegetation he stated, "Time very soon obliterates any difference in the amount of vegetation on burns of different degrees of severity." (18, p. 97) Kienholz used three classes of vegetation (18, p. 98):

I. Virgin timber herbaceous species--those herbaceous species present under the forest canopy and persisting after logging and burning. These survive the slash fire chiefly by underground parts and gradually become less abundant as the site dries out.

II. Virgin timber shrubby species--small trees, shrubs, and creepers present under the virgin canopy surviving by unkilled roots and stems. These often thrive better after clearcutting and burning than herbaceous species.

III. Weed species--those species which are not present under a virgin canopy and invade the clearcut area.

Kienholz discussed the following items in his conclusion: 1. Total cover increased steadily during the first two years but was relatively lower for areas recently burned. 2. Herbaceous species present in the virgin stand starts high in density and frequency. This he concluded was a result of the high survival of sword fern (Polystichum munitum). This group was found higher in density than either shrub or weed classes, but the difference became less significant with time. 3. Shrubby species present in the virgin stand started at a lower density than herbaceous species but were higher in frequency of occurrence. The amount of cover of this group steadily increased with time. 4. Weeds start low in density and frequency but rise rapidly in both to a dominant position (18, p. 103). 5. The important species Kienholz considered in each class were (18, p. 99):

I. Sword fern, star flower (Trientalis latifolia), violet (Viola spp.), (Oxalis spp.), bleeding heart (Bikukulla formosa), vanilla-leaf (Achilys triphylla), miners lettuce (Montia asarifolia), and (Disporum oregonum).

II. Oregon grape (Berberis spp.), blackberry (Rubus macropetalus), salal (Gaultheria shallon), huckleberry (Vaccinium spp.), vine maple (Acer circinatum), evergreen huckleberry (Vaccinium ovatum), and elderberry (Sambucus spp.).

III. Groundsel (Senecio vulgaris), perennial fireweed (Epilobium angustifolium), (Epilobium annuals), thistle (Circium spp.), hawkweed (Hieracium albiflorum), and (Crepis spp.).

Kienholz indicated that no significant difference in density of total cover existed between north and south slopes. He expressed a belief, however, that with more data a difference in species present would be evident. He also said that no difference in amount of cover and species present existed as a result of slope. This was true he indicated as long as there was a soil cover on the slope (18, p. 107).

Ingram (13), in a study near Wind River, Washington, noted an initial liverwort and moss stage of succession during the first year after burning. He also noted that the liverwort-moss stage was followed by annual weeds and short-lived perennials, these being replaced by long-lived perennial shrubs and tree seedlings. Ingram indicated that burned areas were more conducive to establishment of windblown seed species and that within one or two years the area was completely covered with herbaceous vegetation. He noted that this herbaceous vegetation along with the coppic reproduction of shrubs from under the canopy produced a dense cover with abundant height growth (13, p. 396). Ingram considered fireweed ((Chamaenerion (Epilobium) angustifolium)), one of the first plants to appear on a site in abundance, and trailing blackberry (Rubus macropetalus) and bracken fern (Pteridium aquilinum pubescens) as the most frequent invaders. He considered groundsel (Senecio spp.) as a dominant invader on a considerable portion of the Douglas-fir region with

pearly everlasting (Anaphalis margaritacea) and thistle (Circium lanceolatum) as dominant invader on a few areas (13, p. 396 and 397). Ingram indicated that if the site is not reburned, the brush species continued to increase in abundance and the vegetation changed to a more permanent type. If the site was reburned, however, the brush decreased in abundance being replaced by bracken fern (13, p. 401-402).

Isaac (15) considered four stages of succession existing in the region under study. These were: 1. Moss-liverwort; 2. Weed-brush; 3. Intolerant Douglas-fir; 4. Tolerant, all-aged hemlock spruce (15, p. 721). The first stage disappeared after the first year when weed-brush stage developed. The species of the second stage are made up of the shrubby and herbaceous species which were present under the forest canopy and the invading species which quickly dominated the area (15, p. 717). This stage is most susceptible to fire, and repeated fires will prolong it indefinitely (15, p. 718). It is this second stage of succession which was discussed in his paper.

Isaac's results came from information on fifteen widely scattered burned areas in western Washington and Oregon. He examined them promptly after burning and each succeeding year for eight years. He noted that a variation existed in the amount of cover and species present between burned areas and concluded that this was a result of the fast development of vegetation and the isolated nature of the burns. Isaac noted a rapid rise in percent of total weed-brush cover until about the third year when increase tapered off. Some annuals he noted were present for one year in high quantity then disappeared

almost immediately (15, p. 718). Although there was a gradual increase in the frequency of occurrence of species that made up the herbaceous cover, there was a decline in total cover of the herbaceous species. Total cover he indicated rose rapidly for a few years then declined slightly. Isaac also indicated that brush species dominated some plots entirely after the fifth year. Repeated burnings would eliminate most of the brush species; and under repeated burnings, bracken fern (Pteridium aquilinum) would soon dominate the site (15, p. 720). The dominant species on the fifteen areas studied by Isaac were (15, p. 719):

Invaders

Annuals

Groundsel (Senecio vulgaris), willow-herb (Epilobium spp.).

Perennials

Fireweed (Chamaenerion angustifolium), peavine (Lathyrus spp.), and false dandelion (Leontodon spp.).

Shrub

Trailing blackberry (Rubus macropetalus), snowbrush (Ceanothus velutinus).

Virgin Forest Species

Herbaceous

Swordfern, wood sorrel (Oxalis oregana).

Shrub

Berberis? p.5

Oregon grape (Odostemon nervosus), salal (Gaultheria shallon), and vine maple (Acer circinatum).

In a recent study on the effect of slash burning in western Washington and Oregon, Morris and Cramer (28) used paired plots to determine the differences that existed between burned and unburned slash areas. They found that the amount of brush cover was extremely variable on unburned plots with cover ranging from 0 to 79 percent. These unburned plots had a higher percent of brush cover than did the burned plots. The authors found that herbaceous vegetation density of cover was equal on burned and unburned plots and increased rapidly for the first three years. The amount of cover then increased only slightly. The densities of brush species also increased little after the third year. By the fifth year after burning there was 10 percent cover of brush on burned and 20 percent brush cover on unburned plots. The density of herbaceous cover was 30 percent on both burned and unburned plots by the fourth season (28, p. 31).

Brush species encountered by Morris and Cramer were vine maple, most frequently encountered; rhododendron, more important on unburned; and ceanothus, more important on burned. Salal and Oregon grape, although occasionally important in plot cover, were not considered of major importance. Other brush species found of occasional importance were: blackcap, blue elder, chinkapin, thimbleberry, broadleaf maple, dogwood, currant, cherry, rose, snowberry (28, p. 24-25). Herbaceous species that were found to be more important in cover were: perennial fireweed, and trailing blackberry (considered herbaceous in this study). The occurrence of these herbaceous species was somewhat erratic and they did not establish themselves in important quantities on 30 percent of the plot pairs.

Species found on Cascade plots which were occasionally important, or important for only one season, were: senecio, annual fireweed, twinflower, whipplea, bracken, thistle, bunchberry, dogwood, sedge, bindweed, pea, deervetch, prickly lettuce, oxalis, penstemon, mint, lupine, bluebell, and grass[1/] (28, p. 26-27).

The authors of the literature studied were all seemingly in agreement with the general progression of the stages of succession and the general types of vegetation present, but they did not agree completely on the important species present. This disagreement, however, is understandable when one considers the distance that separated the studies and the various sites that were included.

Isaac (15, p. 719) and Ingram (13, p. 400) both disagreed with Kienholz (18, p. 99). They considered trailing blackberry as an invading shrub species, rather than a shrub species from under the virgin forest canopy. This point of contention might also be explained by the variability of the plant populations between widely scattered areas and at greatly different elevations. Cashwiler (7), in a study of small mammals on H. J. Andrews Experimental Forest, found trailing blackberry (Rubus macropetalus) under the canopy in small amounts. The authors of the literature reviewed were also in unanimous agreement concerning the variability of the vegetative cover that existed on cleared areas of Douglas-fir. This unity was both expressed and implied.

[1/] No technical names were provided in this study.

Kienholz (18, p. 108) and Isaac (15) agreed to the fact that the species present were not affected by soil, slope, or aspect. This agreement was implied in their treatment of data if not expressed. In his discussion of the distribution of the various species, Ingram (13, p. 397) stated, "The abundance of a single species or combination of species appears to be accidental rather than a direct result of the ecological condition of the site itself." This statement was not contradicted in subsequent studies in the Douglas-fir region. Only Morris and Cramer (18, p. 31) considered that burning resulted in a difference of vegetation. They also indicated that this difference existed only in the shrubby species.

The general pattern of secondary succession of annuals and short-lived perennials to long-lived perennials, and the variation in cover and species present has been noted in widespread areas of this country (20, p. 72-73; 35, p. 172; 12, p. 258). Unlike studies in the Douglas-fir region, however, variations in lesser vegetation due to topography, aspect, and soil were noted (26, p. 138; 35, p. 155; 12, p. 258; 24, p. 333). Studies in other areas also noted a great variation in the species present and the successional patterns that existed (22, p. 31; 26, p. 138). The problem of the use of lesser vegetation as indicators in the management of forest lands was aptly stated by Samson in a study of burned chaparral lands (34, p. 28). "The most outstanding fact consistently appearing in the literature on fire and succession is that no single criterion or formula may safely be used to predict the outcome--only as a result of careful study in a particular area, taking into account

all possible biotic, climatic, and topographic factors, can rational predictions of plant succession be made."

DESCRIPTION OF STUDY AREA

GENERAL DESCRIPTION SIZE AND TREATMENT OF STUDY AREA

The study area was on the H. J. Andrews Experimental Forest near Blue River, Oregon. This forest is a 15,000-acre tract of land and includes the entire drainage of Lookout Creek, a main tributary of the Blue River. It is located eight road miles north and east of the town of Blue River which is located approximately 40 miles east of Eugene, Oregon, on Highway U. S. 126. The area is in typical Cascade Range topography with slopes ranging from very steep to level. The elevation of the study areas ranged from 1,700 to 3,700 feet.

Logging was started on the area in 1950, and this study was initiated in 1953. At this time four clearcut and burned units were in the first growing season after burning and five were in the second growing season after burning. In 1954, one additional clearcut was added to the study bringing the total to nine. All of these were on general north aspects. In 1956, and in 1957, data were collected on five south aspect units.

Following is a tabulation of the clearcuts studied giving elevation, general aspect, and histories of logging and burning (Table I). Table II indicates the dates each unit was examined. Figure 1 is an aerial photo oblique giving a general view of the study area as it was in 1954. The view is up Lookout Creek and includes all of the study clearcuts except areas 3F, 3G, and 3H which are south aspect units just off the picture to the left.

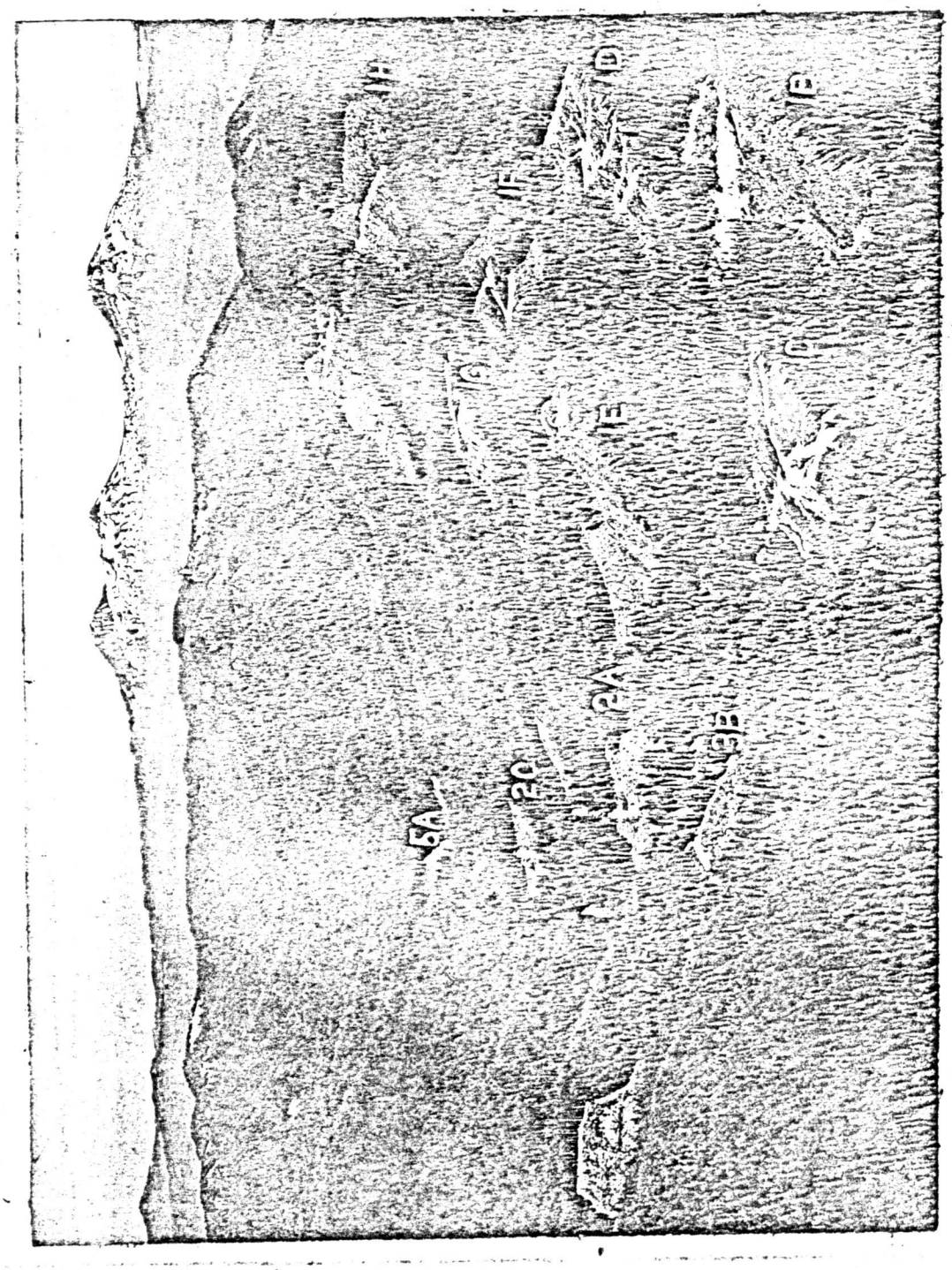


Figure 1--Lookout Creek Drainage Showing Clearcut Units

Table I--General Description of Clearcut Units Included in the Study

Unit	General Aspect	Elevation (feet)	Size (acres)	Date Logged	Date Burned
1B	North	2250	40A	June-Sept. 1950	Fall 1951
1C	North	2000	30A	July-Sept. 1950	Fall 1951
1D	North	2400	35A	Sept.-Nov. 1950	Winter 1951-1952
1E	North	2250	37A	Nov. 1951 May 1952	Fall 1952
1F	North	2800	48A	June-July 1951	Fall 1951
1G	North	2800	24A	Aug.-Sept. 1951	Fall 1952
1H	North	3700	44A	Nov. 1951 June 1952	Fall 1952
2A	North	1850	24A	April-Oct. 1952	Fall 1952
2C	North	2000	36A	Aug. 1952	Fall 1952
3B	South	1900	21A	Oct.-Nov. 1952	Fall 1953
3F	South	2400	50A	April-May 1953	Fall 1953
3G	South	2600	41A	June-Sept. 1953	Fall 1953
3H	South	2800	29A	June-Sept. 1953	Fall 1953
5A	South	2300	70A	Aug.-Oct. 1954	Fall 1955

Table II--Dates of Examinations of Study

	1st Examination			2nd Examination			3rd Examination		
Unit	Month	Day	Year	Month	Day	Year	Month	Day	Year
1B	Aug.	11	1953	Aug.	15	1956	July	25	1957
1C	Aug.	5	1953	Aug.	8, 9	1956	July	22	1957
1D	Aug.	11	1953	Aug.	2, 3	1956	Aug.	13	1957
1E	July	29, 30	1953	Aug.	17, 21	1956	Aug.	12	1957
1F	June	15, 22	1953	Sept.	5, 6	1956	Aug.	13	1957
1G	Aug.	11, 12	1953	Sept.	12	1956	Aug.	13	1957
1H	July	22, 23	1953	Sept.	11, 19	1956	Aug.	15, 16	1957
2A	Aug.	6	1953	June Aug.	30 7	1956	July	26	1957
2C	Oct.	1, 2	1953	Aug.	1	1956	Aug.	12	1957
3B	Aug.	29	1956	July	26	1957			
3F	June	20, 21	1957						
3G	Aug.	9	1957						
3H	Aug.	23, 24	1956	July	25	1957			
5A	Aug.	8	1957						

CLIMATE

Climatic factors most limiting to vegetation growth in successive years are precipitation and temperature. Climate of the study area can best be described by presenting precipitation and temperature records of the study area. Rainfall was measured in a permanent rain gauge installation in the H. J. Andrews Experimental Forest. Temperature was recorded at a U. S. Weather Bureau Climatological Station located at McKenzie Bridge, Oregon, approximately fifteen road miles south and east of the study and about 250 feet lower in elevation than the lowest clearcut unit in the study. Only data for the critical period of March to October for each year that the study was in progress are presented. The winter precipitation was not considered to have an effect on the vegetation present because of the saturated condition of the soil from October or November until March or April. The critical months, characterized by a lack of precipitation, are usually July, August, and September with the other months receiving sufficient moisture for vegetative growth (Table III). No attempt was made to determine the microclimate of the study areas and its effect on vegetation.

The most critical period for vegetative growth in regard to temperature is also the summer months, with high temperature, and the frost-free period. Here again the months of March to September include both critical periods. For the period of the study, and the data available, the last months that the temperature was below freezing at the climatological station was May and June. The first

Table III--Monthly Precipitation and Average Annual Precipitation for Years 1952-1957

Months

	March	April	May	June	July	Aug.	Sept.	Oct.	Ave. Annual
Year	Inches of Precipitation								
1952	5.76	2.75	1.68	2.54	0.51	0.09	1.31	0.30	51.89
1953	9.47	5.37	6.63	2.94	0.00	2.93	1.57	3.27	114.53
1954	5.68	6.03	2.68	4.71	0.65	1.41	3.69	6.15	78.71
1955	8.43	9.92	1.56	2.12	1.86	0.00	2.89	13.36	94.05
1956	10.47	2.00	5.34	2.02	0.00	0.20	0.37	12.23	67.30
1957	12.80	3.37	4.92	2.74	0.37	1.01	2.05	5.95	91.14
Ave. for 6 years		4.91	3.80	2.84	0.57	0.94	1.98	6.88	82.94

time that the temperature dropped below or to freezing in the fall was August or September (Table IV).

By combining the two tables, July, August, and September are critical months for both moisture and high temperature. A prolonged hot and dry period at this time could feasibly affect the vegetation adversely during the next growing season. The period of time that both temperature and moisture are at optimum levels for plant growth is very short. This period occurs from May until July. The fall rains do not, as a rule, begin until the temperature has dropped below optimum, thereby limiting the fall as an optimum period of growth.

SOILS

There are three general soil situations on the study area with their position and characteristics determined by the general topography. On upper slopes and ridge tops there exists a soil 13 to 36 inches deep formed on andesite and basalt with a pH of 5.0-5.4. These soils are of clay loam texture with excellent permeability and stability.

The second soil situation is located generally on mid-slopes or low ridges and occurs intermittently through the study area. This soil with a depth of 36 to 48 inches and a pH of 4.8-5.2 is formed on agglomerates, tufts, and breccias. The texture of this soil is silty clay loam with moderate permeability and it is very unstable when disturbed by road construction.

Table IV--Temperature Records for Annual and Summer Months 1952-1957

Month		Year 1952	1953	1954	1955	1956	1957
		Degrees Fahrenheit					
March	Ave.	-	41.8	-	37.8	39.3	42.4
	Max.	-	75	68	68	65	66
	Min.	-	21	19	16	16	27
April	Ave.	51.6	45.9	48.6	41.8	49.9	50.7
	Max.	82	80	83	77	88	91
	Min.	25	25	25	24	26	29
May	Ave.	55.1	-	56.0	51.3	55.7	56.0
	Max.	91	-	93	83	95	90
	Min.	25	-	22	28	30	32
June	Ave.	59.3	-	55.6	60.5	58.0	61.0
	Max.	88	80	89	102	90	89
	Min.	35	32	32	30	37	-
July	Ave.	68.9	64.5	62.4	61.7	-	63.5
	Max.	104	99	89	95	-	94
	Min.	36	36	31	34	-	38
Aug.	Ave.	65.7	64.6	60.7	63.3	64.6	62.2
	Max.	98	101	88	97	99	92
	Min.	35	34	38	31	38	28
Sept.	Ave.	63.2	63.2	-	59.0	60.5	63.6
	Max.	100	98	-	108	97	101
	Min.	28	32	-	29	28	31
Oct.	Ave.	-	-	-	51.6	48.0	50.4
	Max.	-	-	-	85	92	79
	Min.	-	-	-	29	26	28
Annual	Ave.	-	52.5	-	50.0	49.5	49.9
	Max.	104	101	93	108	107	101
	Min.	-	21	-	3	4	0
No. of Days 28° F.		146	145	130	-	158	155
No. of Days 32° F.		127	113	40	70	122	117

The third soil situation is the soils 36 to 40 inches deep formed on colluvial material of benches and gentle slopes. The average texture here is clay loam with a pH of 5.0-5.4 and with generally good permeability and excellent stability. 2/

2/ Official office memorandum from Robert Tarrant, Soil Scientist, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. On file at Willamette Research Center, Corvallis, Oregon

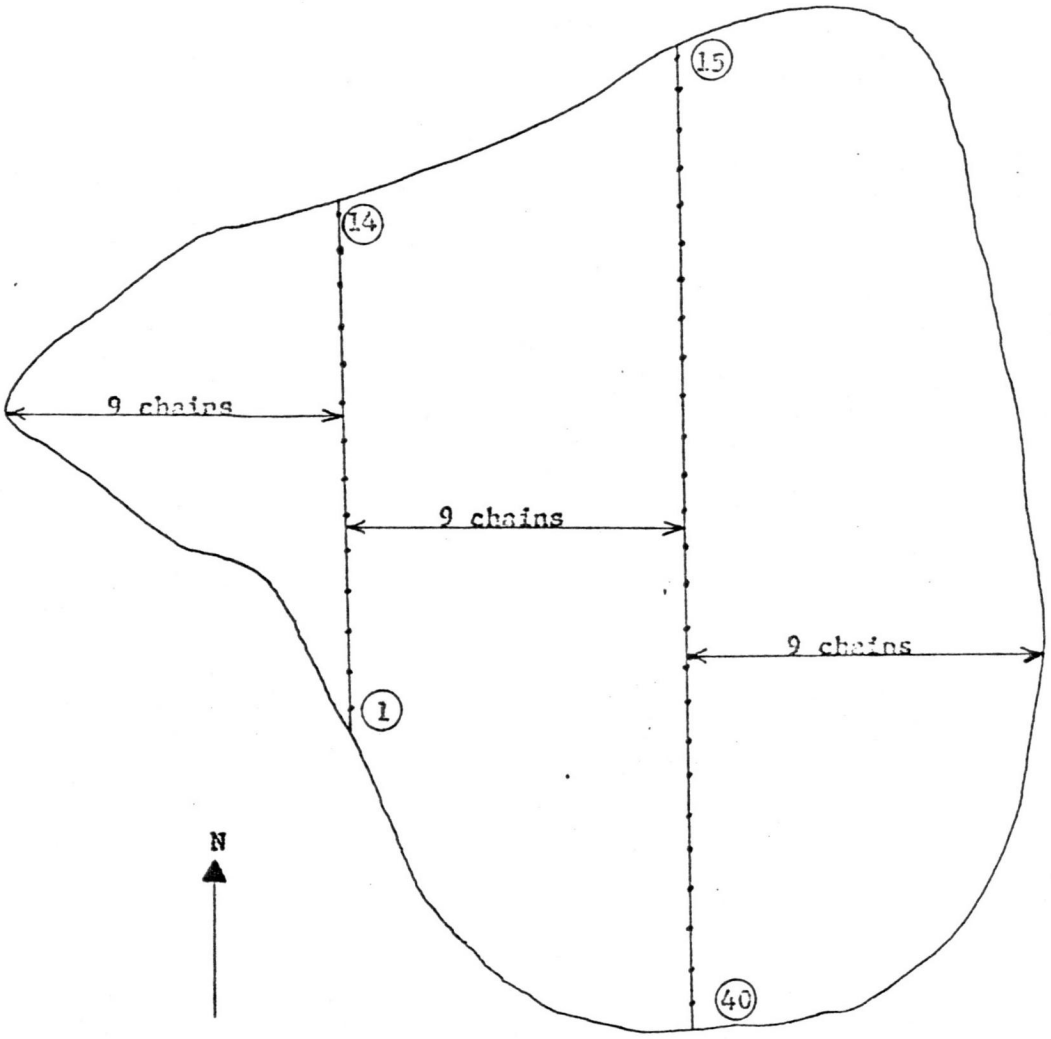
METHOD OF SAMPLING

The sampling in this study was accomplished by recording the species present and the total cover of each species on permanent circular four milacre plots. Forty plots were established mechanically on each clearcut. The data collected from each plot included the species present and the amount of ground covered by each species expressed as a percent of the total plot area.

PLOT ESTABLISHMENT

Forty plots per clearcut unit were mechanically located along two north-south lines spaced one-third and two-thirds the distance from the east and west extremes of the unit (Figure 2). Plot intervals were determined for each clearcut by scaling the total length of the two north-south lines off a topographic map and dividing by 40. The first plot of a line was placed one-half the calculated plot interval from the stand edge with the remainder placed at the full interval. Plots were spaced along the lines without regard to the number of plots in each line.

Equipment used for establishing plot centers consisted of a two-chain trailer tape and a staff compass. The procedure was to start on the south end of one of the north-south lines placing the plots at the proper interval. Plots were numbered chronologically starting with "1" at the south end of either line. The plot series in each line and those next to the roads were noted and recorded. If the scaled map distance was smaller than the actual distance,



Scale 1" = 5 chains

Total line length of 2 lines 40 chains

Plot interval = 1 chain

(1) Plot number ——— Line of plots

Figure 2--Map of Clearcut Unit Showing Placing of Lines and Plots

preventing the last plot from being placed within the clearcut boundary on the established line, the final plot was placed at the calculated plot interval to the east or west of the last plot on the line. Preference was given to the east side of the line.

Plot centers were marked with a seven-foot cedar stake topped and identified by number with aluminum flashing. For ease in examining them, the plots were divided by placing a small cedar stake 7.5 feet to the south of the center stake and plot boundaries were determined with the use of a 7.54-foot stick.

Missing plot centers or plots with the center stake down and possibly moved were either disregarded or replaced. In the 1953 and 1956 examinations, those plots that did not have the center positively located were not included in the sample. As a result values on some units for the 1953 and 1956 examinations are based on less than 40 plots (Table V). In 1957, missing or doubtfully located plots were relocated with a chain and compass from an adjacent plot.

DATA COLLECTION

Data were collected from the study area on three separate occasions. The data collected on the first examination included information on plot conditions as well as information on lesser vegetation present. The data collected for lesser vegetation was the same on all examinations, that is species present and the percent cover of each.

Table V--Number of Plots in Each Clearcut for Each Examination

Unit	1st Examination	2nd Examination	3rd Examination
1B	40	39	40
1C	40	39	40
1D	40	40	40
1E	36	33	40
1F	40	40	40
1G	40	40	40
1H	40	40	40
2A	40	40	40
2C	40	40	40
3B	40	40	
3F	37		
3G	37		
3H	40	40	
5A	40		

Plot Condition Data

The information collected on plot condition on the first examination was aspect, slope, total percent of area burned, percent of area burned rated as hard, light, and medium, percent of area in mineral soil, and percent of area in skid roads. Of the above classes of information, only total burn was used because the information collected for lesser vegetation was from the entire plot without regard to the position of the vegetation or surface conditions. Plot condition data in units 5A and 3G were not taken because two years had lapsed since burning, and the information had been obscured by weather and vegetative litter.

Lesser Vegetation Data

The data collected for lesser vegetation from each plot for each examination were the species present and the total cover of each species, expressed as a percent of total plot area. The number of plots on which a species occurred was expressed as percent of occurrence or the percent of total plots per clearcut that contained that species. Occurrence information was independent of the number of stems of any one species per plot. The percent cover was used as a measure of density of any single species, and the sum of the percent cover for all species on each plot was the total cover on that plot. To determine the average percent cover per clearcut for any one species, the sum of the percents of cover of that species for all plots was divided by the number of plots. The sum of the average percent cover of all species present on any clearcut unit

was considered the average percent cover for the entire unit.

The species present in various layers of vegetation were estimated individually. This could result in a total percent cover for an individual plot of over 100 percent. If an individual plot had a dense undergrowth of a mat-like plant which was overtopped by dense brush, total cover could approach 200 percent. Field examinations, however, indicated that instances of two layers of vegetation covering the same area in great density were relatively rare, thus causing only slight error to be present as a result of this technique.

The percent cover was estimated ocularly by the vertical projection method, and percent occurrence was determined by recording the species present. The estimation of percent cover was aided initially by placing a one-foot square piece of cardboard on the plot and using it as a guide to estimate the number of square feet of cover for any particular species. The estimate of the number of square feet of cover was then converted to percent of total plot area. By grouping the cover into 1 3/4 square-foot clumps and totaling the number of these, 1 percent estimates could be made. For species with a high amount of cover on a plot, an estimate of the percent of cover was made by dividing the plot into quarters and determining the amount of the quarters that were covered. Any species present which did not have at least 1 percent, or 1 3/4 square-foot, of cover on a plot was considered a trace. Traces were given a value of one-half of 1 percent of cover in the final analysis.

Field records were kept on prepared mimeographed forms which allowed tabulation of species present and the percent of cover for each species on each plot (Appendix III, a, b, c). An entry for any one species on any one plot constituted one occurrence. A value entered for any species was the percent cover for that species. Figures 3 through 7 give examples of cover situations encountered with the total percent cover and the number of species present on the plot. Figures 8 through 12 show various conditions and average cover for some units.

Sequence of Data Collection

The sequence of data collection in number of years from burning is not the same for all units. All examinations of vegetation on north slopes took place in 1953, 1954, 1956, and 1957 (Table 1). Only one clearcut unit was examined in 1954, leaving the bulk of examinations in 1953, 1956, and 1957. Although they were examined the same calendar year, the units were grouped into two examination sequences due to a difference in the time of burning. Units 1B, 1C, 1D, and 1F were all examined during second, fifth, and sixth growing seasons after burning, while units 1E, 1G, 1H, and 2A were examined during the first, fourth, and fifth growing season after burning (Table 2). As a result of this examination sequence, no one unit could indicate successional trends from the first to the sixth season after burning. Because of the variability that exists between different clearcuts, errors could be present if different areas were compared for trends in successive years. As a result,

data were handled separately for each examination sequence with unit 2C included in either group as it was examined, even though it was not examined at the same calendar year sequence.

The date of burning was used as the beginning point in the handling of data. As a result of this technique five units 1B, 1C, 1D, 3B, and 5A had one complete growing season between logging and burning. The remaining units were burned the fall following summer logging.

The examination sequence on south slopes is more varied than on north slopes with fewer units examined. One unit, 5A, was examined only once during the second year after burning. Two different units, 3B and 3H, were examined during the third and fourth growing season after burning. Two additional units were examined once during the fourth growing season after burning. The method used to follow trends on south slopes was to compare different areas at different years. This was admittedly not the best practice due to the variations that existed between units; but with the existing data, it was the only possible method.

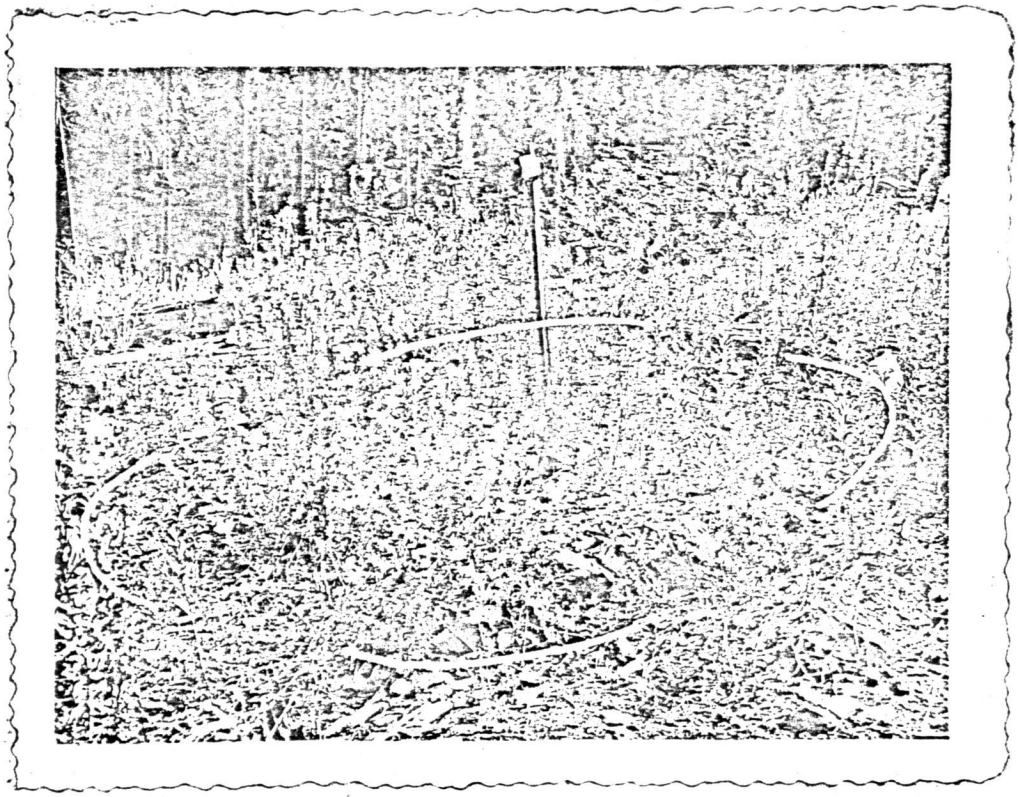


Figure 3--Plot 7, Unit 2C. Plot dominated by herbaceous vegetation with no one species dominant. Total percent cover 9 percent with 11 species present. Photo taken August 23, 1957.

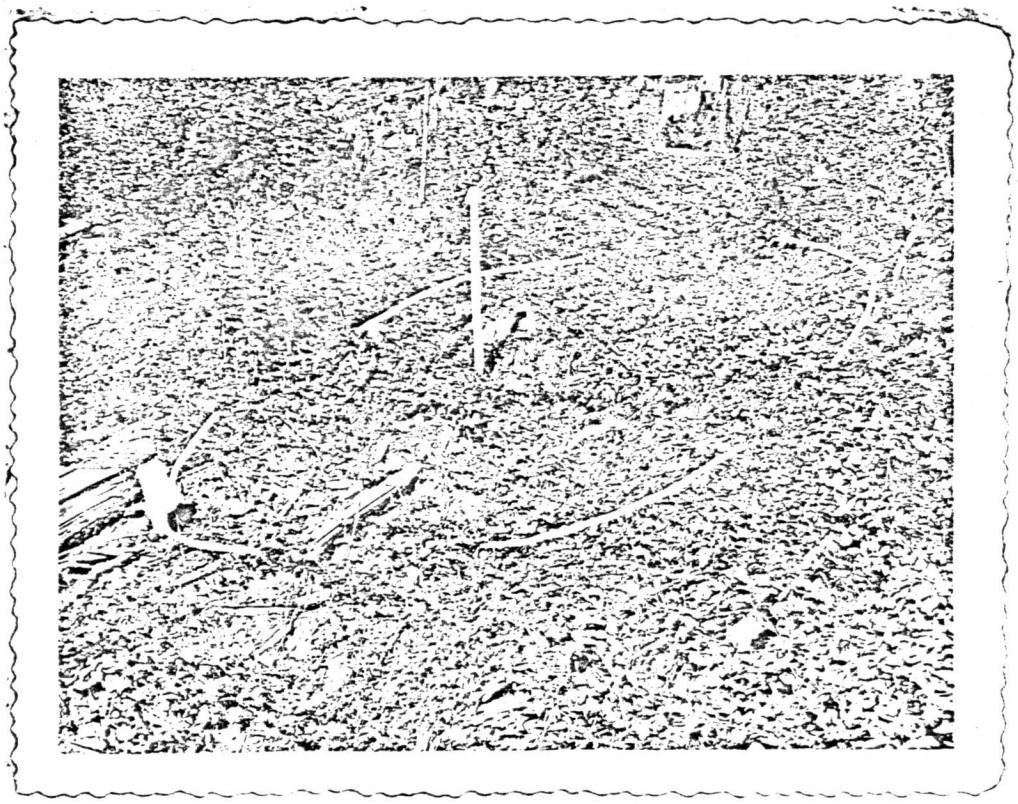


Figure 4--Plot 38, Unit 3F. Western dewberry (Rubus vitifolius) dominated plot. Total percent cover 14 percent, Rubus cover 10 percent with eight species present. Photo taken August 20, 1957.

Figure 5--Plot 38, Unit 3B. Bare plot on landing. Three species present 3 percent total cover. Willow clump next to log is only large piece of vegetation present and contributes 2 percent to the plot cover. The other 1 percent is made up of two trace occurrences.

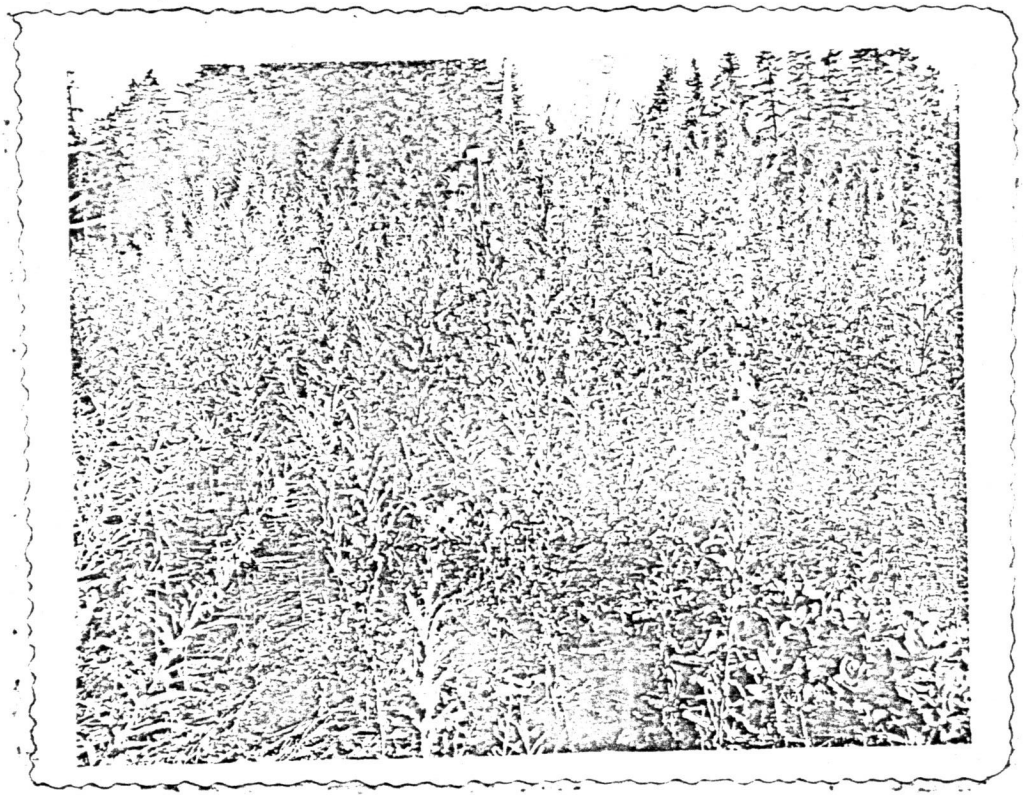


Figure 6--Plot 11, Unit 1C. Fireweed (Epilobium angustifolium) dominated plot. Center stake is 7.5 feet tall. Total cover 52 percent, fireweed 50 percent cover with six species present.

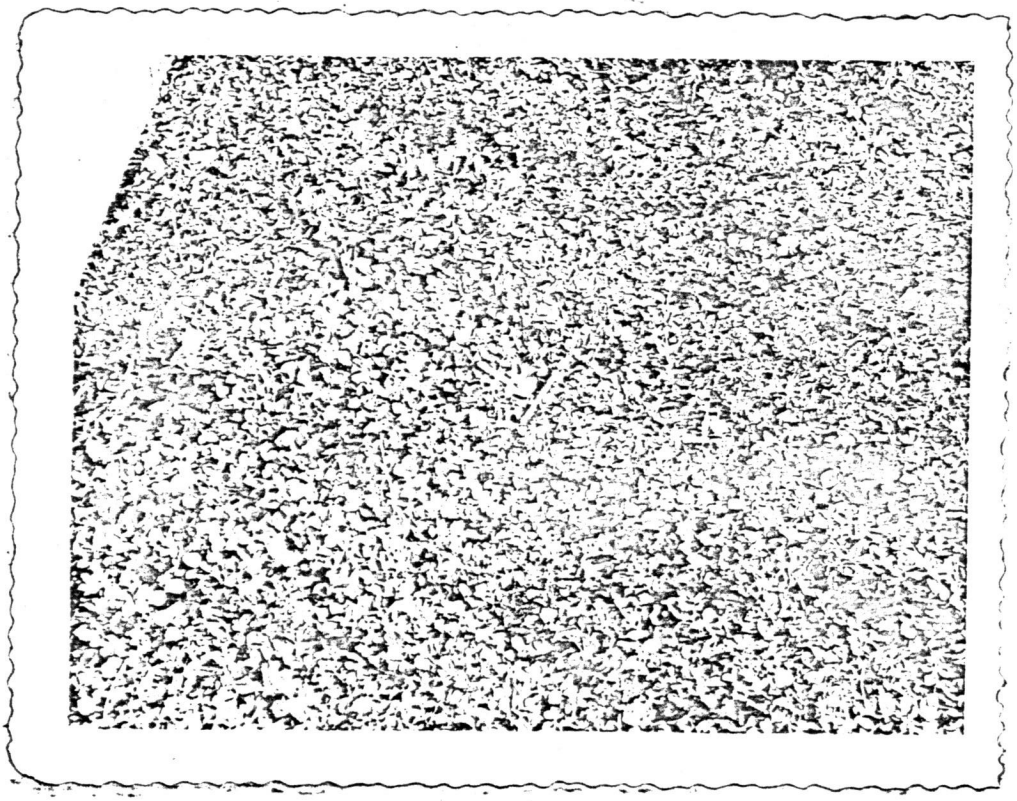


Figure 7--Dense mat of twinflower (Linnea borealis). Note pencil in center of photo. Taken from about two feet from the ground. This is the only type of cover that was considered 100 percent dense.

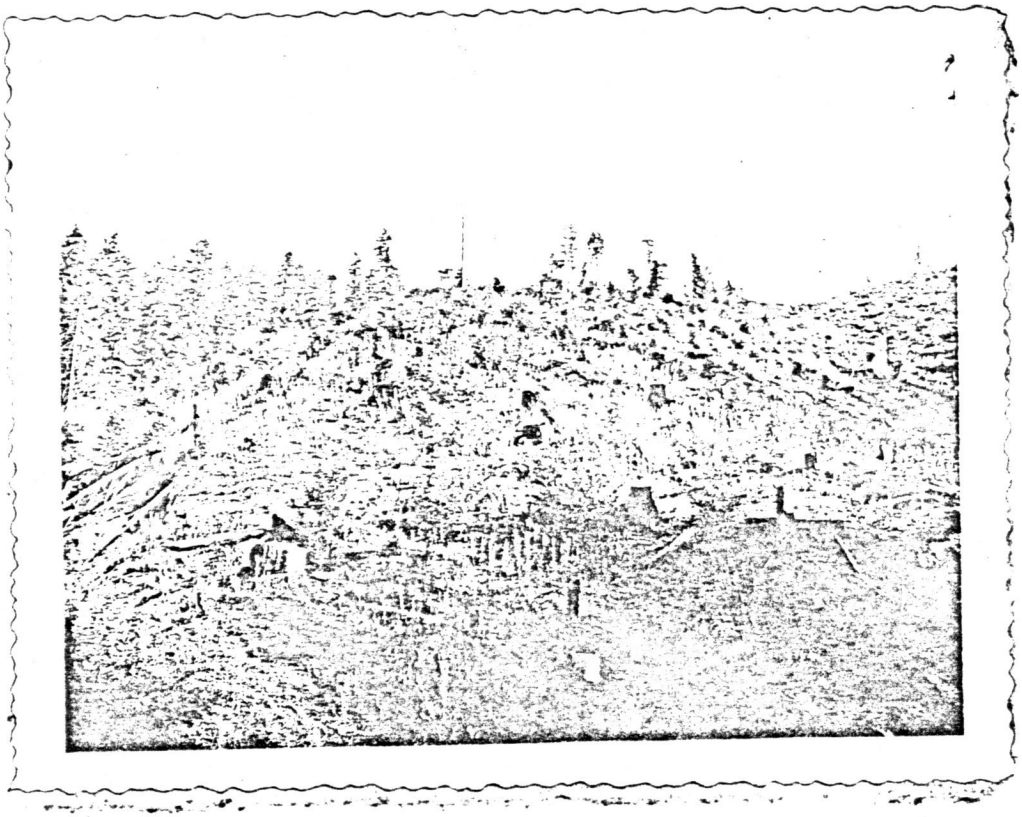


Figure 8--North aspect Unit 2A five years from burning. Photo taken August, 1957. Average percent cover for this unit, 24.7 percent.

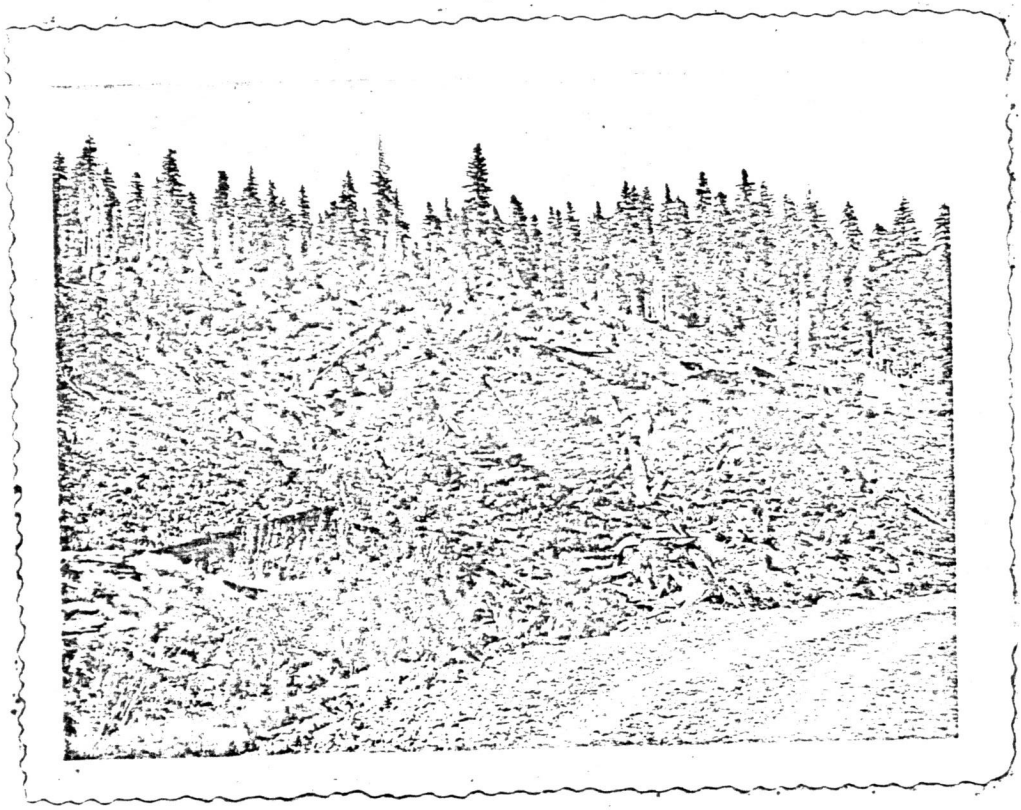


Figure 9--South aspect Unit 3F four years from burning. Photo taken August, 1957. Average percent cover 10.5 percent.

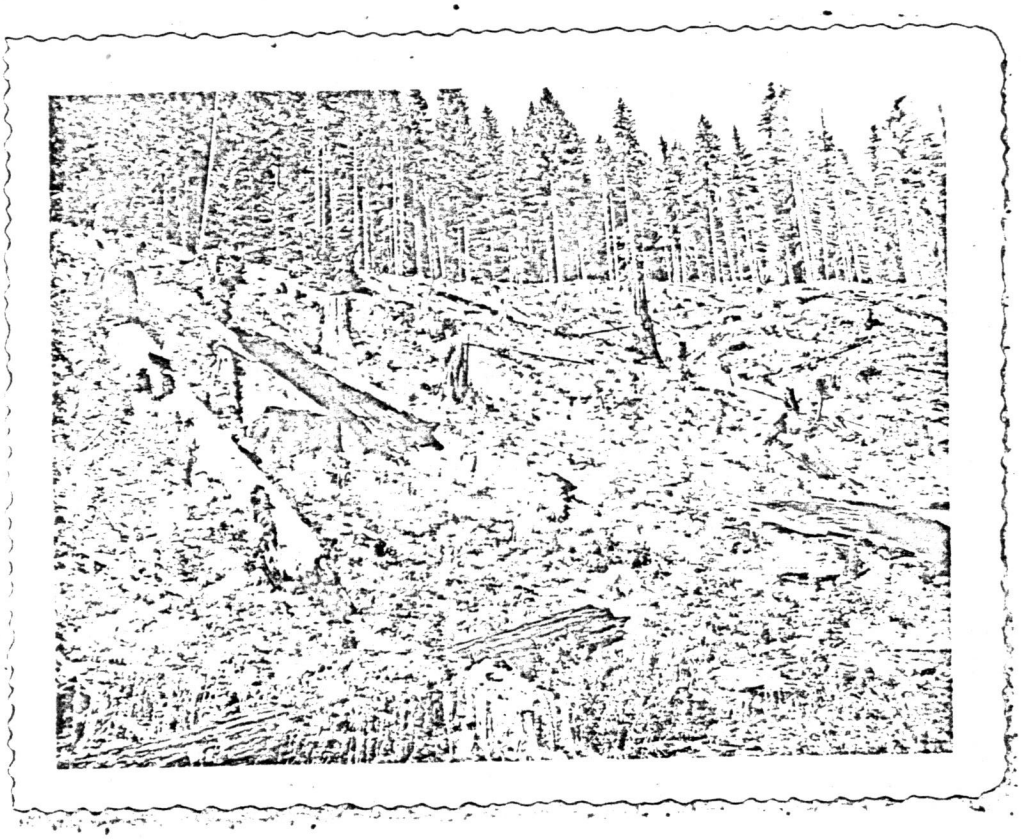


Figure 10--South aspect Unit 5A two years after burning. Dense wood groundsel (Senecio sylvaticus) cover. Photo taken August, 1957.

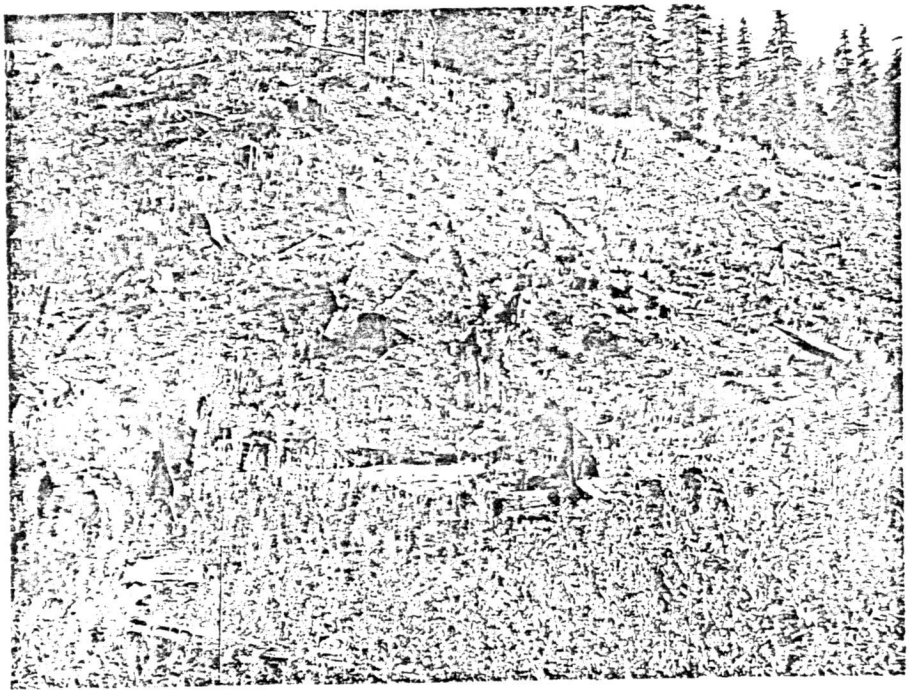


Figure 11--South aspect Unit 5A two years after burning. Photo taken August, 1957. Average percent cover for this unit 8.8 percent.

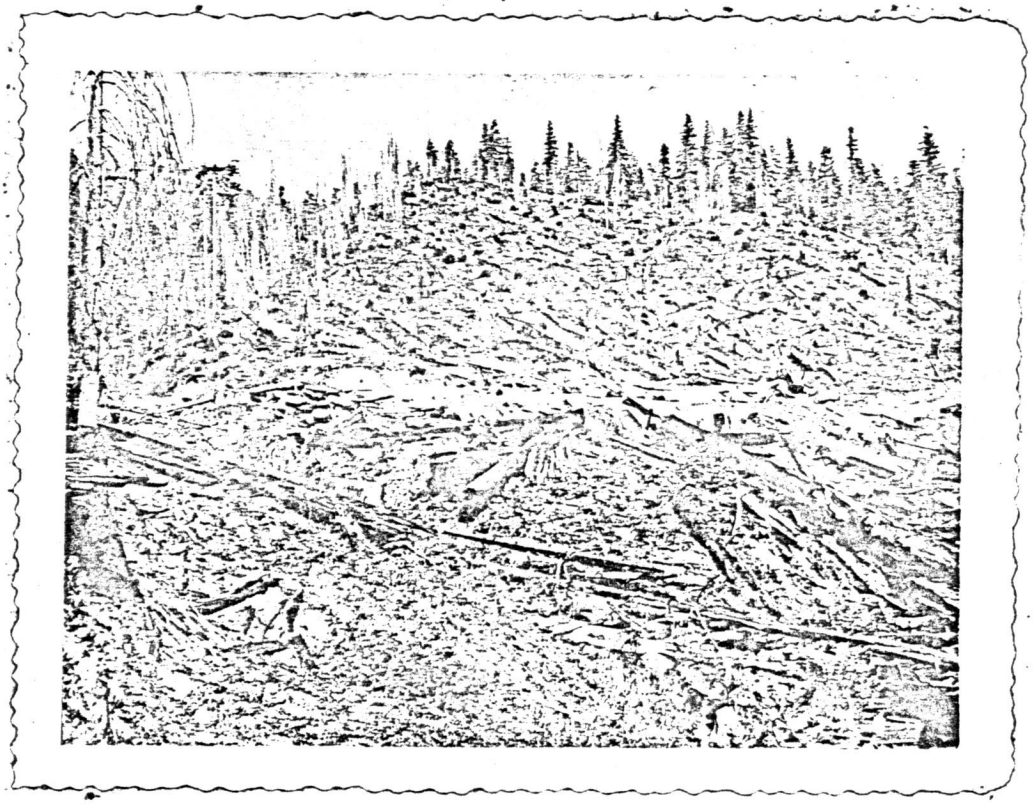


Figure 12--North aspect Unit 1B six years after burning. Note that brush species are beginning to dominate the area. Photo taken August, 1957. Average percent cover of this unit 23.5 percent.

METHOD OF ANALYSIS

Analysis of data proceeded from a master tabulation giving all species encountered with the percent occurrence and cover for each species on each unit and examination. The trends in total average percent cover for units, as well as the percent cover and the percent occurrence of each individual species, was developed from this master tabulation. Tabulation for elevations was made by grouping the clearcut units in their respective elevation classes and comparing total average percent cover and individual species percent cover and occurrence between elevation classes. Comparison of burned and unburned areas was made by selecting burned and unburned plots from the field records of each unit and with the same form of tabulation comparing total cover, species occurrence, and species percent cover as well as woody and herbaceous cover.

Analysis was accomplished by graphs indicating mean, maximums, and minimums for each growing season after burning. The weight of each point was equal to the number of units examined in each sequence in each growing season after burning (Table VI). Due to a great variation between the units sampled, and the small sample of units, an analysis of variance was not used to test the significance of expressed trends. Comparisons of trends were made within each examination sequence since these data were from repeated examinations on the same areas.

Table VI--Number of Units Included in Examination for Each Growing Season After Burning

Slope and Examination Sequence	Growing Seasons After Burning					
	1	2	3	4	5	6
North Slope						
1 - 4 - 5 sequence	4			5	4	
2 - 5 - 6 sequence		5			5	4
South Slope		1	2	4		

SPECIES PRESENT TRENDS

The total number of species present on units within each examination sequence was determined. The presence of individual species on each examination was tabulated providing a record of species which appeared and disappeared from the area (Appendix II). Trends were traced by totaling the number of species present on each examination.

TOTAL PERCENT COVER TRENDS

Total percent cover trends were followed from the master tabulation using average percent cover for each unit. The units were grouped according to their examination sequence to reduce errors. Tests of significance were not conducted due to excessive variation between units of the same examination sequence and the small sample of units. Therefore, only graphs showing the mean and extremes of total cover for each growing season after burning are presented

(Figures 15 and 16). see Pages 54 & 55.

NORTH AND SOUTH ASPECT TRENDS

Tabulation and analysis for comparison of north and south aspects was accomplished by using the previously mentioned master tabulation. Total average percent cover for units on the north and south slope by growing season from burning were found and compared by graphs (Figures 15 and 16).

INDIVIDUAL SPECIES TRENDS

Trends expressed by individual species were followed by both percent occurrence and percent cover. This was accomplished by averaging the percent cover and percent occurrences for each species on units examined in the same growing season after burning. The grouping by examination sequence used in total average percent cover was also used for individual species. Trends of selected species are expressed in tabular form with the percent cover and percent occurrence for each growing season in each sequence (Tables VII and VIII). A comparison of individual species on north and south aspects was made. However, due to the extreme variability in percent occurrence percent cover that exists for the same species between any two units and the small number of units, this comparison is only general and not conclusive.

WOODY AND HERBACEOUS PERCENT COVER TRENDS

Successional trends expressed by woody and herbaceous vegetation were also followed by graphs. Total average percent cover of woody species was calculated for each unit. Graphs were presented showing the mean, maximum, and minimum for each growing season for the examination sequences. The same treatment was applied to herbaceous data and compared with woody percent cover for differences or similarities within examination sequences. North and south slope data are both presented (Figures 16, 17, and 18).

BURNED AND UNBURNED PLOT COVER TRENDS

The successional trends expressed by total cover, woody cover, herbaceous cover, and a few selected species were followed on burned and unburned plots (Figures 20-25). Burned plots included those that were 90 percent or more burned, and unburned plots were those less than 10 percent burned. Plots from 10 to 90 percent burned were not considered.

Average percent cover trends were followed on burned and unburned plots within each unit and graphed by examination group in the same manner as was previously explained. Cover trends of herbaceous and woody vegetation on burned and unburned plots were included. This was accomplished by finding the total average cover for all woody and herbaceous species on each unit for burned and unburned plots which were then graphed in the manner previously explained. Trends of individual species on burned and unburned areas were followed by

selecting individual species with data that indicated possible differences between burned and unburned areas. The average percent cover and percent occurrence for each species on each unit on burned and unburned plots were calculated. Consistent differences were noted in the tabulated data.

RESULTS AND DISCUSSION

Results of a six-year study of vegetation on clearcut and burned area of old-growth Douglas-fir stands indicate an increase in the number of species present for the first four or five years (Figures 13 and 14). Accompanying this increase in number of species was a steady decrease in total percent of vegetative cover (Figures 15 and 16). The amount of woody species cover increased slowly while herbaceous vegetation decreased steadily (Figures 17, 18, and 19). Variations in trends as a result of burning or elevation differences were not noted. North slopes had more cover and species present than the south slope (Figures 13 and 14; 15 and 16). Trends of average percent cover on south slopes were level or increasing slightly (Figure 16). One or two individual species provide the major portions of cover of woody, herbaceous, annual, and perennial vegetation (Tables 7 and 8).

SPECIES PRESENT TRENDS

The general trend expressed by the total number of species present is generally upward until the fourth or fifth year, then leveling off or dropping slightly (Figures 13 and 14). Although the trend is upward for the first few years, some plants disappear. The species missing after the first two to three years were mostly annuals and unidentified species. These were replaced by both woody and herbaceous perennials. All but one of the species which were not found again after the first examination were annuals or unidentified species. Species which disappeared after the first and second growing season

after burning were not important in percent occurrence or percent cover. Species which disappeared after the later examinations include a mixture of annual and perennial herbs and unidentified species. Here again the species lost contributed only a small amount of cover and had few occurrences. For purposes of total cover determination, unidentified species were classed by their general appearance unless growth characteristics were not known. In this instance, they were classes as herbaceous annuals.

A general trend from annual to perennial species is expressed, but only two annual species were important the first two years. Examinations in the fourth, fifth, and sixth growing seasons after burning found five annuals, all of little importance in their contribution to total cover, but still present on the area in fairly high numbers. This would indicate that three to four years after burning, the annual vegetation is of little consequence in ground cover with perennials, both herbaceous and woody, dominating.

There were 107 species encountered in the study (Appendix I). They were identified as they appeared on each examination, except when lack of identifiable characteristics made this impossible. As a result, 17 plants were not identified; and four groups were considered as individual species. Those groups considered as individual species were mosses, liverworts, ferns (other than bracken fern and sword fern), and grasses. Four groups of plants were classed by family names, and 16 plants were identified by generic name.

All but two of the species present were on the north slope (Appendix II). There were 12 species of annuals occurring on the north slope with five remaining at the last examination. Thirty-one woody species appeared on the north slope with only one disappearing completely during the study. Sixty-five species were found on the south slope. Two of these were present only on south slope units with 63 occurring on both slopes. Five were annuals with four of these annuals remaining through the fourth growing season after burning. Twenty-three brush species present on the north slope were also found on the south slope.

Fireweed (Epilobium angustifolium) was the only species found on all units on every examination. There were, however, 20 species which were represented on at least one unit in each growing season. Of these 20, five were woody species surviving from the stand, and seven were invading herbaceous species. Two annuals were included in the invading herbaceous group.

TOTAL PERCENT COVER TRENDS

The average total percent cover trends is downward from the first year after burning. Both examination sequences on the north slope produced the same general trend, while south slope total cover was much lower and tended to maintain a constant level (Figures 15 and 16). South slope data were based on only five units, so this trend is not conclusive. This continued downward trend of total percent cover on the north slope is a result of a sharp decrease in annual species cover after the first and second years and a general

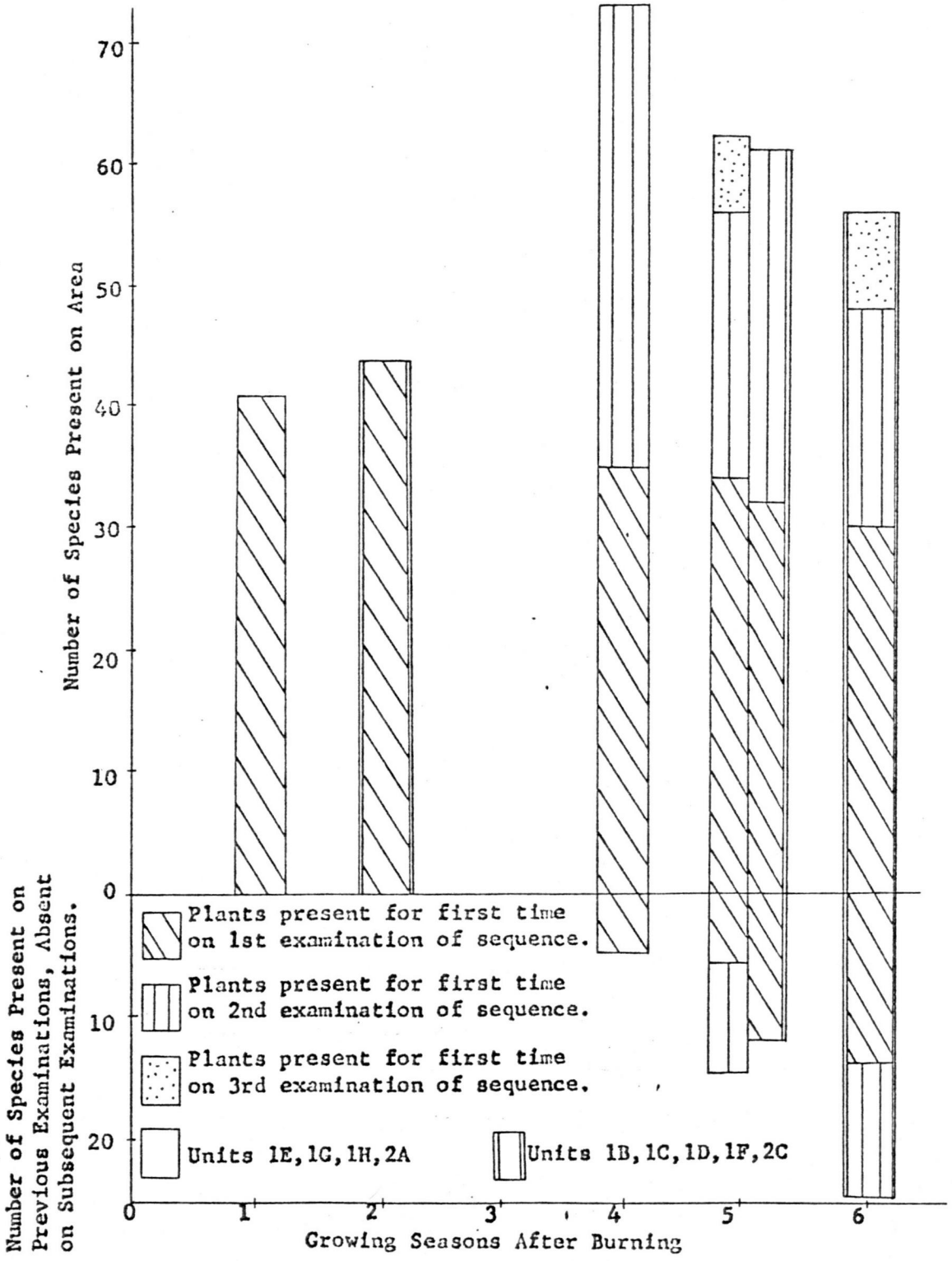


Figure 13--Number of Species on North Slopes by Examination Sequence and Year After Burning

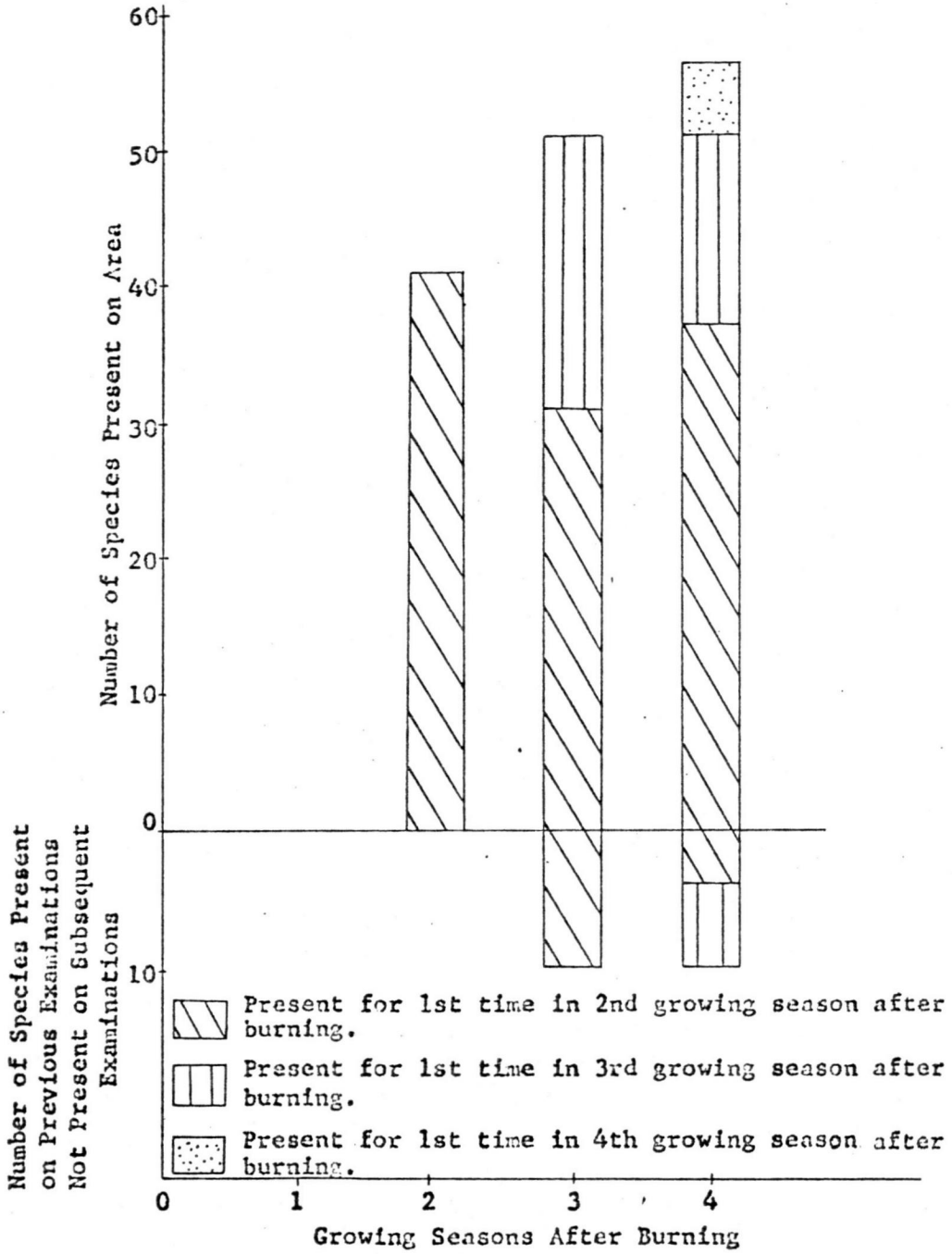


Figure 14--Number of Species on South Slopes by Growing Seasons After Burning

decline in herbaceous perennial vegetation in succeeding years (Figure 17). The sharp drop in annual cover is what would be expected, but the general decline in perennial herbaceous vegetation is more difficult to resolve. The decline in cover is probably a result of a transition from short-lived to long-lived perennials. The low amount of ground cover present during the fifth and sixth growing seasons after burning could be a result of a short period of time lapse when short-lived perennials are on the decline and long-lived perennials are not present in great enough quantity to keep total cover high.

Another plausible reason for the decline is examination error. On any study with a duration of several years, and several examiners using ocular estimation of cover, the personal interpretation of examiners will, of necessity, be evident in the data. In this study, however, each examiner was trained by his predecessor and the mechanical device of the square-foot piece of cardboard used to aid cover estimation would have reduced any differences. Another fact discounting difference in examiners is the general upward trend expressed by woody species (Figure 18). The general slow rise exhibited by these species is what one would normally expect and any great differences between examiners would be evident here.

The variation in total cover between clearcuts reduces considerably with time. The same converging of the maximum and minimum lines is evident on all graphs presented (Figures 15-25). This is the normal progression of secondary succession in the movement toward a homogeneous climax vegetative cover. This reduction in the

heterogeneity of the plant communities may allow more refined analysis methods on examinations after the sixth growing season after burning.

There was little correlation evident between total average cover and known weather conditions on the area, nor was there evidence of differences in cover to time of year examined. The majority of examinations in each year were completed by late August with late July and August the most frequent examination period (Table II). Summer moisture records on the area indicate July and August as the two driest months of the summer (Table IV). Due to this lack of moisture in July and August, examinations in September would undoubtedly have a lower percent cover indicated. Examinations on all but two units in 1953 were made between July 22 and October 1. This was after a June in which no precipitation was recorded. Still this year indicated the highest cover. One possible explanation of the low percent cover encountered in 1957 was the extremely dry summer of 1956. The effect of this dry summer could possibly remain for the following year through reduced vigor and seed production. This is somewhat discounted, however, by the expressed trends being steadily downward with no great variation evident.

The immediate influx of vegetation noted in this study is not surprising. Clearcut units cut prior to this study are within 1½ miles of the study area. This distance is not great for windblown species. High amounts of cover from heavy seeded species could result from those growing under the forest stand and not completely destroyed. Only one of the units had more than 75 percent of its area burned. The amount of burning ranged from 23 percent to 88

percent. This would allow a greater seed source for these species than would be expected had the area been entirely burned. Another possible source of heavy seeded species is those that have seed present in the duff and litter of the forest floor. The woody cover the first few years is almost entirely from species from under the canopy. The actual amount of cover from these surviving species that resulted from surviving plant parts or from duff-stored seed is not known. Only by establishing and examining plots prior to clearcutting could this be determined.

NORTH AND SOUTH ASPECT TRENDS

Only a general comparison can be made between north and south slopes total average cover. As would be expected, the total woody and herbaceous cover on south aspects is less than that on north slopes (Figures 15 and 19). The general trends of south slope total cover are level or possibly upward. Here the annuals are not an important part of the vegetation after the third growing season from burning. As was previously noted, there are fewer species present on the south aspects; and as would be expected, the individual species do not provide as much cover on south slopes. The south slopes are much drier and the species which require more xeric conditions are more prominent in south slope cover.

WOODY AND HERBACEOUS COVER TRENDS

Woody species total cover increased slightly while herbaceous vegetation followed a downward trend. Herbaceous vegetation, although

dominated mostly by one or two species, constituted the bulk of the total cover for the first four or five growing seasons. This resulted in the total percent cover trend following the herbaceous cover trends. In the fifth and sixth year, however, woody species were beginning to dominate. After the sixth growing season after burning, total percent cover will probably follow the trends expressed by woody species cover (Figure 17 and 18).

Thirty-two species were included as woody vegetation. Any species which had unknown growth habits and which were not definitely called woody by the authority followed (29) were considered herbaceous. Those species that had not been identified positively were classed according to their growth form.

During the first growing season, herbaceous species cover constituted about 75 percent of total cover, with woody plants providing 25 percent. By the last growing season, woody species constituted approximately 65 percent of the total cover. The change from herbaceous to woody species domination was a result of a general rise in woody species cover with a general drop in total and herbaceous cover.

On the north slope woody species from under the forest canopy that survived the clearcutting and slash burning dominated the woody vegetation on the area. They provided 91 percent of the total woody cover the first growing season, 76 percent the fourth growing season, and nearly 85 percent of woody cover the sixth growing season. The major herbaceous cover was made up of fireweed and wood groundsel the first two years with fireweed dominating thereafter. These two

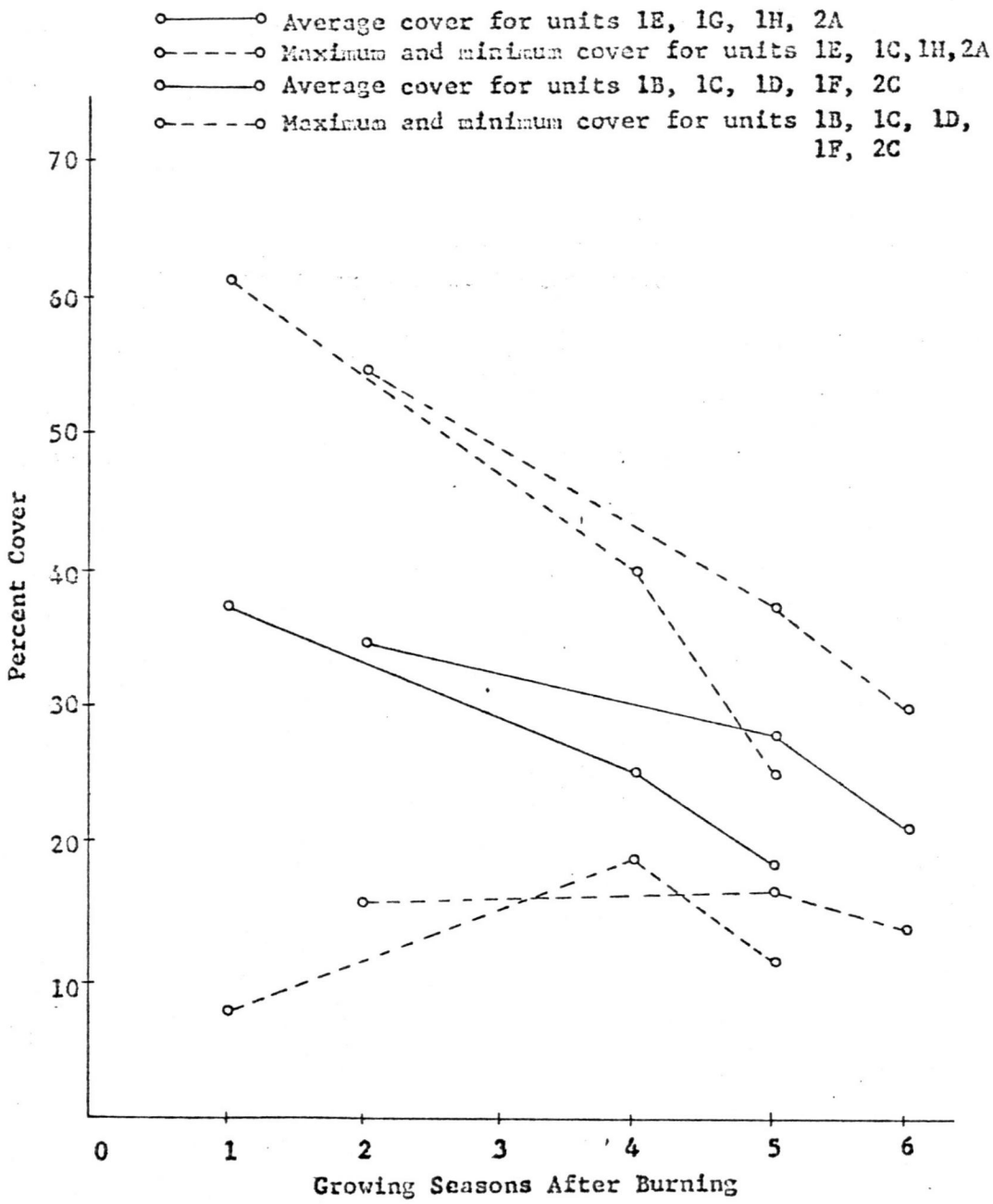


Figure 15--North Slope Percent Cover Trends by Examination Sequence and Growing Season After Burning

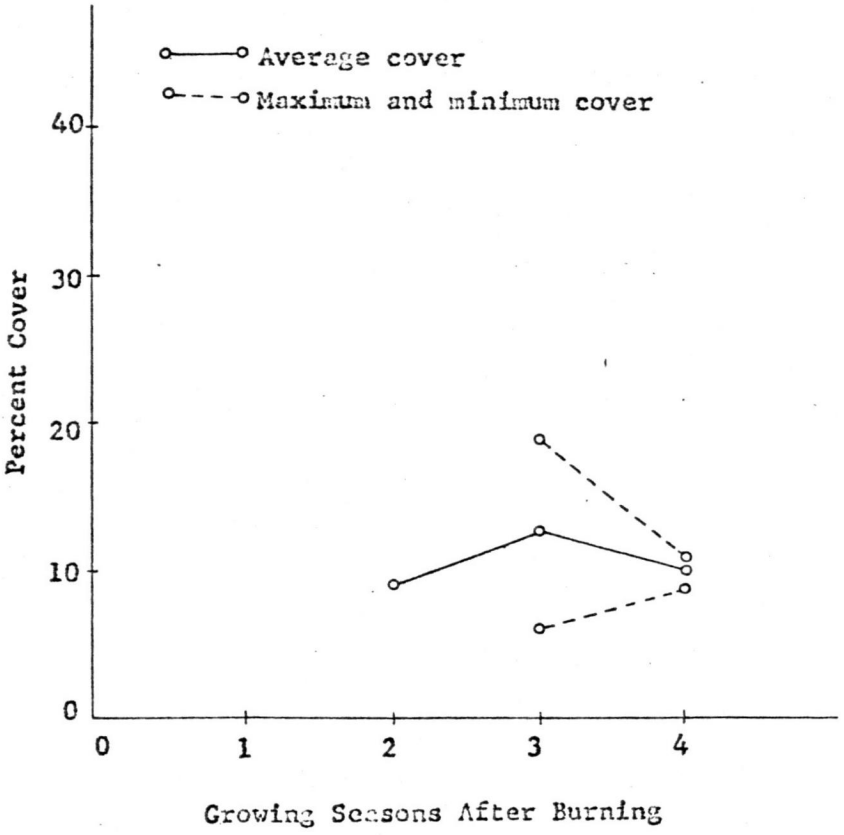


Figure 16--South Slope Percent Cover Trends by Growing Season After Burning

species constituted 89 percent of herbaceous vegetation the first year. The fourth year from burning the same two species contributed 66 percent of total herbaceous cover and the sixth year fireweed alone contributed 74 percent of total herbaceous cover. Major species in each group constitutes over 60 percent of the total cover for that group. Western dewberry and twinflower contribute over 75 percent of all woody vegetation for each growing season after burning. Wood groundsel, fireweed, and willow-herbs (Epilobium annuals) contribute 66 percent to 89 percent of total herbaceous cover.

BURNED AND UNBURNED AREAS COVER TRENDS

There is no apparent difference between burned and unburned plots, either in total cover, woody, or herbaceous cover (Figures 20-25). Wood groundsel and willow-herb had higher percent cover on burned areas causing slightly higher herbaceous vegetation on burned plots. This difference disappeared after the second growing season when these species became nearly equally distributed on burned and unburned plots. These were the only two species that expressed a consistent difference as a result of burning.

Burning in the study area was confined to slash fires which burned from 23 to 80 percent of the area in individual clearcuts. As a result of this, neither area was isolated from the seed source of the other. If a possible difference was expressed during the first two or three years, it would certainly be reduced in a very short time.

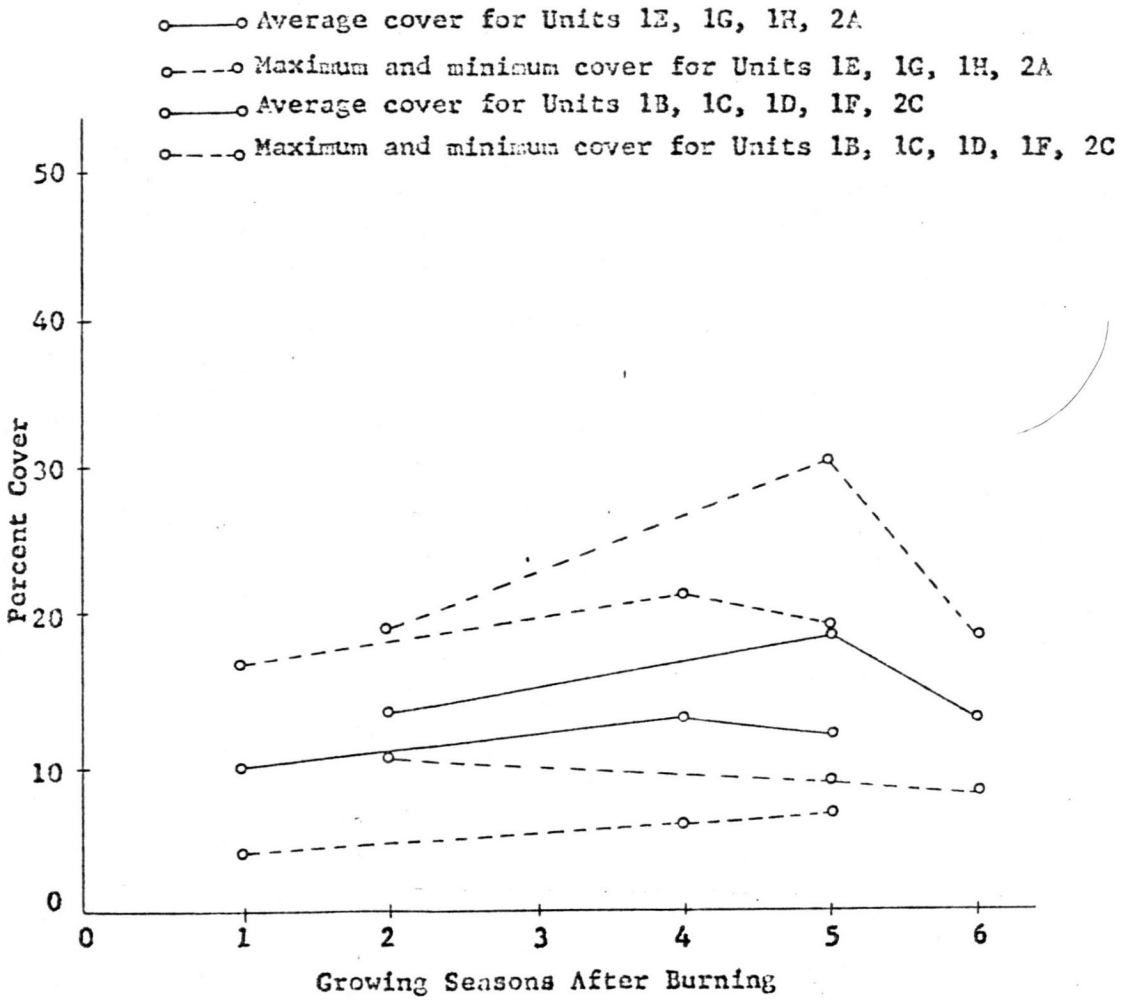


Figure 17--North Slope Woody Cover Trends by Examination Sequence and Growing Season After Burning

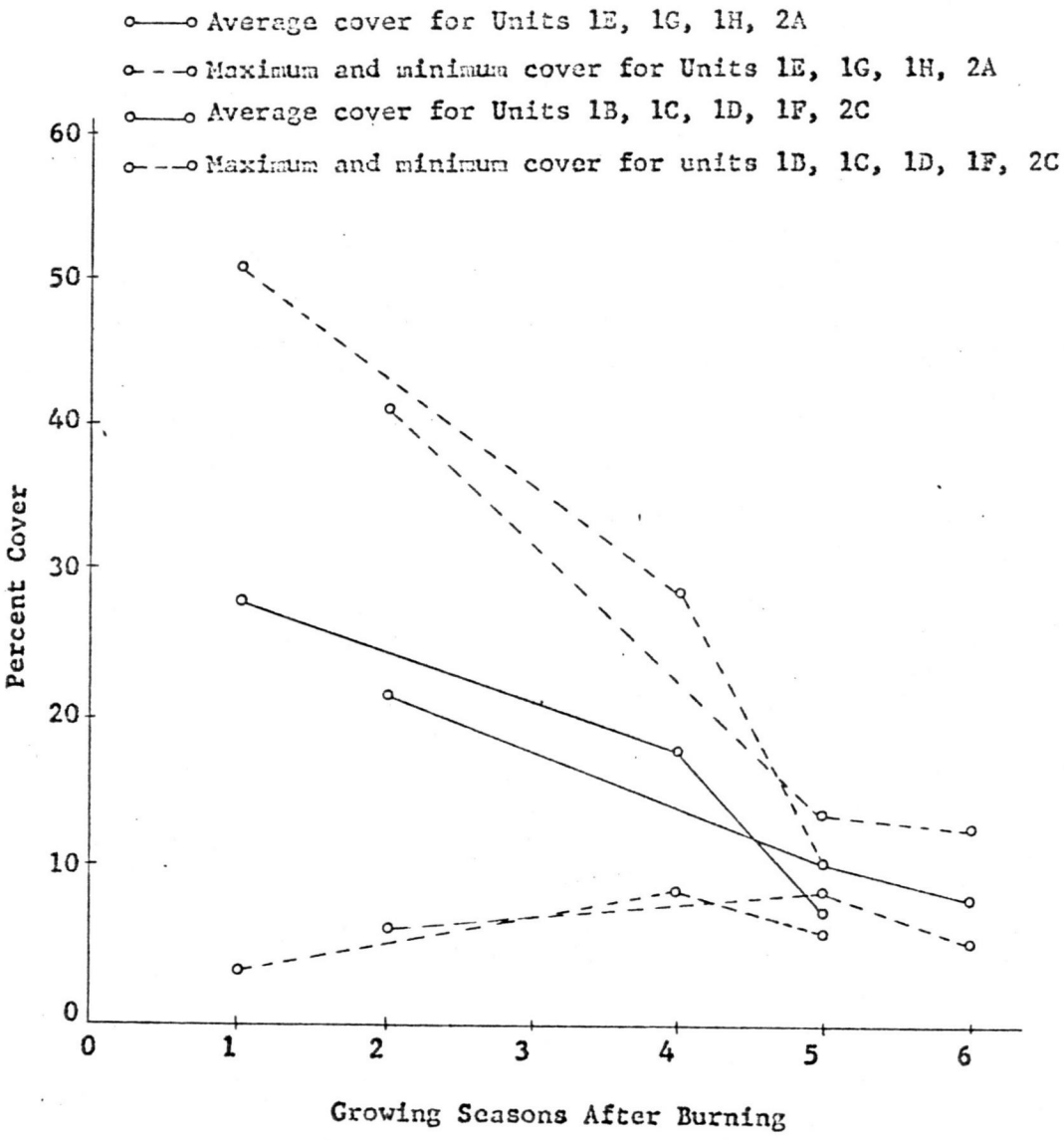


Figure 18--North Slope Herbaceous Cover Trends by Examination Sequence and Growing Season After Burning

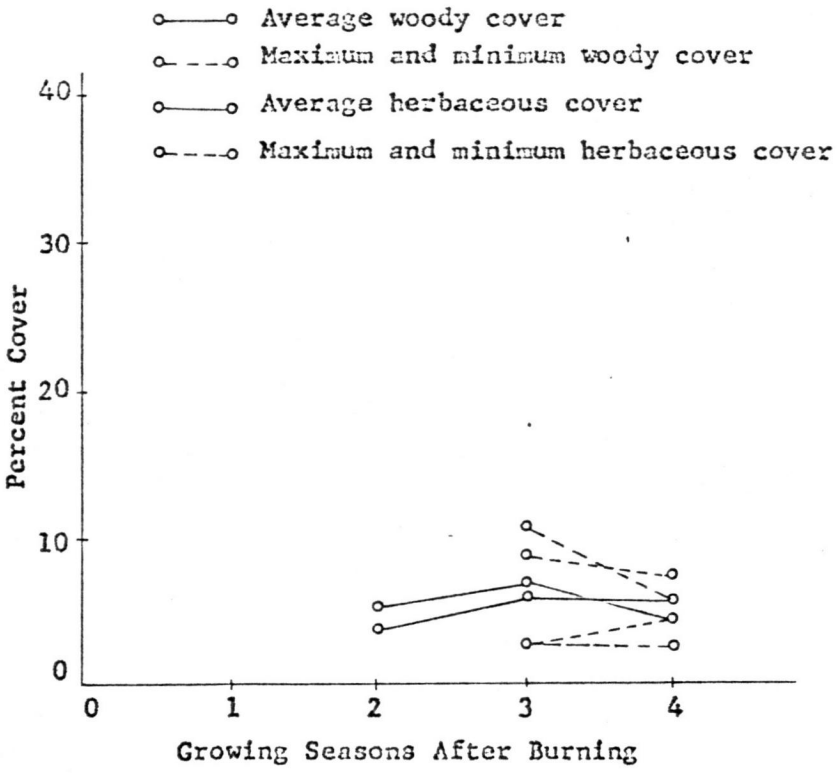


Figure 19--South Slope Woody and Herbaceous Cover Trends by Growing Season After Burning

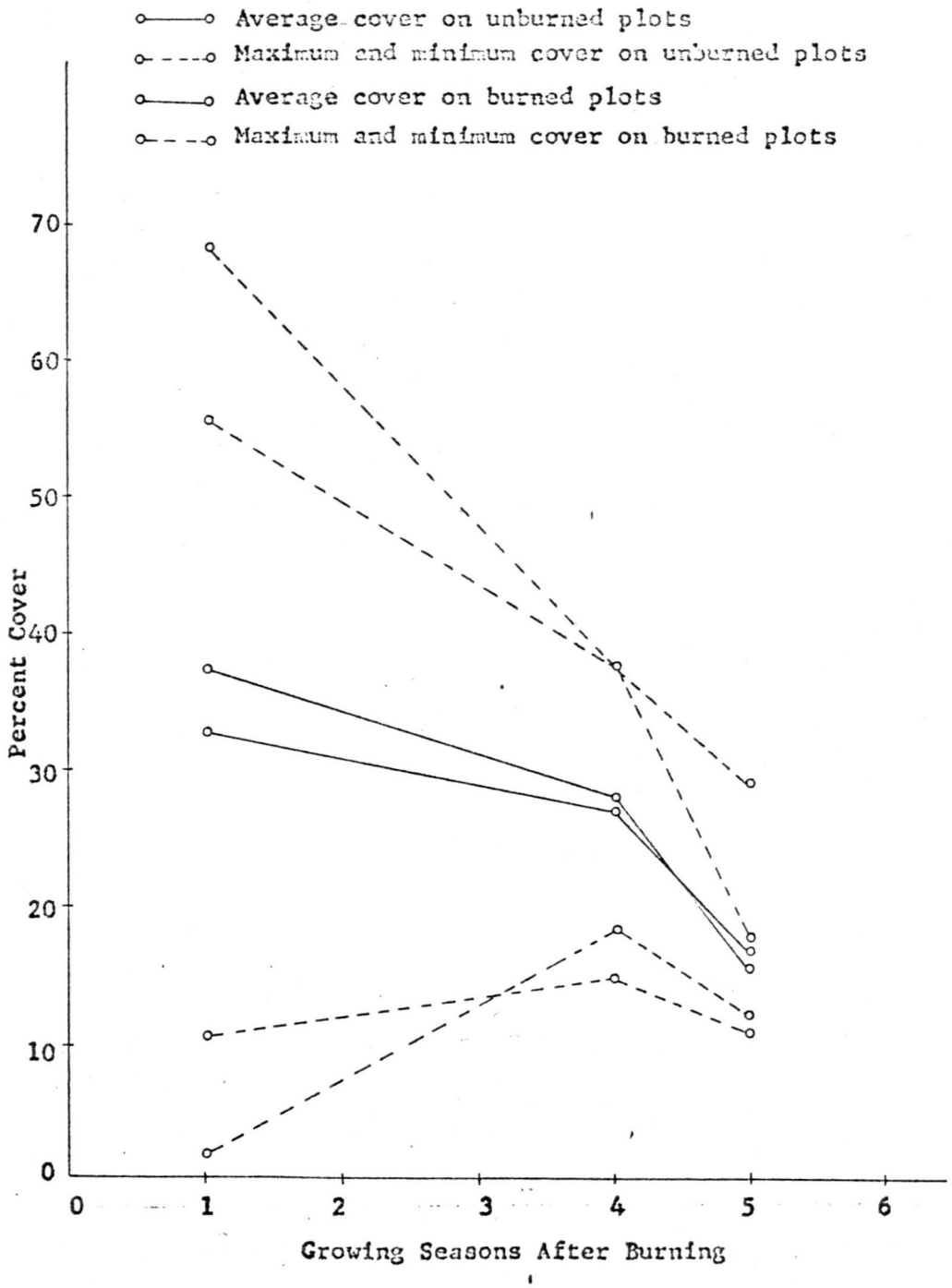


Figure 20--Cover Trends on Burned and Unburned Plots on Units 1E, 1G, 1H, and 2A

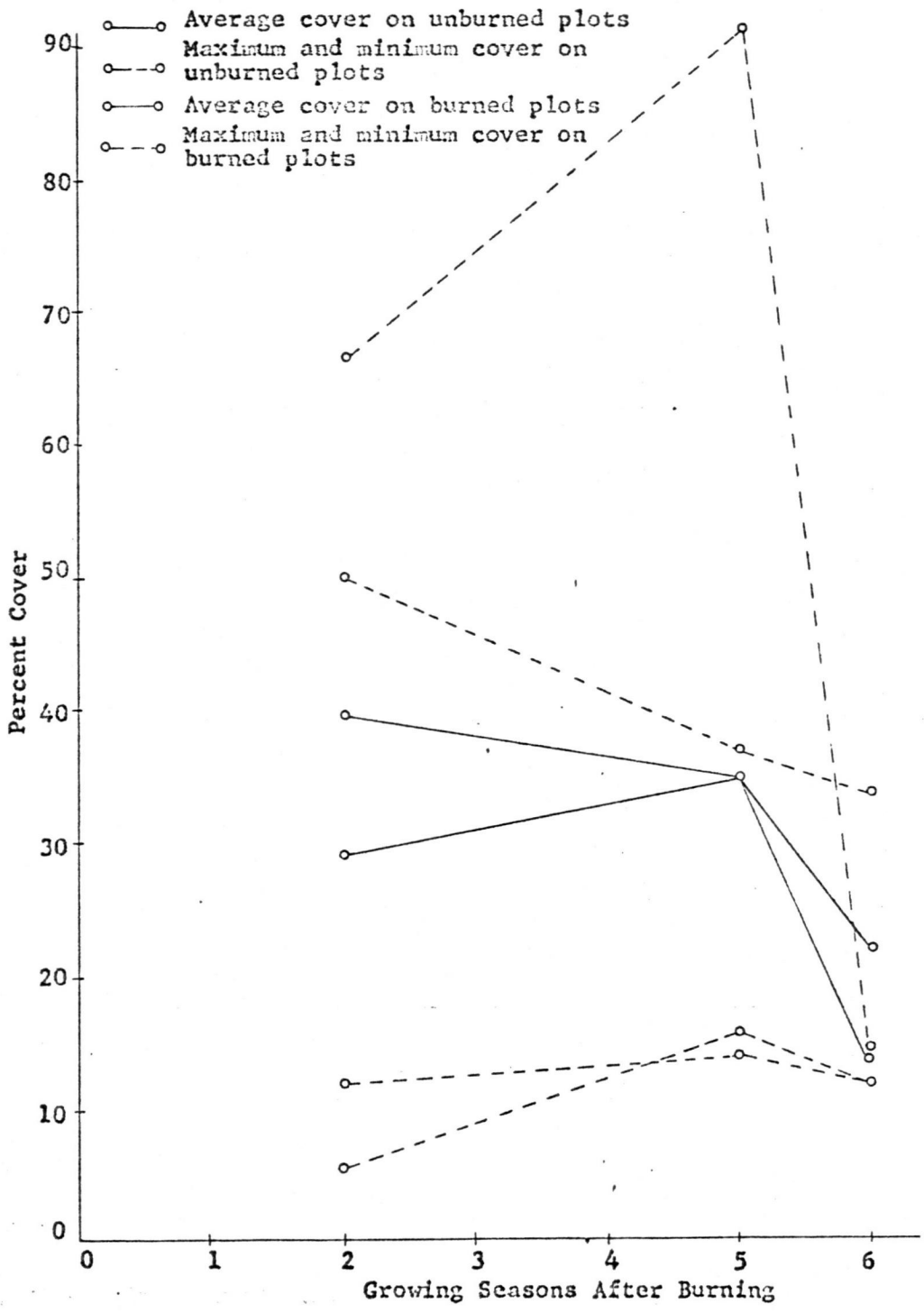


Figure 21--Cover Trends on Burned and Unburned Plots for Units 1B, 1C, 1D, 1F, 2C

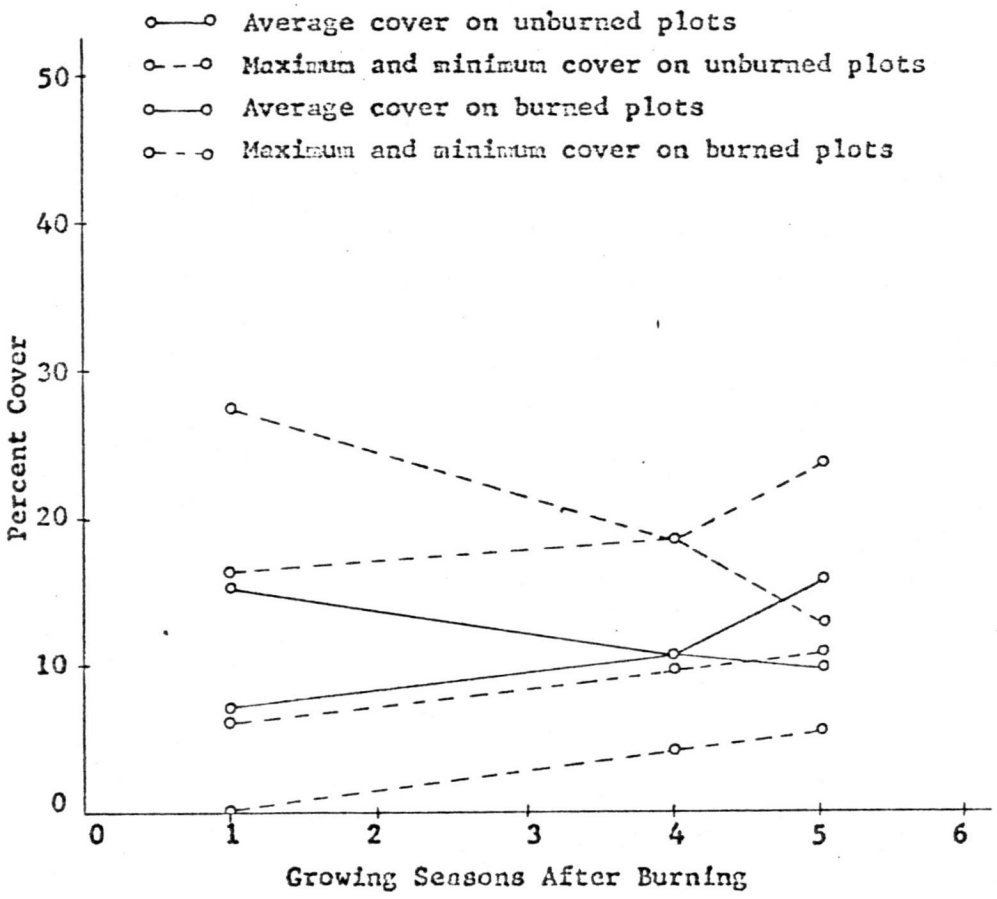


Figure 22--Woody Cover Trends on Burned and Unburned Plots on Units 1E, 1G, 1H, 2A

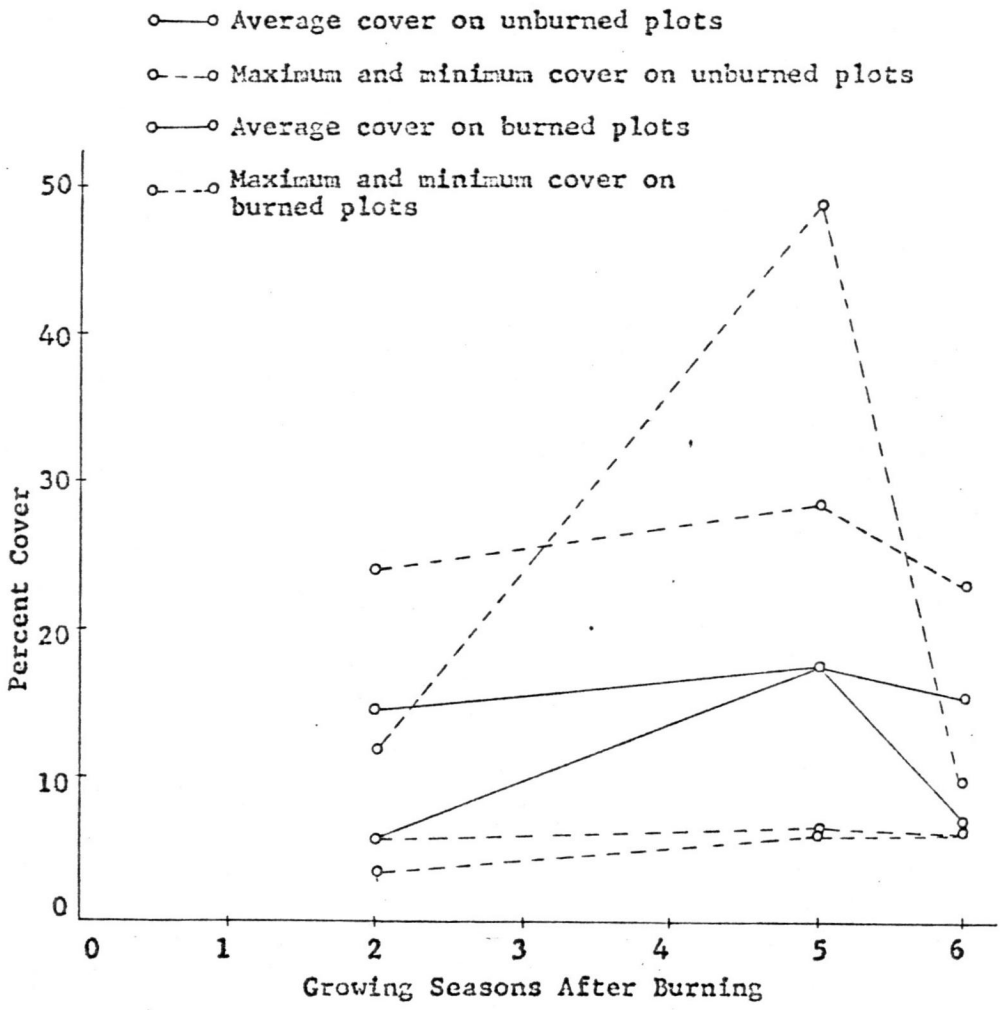


Figure 23--Woody Cover Trends on Burned and Unburned Plots on Units 1B, 1C, 1D, 1F, and 2C

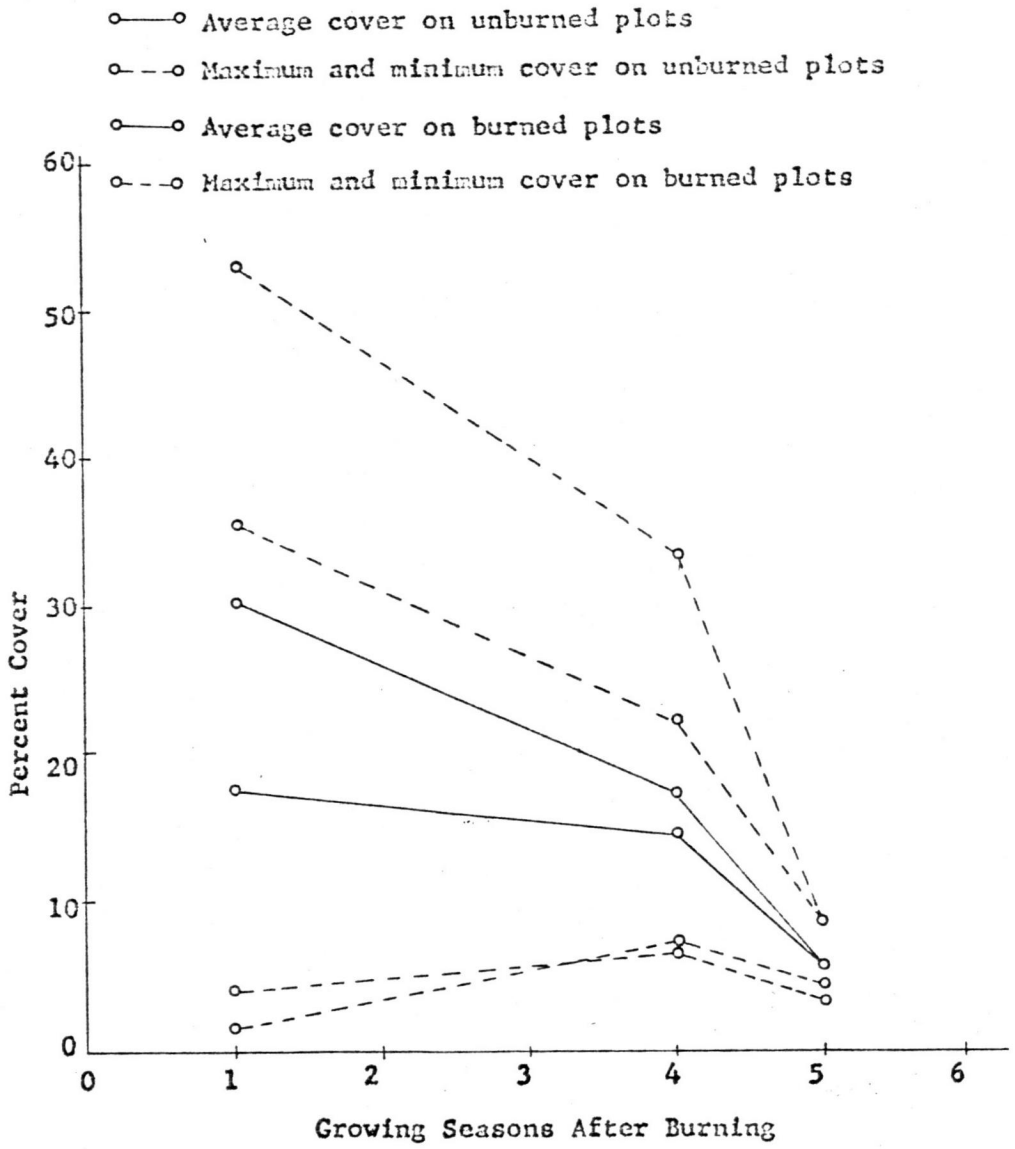


Figure 24--Herbaceous Cover Trends on Burned and Unburned Plots on Units 1E, 1G, 1H, 2A

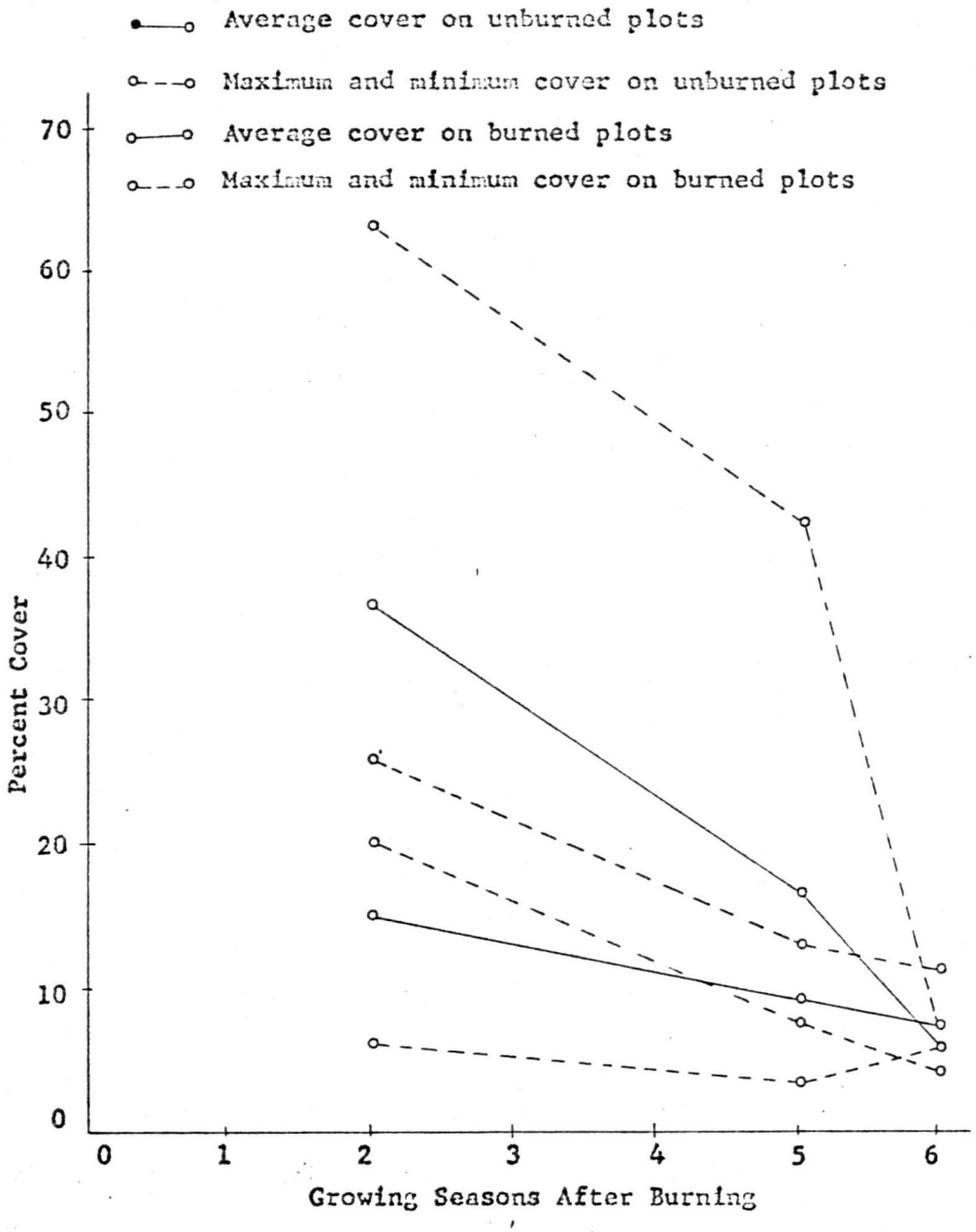


Figure 25--Herbaceous Cover Trends on Burned and Unburned Plots on Units 1B, 1C, 1D, 1F, 2C

South slope data for burned and unburned plots were based on only two units. Therefore, comparisons are not made here.

COVER TRENDS BY ELEVATION

There was no consistent difference between the amount and type of cover on study units at different elevations. There was also no consistent difference in either species present or their individual trends. This was probably due to the short range in elevation included in the study. All of the units except one were between 1,850 feet and 2,800 feet. The highest unit was at an elevation of 3,700 feet. One unit was not enough to provide positive results, so this unit was of little actual value for comparing differences due to elevation. If more units were present in the higher and lower elevation classes, some differences may be indicated in species present and the amount of cover.

INDIVIDUAL SPECIES TRENDS

Species contributing the majority of cover to woody, herbaceous, annual, and perennial classes were followed (Tables VII and VIII). In each class of vegetation, one or two species contributed at least one-half of the cover provided by the class.

Ten woody species survived the clearcutting and burning, but this group was dominated by western dewberry and twinflower on the north slope and western dewberry and whipple-vine (Whipplea modesta) on the south slope. Salal (Gaultheria shallon) and long-leaved Oregon grape (Berberis nervosa) were less important in the cover than whipple-vine

and vine maple (Acer circinatum). Species in this woody group were somewhat varied in their individual trends. Cover of western dewberry decreased steadily while percent occurrence was erratic. Twinflower and vine maple increased steadily both in percent cover and percent occurrence. The remaining species were somewhat more erratic in expressed cover trends. Oregon grape and salal indicated a general trend upward in both percent cover and occurrence with a fairly high occurrence.

On the south slope whipple-vine replaced twinflower in dominance along with western dewberry, but the same results were indicated in the percent of total woody cover provided by the dominants on the north slope species. Fireweed provided a smaller portion of total herbaceous cover on south slopes. Invading woody species were not so definite in expressed trends, either in amount of cover or occurrence. The percent cover and percent occurrence of the individual species were erratic but on a general increase.

Herbaceous vegetation was dominated by two species. During the first two years fireweed and wood groundsel provided nearly 70 percent of all herbaceous cover. During the fourth, fifth, and sixth years willow-herb replaced wood groundsel, and with fireweed, dominated herbaceous cover. Wood groundsel dropped rapidly in cover after the first two years but was slow to decline in percent occurrence. After six growing seasons, it was present on 15 percent of the plots examined but provided an extremely small amount of cover. Willow-herb began generally lower in the amount of cover provided but did not drop as rapidly in cover or occurrence. The percent cover trend expressed

by fireweed was steadily downward. Its average percent occurrence, however, remained over 93 percent after the first growing season from burning. Fireweed was the only species encountered in the study which was present on every examination of all units. In every growing season after burning, except one, it provided over 50 percent of all herbaceous cover.

The trends of other herbaceous vegetation were extremely variable. Many species such as star flower (Trientalis latifolia) and hawkweed (Hieracium albertinum) contributed extremely small quantities of cover, but had a high percent of occurrence. These species were present on nearly 50 percent of the plots examined during the fifth and sixth growing season after burning. Herbaceous species surviving from the forest stands were of little importance in either percent cover or occurrence.

The trends expressed by the major species in each class of vegetation determined the trends of the group as a whole. The minor species in each class, however, either followed the same trend or were erratic. Seldom did they follow trends opposite of the class as a whole. Thistle (Cirsium spp.) indicated a general trend upward in percent occurrence but expressed no definite trend in percent cover and was considered erratic.

Table VII

Important Species Average Percent Cover and Average Percent Occurrence by Examination Sequence and Growing Seasons After Burning

North Slope

Woody Species	Average Percent Cover						Average Percent Occurrences					
	Units 1E,1G,1H,2A			Units 1B,1C,1D,1F,2C			Units 1E,1G,1H,2A			Units 1B,1C,1D,1F,2C		
	Growing Seasons After Burning											
	1	4	5	2	5	6	1	4	5	2	5	6
Survivors of Understory												
Acer circinatum	0.7	0.7	1.6	1.4	1.5	1.5	16.4	21.8	20.6	13.0	23.8	25.6
Berberis nervosa	0.5	0.4	0.2	0.3	0.5	0.3	32.8	44.2	42.5	18.5	49.5	49.4
Gaultheria shallon	0.1	0.1	0.1	0.5	0.7	0.3	3.3	12.9	10.6	9.0	21.2	24.4
Rhododendron spp.	0.4	0.3	0.1	1.0	0.7	0.7	6.2	9.4	9.4	12.5	18.2	16.9
Rubus vitifolius	5.2	5.6	3.1	6.5	4.2	2.5	47.4	71.3	52.5	47.0	81.3	78.1
Linnaea borealis	0.9	1.5	1.8	1.5	5.5	5.0	9.5	19.1	27.5	8.5	24.3	27.5
Whipplea modesta	0.2	0.9	1.5	0.0	1.8	0.7	8.2	24.0	27.5	0.0	23.7	31.2
Others	0.6	0.0	0.8	0.0	0.0	0.0						
Total	8.6	9.5	9.2	11.2	14.9	11.0						
Invaders												
Sambucus spp.	0.3	0.8	0.4	0.2	0.6	0.2	8.8	24.1	13.8	6.5	13.0	5.0
Rubus parviflorus	0.1	0.5	0.3	0.2	0.2	0.1	15.2	32.1	36.2	3.5	13.6	14.4
Salix spp.	0.1	0.4	0.8	0.9	0.8	0.1	8.8	22.1	16.9	8.5	9.6	11.2
Others	0.0	1.3	2.3	0.4	0.9	1.7						
Total	0.5	3.0	~~0.5~~ 3.8	1.7	2.5	2.1						
Woody Total	9.1	12.5	~~11.5~~ 13.0	12.9	17.7	13.1						

Continued

Table VII
Continued

North Slope

Herbaceous Species	Average Percent Cover						Average Percent Occurrences					
	Units 1E, 1G, 1H, 2A			Units 1B, 1C, 1D, 1F, 2C			Units 1E, 1G, 1H, 2A			Units 1B, 1C, 1D, 1F, 2C		
	Growing Seasons After Burning						Growing Seasons After Burning					
	1	4	5	2	5	6	1	4	5	2	5	6
Survivors of Understory												
All species	1.8	1.3	0.7	0.3	0.9	0.8						
Invaders												
Annuals												
Senecio sylvaticus	12.0	0.3	0.0	4.4	0.1	0.0	54.2	13.2	5.6	18.5	13.7	15.2
Epilobium spp.	0.1	0.4	0.2	5.9	0.1	0.6	5.0	47.7	38.1	33.0	21.7	24.4
Others	0.9	0.2	0.0	0.1	0.2	0.0						
Total	13.0	0.9	0.2	10.7	0.4	0.6						
Perennials												
Epilobium angustifolium	11.9	11.2	3.7	9.7	7.1	4.7	73.8	95.7	94.5	56.0	94.9	93.1
Anaphalis margaritaceae	0.0	0.2	0.1	0.1	0.1	0.1	1.2	24.2	20.6	3.5	20.7	21.9
Hieracium albertinum	0.0	0.1	0.1	0.0	0.4	0.2	0.6	14.5	27.5	0.0	11.0	45.6
Gnaphalium microcephalum	0.1	0.0	0.0	0.0	0.0	0.1	4.4	8.5	10.0	1.5	3.5	12.0
Cirsium spp.	0.1	0.1	0.1	0.2	0.2	0.4	5.9	12.5	25.6	3.5	11.6	21.9
Pteridium aquilinum	0.0	0.0	0.0	0.0	0.0	0.0	2.5	3.6	6.4	0.0	5.0	5.0
Others	1.9	3.6	1.6	0.2	0.9	0.3						
Total	14.0	15.2	5.6	10.2	8.7	5.8						
Total Herbaceous	27.8	17.4	6.5	21.2	10.0	7.2						
Total Woody & Herbaceous	36.8	24.9	17.9	34.1	27.7	20.3						

Table VIII

Important Species Average Percent Cover and Average Percent Occurrence by Examination Sequence and Growing Seasons After Burning

South Slope

Woody Species	Average Percent Cover			Average Percent Occurrences		
	Growing Seasons After Burning			Growing Seasons After Burning		
Survivors of Understory	2	3	4	2	3	4
Acer circinatum	0.1	0.7	0.5	12.5	17.5	12.5
Berberis nervosa	0.1	0.2	0.1	22.5	30.0	27.5
Gaultheria shallon	0.1	0.4	0.1	15.0	26.2	25.6
Rhododendron spp.	0.0	0.1	0.4	0.0	6.2	26.1
Rubus vitifolius	2.1	1.7	0.7	52.5	40.0	50.6
Linnaea borealis	0.1	0.7	0.8	7.5	17.5	16.4
Whipplea modesta	0.8	0.8	2.1	47.5	57.5	53.6
Others	0.0	0.3	0.2			
Total	3.3	4.9	4.9			
Invaders						
Sambucus spp.	0.0	0.0	0.0	5.0	0.0	0.6
Rubus parviflorus	0.1	0.0	0.0	7.5	3.8	1.9
Salix spp.	0.0	0.0	0.0	0.0	3.8	3.9
Others	0.3	0.7	0.6			
Total	0.3	0.7	0.6			
Woody Total	3.6	5.6	5.5			

Continued

Table VIII
Continued

North Slope

Herbaceous Species	Average Percent Cover			Average Percent Occurrences		
	Growing Seasons After Burning			Growing Seasons After Burning		
Survivors of Understory	2	3	4	2	3	4
All species	0.8	2.0	0.4			
Invaders						
Annuals						
Senecio sylvaticus	2.5	0.0	0.2	85.0	46.2	46.8
Epilobium minutum	0.8	1.2	0.3	47.5	45.0	50.6
Others	0.1	0.0	0.0			
Total	3.4	1.2	0.5			
Perennials						
Epilobium angustifolium	0.4	2.7	1.4	57.5	61.2	79.8
Anaphalis margaritaceae	0.0	0.0	0.0	2.5	2.5	2.5
Hieracium albertinum	0.1	0.0	0.1	15.0	5.0	23.6
Gnaphalium microcephalum	0.1	0.0	0.0	12.5	3.8	4.4
Cirsium spp.	0.0	0.1	0.1	7.5	17.5	21.5
Pteridium aquilinum	0.0	0.0	0.0	0.0	0.0	0.0
Others	0.0	0.6	1.7			
Total	0.3	3.4	3.3			
Herbaceous Total	5.1	6.6	4.2			
Total Woody and Herbaceous Percent Cover	8.7	12.2	9.8			

CONCLUSIONS

A study of successional trends of lesser vegetation on clearcut and burned areas of old-growth Douglas-fir indicates great variation during the first six years in the amount and type of cover between clearcut areas. The vegetation becomes more homogeneous in both species present and the amount of cover with time. The study found an increase in the number of species present on the clearcuts for about four or five years. After this time, the number of species remains about the same. Annuals and unidentified species dropped out after the first two growing seasons with unimportant perennials, annuals, and unidentified species disappearing thereafter. Total cover on the area decreased. This was a result of a decrease in herbaceous vegetation cover with woody vegetation exhibiting an upward trend in its amount of cover.

Differences in the amount and type of cover, as a result of elevation differences, or between burned and unburned areas, were not evident. Wood groundsel and willow-herb were the only species which exhibited a consistent difference between burned and unburned areas. These had a higher percent cover on burned plots for the first two years. South slopes had fewer species present with less total cover. The amount of cover contributed by each species was less on south slopes. There was no great difference in the relationship between major species dominating the area on north and south slopes. There was a change in dominant species of woody vegetation which survived from the understory when twinflower was replaced by whipple-vine on south slopes.

Most species included in woody, herbaceous, annual, and perennial vegetation classes either followed the general trend of the class or expressed no definite trend in percent cover or percent occurrences. Very few species within each class indicated a trend opposite that of the class. One to four major species dominated each class providing the major portion of the cover for that class. Fireweed, wood groundsel, and willow-herb dominated the herbaceous vegetation. Twinflower, whipple-vine, and western dewberry dominated the woody vegetation class. Perennials were dominated by fireweed, western dewberry, twinflower, and whipple-vine while annuals were dominated by wood groundsel and willow-herb. Percent occurrence trends of individual species usually followed the same general trends as percent cover. Fireweed and dewberry were exceptions to this. When total cover of these species dropped, the percent occurrences remained high. Some species with very little cover exhibited a fairly high percent occurrence. Relatively few annuals were present; and these, if they did not cease to exist, contributed only small quantities of cover after the second growing season.

RECOMMENDATIONS

Due to the lack of information about lesser vegetation, its species, composition, and amount, in the Douglas-fir region, more information in this field is needed. Existing studies should be used to their fullest advantage and new studies established. In order that fuller use can be made of this study, the author heartily recommends that it be continued. This is a result of several observations.

1. The variation between units within the same general class is narrowing. Homogeneous vegetation on the various units would permit the use of more refined methods of analysis. Therefore, any differences due to elevation, burning, slope, or site which are now masked by great variation would be more clearly evident.
2. The total cover is at a low level. If this is a portion of secondary succession, then the length of duration of this low amount of cover would be extremely important to the regeneration of conifers. Future examination may indicate this is due to examination error.
3. Woody species show a steady increase in total cover. It would be of great interest to foresters and game managers to find the point where woody vegetation reaches a high density.
4. Future examinations of clearcuts would be simple since the plots are established and marked.

In future examinations care should be taken in identifying each new species as it is encountered. Each new species encountered should be collected, identified, and placed in a herbarium as soon as practicable. Only specimens not located on established plots should be collected.

For the establishment of new studies, the author recommends that a method other than ocular estimation of cover be used. Either a point sampling technique or some other objective method such as distance between plants would reduce interpretation errors due to different examiners. Due to the variation noted between clearcut units in this study, a new study should include more units with better distribution on north and south slopes and in elevation classes.

SUMMARY

A study of successional trends of lesser vegetation following clearcutting in old-growth Douglas-fir stands was initiated in 1953. The study was a portion of a regeneration study on the H. J. Andrews Experimental Forest, located on the west slope of the mid-Oregon Cascades. The study included 14 clearcut and burned areas varying in size from 21 to 70 acres with 40 circular four-milacre plots mechanically spaced across each. Percent cover by species present was recorded for each plot. Percent cover was estimated ocularly using the vertical projection method. The average percent cover for each species was found for each clearcut and the total average percent cover for each clearcut was determined. Percent occurrence was determined by totaling the number of plots on a clearcut unit that included an individual species, and expressing this as a percent of plots on the unit.

The species present and expressed trends in total cover, as well as trends in woody, herbaceous, annual, and perennial cover classes, were followed by examinations in 1953, 1954, 1956, and 1957. Units were grouped according to the sequence of examination and growing season after burning. Nine north slope units were examined--four during the second, fifth, and sixth growing seasons after burning and five during the first, fourth, and fifth growing seasons after burning. Five south slope units were examined--three once and two twice. They were examined during the second, third, and fourth growing seasons after burning.

Results on north slope units indicated a general downward trend in total percent cover. Herbaceous vegetation constitutes the major portion of total cover for the first five growing seasons after burning and steadily declined in amount of cover. Woody vegetation showed small but steady increase in cover and in its share of total cover. The total number of species present rises until about the fifth year with annuals dropping out and being replaced by perennials. By the fifth growing season there were about 73 separate species present. There were 107 species encountered. There were fewer species present on the south slope. Only fireweed was common to all units on all examinations.

South slopes had a lower total average percent cover and fewer species than did north slopes. Trends in total percent cover were level or upward for south slope. Herbaceous vegetation cover on the south slopes dropped slightly while woody percent cover increased slightly.

Variations in percent cover of individual species and classes of vegetation were not evident as a result of differences in elevation. Two species, wood groundsel, and willow-herb, existed at higher percent cover on burned areas for the first two years. Other variations, as a result of burning, were not evident.

Two to four species dominated each class of vegetation and provided over 50 percent of the cover of the class. The minor species in each class generally followed the trend of the class as a whole or did not express a definite trend. Fireweed, western dewberry,

twinflower, whipple-vine, wood groundsel, and willow-herb were the dominant species found.

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APPENDIX

APPENDIX I

SPECIES FOUND ON H. J. ANDREWS CLEARCUT AND BURNED AREAS

Plant Symbol	Technical Name	Common Name
Woody Species		
Survivors From Forest Canopy		
Ac.c	Acer Circinatum Pursh.	Vine Maple
Be.n	Berberis nervosa Pursh.	Long-leaved Oregon Grape
Ga.s	Gaultheria shallon Pursh.	Salal
PP	Chimaphila umbellata (L.) Nutt.	Western Prince's Pine
RH	Vaccinium parvifolium Smith	Red Huckleberry
Rh.sp.	Rhododendron spp. L.	Rhododendron
Ru.n.	Rubus nivalis Dougl.	Snow Bramble
Ru.V.	Rubus Vitifolius C. & S. (Ursinus)	Western Dewberry
TF	Linnaea borealis L. var. americana (Forbs.) Rehder.	American Twinflower
W	Whipplea modesta Torr.	Whipple-vine
Invaders		
Ac.m	Acer macrophyllum Pursh.	Oregon Maple (Bigleaf Maple)
BC	Rubus leucodermis Dougl.	Western Blackcap
C	Cornus nuttallii Aud.	Western Flowering Dogwood

Continued

SPECIES FOUND (Continued)

CC	Castanopsis chrysophylla (Dougl.) A.DC.	Chinquapin
C.ca	Corylus californica (A.DC.) Rose	Western Hazel
Ce.s.	Ceanothus sanguineus Pursh.	Buckbrush; Oregon Tea-Tree
Ce.v.	Ceanothus velutinus Dougl.	Sticky laurel; Mountain balm
CS	Rhamnus purshiana DC.	Cascara
C.W.	Populus trichocarpa T. & G.	Black Cottonwood
Garrya	Garrya fremontii Torr.	Bear Brush
Green Manzanita	Arctostaphylos patula Green.	Green Manzanita
Ocean-Spray	Holodiscus discolor (Pursh.) Maxim	Ocean Spray
Z	Arctostaphylos columbiana Piper.	Hairy Manzanita
Pachystima	Pachystima myrsinites (Pursh.) Raf.	Oregon Boxwood
Prunis	Prunis emarginata (Dougl.) Walp.	Bitter Cherry
R.A.	Alnus rubra Bong.	Red Alder
Rose	Rosa gymnocarpa Nutt.	Little Wild Rose
RS	Ribes sanguineum Pursh.	Red-flowering Currant
SA	Symphoricarpos albus (L.) Blake	Snowberry
SB	Rubus spectabilis Pursh.	Salmon Berry
Sa.sp.	Sambucus L. sp.	Elderberry
TB	Rubus parviflorus Nutt.	Thimble Berry

SPECIES FOUND (Continued)

Wil	Salix spp. (Tourn) L.	Willow

Herbaceous

Survivors From Forest Canopy

IF	Vancouveria hexandra (Hook) Moor. & Dche.	Inside-out Flower
O	Oxalis oregana Nutt.	Oregon Oxalis
Tri	Trientalis latifolia Hook	Broad-leaved Star Flower
V	Viola (Tourn) L. spa	Violat
S.F.	Polystichum munitum (Kaulf.) Presl.	Western Swordfern
X	Coptis laciniata Gray.	Western Gold-Thread

Invaders

Annuals

Campanulae	Campanula spp. (Tourn.) L.	Harebell; Campanula
Cruciferae	Cruciferae	Mustard Family
Er.c.	Erigeron canadensis L.	Horseweed
Ep.sp	Epilobium minutum Lindl.	Small-flowered Willow-herb
Ep.sp.	Epilobium paniculatum Nutt.	Tall annual Willow-herb
Gernaium	Geranium spp. (Tourn.) L.	Geranium
L	Lactuca scarlola L.	Prickly Lettuce
ML	Montia perfoliata (Donn.) How.	Miner's Lettuce

Continued

SPECIES FOUND (Continued)

Monkey Flwr.	Mimulus spp. L.	Monkey Flower
Net	Stachys chamissonis Nutt.	Hedge Nettle
S	Senecio sylvaticus L.	Wood Groundsel
Sheradia	Sherardia arvensis L.	Blue field Madder
Perennials		
Achillae	Achillae spp. L.	Yarrow
B	Dicentra formosa (Andr.) DC.	Western Bleeding-heart
B.B.	Cornus canadensis L.	Dwarf Dogwood; Bunchberry
BF	Pteridium aquilinum (L.) Kuhn	Western Brake-fern
CL	Lilium washingtonianum Kell.	Washington's Lilly
E.C.	Aralia californica Wats.	Western Aralia
Ep.a	Epilobium angustifolium	Fireweed
Eq.u.	Equisetum spp. L.	Horsetail; Scouring-rush
F	SAXIFRAGACEAE	Saxifrage Family
False Dandilion	Hypochaeris radicata L.	Cosmore
Fern	All fern except brake-fern and sword fern	
G	Galium spp. L.	Bedstraw
Grass	Grass spp. no separation	

SPECIES FOUND (Continued)

HA	Hieracium albertinum Farr.	Western Hawkweed
LB	Streptopus ampleyifolius (L.) DC.	Large Twisted-stalk
LG	Xerophyllum tenax (Pursh.) Nutt.	Indian Basket-grass
Linaria	Linaria vulgaris Hill.	Butter and Eggs
LL	Lupinus laxiflorus Dougl.	Spurred Lupine
LM	All mosses (not identified)	
Lotus	Lotus crassifolius (Benth.) Greene	Thick-leaved Lotus
LW	Liverworts (not identified)	
M	Gnaphalium microcephalum Nutt.	Slender Cudweed
Mint	LABIATAE	Mint Family
PE	Anaphalis margaritacede (L) B. & H.	Pearly Everlasting
Penstemen	Penstemon cardwellii How.	Cardwell's Penstemon
Pyrolia	Pyrolia spp. (Tourn.) L.	Pyrolia
Q	Petasites speciosa (Nutt.) Piper	Western Coltsfoot
Sedge	Carex (Rupp.) L.	Sedge
Shooting Star	Dodecatheon L. spp.	Shooting Star
Skunk Cabbage	Lysichitum americanum St.John	Yellow Skunk Cabbage
Tansey	Tanacetum L. sp.	Tansey

SPECIES FOUND (Continued)

Th	Cirsium (Tourn.) Hill spp.	Thistle
T.o.	Trillium ovatum	Western Trillium
V.A.	Veronica americana (Raf.) Schwein.	American Speedwell
Vetch	Vicia (Tourn.) L. sp.	Vetch
VL	Achlys triphylla (Smith) D.C.	Vanilla-leaf

Unknown Species

Comon	Not identified
LT	Not identified
NG	Not identified
OF	Not identified
R.G.	Not identified
T	Not identified
TE	Not identified
Tw.	Not identified
Wild Ginger	Not identified
Wild Parsley	Not identified
Wild Parsnip	Not identified
U. comp.	
U 1	
U 2	
U 3	
U 7	
U 11	
U 12	

APPENDIX II

SPECIES PRESENT BY GROWING SEASONS AFTER BURNING

Name	Growing Seasons After Burning								
	North Slope						South Slope		
	1	4	5	2	5	6	2	3	4
Woody Species									
Survivors From Forest Canopy									
Acer Circinatum	X	X	X	X	X	X	X	X	X
Berberis nervosa	X	X	X	X	X	X	X	X	X
Gaultheria shallon	X	X	X	X	X	X	X	X	X
Chimaphila umbellata		X	X		X	X	X	X	X
Vaccinium parvifolium	X	X	X	X	X	X		X	X
Rhododendron	X	X	X	X	X	X		X	X
Rubus nivalis	X	X	X			X	X		X
Rubus vitifolius	X	X	X	X	X	X	X	X	X
Linnaea borealis var. *americana*	X	X	X	X	X	X	X	X	X
Whipplea	X	X	X		X	X	X	X	X
Invaders									
Acer macrophyllum	X	X	X	X	X	X	X	X	X
Rubus leucodermis	X	X	X		X	X	X		X
Cornus nuttallii		X	X		X	X	X	X	X
Castanopsis chrysophylla		X	X	X	X	X		X	X
Corylus californica	X	X	X					X	X
Ceanothus sanguineus	X	X	X	X	X	X	X	X	X
Ceanothus velutinus		X	X	X	X	X	X	X	X
Rhamnus purshiana								X	

SPECIES PRESENT (Continued)

Name	Growing Seasons After Burning								
	North Slope						South Slope		
	1	4	5	2	5	6	2	3	4
Populus trichocarpa		X	X						
Garrya fremontii						X			
Arctostaphylos patula	X					X			
Holodiscus discolor		X	X	X	X				
Arctostaphylos columbiana		X			X	X	X	X	X
Pachystima myrsinites									X
Prunis emarginata		X	X					X	X
Alnus rubra		X	X		X	X			
Rosa gymnocarpa		X	X	X		X	X		X
Ribes sanguineum		X	X		X	X			
Symphoricarpos albus					X	X			
Rubus spectabilis		X		X					
Sambucus	X	X	X	X	X	X	X		X
Rubus parviflorus	X	X	X	X	X	X	X	X	X
Salix spp.	X	X	X	X	X	X		X	X
Herbaceous Species									
Survivors From Forest Canopy									
Vancouveria hexandra	X	X	X	X	X	X	X	X	X
Oxalis oregana	X	X	X		X	X			
Trientalis latifolia	X	X	X	X	X	X	X	X	X
Viola	X	X	X	X	X	X	X	X	X

SPECIES PRESENT (Continued)

Name	Growing Seasons After Burning								
	North Slope						South Slope		
	1	4	5	2	5	6	2	3	4
Polystichum munitum	X	X	X	X	X	X	X	X	X
Contis laciniata	X	X	X	X	X	X	X		X
Invaders									
Annuals									
Campanula			X			X			
Cruciferae	X			X					
Erigeron canadensis	X			X					
Epilobium annuals	X	X	X	X	X	X	X	X	X
Geranium	X								
Lactuca scarlola		X	X		X	X		X	X
Montia perfoliata								X	X
Mimulus spp.		X							
Stachys chamissonis	X	X			X		X		
Senecio sylvaticus	X	X	X	X	X	X	X	X	X
Sherardia arvensis				X					
Perennials									
Achillae					X				
Dicentra formosa	X	X	X	X	X	X		X	X
Cornus canadensis		X	X		X		X	X	X
Pteridium aquilinum			X			X			
Lilium washingtonianum					X	X			

SPECIES PRESENT (Continued)

Name	Growing Seasons After Burning								
	North Slope						South Slope		
	1	4	5	2	5	6	2	3	4
Aralia californica		X	X		X				
Epilobium angustifolium	X	X	X	X	X	X	X	X	X
Equisetum spp.		X	X		X	X		X	X
SAXIFRAGACEAE	X	X	X	X	X	X	X	X	X
Hypochaeris radicata			X			X			
Fern	X	X	X	X	X	X	X	X	X
Galium	X	X	X	X	X	X	X		X
Grass	X	X	X	X	X	X		X	X
Hieracium albertinum	X	X	X		X	X	X	X	X
Streptopus amplexifolius		X			X	X	X		
Xerophyllum tenax	X	X	X		X	X	X	X	X
Linaria vulgaris				X	X				
Lupinus laniflorus			X				X	X	X
LM Mosses		X	X	X	X	X	X	X	X
Lotus crassifolius		X						X	X
LW Liverworts		X	X		X	X			X
Gnaphalium microcephalum	X	X	X	X	X	X	X	X	X
LABIATAE				X					
Anaphalis margaritaceae	X	X	X	X	X	X	X	X	X
Penstemon cardwellii			X						
Pyrolia spp.		X							
Petasites speciosa		X	X				X	X	X

SPECIES PRESENT (Continued)

Name	Growing Seasons After Burning								
	North Slope						South Slope		
	1	4	5	2	5	6	2	3	4
Carex		X	X					X	X
Dodecatheon		X							
Lysichitum americanum	X	X	X						
Tanacetum				X					
Cirsium	X	X	X	X	X	X	X	X	X
Trillium ovatum		X						X	
Veronica americana			X						
Vicia		X			X			X	X
Achlys triphylla		X	X		X	X	X		X
Unknown									
Comox	X			X					
LT		X			X			X	
NG		X			X				
OF		X						X	
R.G.		X			X			X	
T		X							
TE		X							
Tw.						X			
Wild Ginger		X	X		X				X
Wild Parsley		X	X			X			
Wild Parsnip		X			X				

SPECIES PRESENT (Continued)

Name	Growing Seasons After Burning								
	North Slope						South Slope		
	1	4	5	2	5	6	2	3	4
U. composite					X			X	
U 1									X
U 2									X
U 3				X					
U 7				X					
U 11				X					
U 12				X					

APPENDIX IIIa

H. J. ANDREWS EXPERIMENTAL FOREST
Regeneration Survey

Date_____ Examined by _____
Unit_____

QUADRAT INFORMATION

Quadrat No.	Percent burned	Seedbed						Aspect-percent slope	Pct. skid trail	Plant density - percent					Other (list)	Remarks
		M	L	SI	R	Lg	Other			Acer. M.	Acer. C.	Rubus V.	Cean. V.	Epil. A.		

APPENDIX IIIb

H. J. ANDREWS EXPERIMENTAL FOREST
Regeneration Survey

Date_____ Examined by

Unit_____ _____

West line plot_____ to_____. Road between plots_____and_____.
East line plot_____ to_____. Road between plots_____and_____.

QUADRAT INFORMATION

Quadrat No.	Percent burned			Seedbed						Aspect-percent slope	Skid trail Pct.	Road Pct.	Plant density - percent										Non seeded-bed	Remarks
	L	M	H	M	U&L	L&L	RW	M&H	LB	HB				Epa	Ruv	Acc	Rhsp	Tri	Cas	Acm	Bon	Cas	Sasp	Other (list)		

APPENDIX IIIc

H. J. ANDREWS EXPERIMENTAL FOREST
Regeneration Survey

Date_____ Examined by

Unit_____ _____

West line plot_____to_____. Road between plots_____and_____.

East line plot_____to_____. Road between plots_____and_____.

PLANT DENSITY AND OCCURRENCE INFORMATION

Plant density - percent																												
Plot No.	Epa	Ruv	Acc	Rhsp	Tri	Ces	Acm	Ben	Css	Sasp																		