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STEPHEN WILLIAM COX for the M. S.
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Title: MICROSITE SELECTION OF RESIDENT AND INVADING PLANT SPECIES FOLLOWING LOGGING AND SLASH ON DOUGLAS FIR CLEAR-CUTS IN THE OREGON COAST RANGE

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Dr. W. W. Chilcote

In 1967 an investigation seeking to understand the disturbance effects produced by broadcast slash burning was conducted on Douglas fir clear-cuts in the Harlan area of the Siuslaw National Forest. Specifically, this study was concerned with the effects disturbance has on the growth (spatial) patterns and the replacement (time) patterns of the plant species found in the early successional stages.

The study was conducted on two Douglas fir clear-cuts, one logged in 1966 and slash burned in 1967 and the other was logged in 1965 and slash burned in 1966. All sampling was done in 1968; one and two years after slash burning. The disturbance conditions were defined as being unburned or burned, and five 15' x 15' plots were placed on unburned soil sites and five 15' x 15' plots were also placed on burned soil sites on both clear-cuts, creating a two-year successional sequence. Each plot was subdivided into 25 3' x 3'

subplots, 11 of these subplots randomly selected to be sampled. Each subplot was then divided into nine 1' x 1' microplots, giving a total of 99 microplots per plot. Frequency data on the occurring species was obtained by counting the number of subdivisions within which a specie occurred and expressing this as a percentage of the total number of subdivisions (99).

Tabular ordination of frequency values for presenting and newly established species according to the two disturbance conditions (burned and unburned) provide a basis for an evaluation of the relative tolerance of these species to microenvironments within the clear-cut. Species preferring burned sites one year after burning include Senecio sylvaticus, Funaria hygrometrica, Montia sibirica, Senecio jacobea, Epilobium adenocaulon, Sonchus asper, and Erechites prenanthoides. Two years after burning Epilobium minutum may be added to the species listed above.

There also was a group of species found to prefer the unburned sites which result from the mechanical removal of logs. Species found consistently in this situation on the clear-cut, sampled two years after logging (one year after broadcast burning on the clear-cut) include Agrostis exarata, Rubus parviflorus, Carex festivilla, Crepis setosa, and Hypochoeris radicata.

For disturbed but unburned locations within the clear-cut three years after cutting (two years after broadcast burning on the clear-cut), Luzula campestris and Holcus lanatus may be added to the above list.

A wide variety of remnant plant assemblages and microsites are characteristic of the aftermath of logging and burning on clear-cuts--particularly during the first years following disturbance. A sample ordination of microsites according to frequency of occurrence of plant species provides a basis for comparing the relative compatability of a species to logging and burning effects. This limited analysis sugests a relatively narrow place and time niche requirement of certain plant species occupying Douglas fir clear-cuts during the first three years following logging and burning.

Microsite Selection of Resident and Invading Plant Species Following Logging and Slash Burning on Douglas fir Clear-cuts in the Oregon Coast Range

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Professor of Botany
in charge of major

Redacted for Privacy

Head of Department of Botany and Plant Pathology

Redacted for Privacy

Dean of Graduate School

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Typed by Opal Grossnicklaus for Stephen William Cox

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INTRODUCTION

Douglas fir clear-cuts provide good opportunities to study secondary succession in that the history of a clear-cut is usually available, making it possible to know the date the cut was made, the type of logging used, and the slash burning date. It is possible to study in one locality a number of clear-cuts of various ages so that several stages of succession may be sampled simultaneously.

Most of the Douglas fir successional studies have been of a general nature with the objective of learning the successional sequence associated with a given area. A particularly thorough investigation of plant succession has been carried out by Dr. W. W. Chilcote and his graduate students (Chilcote, 1962; Brown, 1963; Robinson, 1967; West, 1969). Through this work, a fairly consistent pattern of plant succession was established for the Marys Peak watershed and surrounding area. Even with the general successional pattern known, there still remains many unanswered questions concerning the details of the process. In particular, there is little information assessing the importance of different disturbance conditions found within individual clear-cuts, and how these conditions influence the growth and replacement patterns of residual transient plant species.

Accordingly, the present investigation was initiated in the summer of 1967 with the purpose of identifying major disturbance differences within clear-cuts and to relate these differences to plant distribution patterns.

REVIEW OF LITERATURE

Frederic E. Clements was probably the most influential of the early American ecologists. He established and presented the basic principles of plant succession in his book, Plant Succession and Indicators (Clements, 1928). He also elaborated the notion that every plant is a product of the conditions under which it grows and, as such, is a measure of those conditions. More recently a number of authors, including Oosting (1948), Odum and Odum (1959), and Kershaw (1964) have reviewed and summarized the general principles pertaining to plant succession.

According to Weaver and Clements (1938) the climax association for the coastal forest of the Pacific Northwest is Western Hemlock (*Tsuga heterophylla*) and Western red cedar (*Thuga plicata*). To Clements, Douglas fir (*Pseudotsuga menziesii*) dominance in this region represents a sub climax association due to recurring fires. Munger (1940) summarized in more detail the cycle from Douglas fir to hemlock and red cedar. He states that Douglas fir forests are unable to perpetuate themselves, being intolerant of the shade produced by their own canopy. Instead, the very shade tolerant hemlocks, cedars, and Grand firs (*Abies grandis*) are able to establish themselves under the Douglas fir canopy and in this manner the Douglas fir is replaced in time (400-500 years) by these shade tolerant species. Munger did not believe this cycle to be universal in this region. Because hemlock and cedar require a more moist, colder site than Douglas fir, the old Douglas fir forest in West-Central Oregon may not always be replaced by hemlock on these dryer sites.

Investigations by Neiland (1958) in mature and burned forests in the vicinity of Tillamook, Oregon, demonstrated that Douglas fir was being replaced by hemlock instead of red cedar. A study conducted by Sprague (1946) in the McDonald forest near Corvallis, Oregon, suggests that the climax association on the lower east slopes of the Coast Range is Douglas fir and grand fir. These species were interpreted as being favored because the sites are too dry for hemlock and cedar and are subject to a higher chance of recurring fires.

It seems possible that Douglas fir may be a climax species in a few situations, but most evidence supports the belief that this species is dependent on some form of disturbance in order to maintain itself. Morris (1934) has shown that extensive forest fires have been a common part of the history of Western Washington and Oregon. The existence of extensive areas of even-aged stands of Douglas fir supports the belief that fire has produced the disturbance necessary for these stands. Today the fire factor has been considerably reduced and clear-cut logging substitutes for fire as the disturbance necessary in the maintenance of pure stands of Douglas fir.

Great emphasis has been placed on the successional pattern of commercial trees, but there has been a number of studies conducted which have investigated the successional trends of the lesser vegetation found on Douglas fir clear-cuts. Kienholz (1928), examining the regeneration after logging and slash burning in Western Washington, divided the vegetation into three major groups: virgin timber--herbaceous species, virgin timber--shrubby species, and weedy species. Virgin timber herbaceous species consist of all herbaceous species present in the original forest. These species are usually found after slash fires because their underground parts and buried seed are not destroyed. Kienholz states that this group as a whole is less able to withstand the more xeric conditions of the burned sites. Because other specie groups do grow better on these sites, the cover value of these herbaceous species decreases with time. Generic examples of this group include *Polystichum*, *Trientalis*, *Viola*, *Oxalis*, *Disporum*, *Achlys* and *Montia*.

The virgin forest shrubby species group identified by Kienholz contains all the shrubby or woody species found in the original forest which remain on the clear-cut after slash burning. The composition of this group will depend on the degree of fire and logging disturbance these species receive, and the tolerance of the species to withstand these disturbances. These species survive with varying degrees of success and sprout again from persisting stems, crowns, and roots.

The last group designated by Kienholz are weedy species. This group includes all species which are normally absent in the virgin forest. Wind dissemination of light seeds and fruits provide the means for transportation of this group of species to recently exposed ground, thus their ability to become established is dependent upon the distance from the seed source. Kienholz noted that this group was practically absent from the clear-cuts immediately after cutting but increase very rapidly to a dominant position of both frequency and density. Eventually these species are shaded out by the shrub and tree species. Some of the genera mentioned by Kienholz include _Senecio_, _Cirsium_, _Epilobium_ _Hieracium_, and _Crepis_.

Measurements by Kienholz of the total vegetative cover indicate that cover increases steadily and rapidly on burned areas with time. These measurements also indicate a definite slow down in the rate of cover increase during the second year. Cover measurements during the first years following cutting and burning produced no consistent difference in total vegetation on south or north slopes nor with degree of slope.

Studies by Isaac (1940) on clear-cuts in Western Washington and Oregon disclose that there is a considerable element of chance as to what species go to make up the weed-brush cover following logging. The availability of wind-blown seed of invading species and the extent to which cover species present in the original forest are killed by logging and slash burning partially determines the extent to which invading weeds and brush species appear in the regeneration that follows. He noted that many of the weed species growing on these clear-cuts consisted of exotics from other countries. Examples cited include Cytisus scoparius, Digitalis purpurea, Senecio vulgaris, Cirsium vulgare, Hypericum perforatum and a number of grasses.

Although Isaac noted a definite rise in total weed-brush cover as the clear-cut matured, he observed that after a rapid development of the invading herbaceous species their cover values begin tapering off three years after logging. For example Senecio and Epilobium increased in cover very rapidly within a year or two and then vanish from the same area as rapidly as they had come. He was not able to explain why these species acted in such a manner, but he noted that the effect was often so great that the total cover would decrease significantly as these species died out.

Isaac advances the idea that some species, both invaders and those in the original forest understory, may be temporarily favored by the burning effects of slash fires. He noted that the ashy seed bed and the removal of brush competition favors herbaceous plants with wind-disseminated propagules such as Epilobium, Senecio and Pteridium.

A later study of clear-cut succession by Morris (1958) employed the paired plot approach to assess the effect of slash burning upon conifer establishment and plant composition. One plot was slash-burned while the other was left unburned. The study dealt primarily with the restocking of conifer seedlings but cover data was also recorded for herbaceous species. He found that differences in average quantity of herbaceous cover between burned and unburned plots lacked statistical significance. In agreement with Isaac he noted little difference between burned and unburned plots after the third year. Wide variation in the site and composition represented by individual plots undoubtedly contributed to his inability to verify differences between burned and unburned plots.

Yerkes (1960) has studied succession on clear-cuts located in old growth Douglas fir forests in the Central Oregon Cascades. He examined clear-cut units for trends in vegetation development based on the frequency of the species considered most important in respect to cover density and general distribution over the study areas. This study reported that woody survivors increased slowly in frequency and that herbaceous survivors were a relatively unimportant part of the vegetation cover. Annual herbaceous invaders exhibited a high frequency the first two years and then declined. Perennial herbaceous invaders rise in frequency for about five years, after which little increase is observed. He points out that species present under the forest canopy tended to be more prominent on unburned areas whereas invading species tend to become established more rapidly on burned areas. After five growing seasons, the burned and unburned areas differed only slightly.

Dryness (1965) looked at vegetation before logging, after logging, and then after slash burning on clear-cuts in the Anderson Experimental Forest in Central Oregon. In the same area where Yerkes had worked earlier he found that there were broad vegetational trends but that each individual plot exhibits a large degree of uniqueness. As plant succession advances, the influence of logging and slash burning disturbance decreases and other site factors, such as soil and aspect, become increasingly important in controlling plant cover composition.

Bailey (1966) has reported on clear-cut succession in certain forest associations typical of South Central Coast Range forests in Oregon. Plots were established on disturbed and undisturbed soils within Douglas fir clear cuts. The undisturbed plots tended to have high cover values for remnant, surviving species mixed with only a few weedy species. Typical genera of remnant species found in these undisturbed areas are Polystichum, Oxalis, Gaultheria, Berberis, Acer and Montia.

Bailey further found that highly disturbed areas tended to have high cover values for weedy species including such genera as Senecio, Cirsium, Erechites, Epilobium, Hypochoeris, and Crepis. He stresses that the highly variable degree of disturbance strongly influences vegetative succession.

Chilcote (1962) and Brown (1963) have worked out the main successional trends occurring on Douglas fir clear-cuts located at intermediate elevations on Marys Peak in the Oregon Coast Range. Three introduced species dominate during the first six years. Peak cover values indicate that Senecio sylvaticus dominates during the second year. Cirsium vulgare reaches its peak cover values and dominates during the third and fourth year. Holcus lanatus dominates the clear-cut during the fifth and sixth year. By the seventh year, the introduced weedy species are gone and the clear-cut is dominated by Lotus crassifolius which is at its peak cover value. These peak cover values seem to be highly consistent. Total cover was found to to increase with time. There was a slight depression in total cover during the third year which seemed attributable to the disappearance of Senecio sylvaticus. It was further noted that the early stages of succession are dominated by relatively few species.

Chilcote and West (1969) have attempted to relate the dramatic decline in Senecio sylvaticus to changes in soil nutrient levels. By applying nitrogen and phosphorus in greenhouse and field experiments, they were able to maintain the dominance of this specie for two growing seasons.

METHODS AND MATERIALS

The Marys Peak ranger district in the Siuslaw National Forest was the site of the study. All sampling was from two clear-cut and burned areas. These two clear-cuts are designated as number 12-9, Savage Ridge, and 12-11, Savage Creek, by the U. S. Forest Service. Both clear-cuts are found in township 12 south, range 9 west. The Savage Ridge unit is in section 27, and the Savage Creek unit is in section 23. These two clear-cuts were chosen because they were accessible, they share similar topographic features, and they have a similar history of logging and slash burning. Table 1 presents a comparison of some of the features found in these two areas.

Sampling of the two clear-cuts was carried out in the spring and summer of 1968. The Savage Creek unit was logged in 1966 and slash burned in the spring of 1967. Since slash fires are known to kill part of the vegetation which survives logging and most all of the seed, on or near the soil surface, little vegetation was evident on the burned areas of this clear-cut when a reconnaissance visit was made in the summer of 1967. Thus, plant composition data made later on burned soils in the summer of 1968 indicate the results of a single, growing season. Plant composition data taken at the same time on unburned portions of the clear-cut measured vegetation development since the time of cutting (a two-year period) without the intervening effects of fire. For the remainder of this study, this clear-cut is referred to as the "first-year" clear-cut even though the unburned portions had not been disturbed for two years.

The Savage Ridge unit was logged in 1965 and slash burned in the spring of 1966. This means that data obtained in 1968 from burned soils represents two growing seasons, while that obtained from unburned soils represents three years. This unit is referred to as the "second year" clear-cuts although the unburned portions had not been disturbed for three years.

Disturbance on Douglas-fir clear-cuts is due to two different events. The first of these is the mechanical removal of logs and the other is the broadcast method of slash burning. Mechanical disturbance occurs throughout the entire clear-cut, but slash burning prevails only when certain conditions are present. This investigation was concerned in the selectivity of plant species for the two conditions, i.e., soils disturbed by log removal as compared to those soils which supported slash fires in addition to the mechanical disturbance. Further, it may be expected that magnitude of these conditions would be reflected also in the vegetational response. Since disturbance selectivity was of primary concern, a method for identifying burned and unburned soil needed to be formulated so that the sampling within the clear-cuts could be stratified. This need led to the development of a rigid criteria to determine sampling locations for burned and unburned soils.

The criteria as to what constitutes burned soil incorporates the conditions that are described by Morris (1958) as a moderate burn. A moderate burn is described as one where litter, duff, and other woody debris is consumed, but the color of the soil under ash is not changed. A burn of this type arises where enough surface litter is present to carry the fire, but large amounts and large pieces of fuel are absent. Where large pieces and large amounts of fuel occur a greater amount of heat is generated, resulting in the soil becoming highly colored and very crusty. The soils in this condition are the result of what Morris terms a heavy burn. A light burn is the condition that arises when the soil is covered with very little litter or where the litter is decomposed or wet and does not generate a hot fire. Data was not obtained from light and heavy burned soils. Light burned soils were excluded because a year of plant growth and weathering appears to obliterate the characteristics that distinguish this type of burn. Heavy burns were excluded because they occurred too infrequently to be adequately sampled.

Criteria for the recognition of unburned soil were developed by using disturbance effects described by Dryness (1965). He states that the mechanical disturbance of an area exerts a major influence on the amount of vegetation found during the first two years following logging. Disturbance on these logged areas ranges from light to severe. On lightly disturbed soils, many of the original forest species may survive. These lightly disturbed soils usually have enough litter to carry a fire, and when this litter burns it creates the moderately burned soil that was described above.

Where the mechanical disturbance was severe, few original forest species survive and usually a fire cannot be supported by the remaining litter. This situation arises when large amounts of soil has been compacted or displaced. These severely disturbed situations constitute the unburned soil classification used in this study.

Sampling began on each clear-cut with the establishment of five 15' x 15' plots on burned soil and also five 15' x 15' plots on unburned soil. Each of these plots was then subdivided into 25 3' x 3' subplots. This was accomplished by laying out two 15-foot lines forming a right angle. Each line served as an axis and was marked at three-foot intervals. The five marks on each axis were then used as coordinates to locate the placement of the subplots. Out of these 25 subplots in each plot, 11 were randomly selected to be sampled. Each of these 11 3' x 3' subplots was further divided into nine one square foot microplots. Thus the placement of 11 3' x 3' subplots in each plot created 99 one square foot microplots.

Each of the 99 microplots on each plot was examined and the presence of each specie was recorded. The percentage of the 99 microplots on which a specie was found (% frequency) was the statistic used to correlate the degree to which that specie was associated with the condition existing on the 15' x 15' plot. Thus plant species associated with disturbance condition (burned or unburned) on each of the two clear-cuts was thus described by five 15' x 15' plots with the plant composition on each plot evaluated in terms of plant species present and on their percent frequency based on 99 observations.

RESULTS

Frequency values for species occurring on moderately burned plots on the Savage Creek and Savage Ridge clear-cuts are shown in Tables 2 and 3. Table 2 lists the frequency (percent occurrence on 99 one square foot observations) for those species present on each of the plots (15' x 15') located on the one-year-old clear-cut. There are five columns in this table, one representing each plot. Species are arranged according to the size of their frequencies on the five plots, with species of highest frequency located at the top of the table. Plots (columns) are arranged so that the first plot on the left contain the greatest number of species, and upon going from left to right, the number of species found in each plot decreases. Plot number one contains 18 different species while the plot represented by the last column contains only ten different species. In all plots Senecio sylvaticus (based on percent occurrence) was the most frequent specie. Funaria hygrometrica, a moss, had the next highest frequency value, followed by Senecio jacobea and Cirsium vulgare. Erechites prenanthoides was found only in those plots containing the fewest species.

Frequency values for species occurring on moderately burned soils two years after burning, arranged in a similar manner to Table 2, are presented in Table 3. Total number of species occurring on plots range from 23 to 11. Considering all plots, Funaria hygrometrica has replaced Senecio sylvaticus as the specie with the largest frequency value. Epilobium adenocaulon, Epilobium minutum, and Agrostis exarata follow with decreasing frequency values.

Frequency values for species occurring on unburned portions of the two clear-cuts are given in Tables 4 and 5. Species and plots are arranged in decreasing order from top to bottom and from left to right respectively. The plot represented in the first column contained 19 species, while the other plots contain either 13 or 14. In all plots, Agrostis exarata had the highest frequency values. This specie is followed by Rubis parviflorus, Crepis setosa, Hypochoeris radicata, and Carex festivilla.

Crepis setosa and Hyochoeris radicata were recorded together due to difficulty of recognition in the field in the early rosette stage.

The frequencies of specie occurrence on unburned plots two years after slash burning are given in Table 5. The number of species occurring within the plots ranged from 21 to 13. Crepis setosa and Hypochoeris radicata replace Agrostis exarata as species with highest frequency values during the second year, while Carex festivilla, Holcus lanatus and Luzula campestris follow in decreasing order.

In order to correlate a specie with either mechanical or burning disturbance, all the species present on the first year clear-cut were sorted into a single table, Table 6. Frequencies of plant species on burned and unburned soil one year after burning are given in Table 6. The table suggests that *Agrostis exarata*, *Rubus parviflorous*, *Crepis setosa*, *Hypochoeris radicata*, and *Carex festivilla* are most suited to unburned sites. Following these species are a group of species which appear less selective for unburned sites. In the middle of the table are placed species which seem to be independent of either the unburned or the burned sites. The most pronounced in this regard appears to be *Cirsium vulgare*. At the bottom of the table, species with a greater affinity for burned sites are listed. On burned sites, *Senecio sylvaticus*, *Funaria hygrometrica*, *Montio sibirica*, and *Senecio jacobea* show a particularly high preference for burned soils during the first year.

Frequency values for those plant species recorded on the two-year-old clear-cut on burned and unburned plots (ordinated as in Table 6) are given in Table 7. *Crepis setosa*, *Hypochoeris radicata*, *Agrostis exerata*, *Carex festivilla*, and *Luzula campestris* appear to prefer the unburned sites. Species found to have their highest frequency values on burned plots were *Funaria hygrometrica*, *Senecio sylvaticus*, *Epilobium adenocaulon*, *Epilobium minutum*, and *Erechites prenanthoides*. Between these two groups of species are those species which appear less dependent upon disturbance.

Table 8 presents another ordination of frequency values for those species recorded on burned plots the first and second year after slash burning. The important species listed in this position are Senecio sylvaticus, Montia sibirica, and Senecio jacobea. The species occurring more frequently during the second year are found in the bottom right portion of the table. The species with high frequency values found in this position are Funaria hygrometrica, Epilobium adenocaulon, and Epilobium minutum. Between these groups of species are found those species in which time preference cannot be determined from the data obtained.

In Table 9, an ordination (similar to that in Table 8) is given for species recorded on unburned plots. Agrostis exarata and Rubus parviflorus occur most frequently during the first year. By the second year there appears to be a shift to Crepis setosa, Hypochoeris radicata, Luzula campestris, Holcus lanatus, and Carex festivilla as having the highest frequencies.

Plant species may be divided into the three categories: (1) remnant species from the original forest vegetation that survive either or both types of disturbance, (2) annual invaders which did not occur in the original vegetation, and (3) perennial invaders. The species within each category are sorted according to age of clear-cut and type of disturbance in Tables 10, 11, and 12.

Frequency values for species present in the original forest vegetation on burned and unburned plots during the first and second year after slash burning are given in Table 10. Those species found to occur more frequently on unburned plots are placed in the top left part of the table. At the bottom of the table are placed species found to occur more frequently on burned plots. Luzula campestris, Iris tenax, and Gaultheria shallon are found to occur more on the unburned plots than on the burned plots. Montia sibirica and Polystichum minitum appear to survive better on the burned plots. Montia sibirica appears to decrease in frequency by the second year.

Only three species fall into the "annual invaders" category. Their frequency values are arranged in a manner similar to Table 10 in Table 11. Senecio sylvaticus is by far the most prominent annual invader on both burned and unburned plots. A marked reduction in occurrence is noted during the second year on burned plots. Epilobium minutum was almost nonexistent the first year, but its numbers increased sharply by the second year.

The sorting of the frequency values for invading perennial species on burned and unburned plots during the first and second year after slash burning are given in Table 12. Favoring the unburned plots during the first year are Agrostis exarata, Carex festivilla, and Rubus parviflorus. In the second year Crepis setosa and Hypochoeris radicata, Holcus lanatus are more prominent on these sites. Funaria hygrometrica and Epilobium adenocaulon are found most frequently on burned plots, and increasingly during the second year.

Table 1. Some features of the two clear-cut areas selected.

	Savage Creek	Savage Ridge
Forest Service designation	12-11	12-9
Size	79 acres	47 acres
Cutting date	1966	1965
Slash burning date	5-23-67	5-4-66
Elevation range	500-1400'	950-1250'
Aspect	East	West
Slope range	5-35%	7-30%
Timber type	Douglas fir	Douglas fir

Table 2. Frequency of specie occurrence on five burned plots one year after slashing.

Species	Frequency of occurrence				
Senecio sylvaticus	100	99	100	100	100
Funaria hygrometrica	10	32	20	65	56
Montia sibirica	53	37	29	47	44
Senecio jacobea	31	4	6	20	32
Cirsium vulgare	14	15	17	27	9
Erechites prenanthoides				30	29
Agrostis exarata	7	14	8	10	
Sonchus asper	8		9	8	1
Epilobium adenocaulon	2	7	1	8	8
Polystichum munitum	8	1	4	3	8
Crepis setosa and Hypochoeris radicata	3	1	1	2	2
Trientalis europea	1	4			
Berberis nervosa	1	1			
Oxalis oregana	7	5			
Pteridium equillinium	1				
Galium triflorum	1				
Luzula campestris	2				
Vancoureria hexandra	1				
Achyls triphylla	1		1		
Rubus parviflorus			1		
Lupinus latifolius			6	2	
Epilobium minutum				1	

Table 3. Frequency of specie occurrence on five burned plots two years after slash burning.

Species	Frequency of occurrence				
Funaria hygrometrica	32	28	58	52	70
Senecio sylvaticus	46	23	62	28	65
Epilobium adenocaulon	34	46	14	45	53
Epilobium minutum	29	62	5	37	10
Agrostis exarata	5	18	23	10	18
Cirsium vulgare	25	8	8	27	5
Erechites prenanthoides	5	10	13	15	6
Sonchus asper	11	4	5	22	3
Senecio jacobea	3	9	7	12	7
Holcus lanatus	4	6	3	1	3
Crepis setosa and Hypochoeris radicata	1	3	4	4	3
Gaultheria shallon	6	2	3	1	
Montia sibirica	15	7	9	8	
Polystichum munitum	12	6	1	5	
Rubus macropetalus		1	1		
Trientalis europea	6	2	5		
Luzula campestris	3	1	2		
Galium triflorum	1	2			
Oxalis oregana	4	4			
Digitalis purpurea	1	1			
Plantago	1	1			
Rosa gymnocarpa	2				
Vaccinium myrtillus	2				
Viola semprevirins	2				

Table 4. Frequency of specie occurrence on five unburned plots one year after slash burning.

Species	Frequency of occurrence				
Agrostis exarata	93	96	66	98	100
Rubus parviflorus	13	49	20	40	29
Crepis setosa and Hypochoeris radicata	38	10	54	15	15
Carex festivilla	32	18	8	11	33
Rubus macropetalus	2	2	21	7	4
Senecio sylvaticus		5	3	5	20
Cirsium vulgare	3	5	11	11	45
Lupinus latifolium	1	2		1	3
Stachys rigida	4	11		4	4
Luzula campestris	2	4			
Polystichum munitum	1				
Holcus lanatus	1				
Iris tenax	1	1	1		
Festuca megalura	11	3	9		
Senecio jacobea	3	3	2		
Gaultheria shallon	5		3	1	
Trientalis europea	1			1	
Galium triflorum		2	1	1	
Sonchus asper				1	
Erechites prenanthoides			5		
Pteridum aquilinum		1			
Lotus stipularis		2			
Epilobium adenocaulon	1		1		6
Montia sibirica	1				7
Viola semprevirins	1				1
Alrus rubra					1
Mimulus ssp					2

Table 5. Frequency of specie occurrence on five unburned plots two years after burning.

Unburned plots second year	Frequency of occurrence				
Crepis setosa and Hypochoeris radicata	82	95	55	95	99
Agrostis exarata	10	53	13	57	82
Carex festivilla	51	43	19	29	12
Holcus lanatus	27	30	59	1	30
Luzula campestris	31	27	37	11	10
Cirsium vulgare	3	6	2	4	3
Festuca megalura	1	5	18		9
Senecio jacobea	47	2		1	1
Gaultheria shallon	1	3	1	3	2
Rubus parviflorus	5	6		10	5
Senecio sylvaticus	7	15	5		2
Trientalis europea	1	6	2		1
Erechites prenanthoides	1		1		1
Epilobium adenocaulon	2	10		1	
Polystichum munitum	3	4	2		
Iris tenax	1	2	5		
Galium triflorum		1			
Berberis nervosa	7				
Epilobium minutum	2				
Vancouveria hexandra	2				
Holodiscus discolor	4				
Rubus macropetalus			1		
Lupinus latifolium				1	
Mimulus ssp				1	
Lotus stipularis				1	
Stachys rigida				5	

Table 6. Frequency of occurrence of plant species on burned and unburned plots one year after slash burning.

"First Year" species	Frequency of Occurrence: Unburned plots					Burned plots				
Agrostis exarata	93	96	66	98	100	7	14	8	10	
Rubus parviflorus	13	49	20	40	29			1		
Crepis setosa and Hypochoeris radicata	38	10	54	15	15	3	1	1	2	2
Carex festivilla	32	18	8	11	33					
Rubus macropetalus	2	2	21	7	4					
Luzula campestris	2	4				2				
Stachys rigida	4	11		4	4					
Iris tenax	1	1	1							
Galium triflorum	2	1	1			1				
Gaultheria shallon	5		3	1						
Lotus stipularis		2								
Viola semprevirins	1									
Cirsium vulgare	3	5	11	11	45	14	15	17	27	9
Lupinus latifolium	1	2		1	3			6	2	
Trientalis europea	1			1		1	4			
Vancouveria hexandra						1				
Berberis nervosa						1	1			
Achyls triphylla						1		1		
Oxalis oregana						7	5			
Erechites prenanthoides			5						30	29
Sonchus asper				1		8		9	8	1
Polystichum munitum	1					8	1	4	3	8
Epilobium adenocaulon	1		1		6	2	7	1	8	8
Senecio jacobea	3	3	2			31	4	6	20	32
Montia sibirica	1					53	37	29	47	44
Funaria hygrometrica						10	32	20	65	56
Senecio sylvaticus		5	3	5	20	100	99	100	100	100

Table 7. Frequency of occurrence of plant species on burned and unburned plots two years after slash burning.

"Second Year" species	Frequency of Occurrence: Unburned plots					Burned plots				
Crepis setosa and Hypochoeris radicata	82	95	55	95	99	1	3	4	4	3
Agrostis exarata	10	53	13	57	82	5	18	23	10	18
Holcus lanatus	27	30	59	1	30	4	6	3	1	3
Carex festivilla	51	43	19	29	12					
Luzula campestris	31	27	37	11	10	3	2	1		
Rubus parvifloris	5	6		10	5					
Trientalis europea	1	6	2		1					
Iris tenax	1	2	5							
Holodiscus discolor	4									
Vancouveria hexandra	2									
Berberis nervosa	7									
Stachys rigida				5						
Lotus stipularis				1						
Lupinus latifolium				1						
Gaultheria shallon	1	3	1	3	2	6	2	3	1	
Cirsium vulgare	3	6	2	4	3	25	8	8	27	5
Rubus macropetalus			1				1	1		
Galium triflorum	1					1	2			
Viola semprevirins						2				
Digitalis purpurea						1	1			
Polystichum munitum	3	4	2			12	6	1	5	
Montia sibirica	7					15	7	9	8	
Senecio jacobea	47	2		1	1	3	9	7	12	7
Sonchus asper						11	4	5	22	3
Erechites prenanthoides	1		1		1	5	10	13	15	6
Epilobium minutum	2					29	62	5	37	10
Epilobium adenocaulon	2	10		1		34	46	14	45	53
Senecio sylvaticus	7	15	5		2	46	23	62	28	65
Funaria hygrometrica						32	28	58	52	70

Table 8. Frequency of occurrence of species occurring on burned plots during the first and second year after slash burning.

Burned plots species	Frequency of Occurrence									
	One year					Two years				
Senecio sylvaticus	100	98	100	100	100	46	23	62	28	65
Montia sibirica	53	37	29	47	44	15	7	9	8	
Senecio jacobea	31	4	6	20	32	3	9	7	12	7
Cirsium vulgare	14	15	17	27	9	25	8	8	27	5
Digitalis purpurea						1	1			
Luzula campestris	2					3	2	1		
Holcus lanatus						4	6	3	1	3
Gaultheria shallon						6	2	3	1	
Crepis setosa and Hypochoeris radicata	3	1	1	2	2	1	3	4	4	3
Polystichum munitum	8	1	4	3	8	12	6	1	5	
Sonchus asper	8		9	8	1	11	4	5	22	3
Agrostis exarata	7	14	8	10		5	18	23	10	18
Erechites prenanthoides				30	29	5	10	13	15	6
Epilobium minutum				1		29	62	5	37	10
Epilobium adenocaulon	2	7	1	8	8	34	46	14	45	53
Funaria hygrometrica	10	32	20	65	56	32	28	58	52	70

Table 9. Frequency of occurrence of species occurring on unburned plots during the first and second year after slash burning.

Burned plots species	Frequency of Occurrence: One year					Two years				
Agrostis exarata	93	96	66	98	100	10	53	13	57	82
Rubus parviflorus	13	49	20	40	29	5	6		10	5
Stachys rigida	4	11		4	4				5	
Rubus macropetalus	2	2	21	7	4			1		
Lupinus latifolium	1	2		1	3			1		
Galium triflorum		2	1	1			1			
Iris tenax	1	1	1			1	2	5		
Cirsium vulgare	3	5	11	11	45	3	6	2	4	3
Senecio sylvaticus		5	3	5	20	7	15	5		2
Epilobium adenocaulon	1		1		6	2	10		1	
Trientalis europea	1			1		1	6	2		1
Gaultheria shallon	5	3	1			1	3	1	3	2
Senecio jacobea	3	3	2			47	2		1	1
Carex festivilla	32	18	8	11	33	51	43	19	29	12
Holcus lanatus	1					27	30	59	1	30
Luzula campestris	2	4				31	27	37	11	10
Crepis setosa and Hypochoeris radicata	13	49	20	40	29	82	95	55	95	99

Table 10. Frequency occurrence of species present in the original forest on burned and unburned plots during the first and second year after slash burning.

Surviving species	Frequency of Occurrence: Unburned plots, One year					Unburned plots, Two years				Burned plots, One year					Burned plots, Two years			
Iris tenax	1	1	1		1	2	5											
Trientalis europea	1			1	1	6	2		1	1	4							
Holodiscus discolor					4													
Luzula campestris	2	4			31	27	37	11	10	2					3	2	1	
Gaultheria shallon	5		3	1	1	3	1	3	2						6	2	3	1
Vancouveria hexandra					2					1								
Berberis nervosa					7					1	1							
Viola semprevirins					1										2			
Montia sibirica	1				7					53	37	29	47	44	15	7	9	8
Achyls triphylla										1		1						
Oxalis oregana										7	5							
Polystichmum munitum	1				3	4	2			8	1	4	3	8	12	6	1	5
Rosa gymnocarpa															2			
Vaccinium myrtillus															2			

Table 11. Frequency occurrence of annual invading species on burned and unburned plots during the first and second year after slash burning.

Annual invaders	Frequency of Occurrence																			
	Unburned plots										Burned plots									
	One year					Two years					One year					Two years				
Senecio sylvaticus	5	3	5	20	7	15	5		2		100	99	100	100	100	46	23	62	28	65
Epilobium minutum					2									1		29	62	5	37	10
Erechites prenanthoides		5			1		1		1					30	29	5	10	13	15	6

Table 12. Frequency occurrence of perennial invading species on burned and unburned plots during the first and second year after slash burning.

Perennial invaders	Frequency of Occurrence																			
	Unburned plots										Burned plots									
	One year					Two years					One year					Two years				
Agrostis exarata	93	96	66	98	100	10	53	13	57	82	7	14	8	10		5	18	23	10	18
Rubus parviflorus	13	49	20	40	29	5	6		10	5			1							
Rubus macropetalus	2	2	21	7	4			1									1	1		
Stachys rigida	4	11		4	4				5											
Crepis setosa and Hypochoeris radicata	38	10	54	15	15	82	95	55	95	99										
Carex festivilla	32	18	8	11	33	51	43	19	29	12										
Lotus stipularis		2							1											
Cirsium vulgare	3	5	11	11	45	3	6	2	4	3	14	15	17	27	9	25	8	8	27	5
Holcus lanatus	1					27	30	59	1	30						4	6	3	1	3
Galium triflorum		2	1	1	1		1				1					1	2			
Digitalis purpurea																1	1			
Lupinus latifolium	1	2		1	3				1				6	2						
Funaria hygrometrica											10	32	20	65	56	32	28	58	52	70
Epilobium adenocaulon	1		1		6	2	10		1		2	7	1	8	8	34	46	14	45	53
Sonchus asper				1							8		9	8	1	11	4	5	22	3
Senecio jacobea	3	3	2			47	2		1	1	31	4	6	20	32	3	9	7	12	7

DISCUSSION

The data collected from the various plots was an attempt to assess how strongly disturbance history influences vegetative succession and to gain some insight into the niche requirements of species that invade the clear-cut during early stages of succession. The original forest, after being logged and burned, cannot be considered a uniform environment. This fact led to the definition of two disturbance types: (1) mechanical disturbance resulting from logging, and (2) moderately burned soil as a result of slash burning. Both types are sampled separately on each clear-cut.

The variation in plant composition (frequency) between plots may be attributed to various factors including the variations in degree of disturbance within the two categories studied, minor differences in the original vegetation cover, and differences in microrelief within the clear-cut. These variations were expected. To some degree (for this initial study) they provided the variation (after the data was ordinated) that help to associate the various species with the range of existing microenvironmental conditions.

The sorting of species frequency values for the five burned plots one year after slash burning in Table 2 reveals a severity of burn effect which suggests that the first column (plot) was subjected to a lighter burn than that which took place on the plot represented by the last column. There are two probable causes for this condition. The amount and the size of slash together with the amount of log removal disturbance act to produce many different slash conditions and, thus, degrees of burn.

Keinholz (1928) also noted "degree affects" and states that plots severely burned have "less" vegetation than those moderately burned. A limited example of vegetational response to severity of the slash fire is seen when the numbers of original surviving species in each plot are compared. Thus in the examination of the five burned plots one year after slash burning (Table 2), eight survivors are found in the plot represented by the first column while the number of survivors in the remaining plots decreases, with only five such species found in the last plot. Since the last plot (column) had the fewest survivors, it is possible that it experienced more fire damage than the plot with the most surviving species. Also in this table the difference in total number of species in each plot is largely related to the number of plant species surviving the fire. The presence of some of these fire sensitive species may be significant. Erechities prenanthoides was recorded as being present only in the last two plots. It may be noted that this plant was often observed growing near pieces of heavy slash, associated with hard burned microsites. Hence, the presence of this specie only in the last two columns would add additional evidence to the belief that it may be favored by a harder burn.

Variations in frequency values for species on the burned plots two years after slash burning (Table 3) also suggests a difference in the severity of the burn between plots. Again the first column (plot) is interpreted as having less fire damage than the last column (plot). A comparison of the plots in this table with the corresponding burned plots from the "first year" clear-cut cannot be made because in each case the severity of burn is only relative to like plots occurring within each clear-cut. But comparison of the number of important species (determined by frequency) found on the first year clear-cut with the important species found on the second year clear-cut can be made. The vegetation one year after slash burning consists almost entirely of one specie, Senecio sylvaticus, while two years after burning several species are of equal importance. This suggests that with time, the flora on burned plots becomes more diversified.

Variations between plots and species composition and frequency values on unburned plots on the "first year" clear-cut (Table 4) also suggests a degree of disturbance effect. The first column (plot) contains 19 species, six of which are original species which survive this type of disturbance. The next three columns (plots) have but two survivors from the original forest and the last column (plot) is without survivors. Again, the first column appears to represent the least disturbed plot and the last column appears to represent the plot most disburned. The last plot in this table also appears to be more mesic than the other plots. This belief is derived from the presence of Alrus rubra, Viola semprevirins and Mimulus ssp which prefer moist sites.

The unburned plots observed on the clear-cut one year after slash burning (Table 4) were not as easily ordinated according to species frequency values as were the burned plots. This could indicate a wider range of disturbance is possible on unburned plots. These plots appear to have been unburned because the mechanical moving of the soil did not leave enough slash to support a fire. This condition could be achieved with very little soil movement and compaction and it can also be achieved with much soil movement and compaction, thus producing a wide range of disturbance.

When the frequency of specie occurrence on five unburned plots two years after spot burning on the clear-cut (Table 5) is appraised in reference to the degree of disturbance, the number of survivors in the first column (plot) is ten and the survivors in the last column (plot) is but two, suggesting that the effect of disturbance seems to increase progressively on the five plots. The plot represented by column 4 appears to be the most mesic.

The frequency of occurrence of plant species on burned and unburned plot one year after slash burning and the frequency of occurrence of plant species on burned and unburned plots two years after burning were sorted in tables to see if the more prominent species (based on frequency) could be correlated to one or the other disturbance types. According to Isaac (1940), when the existing ground cover is sufficiently disturbed, any or all of the important species found on Douglas fir clear-cuts may occur whether the slash was burned or not. He also found many of the species being favored by fire and others eliminated or retarded from succession by slash fires. This study goes on a step further. It attempts to correlate the vegetational trends, based on frequency, to two site features (burned, unburned). Enough data is present so that some of the species from Tables 6 and 7 do indicate a definite habitat preference while the other species occur on one or the other sites too infrequently to indicate any preference. Agreement can be found in the literature with these preference placements. Bailey (1960) reports that *Crepis setosa* and *Hypocheoris radicata* occur on highly disturbed areas. Isaac (1940) points out that *Trientalis* and *Gaulthoria* favor unburned clear-cuts while *Senecio sylvaticus*, *Cirsium vulgare* and the *Epilobium adenocaulon* and *E. minutum* are found primarily favoring burned *clear-cuts*.

Several investigators have described the physical and chemical changes found in soil subjected to slash fires. Isaac (1940) noted that burning: (1) reduces acidity, (2) consumes humas, (3) drives off most of the nitrogen, and (4) leaves certain soil nutrients in a readily available form. He suggests that these soil changes are proportional to the intensity of the burn. Tarrant (1956) emphasizes the change in soil pH from an acidic to an alkaline condition following slash fires. He also found that the amount of change in soil pH related to the severeness of the burn. Based upon a preliminary study, he suggests that light burning stimulates nitrification but severe burning strongly reduces the soil nitrogen content. Light burning also increases the amount of acid soluble phosphorus and exchangeable potassium. Severe burning increases even more the available supply of these nutrients. Thus, both studies point out that for the first year or so, soils have a relatively high nutrient status following light slash burning. These chemical effects of burning can most likely be related to seed germination and seedling growth, especially in the case of the seral invading species.

Table 8 (showing frequency values for species occurring on burned plots during the first and second year after slash burning), and Table 9 (showing frequency values for species found on unburned plots during the first and second year after slash burning), were constructed in an attempt to demonstrate the influence time exerted on these vegetation patterns. The tables, to a limited degree, point out the appearance and disappearance of certain species.

Several interesting events are evident from the sorting of the frequencies of the species found on the burned plots in Table 8. Senecio sylvaticus is a specie which declines in frequency in the second year. Frequency figures do not indicate the explicitness of this reduction. Cover data would have likely shown Senecio sylvaticus in the first year to be in nearly pure stands. In the second year cover values would have shown that after one growing season Senecio sylvaticus would be less important despite its phenomenal production of seed. Senecio sylvaticus growing on the first year burned plots grow to heights of 32-36 inches, but the same plants found a year later on burned plots are less vigorous, attaining heights of 8-14 inches. Kienholz (1928) and Morris (1958) report high densities of Senecio sylvaticus and its abrupt decrease to a minor specie. Also declining in frequency from the first to the second year is Montia sibirica. This is an original forest specie which seems able to withstand the fire but not able to withstand the more xeric conditions fires produce because it gradually becomes less abundant. Epilobium adenocaulon and Epilobium minutum show the largest increase of frequencey from the first to the second year after burning. Isaac (1940) and Yerkes (1960) also note the increase in the Epilobium species with the decline of Senecio sylvaticus. However, the most prominent Epilobium, Epilobium minutum, in the Douglas fir parts of the Cascades is not commonly found in the Coast Range Douglas fir forests in Oregon. The increase in frequency of Funaria hygrometrica and Erechites prenanthoides may be due to differences in site. Erechites prenanthoides seems to react to fire intensity and

Funaria hygrometrica might react in a similar manner, which might indicate that the "second year" plots burned hotter than the "first year" plots. Holcus lanatus and Agrostis exarata are probably just becoming established in the second year, and Polystichum minutum and Crepis setosa appear to be independent of time.

The frequency of occurrence of species occurring on five unburned plots during the first and second year after slash burning (shown in Table 9) attempts to determine the effect of time upon species composition and frequency. As mentioned earlier, these sites were available to invading species before the burned sites due to the fact that log removal was completed prior to slash burning. The additional time for specie growth is probably one year for both clear-cuts. Agrostis exaruta and Rubus parviflorus are species which occur more frequently in the first year than in the second year after slash burning. This might be an expected pattern for a grass like Agrostis exaruta. But, this decline is not the expected pattern for Rubus parviflorus, and may be just a reflection of spatial differences. The frequency of Holcus lanatus increases substantially in the second year. This specie is present on both types of disturbance and the fact that on the burned plots is just becoming established in the second year suggests the consumption of the introduced seed by fire. Holcus lanatus is also an important on Marys Peak clear-cuts. Chilcote (1962) and Brown, using cover data found this specie to dominate clear-cuts four to six years of age. Crepis setosa and Hypocheoris radicata, Luzula campestris, and Carex festivilla also increase in frequency between the first and second year. Brown observed that Luzula campestris and Carex festivilla have peak cover values during the third and fourth year and then decrease gradually. Seed consumption by fire might also cause the establishment of Cirsium vulgare, a biennial, to be delayed. On the first year unburned plots it is flowering but on the first year burned plots it is only in the rosette stage of development.

The sorting of the frequency values for species present in the original forest on burned and unburned plots during the first and second year after slash burning are given in Table 10. With these species, the degree to which they are able to withstand injury or death varies greatly and determines their abundance immediately after different degrees of disturbance. According to Kienholz (1928), the herbaceous surviving species usually have their aerial parts destroyed by a fire of any severity but their underground parts and seeds often survive a fire that is not too severe. These species are not able to withstand the exposed conditions following burning, so they gradually become less abundant. Montia sibirica and perhaps Oxalis oregana and Achlys triphylla are species in Table 10 which respond in this way.

Surviving species of shrubs resprout from stems and roots and appear more able to thrive in the new conditions than are herbaceous survivors. Kienholz (1928) lists shrubby survivors. Those he noted appearing in Table 10 include Gaultheria shallon, Rosa gymnocarpa, and Vaccinum myrtillus.

The sorting of the survivors in Table 10 tends to lump Iris tenax, Trientalis europea, and Gaultheria shatton into a group preferring the unburned sites, suggesting that it is possible for these species to withstand mechanical disturbance more effectively than fire disturbance. Montia sibirica, Polystichum mumitum, and possibly Achyls triphylla and Oxalis oregana seem to exhibit the opposite response, being able to withstand the fire better than mechanical disturbance. These four species may depend on their underground parts for survival. It could be that mechanical disturbance destroys these parts, which would explain why they are present more often on the burned sites.

Yerkes (1960) states that woody survivors slowly increase in frequency, whereas herbaceous survivors slowly decline as succession advances. These remnant species found surviving in new sites are likely to change less rapidly from year to year than the species which invade these sites. Yerkes further says that invaders are more frequent on burned areas than on unburned areas, while survivors occur more frequently on the unburned areas. The invading species were emphasized in this study by virtue of the fact that both types of disturbance expose vast areas of bare mineral soil. The preference shown by the invading species may thus be largely attributed by chemical differences between the two types of soil.

Invaders are species not present in the virgin forest but seeded from outside the clear-cut. Several factors play a role in the ability of these species to become established in a clear-cut. The availability of a nearby seed source is essential. The mobility of the seed, their number and viability, are also very important. The nutrient characteristics and the physical features of the site also exert a major influence on the establishment of invaders. Also, the chance of the seed availability and the chance of the seed finding a site which meets its germination and seedling requirements, is an over-all factor in the establishment of any plant on these clear-cuts.

The frequency occurrence of the annual invading species on burned and unburned plots during the first and second year slash burning as seen in Table 11 definitely suggest that these species prefer the burned sites. But the sorting of the frequencies of the perennial invading species on burned and unburned plots one and two years after slash burning in Table 12 shows the species falling into two groups, one on burned plots, and one on unburned plots.

Emphasis has been placed on soil changes as being an important factor in the early steps of succession. West (1969) has investigated some of these soil changes. By adding nitrogen, he had limited success in maintaining Senecio sylvaticus populations beyond the normal time of decline. Thus, the decline in Senecio sylvaticus could possibly reflect a reduction of the available nitrogen. Further autecological and nutrient requirement investigations remain to be done on Senecio sylvaticus and other species found in these early successional stages. The establishment of permanent plots and controlled field experiments would be advisable additions for studies continuing where this study ends.

SUMMARY

In 1967 an investigation seeking to understand the disturbance effects produced by broadcast slash burning was conducted on Douglas fir clear-cuts in the Harlan area of the Siuslaw National Forest. Specifically, this study was concerned with the effects disturbance has on the growth (spatial) patterns and the replacement (time) patterns of the plant species found in the early successional stages.

The study was conducted on two Douglas fir clear-cuts, one logged in 1966 and slash burned in 1967 and the other was logged in 1965 and slash burned in 1966. All sampling was done in 1968; one and two years after slash burning. The disturbance conditions were defined as being unburned or burned, and five 15' x 15' plots were placed on unburned soil sites and five 15' x 15' plots were also placed on burned soil sites on both clear-cuts, creating a two-year successional sequence. Each plot was subdivided into 25 3' x 3' subplots, 11 of these subplots randomly selected to be sampled. Each subplot was then divided into nine 1' x 1' microplots, giving a total of 99 microplots per plot. Frequency data on the occurring species was obtained by counting the number of subdivisions within which a specie occurred and expressing this as a percentage of the total number of subdivisions (99).

Tabular ordination of frequency values for persisting and newly

established species according to the two disturbance conditions (burned and unburned) provide a basis for an evaluation of the relative tolerance of these species to microenvironments within the clear-cut. Species preferring burned sites one year after burning include Senecio sylvaticus, Funaria hygormetrica, Montia sibirica, Senecio jacobea, Epilobium adenocaulon, Sonchus asper, and Erechtites prenanthoides. Two years after burning Epilobium minutum may be added to the species listed above.

There also was a group of species found to prefer the unburned sites which result from the mechanical removal of logs. Species found consistently in this situation on the clear-cut, sampled two years after logging (one year after broadcast burning on the clear-cut) include Agrostis exarata, Rubus parviflorus, Carex festivilla, Crepis setosa, and Hypochoeris radicata.

For disturbed but unburned locations within the clear-cut three years after cutting (two years after broadcast burning on the clear-cut), Luzula campestris and Holcus lanatus may be added to the above list.

A wide variety of remnant plant assembleges and microsites are characteristic of the aftermath of logging and burning on clear-cuts--particularly during the first years following disturbance. A sample ordination of microsites according to frequency of occurrence of plant species provides a basis for comparing the relative compatability of a species to logging and burning effects. This limited analysis suggests a relatively narrow place and time niche requirement of certain plant species occupying Douglas fir clear-cuts during the first three years following logging and burning.

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