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THE EFFECT OF LOGGING AND SLASH BURNING ON UNDERSTORY VEGETATION IN THE H. J. ANDREWS EXPERIMENTAL FOREST

by

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Plant succession on clearcut areas is presently under study on two experimental watersheds in the H. J. Andrews Experimental Forest. One watershed (No. 1, 237 acres) is currently being completely logged. On the second (No. 3, 250 acres), timber was harvested from three clearcuts, 13, 20, and 28 acres in size, in the winter of 1962-63 following the conventional staggered-setting system. This paper reports on early trends in vegetation development after logging of these three clearcut units. A future paper will deal in more detail with the results of the study, exploring such questions as whether or not successional patterns vary with understory plant community present before logging.

The study area is typical of the Western Cascades geologic province. The area is topographically mature with extremely steep slopes and sharp ridges. Soils in the clearcut units are largely derived from breccias and tuffs with varying amounts of influence from basalt and andesite. The soils are of medium texture, extremely porous, and are generally at least moderately deep.

The timber stand before logging was dominantly Douglas-fir[1/] mixed with varying amounts of western hemlock. Douglas-fir ages at harvest ranged from 100 to 500 years, with the older age classes being most common. Hemlock in the stand was generally younger. Other coniferous species present included western redcedar, Pacific yew, and sugar pine. Hardwoods were of scattered occurrence and included bigleaf maple, Pacific dogwood, golden chinkapin, and red alder.

1/ Scientific names for all species mentioned are shown in table 1. Common names for herbaceous species and most shrubs are from "A Manual of the Higher Plants of Oregon," by Morton E. Peck, Ed. 2, 936 pp., illus., 1961. Common names for trees and a few shrubs are from "Check List of Native and Naturalized Trees of the United States (Including Alaska)," by Elbert L. Little, Jr., U.S. Dept. Agr. Handb. 41, 472 pp., 1953.

STUDY METHODS

Sixty-three permanent milacre plots were located in the three cutting units during the summer of 1962 prior to disturbance. These plots were located at 100-foot intervals along randomly placed transects which traversed the cutting units from one boundary to another.

Plot arrangement followed a modified nested quadrat design. The large plot was 1 milacre in size (6.6 feet square). Crown cover of all shrubs and trees up to 20 feet in height occurring within this plot was estimated and recorded by species. One-quarter of the milacre plot was subdivided into nine subplots, each 1.1 feet square. Percent cover of herbs and grasses occurring on each subplot was also estimated and recorded by species. The cover is crown cover; i.e., an estimate of the percentage of the total plot area covered by the foliage of a given species.

Understory vegetation was inventoried during the summers of 1962 (undisturbed vegetation before logging), 1963 (after logging but before slash burning), and 1964 (after slash burning).

PRELOGGING VEGETATION

Vegetation sampling before logging disclosed the presence of five distinct understory communities in the three cutting units. A brief summary of some of the more outstanding characteristics of these communities follows:

1. Rhododendron-salal. This community is characterized by an extremely dense shrub cover dominated by rhododendron and salal. Other shrub and understory tree species generally present include vine maple, hemlock, and chinkapin. The herbaceous layer is generally not well developed and plants are scattered. The two most common species are American twin-flower and western gold-thread. This community is generally indicative of dry growing conditions.

2. Vine maple-salal. The most outstanding characteristic of this community is the dense cover of vine maple and salal. Other woody species having some importance are long-leaved Oregon grape and Pacific yew. Herbaceous species are of limited occurrence, probably due to the very dense shrub cover. Only three species occurred in 10 percent or more of the observation plots: twin-flower, evergreen violet, and rattlesnake plantain. This community occurs on sites with medium effective moisture and fertility levels.

3. Vine maple-Oregon grape. This community is characterized by a moderately dense shrub and small tree cover over very scattered herbaceous plants. The most important tall woody species

are vine maple, hemlock, and Pacific yew. Oregon grape is the only common low shrub. Herbaceous cover averages only 3.5 percent, with twin-flower and gold-thread being the most abundant species. Sites occupied by the vine maple-Oregon grape community are moderately moist.

4. Gold-thread. This community has both a sparse shrub layer and a sparse herb layer. Very often the forest floor appears virtually bare except for scattered stems of young hemlock and Oregon grape. Closer inspection generally reveals a small amount of gold-thread and twin-flower. Other plants occur only sporadically. This plant grouping occupies the same type of sites as the vine maple-Oregon grape community, but is situated under a denser tree canopy.

5. Sword-fern. This community is the only one of the five which has a well-developed herbaceous layer. Western sword-fern is by far the most abundant plant. Other species present in significant amounts are twin-flower, gold-thread, evergreen violet, inside-out flower, cleavers,[2/] and Oregon oxalis. Characteristics of the shrub layer vary, probably largely due to differences in the density of the tree canopy. For example, vine maple averaged 26 percent cover but it occurred on only half of the plots. Sword-fern is the climax understory community on moist habitats, and it is generally situated along drainage channels and on north-facing slopes.

VEGETATION AFTER LOGGING AND SLASH BURNING

Crown cover, by species, is summarized for the three units before logging (1962), after logging (1963), and after slash burning (1964) in table 1. Results of the first postlogging sampling (1963) show that very few invading plants were present and, consequently, almost all vegetation encountered was a remnant from the preexisting stand. The cover of all species was greatly decreased by logging. However, low shrubs apparently withstood logging more successfully than taller shrubs such as vine maple and rhododendron. Cover values for salal, Oregon grape, and western dewberry decreased the least. It is interesting to note that in unit L222 the "before logging" and the "after logging" cover values for salal were identical.

A marked recovery in the coverage of low shrubs and herbs began during the first growing season after slash burning (1964) (table 1).

[2/] Locally known as bedstraw.

Table 1.--Understory plant cover on three cutting units before logging, after logging, and after slash burning[1/]

(In percent)

Vegetation	Unit L141			Unit L221			Unit L222		
	1962 Before logging	1963 After logging	1964 After burning	1962 Before logging	1963 After logging	1964 After burning	1962 Before logging	1963 After logging	1964 After burning
TREE SPECIES									
Western hemlock *Tsuga heterophylla* (Raf.) Sarg.	12.6	0.2	0.5	3.3	0.2	0.5	17.8	4.2	1.2
Western redcedar *Thuja plicata* Donn	.2	0	0	3.7	0	0	5.8	0	0
Pacific yew *Taxus brevifolia* Nutt.	.9	.2	.05	4.6	.05	0	.4	0	0
Douglas-fir *Pseudotsuga menziesii* (Mirb.) Franco	.2	.05	.4	.05	.2	.3	0	.1	.2
Bigleaf maple *Acer macrophyllum* Pursh	0	0	1.9	.4	.05	.05	0	0	1.9
Golden chinkapin *Castanopsis chrysophylla* (Dougl.) A. DC.	.8	0	0	.6	.1	0	0	0	0
Pacific dogwood *Cornus nuttallii* Audubon	7.0	.05	0	0	0	0	0	0	0
Total, tree species	21.7	.5	2.8	12.6	.6	.8	24.0	4.3	3.3
SHRUB SPECIES									
Vine maple *Acer circinatum* Pursh	11.1	.3	.3	18.6	1.4	.4	12.3	.4	1.2
Long-leaved Oregon grape *Berberis nervosa* Pursh	3.0	1.3	.5	6.3	1.2	.6	8.2	1.8	.7
Salal *Gaultheria shallon* Pursh	12.6	3.1	1.2	3.4	1.1	.8	.3	.3	.1
Western rhododendron *Rhododendron macrophyllum* G. Don	10.3	1.5	.3	10.2	1.0	.2	.6	.3	0
Red huckleberry *Vaccinium parvifolium* Smith	5.3	.4	.2	1.3	.8	.2	.9	.1	.1
Western dewberry *Rubus ursinus* Cham. & Schlecht.	.9	.5	3.2	.4	.4	.9	.4	.1	.4
Snow bramble *Rubus nivalis* Dougl.	.1	0	.5	1.1	.2	.4	.3	0	0
Western blackcap *Rubus leucodermis* Dougl.	0	0	0	.5	.05	.2	0	0	.1
Thimble berry *Rubus parviflorus* Nutt.	0	0	0	0	0	.05	.4	0	.2
Snowbrush *Ceanothus velutinus* var. *laevigatus* (Hook.) Torr. & Gray	0	0	.3	0	0	.3	0	0	0
California hazel *Corylus cornuta* var. *californica* (A. DC.) Sharp	.2	0	0	0	0	0	0	0	0
Little wild rose *Rosa gymnocarpa* Nutt. in T. & G.	.2	0	0	0	0	0	0	0	0
Serviceberry *Amelanchier alnifolia* Nutt.	0	0	0	.1	0	0	0	0	0
Snowberry *Symphoricarpos albus* (L.) Blake	0	0	.05	0	0	0	0	0	0
Total, shrub species	43.7	7.1	6.6	41.9	6.2	4.0	23.4	3.0	2.8
HERBACEOUS SPECIES									
Western sword-fern *Polystichum munitum* (Kaulf.) Presl.	7.2	.2	.7	6.8	1.5	1.0	5.2	1.7	(2/)
Western gold-thread *Coptis laciniata* Gray.	1.1	.2	.1	1.4	.7	.6	1.2	.4	.3
American twin-flower *Linnaea borealis* var. *longiflora* (Torr.) Hulten	3.0	.05	1.3	1.1	.2	1.0	.2	0	0
Evergreen violet *Viola sempervirens* Greene.	.1	0	(2/)	.05	.05	.05	.05	0	(2/)
Western prince's pine *Chimaphila umbellata* var. *occidentalis* (Rydb.) Blake	.4	.05	0	.2	.05	(2/)	(2/)	0	0
Broad-leaved star-flower *Trientalis latifolia* Hook.	.2	.5	.7	.3	.2	1.0	0	(2/)	.1
Western coolwort *Tiarella unifoliata* Hook.	(2/)	0	.6	.1	(2/)	.05	.1	0	(2/)
Cleavers[3/] *Galium Aparine* L.	.05	.05	1.2	.5	.05	.1	.6	0	.6
Inside-out flower *Vancouveria hexandra* (Hook.) Morr. & Dec.	1.1	.05	0	.2	.05	.6	.05	0	0
Whipple-vine *Whipplea modesta* Torr.	.6	.2	(2/)	.6	0	(2/)	(2/)	0	.1

Note: See footnotes at end of table.

Table 1.--Understory plant cover on three cutting units before logging, after logging, and after slash burning[1/]--Continued

(In percent)

Vegetation	Unit L141			Unit L221			Unit L222		
	1962 Before logging	1963 After logging	1964 After burning	1962 Before logging	1963 After logging	1964 After burning	1962 Before logging	1963 After logging	1964 After burning
HERBACEOUS SPECIES (Cont.)									
Grasses	.6	.05	.2	1.1	.7	.4	(2/)	0	0
Oregon oxalis *Oxalis oregana* Nutt. ex T. & G.	1.8	.7	2.3	0	0	0	0	0	0
Wood groundsel *Senecio sylvaticus* L.	(2/)	0	.8	0	.05	1.6	0	0	3.1
Fire-weed *Epilobium angustifolium* L.	.3	0	.9	0	0	2.1	0	0	.1
Tall annual willow-herb *Epilobium paniculatum* Nutt. ex T & G	0	0	.8	0	(2/)	.5	0	0	1.4
Willow-herb *Epilobium watsonii* Barbey in Brew & Wats.	0	0	.9	0	0	1.1	0	0	.3
Western bleeding-heart *Dicentra formosa* (Andr.) Walpers	0	0	.1	0	0	.1	0	0	.1
Pearly everlasting *Anaphalis margaritacea* (L.) B. & H.	0	0	0	0	0	.05	0	0	0
Harebell *Campanula* sp. [Tourn.] L.	0	0	(2/)	0	0	(2/)	0	0	.3
Vanilla-leaf *Achlys triphylla* (Smith) DC.	.1	(2/)	(2/)	(2/)	0	(2/)	0	0	0
Bear-grass *Xerophyllum tenax* (Pursh) Nutt.	.9	0	0	0	0	0	0	0	0
Little prince's pine *Chimaphila menziesii* (R. Br.) Spreng.	.1	0	0	.05	0	0	0	0	0
Rattlesnake plantain *Goodyera oblongifolia* Raf.	.05	(2/)	0	.3	0	0	0	0	0
Western trillium *Trillium ovatum* Pursh	.5	(2/)	(2/)	(2/)	0	0	.2	.1	(2/)
Round-leaved synthyris *Synthyris reniformis* (Dougl.) Benth.	.2	(2/)	(2/)	(2/)	0	0	0	0	0
Larger twisted-stalk *Streptopus amplexifolius* (L.) DC.	0	0	0	(2/)	(2/)	0	0	0	0
Large pyrola *Pyrola asarifolia* Michx.	(2/)	(2/)	0	.2	(2/)	(2/)	0	0	(2/)
Western white anemone *Anemone deltoidea* Hook.	(2/)	0	0	0	(2/)	0	.05	(2/)	(2/)
White-flowered hawkweed *Hieracium albiflorum* Hook.	0	0	.05	(2/)	(2/)	(2/)	0	0	(2/)
Miner's lettuce *Montia perfoliata* (Donn) How.	0	0	0	0	(2/)	0	0	0	.7
Varied-leaved collomia *Collomia heterophylla* Hook.	0	0	0	0	.1	0	0	0	.7
Lady-fern *Athyrium filix-femina* (L.) Roth.	(2/)	0	0	.9	0	0	0	0	0
Western wild ginger *Asarum caudatum* Lindl.	0	0	0	(2/)	0	0	(2/)	0	0
One-flowered clintonia *Clintonia uniflora* (Schult.) Kunth.	(2/)	0	0	0	0	0	0	0	0
Three-leaved coolwort *Tiarella trifoliata* L.	0	0	0	0	(2/)	0	0	0	0
Total, herbaceous species	18.3	2.0	10.0	13.8	3.6	10.2	7.6	2.2	7.1
Total understory cover	83.7	9.6	19.4	68.3	10.4	15.0	55.0	9.5	13.2

1/ Nomenclature follows the most recent taxonomic manuals available, as follows: herbs and most shrubs from Pterdiophyta through Monocotyledonae, "A Manual of the Higher Plants of Oregon," by Morton E. Peck, Ed. 2, 936 pp., illus., 1961; herbs and shrubs from Salicaceae through Compositae, "Vascular Plants of the Pacific Northwest," by C. Leo Hitchcock, Arthur Cronquist, Marion Ownbey, and J. W. Thompson, 4 v., illus., 1955-1964; trees and a few of the shrubs, "Check List of Native and Naturalized Trees of the United States (Including Alaska)," by Elbert L. Little, Jr., U.S. Dept. Agr. Handb. 41, 472 pp., 1953.

2/ Trace.

3/ Locally known as bedstraw.

Some species, present in the undisturbed stand in small amounts, had substantially increased their coverage. Species with more cover after slash burning than they had in the undisturbed stand include western dewberry, star-flower, bedstraw, and Oregon oxalis. Herbaceous cover was also increased by a number of invading species, including wood groundsel, fire-weed, willow-herb, tall annual willow-herb, western bleeding-heart, and pearly everlasting. Snowbrush was the only shrub invader found consistently on the plots.

Cover trends for selected species in unit L141 are shown in figure 1. The adverse effect of logging and burning on shrubs such as Oregon grape and salal is clearly shown. However, tree canopy removal had the opposite effect on western dewberry. This species had more than three times as much cover after slash burning as it had in the undisturbed stand. Sword-fern showed some recovery in coverage following burning; however, it is doubtful whether this trend will be maintained in the future. This same pattern was observed in the case of twin-flower. Interestingly, star-flower has shown a slight increase in cover for each year following logging.

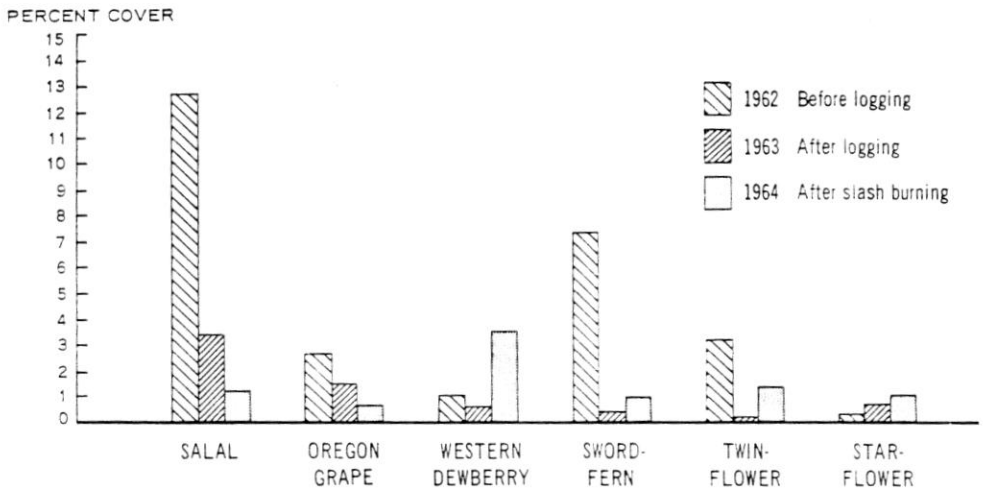

Figure 1.--Cover of selected species occurring on unit L141 before logging (1962), after logging (1963), and after slash burning (1964).

Figure 2 illustrates the 3-year trends for understory tree cover, shrub cover, and herb cover. For shrub and tree species, the general pattern was a marked decrease in cover the first year after logging, followed by generally small decreases after slash burning. Herbaceous cover also decreased appreciably the first year after logging. However, after slash burning, there was a marked increase in herbaceous cover in all three units. In units L221 and L222, herb cover values for 1964 approached predisturbance levels.

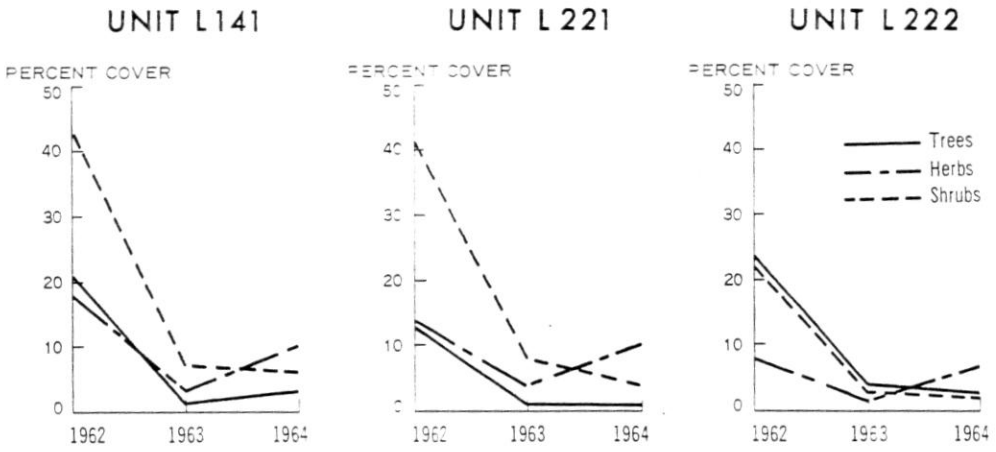

Figure 2.--Total tree cover (less than 20 feet high), shrub cover, and herbaceous cover on three cutting units before logging (1962), after logging (1963), and after slash burning (1964).

SPECIFIC DISTURBANCE EFFECTS

Following logging or burning in a clearcut area, degree of disturbance ranges from none to severe. Each milacre sampling plot was classified on the basis of type and amount of disturbance in an effort to correlate logging and slash burning disturbance with characteristics of the vegetation. Soil surface disturbance and slash burning classes, developed for other studies, were used. Logging disturbance classes are undisturbed, slightly disturbed, deeply disturbed, and compacted.[3/] Slash burning classes are undisturbed, disturbed-unburned, lightly burned, and severely burned.[4/]

Degree of disturbance exerts a major influence on the amount of vegetation present during the first 2 years following logging (table 2). After logging, plant cover on largely undisturbed plots was more than three times as great (28.4 percent) as coverage on slightly disturbed plots (9 percent). On deeply disturbed or compacted plots, plant cover

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3/ Defined in: Dyrness, C. T. Soil surface condition following tractor and high-lead logging in the Oregon Cascades. Jour. Forestry 63: 272-275, illus. 1965.

4/ Defined in: Dyrness, C. T., and Youngberg, C. T. The effect of logging and slash-burning on soil structure. Soil Sci. Soc. Amer. Proc. 21: 444-447, illus. 1957.

totaled only 1.6 percent. Differences are even more striking after slash burning. Whereas total plant cover averaged 41.7 percent on undisturbed plots, total coverage averaged only 6.8 percent on lightly burned plots. Severely burned plots had an average of only 1.1 percent cover, indicating almost no recovery the first season following this severe disturbance.

Table 2.--Plant cover following logging and slash burning on plots within four disturbance classes

(In percent)

Disturbance class	All tree species	All shrub species	All herbaceous species	Total
After logging (1963):				
Undisturbed	5.3	19.1	4.0	28.4
Heavy slash and logs	2.8	2.7	.1	5.6
Slightly disturbed	1.0	4.2	3.8	9.0
Deeply disturbed or compacted	.4	1.1	.1	1.6
After slash burning (1964):				
Undisturbed	7.7	14.6	19.4	41.7
Disturbed-unburned	.8	3.0	15.4	19.2
Lightly burned	1.4	2.5	2.9	6.8
Severely burned	.1	.6	.4	1.1

A consideration of the influence of disturbance on the distribution of individual species reveals some interesting differences (fig. 3). Some species, such as vine maple, show a very low tolerance to disturbance and are confined almost exclusively to undisturbed sites. Others, western dewberry and sword-fern, for example, occur to a limited extent in disturbed areas, but are virtually excluded from burned-over locations. Invading herbaceous species, such as wood groundsel and fire-weed, are apparently not uniform in their site requirements, if we can tell from these early results (fig. 3). It is interesting to note, however, that only a limited amount of these plants occurred on lightly or severely burned plots. This may be partially due to destruction of seed present on the plots prior to burning. On the basis of the results of other studies, we can predict that these species will expand rapidly into burned areas during the next 2 to 3 years.

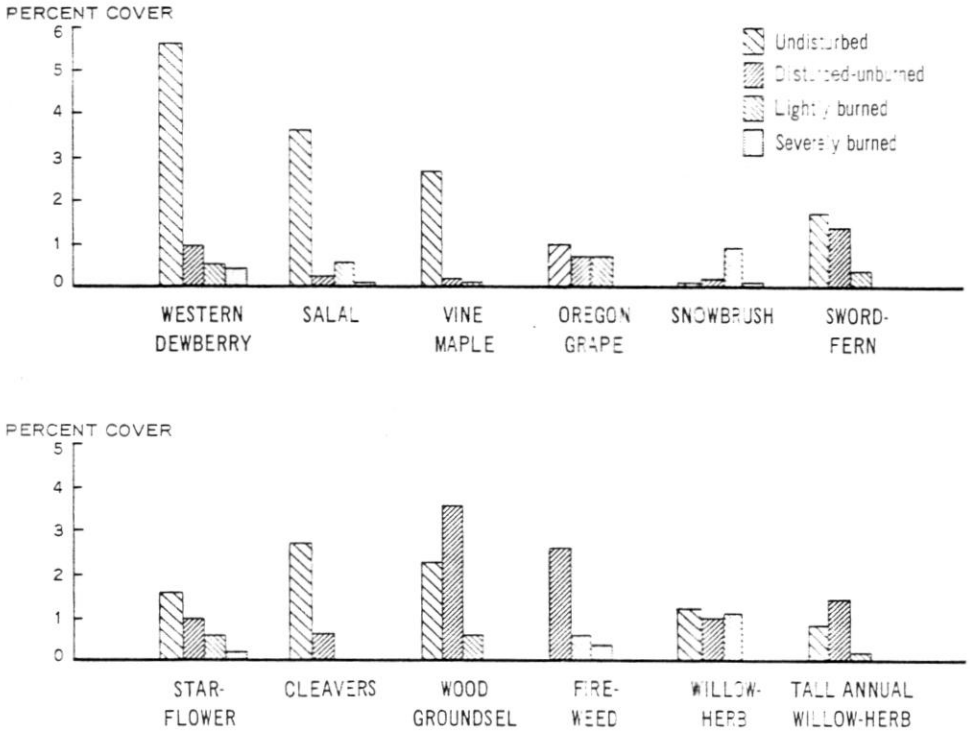

Figure 3.--The effect of disturbance on mean cover values for 12 plant species (values are averages for all three cutting units).

Average values for entire cutting units do not provide a complete picture of vegetation changes because of the variety of existing conditions. One way to gain a better understanding of plant dynamics is to study changes in species composition and plant cover from year to year on individual plots. Individual plot trends can easily be followed on the permanently located milacre plots used in this study. The records indicate that, although certain broad trends are fairly uniform, each plot exhibits a large degree of uniqueness related to disturbance history, site characteristics, prelogging vegetation, and just plain chance.

Vegetational changes on three typical plots are shown in figures 4 through 12. Plot 1-1 on unit L141 (figs. 4 and 5) originally supported vegetation classified as the vine maple-salal understory community. Even though the ground surface after logging was 100 percent undisturbed, all species excepting long-leaved Oregon grape decreased appreciably in cover (fig. 6). The year after slash burning, western dewberry increased in cover, and invading wood groundsel covered about one-tenth of the plot area.

Figure 4.--The vine maple-salal understory community. This community was originally present on plot 1-1, unit L141.

Figure 5.--Plot 1-1, unit L141 in August 1964 (first year after slash burning).

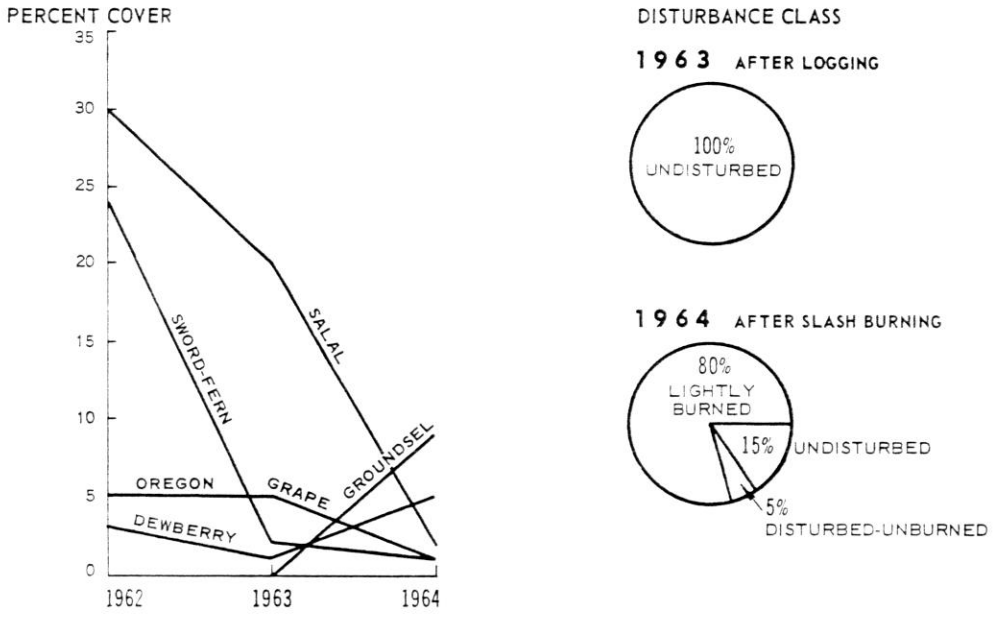

Figure 6.--Vegetation present on plot 1-1, unit L141 in 1962 (before logging), 1963 (after logging), and 1964 (after slash burning).

Prelogging vegetation on plot 1-1 in unit L221 (figs. 7 and 8) was originally classified in the gold-thread community; shrubs occurred in only very small amounts and the dominant species was twin-flower. The entire plot was disturbed to some extent by logging and, as a result, plant cover was reduced to a low level during the summer of 1963 (fig. 9). Because almost the entire plot escaped the slash fire and the exposed mineral soil offered a favorable seedbed, six new species invaded the plot during the summer of 1964. Wood groundsel was by far the most common. In addition, certain species originally present resumed vigorous growth. Twin-flower made the most spectacular recovery, increasing its coverage over 10 times between the 1963 and 1964 measurements.

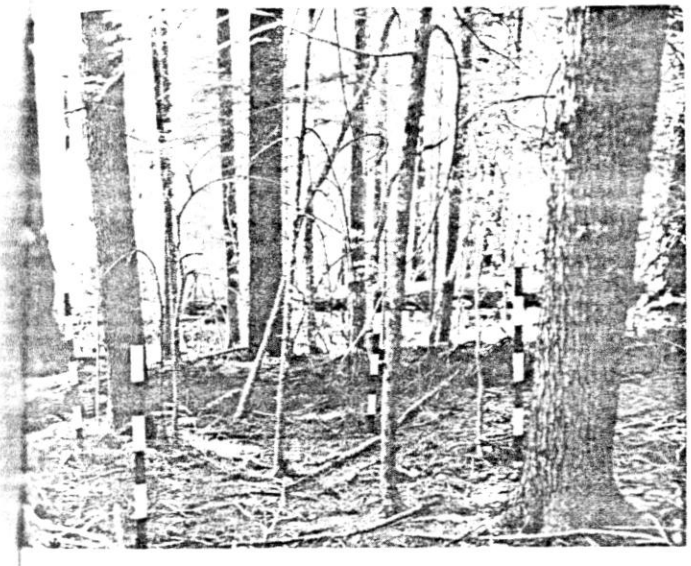

Figure 7.--The gold-thread understory community. This community was originally present on plot 1-1, unit L221.

Figure 8.--Plot 1-1, unit L221, August 1964 (first year after slash burning).

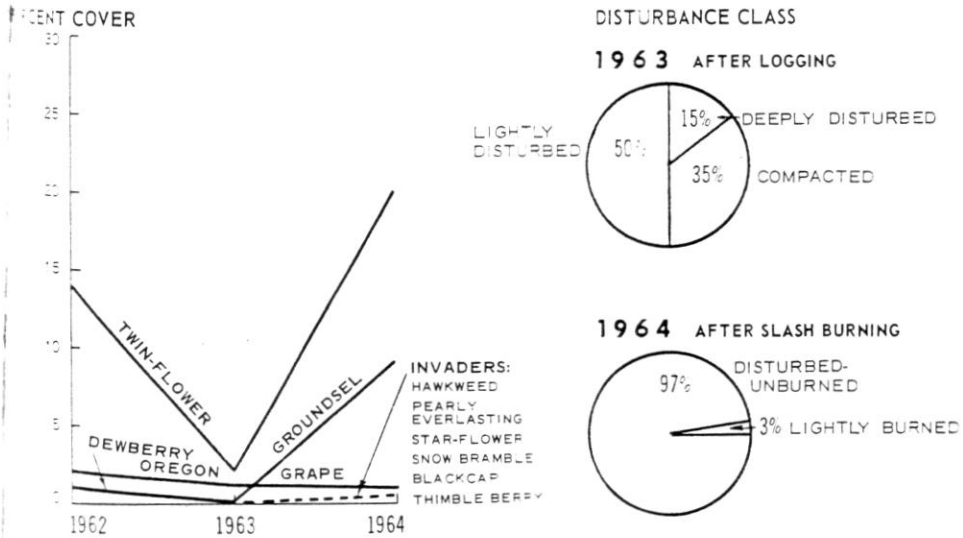

Figure 9.--Vegetation present on plot 1-1, unit L221 in 1962 (before logging), 1963 (after logging), and 1964 (after slash burning).

A vigorous understory, typical of the rhododendron-salal community, occupied plot 4-4 in unit L221 (figs. 10 and 11) prior to logging. As on the first plot discussed, plant cover greatly decreased, even though logging resulted in no appreciable soil disturbance (fig. 12). Sixty percent of the plot surface was burned over by the slash fire, and the other 40 percent remained undisturbed. The failure of residual species to increase their cover during the 1964 growing season and the presence of only one invading species, western dewberry, is noteworthy. This may be due largely to the fact that very little mineral soil was exposed on this plot. However, additional invading species such as wood groundsel may be expected, at least in the burned portion, during the second season following burning.

CONCLUSIONS

It is apparent from the data presented that disturbance history is at least as important as species composition of the undisturbed stand in determining plant distribution on these clearcut units. As plant succession advances, the influence of logging and slash burning disturbance will decrease and other site factors, such as soil characteristics and aspect, will become increasingly important in controlling plant cover and composition.

Figure 10.--The rhododendron-salal understory community. This community was originally present on plot 4-4, unit L221.

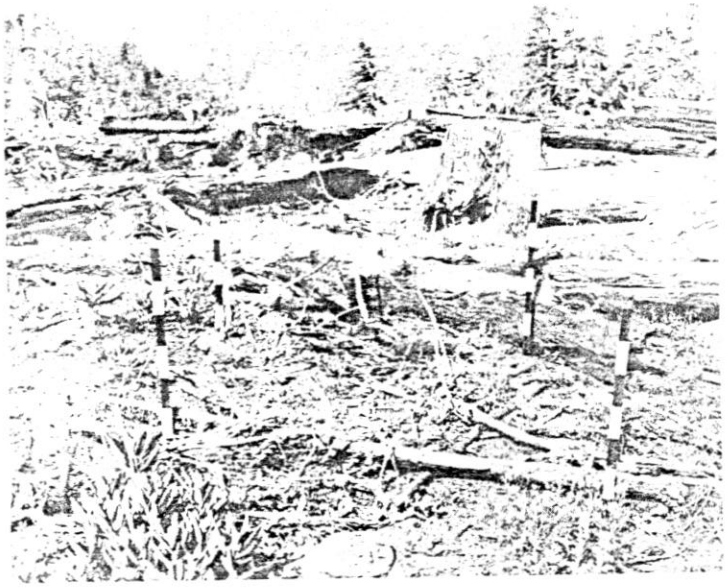

Figure 11.--Plot 4-4, unit L221 in August 1964 (first year after slash burning).

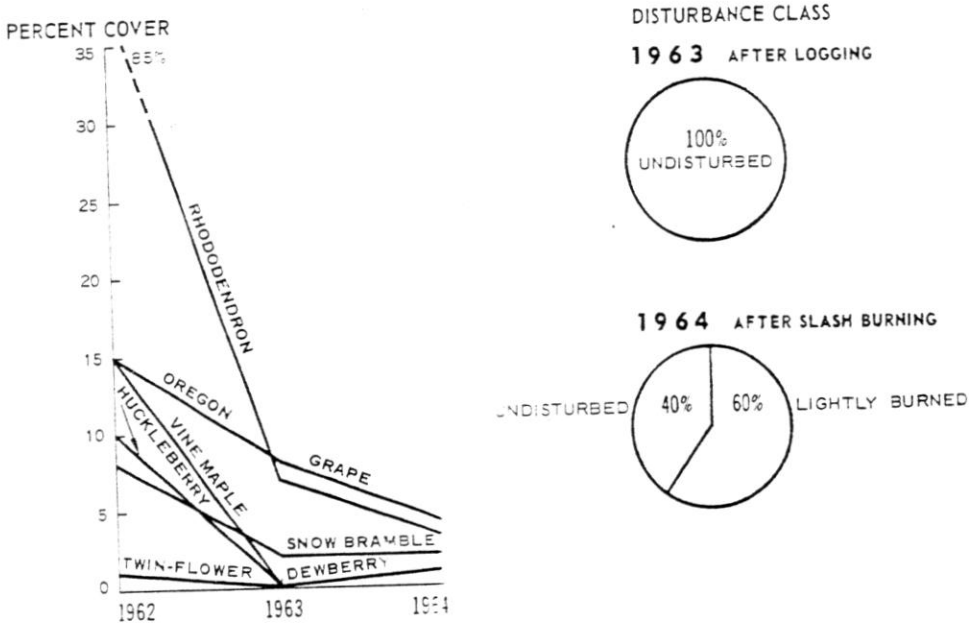

Figure 12.--Vegetation present on plot 4-4, unit L221 in 1962 (before logging), 1963 (after logging), and 1964 (after slash burning.)