POST-BURN EVALUATION OF PLANT SUCCESSION AND FOREST REGENERATION IN COASTAL DOUGLAS-FIR - WESTERN HEMLOCK - RED CEDAR TYPES

by

R.R. LAFFERTY

Havco Resource Services Ltd.

Abbotsford, British Columbia

Unsolicited proposal for
Research Work,
Dept. of Supply & Services.
Contract Number 075 KL017-9-0014

ACKNOWLEDGMENT

This paper is the result of an unsolicited proposal for scientific work submitted to the Department of Supply and Services (Canada) by HAVCO RESOURCE SERVICES LTD. of Abbotsford, B.C. The project was performed under the direction of the department of Supply and Services and the Canadian Forestry Service, Pacific Forest Research Centre, Victoria, B.C. Contract number 075B KL017-9-0014 started June, 1979 and was completed March, 1980 with the acceptance of this paper.

The author thanks the following companies:

- Conair Aviation Ltd. Abbotsford, B.C. for their facility.
- Meeker Cedar Products Ltd., Mission, B.C. for the use of their dry kiln, and
- The Municipality of Mission for the study areas and assistance on their Tree Farm Licence number 26.

INDEX

INDEX (Cont'd)

FIGURES

TABLES

APPENDIX

INTRODUCTION

The forest industry is a major entity of the British Columbia and Canadian economic system. Demand for wood products is high, yet an understanding of improving reforestation with the use of prescribed slash burning and good ecological principles is at a relatively low level. Additional fire ecology research seems to be a productive venture at this time.

Obtaining adequate conifer regeneration artificially and naturally after clearcut logging in the coastal cedar hemlock zone of British Columbia is an important problem facing forest managers today. If adequate stocking is not immediately established after harvesting and site treatment, the results can be extensive brush fields and consequently added site preparation and planting cost. An additional cost is the loss of production because of the increased length of rotation. How can broadcast slash burning improve conifer regeneration success? To answer this, research must be done to determine conifer growth and success on various sites burned at different intensities. This study contributes information toward that end.

HISTORY

In 1967, the Regional Advisory Council requested of the Canadian Forestry Service that a long-term research project be initiated to study fire physics and fire effects on plant succession and forest regeneration in the lower mainland. The project started in 1968 and an internal progress report (BC-33) was published in 1972 (Lafferty, 1972a). Mimeographed reports on hydrogen ion concentrations, seedling growth rates, burning prescriptions, microenvironment and Mission Tree Farm history were also filed (Lafferty, 1972, 1973, 1973a, 1973b and 1970, respectively). During the study period, and today, government, industry and others are interested in the final results, which this report presents.

The progress report (BC-33), a Canadian Forestry Service Internal Report, describes work completed to 1972 on two closely associated research projects. One, a fire physics project which studied fire behavior in relation to fuel and fire variables, was helpful in developing prescribed burning application of the Canadian Fire Weather Index (Anon. 1978) and demonstrating that fires of different intensities can be predicted and created. Since 1972, guides using some results from the Mission project have been developed by Canadian Forestry Service scientists at the Pacific Forest Research Centre (Muraro, 1975). Two, a fire ecology project, is described in the aforementioned internal report and is the topic of this paper.

OBJECTIVES

In accordance with the original project schedule, it is proposed to re-assess the original plots and meet the following objectives:

1. Determine plant succession on plots burned at different intensities, and on unburned control plots;
2. Relate natural and artificial conifer regeneration to fire intensity.
3. Compare growth of planted and natural conifer regeneration in burned and unburned areas.
4. Determine plant biomass accumulation within the new stands.
5. Type each study area as per Klinka's (1977) guide.

METHODS

This project is an extension of the original fire ecology project; therefore, methods are similar to those described in Internal Report BC-33 (Lafferty, 1972a). Location of plots, methods, and some results described in BC-33, will be followed to help retain continuity between the original and this project, and to help accomplish the previously stated objectives. Ten previously established 4-hectare treatment units or plots were chosen for sampling on the basis of fire intensity, aspect, elevation and site.

Fire Intensity

The determination of fire intensity is described in BC-33 and the results are shown in Table 1.

Table 1. Fire intensity by plot.

	Fire Intensity			
Plot	Non	Low	Mod	High
T6				X
C6	X			
T7			X	
C7	X			
T8				X
T11			X	
T12		X		
C12	X			
T13			X	
C13	X			
T14		X		

Sample Plot Layout

On each 80 x 80 metre treatment plot, 25 points were systematically established in grid form (5x5). On all control plots, 12 points were established. The point is the center of a cluster of five 4-sq m square quadrats and the cluster is a sub-plot (Figs. 1 and 2).

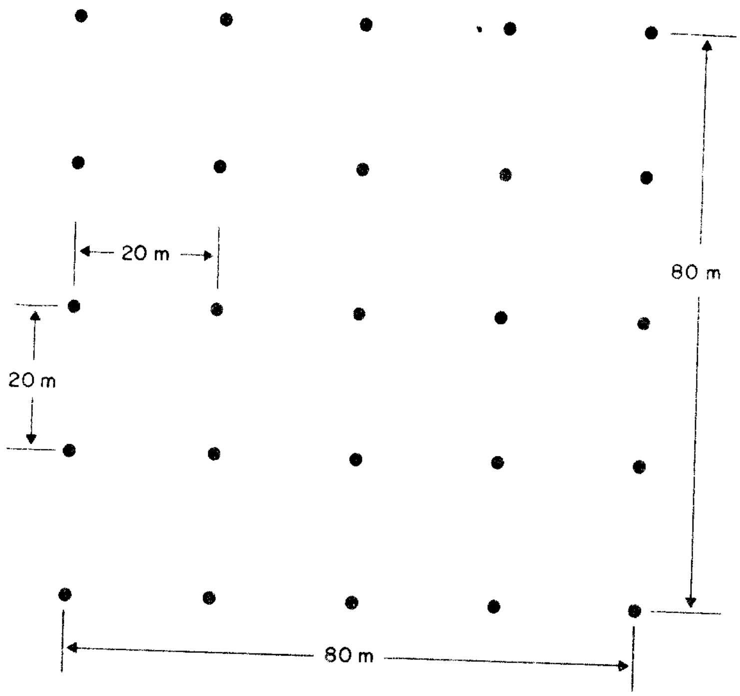

Fig. 1. Plot and sub-plot layout.

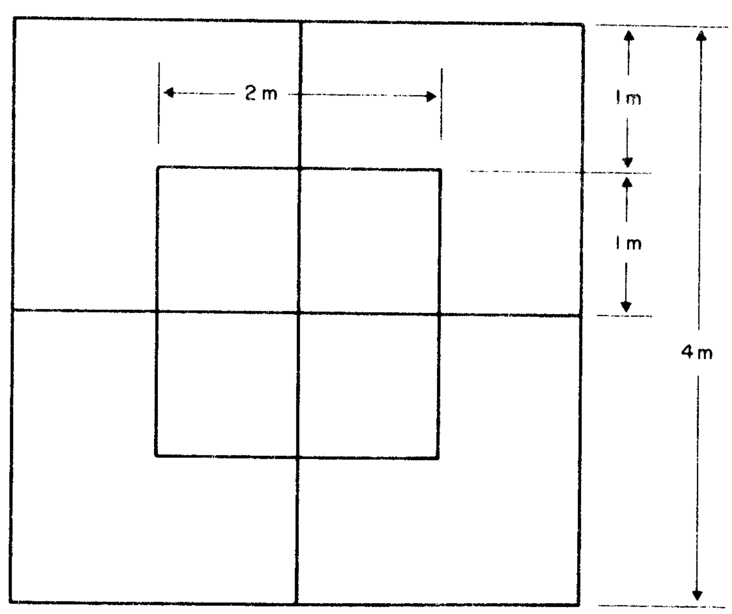

Fig. 2. Sub-plot and quadrat cluster design.

Conifer Transect Layout

Parallel to contour of the hill and sub-plot axis, 11, 3 x 100 metre, equally spaced transects were established by running string lines across the hill. A total conifer sample was done 1.5 m on each side of the transect center line.

Plant Succession and Natural Conifers

Shrubs, forbs, grasses, sedges and ferns, by species, had canopy-cover to the nearest 1 percent estimated by vertical projection on each sub-plot for an abundance estimate, and their frequency was calculated. Average height of each species was determined to the nearest 1 centimeter.

In each sub-plot, natural regeneration was noted by recording species, average height and number of stems.

A species check list is included in Appendix 1 and the vegetal nomenclature follows Hitchcock, Cronquist, Ownbey and Thompson (1959).

Planted Conifer Seedlings

More than 650 trees per hectare of planted Douglas-fir trees were measured on each treatment plot, and more than 3,500 natural and planted trees per hectare were measured in each of the control plots. A total of 6,555 western hemlock, western red cedar and Douglas-fir seedlings were measured in transects on 10 plots.

An unburned area adjacent to plot T7 was planted in 1966 and 1968 with 2-1 Douglas-fir seedlings and the area was used as a control plot (C7).

In 1979, 3-metre-wide transects, with string in the centers for identification, were established. The strings were about 8 metres apart and 100 metres long. All trees within the transects over 1 meter high were identified to species, condition and whether natural or planted. Their height was measured and diameter-at-breast-height was recorded. Number of trees per hectare, basal area (m^2/ha), average basal area per tree (cm^2), average height per tree (m) and standard deviation of basal area and height were calculated (Appendix 4).

Spring Hazard

Spring hazard is identified as being 2 year's accumulation of dead vegetation. It consists of fallen leaves, needles, fronds and stems of annual, and perennial plants. Moss, lichen and other green vegetation were avoided, as was slash more than 1 year old.

Five representative sub-plots on each study plot were subjectively chosen to be destructively sampled and the samples were dried and weighed. Samples were collected in 1 pound burlap feed bags and placed in the dry end of a dry kiln at 82°C for 6 days. Humidity was not recorded, but throughout the litter sample, material was crisp and assumed to be oven dry. Samples were weighed on a balance beam scale with a sensitivity of 1 ounce. One pound was deducted from the gross weight to determine net weight of sample. Sample weights were converted to kg/ha. After the litter layer was removed, average duff depth was determined from 10 points within the sub-plots.

Site Type

A soil map[1] of the Mission area and the results from BC-33 were used to help determine soil types.

Pre-burn and early stages of post-burn vegetation were taken from Lafferty (1972a).

Klinka's (1977) "Tree Species Selection and Prescribed Burning Guide" was used to help identify the site type of each plot.

General Comments

Conclusive results of the original study were not reported in 1972 because of the early stages of plant succession and growth at the time. However, history, study area, method, and results are included in the 1972 report.

The objectives of the original study were to:

1. Compare pre- and post-burn plant communities.

2. Determine vegetal succession patterns after fires of different intensities.

3. Relate successional patterns to natural and artificial regeneration after fire of different intensities.

To achieve those objectives, studies were initiated on plant succession, natural and artificial regeneration, and general effects of fire on the site.

Preliminary results in 1972 indicated that:

---

1 Soil Survey of Mission Area, preliminary report number 9 of the Lower Fraser Valley Soil Survey, British Columbia Department of Agriculture, Kelowna, B.C. 1968.

1. Fire intensity could be predicted with confidence using the Canadian Fire Weather Index and fuel loading in the Coastal Douglas-fir-western hemlock-western red cedar types.

2. Plant succession could be set back to different stages using fires of different intensities.

3. Early stages of forest regeneration growth and success were directly related to fire intensity, plant succession and site.

It has been more than 10 years since the inception of the original study and recent preliminary examination of the study area showed that plant species had changed, conifer seedlings had grown considerably, and the original plots were becoming obscured by vegetation and their identity was fading.

The original study plan stated that a 10 year examination should be made to determine the feasibility of continuing the project another 10 years, and also to help answer some of the original objectives. We are now at the first 10 year juncture and additional work is required.

The results presented in this paper will facilitate management decision making processes and policy concerning slash burning and reforestation in the coastal Douglas-fir western hemlock-western red cedar types of southwestern British Columbia.

RESULTS AND DISCUSSION

Fire Intensity

Fire intensity was determined at time of burning and described in report BC-33. Table 2 shows a summary of those results.

Table 2. Matrix of fire intensity and aspect by plot.

Fire Intensity

Aspect	Non	Low	Mod	High
South	C-13 C-7	T-14	T7 T13	T-8
North	C-6 C-12	T-12	T-11	T-6

Fire intensity is described in relative terms; however the determination was a result of objective observation and definitive measurement. Factors that helped determine fire intensity were the amount of energy released over a specific area within a given period of time (Cal./m^2/min), fire rate of spread, mineral soil exposure, organic mantle reduction and weather variables.

Prescribed fires in the coastal hemlock type have not been documented as well as those in this study. Beaufait (1977) had an elaborate system of fuel measurement, fire intensity measurements and vegetation surveys in the western larch-ponderosa pine type of northwestern Montana. This study resembles that one, and both produced definitive fire intensity and plant succession data.

Tarrant (1954) wrote that increased pH after slash burning was related to fire intensity of the burn. Soil pH was monitored and reported in a mimeographed note (Lafferty 1972), and in BC-33 by this author for the Mission Tree Farm prescribed burns. It was thought that the soil pH changes would indicate relative fire intensity. However, even though pH increased in the humus layer as much as 1.03 and 1.96 on two high intensity burns, moderate and low intensity burns were not significantly different with their change of only 0.32 (Mod.) and 0.54 (Low).

Baker (1968) brought small soil samples, burned at different fire intensities, into the laboratory to test conifer germination and growth. His relative determination of fire intensity was different than Humphrey and Lambert's (1965) even though both used soil pH as an indicator.

In 1947-51, Morris (1958, 1970) determined four classes of fire intensity by post-burn fuel measurements and subjective observation in western Washington and Oregon. Kraemer and Hermann (1979) relocated Morris's plots to determine the effect of burning on forest soils 25 years post-burn. Burned plots were those with 70% or more of the total area burned, and severity was assumed from subjective line transect data collected the year of plot establishment.

In Jablanczy's (1964) dissertation abstract, he and Krajina pointed out the good and bad effects of burning various sites at various intensities. Their criteria for burn intensity appears to be the percentage of humus consumed.

Many of these researchers came to their conclusions by using subjective and relative fire intensity values. They did not measure temperature, rate of spread, site impact, total energy nor combustion rates. They did designate a relative fire intensity value determined from the condition of the post-burn site, plant species changes or soil-pH. It would be difficult to duplicate their fire intensities.

During 1971, Muraro, Lawson, Turner, Russell and Lafferty (1973) used codes of the Canadian Forest Fire Weather Index (1978) and fuel loading to predict fire intensity and consequently fuel reduction, organic layer consumption and plant succession on research areas within Pacific Rim National Park. In studies by Muraro et al. and in the original Mission study, codes of the CFFWI and fuel consumption were used to determine fire intensity.

The CFFWI is a system of indices that accounts for meteorological factors and fuel wetting and drying lag times of three classes of fuels. This system seems to be one of the most predictable, reproducible and accurate methods of predicting probable fire intensity in Canada today.

Plant Succession

One span of plant succession consisting of the rotation period of the crop tree, estimated at 95 years, is considered in this paper. A deterministic single pathway subjective prediction of plant succession is made from objective data. A replacement sequence plant succession model (Cattelino and others, 1979) is not used because frequency and intensity of pre-burn disturbances, history and other factors are not well known.

Our study areas are divided into two types distinguished by elevation and aspect. The two elevations are 246 m asl and 550 m asl, and the two aspects are generally south and north (Table 3).

Table 3. Location of sample plots by aspect and elevation.

	South	North
246 m asl	T7,T8,T14	T6,C6
550 m asl	T13,C13	T11,T12,C12

Low elevation south aspects had fire intensities of low, moderate and high. Low elevation north aspects had intensities of unburned and high.

High elevation south aspects had fire intensities of unburned and moderate, and north aspects, unburned, low and moderate.

1971 vegetation survey

Low elevation pre-burn vegetation was predominantly hemlock and Douglas-fir on south aspects, and hemlock and cedar on north aspects.

Plant associations were Douglas-fir-hemlock-Oregon grape-red huckleberry-sword fern on south aspects, and hemlock-cedar-elderberry-salmonberry-sword fern on north and east aspects. About three growing seasons post burn, the plant aassociation at the lower elevation south aspect study areas were fireweed-salal-trailing blackberry-bracken fern, and on the north aspects, maple-elderberry-thimbleberry-salmonberry-trailing blackberry and sword fern.

Low elevation south aspect plots had the same dominant species 3 years' post-burn as they did during the first growing season, but the north aspect plots, burned at high intensity, had rapid plant succession over that period. Senecio was dominant the first summer, but had almost vanished by the third growing season.

Shrub species were expected to dominate for several more years on both low elevation aspects. Refer to Lafferty (1972a) for details of plant succession up to year 3.

Three years' post burn, on the unburned low elevation north aspect plot (C6), thimbleberry and salmonberry increased the same amount. Fireweed was slowly increasing in abundance from the first year's 1% canopy-cover. Salal was less than 1% and had not increased by the third year. Willow and birch had low canopy-cover and had not increased. Senecio was only recorded in 1970, the year it was most abundant in treatment plot 6. Other annuals and pioneers were rarely present 3 years' post burn.

1979 vegetation survey[2]

During the 1979 study period, vegetation on low elevation areas had 10 (T8 and T14) and 11 years (T7, T6 and C6) of growth since logging. Vegetation on high elevation areas had 9 (T12 and T13) and 10 years (C12 and C13) growth since logging. Burning took place 1-year post logging on all treated areas.

Low elevation sites in general had a higher "total", "shrub" and "fern" abundance (canopy-cover) than areas at higher elevation. The difference may be attributed to the time since burning, which was 1 and 2 years more than at low elevation (Fig. 4b).

"Total" abundance on all areas ranged from 78 to 100%, with 92% the average. "Shrub" abundance ranged from 41 to 100%, with an average of 72% (Fig. 3a).

"Shrubs" at low elevations averaged 84% with 94 and 78% on north and south aspects, respectively. At high elevations, "shrubs"

---

2 Appendix 1. Checklist of Plants.

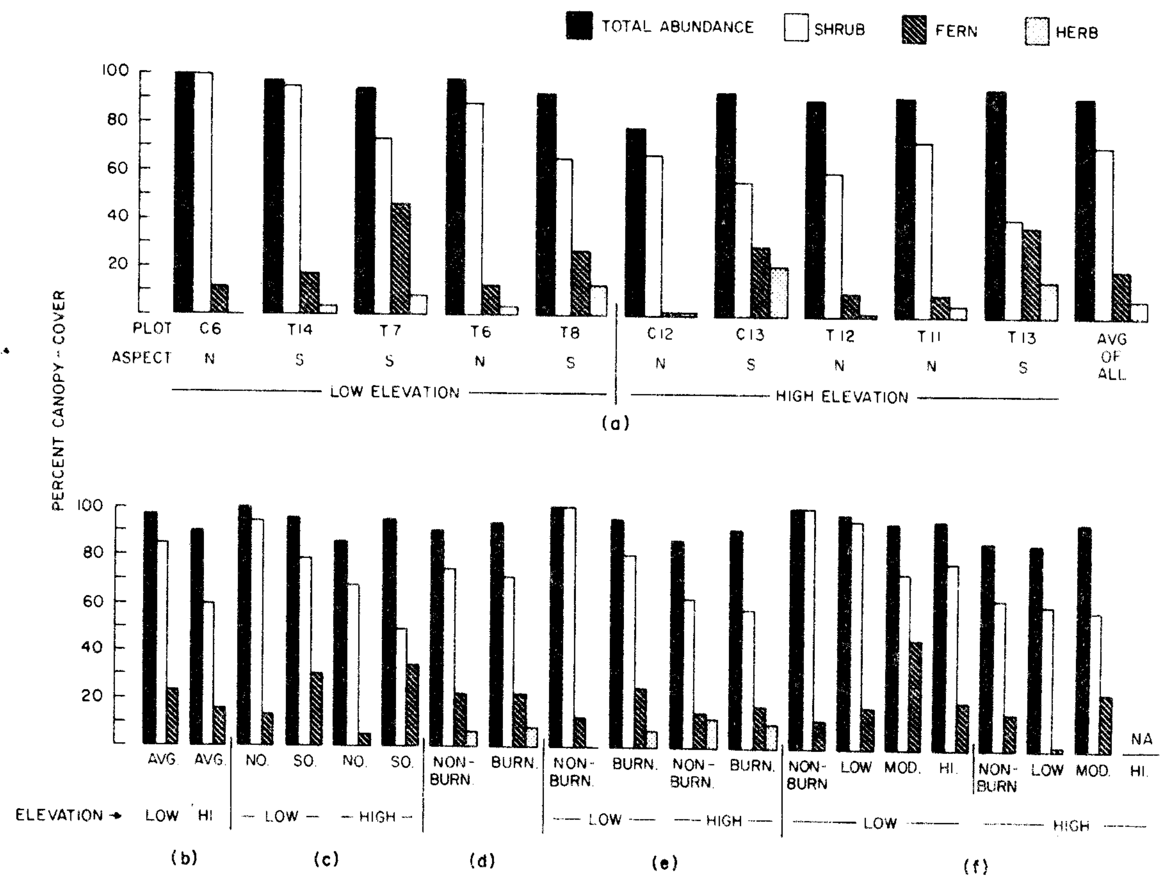

Fig. 3. Percent canopy cover of ingrowth vegetation by elevation, aspect and treatment.

averaged 59%, with 67% and 49% on north and south aspects, respectively (Fig. 3b).

The difference between all unburned and all burned areas appears minimal, "total" abundance being 90 and 93%, respectively (Figs. 3d and 3e). Although there was not a high intensity burn at high elevation, it appears fire intensity does not significantly affect "total" abundance of undergrowth vegetation on high or low elevation plots 8 to 10 years post-burn (Fig. 3f).

All study plots had a high abundance of vegetation. Most plants were mature and displayed maximum height growth; the exceptions were tall shrubs and deciduous trees. Undergrowth vegetation was different under the closed conifer stands from that in the sub-plots, which was not under a conifer canopy. Plot 6, on a north aspect at low elevation burned at high intensity, had almost 100% conifer canopy closure. Within the stand, outside of the sub-plots, sword fern was vigorous, but remnant plants of salmonberry, alder, willow and fireweed were present. Plants under the conifer canopy in this plot are good examples of vegetal succession within a Douglas-fir stand 10 years after good conifer growth on an overstocked area (Fig. 4b).

Control plot C6, immediately adjacent to treatment plot T6, had "shrub" canopy cover of 100% and similar ingrowth vegetation to that found on sub-plots in plot T6.

Successional trends at low elevation

north aspect

Control plot 6 had 6% vine maple and 6% thimbleberry the first year following logging. During the next 10 years, vine maple increased to 8%, and thimbleberry increased to 16%, and then decreased to 4%. On the same plot, alder and birch were not recorded until several years after logging and are now 28 and 29%, respectively. Salmonberry is most abundant at 80%. Sword fern is increasing slowly and is now 14%. All species except thimbleberry are increasing in abundance. As the canopy closes, thimbleberry appears to be the least tolerant of the species shown (Fig. 4a).

Treatment plot T6, on a north aspect also and burned with a high intensity fire, has similar plant species as control plot C6, the difference being that thimbleberry is a little more abundant and salmonberry has 24% canopy cover as opposed to 80% on C6. Very little salmonberry was present in the pre-burn plant community; however, sword fern, vine maple and thimbleberry had 6, 4 and 3% pre-burn canopy cover, respectively. Succession of ingrowth vegetation in sub-plots on T6 is stabilizing and will decrease over the next 10 years because the conifer canopy will cover the sub-plot openings. Thimbleberry will be the first species to disappear from the sub-plots. Planted conifers, average height of 7 metres, have a definite effect on the undergrowth vegetation

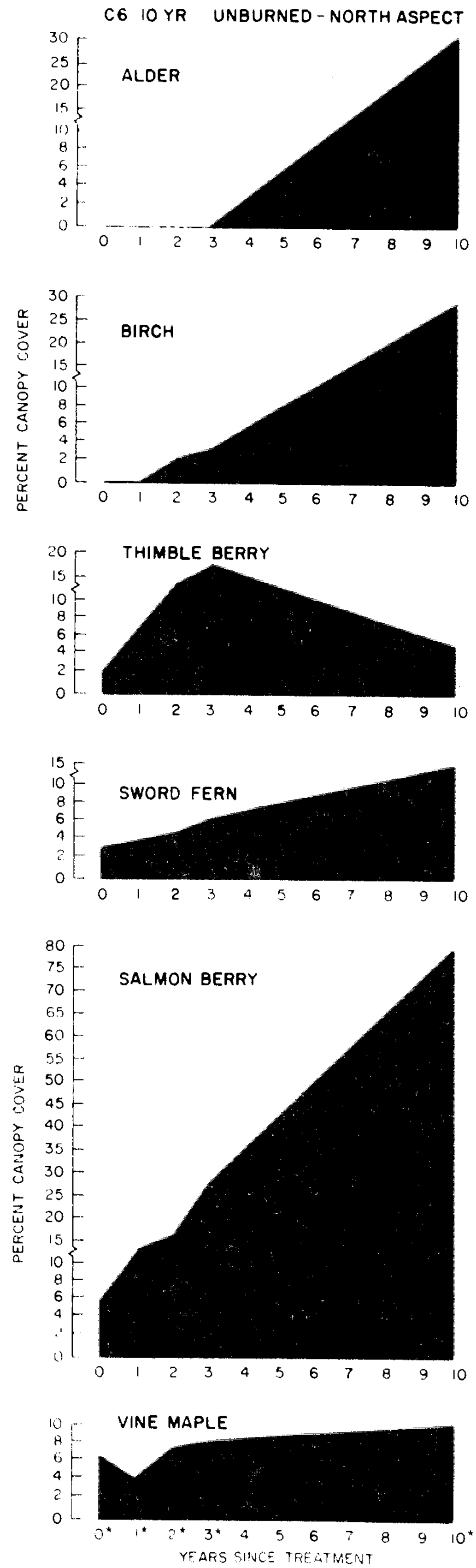

Fig. 4a. Plant succession, low elevation. Plot C6 unburned, north aspect.

in this plot because of competition for space, light, nutrients and water. Plot C6 did not have conifer competition; therefore undergrowth vegetation developed uninhibited (Fig. 4b).

south aspect

Plot T7, just around the hill from T6 and C6, on a south aspect, was burned with a moderate intensity fire. Oregon grape, which was present pre-burn (7% c-c), has vanished from the sample sub-plots. Remnants may still be seen in isolated microsites on the plot and adjacent to it. The moderate intensity fire was not hot enough to destroy plant rooting systems, or spores of some plants a few centimeters below the soil surface. Consequently, salal, red huckleberry, bracken fern and fireweed sprouted from below ground parts shortly after the fire. Fireweed was most abundant the first few years after burning and is now diminishing to an insignificant amount within this plant community. Fireweed, Oregon grape, salal and thimbleberry will decrease or vanish from this site within 10 years. Birch, alder and willow will increase in abundance for some time, until the conifer canopy squeezes them out; possibly in another 10 years (Fig. 4c).

Plot T8, up the hill about 500 metres from plot T7, was burned with a high intensity fire. More salal and less Oregon grape were recorded in its pre-burn community than in T7. Plant succession is very similar here to that in plot T7, with the exception that Oregon grape is still an entity of this plant community and will be present for several more years. Fireweed and thimbleberry have already disappeared from this plot. Salal had 3% canopy cover pre-burn and now, 9 years later, has 50% (Fig. 4d).

Adjacent to plot T8 is plot T14, which was lightly burned in February 1971. The fire did not destroy roots of most perennials sampled. Salal had 8% canopy cover pre-burn and bracken fern 2%. Nine years post-burn, salal is 89% and bracken fern 17%. Fireweed is still persistent, and red huckleberry, sword fern and deer fern have 1% canopy cover each. Bracken fern, and fireweed will decline over the next 10 to 15 years as the conifer canopy starts to fill in (Fig. 4e).

It seems that each sample plot has a certain capacity to produce biomass. On all of the Mission study plots, regardless of aspect, elevation or burn intensity, there does not seem to be a significant limiting factor to growth. (Length of growing season does not seem to have a significant effect on total plant biomass.) The one factor that is expected to become significant in future years is conifer canopy closure.

Bracken fern and fireweed seem to have propagules in all our study areas and by removing competition for light, space and nutrients, fire stimulates new growth of these and other species.

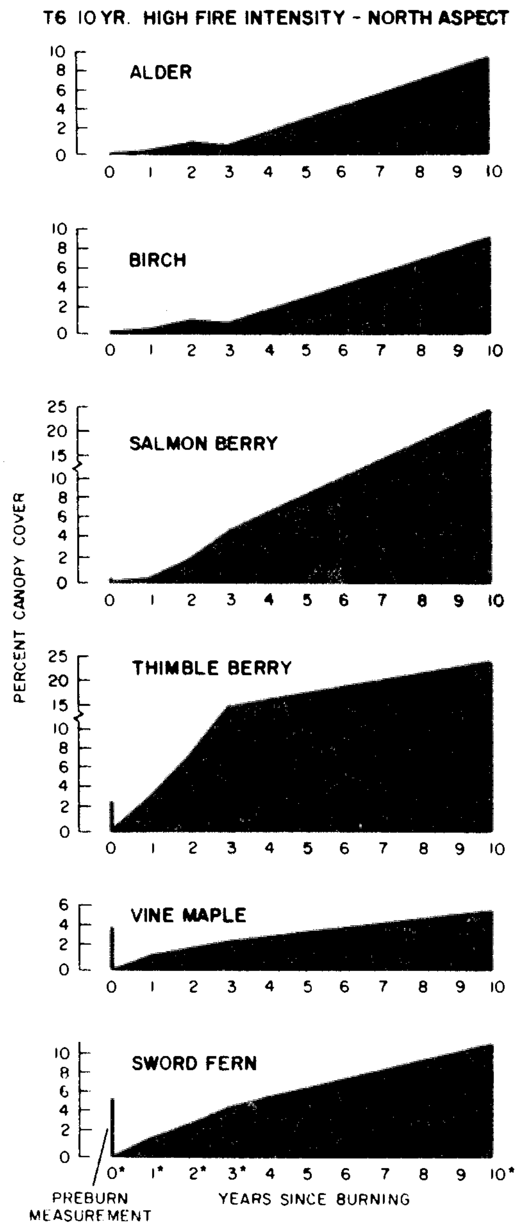

Fig. 4b. Plant succession, low elevation. Plot T6. High fire intensity, north aspect.

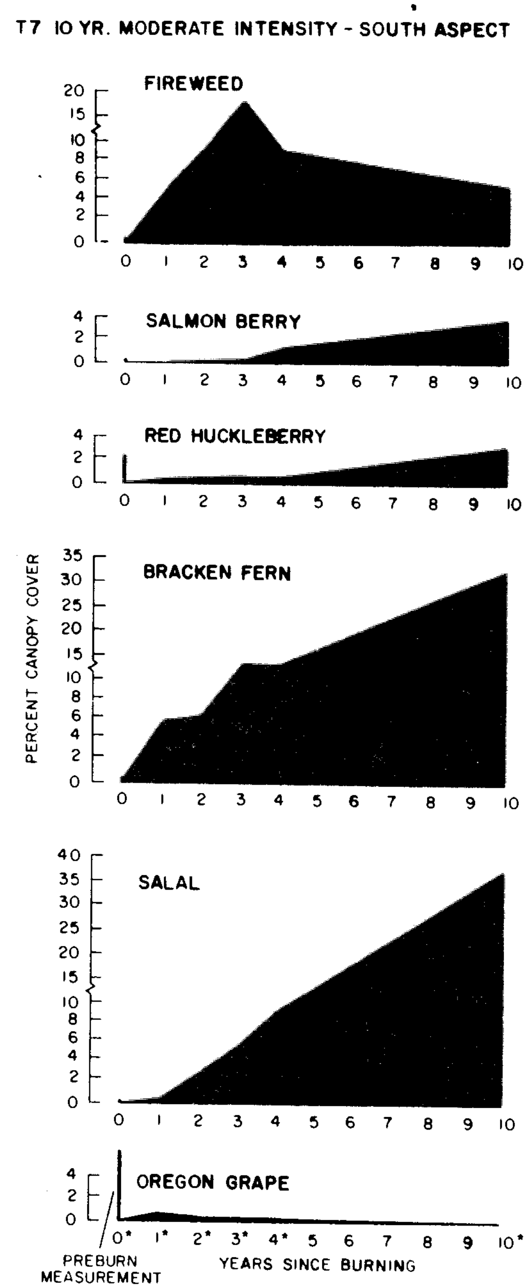

Fig. 4c. Plant succession, low elevation. Plot T7. Moderate intensity, south aspect.

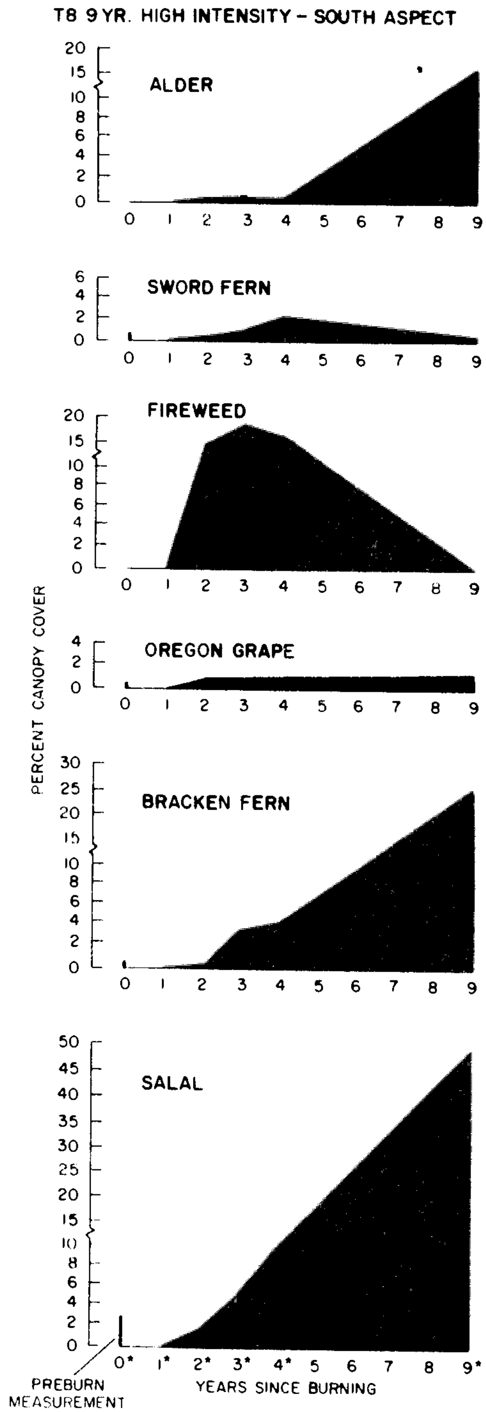

Fig. 4d. Plant succession, low elevation. Plot T8. High intensity, south aspect.

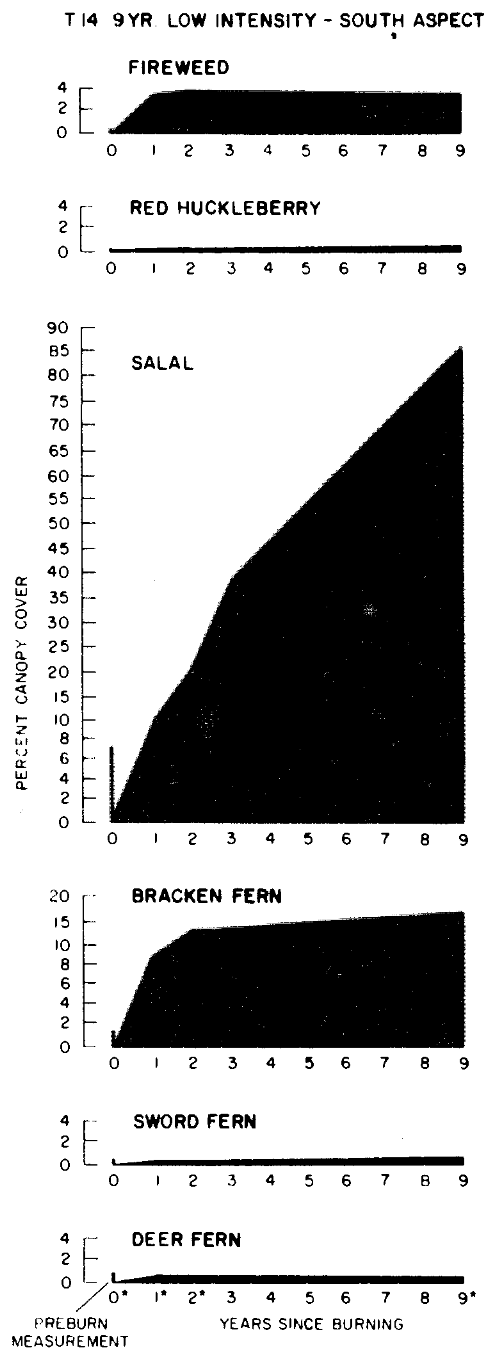

Fig. 4e. Plant succession, low elevation. Plot T14. Low intensity, south aspect.

Successional trends at high elevation

north aspect

Plot T11, on north aspect burned at moderate intensity, had 6, 15, 5 and 20% abundance of sword fern, salmonberry, elderberry and black huckleberry pre-burn, respectively. Today, sword fern is 1%, salmonberry 60%, elderberry 1% and black huckleberry 3%. Bracken fern and fireweed became significantly abundant, with canopy covers of 7 and 28%, respectively, 3 years post burn. Salmonberry will probably increase and elderberry, fireweed and salal will probably disappear within 10 years (Fig. 5a).

Plant succession on plot T12, on north aspect burned at low intensity, is similar to that on T11, except that the vegetal abundance is less in most respects. Salal was not found here, but Devil's club was, indicating a cooler, more moist and more acid (Lafferty, 1972) site (Fig. 5b).

Salal was found on north aspect control plot C12 during the first few years after logging but has now disappeared. Deer fern, fireweed and Devil's club are all declining. Salmonberry and black huckleberry are, respectively, 29 and 28% abundance now, and will probably maintain that until the conifer canopy closes (Fig. 5c).

south aspect

The south aspect control plot C13 is similar to the treatment plot T13, burned at moderate intensity. Abundance of sword fern, deer fern, bracken fern, black huckleberry and salmonberry was 7 to 13% immediately after logging on the control plot (C13). Deer fern and sword fern have been the only species to decline over 9 years. Red huckleberry has increased in abundance from near zero pre-burn to the present 10%. In the future, bracken and sword fern will decrease, and thimbleberry and salal will disappear from these south aspect sites (Fig. 5d).

The south aspect treatment plot T13 also had sword fern, deer fern, bracken fern, salmonberry and black huckleberry present in significant amounts pre-burn. Two years after the moderate intensity fire, bracken fern increased to 31% canopy cover and today is 37%. Salmonberry did not increase as fast and is now 17%. The other species mentioned are equal to or less than pre-burn abundance levels (Fig. 5e).

Appendix 2 shows percent frequency of occurrence, height and percent canopy cover of plants found on all sub-plots.

It is not believed that the data show a significant difference in ingrowth plant abundance between high and low elevations, fire intensities and aspects. As mentioned earlier, our sites have a high capacity to grow biomass, and ingrowth vegetation will be found in high abundance until the conifer canopy cover closes.

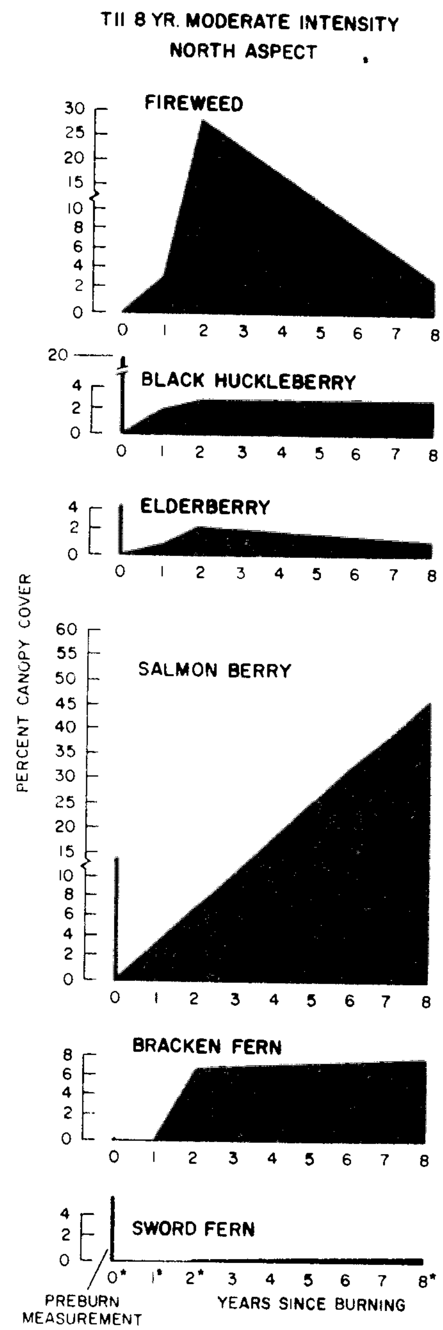

Fig. 5a. Plant succession, high elevation. Plot T11. Moderate intensity, north aspect.

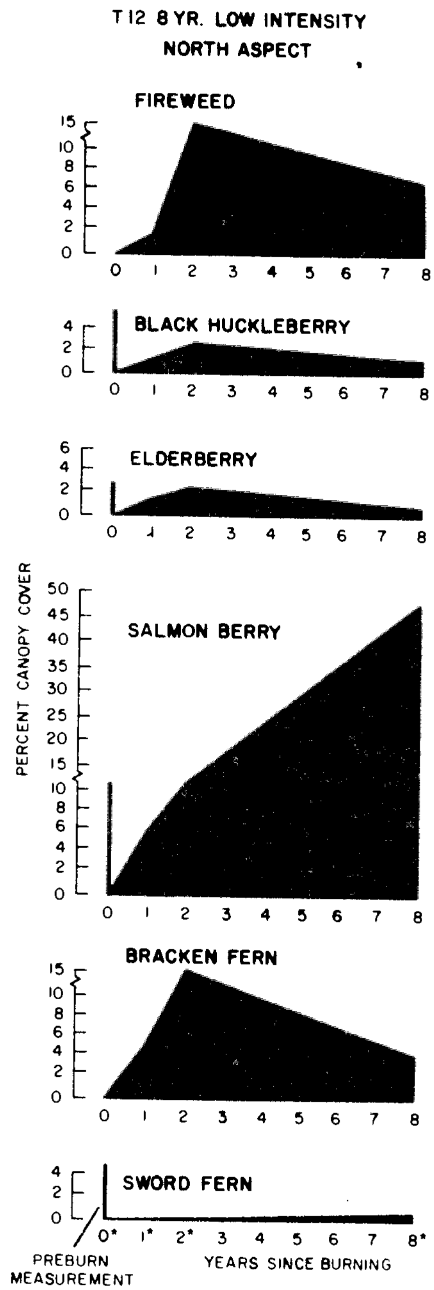

Fig. 5b. Plant succession, high elevation. Plot T12, low intensity, north aspect.

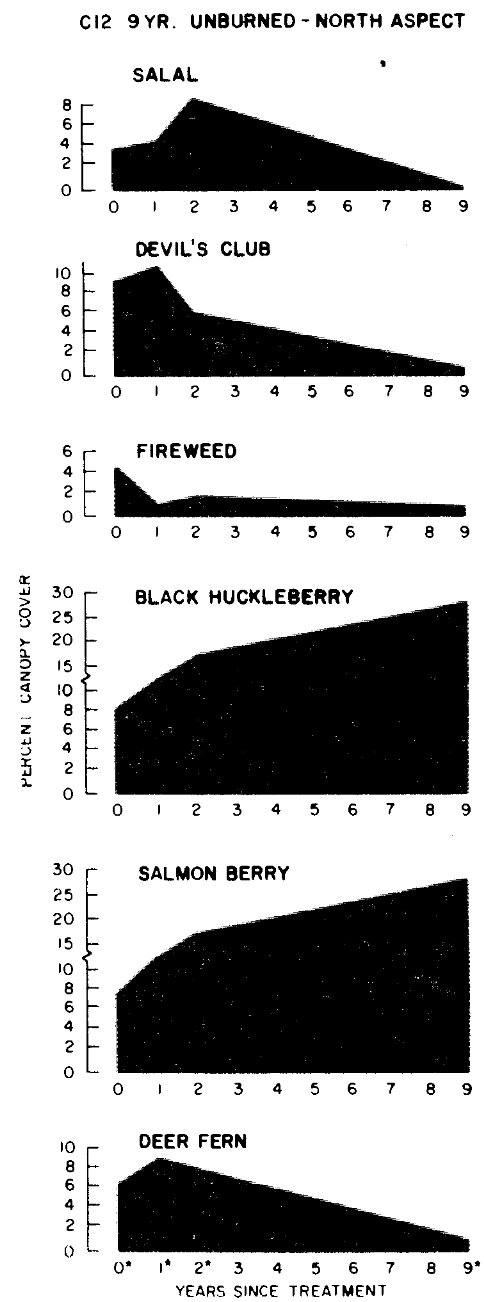

Fig. 5c. Plant succession, high elevation. Plot C12, unburned, north aspect.

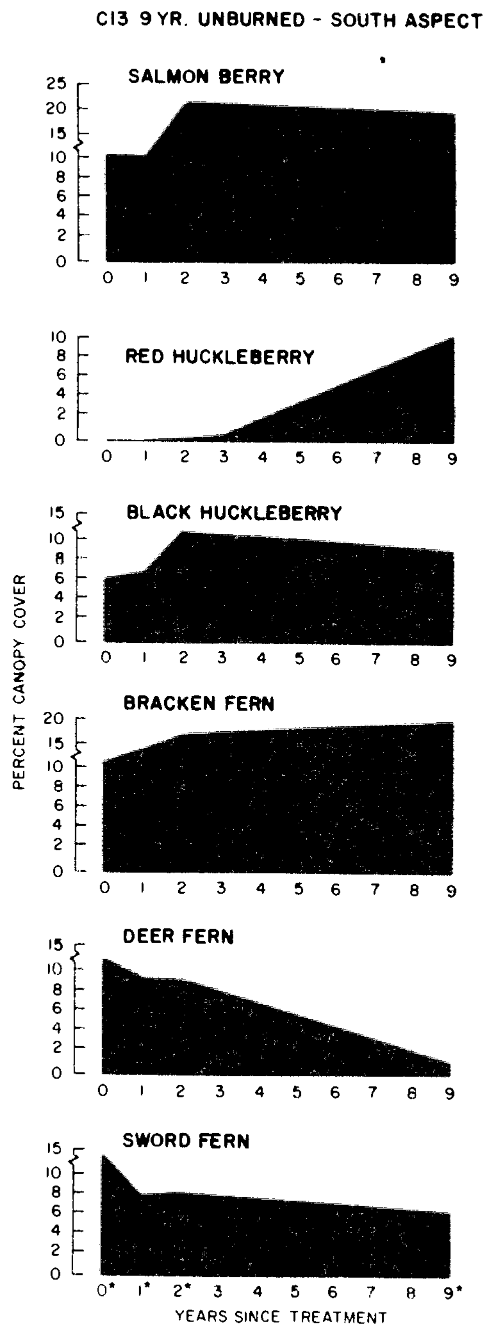

Fig. 5d. Plant succession, high elevation. Plot C13 unburned, south aspect.

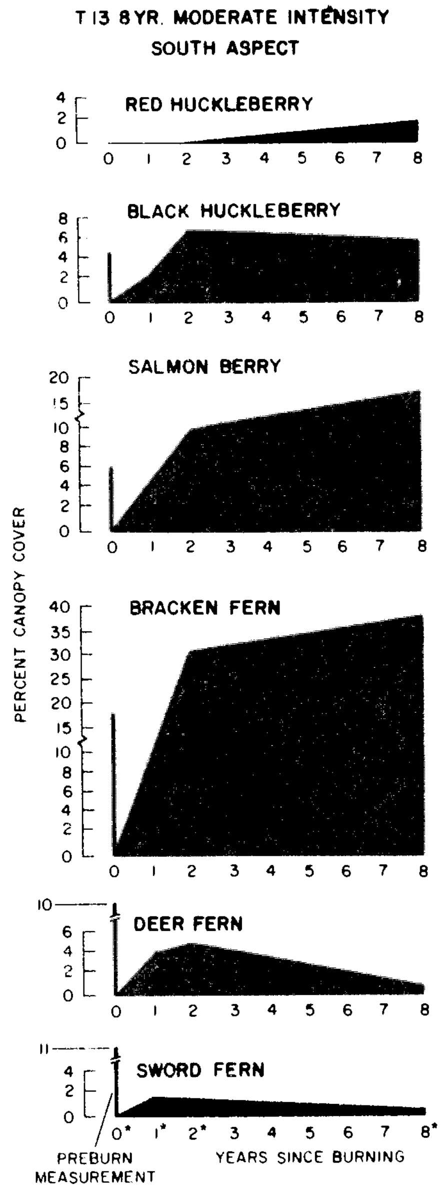

Fig. 5e. Plant succession, high elevation. Plot T13. Moderate intensity, south aspect.

Natural Conifers Growing in Sub-plots

Frequency of occurrence

In each sub-plot, natural conifer ingrowth was sampled to determine the receptiveness of the site for conifer regeneration under existing conditions of site type, vegetal ingrowth and burn intensity. Table 4 shows frequency of occurrence of several conifer species, by elevation, aspect and fire intensity.

Table 4. Frequency of occurrence of conifers by elevation, aspect and fire intensity.

a) Low elevation

Fire Intensity

		Non	Low	Mod	High
W.R. Cedar	South	NA	NA	14	79, 13
	North	17	NA	NA	47
W. Hemlock	South	NA	NA	86	46, 15
	North	50	NA	NA	74
Douglas fir	South	NA	NA	14	17, 8
	North	0	NA	NA	0
Balsam	South	NA	NA	0	0, 0
	North	0	NA	NA	0
Spruce	South	NA	NA	5	0, 0
	North	0	NA	NA	0

b) High elevation

		Non	Low	Mod	High
W.R. Cedar	South	17	NA	74	NA
	North	33	50	80	NA
W. Hemlock	South	83	NA	95	NA
	North	83	68	75	NA
Douglas-fir	South	17	NA	42	NA
	North	42	64	80	NA
Balsam	South	58	NA	11	NA
	North	58	9	0	NA
Spruce	South	0	NA	0	NA
	North	0	0	0	NA

Data are not available for some conditions because of the lack of sample plots burned at all intensities; i.e., for low elevation low intensity burn or high elevation high intensity burn (Table 4).

Balsam fir and Sitka spruce

Frequency of occurrence of balsam fir was only important at high elevation unburned south and north aspects. Spruce was unimportant in all areas.

Douglas-fir

Douglas-fir naturals were found most often at high elevations and on both unburned and burned areas. Further sub-plot analysis should be done to determine the percentage of sub-plots burned, mineral soil exposure and duff reduction. This may indicate that natural Douglas-fir seed germinates on unburned sites more often than on burned ones. However, that analysis is beyond the scope of this study. A further complication for this survey was that only one area was left unburned at low elevation and all seedlings planted in that area were eaten and killed by animals the first year after planting. Because that area appeared to be a feeding area for animals, all natural conifer germinates were assumed to have been eaten.

Western hemlock

Western hemlock naturals were found as often at both elevations in unburned as in burned areas. At high elevation they were found in more than 68% and at low elevation more than 46% of the sub-plots.

Western red cedar

Western red cedar naturals seemed to frequent burned sub-plots most often, especially those burned at high intensity.

Height and number

Western red cedar

Height of western red cedar naturals at low elevations averaged 108 centimeters and number of trees averaged 736 trees per hectare. Burned areas averaged 589 trees per hectare, heights averaged 135 centimeters, and trees on unburned areas were much shorter. Of the burned plots, low intensity ones had the tallest trees, but fewer of them compared to high intensity burned areas (Fig. 6a). South aspects had more and, taller trees than north aspects, similar to pre-logging conditions.

At high elevation, western red cedar averaged 138 centimeters and 748 trees per hectare. It was tallest on unburned areas, but on unburned areas it had fewer trees per hectare than on burned plots. The opposite was found at low elevation. Cedar on south and north aspects seem to be about equal in number and height at high elevation (Fig. 6a).

Jablanczy (1964) reported that western red cedar put on more growth on severely burned sword fern sites than on sword fern sites moderately burned or unburned. He also found that cedar seedlings grew best on moderately burned areas on salal sites, but poorest on severely burned salal sites.

As explained before, the data presented here do not adequately represent low elevation unburned sites because of browsing in the early stages of this study on high elevation severely burned sites. Keeping this in mind, it is concluded that natural western red cedar grows equally well on burned or unburned sites at high elevations on north or south aspects. However, at low elevation cedar is most common on burned south aspects.

Western red cedar appears to regenerate and survive best under conditions created by fire; the more intense the fire, the more trees per hectare. Height growth is lower on more intensely burned areas, probably because seedlings become established earlier on less intensely burned areas. It appears that more intense fires create a condition that is better for western red cedar establishment and survival.

Western hemlock

Western hemlock is suited to our study sites. It averaged 129 centimeters of growth at low elevation and 222 centimeters at high elevation. Both low and high elevation areas are over-stocked; 1,497 and 3,185 trees per hectare, respectively. At both elevations, hemlock grows as well on burned areas as on non burned areas, but very well on high elevation unburned areas. Low elevation high intensity burns do not appear to be conducive to good hemlock establishment and growth (Fig. 6b), which is contrary to Jablanczy's 1964 findings on sword fern and salal sites.

Western hemlock grew better than the other natural conifers on almost all areas sampled. There appears to be no advantage to prescribe burn for the management of western hemlock. However, subjective observations note that prescribed burning generally reduces the amount of rotten wood and other germination medium and, therefore, hemlock germinates more at random and more evenly spaced on burned areas.

Douglas-fir

Douglas-fir grew an average of 88 centimetres over about 11 years at low elevation and, in comparison, 214 centimetres over 9 years

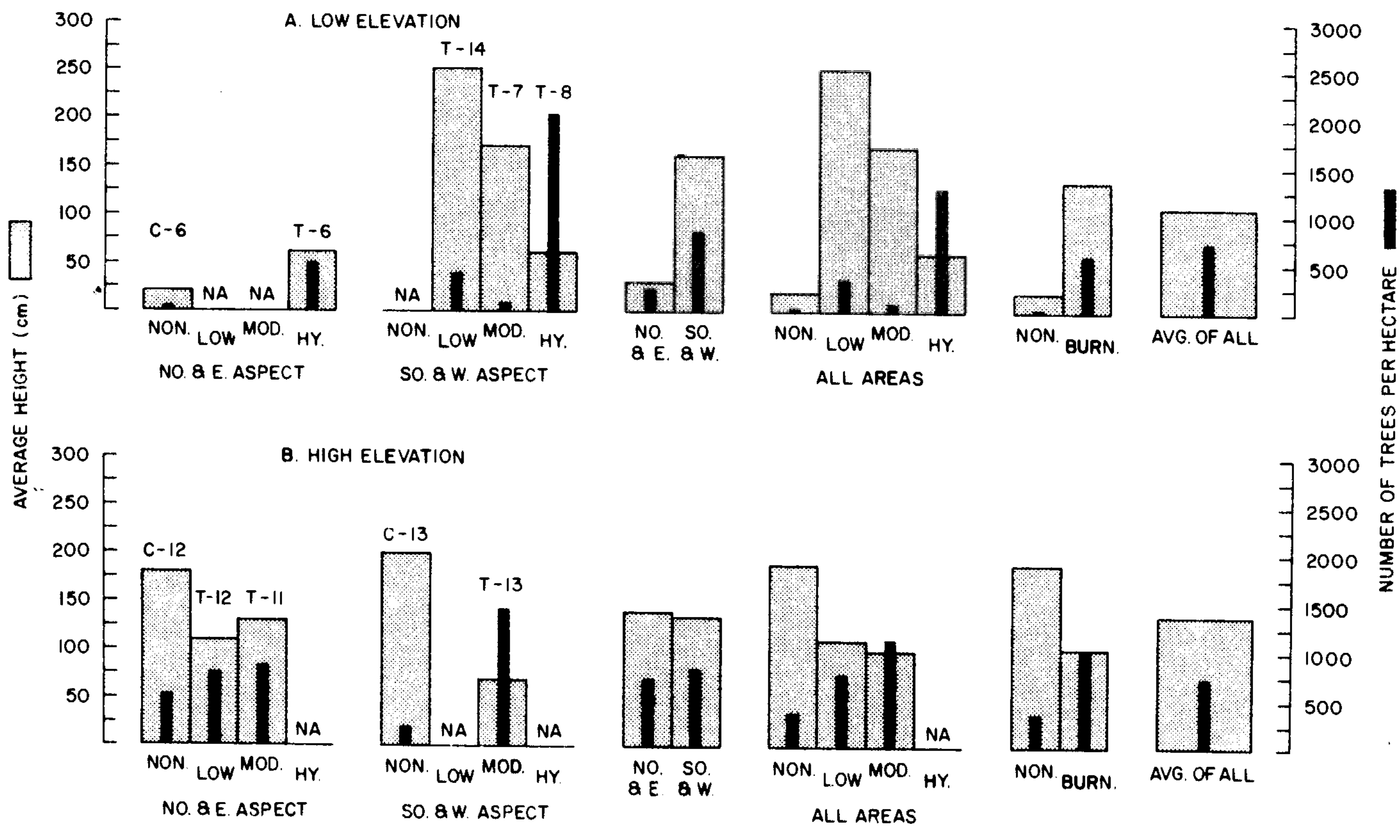

Fig. 6a. Average height and number of natural western red cedar trees per hectare by elevation, aspect and treatment.

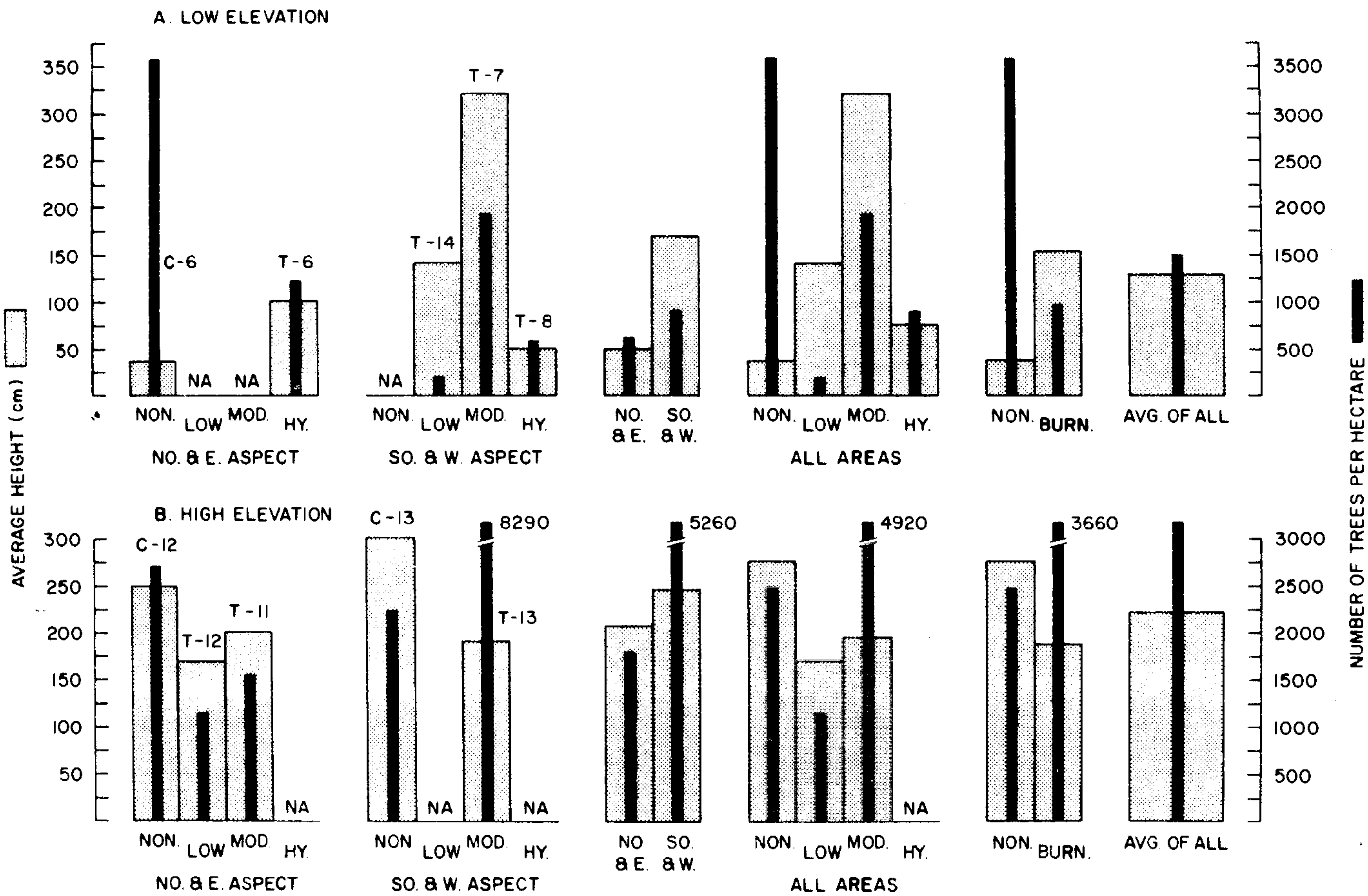

Fig. 6b. Average height and number of natural western hemlock trees per hectare by elevation,aspect and treatment.

at high elevation. Also, low elevation areas were understocked with natural Douglas-fir (average 58 trees per hectare) and, at high elevation, satisfactorily stocked (average 547 trees per hectare).

At high elevation, burned north aspect plots were the only areas with satisfactory stocking. Generally, burned areas were better stocked than unburned areas (Fig. 6c). All low elevation areas were understocked.

At high elevation, trees on burned areas averaged 190 centimetres and on unburned areas 250 centimetres. The tallest Douglas-fir seedlings were found on north aspects and in areas treated with less than moderate intensity fire.

At low elevation, those trees growing on south aspects, with plots burned at high intensity, were taller than the average Douglas-fir.

Balsam fir

Balsam grew best on unburned north and south aspects at high elevation, mainly because the species was present pre-burn. It appears that burning does reduce their chances for establishment.

Variability of percent frequency of occurrence of each species is understandable. The trend is similar to that found in number of trees per hectare; i.e., where there are more trees, there is a higher percent frequency of occurrence. This holds true with all conifer species studied and indicates equal distribution over the study areas. It is interesting to note that balsam fir was found in almost 60% of the sub-plots on unburned high elevation plots. Burned areas had about 10%.

At this time, natural conifer seedlings do not present significant competition to planted conifers. They do contribute to biomass and they do compete for various life systems but, because of their height, frequency of occurrence and numbers, it is believed they will be crowded out and eventually die within the planted conifer understory. This effect is visible in plot T6. The one exception to this is plot T13, in which western hemlock averaged 190 centimeters in height, frequency of occurrence was 95% and they numbered 8,289 trees per hectare. Plot T13 is a relatively small area with an abundant seed source around the perimeter, and a good growing site.

Appendix 3 is a summary of field data on natural conifers by plot.

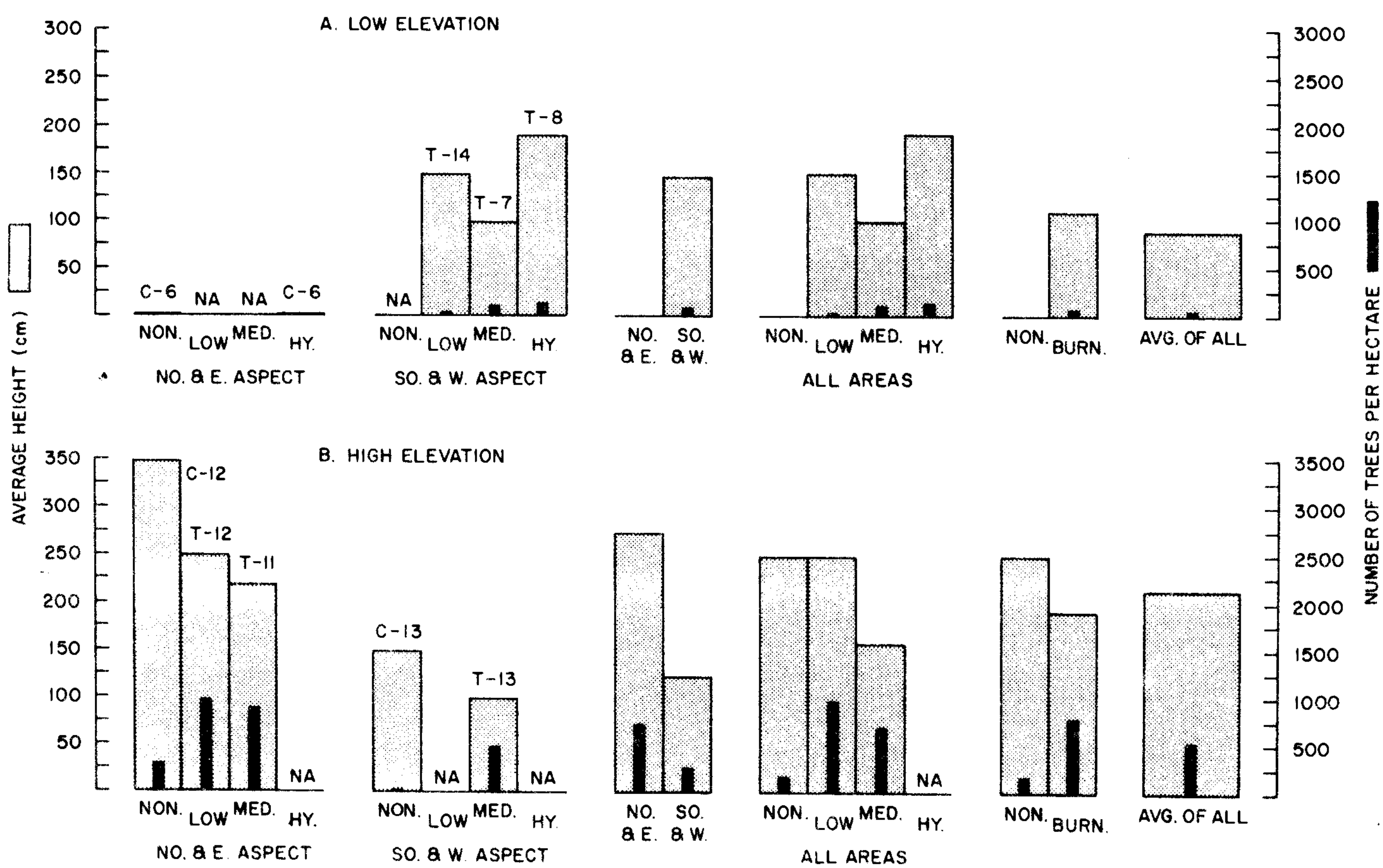

Fig. 6c. Average height and number of natural Douglas-fir trees per hectare by elevation, aspect and treatment.

Planted Conifer Seedlings

Number of trees

The number of planted Douglas-fir seedlings ranged from 654 to 2,512 trees per hectare. Sample areas C7 and T11 were planted twice, which accounts for 2,033 and 2,515 trees per hectare, respectively (Fig. 7). The original stocking goals was about 1,300 trees per hectare. Mortality rates averaged 20%, several years after planting, with a high of 55 and low of 6%. The 55% mortality was the result of an unexplainable failure in all the fall planted stock on 50% of the area of plot T7. Plot T8 had the next highest mortality of 32%, which partially accounts for the low number of trees per hectare (654) found this year.

Generally, unburned control plots have the most trees per hectare (mostly naturals). The exception is plot T13 which, as mentioned earlier, was inundated with natural hemlock from nearby stands. The low elevation areas that were burned had the optimum stocking of planted stock and naturals as well (Fig. 7).

Height and basal area

Seedling heights and basal area per hectare have been adjusted to centimeters of growth per year (Fig. 8). Table 5 shows year and season of planting and years of growth.

The average height growth for all planted stock was 46 centimeters per year and average basal area per hectare 32 square centimeters per year (Fig. 8a). Douglas-fir grew higher on burned areas but basal area was essentially the same (Fig. 8b). Trees grew highest on areas burned with the hottest fire and least on areas unburned. Again, basal area was similar on all areas (Fig. 8c).

Low elevation areas produced more wood than high elevation areas (Fig. 8d). In Figure 8e, low elevation unburned plot C7 shows slightly higher production than the low intensity burn area T14, but less than the moderate and high intensity burn areas. This is due in part to the fact that some of the measured stock was planted in 1966 instead of 1968, and therefore has a couple of years additional growth that was not previously accounted for.

At low elevation, planted Douglas-fir grew best on north aspects, but on south aspects it grew as well as or better than those on either aspect at high elevation (Fig. 8f).

In May 1969, a study was conducted to determine above and below ground temperature differences in a 60-year-old stand, fresh slash (C6), and a freshly burned area (T6) (Lafferty 1973).

TABLE 5

Planted Seedling

Plot	Yr & Season(s) Planted	Yr of growth to Summer 1979
C6	Fall 1969 Spring 1970	10
T6	Fall 1969 Spring 1970	10
T7	Fall 1968 Spring 1969	11
C7	Fall 1968	11+
T8	Fall 1969 Spring 1970	10
T11	Fall 1970	9
T12	Fall 1970	9
C12	Fall 1970	9
T13	Spring 1971	9
C13	Fall 1970	9
T14	(Spring 1970) Spring 1971	9

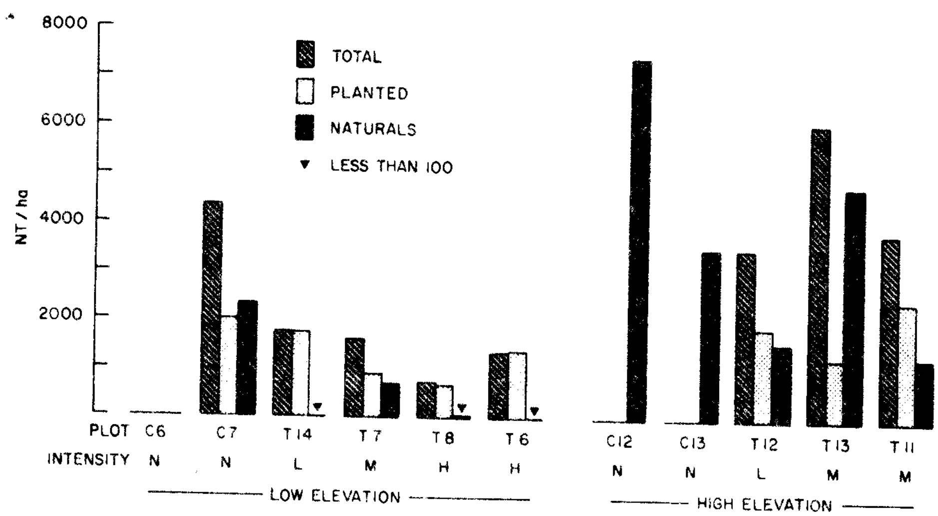

Fig. 7. Number of planted and natural conifers by plot.

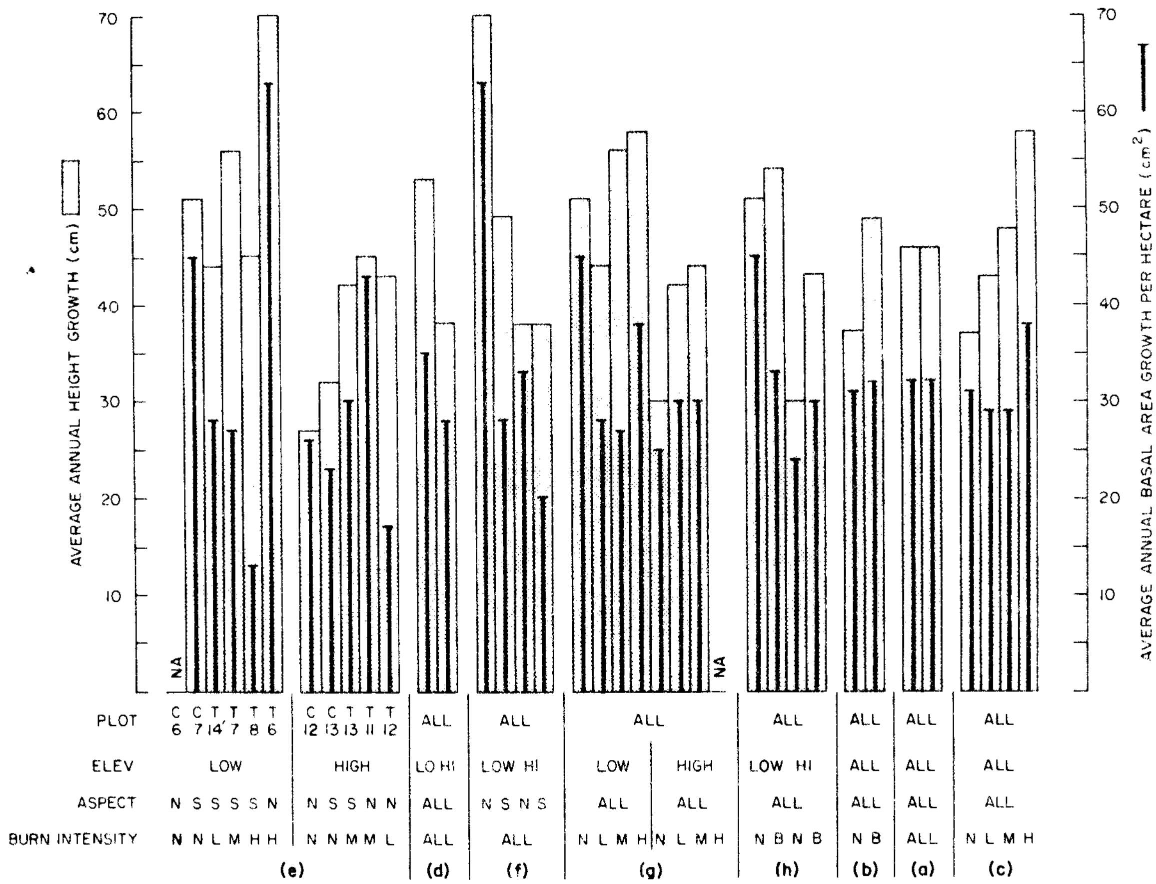

Fig. 8. Average yearly height growth and basal area growth of planted conifers by elevation, aspect and treatment (control plots C12 and C13 represent mostly natural conifers.)

The results showed soil temperatures in the rooting zone of young Douglas-fir 2-0 seedlings were always higher in early summer in the prescribed burned area than in the slash-covered area or in the stand. Air temperatures in the leaf area of conifer seedlings, 15 centimetres above ground, were always lower over the burned area than in the slash, probably because of increased reflection and decreased air movement in the latter. It was expected that this effect would diminish after ingrowth vegetation shaded the ground.

Franssila (1962) and Sorensen and Campbell (1978) found the same results in their studies and Sorensen and Campbell concluded that average date of terminal bud flush was advanced by 7.7 and 3.5 days by increased air and soil temperatures, respectively. In another test, they increased bud flush by 14.3 and 5.3 days, respectively. Flushing was advanced 5.7 days per 1°C increase in average daily air temperature and 0.45 days per 1°C increase in average soil temperature.

Assuming that increased soil temperatures are beneficial to seedling growth under the environmental conditions of vegetation, climate, site, etc., experienced in this study, a site treatment that allows soil temperatures to increase in the rooting zone is desirable. In fact, results of a preliminary planted conifer growth study in 1972 (Lafferty and Ogilvie 1973a) showed that 5-year planted Douglas-fir 2-1 stock grew 1 metre more in moderately burned plot T7 than in the adjacent unburned plot C7. In this examination, all sample trees were planted at the same time and identified with tags. The same trees were re-sampled 5 years later.

It is theorized that the reasons for the increased growth of seedling planted on the burn area were:

1. additional nutrients made available by burning,

2. increase in microbial activity,

3. reduced competition for nutrients, light and space, and

4. increased soil temperature, therefore increased root metabolism, photosynthesis and transpiration.

All of these reasons contribute to the fact that bud flush on seedling growing on the burned area took place at least 1 week earlier than on the unburned area.

The apparent beneficial effects of broadcast burning are not expected to last more than 10 years. Kraemer and Hermann's (1979) results failed to show statistically significant differences between properties of burned and unburned soils, 20 years post-burn, suggesting that broadcast burning does not have a lasting effect on chemical and physical properties of soil. Their work, and Morris' (1958) original work, are important because few researchers have attempted to deduce conclusions from studies covering a period of more than a couple of years.

The data indicate that planted Douglas-fir seedlings grow best on burned areas as opposed to unburned areas. Also, they grow better on areas burned with high intensity fire, and on north aspects at low elevation.

Site Type

The soil series is an integration of Cardinal, Cannel Steelhead and Hoover. Cardinal series is described by Kowal (1967) as an Orthic Humic Podzol, Cannel as an Orthic Concretionary Podzol, Steelhead as a Gleyed Humic Podzol, and the Hoover series as an Orthic Concretionary Podzol.

Soil maps[3] show plots 11 through 13 to be classified in the Hoover-Cannel series; however, soil texture and organic matter indicate they should be classified Cardinal-Cannel series. Slope ranges from 20 to 45% and soil depth to basal till is generally 1 metre, and well drained. Profile textures are loamy, with stones and gravel mixed throughout. On the deeper soils, the Mean Annual Increment is 161 cubic feet per acre per year (Kowal, 1967). At the highest point in the highest plot (2,000 feet), the MAI is probably somewhat less because of shorter growing season. Soil Capability rating for forestry is 1b (McCormack, 1965). On shallow soils over bedrock, the MAI is 82 cubic feet per acre per year, and a Capability class rating of 3R.

The soil map shows plots 6, 7, 8 and 14 to be a Cardinal-Cannel series; however, the soil measurements in 1962 indicate that the soil depth to basal till or bedrock varies from 39 centimeters to 1 metre. These low elevation plots appear to be better growing sites than the high elevation ones because of more gentle slope and milder weather conditions. The lower portion of plot 7 (5% of the plot) is classified in the Steelhead series and has less than 10% slope. It is at the bottom of a general slope with moderately well-drained gleyed soil. Most of the plots are a heterogeneous mixture of Steelhead-Cannel and Cardinal soil series.

Plots 6, 7, 8 and 14 pre-logging conifer vegetation consisted predominantly of Douglas-fir with western hemlock and western red cedar in lesser amounts south and west aspects. The lesser vegetation associations are Oregon grape-Pacific red huckleberry-bracken fern-sword fern on south and west aspects, and poplar-maple-elderberry-salmonberry-thimbleberry-sword fern on north and east aspects.

---

3 Soil Survey of Mission area, Preliminary Report No. 9 of the Lower Fraser Valley soil survey, British Columbia Department of Agriculture, Kelowna, B.C. 1968.

Plots 11, 12 and 13 conifer vegetation consisted primarily of Douglas-fir-hemlock-cedar on south and north aspects. Lesser vegetation on south aspects consisted mainly of bracken fern-sword fern-pearly everlasting-salmonberry-black and red huckleberry and bunch berry. On north aspects, lesser vegetation is mostly bunch berry-bracken fern-deer fern-salmonberry-black huckleberry and thimbleberry. Balsam fir is an important conifer in north aspect plots 11 and 12.

Upon examining pre- and post-burn vegetation, physiographic and weather information for the study areas, the following site description, as per Klinka's guide, was made.[4]

Plot	Classification and Description
T6, C6	CWHxz - coastal western hemlock drier subzone. (Douglas-fir-western hemlock). Rhytidiadelphus-Plagiothecium-Pseudotsuga-Tsuga developed on Humo-Ferric Podzol with thin mor humus. Moisture class 4, Nutrient regime C. Dominant and subdominant species - F, C, HW. (HW, F.C.)
T7, T8, T14	CWHxa - coastal western hemlock drier subzone. (Douglas-fir-western hemlock). Rhytidiadelphus-Plagiothecium-Pseudotsuga-Tsuga developed on Humo-Ferric Podzol with thin mor humus. Moisture class 3, Nutrient regime B-C. Dominant and subdominant species - F, C, HW. (HW,F, C)
T13, C13	CWHxz - coastal western hemlock drier subzone. (Douglas-fir-western hemlock). Rhytidiadelphus-Plagiothecium-Pseudotsuga-Tsuga developed on Humo-Ferric Podzol with thin mor humus. Moisture class 3, Nutrient regime B-C. Dominant and subdominant species - F.C.HW(HW,F.C.).
T12,T11,C12	CWHxb-s - coastal western hemlock wetter. Subzone-submontane variation (submontane Amabilis fir-western hemlock). Rhytidiadelphus-Vaccinium-Abies-Tsuga developed on Ferro-Humic or Humic Podzols with thick mycelial mor humus. Moisture class 4, Nutrient regime C. Dominant and subdominant species - HW, Ba, C.

---

4 Site Description as per K. Klinka, 1977, Guide for The Tree Species Selection and Prescribed Burning in the Vancouver Forest District. BCMF. 42 pp plus Appendix.

Spring Hazard

Spring hazard samples do not indicate that less intensely burned or unburned areas contribute more or less to spring fire hazard than intensely burned areas about 10 years after burning (Fig. 9). Average sampled fuel loading was 902 kg/ha.

Spring hazard on control areas was variable, depending on the site. At the lower elevation north aspect sites, devoid of conifers: salmonberry, alder, birch, maple and sword fern were most abundant. At higher elevation north aspect sites, with some conifers, salmonberry, black huckleberry, bunchberry, etc., were most abundant. On high elevation south aspects there was more fireweed, bracken fern and pearly everlasting as well.

Natural conifers do not seem to contribute to spring hazard at this time. However, planted conifers seem to contribute significantly to spring hazard and because of form, arrangement of needles, etc., they may create a worse hazard than broad leaved plants. The exception may be salal sites because of the way dead salal leaves are arranged on the ground and on the stem.

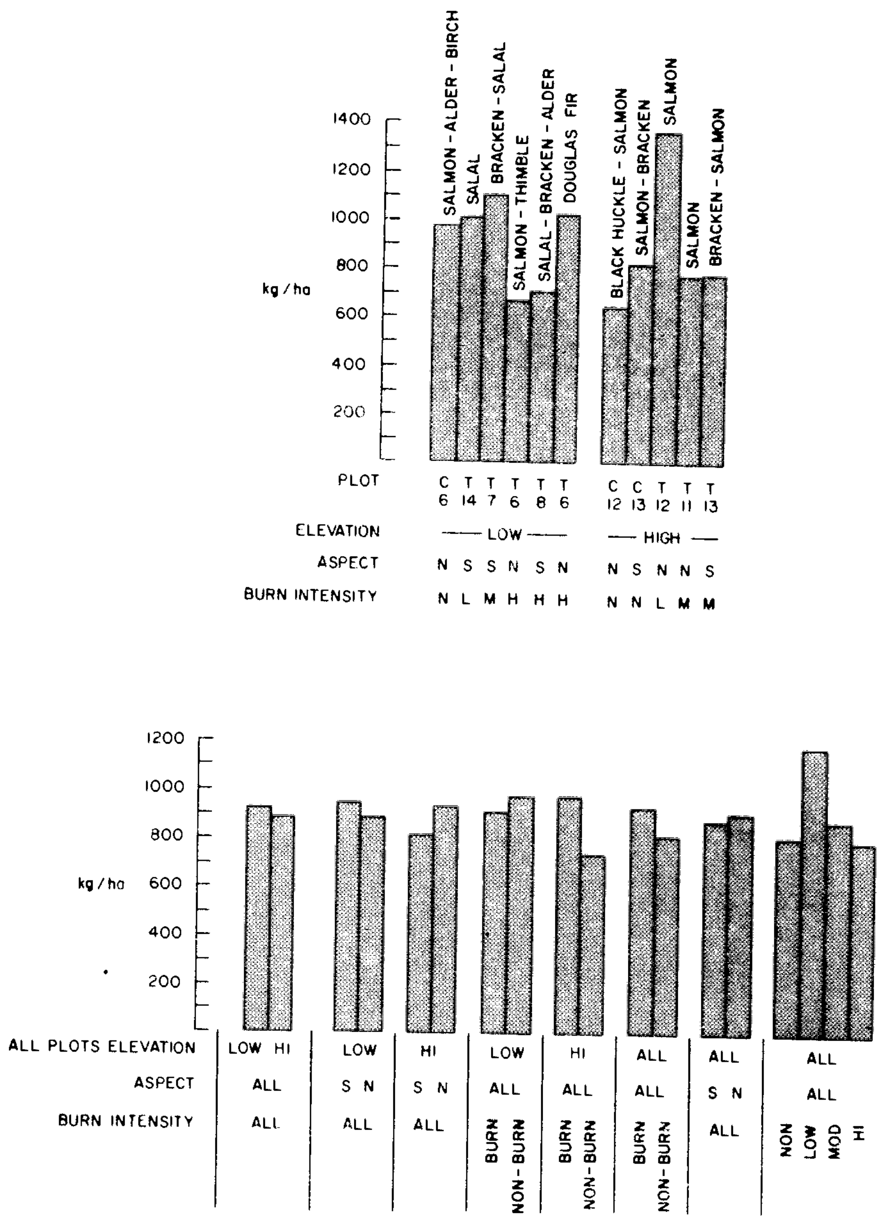

Fig. 9. Spring hazard expressed as litter production from annual and perennial herbaceous and shrub species by elevation, aspect and burn intensity.

SUMMARY AND CONCLUSIONS

General

The original Canadian Forestry Service Mission fire physics and ecology studies were unique and meaningful to fire managers in Western Canada. The fire physics portion contributed to an overall understanding of fire behavior and, consequently, to the operational use of the Canadian Fire Weather Index in prescribed fire guidelines.

The fire ecology study was unique in that it was designed to use definitive fire intensities and, designed for at least 10 years of study, with all data stored on the CFS computer file in a programmed retrieval system. Although the program and stored data were not used in this study, they are still available for analysis at a later date. Data submitted to CFS by this study should be considered for integration with the existing computer file and 1972 data.

Fire Intensity

Fire intensity is described in relative terms; however, the determination was a result of objective observation and definitive measurement.

There were four areas unburned; two burned with low intensity fire; two burned with moderate intensity fire and two burned with high intensity fire.

Fire intensity can be predicted and a desired intensity created by combining the Canadian Fire Weather Index, fuel loading variables, slope and aspect.

Site

All sites studied in the Mission area have an abundance of moisture and nutrients. This is shown by the speed in which plants completely revegetate treated areas and the good growth of planted conifers. High elevation sites had a slightly shorter growing season than low elevation ones, but this had little effect on yearly plant growth.

Sites are described as per Klinkas' Guide for the Tree Species Selection and Prescribed Burning in the Vancouver Forest District.

Plant Succession

This paper is concerned with a deterministic single pathway subjective prediction of plant succession over one rotation period of the crop tree.

All sites studied have a capacity to grow much biomass and, until the conifer canopy closes, ingrowth vegetation will be found in high abundance. Study areas are divided into two types, each distinguished by elevation and aspect. There is a high and low elevation, and a south and north aspect.

Resultant vegetal ingrowth and plant succession 10 years post treatment are dependent on pre-burn vegetation, adjacent vegetation, treatment, elevation, aspect and conifer canopy closure.

Annual plants invade severely burned areas immediately after fire. After 1 or 2 years, the annuals give way to plants that survived the treatment and plants that arrive from outside the treated area. High intensity fires definitely set succession back further than less severe fires. In general, high intensity burns reduce the number and abundance of perennials and create conditions conducive for annual plant growth.

Moderate intensity burns that do not consume all the humus layer, do not destroy below ground parts of many perennials, thereby stimulating fireweed, bracken fern, salal, salmonberry, thimbleberry and sometimes trailing blackberry, maple and red elderberry. Willow in our area did not seem to increase with fire disturbance.

Vegetation on low intensity burned areas will be similar to pre-burn vegetation. It increases in abundance quickly because of lack of competition and stimulation from increased nutrients and light.

Plants on unburned areas flourish because of lack of competition from mature conifers. The species of plant on these areas will be similar to pre-burn vegetation. In our area, willows, alder, maple, elderberry, salmonberry and others are most common on unburned and low intensity burn areas 10 years after treatment.

It appears that on all areas annual plants disappear first, followed by more persistent perennials; i.e., fireweed, elderberry, bracken fern, thimbleberry, willow, salmonberry, salal, etc. The speed with which they disappear is dependent on conifer canopy closure. All shrubs, deciduous trees and annuals disappear from the site once the conifer canopy closes. The remaining vegetation is made up of several shade-tolerant species insignificant to conifer competition; i.e., sword fern, deer fern, lady fern, foam flower, trailing rubus, bunchberry, vanilla leaf, with others persistent in their own microsites. The speed at which lesser vegetation secedes from the site is generally dependent on conifer canopy closure itself.

Natural Conifers

The number, frequency of occurrence and height of natural conifers in sub-plots was recorded.

Western hemlock is adaptable to our study sites. It averaged 129 centimetres of growth at low elevation and 222 centimetres at high elevation. Both low and high elevations are overstocked, with 1,497 and 3,185 trees per hectare, respectively. It was found with more than 46% frequency of occurrence at low elevation and more than 68% at high elevation. Only high intensity burns seemed to retard hemlock establishment.

Western red cedar was found most often on burned areas. At low elevations, it seemed to prefer south aspects. Of the burned plots, those burned with low intensity fire had the tallest trees, but fewer of them. At high elevations, the opposite was found.

Balsam fir was found only at high elevation and spruce at low elevation.

Douglas-fir was found most often at high elevation and on both unburned and burned areas. It grew 214 centimetres over 9 years at high elevation, compared to 88 centimetres over 11 years at low elevation. Also, high elevation areas were satisfactorily stocked and low elevation areas were not. The burned areas were better stocked than unburned ones, but trees on unburned sites averaged 250 centimetres high, compared to 190 centimetres on burned ones. This difference could be because of the lag time between burning and seedling establishment. Considering the age of trees, the naturals grew at about 60% the rate of the best planted stock.

Natural conifers play an insignificant conifer-competitor role on burned areas even though the most abundant conifer, western hemlock, was found in more than 50% of the sample. Their height and spacial requirements were not considered significant to planted conifer competition.

Many natural conifers will be suppressed and crowded out by planted conifers within 20 years after planting. Those naturals that survive will make up an important ecological entity of the forest.

Planted Conifer Seedlings

The number of planted Douglas-fir seedlings ranged from 654 to 2,512 trees per hectare. Two areas were planted twice, which accounts for some high numbers, and some areas had a high mortality rate, which accounts for some low numbers. The original stocking goal was about 1,300 trees per hectare. Average mortality rate was 20% several years after planting. On all areas, planted Douglas-fir has adequate growth and survival rates.

The average height growth rate for planted stock was 46 centimetres per year, and the average basal area was 32 square centimetres per hectare per year. Douglas-fir grew highest on areas burned with the hottest fires and least on unburned areas; basal area was essentially the same on all areas. This indicates that planted Douglas-fir has little competition for space and light on burned areas. On north aspects, where fire slowed ingrowth vegetation, and where soil and above-ground air temperatures were optimum during the growing season and drought periods, Douglas-fir growth was attributable to increased temperatures as well as to increased space, light and nutrients.

Data indicate that planted Douglas-fir seedlings grow best on burned areas as opposed to unburned ones. Also, they grow better on areas burned with high intensity fire on north aspects at low elevation.

Spring Hazard

Burn intensity does not seem to affect spring hazard 10 years' post-burn in our area. Average fuel loading of all plots was 0.902 tonnes per hectare. Maximum fuel loading was 1.370 t/ha per hectare and was mostly made up of salmonberry litter. Minimum fuel loading was .653 t/ha and most of the leaves were from huckleberry.

Under the closed canopy, conifer needles make up most of the spring hazard, and within an 11-year-old stand, equalled 1.031 t/ha.

On north aspects salmonberry, thimbleberry, bracken fern, tall shrubs and sword fern make up most of the spring hazard.

In the openings on the drier south aspects, bracken fern, fireweed and salal are most abundant, while salal and deer fern are most abundant under the canopy.

On low elevation north aspects, devoid of conifers, salmonberry, alder, birch, maple and sword fern make up most of the spring hazard. At higher elevation north aspect control sites, salmonberry, black huckleberry and bunchberry are most abundant.

Natural conifers do not seem to contribute to spring hazard at this time. The most important plants seem to be planted Douglas-fir, salal, bracken fern and other broad leafed plants, in that order, depending on site.

SUGGESTIONS FOR IMPROVED SITE PREPARATION, PRESCRIBED FIRE PRACTICES AND RESEARCH

1. Prescribed fire should be considered first as a silvicultural tool, and second as a hazard reduction method in the Coastal Cedar-Hemlock type of British Columbia.

2. Moderate intensity prescribed fire should be used when operationally practical on all sites similar to those sampled in this study for Douglas-fir management. High intensity fire can be both beneficial

and detrimental, but is generally not operationally practical. Unburned areas are not beneficial for Douglas-fir management.

3. The Canadian Forest Fire Weather Index system and Klinka's "Site Preparation Guide" should be integrated, and a more definitive Site Preparation Guide developed for prescribed burning in the Coastal Cedar-Hemlock.

4. Biometrics-oriented research personnel at Pacific Forest Research Centre should reorganize the Mission data and determine if it can be analyzed statistically. There seems to be much relevant information stored in the computer files that can be used to relate the effects of different fire intensities on site, fuel, plant succession, conifer growth and survival. Data may be useful in fire effects modelling.

5. Further field data collection should be discontinued at this time.

6. The following are suggestions for planning prescribed burns on sites and in areas similar to those studied here. When planning prescribed burns, reference should be made to the "Prescribed Fire Predictor", "Guide for Tree Species Selection", B.C. Ministry of Forests "Broadcast Burning Guidelines", "Planning for Prescribed Burning" (Martin and Dell, 1978) and Ministry of Forests Regional "Prescribed Burning Plan".

   Rocky outcrops, very dry and very moist sites have been excluded because they require special attention to determine treatment with fire for Douglas-fir management. Keep in mind that fire is only one tool to help with forest management and it can be destructive if misused.

   Spot burning is not considered here because the success of spot burning is more dependent on fuel loading, age of fuel, fuel configuration, ingrowth vegetation, wind, rain, ignition technique and slope than it is on fuel moisture by fuel class, of which the Fire Weather Index is most concerned.

   The following prescriptions require that the weather station be on a flat area, to BCMF standards and representative of the area to be burned.

CONDITION I

Site

CWHxa and CWHxb-s, hygrotope 2 to 5 and trophotope B to D (Klinka, 1977).

Slope

Less than 50%.

Aspect

South

Slash Age

1 year

Fuel Loading

Light to medium - 150 to 250 tonnes per ha.

Humus Depth

Less than 8 centimetres.

Vegetation (postlogging)

Typical of the site and low abundance.

Objective

1. Create planting sites
2. Reduce fire hazard
3. Reduce humus layer 20-30%
4. Reduce: Fine fuels - 80-100%
   Medium fuels - 20-30%
   Large fuels - 5-15%
5. Blacken 90% of the area

Burning Prescription

1. Spring burn
2. Afternoon burn
3. Start ignition sequence with a strip fire along uppermost fire guard and let fire slowly burn down hill, creating a safety strip. Continue igniting in an acceptable manner and pattern after successfully burning off a safety strip.

4. FWI indices:[5]

FFMC - 76-80
DMC - 10-25
DC - < 140
BUI - > 18
FWI - > 3
Winds - < 13 km/h

Probable Results

1. 90% of fine fuel consumed.

2. Some medium and heavy fuel consumed.

3. 25% of humus layer consumed.

4. 90% of burn area blackened.

5. Plant succession set back and slowed for 2 years. Perennial plants will resprout and cover 50% of the area in 3 years.

CONDITION II

Site

CWHxa and CWHXb-s, hygrotope 2 to 5 and trophotope B to D (Klinka, 1977).

Slope

Less than 50%.

---

5 Fire Weather Indices are specific because there are specific conditions presented. Generally, indices will be slightly different than those shown and the following general indices have been used with success, depending on specific conditions:

FFMC - 74-90
DMC - 10-40
DC - < 290
BUI - 18-38
FWI - > 3
Wind - < 13 km/h

Aspect

North

Slash age

1 year old

Fuel loading

Medium - 250 to 350 t/ha

Humus depth

8 to 15 cm

Vegetation (postlogging)

Typical of the site with about 25% canopy cover - shrub prone.

Objective

1. Create planting sites
2. Reduce humus layer 25 to 50%
3. Reduce: Fine fuels- 85-100%
   Medium fuels - 30-35%
   Large fuels - 15-25%
4. Blacken 85-95% of area
5. Reduce plant competition

Burning Prescription

1. Summer, early fall or fall burn
2. Burn with acceptable ignition technique. Suggest using helicopter slung "heli-torch".
3. Early or mid-afternoon burn
4. FWI indices: FFMC - 84-86
   DMC - 20-40
   DC - 180-250
   BUI - 25-32
   FWI - > 3
   Wind - < 13 km/h

Probable Results

1. 90% of fine fuel consumed.
2. 35% of medium fuel consumed.
3. 25% of heavy fuel consumed.
4. > 35% of humus layer consumed.
5. 90% of area blackened.
6. Plant succession set back and slowed for 2 years. Perennial plants will resprout and cover 50% of the area in 2 years.

CONDITION III

Site

CWHxa and CWHxb-s, hygrotope 2 to 5 and trophotope B to D (Klinka, 1977).

Slope

Flat

Aspect

Flat

Slash age

1 year

Fuel loading

Heavy - 350 + (avg. 400) t/ha

Humus depth

More than 12 cm (avg. 15 cm)

Vegetation (postlogging)

Typical of the site, shrub prone with about 35% canopy cover.

Objective

1. Create planting sites
2. Reduce humus layer 40 to 60%.

Objective (Cont'd)

3. Reduce: Fine fuels- 100%
   Medium fuels - 40-50%
   Large fuels - 30-40%

4. Blacken 95-100% of area

5. Reduce plant competition

Burning Prescription

1. Summer burn

2. Mid- to late afternoon burn

3. Burn with acceptable ignition technique. Suggest using helicopter slung heli-torch.

4. FWI indices: FFMC - 85-88
   DMC - 30-40
   DC - 250-290
   BUI - < 35
   FWI - < 3
   Wind - < 13 km/h

Probable Results

1. 100% fine fuel consumed.

2. 50% medium fuel consumed.

3. 30% heavy fuel consumed.

4. 40% of humus layer consumed.

5. 100% of area blackened.

6. Plant succession set back and slowed for 2 years. Perennial plants will resprout and cover 50% of the area in 2 + years.

The above "conditions" are only a few of the many that will be encountered while prescribed burning. For other objectives and conditions, please refer to the general indices given earlier under condition I.

REFERENCES

Anon. 1978. Canadian Forest Fire Weather Index. Can. Forestry Service, Forestry Tech. Rep. No. 25.

Baker, J. 1968. Effects of slash burning on soil composition and seedling growth. Forest Res. Lab. Inf. Report BC-X-28.

Beaufait, W.R., C.E. Hardy and W.C. Fischer. (1977). Broadcast burning in larch-fir clearcuts. USDA FS Intmtn. Forest and Range Exp. Sta. INT-175, Revised.

Cattelino, P.J., I.R. Noble, R.O. Slatyer and S.R. Kessel. 1979. Predicting multiple pathways of plant succession. Environmental Management, Vol. 3, No. 1, pp. 41-50.

Franssila, M. 1962. On the influence of prescribed burning on the temperature and humidity condition of the soil. Scientific Session presentation-CAgM-III Toronto, July 13. 10p.

Hitchcock, C.L., A. Cronquist, Marion Ownbey and J.W. Thompson. 1959. Vascular plants of the Pacific Northwest. 5 Vols. Univ. of Wash. Press. Seattle.

Humphreys, F.R. and M.J. Lambert. 1965. An examination of a forest site which was exhibited the ash-bed effect. Abstr. J. Soils Res. 3(1): 81-94.

Jablanczy, A. 1964. Influence of slash burning on establishment and initial growth of seedlings of Douglas-fir, western hemlock and western red cedar. Univ. of British Columbia Ph.D Thesis. Abstr. 25(4): (2188) ORS available.

Klinka, K. 1977. Guide for the tree species selection and prescribed burning in the Vancouver Forest District. Ministry of Forests, Vancouver Forest Dist. Van. B.C.

Kowal, R. 1967. Soils and soil capability classification for forestry of the Mission Tree Farm. Masters Thesis, U.B.C., Van. B.C.

Kraemer, J.F. and R.K. Hermann. 1979. Broadcast burning: 25 year effects on forest soils in the western flanks of the Cascade Mountains. Forest Sci., Vol. 25, No. 3, pp. 427-439.

Lafferty, R.R. 1970. Mission Tree Farm. Mimeographed Report. CFS, PFRC. Vic.

———. 1972. Soil pH changes after fires of a different intensities. Proposed Inf. Report. 5 p., CFS, PFRC.

Lafferty, R.R. 1972a. Regeneration and plant succession as related to fire intensity on clear-cut logged area in coastal cedar-hemlock type. CFS, PFRC, Int. Report No. BC-33. 129 p.

Lafferty, R.R. and C.J. Ogilvie. 1973. Douglas-fir growth and success on areas burned at different intensities in coastal cedar-hemlock type. Mimeographed report.

Lafferty, R.R. 1973a. Above and below ground temperature differences after prescribed burning in the coastal Western Hemlock Zone of British Columbia. Proposed Res. Note. 5 p., CFS, PFRC.

__________. 1973b. Description of "Pikes Peak" prescribed slash burn, Mission Tree Farm July 11, 1973. Mimeographed Report. CFS, PFRC. 11 p.

Martin, R.E. and J.D. Dell. 1978. Planning for prescribed burning in the Inland Northwest. USDA FS. Pac. NW Forest and Range Exp. Sta. PNW 76.

McCormack, R.J. 1965. Outline of the Canada Land Capability Classification for Forestry. Prepared for the Canada Land Inventory Program of ARDA.

Morris, W.G. 1958. Influence of slash burning on regeneration, other plant cover, and fire hazard in the Douglas-fir region. USDA FS, Pac. Nw. Res. Paper 29. 49 p.

__________. 1970. Effects of slash burning in overmature stands of Douglas-fir region. For. Sci., Vol. 16, No. 3.

Muraro, S.J. 1975. Prescribed Fire Predictor. PFRC, CFS, Victoria.

Muraro, S.J., R.R. Lafferty, B.D. Lawson, and J.A. Turner. 1973. Fire behavior, fire physics and fire ecology on a prescribed burn in the Pacific Rim National Park. Mimeographed Report CFS, PFRC. 34 p.

Noble, I.R. and R.O. Slatyer. 1977. Post-fire succession of plants in Mediterranean ecosystems. USDA FS Gen. Tech. Rep. WO-3.

Sorrensen, F.C. and R.K. Campbell. 1978. Comparative roles of soil and air temperatures in the timing of spring bud flush in seedling Douglas-fir. Can. J. Bot. Vol. 56, No. 18., pp 2307-2308.

Tarrant, R.F. 1954. Effects of slash burning on soil pH. USDA FS, Pac. Nw. Forest and Range Exp. Sta. Res. Note 102, 5 p.

APPENDIX I

Checklist of Plants

APPENDIX I

Check list of plants found on the plots

Conifers

Genus	Species	Author	Common Name
Abies	amabilis	(Dougl.) Forbes	balsam fir
*Chamaecyparis	nootkatensis	(D. Don) Spack	yellow cedar
Pseudotsuga	menziesii	(Mirb.) Franco	Douglas-fir
Thuja	plicata	Donn.	western red cedar
tsuga	heterophylla	(Raff.) Sarg.	western hemlock
Picea			spruce

* Asterisk designates plants found in the plots but outside the sub-plots.

Shrubs

Genus	Species	Author	Common Name
Acer	circinatum	Pursh	vine maple
Acer	glabrum var. douglasii	Pursh	Douglas maple
Acer	macrophyllum	Pursh	big leaf maple
Alnus	rubra	Bong.	red alder
Aruncus	sylvester	Kostel	goats beard
Berberis	nervosa	Pursh	mahonia
Betula	papyrifera	Marsh.	paper birch
*Chimaphila	menziesii	(R.Br.) Spreng	princes pine
Cornus	canadensis	L.	bunchberry
Cornus	occidentalis	L.	redosier dogwood
Cornus	nuttallii	Aud. ex T&G	pacific dogwood
Gaultheria	shallon	Pursh	salal
Linaea	borealis	L.	twin flower
Menziesia	ferruginea	Smith	Fool's huckleberry
Oplopanax	horridum	(JE Smith) Mig.	devils club
Populus	trichocarpa	T&G ex Hook	poplar
Prunus	emarginata	(Dougl.) Walpers	bitter cherry
Rhamnus	purshiana	DC	cascara
Ribes	sanguineum	Pursh	red current
Ribes	spp.		swamp gooseberry
*Rosa	nutkana	Presl.	rose
Rosa	gymnocarpa	Nutt.	rose
Rubus	laciniatus		split leaf blackberry
Rubus	leucodermis	Dougl. ex T&G	black raspberry
Rubus	parviflorus	Nutt.	thimbleberry
Rubus	pedatus	JE Smith	trailing rubus
Rubus	spectabilis	Pursh	salmonberry
Rubus	ursinus	Cham. & Schlecht	trailing blackberry
Sambucus	racemosa	Var. (T&G) Gray	red berry elder
Salix	spp.		willow
Sorbus	sitchensis	Hook	mountain ash
Spiraea	douglasii		spiraea
Vaccinium	alaskaense	Howell	blueberry
Vaccinium	ovalifolium	Smith	blueberry
Vaccinium	parvifolium	Smith	red huckleberry
Virburnum	edule Michx.	Raf.	squashberry

Forbs

Genus	Species	Author	Common Name
Achyls	triphylla	(Smith)DC	vanilla leaf
Anaphalis	margaritacea	(L)Beath & Hook	pearly everlasting
Chrysanthemum	leucanthemum	L.	oxeye daisy
Cirsium	spp.	Mill	thistle
*Crepis	capillaris	(L) Wallr.	hawks-beard
Disporum	oregonum		fairy bell
Epilobium	angustifolium	L.	fireweed
*Equisetum	arvense	L.	horsetail
*Hieracium	scouleri	Hook	hawkweed
*Hypochaeris	radicata	L.	cat's ear
Lactuca	spp.		lettuce
Lysichitum	americanum	Hulten & St. John	skunk cabbaga
Maianthemum	dilatatum	(Wood)Nel.&Macbr.	wild lily-of-the-valley
*Senecio	sylvaticus	L.	groundsel
Smilacina	amplexicaulis		false lily-of-the-valley
Solidago	canadensis	(L)	golden rod
Streotopus	amplexifolius	(L) D.C.	twisted stock
Tiarella	trifoliata	L.	false mitrewort
Trillium	ovatum	Pursh.	wake robin

Grasses

Genus	Species	Author	Common Name
*Agropyron	spp.		
Agrostis	spp.		
Poa	spp.		
Carex	spp.		
Juncus	spp.		
*Lazula	spp.		
*Scirpus	spp.		

Fern

Athyrium	filix-femina	(L)Roth	lady fern
*Adiantum	pedatum	L.	maidenhair fern
Blechnum	spicant	(L)With	deer fern
Polystrichum	munitum	(Kaulf) Presl	sword fern
Pteridium	aquilinum	(L)Kuhn in Von der Decken	bracken fern

Moss

Lycopodium	annotinum	L.	clubmoss
Eurhychium	oreganum	(Sull)J&S	sphagnum

APPENDIX 2

Ingrowth Vegetation Canopy cover,
Height and Frequency of Occurence by Plot.

	SPECIES	CANOPY COVER (%)	AVERAGE HEIGHT (m)	PERCENT FREQUENCY OF OCCURRENCE
PLOT C-11				
	Shrub	100		100
	Herb	0		0
	Grass	0		0
	Moss	0		0
	Fern	12		100
	Total	100		100
	Sword fern	14.0	0.6	63
	Lady fern	0.8	0.3	47
	Deer fern	0.4	0.2	32
	Alder	28.0	6.6	83
	Salmonberry	80.4	2.8	100
	Thimbleberry	4.4	1.6	85
	Birch	29.2	9.1	83
	Vine Maple	10.0	5.0	17
	Elderberry	0.3	2.0	17
	Split leaf raspberry	0.2	3.0	17
	Willow	1.8	5.0	33
	Red Huckleberry	1.6	2.0	33
	Douglas Maple	1.6	5.0	8
# TREES				
2	Cedar		0.2	
37	Hemlock		0.4	

PLOT T-6

SPECIES	CANOPY COVER (%)	AVERAGE HEIGHT (m)	PERCENT FREQUENCY OF OCCURRENCE
Shrub	88		100
Herb	4		90
Grass	1		11
Moss	0		0
Fern	13		90
Total	98		100
Deer fern	1.0	0.29	42
Sword fern	11.0	0.88	84
Lady fern	0.6	0.5	10
Fireweed	1.7	2.2	68
D. Spiraea	1.5	2.2	37
Thimbleberry	24.0	2.0	63
Mahona	0.8	0.5	5
Red Elderberry	1.4	2.0	47
Trailing Blackberry	1.4	0.2	47
Red Alder	2.3	5.3	32
Cascara	0.2	8.6	21
Salmonberry	24.1	1.9	79
Willow	4.4	4.4	42
Birch	9.4	4.9	63
Big leaf Maple	2.7	5.0	11
Red Huckleberry	0.4	1.3	21
Vanilla Leaf	0.3	0.3	32
Vine Maple	5.8	3.8	32
Salal	0.5	0.3	16
Dogwood	0.1	5.0	5
Poplar	0.1	5.0	5
Lily Sp.	0.1	0.2	5
Sedge Sp.	0.5	0.5	5

# TREES	SPECIES	CANOPY COVER (%)	AVERAGE HEIGHT (m)	PERCENT FREQUENCY OF OCCURRENCE
15	Cedar		0.6	47
37	Hemlock		1.0	74

	SPECIES	CANOPY COVER (%)	AVERAGE HEIGHT (m)	PERCENT FREQUENCY OF OCCURRENCE
PLOT T-7				
	Shrub	73.0		100
	Herb	8.4		100
	Grass	1.1		14
	Moss	38.9		50
	Fern	45.6		96
	Total	94.1		100
	Bracken fern	33.0	1.8	64
	Lady fern	0.2	0.7	5
	Deer fern	0.3	0.4	18
	Sphagnum Moss	0.5	0.1	5
	Sedge spp.	0.9	1.0	5
	Grass spp.	0.1	0.3	5
	Salal	37.3	0.3	82
	Fireweed	5.4	1.0	82
	Red Huckleberry	3.0	1.4	77
	Thimbleberry	7.0	1.0	41
	Salmonberry	3.9	1.0	36
	Birch	6.0	4.4	55
	Willow	2.6	3.6	55
	Alder	2.5	7.0	9
	Ocean Spray	0.2	2.0	14
	Spiraea	2.3	1.7	50
	Vine Maple	0.3	2.0	14
	Poplar	0.2	4.0	9
	Cherry	1.1	4.5	9
	Fool's Huckleberry	0.2	2.0	5
	Cascara	0.1	3.0	5
	Big Leaf Maple	0.1	4.0	5
	Trailing Rubus	5.8	0.2	68
	Douglas Maple	0.2	1.3	5
	Skunk Cabbage	0.5	0.4	5
	Bunchberry	0.1	0.1	5
# TREES				
69	Hemlock		3.2	86
3	Cedar		1.7	14
4	Douglas-fir		1.0	14
1	Spruce		0.2	5

PLOT T-8

# TREES	SPECIES	CANOPY COVER (%)	AVERAGE HEIGHT (m)	PERCENT FREQUENCY OF OCCURRENCE
	Shrub	65.3		100
	Herb	12.7		100
	Grass	4.7		25
	Moss	57.1		58
	Fern	26.6		83
	Total	92.3		100
	Bracken fern	26.2	1.1	71
	Sword fern	0.5	0.6	13
	Deer fern	0.3	0.4	13
	Birch	3.2	2.6	33
	Cherry	4.8	2.4	58
	Vine Maple	1.3	2.8	9
	Mahonia ne.	2.1	0.2	29
	Alder	17.0	3.0	8
	Poplar	0.5	2.5	17
	Willow	0.1	1.3	13
	Ocean Spray	0.3	2.2	13
	Salal	50.0	0.2	79
	Spiraea	0.4	0.7	25
	Ribes viscos.	1.1	1.4	29
	Ribes sang.	0.1	1.0	4
	Rosa	0.1	2.0	4
	Trailing Rubus	17.6	0.1	83
	Thimbleberry	1.8	0.7	38
	Blackcaps	0.1	2.0	4
	Salmonberry	0.1	1.5	4
	Split Leaf Blackberry	0.1	0.3	4
	Pearly Everlasting	1.8	0.4	46
	Red Huckleberry	1.0	1.0	46
	Fireweed	7.3	0.7	96
	Grass spp.	0.8	0.4	8
	Lactuca spp.	0.1	0.3	4
78	Cedar		0.6	79
22	Hemlock		0.5	46
5	Douglas-fir		1.9	17

	SPECIES	CANOPY COVER (%)	AVERAGE HEIGHT (m)	PERCENT FREQUENCY OF OCCURRENCE
PLOT T-11				
	Shrub	73.0		100
	Herb	4.6		95
	Grass	0		
	Moss	1.0		10
	Fern	10.0		95
	Total	91.5		100
	Bracken Fern	8.3	1.1	50
	Lady Fern	1.2	0.5	45
	Deer Fern	0.8	0.2	70
	Foam Flower	0.6	0.1	35
	Sword Fern	0.1	0.3	5
	Pearly Everlasting	0.6	0.5	35
	Salmonberry	59.5	1.2	100
	Thimbleberry	5.9	1.3	80
	Fireweed	2.8	1.7	50
	Black Huckleberry	3.0	0.9	30
	Red Huckleberry	0.1	2.0	5
	Elderberry	1.2	1.6	30
	Willow	1.7	3.0	60
	Lily	0.3	0.2	20
	Crooked Stock	0.1	0.2	10
	Bunchberry	1.8	0.1	40
# TREES				
27	Cedar		1.3	80
50	Hemlock		2.0	75
29	Douglas-fir		2.2	80

	SPECIES	CANOPY COVER (%)	AVERAGE HEIGHT (m)	PERCENT FREQUENCY OF OCCURRENCE
PLOT T-12				
	Shrub	59.8		100
	Herb	10.4		100
	Grass	2.7		9
	Moss	1.6		18
	Fern	2.3		96
	Total	84.7		100
	Deer Fern	1.6	0.3	46
	Bracken Fern	3.6	1.1	50
	Lady Fern	1.8	0.5	46
	Sword Fern	0.3	0.4	9
	Sedge	2.7	1.0	9
	Grass	0.1	1.0	5
	Mountain Ash	0.1	2.0	5
	Black Huckleberry	5.1	0.8	64
	Red Huckleberry	3.2	0.9	32
	Elderberry	0.6	1.0	23
	Willow	1.0	1.7	36
	Rosa	0.5	0.8	9
	Devil's Club	0.6	0.7	14
	Fool's Huckleberry	0.6	0.9	14
	Pearly Everlasting	2.6	0.5	41
	Fireweed	7.2	1.6	91
	Salmonberry	47.5	1.0	100
	Thimbleberry	0.1	1.0	5
	Ru pedatus	0.3	0.1	18
	Foam Flower	0.5	0.1	23
	Bunchberry	4.5	0.1	36
	Crooked Stock	0.1	0.1	5
	Lily	0.4	0.1	23
	Lactuca spp.	0.1	0.1	14
	Golden Rod	0.1	0.4	5
	Trailing Blackberry	0.1	0.1	5
# TREES				
27	Cedar		1.1	50
35	Douglas-fir		2.5	64
41	Hemlock		1.7	68
2	Balsam		2.5	9

	SPECIES	CANOPY COVER (%)	AVERAGE HEIGHT (m)	PERCENT FREQUENCY OF OCCURRENCE
PLOT C-12				
	Shrub	67.1		100
	Herb	2.0		75
	Grass	1.9		17
	Moss	-		-
	Fern	2.4		83
	Total	77.9		100
	Lady Fern	1.4	0.5	42
	Deer Fern	1.0	0.4	50
	Pearly Everlasting	0.7	0.5	33
	Grass	0.3	0.4	8
	Sedge	1.7	1.0	8
	Foam Flower	0.8	0.1	8
	Lily	0.7	0.1	33
	Rubus pedatus	0.8	0.1	8
	Salmonberry	29.0	1.0	83
	Black Huckleberry	28.0	1.0	75
	Fool's Huckleberry	1.6	1.3	50
	Bunchberry	9.9	0.1	42
	Spiraea	0.2	1.2	8
	Fireweed	1.3	1.5	58
	Devil's Club	0.6	0.7	25
	Red Huckleberry	1.3	1.5	8
# TREES				
52	Hemlock		2.5	83
10	Cedar		1.75	33
13	Balsam		2.4	58
6	Douglas-fir		3.5	42

#	SPECIES	CANOPY COVER (%)	AVERAGE HEIGHT (m)	PERCENT FREQUENCY OF OCCURRENCE
PLOT T-13				
	Shrub	40.5		100
	Herb	15.5		100
	Grass	-	-	-
	Moss	9.5		21
	Fern	37.7		100
	Total	94.7		100
	Bracken Fern	37.4	1.4	84
	Deer Fern	0.3	0.3	16
	Sword Fern	0.4	0.5	21
	Foam Flower	0.2	0.1	16
	Twin Flower	2.6	0.1	5
	Pearly Everlasting	6.4	0.7	79
	Bunchberry	4.4	0.1	26
	Trailing Blackberry	0.7	0.1	42
	Salmonberry	16.9	0.8	89
	Fireweed	5.9	1.6	79
	Willow	1.7	2.5	53
	Elderberry	0.5	0.6	42
	Thimbleberry	1.6	0.6	68
	Black Huckleberry	5.5	0.8	32
	Fool's Huckleberry	0.2	1.5	10
	Red Huckleberry	1.8	1.5	53
	Spiraea	0.4	1.5	16
	Blackcap	0.3	0.9	16
	Douglas Maple	0.3	1.6	5
# TREES				
43	Cedar		0.7	74
252	Hemlock		1.9	95
2	Balsam		2.1	11
15	Douglas-fir		1.0	42

	SPECIES	CANOPY COVER (%)	AVERAGE HEIGHT (m)	PERCENT FREQUENCY OF OCCURRENCE
PLOT C-13				
	Shrub	56.3		100
	Herb	21.3		100
	Grass	-		-
	Moss	-		-
	Fern	28.9		100
	Total	92.8		100
	Lady Fern	0.1	0.5	10
	Deer Fern	1.1	0.3	58
	Sword Fern	6.3	0.5	50
	Bracken Fern	20.0	1.7	67
	Salal	0.2	0.7	17
	Blackcaps	0.2	2.2	17
	Trailing Blackberry	11.9	0.1	33
	Fool's Huckleberry	0.4	1.2	8
	Red Huckleberry	10.4	1.1	66
	Black Huckleberry	9.4	1.0	66
	Fireweed	16.4	2.0	92
	Salmonberry	19.8	1.4	83
	Elderberry	4.8	1.9	58
	Thimbleberry	0.8	0.5	17
# TREES				
13	Balsam		1.7	58
43	Hemlock		3.0	83
4	Douglas-fir		1.5	17
4	Cedar		2.0	17

SPECIES	CANOPY COVER (%)	AVERAGE HEIGHT (m)	PERCENT FREQUENCY OF OCCURRENCE
PLOT T-14			
Shrub	95.0		100
Herb	3.8		92
Grass	0.5		15
Moss	7.7		8
Fern	16.9		77
Total	96.9		100
Split Leaf Blackberry	0.1	0.5	8
Willow	0.2	1.9	23
Birch	0.2	2.5	15
Pearly Everlasting	0.1	0.4	8
Grass	0.4	0.2	8
Ribes	0.1	1.0	8
Bracken Fern	16.8	1.3	69
Deer Fern	0.2	0.6	15
Sword Fern	0.1	0.8	8
Fireweed	3.5	0.9	85
Salal	89.2	0.3	100
Sedge	0.2	0.5	8
Lady Fern	0.2	0.3	15
Cascara	0.1	2.5	8
Dogwood	1.2	3.5	15
Trailing Rubus	14.2	0.1	77
Cherry	0.3	2.8	23
Red Huckleberry	0.8	1.1	54
Alder	3.9	3.5	8
Spiraea	0.5	0.8	23
Salmonberry	0.2	0.9	23
Rosa	0.1	1.2	8
Thimbleberry	0.2	0.5	23
# TREES			
7 Cedar		2.5	31
4 Hemlock		1.4	15
1 Douglas-fir		1.5	8

APPENDIX 3

Natural Conifer Seedling Data Summary by Plot

NATURAL SEEDLING

(1979 SAMPLE)

(FROM SUB-PLOTS ONLY)

PLOT	SPECIES	NUMBER OF TREES	AVERAGE HEIGHT(M) OF TREES	PERCENT FREQUENCY OF OCCURRENCE	NUMBER TREES PER Ha.	NUMBER OF SUB-PLOTS
T-6	w.r. cedar	15	0.6	47	495	19 ($304m^2$)
	w. hemlock	37	1.0	74	1,221	1/33 ha
C-6	w.r. cedar	2	0.2	17	42	12 ($192m^2$)
	w. hemlock	37	0.4	50	3,570	1/52 ha
T-7	w.r. cedar	3	1.7	14	84	22 ($352m^2$)
	w. hemlock	69	3.2	86	1,932	1/28 ha
	D. fir	4	1.0	14	112	
	s. spruce	1	0.2	5	28	
T-8	w.r. cedar	78	0.6	79	2,028	24 ($384m^2$)
	w. hemlock	22	0.5	46	572	1/26 ha
	D. fir	5	1.9	17	130	
T-12	w.r. cedar	27	1.1	50	756	22 ($352m^2$)
	w. hemlock	41	1.7	68	1,148	1/28 ha
	D. fir	35	2.5	64	980	
	balsam	2	2.5	9	56	
T-11	w.r. cedar	27	1.3	80	837	20 ($320m^2$)
	w. hemlock	50	2.0	75	1,550	1/31 ha
	D. fir	29	2.2	80	899	
C-12	w.r. cedar	10	1.8	33	520	12 ($192m^2$)
	w. hemlock	52	2.5	83	2,704	1/52 ha
	D. fir	6	3.5	42	312	
	balsam	13	2.4	58	676	

PLOT	SPECIES	NUMBER OF TREES	AVERAGE HEIGHT(M) OF TREES	PERCENT FREQUENCY OF OCCURRENCE	NUMBER TREES PER Ha.	NUMBER OF SUB-PLOTS
T-13	w.r. cedar	43	0.7	74	1,419	19 ($304m^2$)
	w. hemlock	252	1.9	95	8,289	1/33 ha
	D. fir	15	1.0	42	495	
	balsam	2	2.1	11	66	
C-13	w.r. cedar	4	2.0	17	208	12 ($192m^2$)
	w. hemlock	43	3.0	83	2,236	1/52 ha
	D. fir	4	1.5	17	208	
	balsam	13	1.7	58	676	
T-14	w.r. cedar	7	2.5	31	336	13 ($208m^2$)
	w. hemlock	4	1.4	15	192	1/48 ha
	D. fir	1	1.5	8	48	