VEGETATIONAL COMPOSITION AND REGENERATION IN

THREE FOREST ASSOCIATIONS AFTER LOGGING IN THE

COASTAL WESTERN HEMLOCK ZONE

by

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ABSTRACT

The study was initiated to determine the composition and structure of vegetation and natural tree regeneration invading logged areas within three major forest associations that were subjected to different site treatments in coastal British Columbia.

To accomplish the above objectives, 50 one-fortieth acre plots were established in logged areas ranging in age from 2 to 14 years following logging and the accompanying site treatment. The number of trees per acre by height class, rooting substratum of the coniferous trees, and qualitative coverage estimates of the trees, shrubs, herbs and mosses encountered on each plot were sampled. These data were grouped into associations and analyzed using the relevé method for the vegetation and analysis of variance to assess the role of natural regeneration in each association and treatment class. Distance to the seed source and the type of seed source were measured to provide adjacent stand information.

Environmental parameters such as slope, aspect, topographic position, seedbed type, parent material and depth, and altitude were measured to determine their significance in forming each association and their effect

on natural regeneration.

The results of the study indicate that the three forest associations are identifiable in the early stages of secondary succession. The identification of the swordfern - western redcedar and salal - Douglas-fir associations was possible from vegetation characteristics alone. Identification of the moss - western hemlock association necessitated the use of physiographic position, soil depth, and vegetation.

Structurally, all associations contained the same average total cover, but differed considerably in species composition and layer dominance. The salal - Douglas-fir association had a very well developed shrub layer dominated by a low cover of Gaultheria shallon, a well developed moss layer dominated by Hylocomium splendens, and a poorly developed herb layer. The moss - western hemlock association followed a similar trend. The swordfern - western redcedar association was characterized by a well developed shrub layer dominated by Rubus spectabilis, a herb layer that was welldeveloped both in species composition and cover, and a poorly developed moss layer. It was found that factors such as the degree of disturbance, spacing of the planted trees, age, and parent material caused changes in structure and species composition within each association and between associations. In addition, site treatment, especially slashburning, affected the species composition by eliminating many of the low growing indicator species normally found in an association that had had no treatment. Slashburning decreased the number of species in the salal - Douglas-fir association the greatest, while in the swordfern - western redcedar association, this reduction was of a lesser extent.

The results of the statistical analysis indicate that associations coupled with site treatment are more important in determining the number and species of coniferous trees invading a logged site than the association type.

Coniferous trees preferred the salal - Douglas-fir and moss - western hemlock associations that had no treatment or were piled and burned. Douglas-fir, western hemlock, and western redcedar were all decreased in numbers by slashburning.

The regeneration of deciduous trees was found to be more strongly controlled by the association type. The swordfern - western redcedar association was the favoured association.

All coniferous species preferred a mineral soil seedbed for germination, however, survival was low except for Douglas-fir. Western hemlock preferred a decaying wood substratum and western redcedar was found most often on rapidly decomposing organic matter in moist pockets.

The study indicated that an adequate number of coniferous trees existed in all associations and site treatments according to normal restocking standards. Western

hemlock was the dominant tree species and generally occurred in an uneven clumped pattern. Douglas-fir and western redcedar were relatively poorly stocked in all associations and site treatment classes. Indications are that supplemental planting of Douglas-fir would be needed to reach a desirable level of stocking of Douglas-fir in all associations studied.

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I. INTRODUCTION

The Coastal Western Hemlock Zone, identified by Krajina (1965), occupies a large area of coastal British Columbia. In this zone, the three major timber trees, namely Douglas-fir (Pseudotsuga menziesii), 1) western hemlock (Tsuga heterophylla), and western redcedar (Thuja plicata) attain their highest level of wood production. Empirical yield tables for natural stands in British Columbia show that the productivity of the coastal region may be two to three times that of good sites in the interior (Fligg 1960). Consequently, this zone is exceedingly valuable to the forest industry. Therefore, any practice that will promote faster regeneration and growth of the preferred species is of the utmost importance. Both the University of British Columbia Research Forest and the Mission Tree Farm, where this study was conducted, lie within the Coastal Western Hemlock Zone. This factor places a greater value on the results derived from the study. However, because of the time involved in field analysis, only the dry subzone was studied. But many of the conclusions and procedures for the dry subzone can be applied to the wet subzone.

¹⁾ Scientific, common names and authors are contained in Appendix II.

Forests affected by human activity, that contain a number of age classes and successional stages, are frequently quite heterogeneous and unstable. Therefore, having some knowledge of the developmental patterns of vegetation after a disturbance greatly enhances the amount of information gained. Because of their longevity and diversity in structure and within time, forest successional patterns are difficult to define. Yet the dynamic processes during the initial stages of succession must be recognized if an effective system of forest classification is to be developed that is accurate and useful in the understanding of the regeneration characteristics of the tree species found in each forest association.

In recognition of a need for a more ecologically sound programme of silviculture and the division of the land-scape into homogeneous units to provide for a better understanding as well as a more accurate one, regarding regeneration of trees and vegetation patterns after logging, the following study was undertaken. The objectives of this study were two-fold: to describe and interpret the vegetational composition and structure of logged openings in the initial stages of secondary succession, and to evaluate the role of natural tree regeneration in three forest associations within the dry subzone of the Coastal Western Hemlock Zone. It is hoped that differences in vegetation patterns and tree regeneration characteristics will be evident between the three forest associations that will provide added information for

the management of logged over areas. To meet these objectives it was found advantageous to divide the thesis into two parts. Part I deals with the vegetation analysis and variations due to man's activities within the three associations studied, and Part II analyzes the seedling establishment within each association. In this way the objectives can be met in a more clear and easily understood manner.

II. LITERATURE REVIEW

In British Columbia, the most significant and complete ecosystematic classification was developed by Krajina (1959, 1965, 1969). This approach was adopted for this study. Krajina divided British Columbia into eleven biogeoclimatic zones, which were further subdivided into subzones. Basically his approach is founded on the concept devised by Jenny (1941, 1961) and Major (1951) which is that vegetation as well as soils is a product of climate, parent material, topography, organisms and time. It is this integration of ideas in the concept of the plant association (Krajina 1960) that makes this approach ecosystematic or holocoenotic.

Each biogeoclimatic zone is differentiated by the climate, the zonal soil, and the climatic climax plant community existing on a mesic habitat. The recognition of each subzone is based mainly on the amount of precipitation received and the associated vegetation changes. The name of the zone is derived from the name of the dominant self-regenerating plants in the overstory and in the understory. Although Krajina recognizes the mesic association as being the climatic climax community, he does distinguish between edaphic and topographic climaxes, in recognition of the concept of the polyclimax.

Previous studies of secondary succession following clearcutting have been aimed at obtaining a general knowledge of succession following logging (Isaac 1940, Morris 1958, Yerkes 1960). There has been little attempt to stratify the early successional stages into communities, based on existing vegetation and nearby mature communities. As a result only broad successional stages have been distinguished because of the variation due to age, fire intensity, site type and variables such as soil, elevation, and aspect. Dyrness (1973) outlined the typical successional stages after logging:

(1) moss-liverwort, (2) annual weeds and short-lived perennials, and (3) shrubs and tree seedlings.

McMinn (1951) described the vegetation on a 20-year-old burn at the University of British Columbia Research Forest and distinguished a number of secondary vegetation types based on species composition and habitat. No evaluation of the previous stand was made. Also in this same area, Kellman (1969) studied the plant interrelationships during secondary succession. He noted that the prelogging species maintain themselves after logging and gradually re-establish dominance during succession whereas invader (pioneer) species respond initially to canopy removal and concentrate in the more severely disturbed sites.

Mueller-Dombois (1960) studied the early successional stages in eight associations that were described in their mature state by Krajina and Spilsbury (1953). Information on their environmental and vegetational aspects in early secondary succession was described and evaluated. He found that even after clearcutting and slashburning the original plant association was still evident. Bailey (1966), using a similar method, investigated plant succession in the southern Oregon Coast Range.

Bailey and Poulton (1968) classified 23-, 29- and 35-year-old secondary communities in northwest Oregon and related them to site type. The results revealed that seral vegetation developing after fire is classifiable and that communities exhibit consistent relationships to environmental factors.

Dyrness (1965, 1973) followed the early stages of plant succession after logging and burning in the western Cascades in Oregon. He documented vegetative changes for seven years on permanent milacre plots. The prelogging plant communities were described before logging. Differences in disturbance from logging and burning highly affected the successional trends. Areas disturbed by logging, but unburned, supported a diversity of residual and invader species; whereas burned areas were occupied mostly by invader species. He also found that the postlogging and the prelogging communities were distinguishable.

III. DESCRIPTION OF AREA STUDIED

The study was conducted on two areas: The University of British Columbia Research Forest, Haney, B.C. and the Mission Tree Farm located near Mission, B.C. Both areas are located on the southern fringe of the coast mountain range between Pitt and Harrison Lakes (Fig. 1). Figures 2 and 3 indicate the location of the study plots on the two forests. Both lie within the Coastal Western Hemlock Zone and are generally similar in climate, vegetation, and soil development. The topography is rugged with numerous rock outcroppings. The soil is mainly of glacial till origin and varies in depth from a few inches to three or more feet. The climate is characterized by mild wet winters and comparatively warm dry summers (Kendrew and Kerr 1955). Fire and logging history contribute to the major differences between the two areas.

1. The Coastal Western Hemlock Zone

The Coastal Western Hemlock Zone was identified by Krajina (1959, 1965, 1969) and has been studied by several investigators: Krajina and Spilsbury (1953), Orloci (1961, 1964), Mueller-Dombois (1960, 1965), Lesko (1961), Eis (1962), Kuramoto(1965), and Wade (1965). This zone is the most typical

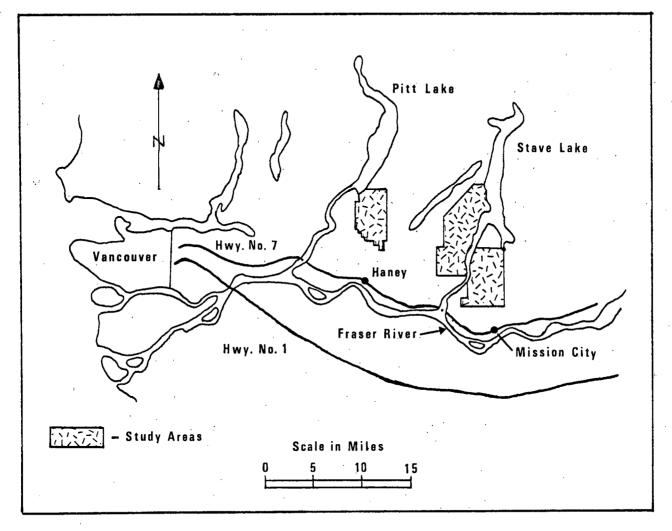


FIGURE 1 Map showing the location of the U.B.C. Research Forest and the Mission Tree Farm where the study was carried out.

FIGURE 2 Photo-mosaic map of the University of British Columbia Research Forest, Haney, B.C. Dots indicate location of study plots. Approximate scale - 1:24,000.

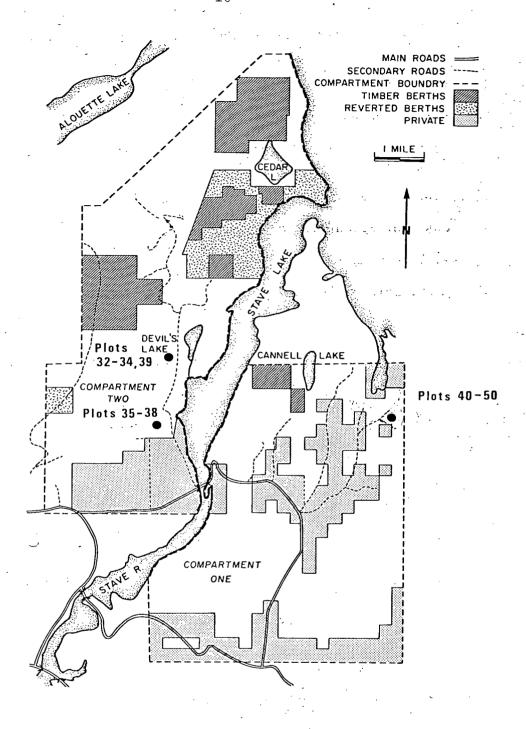


FIGURE 3 Map of Mission Tree Farm. Dots indicate location of study plots. Scale - 1:125,000.

of coastal British Columbia, beginning directly at the coast and extending inland on the slopes of the Coast and Cascade Mountains.

The Coastal Western Hemlock Zone is the wettest zone in British Columbia. The climate is characterized by an equable mesothermal climate (Cfb) and to some extent a milder Dfb climate, after Köppen (1936). Krajina (1969) summarized its attributes as follows: mean annual temperature: $5 - 9^{\circ}$ C; annual range of temperature: $9 - 21^{\circ}$ C; absolute maximum temperature: $26 - 40^{\circ}$ C; absolute minimum temperature: -30 to -7° C; number of frost-free days: 120 - 250 days; annual total precipitation: 65 - 262 inches; annual snowfall: 5 - 295 inches; seasonal occurrence in percent of total precipitation: 30 - 45% in winter and 7 - 15% in summer; elevation: 0 - 3000 feet.

The zone is subdivided into two subzones based on precipitation. The annual total precipitation in the dry subzone ranges from 65 to 110 inches. The wet subzone is characterized by an annual total precipitation of 110 to 262 inches.

Since the study is only concerned with the drier subzone of the Coastal Western Hemlock Zone, only this subzone will be discussed further concerning soils and vegetation.

Soi1s

The zonal soils of the drier subzone were identified by Krajina (1969) as Humo-Ferric or Ferro-Humic Podzols. Zonal

soils are those having well developed characteristics which directly and indirectly reflect the climate, without being influenced by extremes of parent material and drainage. Podzols generally have thick raw humus accumulations on the mineral The thick accumulation of raw humus is the result soil surface. of the cool temperatures of this zone and a predominance of fungal activity, with relatively little activity by bacteria and burrowing fauna. Fungi are promoted in an acid environment (Lutz and Chandler 1946; Buol, Hole and McCracken 1973), which is characteristic of coniferous litter (Ovington 1956). The heavy precipitation in this zone causes a strong leaching of the soil to take place, thus removing many of the minerals from the upper soil horizons to form an eluviated horizon under the organic layers and an illuviated horizon in the lower Throughfall and stemflow precipitation also contribute to the leaching process and the cycling of nutrients in the forest environment (Madgewick and Ovington 1959; Tarrant et al. 1968).

Lesko (1961) found the soils to be very acid with pH ranging from 2.9 to 4.9 in the O horizons, 3.5 to 4.6 in the Ae horizon, 3.7 to 5.4 in the Ah horizon and 4.0 to 6.0 in the B horizon. He also noted the absence of an accumulation of calcium, magnesium, and potassium in the B horizon caused by the high precipitation promoting leaching.

The soils generally exhibit a coarse texture ranging from sandy loam to gravelly loamy sand. The soils are stony

with the stones varying in size from gravel to large boulders.

Soil mapping of the study areas has been done by several investigators. Kowall (1967) mapped compartment 1 of the Mission Tree Farm and determined the capability of the soils for forestry purposes. Subsequently, the entire Mission Tree Farm, as well as the surrounding area, was mapped by Luttmerding and Sprout (1968) for the British Columbia Department of Agriculture. The University of British Columbia Research Forest has been preliminarily mapped by the soils division of the British Columbia Department of Agriculture in cooperation with Rowles and Lavkulich of the Department of Soil Science, University of British Columbia. In all cases the basic mapping unit was the soil series.

Vegetation

The study of the mature forest associations in the drier subzone of the Coastal Western Hemlock Zone has been done by Orloci (1961, 1964), Eis (1962) and Kojima (1972). The mature associations must be analyzed before the more unstable and ecologically diverse seral stages can be fully understood.

In this zone Tsuga heterophylla, Pseudotsuga menziesii, and Thuja plicata reach the most productive state. Pseudotsuga menziesii attain its best growth, sometimes reaching 300 feet in height and 12 feet in diameter (Krajina 1959). Pseudotsuga menziesii occurs as a pioneer

tree (moderately shade intolerant) on all sites except the driest hygrotope. Consequently, it usually becomes established after fire or logging as secondary succession progresses. As the growth of the stand continues under the humid conditions, coniferous litter and dead trees begin to decay, advancing the process of podzolization and promoting raw humus formation causing the habitat to become more favorable to the establishment of Tsuga heterophylla. According to Krajina (1965), an abundance of acid mor humus greatly enhances the establishment of Tsuga heterophylla. Tsuga heterophylla is the climatic climax species on mesic habitats but is commonly found in all habitats throughout the Coastal Western Hemlock Zone.

Thuja plicata grows best on sites where seepage water is abundant. Because of the ample supply of nutrients and moisture on these sites, soil organisms are abundant, forming a mull humus which is favourable to the species.

Thuja plicata usually becomes dominant in depressional receiving areas or alluvial habitats along streams.

Several deciduous trees are commonly found: Acer macrophyllum, Prunus emarginata, Cornus nuttallii, Alnus rubra, Acer circinatum, Populus trichocarpa, Betula papyrifera, and Rhamnus purshiana. All of these deciduous trees require a fairly moist and rich habitat to attain their peak productivity.

Pinus contorta and Pinus monticola occur infrequently. Pinus monticola is better adapted to montane areas but
it is usually eliminated by the white pine blister rust before

it achieves dominance. $Pinus\ contorta$ is very shade intolerant and therefore acts primarily as an invader of open areas if a seed source is available.

2. Geological History of the Study Areas

The study areas were subjected to four glaciations: Seymour, Semiamu, Vashon, and a minor one that only glaciated the valleys, the Sumas (Armstrong 1957). The Vashon was the most important glaciation as far as the soils and present land features of the study area are concerned. During each glaciation the land was depressed relative to the sea. As the ice wasted, the ice previously resting on the sea floor thinned and floated, leaving glaciomarine stoney clay deposits below 500 feet elevation. Succeeding the ice melt, the land surface rose above the sea. Meltwater, produced from wasting glacial ice, created localized areas of glacial outwash deposits above 500 feet elevation.

The ice moved in a generally southerly direction forming a valley trend running north to south. The valleys are usually broad and U-shaped with steep sides.

The mountains are composed mainly of quartz diorite, granodiorite, or diorite. Volcanic or sedimentary rocks are found only locally and considered of minor importance (Geological Map of B.C., 1948). Within the study area, glacial drift is by far the most abundant material and underlies most of the terrain. The depth of the till varies from a thin veneer on the top of the slopes to deep plain deposits on the

lower slopes. The till is derived from the mechanical abrasion of the ice against the rock strata and consists of two types, ablation till and basal till. Ablation till is material on and within the ice, and as the glacier melts it falls to the surface. Basal till is compacted under the weight of the glacier. This compacted material is relatively impermeable to roots and water. The basal till generally does not travel a great distance and therefore tends to reflect the crystal size and composition of the underlying bedrock.

IV. METHODS

1. Approach

The basic approach and methods initially developed by the phytosociologists of the Zürich-Montpellier school were followed in conducting this study. These have been discussed in detail by Braun-Blanquet (1932, 1951), Billings (1952), Poore (1955, 1956), Becking (1957), and Krajina (1933, 1959, 1960, 1965). Only a brief discussion is necessary here to clarify the methods adopted.

2. <u>Selection of Plots</u>

The sample plots were subjectively chosen so that each represented a uniform stand floristically as well as physiographically. Each plot is considered to be a sampling unit, which represents a complete sample of that particular ecosystem and can be characterized by a certain set of properties. Although it is apparent that no two plots are going to be identical in every detail, comparison of floristic and environmental data has disclosed analogous relationships in vegetation pattern and structure.

At the University of British Columbia Research
Forest sample plots were tentatively selected using Klinka's
preliminary ecosystem map of the Forest (1972). Final identi-

fication of the site type was made in the field utilizing position on slope, depth and type of parent material, residual vegetation and existing vegetation in the adjacent stands.

In the absence of a detailed ecological study at the Mission Tree Farm, a map could not be used to tentatively choose the location of the plots established there. The experience gained from the field work at the University of British Columbia Research Forest, as well as the previously mentioned indicators, were used to locate each plot at this forest.

When sampling was carried out in a cut-over area, more than one plot was usually laid out in one site type in an effort to sample variations in site preparation, burning intensity, and topographic position. Such variations will cause lesser vegetational dissimilarities as well as affecting tree growth and regeneration.

3. Plot Size

Each site type was described on a one-fortieth (1/40) acre square plot. At the beginning of the field work in the summer of 1973, one-tenth (1/10) acre plots were used. But it was found that even though the larger plot size could provide more information (Orloci 1964), it was very difficult to handle and time-consuming because of the complex nature of the vegetation in cut-over areas. Consequently, one-fortieth (1/40) acre plots were chosen.

4. Forest Association

The definition of a forest association adopted for this study is as follows:

"A forest association has a definite uniform vegetation composition and physiognomy, and is associated with a certain set of environmental and physical factors. It is in a climax state and at equilibrium with the climate of the area."

Because of past fires and logging, numerous successional stages exist before the final climatic climax stage is reached. Although it is emphasized that these successional stages will eventually reach the final climax association, the reason for centering a classification on the more stable climax association is that it draws together several successional stages that will all develop into the same climax association. This reduces the size of the classification and increases its usefulness. For these reasons, the seral associations of this study have been identified and named according to the climax association to which they relate, since intrinsic characteristics such as soil, climate, parent material, and topography remain relatively unaltered, as does the independent biotic factor discussed by Jenny (1941).

5. <u>Associations Examined</u>

Three associations were selected to be sampled:

Salal - Douglas-fir (xeric) type

Moss - western hemlock (mesic) type

Swordfern - western redcedar (subhygrichygric) type

The non-forested ecosystem on rock, skunk cabbage - western redcedar and Devil's club - western redcedar associations were disregarded in this investigation because the area covered by these is small compared to the other associations and insignificant in terms of management potential.

6. Analytical Procedure

General Environmental Data

On all the plots examined, the following parameters were taken into consideration for analysis of the environment and plot history:

Physiography:

- 1. Altitude
- 2. Aspect
- 3. Topography
- 4. Micro-relief within plot
- 5. Slope gradient
- 6. Position on slope
- 7. Landform
- 8. Texture of parent material

Stand description:

- 9. Location
- 10. Setting size
- 11. Date logged
- 12. Date since last disturbance
- 13. Age of stand
- 14. Date planted
- 15. Type of treatment
- 16. Burning intensity
- 17. Distance to seed source
- 18. Distance to south edge
- 19. Type of seed source

Soil and organic layers:

- 20. Soil order
- 21. Depth of organic layers
- 22. Hygrotope
- 23. Percentage of plot covered by rock, slash, mineral soil, organic material, and decaying wood
- 24. Percentage of brush species overtopping or nonovertopping trees.

The scales used for each parameter are contained in Appendix I.

Vegetation Data Analysis

to the following aspects:

1. Estimate of percentage surface cover of each vegetation

layer defined according to life form and height:

Layer A: Tree layer - trees over 30 feet in height

Layer B: Shrub layer - B_1 - woody plants over 6 feet but less than 30 feet

B₂ - woody plants less than 6 feet in height

Layer C: Herb layer - all herbaceous plants including creeping shrubs and commercial trees species less than 1 foot tall

Layer D: Moss layer - DH - Bryophytes growing on humus

DW - Bryophytes growing on decaying wood

DM - Bryophytes growing on mineral soil

DR - Bryophytes growing on rock.

Each species is rated in terms of species significance 2. and sociability in each respective vegetation layer according to the Domin-Krajina scale (1933). The scales employed are shown in Tables 1 and 2. Species significance was used to assess the abundance or dominance of a species in each plot, and sociability allows for an approximate estimate of a species tendency to grow in groups or singly. The significance and sociability estimates were done visually. The visual estimation approach has been adopted by most phytosociologists (Braun-Blanquet 1932, 1951; Krajina and Spilsbury 1953, Brayshaw 1955, Becking 1957, Orloci 1964, Bell 1964, Kojimi 1972) because of its efficiency and speed for most comparison purposes.

Table 1 Species significance scale (Domin - Krajina, 1933)

<u>Class</u>	Description
+	Solitary, very low dominance (0 - 1%)
1	Seldom, very low dominance (1 - 2%)
2	Very scattered, low dominance (2 - 3%)
3	Scattered, low dominance (3 - 5%)
4	Covering 5 - 10% of the plot
5	Covering 10 - 20% of the plot
6	Covering 20 - 33% of the plot
7	Covering 33 - 50% of the plot
8	Covering 50 - 75% of the plot
9	Covering more than 75% but less than 100% of the plot
10	Covering 100% of the plot

Table 2 Sociability scale (Krajina, 1933)

Class	Description	
+	Sociability 0, individual plants	
1	Groups, up to $4 \times 4 \text{ cm}^2$	
2	Groups, up to 25 x 25 cm^2	
3	Groups, up to $50 \times 50 \text{ cm}^2$	
4	Groups, up to $1/3 - 3/4 \text{ m}^2$	
5	Groups, up to $1 - 2 m^2$	
6	Groups, up to 5 m ²	
7	Groups, up to 25 - 50 m^2	
8	Groups, up to 100 m ²	
9	Groups, up to $200 - 250 \text{ m}^2$	٠
10	Groups, at least 500 m ²	

Tree Data Analysis

Tree information was handled in a somewhat more detailed manner than the vegetational component.

The tree analysis consisted of a tally of all tree species present in one foot height classes (Table 3). Depending on the density of the stocking on a plot, it was divided into quarters or thirds and regeneration recorded in each section and then totalled for all sections in that plot. The number of trees recorded on each plot were then converted to a per acre basis for purpose of comparison.

On cut-over areas that had been planted, an attempt was made to separate and tally the planted trees from those of natural origin. This was done by comparing the height of the planted vs. naturally regenerated trees, by whorl counts, and by observing if the trees were in rows. This method worked well in all areas except those that were older and extremely dense in which the row effect of the planted trees was obscured.

Synthesis of Vegetation

The vegetation synthesis consists of a summation and analysis of the vegetation data collected. The data were then abstracted to form associations.

When the plots were sampled they were grouped into tentative associations. All plots of the same tentative associations were grouped and species stratified by

Table 3 Regeneration height classes

Regeneration Class	Height (ft.)
0	under 1 foot in height
1	1-2
2	2 - 3
3	3 - 4
4	4 - 5
5	5 - 6
6	6 - 7
7	7 - 8
8	8 - 9
9	9-10
10	10-11
etc.	etc.

layer. For each species within an association, a presence, mean significance, and range of significance value were determined. The species were arranged within each vegetation layer in decreasing order, firstly by presence. If two or more species were alike in presence value, they were arranged according to highest mean significance values, and finally if two or more species were alike in both presence and mean significance, they were arranged alphabetically. This procedure was carried out using a computer method developed by. Ktinka (1974).

Once the synthesis tables were formed, they were manipulated until the final associations were abstracted. The "characteristic combination of species" (Braun-Blanquet 1932, Krajina 1933, Orloci 1961) was employed to typify an association. Only species that fell into one of the following classes were considered as having some diagnostic value for identifying the association:

- 1. Constant dominant species: a species which has high presence (80 100%) and high significance (mean species significance more than 5.0).
- Constant species: a species which has high presence
 (70 80%) but low significance (mean species significance less than 5.0).
- 3. Important companion species: a species which does not belong to any of the above, but tends to associate more or less exclusively with a certain association.

Lesser Vegetation

The use of this classification places heavy emphasis on the role of lesser understory vegetation for identification of a particular association. Lesser vegetation is generally more sensitive to environmental differences and variation (Becking 1957, Daubenmire 1968, Dyrness and Youngberg 1958) than overstory species. First, the feeding roots of trees, shrubs, and various herbs are usually all located in the most fertile part of the soil profile (Kalela 1950, Coile 1952). Second, lesser vegetation ordinarily has a narrower ecological amplitude than overstory species, such as Tsuga heterophylla or Pseudotsuga menziesii. Third, after a major disturbance such as fire, lesser vegetation tends to sprout from rhizomes and continue the original vegetation pattern, although a change in structure may occur (Mueller-Dombois 1960). However, this may be masked by invading weed vegeta-Fourth, important indicative tree species tend to be preceded by short-lived seral species that do not truly indicate the effect of environment, but rather the availability of seed and their ability to capitalize on disturbed situa-This results in an unstable condition persisting for a number of years.

One problem in the use of lesser vegetation is the lack of knowledge about its distribution, habits, and tolerance in response to different treatments or disturbances (Rowe 1956).

V. RESULTS AND DISCUSSION

The vegetation has been analyzed as described in Chapter III, and the results recorded in Appendix I. The data are organized into three parts: general plot information, vegetation synthesis tables, and stand description. Within each association, the plots are ordered from left to right by treatment and age. The species in the vegetation synthesis tables are arranged vertically in the following order:

- a) by strata
- b) by decreasing presence within a stratum
- c) by decreasing mean significance, where presence within a stratum is identical and
- d) alphabetically, if presence and mean significance are identical.

The stand description section contains the number of trees per acre found on each plot by species and height class.

It should be realized that these associations are relatively broad in vegetative characteristics and could possibly be divided into a number of smaller units if mature associations were being dealt with rather than early successional ones. However, because of the heterogeneity of the vegetation at this stage of development, brought about by the severe alteration of the environment after clearcutting, the permanent vegetative characteristics have not had time to stabilize. Therefore extensive variability occurs

within and between plots grouped in the same association, regardless of how far the divisive process is carried. This variability in vegetative features in the early successional stages causes difficulty in the identification and description of the early successional associations. This difficulty is aggravated by the occurrence of many short-lived annual plants and shade intolerant shrubs, trees and herbaceous plants that are not found in the mature associations and tend to cover up the more important plant species indicative of a particular association. This results in a greater use of environmental features to characterize each individual association. Water status and soil depth become two of the most important parameters for this purpose.

PART I - ASSOCIATION AND STRUCTURAL ANALYSIS

1. Floristic Features of the Three Seral Associations

Salal - Douglas-fir association

This association develops on relatively shallow soils over bedrock usually possessing a convex topography.

It generally occupies ridgetops and upper slope positions.

The slope gradient varies from 0 - 5 percent on ridges to 45 percent on neutral slopes (Figs. 4, 5, and 6). Appendix I, Parts I and II contains the data discussed in this section.

The characteristic combination of species for this association is:

Constant dominant species:

Gaultheria shallon

Tsuga heterophylla

Pteridium aquilinum

Polytrichum juniperinum

Constant species:

Betula papyrifera

Vaccinium parvifolium

Rubus spectabilis

Epilobium angustifolium

Blechnum spicant

Rubus ursinus

Pseudotsuga menziesii

FIGURE 4

Plot 48 in the salal - Douglas-fir association was severely slashburned 2 years prior to examination. Note cover of *Pteridium* aquilinum and *Epilobium* angustifolium, and lack of any visible tree regeneration.

FIGURE 5 Plot 47, 7 years after piling and burning.
Note poor regeneration and survival of planted
Douglas-fir.





The A and B₁ layers are largely a function of the age of the stand. Early successional tree species reach these layers first as well as Tsuga heterophylla on unburned plots where it occurs as advanced regeneration. Betula papyrifera, Salix sitchensis, and Tsuga heterophylla are dominant species with Prunus emarginata, Alnus rubra, Populus trichocarpa, Acer circinatum, and Thuja plicata occurring sporadically. The B2 layer is consistently dominated by Gaultheria shallon, accompanied by Vaccinium parvifolium, Tsuga heterophylla, Rubus spectabilis, and Betula papyrifera. As in the mature association, Gaultheria shallon is dominant but to a greater extent, forming a continuous carpet (Fig. 7) one to two feet tall. The extensive layer of Gaultheria shallon largely eliminates low growing herbs and tree regeneration or restricts their occurrence to moist pockets and exposed areas. burning did not seem to reduce Gaultheria shallon in significance but did cause a more pronounced patchy occurrence rather than a continuous layer. Vaccinium parvifolium is strongly associated with the amount of decayed wood present and decreases noticeably as the amount of decayed wood is decreased. Rubus spectabilis also had a relatively high dominance which is quite different from the mature association where it occurs only sporadically. This is due to the increased light and the mineralization of the organic layers brought about by clearcutting. Other common shrubs in the B2 layer are Menziesia

FIGURE 6 Plot 11 in the salal - Douglas-fir association illustrates the vegetation in an area that had no treatment after logging.

FIGURE 7 Heavy Gaultheria shallon cover forming on decaying wood after logging and no further treatment in the salal - Douglas-fir association.





ferruginea, Spiraea douglasii, Vaccinium ovalifolium, Rubus parviflorus, Vaccinium alaskaense, and Rubus leucodermis. All the tree species prevailing in the B_1 layer also occur in the B_2 layer, but usually with a higher constancy and significance.

The C layer is largely composed of tall weed vegetation present because of clearcutting, and numerous ferns, some of which are residual from the period before cutting. Pteridium aquilinum, Epilobium angustifolium, Blechnum spicant, Anaphalis margaritacea, and Rubus ursinus compose the major proportion of this layer. Blechnum spicant, Polystichum munitum, Dryopteris austriaca, and Athyrium filix-femina occur mostly in moist pockets that offer a most favorable habitat (Fig. 8). The development of these moist pockets is quite common after They result from the logging operation and usually contain a high proportion of organic matter and are shaded by adjacent logging slash. Slashburning removes much of the adjacent slash and organic matter from the moist pockets, and destroys pre-existing plants, reducing their favourability to shade-loving species. Consequently, after slashburning the fern species are greatly reduced in significance. Athyrium filix-femina is completely eliminated. However, Pteridium aquilinum exhibits a different trend. It seems to be enhanced by any disturbance that takes place. On areas that were untreated, but where the logging operation exposed mineral soil, Pteridium aquilinum was present in high proportions also.

FIGURE 8

Moist pockets characteristic of logged areas. Polystichum munitum, Blechnum spicant, Dryopteris austriaca and Hylocomium splendens are prominent here.





Maini and Horton (1966) found regeneration of *Pteridium* aquilinum considerably stimulated by either scarification or burning, and the density significantly greater than on untreated soil.

Linnaea borealis covers significant areas of the ground in the unburned plots and can be considered a constant dominant species on these areas. Slashburning, however, effectively excludes Linnaea borealis.

The moss layer (D) is extensive (57%) after clear-Hylocomium splendens and Rhytidiadelphus loreus are the dominant mosses on humus. Eurhynchium oreganum, which is important in the mature association, assumes a very minor role after clearcutting. On mineral soil Polytrichum juniperinum is consistently the most common. Pogonatum contortum and Pohlia nutans are largely restricted to unburned areas. These mosses are controlled by the degree in which the mineral soil is exposed in logging. The moss flora on decaying wood is restricted to unburned areas and consists of Plagiothecium undulatum, Hylocomium splendens and Rhytidiadelphus loreus as the most common, but they possess a relatively low significance value. The mosses on rock depend on the amount of rock exposed. This layer is normally not as welldeveloped as in the mature association, because the rock areas are sometimes covered with slash, mineral soil, and organic material during the logging operation, or if slashburning is carried out, the existing flora is partially destroyed.

The two most common mosses are Rhacomitrium canescens and Rhacomitrium heterostichum.

higher cover than either Pseudotsuga menziesii or Thuja plicata in all layers. Tsuga heterophylla is associated with decaying wood on which it reaches its best growth. It can also be found germinating on mineral soil. However the survival rate is exceedingly low and most germinants are eliminated in the first two seasons. Slashburning greatly decreases Tsuga heterophylla in significance. Pseudotsuga menziesii is less abundant than Tsuga heterophylla and is found almost exclusively growing on mineral soil. Thuja plicata is a common seedling but seldom reached the B₁ layer, unless it occurs as advanced regeneration on the unburned plots.

The structure of this association is comprised of a very well-developed shrub layer that restricts the development of a low growing herbaceous layer. Tall herbs and ferns are the only significant dominants. The moss layer is well-developed on humus and mineral soil, but relatively less developed on decaying wood and rock.

Moss - Western Hemlock Association

This association occurs on lower mountain slopes with moderate slope gradients (Figs. 9 and 10). It can also occupy relatively flat areas with deep soils that are well-

FIGURE 9 Plot 32 in the moss - western hemlock association, 8 years after logging and no treatment.

Tsuga heterophylla is primary species.

FIGURE 10 Plot 33 in the moss - western hemlock association 8 years after logging, piling and burning, and planting of Douglas-fir at a 6x6 foot spacing.





drained. This association will ordinarily occupy an equivalent physiographic position on north exposures as that which the salal - Douglas-fir association does on south exposures (Figs. 11 and 12). Refer to Appendix I, Part I and II for the data discussed in this section.

The characteristic combination of species for this association is:

Constant dominant species:

Gaultheria shallon
Tsuga heterophylla
Rubus spectabilis
Pteridium aquilinum
Hylocomium splendens

Constant species:

Vaccinium parvifolium

Vaccinium alaskaense

Thuja plicata

Polystichum munitum

Blechnum spicant

Dryopteris austriaca

Rubus ursinus

Rhytidiadelphus loreus

Polytrichum juniperinum

Plagiothecium undulatum

The B₁ layer is dominated by Tsuga heterophylla and Betula papyrifera. Acer circinatum, Salix sitchensis,

FIGURE 11 Moss - western hemlock association (Plot 45) on a north exposure. Note amount of Tsuga heterophylla.

FIGURE 12 Salal - Douglas-fir association (Plot 41) 7 years after slashburning on a southwest exposure. Note amount of *Gaultheria shallon* and lack of any regeneration except for planted Douglas-fir.





and Rhamnus purshiana all frequently occur also. The B₂ layer is well developed and is dominated by a number of species, Gaultheria shallon, Vaccinium parvifolium, Vaccinium alaskaense, Rubus spectabilis, Tsuga heterophylla, and Thuja plicata. Vaccinium ovalifolium, Sambucus racemosa, Spiraea douglasii, Menziesia ferruginea, and Rubus parviflorus are commonly occurring shrubs.

As in the salal - Douglas-fir association, the C layer is highly influenced by the thick shrub layer and is composed mainly of tall herbs, ferns, and shade tolerant trees such as Tsuga heterophylla and Thuja plicata. Blechnum spicant, Tsuga heterophylla, Pteridium aquilinum, Polystichum munitum, Dryopteris austriaca, Thuja plicata, and Rubus ursinus are the dominant plants. Moist pockets account for a large proportion of the fern development. Luzula parviflora, Tiarella trifoliata, and Trillium ovatum begin to occur sporadically in this association as an increase in moisture and nutrient availability takes place.

The moss layer is well developed. The dominant mosses on humus are Hylocomium splendens, Rhytidiadelphus loreus, and Plagiothecium undulatum. All of them are characteristic of this association. Eurhynchium oreganum occurs frequently. The mosses on mineral soil consisted mainly of Polytrichum juniperinum, Pogonatum contortum, and Pogonatum alpinum. As stated earlier, this layer depends on the extent of microsites (exposed mineral soil) available after logging.

Plagiothecium undulatum, Hylocomium splendens, and Rhytidiadelphus loreus are the prominent mosses on decaying wood,
although their significance is quite low. They usually form
patches on logs, decaying wood, and less commonly on humus
rather than a continuous layer. The patches are usually
four to six feet in diameter and confined to micro-depressions,
where they show the most vigor. Elsewhere, they are quite
yellowish and less vigorous. This is especially true for
Hylocomium splendens. On rocks, the moss layer was nonexistent except for a solitary occurrence of Rhacomitrium
canescens. As in the salal - Douglas-fir association, the
degree to which the rock areas are disturbed is a determining
factor.

In all layers, Tsuga heterophylla had the highest stocking of the three major coniferous trees. It was found growing on decayed wood and organic matter as well as on mineral soil. As in the salal - Douglas-fir association, Tsuga heterophylla was germinating readily on mineral soil which provided a favourable substratum for seed germination. However, in this association where precipitation is the major source of water, droughts are common, and elimination of Tsuga heterophylla occurs before it reaches a dominant position.

Thuja plicata also regenerates abundantly in this association, but very few seedlings become established. This is probably due to the high nutrient requirements of this species as well as the frequency of drought. The best survival,

as distinct from maximum germination, existed in moist microdepressions where very rapidly decomposing organic material formed a two to three inch deep layer. Thuja plicata occurs in all layers but decreases sharply in abundance toward the B_1 layer. In the B_1 and taller height classes of the B_2 layer it persists primarily as advanced regeneration.

Pseudotsuga menziesii was absent in micro-depressions and prevailed on mineral soil with sporadic occurrences on shallow organic matter and decaying wood. It was present in all layers. However, it was noticeably absent from a number of the Mission Tree Farm plots. This is apparently the result of age, seed source, and the planting density that will be discussed later. In order of abundance, Tsuga heterophylla was most prolific followed by Thuja plicata and Pseudotsuga menziesii.

The mature moss - western hemlock association is characterized by a lack of any shrub or herb species and a moss layer that forms a complete carpet over the ground. The major mosses are Hylocomium splendens, Rhytidiadelphus loreus, and Plagiothecium undulatum. These mosses are still present after logging. However, their significance is greatly reduced. In addition, there are a number of saprophytes that occur in the mature association, namely, Hemitomes congestum, Corallorhiza maculata, and Monotropa lanuginosa. These are completely absent after logging.

Probably the most outstanding feature of the moss -

western hemlock association after logging is the predominance of the shrub layer as well as numerous herbaceous plants. After logging, Gaultheria shallon, Vaccinium parvifolium, Vaccinium alaskaense, and Rubus spectabilis form a very well developed shrub layer. The average cover percent in the B2 layer is 65%. Gaultheria shallon dominates the B2 layer after logging. Aggressive weed species such as Epilobium angustifolium, Anaphalis margaritacea, and Pteridium aquilinum rapidly invade the site and mask many of the more useful identifying characteristic plants. Although the shrub and tall herb species tend to conceal the moss layer, it still forms a dominant part of the association.

Swordfern - Western Redcedar Association

This association is found at the base of slopes and in depressions where an adequate supply of seepage water is present. The parent material is mostly glacial till, marine deposits, and outwash. The parent material is usually deep and receives a large portion of its water supply from seepage water (Figs. 13, 14, 15, and 16). Appendix I, Part I and II contains the data discussed in this section.

The characteristic combination of species for this association is:

Constant dominant species:

Alnus rubra
Rubus spectabilis

FIGURE 13 Plot 2 exhibits the thick undergrowth of the swordfern - western redcedar association.

FIGURE 14 A successful plantation of Douglas-fir in the swordfern - western redcedar association (Plot 27).





FIGURE 15

Plot 8 in the swordfern - western redcedar association 5 years after logging and no treatment. Note the amount of deciduous tree regeneration and lack of any visible coniferous regeneration.

FIGURE 16

Thick deciduous undergrowth in swordfern - western redcedar association. Note the poor establishment of planted Douglas-fir (Plot 28).





Pteridium aquilinum

Polytrichum juniperinum

Constant species:

Spiraea douglasii
Rubus parviflorus
Tsuga heterophylla
Salix sitchensis
Polystichum munitum
Epilobium angustifolium
Anaphalis margaritacea
Blechnum spicant
Luzula parviflorus
Lactuca biennis
Dryopteris austriaca
Thuja plicata
Athyrium filix-femina

Plagiomnium insigne
Mnium lycopodiodes
Viola sempervirens
Eurhynchium praelongum
Trientalis latifolia
Galium triflorum

Important companion species:

The B₁ layer is dominated by *Alnus rubra*, *Salix* sitchensis, and *Populus trichocarpa*. On the areas that were planted, *Pseudotsuga menziesii* becomes an important dominant.

Tsuga heterophylla and natural Pseudotsuga menziesii occur frequently, but not in the proportion recorded in the previous two associations. On the older plots (004, 029, 007), Rubus spectabilis and Rubus parviflorus may reach a height of Other companions in this layer are Prunus emarginnine feet. ata, Acer circinatum, Salix scouleriana, and Betula papyri-The B₂ layer is very well developed. Rubus spectabilis, Spiraea douglasii, Rubus parviflorus, Tsuga heterophylla and Salix sitchensis are the prevalent species. layer is not defined by a few dominant species. It contains a large number of species that form a dominant portion of the Other common associates are Ribes sanguineum, Rubus leucodermis, Sambucus racemosa, and Rubus laciniatus. Oplopanax horridum may occur in moist, shaded pockets. Gaultheria shallon, although quite common in this association, is localized on decaying wood, which composes very little of the total ground cover. Vaccinium parvifolium is also reduced in significance due to the lack of decaying wood.

The C layer is very well developed, even though the shrub layers were dense. The increased moisture and relatively higher nutrient availability undoubtedly accounts for the rich development of the C layer. *Polystichum munitum* is constantly present, as would be expected for this association and was little affected by logging. In fact, logging seemed to increase its occurrence in all of the associations studied. Mueller-Dombois (1960) also noted this occurrence.

Epilobium angustifolium and Anaphalis margaritacea are both highly dominant and reach their optimum in this association. As in the previous two associations, Pteridium aquilinum is also extremely prevalent. Other frequent companions in the C layer are Blechnum spicant, Luzula parviflora, Lactuca biennis, Dryopteris austriaca, Athyrium filix-femina, Galium triflorum, Trientalis latifolia, Tiarella trifoliata, Viola sempervirens and Rubus ursinus. Agrostis scabra, Holcus lanatus, Hypochaeris radicata, and Festuca occidentalis are all strongly indicative of the degree of disturbance. Juncus effusus and Scirpus microcarpus usually indicate moist depressions or high moisture status of the parent material. example, plots 005, 030, and 031 are all located on glaciomarine deposits and are poorly drained. These plots contain large amounts of Juneus effusus and Scirpus microcarpus as well as a very rich flora of other species.

The moss layer is not well developed (average cover of 37%). Eurhynchium oreganum and Eurhynchium praelongum are the dominant mosses on humus; however, their presence and mean significance values are low. On moist habitats, Plagiomnium insigne and Leucolepis menziesii are commonly found. On mineral soil in exposed sunny habitats, Polytrichum juniperinum and Ceratodon purpureus occur as the dominant mosses. Mnium lycopodiodes is established on mineral soil in moist habitats shaded by slash or deciduous cover. In the plots examined, the moss flora on decaying wood is not well represented. This results from the lack of decaying

wood or slash, because of prior treatment either by slash-burning or piling and burning. *Hylocomium splendens* is the most common but has a low presence and mean significance. Plot 008, the only untreated plot, showed a definite increase in the decaying wood mosses.

Tsuga heterophylla, as in the previous two associations, germinates well in this association and surpasses both Thuja plicata and Pseudotsuga menziesii. However very few seedlings ever constitute a significant portion of the upper shrub layer. Its relatively slow growth rate and the intense competition from the dense shrub and herb layers could account for this. Thuja plicata obtains its best growth in this association. It was found in all layers except the ${\bf B}_1$ layer. Organic matter, in a state of rapid decomposition, provided the best survival rate. Maximum germination appeared to be on exposed mineral soil, but as in the other associations survival was low. Pseudotsuga menziesii was the least abundant of the three. It did occur in all layers, including the B₁, but very sporadically. Although this association provides the best sites for Pseudotsuga menziesii, competition from herbaceous and woody brush species is an important limiting factor here. Its shade intolerance destroys many new seed-Exposed mineral soil or a fine covering of organic matter provide the best habitat for germination.

The swordfern - western redcedar association differs considerably from the previous two associations. The shrub

layer is highly developed and composed mainly of Rubus parviflorus, Rubus spectabilis, and Spiraea douglasii. In the
previous associations, Gaultheria shallon and Vaccinium parvifolium were dominant shrubs. The rich development of the
herb layer is the most outstanding characteristic of the
swordfern - western redcedar association. This is caused by
seepage water which largely controls the development of this
association. The seepage water also permits a greater diversity
of deciduous trees and shrubs to exist.

In the mature state both the shrub stratum and herb layer are greatly reduced by the canopy coverage. However this association still supports a greater diversity of species and a better developed C layer than the other associations.

The type of treatment seemed to have little effect on the vegetation in this association. The habitat is rapidly invaded by all the characteristic species found in the mature association. Slashburning may even enhance the development of the C layer by rapidly releasing nutrients stored in the organic matter. The abundance of seepage water also reduces the recovery time needed after treatment.

In addition to the previous mosses mentioned, Hypnum circinale, Dicranum fuscescens, and Dicranum howellii were present on decaying wood in all associations. However the significance was very low and restricted to small patches on decaying wood. Slashburning usually eliminated these mosses by reducing the amount of decaying wood.

2. Causes of Variation in Vegetational Composition and Structure Within the Three Seral Association

<u>Variation</u> in vegetation and structure between and within associations

All associations are structurally similar in average percent cover (Fig. 17). However variation did occur in species composition and layer dominance. Consequently, it is difficult to assess the cover values and their significance in each association without having an understanding of the species composition. For example, the shrub layer of the salal - Douglas-fir association is as equally well developed as in the richer swordfern - western redcedar association but possesses a completely different species composition. fore its ecological significance is different. This also applies to stratification within one layer. For instance, tall-growing invader herbs can mask those low growing herbs which are more indicative of the forest association. tion caused by age and treatment is also evident and will be discussed later.

The salal - Douglas-fir and moss - western hemlock associations are both characterized by a well developed shrub layer composed of *Gaultheria shallon* and *Vaccinium parvifolium* and a herb layer consisting of tall herbs and *Pteridium aquilinum*. The swordfern - western redcedar association has an equally well developed shrub layer but is composed of *Rubus spectabilis*, *Rubus parviflorus*, and *Spiraea douglasii*.

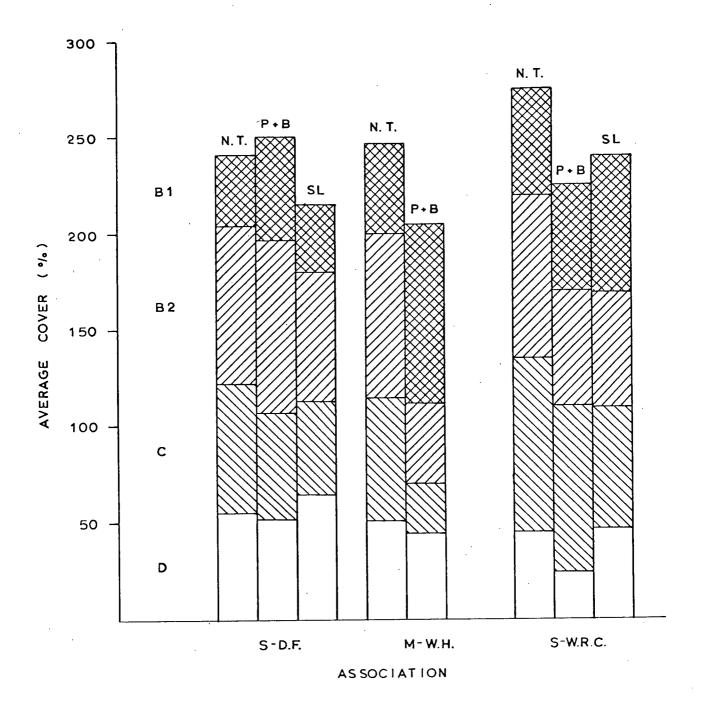


FIGURE 17 Average cover in percent of each layer by association and treatment.

In the swordfern - western redcedar association the herb layer consisted of a large number of low growing herbs as well as tall herbs such as *Epilobium angustifolium* and *Anaphalis margaritacea*. Although all associations had a very well developed shrub layer, the swordfern - western redcedar association offered a greater degree of competition to coniferous tree species because it was taller, denser, and more highly stratified.

A total of 148 species were encountered on the plots. The checklist is contained in Appendix II. Of these 148 species, 93 and 77 were identified on the salal - Douglasfir and moss - western hemlock associations, respectively. In the swordfern - western redcedar association, 119 were identified. The greater number of species found in the latter association is the result of the rich habitat. The C layer is the major contributor. The large number of species encountered in the salal - Douglas-fir association as compared to the moss - western hemlock association was undoubtedly caused by a large number of plots being disturbed, thus allowing various grasses and mosses that are associated with mineral soil to become established.

Age is an important factor affecting the structure and species composition. Plots 004 and 029 in the swordfern - western redcedar association were 12 and 13 years old respectively. At this age in this association the shrub canopy is extremely dense (Fig. 18). This largely eliminates the well

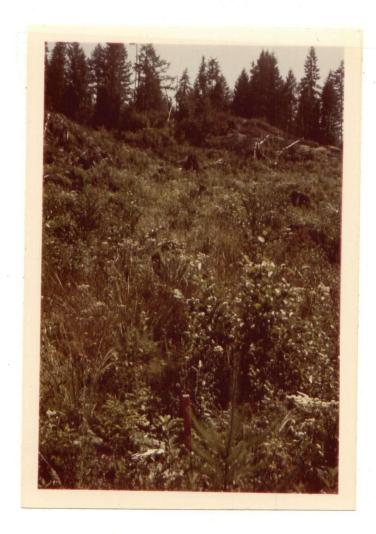
FIGURE 18

Plot 4 in the swordfern - western redcedar association shows the thick development of Rubus spectabilis 14 years after logging and slashburning.

FIGURE 19

Plot 5 in the swordfern - western redcedar association on poorly-drained glacio-marine parent material. Note amount of *Juncus effusus* and *Alnus rubra* and lack of coniferous regeneration 4 years after logging and piling and burning.





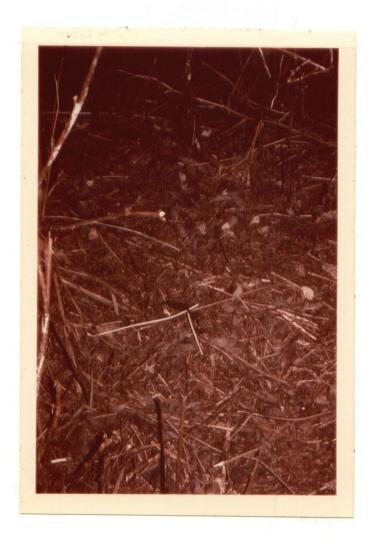
developed C layer found on the younger plots. The moss layer is also affected. The mineral soil mosses are reduced in cover as a result of a build up of humus and a lack of light. Mosses such as *Plagiomnium insigne* and *Leucolepis menziesii* begin to occur as the canopy closes and a rapid mineralization of the mixed coniferous-deciduous litter takes place.

Unlike the University of British Columbia Research Forest which uses an 8 x 8 or 10 x 10 foot spacing, the Mission Tree Farm has an established policy to plant at a 6 x 6 foot This decreased spacing has a considerable influence on the understory vegetation. Plots 037 and 038 are located in the moss - western hemlock association at the Mission Tree Farm and were planted at a 6 x 6 foot spacing in 1959 or 1960. Figure 20 illustrates the resultant ground cover. The thick canopy has eliminated the shrub and the herb layers and the moss layer has been reduced to small patches. Age was also an important factor. At an earlier stand age the resultant effect would not have been as evident. The effect of close spacing is further illustrated in Figure 17. All the plots in the moss - western hemlock association that were piled and burned have been planted at a 6 x 6 foot spacing. reduction in total cover and cover of each layer is well exemplified. A large proportion of the total cover consists of planted Douglas-fir in the B₁ layer.

FIGURE 20

Lack of ground cover under 6 x 6 foot spacing of Douglas-fir in Plot 37. Upper photograph shows several small western hemlock seedlings and coniferous litter. Lower photograph shows decaying stems of *Rubus spectabilis*.





Variation caused by treatment on the structure and general species composition of the three associations

Logging and the accompanying treatment of the area has a notable influence on the general species composition and structure. In the study it is difficult to assess the effects of treatment on the structure because of the mixture of age classes within each treatment. Figure 17 shows the slight variations that take place between treatments. variations are probably caused by age differences. The sala1 -Douglas-fir association exhibited the only significant differences between no treatment and slashburning. Dyrness (1965, 1973) noted, however, a significant variation between treatments with regard to structure. He found that the cover on undisturbed plots was two to five times that found on the disturbed-unburned and lightly burned plots, respectively. Total cover on the severely burned plots consistently lagged behind the other plots. He also observed a substantially lower number of trees on the severely burned plots.

The type of treatment and the accompanying disturbance exert a more obvious influence on species composition.

In all the associations that were untreated, the residual component species still exist and are supplemented by an influx of invader species depending on the amount of disturbance that has taken place. On habitats that have been burned, the residual component is largely destroyed.

In other words, species that were present in the mature stand are also present in the untreated cutover stand. At the same time, piling and burning does not affect the residual component as much as slashburning. Piling and burning allows species to be partially destroyed or untouched altogether. The residual component is, therefore, allowed to expand; whereas, slashburning usually destroys all the vegetation and a complete re-invasion of the site must take place. In most cases, the untreated habitats contained more species than treated areas.

The logged setting presents a heterogeneous habitat for species invasion, with a variety of individual microsites. The degree of disturbance and the associated extent of microsites created strongly control the number and the quantity of species entering a particular habitat. Plots 011 and 012 (Appendix I) illustrates this relationship, having a large number of sporadic species colonizing on favorable microsites. In most cases, these species possess little diagnostic value.

Slashburning reduces the number of species occurring on a site by diminishing the number of moist pockets, decaying wood, and residual component species. Exposed mineral soil is the major microsite available for colonization. Piling and burning does not have as adverse an effect on species composition as slashburning. This is well illustrated in the tables in Appendix I, Parts I and II.

The preceding factors are just a few of the major causes for variation between associations and within each association. Slope, aspect, elevation, and parent material all play an important role in influencing vegetational variation. The effect of parent material is especially noteworthy in plots 005, 029, 030 located in the swordfern - western redcedar association on glacio-marine parent material. The species composition is exceedingly rich, containing a large number of species not found on other parent materials as well as an influx of Salix spp. and Alnus rubra (Fig. 19). This is caused by the poorly drained conditions. Juncus effusus and Scirpus microcarpus are common associates.

Variation caused by treatment and association type on the individual species

Figures 21, 22, and 23 compare the effect of treatment on a number of selected species within each association along with the mean for the association. The number at the top of each bar is a presence value.

It appears from the figures that most species occur in all associations but increase toward a higher mean significance and presence in certain associations. Moisture regime and lack of decaying wood as a growing medium seemed to be the important controlling factors. In addition, a large number of shade intolerant plants occur under all site conditions after logging, exhibiting no preferential trends. These

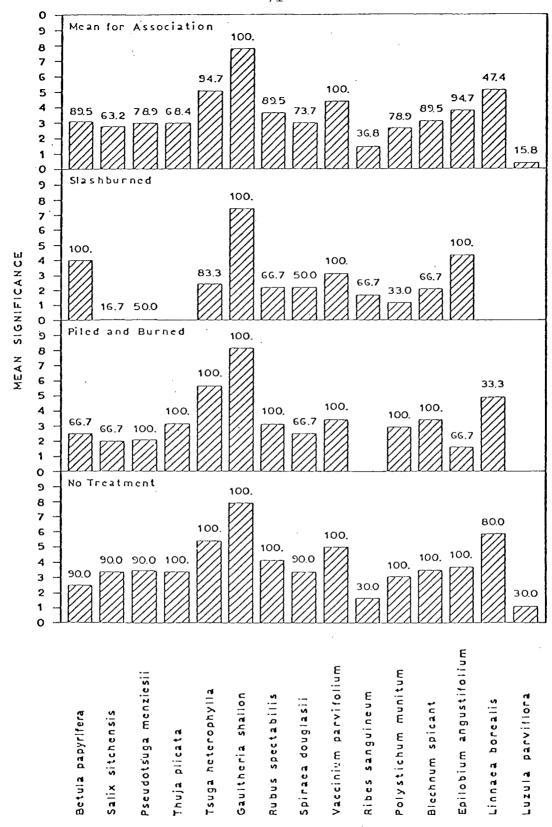


Figure 21 Mean significance and presence of fifteen selected species in the salal - Douglas-fir association

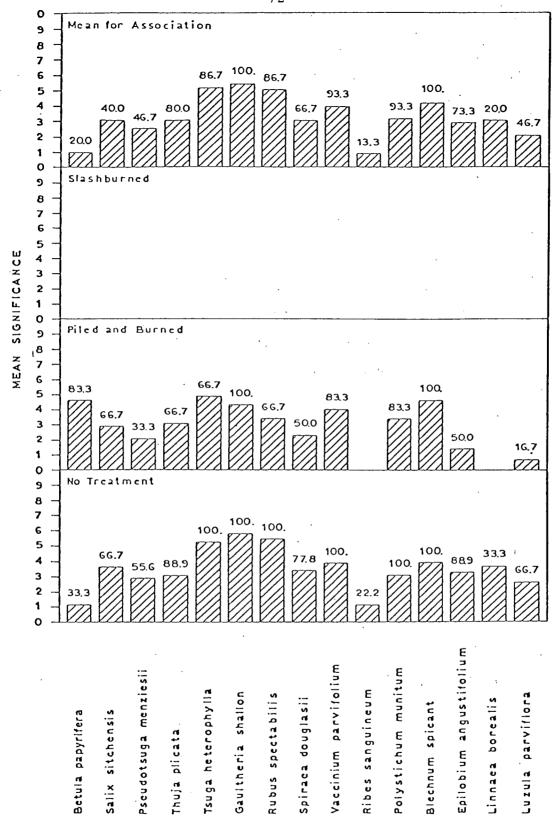


Figure 22 Mean significance and presence of fifteen selected species in the moss - western hemlock association

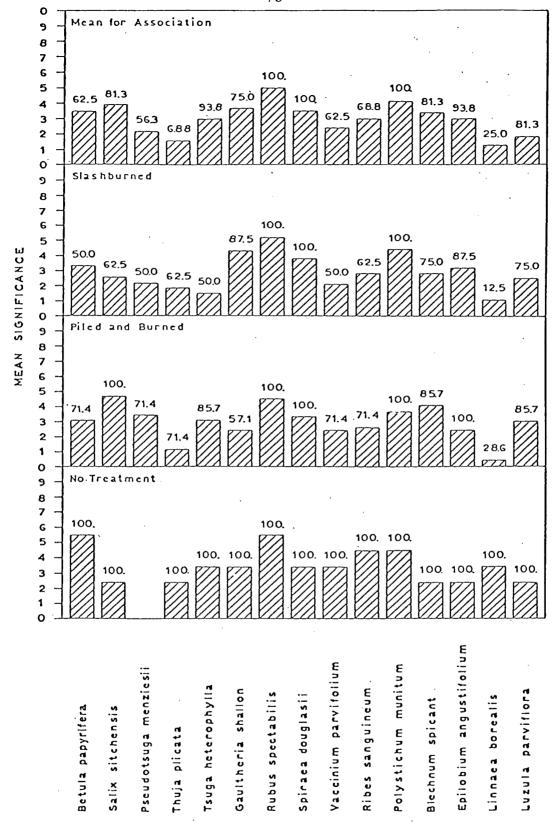


Figure 23 Mean significance and presence of fifteen selected species in the swordfern - western redcedar association

species are responding to increased light conditions due to the lack of the forest canopy. Very few species showed a definite site specificity. These species mostly occurred in the rich swordfern - western redcedar association. For example, species exhibiting an increasing mean significance toward the swordfern - western redcedar association are:

Salix sitchensis
Rubus spectabilis
Polystichum munitum

Species showing an opposite trend are:

Tsuga heterophylla

Gaultheria shallon

Vaccinium parvifolium

Linnaea borealis

Truly ubiquitous species:

Epilobium angustifolium

Betula papyrifera

Spiraea douglasii

The expansion in the normal habitat of a species appears to be characteristic of cutover areas. It results from the increase in light, moisture, mineralization of organic layers, and the creation of micro-habitats. All these features allow the plants to expand their normal range as other favorable habitats are created, as well as inhibiting plants that do not respond to these factors.

Figure 21 of the salal - Douglas-fir association shows that slashburning influences the selected species the greatest. Salix sitchensis, Thuja plicata, Linnaea borealis, and Luzula parviflora were completely eliminated, while Blechnum spicant, Polystichum munitum, and Tsuga heterophylla were greatly reduced in both presence and mean significance. Gaultheria shallon exhibited no identifiable difference between treatments. Betula papyrifera showed the only notable increase with slashburning. Although not shown in Figure 21, Ceratodon purpureus and Polytrichum juniperinum also exhibit an increase with slashburning.

The influence of fire on the moss - western hemlock association (Fig. 22) is more difficult to evaluate since no plots were slashburned. The differences between no treatment and piled and burned are minimal. All species appear to decrease slightly in both presence and mean significance. This is probably due to the close spacing of the planted trees rather than treatment differences.

The swordfern - western redcedar association (Fig. 23) reflects a similar trend with respect to treatment, as did the salal - Douglas-fir association. However the effect is not as great and the number of species affected is less. This undoubtedly reflects the richness of the habitat and the resulting increased response rate in vegetative development.

The mean presence for each association is given at the top of each figure. These values can be compared with each other as a visual technique in identifying each species response to particular habitats of fifteen species given.

Summary

Vegetational variation after logging is influenced mainly by the accompanying human alterations to the site. The variation in vegetation is influenced most directly by the degree of site disturbance to the habitat, type of treatment, spacing of planted trees, amount of light exposure due to clearcutting, age of stand as well as the abiotic factor of moisture regime between associations. Of lesser importance are slope, aspect, and parent material. However, the relationships of these and other abiotic factors may be masked by the impact of the human-related disturbances after clearcutting.

PART II - SEEDLING ESTABLISHMENT WITHIN THE THREE SERAL ASSOCIATIONS

1. Seedling Establishment of Coniferous and Deciduous Trees

The number of seedlings per acre was evaluated on the 1/40th acre plots. The results for each plot are recorded in Appendix I,Part III. The subjectively chosen plots were selected to represent general stocking and spatial distribution of the seedlings for that particular site as well as being representative of the vegetation for the association. Because of the variability in regeneration characteristics, the exact quantitative relationships cannot be observed by use of a subjective sampling system. However, trends and qualitative relationships are well represented with regard to associations and treatments. The results are compared by examining the actual number of trees per acre in each association and treatment.

Table 4 presents the average number of trees per acre that occur in the three associations by treatment for all the tree species encountered on the plots. The standard deviation is also included where it is considered important.

The calculation of the trees per acre is a summation of all age classes. Tables 5 and 6 represent the number of trees per acre by age class for coniferous and deciduous trees. It is apparent that not enough observations were available to make any comparisons between age classes. Therefore, a

Table 4 Distribution of trees in numbers of trees per acre by association and treatment

ASSOCIATION	SALAL - D.F.			MOSS - W.H.			SWORDFERN - W.R.C.				
TREATMENT	NONE	P&B	SL	MEAN	NONE	Р&В	MEAN	NONE	Р&В	SL	MEAN
NO. OF PLOTS	10	3	6	19	9	6	15	1	7	8	16
WESTERN HEMLOCK *	3849 ±2327	6667 ±5286	448 ±479	3220 ±3262	5110 ±1717	3701 ±2928	4547 ±2291	900	889 ±820	636 ±797	763 ±764
WESTERN REDCEDAR	957 ±1350	907 ±845	33 ±53	657 ±1087	889 ±549	860 ±798	877 ±632	1030	267 ±237	303 ±329	333 ±329
NATURAL DOUGLAS- FIR	505 ±345	160 ±160	53 ±65	308 ±330	244 ±342	127 ±178	197 ±286	-	167 ±111	95 ±77	121 ±100
PAPER BIRCH	121	467	620	333	78	333	180	2300	1027	630	908
VINE MAPLE	79	213	33	86	576	693	623	430	244	350	309
CASCARA	35	27	13	27	209	127	176	90	3	11	13
BITTER CHERRY	94	-	53	66	87	7	55	740	366	185	299
BLACK COTTONWOOD	30	13	13	22	42	47	44	60	1581	65	728
RED ALDER	14	-	7	10	28	7	20	120	910	269	540
WILLOW SPP.	473	120	7 3	291	634	193	458	60	4204	770	2228
BIG-LEAF MAPLE	-	_	-	-	-	-	-	30	-	35	19
PACIFIC DOGWOOD	.5	-	-	3	-	13	5	80	-	20	15

^{*}Standard deviation about the mean

Table 4 continued

ASSOCIATION	S	SALAL -	D.F.		M	OSS - W	.н.	SWORI	OFERN -	W.R.	С.
TREATMENT	NONE	Р&В	SL	MEAN	NONE	Р&В	MEAN	NONE	Р&В	SL	MEAN
NO. OF PLOTS	10	3	6	19	9	6	15	1	7	8	16
PLANTED DOUGLAS-F	I R -	1147	1060	516	-	1160	464	-	540	382	379
LODGEPOLE PINE	-	. -	13	4	-	-	-	-	-	-	· -
PACIFIC SILVER FIR	₹ -	-	-	-	-	7	3	-	-	-	
SITKA SPRUCE	-	-		-	4	-	3	-	-	-	79
CONIFEROUS TREES	5311 ±3495	7733 ±6085	547 ±558	4189 ±4186	6248 ±1995	4695 ±3824	5626 ±2847	1930 -	1323 ±1059±		1217 ±1040
DECIDUOUS TREES	851 ±695	840 ±349	813 ±878	837 ±685	1655 ±851	1420 ±639	1561 ±758	3910	8335 ±5981±		5059 ±4930

α

Table 5 Number of deciduous trees per acre

AGE CLASS (yrs.)										
ASSOCIATION	0 - 2	3 - 4	5 - 7	8-10	11-12	13-15				
SALAL - D.F.										
No Treatment	· -	-	_	910.0	792.0	-				
Slashburned	120.0	-	952.0	-	-	-				
Piled & Burned	-	-	840.0	~	-	-				
Total	120.0	-	1792.0	910.0	792.0	-				
MOSS - W.H.	•									
No Treatment	· -	1410.0	-	1460.0	-	2360.0				
Slashburned	-	-	-	-	-	-				
Piled & Burned	-	-	-	1090.0	-	1920.0				
Total	-	1410.0	-	2550.0	-	4280.0				
SWORDFERN - W	R.C.									
No Treatment	-	- -	3910.0	-	-	-				
Slashburned	_	-	4160.0	1680.0	-	1820.0				
Piled & Burned	-	13900.0	4593.0	2870.0	-	-				
Total	-	13900.0	12663.0	4550.0	-	1820.0				

 ∞

Table 6 Number of coniferous trees per acre

AGE CLASS (yrs.)									
ASSOCIATION	0 - 2			8-10:	11-12	13-15			
SALAL - D.F.				· ·					
No Treatment	-	_	_	4618.0	6004.0	-			
Slashburned	280.0	-	600.0	-	-	-			
Piled & Burned	-	-	7733.0	-	-	-			
Total	280.0	-	8333.0	4618.0	6004.0	-			
MOSS - W.H.									
No Treatment	-	4840.0	_	6378.0	-	6560.0			
Slashburned	-	-	-	-	-	-			
Piled & Burned	_	<u>-</u>	-	4220.0	-	5644.0			
Total	-	4840.0		10598.0	· -	12204.0			
SWORDFERN - W	.R.C.					-			
No Treatment	-	-	1930.0	-	· -	-			
Slashburned	-	-	2180.0	883.0	-	195.0			
Piled & Burned	-	1073.0	1933.0	240.0	-	-			
Tota1	-	1073.0	6043.0	1123.0	-	195.0			

summation of all age classes was the only valid means of comparison.

The first and most apparent characteristic is the high degree of variation in trees per acre for western hemlock, western redcedar, and Douglas-fir. This is largely the result of the sampling method and to a lesser extent the summation of age classes. Since the sampling was carried out on large, selectively located plots, errors due to clumping of western hemlock regeneration and uneven distribution of other coniferous species are likely. In the case of western hemlock, the clumped pattern is very noticeable in the field and follows a negative binomial distribution (Smith and Ker 1957). MacBean (1941) found dense bodies of slash and thick ground-cover important factors in restricting seedling establishment. Accordingly, any sampling method that uses a small number of large plots will not sample enough of the variation to accurately estimate the number of trees per acre or their spatial distribution. Therefore, a large within-plot standard deviation is incurred, as the plot encompasses varying distributions of seedbeds and types of seedbeds within a large plot area.

Although statistical analysis is difficult due to the large standard deviation, trends are noticeable between association and treatment and deserve further analysis to determine if there are significant differences. In order to analyze the relationships, analysis of covariance was initially employed, but analysis of variance was chosen for the final

analysis of the data (Wine 1964).

The analysis of covariance was initially used rather than an analysis of variance because of possible effects age could have on the results since the age of each stand was not held constant. By means of an analysis of covariance, the effect of age was removed from the other variables and the means adjusted accordingly. However upon examining the regression equations obtained from the analysis of covariance, it was found that age contributed little to the variation in number of trees per acre. Therefore, analysis of variance would produce as adequate results as analysis of covariance. Consequently, analysis of variance was used in the final analysis of the data.

The following analysis of variance table was constructed to analyze the results:

Source of Variation	Degrees of Freedom
Associations	2
Treatments within association	ns 5
Error	42
TOTAL	49

This table corresponds to the nested design (Hicks 1964). A nested design was used rather than a two-way classification because a nested design allows an unequal number of observations to occur within the sources of variation. A two-way classification loses orthogonality if an unequal

number of observations is present (Hicks 1964). Also in the nested design, the number of levels of the nested factor i.e. treatment, need not be the same for all levels of the other factor i.e. association. This is the case in this experiment, since no slashburned plots exist for the moss—western hemlock association.

A Barlett's test of homogeneity of variance was carried out on the raw data to see if the variances were homogeneous, a basic assumption of analysis of variance. It was found that the variances were not homogeneous. Therefore, a logarithmic transformation was done and the transformed data tested for homogeneity of the variance. The variances were then found to be homogeneous.

Duncan's multiple range test was employed to rank the means if they were found significant in the analysis of variance. The mean value is the number of trees per acre for that particular association and treatment. After all association and treatment means were ranked, the means were arranged diagramatically in declining order of their mean values from left to right. The grouping of mean values that are similar at the 5 percent level of significance is shown by an underline. The following symbols were used to indicate the association and treatment for the Duncan's multiple range tests:

S-NT Salal - Douglas-fir association - no treatment

S-P&B Salal - Douglas-fir association - piled & burned S-SSalal - Douglas-fir association - slashburned Moss - western hemlock association -M-NTno treatment Moss - western hemlock association - piled M-P&B Swordfern - western redcedar association Sw-NT no treatment Swordfern - western redcedar association Sw-P&B - piled & burned Sw-S Swordfern - western redcedar association - slashburned

that a highly significant difference in mean number of trees per acre exists for treatments within an association with an F-value of 6.43 (Table III - 1 in Appendix III). No significant difference was found to exist between individual associations. In other words, the effect of treatment coupled with association was more important in explaining the differences in number of trees per acre than were associations alone. Duncan's multiple range test shows the following relations among treatments within an association for western hemlock:

S-S Sw-S Sw-P&B Sw-NT M-P&B S-NT S-P&B M-NT 306.1 343.2 577.2 900.5 2624.2 3257.6 3832.6 4864.1

The salal - Douglas-fir association - slashburned and swordfern - western redcedar association - slashburned

and piled and burned were significantly different from the other groups, except for the swordfern - western redcedar association - no treatment, which was not significantly different from either group. The S-S, Sw-S, and Sw-P&B also contain the least number of trees per acre. Consequently, it is evident that both slashburning and the swordfern - western redcedar association have a noticeable effect on western hemlock. Slashburning undoubtedly removes the much-needed organic matter and decaying wood that is important to the establishment of western hemlock. The removal of organic matter and decaying wood also alters the moisture and nutrient status of the upper soil layers. The same is true for the swordfern western redcedar association, where rapid mineralization reduces the organic matter quickly. The other group consists of the salal - Douglas-fir and moss - western hemlock associations where the slash was either piled and burned or had no treatment. This group contained the highest number of western hemlock trees per acre. Here the abundance of organic matter and decaying wood accounted for the large amount of western hemlock. This same trend is illustrated for the number of established 2) western hemlock per acre. Table III - 8 indicates that treatments within associations is highly signifi-The following, Duncan's multiple range test, illustrate this analogous trend:

²⁾ One foot or greater in height

 Sw-P&B
 S-S
 Sw-S
 Sw-NT
 M-P&B
 S-NT
 S-P&B
 M-NT

 98.8
 140.1
 175.1
 380.5
 1809.7
 2340.5
 3038.1
 3429.3

Western redcedar: The analysis of variance indicates that treatments within associations is highly significant with a value of F = 5.34 (Table III - 2). Associations alone were not significant. Duncan's multiple range test exhibits the relation among treatments within associations for western redcedar:

S-S Sw-S Sw-P&B M-NT S-NT S-P&B M-P&B Sw-NT 2.9 98.9 101.2 399.2 530.2 557.9 586.4 1030.6

Western redcedar, as stated earlier, thrives well on habitats that are moist and supply an abundant source of nutrients. After clearcutting, these habitats are usually found in moist microdepressions created during the logging operation in the salal - Dougals-fir association and moss - western hemlock association. However, because of the higher moisture status of the soils in the swordfern - western redcedar association, these habitats are more universal and are not always confined to microdepressions. Statistically,

western redcedar does not appear to have a preference as far as germination is concerned. The Duncan's multiple range test shows that there are no significant differences between all treatment and association combinations except for the salal - Douglas-fir association - slashburned which had the lowest number of western redcedar trees per acre. Although the mean number of trees per acre for western redcedar is not significantly different, the trend is an increasing number of trees per acre on the salal - Douglas-fir and moss - western hemlock associations that have not been exposed to slashburn-This is further illustrated when examining the number of established western redcedar trees per acre. The analysis of variance in Table III - 9 indicates that the means for treatments within associations are significant at the 1 percent level. The following Duncan's multiple range test illustrates the relationships among means:

S-S	Sw-P&B	Sw-S	Sw-NT	M-NT	S-NT	M-P&B	S-P&B
0.0	5.8	14.2	110.5	220.2	255.8	403.4	422.6

Established western redcedar exhibits two definite groups, those within the swordfern - western redcedar association except for no treatment and the salal - Douglas-fir association - slashburned, and the remaining salal - Douglas-

fir and moss - western hemlock associations that have either been piled and burned or had no treatment. It is felt that this is due partially to the occurrence of advanced regeneration of western redcedar on areas that have not been heavily disturbed. But more likely an important factor is the lack of competition from deciduous trees and herbaceous plants in the salal - Douglas-fir and moss - western hemlock associations. In the swordfern - western redcedar association, the competition is intense.

3) <u>Douglas-fir</u>: The analysis of variance Table III - 3 denotes that there is a significant difference between means at the 1 percent level for treatments within associations. The F-value is 3.58. The Duncan's multiple range test shows the following relationships among means:

Sw-NT	S-S	M-P&B	M-NT	Sw-S	Sw-P&B	S-P&B	S-NT
0.0	7.1	18.7	30.4	47.2	137.2	139.6	367.8

The salal - Douglas-fir association - no treatment was found to be significantly different from the swordfern - western redcedar association - no treatment, salal - Douglas-fir association - slashburned, moss - western hemlock association - piled and burned, and moss - western hemlock

association - no treatment. The same is true for the number of established Douglas-fir trees per acre as the following Duncan's multiple range test indicates:

Sw-NT	S-S	M-P&B	Sw-S	M-NT	Sw-P&B	S-P&B	S-NT
0.0	4.5	16.9	26.7	28.5	42.3	115.9	300.5
		-					

The data indicates that Douglas-fir has no preference with repect to association or treatment, except for salal - Douglas-fir association - no treatment which totaled the highest number of trees per acre. This could be caused by a coincidence with an excellent seed year, distance to seed source or some other type of extraneous factor. observation is contrary to that of Bever (1954) who observed an increased number of Douglas-fir seedlings on areas that had been slashburned. However, Vogl and Ryder (1969) found a significant decrease in Douglas-fir stocking on burned sites, while Lavender et $\alpha l.$ (1956) found stocking of Douglasfir on unburned plots exceeded that on burned plots. Consequently, many opinions exist. Undoubtedly this is caused by the many variations in sites, degrees of disturbance, and other important environmental controls that differ among In any case, the data in this study indicate various studies. that supplemental planting of Douglas-fir is needed in all

associations and treatments to achieve an adequate stocking level of Douglas-fir.

4) <u>Coniferous trees</u>: This category includes mainly western hemlock, western redcedar, and Douglas-fir. The analysis of variance Table III - 4 shows a highly significant value of F = 7.42. Duncan's multiple range test shows the relations among means:

S-S Sw-S Sw-P&B Sw-NT M-P&B S-NT S-P&B M-NT 373.1 627.9 942.5 1930.6 3336.6 4423.8 4701.1 5993.8

It is evident from the Duncan's multiple range tests that coniferous trees (as a category) follow a pattern identical to that of western hemlock. This results from western hemlock making up the major portion of the coniferous trees, while other tree species only add a small proportion. Consequently, the response of coniferous trees is identical to that of western hemlock and the effect of the other tree species is not shown.

5) <u>Total number of naturally regenerated trees</u>: This group contains all deciduous and coniferous trees minus the planted stock (Douglas-fir). The analysis of variance Table III - 5

expresses a significant difference for treatments within associations at the 1 percent level. Associations themselves demonstrated no significant difference. The following Duncan's multiple range test expresses the relationship among treatments within associations:

S-S Sw-S M-P&B S-NT Sw-NT S-P&B M-NT Sw-P&B 941.7 2867.5 4846.2 5228.8 5841.2 6050.6 7571.8 8081.6

Three distinct groups are visible. Salal - Douglasfir association - slashburned, which had the lowest number
of trees per acre, swordfern - western redcedar association slashburned, and together moss - western hemlock association no treatment and swordfern - western redcedar association piled and burned. It is clear that the slashburning had a
definite effect on regeneration of both coniferous and
deciduous trees in the salal - Douglas-fir association. This
is not true for the swordfern - western redcedar association
that was slashburned. The effect of slashburning was not
as great in this association because of the rapid colonization by deciduous trees largely concealing the influence of
slashburning on coniferous regeneration. The preceding tests
indicate that slashburning reduces the number of trees per

acre in all associations, although it is not always a statistically significant reduction. The effect of slashburning was not as severe in the swordfern - western redcedar association as in the salal - Douglas-fir association because of the superior moisture conditions and possible increase in the nutrient supply from lateral seepage. In a greenhouse study, Jablanczy (1964) found that the swordfern - western redcedar association could benefit from slashburning by accelerating mineralization. Slashburning in this association caused the least damage. The salal - Douglas-fir association suffered the most because there is no supplemental nutrient supply from seepage water and much of the nutrient supply must normally be derived from the humus, and the latter may be partially or completely destroyed by burning. The reason for the moss - western hemlock association - no treatment and swordfern - western redcedar association - piled and burned containing the highest number of trees per acre is directly opposite. The major portion of the moss - western hemlock association - no treatment is made up of coniferous trees, which was shown previously, while the swordfern western redcedar association - piled and burned is composed largely of deciduous trees, and coniferous trees only make This will be up a small percentage of the total number. further illustrated in the following section.

6) <u>Deciduous trees</u>: The analysis of variance Table III-6 indicates that associations are significantly different at the 1 percent level with an F-value of 12.52. Treatments within associations exhibited no significant difference, unlike that of the other tree species. Duncan's multiple range test expresses the following relationships among associations:

S	M	Sw
566.8	1392.8	3503.5

The salal - Douglas-fir association and swordfern - western redcedar association were significantly different from each other. The moss - western hemlock association fell in between these two associations. This conclusion is what would be expected, since the deciduous trees seem to respond to changes in moisture status of the soil. Therefore, because of the high moisture status of the swordfern - western redcedar association, it contains a higher number of deciduous trees per acre than the salal - Douglas fir association which has a low moisture status most of the year. The moss - western hemlock association is intermediate in moisture status between the other two associations.

In general, the Duncan's multiple range tests indicate that all coniferous tree species prefer areas that

have been either piled and burned or had no treatment in the salal - Douglas-fir and moss - western hemlock associations. Slashburning reduces the number of trees present. The swordfern - western redcedar association probably presents just as good an environment for regeneration, but early invasion of the site by deciduous trees, as well as herbaceous plants, limits the establishment of coniferous trees. Figure 24 illustrates diagramatically the role of western hemlock, western redcedar, Douglas-fir, coniferous trees, and deciduous trees in each of the associations studied. The behavior of coniferous and deciduous trees in each individual association is further illustrated in Figures 25, 26, and 27. The number of trees per acre for coniferous and deciduous trees by onefoot height classes is given. An attempt was made to stratify the three associations by age class and treatment to add more comparability to the graphs. This was accomplished for salal -Douglas-fir and moss - western hemlock associations. However, since no comparable age class or treatment existed for the swordfern - western redcedar association, the closest combination was chosen. This was age class 5 - 7 and treatment piled and burned. It is felt that this should provide an acceptable comparison since Duncan's multiple range tests showed that the number of trees per acre did not vary significantly between no treatment and piled and burned.

The comparison between graphs indicates that the number of deciduous trees increases rapidly from the salal -

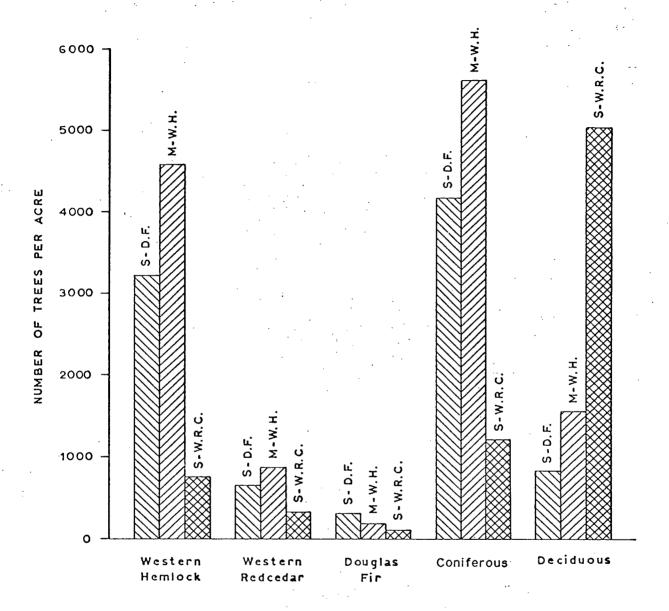


Figure 24 Number of trees per acre of three tree species and two groups of species for individual associations

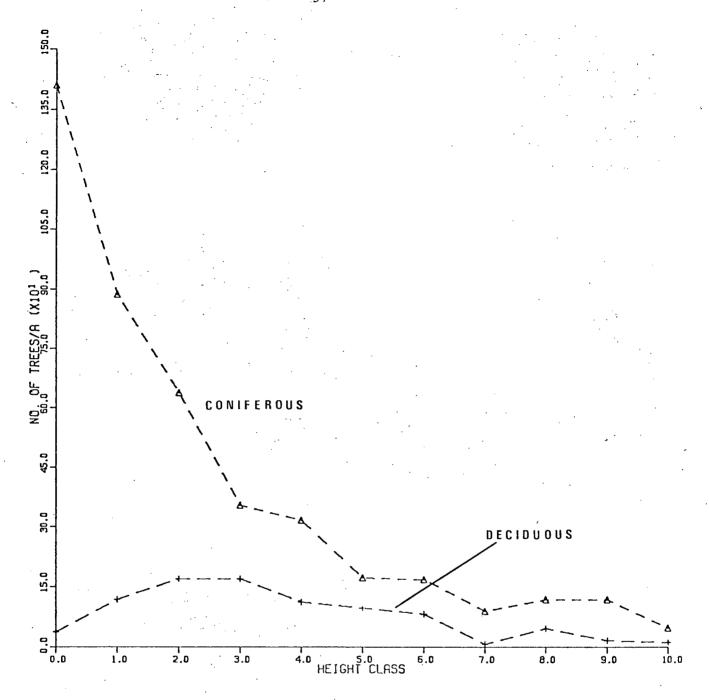


FIGURE 25 The number of trees per acre by height class of coniferous and deciduous trees for the salal - Douglas-fir association, age class 8 - 10, and no treatment.

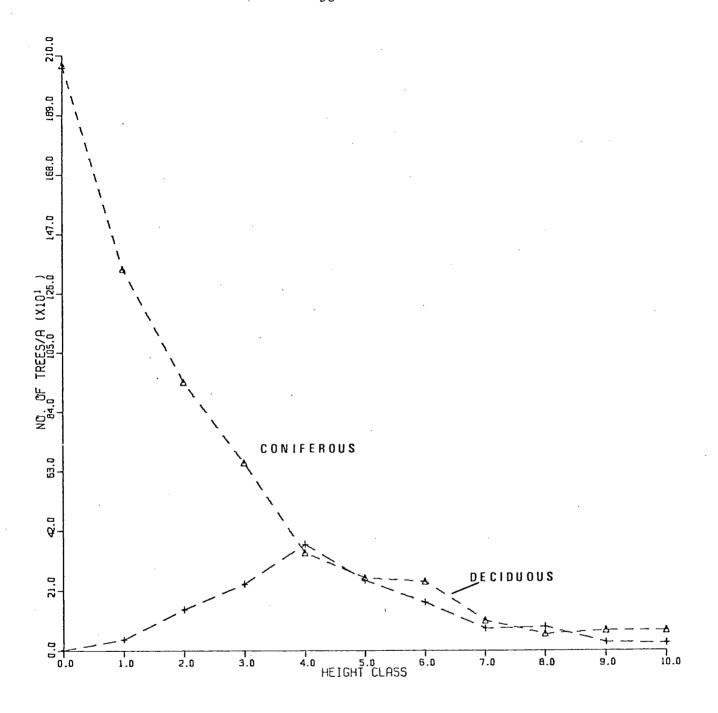


FIGURE 26 The number of trees per acre by height class of coniferous and deciduous trees for the moss - western hemlock association, age class 8 - 10, and no treatment.

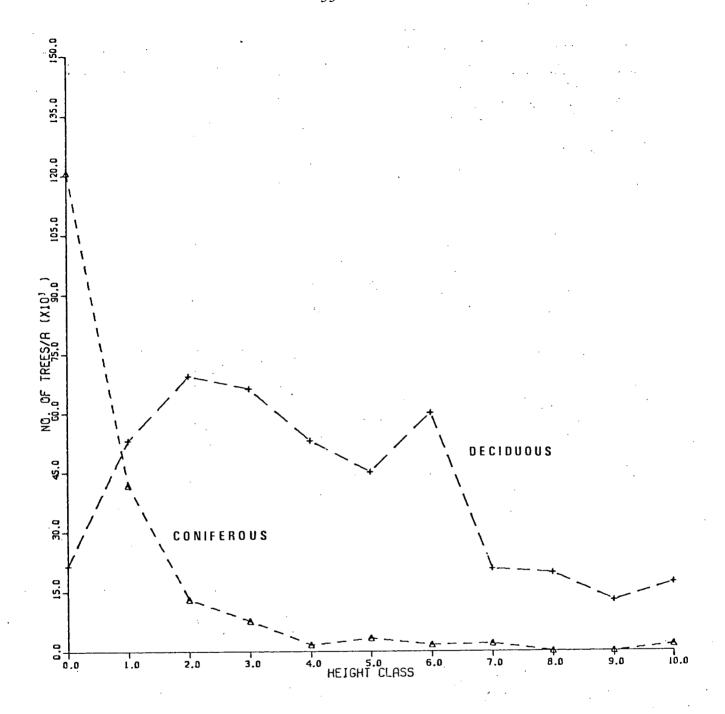


FIGURE 27 The number of trees per acre by height class of coniferous and deciduous trees for the swordfern - western redcedar association, age class 5 - 7, and piled and burned.

Douglas-fir association to the swordfern - western redcedar association. The number of coniferous trees per acre is highest for the moss - western hemlock association and decreases toward each of other associations, especially the swordfern - western redcedar association.

Within each association there is a similar trend, as the height of the trees increased, the number of coniferous trees per acre decreased, while the number of deciduous trees per acre increased. If height is considered an approximate index of tree age, then as height increases so does age. With this analogy in mind, it is apparent that the number of coniferous trees per acre rapidly decreases with age. rapid mortality in the early stages of development is mainly due to mortality of the young seedlings resulting from factors such as drought, exposure, rodents, and other environmental conditions. In the swordfern - western redcedar association (Fig. 27), this process is accelerated because of competition from a heavy cover of deciduous trees. The steepness of the curve for coniferous trees and the low constant level reached for the swordfern - western redcedar association exhibits the competition effect.

The number of deciduous trees per acre increases to a peak with height (age) in each association then begins to drop off. The regeneration of deciduous trees is controlled by the removal of the canopy and initial regeneration of deciduous trees occurs directly after the canopy is removed,

then decreases to a very slow rate. On the graphs, this is shown by the peak in the deciduous trees curve which is considered close to the initial date of establishment. On the left the more recent regeneration is encountered.

The preference of coniferous trees for areas that have been either piled and burned or had no treatment is believed to be caused primarily by seedbed conditions. Isaac (1943) felt this was due to more available seed in the duff that was not destroyed by burning rather than the superior seedbed conditions on unburned areas. Mueller-Dombois (1960) also found this to be true. The moisture-holding capacity of a compact organic layer is also much greater than the mineral soil, thereby preventing drying out of the seed (Isaac and Hopkins 1937). Hatch and Lotan (1969) observed better Douglasfir regeneration on undisturbed seedbeds and attributed it to the conservation of soil moisture, the reduction in herbaceous vegetation, and the protection of seed from rodents and birds.

Shade is another important factor in the early establishment of coniferous trees. Slash left after the logging operation provides beneficial shade for seedling establishment and survival. The diffuse light and shading from direct sunlight reduces seedling mortality caused by moisture loss from the surface layers, and prevents direct heat injury to the seedlings. Minore (1971) and Strothman (1972) both found

that dead shade derived from slash, benefited Douglas-fir seedlings. Shade derived from living brush species complicates the shading effect, with competition to the regeneration for available moisture and nutrients.

Slashburning may affect a site in many ways. The main factors affecting the regeneration of coniferous trees which may be modified by slashburning are soil, temperature, air temperature at the soil surface, soil moisture-holding capacity, nutrient availability, amount of mycorrhizae present in the soil, and soil pH. There is much controversy and conflicting information as to whether these factors are beneficial or not to the regeneration of coniferous trees. In any case, the results of this study indicate that in all associations, slashburning decreased the number of trees per acre present for all tree species. Although the areas that were piled and burned or had no treatment contained an adequate number of coniferous trees per acre, western hemlock made up the major portion of the regeneration. Furthermore, most of the regeneration was spotty and not well distributed.

Since western hemlock was the most abundant conifer in all associations and treatments, environmental factors had the least effect on it. Western hemlock's prolific seedbearing habits, wind disseminated seed, ability to withstand a wide variety of seedbed conditions, and its capability to exist under a forest canopy for long periods of time and grow as advanced regeneration after the canopy is opened, accounted

for its abundance in all associations. Douglas-fir, contithe other hand, bears seed crops at very sporadic intervals, usually 5 to 7 years between heavy crops (Fowells 1965). The seed is also relatively large and is freely eaten by rodents and birds. These factors limit the amount of seed available for germination and establishment. The relative shade intolerance of this species also prevents it from becoming established as advanced regeneration. Western redcedar, even though it is a prolific seed producer and rodent depredations are minor, has a very low regeneration success Advanced regeneration of western redcedar appeared rate. to be an important means of regeneration in areas receiving no treatment. An investigation of the correlation matrix in Appendix IV indicates that the size of the setting and distance to seed source had correlation coefficients of -0.23305 and -0.28355, respectively, for western redcedar. These are relatively high compared to the remaining environmental parameters sampled for western redcedar. Isaac (1930) in his seed release studies noted a dispersion distance of 400 feet when western redcedar seed was released from an elevation of 150 feet. Therefore in large clearcuts, distance from seed source is a limiting factor as it is for western hemlock and Douglas-fir. However, the seed flight of these two species is much greater as compared with that of western redcedar. In addition, the amount of adjacent western redcedar seed

source was limited in most cases to approximately 5 - 10 percent of the total. Consequently, although western redcedar is a prolific seed producer, not many seed trees were present to produce seed.

Western redcedar's rich edaphic requirements are probably the greatest limiting factor to its establishment. Unlike western hemlock it cannot withstand a wide variety of nutrient and moisture conditions within the seedbed environment.

Many other environmental factors such as slope, aspect, position on slope, and altitude can cause localized variations in the number of seedlings per acre and variations in the results obtained from different studies. Most observations and attempts at trying to define the complex natural factors affecting regeneration have had only limited success. The wide sources of variation and complex interrelationships cause problems in analysis of the individual factors. Ιf the factors are subjected to a multiple regression analysis, the amount of variation accounted for can change with different combinations of variables and certain variables that cannot be quantified or measured easily are left out, although they could contribute to a major portion of the variation. The results of one study may not be directly extrapolated to other areas, since the degree in which one factor is important can change from area to area.

Therefore, because of the problems and inaccuracies

involved in interpreting a complex analysis of the natural factors affecting regeneration, only a simple correlation matrix is presented in Appendix IV for the correlations observed in this study between the number of trees per acre for the individual tree species and the environmental factors measured in the field. No attempt will be made to analyze each factor. A Summary Table 7 of the correlation coefficients (r) with a value greater than .30 for the coniferous tree species and deciduous tree groups will be presented. These factors are considered relatively important in determining the regeneration potential of a logged opening.

One environmental parameter, namely, distance to the south edge, exhibited a relatively high negative correlation with western redcedar (-.34609), western hemlock (-.41738) and Douglas-fir (-.29726). The distance to the south edge represents a relative measurement of the time a site is exposed to bright sunlight. In other words, the smaller the setting or more northernly the exposure, the less time direct sunlight will be on the site. The negative correlation coefficients seemed to indicate that tree regeneration prefers to be shaded during some part of day.

2. <u>Seedbed Characteristics of Coniferous Trees</u>

In all associations the three coniferous species investigated, $Tsuga\ heterophlla$ (western hemlock), Thuja

Table 7 Factors with a correlation coefficient of ± .30 or greater

,				
WESTERN HEMLOCK	WESTERN REDCEDAR	DOUGLAS-FIR	DECIDUOUS	
Altitude (.3396)*	Distance to south edge (3461)	Altitude (.6533)	Position on slope (.4712)	
Age of stand (.4140)		Position on slope (4281)	Age of stand (3916)	
Distance to seed source (3982)		Setting size (4015)	Depth of organic matter (3565)	
Distance to south edge (4174)		<pre>% of douglas-fir seed source (.5033)</pre>	d % of plot-rock (3018)	
% of plot-slash (.3698)		% of western hemlock seed source (4601)	% of plot-slash (4378)	
			% of plot mineral soil (.6381)	

^{*}Correlation coefficient

plicata (western redcedar), and Pseudotsuga menziesii (Douglas-fir), all preferred mineral soil over other types of seedbeds for germination (Figs. 28 and 29). With the exception of Douglas-fir, survival was extremely poor.

Western hemlock survived best on decaying wood. The decaying wood substratum met western hemlock's low nutritional requirement and furnished an ammonium source of nitrogen (Krajina 1969). The ability of decaying wood to conserve moisture is also important to western hemlock's survival. Osborn (1968) maintained that mineral soil provides an adequate seedbed if there is no competition and soil moisture is good. Under decaying wood conditions, western hemlock grows best because its competitors will not grow on this substratum. If this substratum is not available, such as after slashburning, western hemlock is greatly decreased in In some cases, western hemlock appeared to be growing very well on mineral soil, but further examination indicated a buried decaying wood source was present and thus sustaining the hemlock seedling (Fig. 31). In most cases, western hemlock occurred in clumps rather than being randomly distributed (Fig. 33). This growth pattern follows the negative binomial or clumped distribution that Smith and Ker (1957) noted for this species. Although the plots indicated the area had an ample supply to western hemlock regeneration, the amount of area occupied by trees was low due to the clumpy nature of the regeneration. The clumpy

FIGURE 28 Western redcedar and western hemlock seedlings germinating on mineral soil seedbed.

FIGURE 29 Douglas-fir seedling germinating on typical mineral soil seedbed.





behavior is brought about by unsatisfactory seedbed conditions and conditioning of the microsite under an established hemlock to favor its further regeneration (Osborn 1968).

Another important factor restricting regeneration, not only of western hemlock but of all species, was the effect of competing vegetation. In the study area, *Pteridium aquilinum* (bracken fern) was the major competitor. Besides heavy canopy and root competition, the matting of the fronds on the ground is particularly destructive to regenerating trees (Fig. 30).

Western redcedar survived best on rapidly decomposing organic matter in shaded moist pockets. Western redcedar was not found on decaying wood or thick organic matter at all. Its rich edaphic requirements restricted it to habitats rich in nutrients and where nitrification provided a readily available source of nitrates (Krajina 1969).

On areas that were not slashburned, advanced regeneration was a prevalent means of western redcedar establishment. After logging, adventitious roots can develop on limbs that have been buried or covered with soil during the logging operation (Fig. 32). These limbs then have the ability to become erect self-sustaining trees. Schmidt (1955) observed this type of cedar regeneration in old growth coastal forests. Western redcedar constituted a very small portion of the regenerating stand and very few made it to the four foot height class in any of the associations, as can

FIGURE 30

Effectiveness of *Pteridium aquilinum* (bracken fern) fronds in restricting tree regeneration.

FIGURE 31 Tsuga heterophylla growing on a buried source of decaying wood.



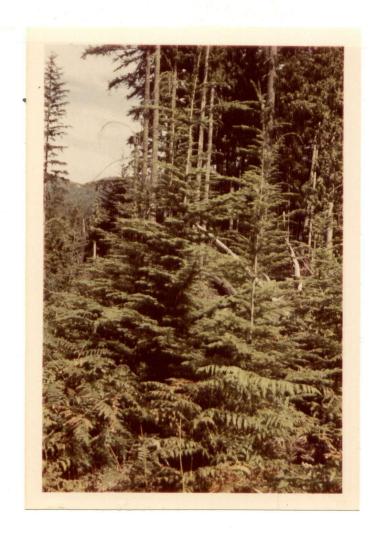


FIGURE 32 Adventitious roots forming on a western redcedar branch following logging.

O

FIGURE 33 Typical clumped habit of western hemlock regeneration following logging.





be seen from the plot data in Appendix I, Part III. This could be attributed to a high mortality rate and a slow growth rate. Western redcedar did not assume a clumped pattern as did western hemlock, but grew as widely scattered individuals.

In the summer of 1974, 181 naturally regenerating Douglas-fir trees were investigated in terms of the type of substratum they were growing on. The results are presented below:

Table 8 Number of Douglas-fir seedlings on three types of seedbeds

	*			
ASSOCIATION	MINERAL SOIL	DECAYING WOOD	ORGANIC MATTER	TOTAL
Salal - D.F.	65	15	1	81
% of total	80	19	1	45
Moss - W.H.	54	14	3	71
% of total	76	20	4	39
Swordfern - W.	R.C. 27	1	1	29
% of total	93	3	. 3	16
TOTAL	146	30	5	181
% of total	81	17	3	

Germination on mineral soil was the highest, followed by decaying wood and organic matter, respectively. The fact

widely accepted (Isaac 1939, Garman 1955, Fowells 1965).

Nevertheless, many young Douglas-fir seedlings were found growing vigorously on decaying wood (Fig. 34). In many cases, it was observed that due to the logging operation mineral soil may have been thrown on top of logs providing a suitable seedbed for Douglas-fir germination. The decaying wood below also provided available moisture. Furthermore, if the seedlings were able to extend their rooting systems either through the decaying wood or around it in order to reach mineral soil, they were then capable of sustaining themselves and growing as well as seedlings established on mineral soil.

The major factors controlling germination appeared to be within-site variations (microsite) resulting from the logging operation. The number of microsites created that are available for germination depends on the logging method and treatment thereafter. Important micro-environmental factors were the amount of shade, soil surface temperatures, available soil surface moisture, type of seedbed, and speed in which the organic layers decomposed. Macro-environmental controls such as local climate, elevation, landform, and depth of parent material less closely control the germination process. In other words, unsatisfactory seedbed conditions such as dense shade, heavy accumulations of undecaying slash,

FIGURE 34

Pseudotsuga menziesii (Douglas-fir) growing well on decaying wood of downed western redcedar tree.



thick layers of organic matter and a desiccated soil surface condition were the primary factors affecting seed germination. While the above factors are important in controlling seed germination, the type of seed source and distance to the seed source are important in determining the amount of seed available. Loss of seed due to rodents and birds could be important but were not identified in this study.

VI. SUMMARY AND CONCLUSION

The results of this study have shown that the forest associations in their initial stages of secondary succession are identifiable in the field although vegetation indicators alone are not enough and must be coupled with physiographic information. The knowledge of the vegetative relationships that exists in the individual forest associations is important to the proper "ecological" management of Silvicultural prescriptions should be developed a site. for each association. Information on the ecology of the different tree species and the effect of different treatments on each association should be the basis for the silvicultural prescriptions and choice of the most ecologically suitable species for planting. Furthermore, certain associations may not require planting and natural regeneration may be safely relied on to stock the site, providing environmental factors such as seed years, distance to seed source, and type of seed source are favorable. In other words, the allocation of silvicultural prescriptions requires not merely identification of the forest association, but realization of the complex interacting environmental factors on planted These should be evaluated before and natural regeneration.

logging as well as after, so a suitable environment can be created for each association. Since man is an active environmental factor, his activities are controlling factors and affect the development of the forest. Therefore, his activities should be guided by the natural controlling factors of the site as much as possible.

The differentiation between associations is distinct between the extremes, namely the salal - Douglas-fir association and swordfern - western redcedar association. The distinction between these two associations could be made by vegetative characteristics alone. The swordfern - western redcedar association possesses a highly diverse group of species indicating its high moisture and nutrient regimes. Structurally, both the shrub and especially the herb strata are very well developed. The moss layer is relatively poorly developed. The salal - Douglas-fir association, on the other hand, has very few species. The shrub and moss strata are well-developed, but the herb stratum is almost lacking. Physiographically, the swordfern - western redcedar association occupies lower slopes and depressions, whereas the salal - Douglas-fir association occupies upper slopes and ridge Unfortunately, the distinction between the salal - Douglasfir association and the moss - western hemlock association is not clear. Vegetatively, no differences arise in species composition. However, the shrub stratum of the salal -

Douglas-fir association contains more Gaultheria shallon, while the moss stratum of the moss - western hemlock association is better developed and the B2 layer has a higher presence and significance of Vaccinium alaskaense. Unfortunately, these changes are slight to an untrained observer. The major means by which these two associations can be divided is by physiographic position and depth to an impervious layer. The salal - Douglas-fir association occupies the top of ridges or the upper slopes. The parent material usually is shallow ablation till over bedrock. moss - western hemlock association invariably occurs on upper slopes on north-facing aspects and moves gradually down in slope position to the mid-slope position on southfacing aspects. However, on areas near the transition zone into the Coastal Western Hemlock wetter subzone, the increased rainfall causes the moss - western hemlock association to occupy flat areas on ridge tops where slight depressions The moisture regime is slightly greater and the parent material is deeper in these depressions. Here, the salal -Douglas-fir association is found on adjacent rocky ridges or steep slopes with a shallow soil.

On the cutover associations, a classification that takes into consideration only the presence or the absence of species is not sufficient to classify the various associations after logging. Mueller-Dombois (1960) also noted this for

the Coastal Douglas-fir Zone. This is brought about by an increase in favorable habitats of the individual species and invasion of the site by short-lived pioneer vegetation responding only to increased light. These tall pioneer herbs have no indicative significance. Very few of the truly indicative forest species are destroyed by logging. Only after a severe slashburn are they reduced to a negligible amount and further covered by weed vegetation.

The creation of microsites or microdepressions is a common phenomenon after logging and accounts for much of the variation between homogeneous associations.

Structurally, all associations contained the same total average cover. All associations were quickly invaded by tall herbs such as <code>Epilobium</code> angustifolium and Anaphalis margaritacea, although the salal - Douglas-fir and moss - western hemlock associations were invaded to a lesser extent. The shrub layers were all well-developed. The shrub layer of the swordfern - western redcedar association consisted of mainly Rubus spectabilis, whereas the salal - Douglas-fir and moss - western hemlock association 's shrub layers were dominated by Gaultheria shallon. The herb layer reacted differently. In the rich swordfern - western redcedar association, the herb layer was well developed. But in the salal - Douglas-fir and moss - western hemlock associations, the low thick cover of Gaultheria shallon largely restricted the herb

layer to tall weedy invading herbs rather than low growing herbs. The moss layer was just the opposite. In the swordfern - western redcedar association it was poorly developed, while the salal - Douglas-fir and moss - western hemlock associations had well-developed moss layers. It was found that the degree and type of disturbance, extent of microsites created, spacing of planted trees, age, and parent material brought about changes in both structure and species composition in each association.

Douglas-fir, western hemlock, and western redcedar all germinated best on mineral soil seedbeds, but survival was very poor, except for Douglas-fir. Western hemlock grew best on decaying wood, while western redcedar preferred rapidly decaying organic matter in moist pockets. Advanced regeneration was an important means of regeneration of western hemlock and western redcedar. Douglas-fir survived well on mineral soil and was not affected by drought as much as the other two species. Douglas-fir was also found growing well on decaying wood.

The results of the statistical analysis indicate that treatments within associations had a definite effect on the number and type of coniferous trees per acre. Associations alone were not significant. The number of deciduous trees per acre, on the other hand, were less affected by the type of treatment and responded more to the association type, with

the swordfern - western redcedar association being the preferred type. The salal - Douglas-fir association - slashburned and the swordfern - western redcedar association slashburned or piled and burned significantly reduced the number of trees per acre of Douglas-fir, western hemlock, and western redcedar in most cases. Although not statistically significant, slashburning did not affect the swordfern western redcedar association as much as the salal - Douglas-The preference of coniferous trees for areas fir association. that have had no treatment is presumed to be caused mainly by a higher amount of available seed present that was not destroyed by burning, a greater variety of seedbed types favorable to all species, and shading of slash. All coniferous tree species preferred areas that were either piled and burned or had no treatment in the salal - Douglas-fir and moss - western hemlock associations. The swordfern - western redcedar association undoubtedly provided an equally suitable habitat to regeneration, but early invasion of this rich habitat by deciduous trees and herbaceous plants, limits the establishment of coniferous trees.

The distribution of western hemlock followed a negative binomial or clumped distribution and in most cases the regeneration was not well distributed over the logged areas. The indications of this study are that supplemental planting of Douglas-fir would be needed to obtain a

satisfactory number of Douglas-fir trees and an even distribution of them on all associations, although the salal - Douglas-fir association provided the best habitat.

Graphs, comparing the number of trees per acre versus height class (age), indicate that as height class increases the number of coniferous trees per acre rapidly decreases, while the number of deciduous trees per acre increases. The reduction in the number of coniferous trees per acre was the greatest in the swordfern - western redcedar association, where intense competition from deciduous trees and herbaceous plants restricted establishment.

The many complex interrelated environmental factors are hard to analyze by statistical means because of a multitude of localized variations and the number of available observations. Consequently, only the correlation coefficients of the more important factors affecting each tree species is presented in Table 7, whereas a complete list is contained in Appendix IV.

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APPENDIX I

PART I. General Environment Tables

PART II. Vegetation Synthesis Tables

PART III. Tree and Stand Description

EXPLANATION AND LEGEND FOR THE SYNTHESIS TABLES

- (1) ASPECT indicates compass readings from north in degrees.
- (2) TOPOGRAPHY refers to the shape of the land profile on a mesoscale and is described as follows:

Topography Class	Description
N.	Neutral (uniform slope)
CC	Concave
CV	Convex
F	Flat

(3) MICRORELIEF pertains to the land surface shape within the sample plot (microscale) and is evaluated by a descriptive scale as follows:

Description
Neutral (smooth)
Hummocky, irregular - very irregular microtopography with a number of sharply rising ridges or mounds running through the plot.
Undulating - a slightly wavy microtopography, less severe than hummocky.
Flat
Outcrop

- (4) <u>SLOPE GRADIENT</u> is the average inclination of the sample plot.
- (5) <u>POSITION ON SLOPE</u> is the location of the sample plot in relation to the land surface and is described as follows:

Position on Slope	Description
0	Peak, ridge sloping in several directions
1	Just below the peak or ridge sloping in one direction
2	Further from peak or edge of terrace
3	Upper slope
4	Upper part of mid-slope
5	Lower part of mid-slope
6	Lower slope
7	Slopes near bottom of depression
8	Flat bottom of the valley or depression itself

^{(6) &}lt;u>LANDFORM</u> describes the type and the origin of the parent material and is evaluated as follows:

Land Form Symbol	Description*
МР	Deep morainal deposit (loose till over compacted basal till): materials thick enough to cover irregularities of underlying bedrock; relatively flat to gently sloping; slopes less than 30%.
MB	Morainal blanket (loose till over compacted basal till bedrock controlled): a thick till cover, more than 3 feet, usually covering irregularities of underlying bedrock; slopes range from 0 to 50%.
MV	Morainal veneer (loose till over bedrock); till less than 3 feet overlying bedrock; materials too thin to mask underlying bedrock irregularities; slopes range from 0 to 50%.
GF	Glacio-fluvial deposits: sand, silt, gravel, and minor coarser material deposited by meltwater from the wasting glacier; relatively flat and usually deposited in thick stratified layers; material masks all features of underlying bedrock or material of another genetic category; slopes less than 10%.
GW	Glacio-marine deposits: sand, silt, clay and minor coarser fragments deposited under the influence of a marine environment; usually poorly drained and relatively flat in topography.

^{*}Fulton, R.J. 1972. Landform Classification. B. C. Department of Agriculture. 8 p., Appendix 6 p., (Mimeo).

Land Form Symbol	Description*
CV	Colluvial veneer: a thin, less than 3 feet heterogeneous mixture of materials, deposited by mass wasting processes; materials too thin to cover irregularities of underlying bedrock; slopes range from 30 to 50%.

(7) TEXTURE OF PARENT MATERIAL - see table below:

Texture of Parent Material (Symbol)	* Description
В	Bouldery - abundance of material classed as boulder in size (greater than 10 in.); not encountered in study area.
G	Gravelly - dominantly gravel and coarse sand sized material (.4 - 10 in.).
S	Sandy - dominantly granule and sand sized material (.405 mm.).
Si	Silty - dominantly fine sand and silt sized (.25005 mm.).

(8) <u>LOCATION</u> - UBCF - University of British Columbia Research Forest

MTF - Mission Tree Farm

^{*}Fulton, R.J. 1972. Landform Classification. B.C. Department of Agriculture. 8 p., Appendix 6 p., (Mimeo).

(9) TYPE OF TREATMENT - NONE - No treatment

SL - Slashburned

P&B - Piled and burned

(10) BURNING INTENSITY - L - bark on stumps lightly blackened.

N - bark on stump blackened as well as the wood being scorched or blackened.

S - wood on stumps hollowed out by fire.

(11) HYGROTOPE - pertains to the moisutre regime classes of the soils and is approximately equal to the soil drainage classes proposed by Leskiw (1973). The symbols employed for the hygrotope classes are as follows (after Krajina, 1969):

X Xeric

SX Subxeric

M Mesic

SHG Subhygric (with temporary

seepage)

HG Hygric (with permanent

seepage, mostly 30 cm to 60 cm below the soil surface)

- (12) ROCK, SLASH, MINERAL SOIL, AND ORGANIC MATERIAL refers to the area in percent of each item on the sample plot.
- (13)% OF BRUSH SPECIES, OVERTOPPING TREES OR NOT OVERTOPPING

 TREES refers to the percentage of herbaceous and noncommercial tree species overtopping or not overtopping

- the commercial tree species, i.e. Douglas-fir, western hemlock, and western redcedar.
- each vegetative stratum. The strata are denoted as A(tree layer), B(shrub layer), C(herb layer), and D (moss layer). The B layer is separated into B₁(woody vegetation 6' 30') and B₂ (woody vegetation 1' 6'). The C layer also contains commercial tree species under 1 foot in height and creeping shrubs. The D layer is separated into mosses on humus (DH), mosses on decaying wood (DW), mosses on rock (DR), and mosses on mineral soil(DM).
- (15) SOIL ORDER was extracted from existing soil association maps and may be prone to errors. It was included merely to give an idea of the type of soil to be expected and not to provide positive proof of the soil order or subgroup. The first four letters of each soil order were used on the synthesis tables.
- (16) PRESENCE (P) was calculated using the following formula:
 - P = number of occurrences of a species total number of relevés in that particular x 100 association
- (17) MEAN SIGNIFICANCE (MS) was calculated by taking the mean of each significance class, then transforming it back to the original scale of species significance. The number

to the left of the decimal in the mean significance column refers to the species significance class, while the number to the right of the decimal refers to the tenth of that particular species significance class the species falls in.

(18) RANGE OF SIGNIFICANCE (RS) is simply the difference between the lowest and highest significance encountered for a particular species.

PART I. General Environment Tables

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PART II. Vegetation Synthesis Tables

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	ACER MACROPHYLLUM			1 •	•	1 - 1	• 1																		
2	. CANITUEDTA EUALLON			14 5	15 4	10 7	4 61	5 2	10 5	17 2	10 4	10 4	10 7	14 5	10 6	10.5	16.4	7.6	17.7	18.7	17.71	6-51	100.0	7.8	4-9
12	GAULTHERIA SHALLON VACCINIUM PARVIFOLIUM		. "	13 +	12.4	17.1	2.4	3.+	3.+	13.+	13.+	13.+	3.+	15.+	5.1	5.1	13.1	3.+	14.1	15.+	15.+1	3.11	100.0	4.4	2-5
ro	.TSUGA HETEROPHYLLA																						94.7		
. 17	RUBUS SPECTABILIS					2.1	3.4	2.1	2.+	13.1	2.+	3.1	14.1	5.1	4.1	3.1	13.1	4.1	14.1	13.+	13.+1	2.11	89.5	3.7	2-5
• •	BETULA PAPYRIFERA			11.+	11.+	3.+	5.+	4.+	+ +	3.+	12.+	•	2.+	3.+		12.+	12.+	2.+	12.+	13.+	12.+1	+.+	89.5	3.1	+-5
·.	PSEUDOTSUGA MENZIESII	(NAT.)		1	١.	1 .	+.+	+.+	+.+	12.+	11.+	12.+	13.+	12.+	11.+	١.	13.+	3.+	13.+	14.+	14.+1	4.+	78.9	3.0	+-4
18	MENZIESIA FERRUGINEA		, '	12.+	1 .	1 . 1	1.+	2.+	۱.	13.1	13.1	13.+	13.+	13.+	15.1	4.1	12.1			13.+	3.+1	2.1!	73.7	3.2	1-5
	SPIRAEA DOUGLASII.			١.	١.	11.1	١.,١	3.4	3.1	13.1	12.1	۱.	3.1	4.1		2.1	2.1	4.1	13.+	13.+	13.+	2.11	73.7	3.0	1-4
	THUJA PLICATA	4.1	100	1 .		1 . !			١.	13.+	13.+	12.+	12.+	4.1	13.1	12.+	4.1	2.+	14.+	13.+	12.+1	+.+	68.4	3.0	+-4
20	VACCINIUM OVALIFOLIUM		"	1 .		l . I	2.+		١.	12.+	13.+		2.1	4.1	4.1	4.1	3.1	١.	13.1	12.+	3.1	2.1	63.2	3.0	2-4
	SALIX SITCHENSIS			1	١.		· • 1	1.+		12.+	12.+		13.1		+.+	+.+	14.1	4.1	4.5	13.+	13.+1	+.+	63.2	2.8	+-4
21	RUBUS PARVIFLORUS			1 .	١.	11.+	3.4	3.1	3.5	12.1	12.+	•	1 • !	3.1		, L.+	2.1		12.1		12.+1	2.1	63.2	2.2	1-3
•	PRUNUS EMARGINATA			1 .	+.+	11.+	2.+	•	+.+	1	١.	١.		14.+		+.+	11.+	2.+	13.+	1+.+	1 • 1	• !	52.6	1.7	+-4
٠.	PSEUDOTSUGA MENZIESII	(ART.)		15.+	3.+	4.+	5.+	5.+	2.+	15.+	4.+	2.+	•			١.	! •				1 • 1	•	47.4	3.9	.2-5
22	RUBUS LEUCODERMIS	100		1 •		1 -	4.1	3.1	2.1		١.	١.	12.+	2.1	2.1	٠.	! •		12.1		[1.+]	• !	42.1	2.0	1-4
23	VACÇINIUM ALASKAENSE			ļ •			2.+	•		12.+	3.+		12.1	ļ	! •	ļ.•_	12.+		12.+	12.+	12.11	• !	42.1	1.6	2-3
	ACER CIRCINATUM				12-1		•	1.1	•		3.4] •	3.1	•	4.5	! •	١	ļ.•.	1+.+	12-11	• !	36.8	1.9	+-4
24	RIBES SANGUINEUM			! •	١.	! + . + !	1.+	1.1	13.+			•			2.1		! . • .	3.1	13.1		! • !	• !	36.8	1.5	+-3
:	RHAMNUS PURSHIANA			! •	١.	! • !	1.+			1 •	1+.+	+.+	12.+	3.+	ļ·•	12.+	+ . +	٠.	! • .		! • !	• ¦	36.8	1.1	+-3
	POPULUS TRICHOCARPA		:	! •	ļ.•] • !	•	1.+	٠.	1+.+	! •	+•+				! •	11.+	١.٠.	13.4	! •	•	• 1	26.3	*•0	7-7
-	SAMBUCUS RACEMOSA			! •	•		•	•	!	! •	! •	•	. •	12.4.		٠.	! •	2.+	12.*		1, • 1	• ¦	15.8	+ 0	1-2
26	RUBUS LACINIATUS			•	١.		•	•	1.2.+	! •	•.	•		12.1] · •	•		•	11.4		14.41	• 1	15.8	¥.4	1-2
· .	CORNUS NUTTALLII	*			٠.	•		•	•	•	•	•	- 1 4	1 20+			•	•	11.7	•	1 ***!	. 1	15.8 15.8	T • 1	4-1
-	SALIX SCOULERIANA			! •		•	14.4	•	*•*	•	· ·	• 1 +	1 1•*		•	•	· ·	: ·	1 .	¦ •	•	• !	10.5	+ n	+= 1
	RIBES LACUSTRE											1107	•		i •	•	•	•	1 .				10.5	+ . n	4-1
	HOLODISCUS DISCOLOR		•	! •	* . *	•	•	•	•	•	1 4 4	1 * • * 1 .			•				1:	! :	1:1	: 1	10.5	+.0	+-+
	TAXUS BREVIFOLIA BERBERIS NERVOSA				1 •	•					, * • *	3.4				.	i :		i :	i .	1:1	: 1	5.3	+.4	3-3
	LEDUM GROENLANDICUM					. •	•	• .	•	: •	•	, , , ,	: •	•	•	: •	:	•	: •	: •	: * :	- :			3-3

LOT N	UMBER	1048	1040	1041	1042	043	044	1046	1047	0501	0101	015	016	017	020	011	1012	1013	1014	10211			
T NO.	SPECIES					SPE	CIE	s si	GNIF	CANC	E AN	ID SC	OCIA	BILI	TY.						Ρ.	MS	R S
			. %			-:																	
	SALIX LASIANDRA	1 -	-	1 .	۱.	1 - 1			•	- 1	• 1	i • I	•	•		•	12.1			. 1	5.3	+.0	2-
- 33	BERBERIS AQUIFOLIUM PYRUS FUSCA	1 .	1 .	1 .	١.	1 • 1	١.	۱.	1 •	•	. 1	l • 1	l • 1			•		11.+	l • ·	1 • 1	5.3	+.0	1-
34	PYRUS FUSCA	١.	1 -	1 .	1 •	1 - 1		۱ -	l • 1	. 1	- 1		• 1	١.	l • [•	١.	۱.	11.1	I • I	5.3	+.0	1-
٠.	ALNUS RUBRA	1 .	1 .	1.	١.	1 .		۱.	l		• 1		•	•	• •	•	١.	١.	1 .	1+.+1	5.3	+.0	+-
35	ROS A GYMNOCARPA	1 .	l •	1 .	1 .	1 .		۱.	1 .		• 1	. !		١.			+.+	1 .		1 - 1	5.3	+.0	+-
36	SORBUS AUCUPARIA	, l •,	1 -	1 .	1 •	1 • 1	•	•	1 •		• 1	• !	•	١.		•	١.	+.+	1 •	. 1	5.3	+.0	+-
27	BERBERIS AQUIFOLIUM PYRUS FUSCA ALNUS RUBRA ROSA GYMNOCARPA SORBUS AUCUPARIA PTERIDIUM AQUILINUM EPILOBIUM AUGUSTIFOLIUM TSUGA HETEROPHYLLA BLECHNUM SPICANT RUBUS URSINUS ANAPHALIS MARGARITACEA POLYSTICHUM MUNITUM DRYOPTERIS AUSTRIACA	15.5	17 5	12 1	15 1	18 6	15.1	14.1	15.1	14.41	5.6	5.5	 I .	17.6	15.1	8.7	17.7	17.6	17.6	16.51	94.7	6.3	2.
. 20.	EDITORIUM AUCHETICALIUM	12.1	12 1	12 1	14 1	12 4	15 5	1 1	1 70 1	2 4	5 6	3 4	2.1	13 1	13.4	2 1	12.1	13.1	12.1	11.4	94.7	3.8	1.
٠٠٠.	TOUCA HETEROPHYLLA	11.4	1301	. 3 - 1	1701	1241	1100	12.4	12.1	20 7 1	3 4	2 1	12 T	11.	3 1	5 1	14 1	14 1	14 1	12 4	89.5	3 4	•
30	DIECUNIA CDICANT	12.4	1 * • *	1 •	12.4	12.4	11.7	1001	130 T	2	201	3 - 1	2 4	12 4	14.1	3 +	12.4	12.7	13 +	4	89 5	3 2	i.
40	DESCRIPTION SPICART	. [4.7	121	14.4	1 4.4	13.4	1 4 4 7	, 7• L	11 1	Z . T	2 1	1207	2 1	12.4	; 7 • L	2 .	12.4	14 1	14 6	12 1	84 2	3.4	1
40	ANADUALIS MADCADITACEA	. •	12 2	1 4 • 4 1 4 4	12.	13.1	J. l.		1 4 6 1	70 3 	3.1	4 o k 2 o k	Je 1	(16.6	3.4	14.5	1701	17.7	1 4 4 1	78 0	3.3	1
41	ANAPHALIS MAKGAKITACEA	13.1	13.5	14.4	13.1	12.1		1 1 • L	1 2 - 1	!	3 4 1	J • 4 J • 4	Z • L	1 •	12.4	3.4	17.7	1201	12.1	ا • ا ند دا	70.7	2 • 2	. J.
42	POLYSTICHUM MUNITUM DRYOPTERIS AUSTRIACA THUJA PLICATA PSEUDOTSUGA MENZIESII (NAT.)	. ! •	! •	! •	1204	14.4	! . • .	13.*	12.4	2.1	3. * [2.*	3.7	13.7	12.7	2.*	13.7	1207	13.4	13.71	70.7	2.1	- 2
43	UKTUPIERIS AUSTRIACA	. . • .	! •	! •	11.**	11.4	11.1	12.*	11.1	•	3. +	2.7	Z + 1	2.+	12.4	2.1	13.7	13.7	13.7	12.71	40.4	2.3	1
	THUJA PLICATA	11.*	•	! •	11.*		! • .	12.+	11.+	. • !	2.11	2.7	2.7	! •	13.1	3.*	13.7	13.7	13.7	12.41	(3.3	203	
44	LINNAEA BOREALIS ATHYRIUM FILIX-FEMINA LYCOPODIUM CLAVATUM CORNUS CANADENSIS HOLCUS LANATUS JUNCUS EFFUSUS HYPOCHAERIS RADICATA		!			• .	•		! • !	6.5	7.6	7.7	5.4	18.5	15.4	5.6	1.	15.5	12.5	1 • 1	41.4	2.4	•
45	ATHYRIUM FILIX-FEMINA		1.00	1 •					! • !	!	1.+	2.+	•	11.+	11.+	2.+	13.+	11.+	12.+	11.+	47.4	1.4	1
46	LYCOPODIUM CLAVATUM) •	1 •		11.1	11.1	٠.	14.4		2.2	•	2.1	•		2.1	2.2	12.1	! •	•		42.1	1.8	1
47	CORNUS CANADENSIS		3.3	13.3	1.		•		ļ • I	4.4	· • 1	3.3	•	•	•	2.3		•	14.4	•	31.6	2.3	2
48	HOLCUS LANATUS		1 •	1 .			•		ļ • !	•	•	2.+	•		11-1	•	12.1	12.+	13.+	! • !	26.3	1.2	1
49	JUNCUS EFFUSUS	1 •	l •	1 :		1 .		۱.	1 • 1	i • I	• 1			•	1.+	1.2	2.3	12.+	12.1	1 • 1	26.3	1.0	1
50	HYPOCHAERIS RADICATA LACTUCA BIENNIS LUZULA PARVIFLORA SOLIDAGO CANADENSIS AGROSTIS SCABRA CALAMAGROSTIS CANADENSIS SCIRPUS MICRUCARPUS	. •	١.	1.	1 -	12.+			1 .		• [· •	1.+	١.	l • '	•		12.+	11.1	1 • 1	21.1	+.6	1
51	LACTUCA BIENNIS	. •		1 .	1 .	11.+	٠.	1 .	1 . 1	. 1	+.+	•		٠.	. :	2.+	12.+	l •	1 .	1 • 1	21.1	+.5	+
52	LUZULA PARVIFLORA		1 :	1.	1 .	1 .	١.	۱.	1		2.3	2.2		٠.	i • i	•	1 .		١.	11.+1	15.8	+.4	1
53	SOLIDAGO CANADENS IS	1.	1.	1 .	1 .	1 . 1	١.	١.		• 1	- 1	. !			١.	1.+	12.+	12.+		1 . 1	15.8	+.4	1
54	AGROSTIS SCABRA	1	1 .	1 .			١.	١.	1 . 1		. 1		. 1	١.		3.2	12.1	l •		1 . 1	10.5	+.8	2
55	CALAMAGROSTIS CANADENSIS	i .	i .	i .	i .	i .		i .		i . i	. 1	i . i	i • i		1.+	3.4	i 🔐	1 .	1 .	1 . 1	10.5	+.6	1
56	SCIRPUS MICRUCARPUS	i .	13.1	i	i .	i . i	i .	i 🚡	i .	i . i	Ài	i		i .			i .	11.+	i .	i . i	10.5	+.6	1
57	HIERACIUM ALBIFLORUM	i I	i .	i .	i I	i	i	i	i . i	i . i	. i	i i	iii	i .	i .	2.+	12.+	i .	i .	i 🛦 i	10.5	+.2	2
58	SCIRPUS MICRUCARPUS HIERACIUM ALBIFLORUM SENECIO SYLVATICUS	- i .	i .	i I	i .	i . i	ί.	i I	i .	i	i i	i		i I			i .	11.+	11.+	i . i	10.5	+.0	1
59	TRILLIUM OVATUM	i •		i I	i] .	i i i	i	: I	i . '	i . i	. i			i .			1+.+	i .	1	i i i	10.5	+.0	÷
Ãή	CAREY ADUATILIS	- i •	1	1:	1	1 : 1	i :		i		- 1 i		-				i .	i :	13.+	i i	5.3	+ 4	. 3
61	SENECIO SYLVATICUS TRILLIUM OVATUM CAREX AQUATILIS EPILOBIUM WATSONII SCIRPUS CYPERINUS CAREX HENDERSONII		i :	i .	i :	1 . 1		i :						i .	i . ˈ	3.4	i	i .	1		5.3	+.4	á
42	SCIPPIS CYPEDIALIS		1	;	•		1 a . A			• •	. 1		• 1	i .			i :	i :	i :		5.3	+.4	3
63	CAREA MENUESCUIII		:	•	: •		, J. T	•	•	• !	•	•	•	i •	•	2.0	¦ :	•	i •	1 : 1	5.2		, ,
6.6	TIADELLA TOTONITATA		! •	: •	1 •	; • !	•		; • 1	• 1	•	•	•	· •	; •	2 .	: •	: •	:	•	6.3	4.0	2
46	TIARELLA TRIFOLIATA TRISETUM CERNUUM	! •	•	: .	•	•	•	•		· • !	•	•	• I	•	•	Z • T	•	12.4		• !		¥.0	2
44	CARCY INTERIOR	. ! •		! •	•	1 • 1	•	1 •		•. }	• 1	•	•	•	•	•	! *	12.7	•	•	5.3	T. 0	
65	CIRCIUM ARVENCE		! •	! •	•	11.4	•	i •	• 1	•	• !	•	•	•	•	•	<u>ا</u> : ا	1 •		; • !	2.3	T.O	1
10	CIRCIUM ARVENSE	•	! •	! •		! • !	•	•	! •	• !	• !	•	•			•	1.0*	•		; • <u>!</u>	2.3	T.0	
00	COORDERA COLONGIACIO	. ! •	! •	! •	! •		•		· •	•	1.4		•	٠.		•	! •		! •	•	2.3	*.0	L
64	GOODTEKA UBLUNGIFULIA		! •			! • !	•				• !	1.4	•	. •	•	•	! •	! •	! •	! • !	2.3	*•0	L
	PSEUDUISUGA MENZIESII (ART.)	1+•+	! •	! •	! •		٠.			• !	• !	•	• :			•	! •	1 •		! • !	5.3	+.0	+
70	UNITED DIGICA	1 •	1 .	1 •	1 •	1 •	l •	l •	1 •	• 	• I			•	l •	+.+	l •	l •	1 •	• 	5.3	+.0	+
71	TIARELLA TRIFOLIATA TRISETUM CERNUUM CAREX INTERIOR CIRSIUM ARVENSE FESTUCA OCCIDENTALIS GOODYERA OBLONGIFOLIA PSEUDOTSUGA MENZIESII (ART.) URTICA DIOICA HYLOCOMIUM SPLENDENS RHYTIDIADELPHUS LOREUS	1 -	12.2	1 -	13.2	15.41	12.2	14.3	14.31	3.31	4,31	5,31	5.4	4.4	 	4.3		1 -	12.1	_	68.4	4.0	2.
72	DUVITATION STEEMBERS	· •	11 2	•	1202	12 2	1 - 4 - 6	1 2 2	14 2	2.21	2 21	2 2	12 2	12 2	. •	1 7 9	: ·	: •	11 1	; • ;	57 0	2 4	1
	WILL IDIADCELIOS CONCOS				1606	1202		13.3	1 40 2	!		, , , , ,	406	16.66		•			1 + • •	; • !	21.7	4 . 4	

LOT	NUMBER	10481040104110421043104410461047105010101015101610171020101110121013101410211			
T NO	• SPECIES	SPECIES SIGNIFICANCE AND SOCIABILITY	P M	15 R.S	5
			•		
	PLAGIOTHECIUM UNDULATUM				
	EURHYNCHIUM DREGANUM	• • • • 4.3 • • • 3.2 • • • • • 1.2.3 • • • 1.3.3			
		• • • • • • • • • •			
	RHYTIDIADELPHUS TRIQUETRUS SPHAGNUM PALUSTRE				
	AULACOMNIUM ANDROGYNUM	_ , . , . , . , . , . , . , . , . , . ,	5.3 4	-	
# 'O	AUCACOMNIOM ANDRUGINOM		2.3	.0 2-	٠.
	POLYTRICHUM JUNIPERINUM	19.714.418.617.417.517.516.314.412.213.215.412.21 . 14.414.313.313.316.31 . 1	PO 6 5	. 7 2.	- 0
		1			
		1. 			
	CERATODON PURPUREUS	14.2[5.4] . [3.2] . [2.2] . [. [. [. [. [. [2.2] .] . [3.2] .] .]			
83	POGONATUM ALPINUM	. 2.2 			
84	EURHYNCHIUM PRAELONGUM	1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 2 . 2 .			
85	OLIGOTRICHUM ALIGERUM				
86	DITRICHUM HETEROMALLUM		10.5 +	.2 2-	- 2
· 87	DICRANELLA HETEROMALLA		10.5 4	0 1-	- 2
88	POLYTRICHUM COMMUNE		5.3 +	• 4 3-	- 3
	AULACOMNIUM ANDROGYNUM				
	DICRANUM TAURICUM		5.3 +	.0 1-	- 1
W					
	PLAGIOTHECIUM UNDULATUM	• • • • • • • 1.1 1.2 3.2 3.2 2.1 3.3 2.1 2.2 1.1 1.1 1.1 2.1			
	HYLOCOMIUM SPLENDENS	- - - - - - 3.2 - - 3.3 2.2 2.2 2.2 2.2 1.1 - 1.1 1.1 1.1			
• • • •	RHYTIDIADELPHUS LOREUS	• • • • • • 1.1 • • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 2.2 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 2.2 1.1 3.3 2.2 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 2.2 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 2.2 1.1 3.3 2.2 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 2.2 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 2.2 1.1 • (4.3 2.2 3.3 2.2 1.1 3.3 2.2 1.1 • (4.3 2.2 3.2 3.2 2.2 3.3 2.2 1.1 3.3 2.2 2 2. 2 2.			
R '	RHIZOMNIUM GLABRESCENS		5.3 +	.0 1-	٠1
•	DUACONITOTUM CANGEEGINE				_
		_ , _ , _ , _ , _ , _ , _ , _ , _ , _ ,	36.8 1		_
72	RHACOMITRIUM HETEROSTICHUM POHLIA NUTANS	• • • • • • 2.2 2.2 • 2.3 • • • 2.1 • 4.3 4.4 • • 1			
02	BARBULA SP.				
73					
	DITRICHUM HETEROMALLUM		5.3 +	.0 2-	. 2

PLOT NUMBER	003 009 018 019 022 032 039 035 036 033 034 037 038 045 049	
ST NO. SPECIES	SPECIES SIGNIFICANCE AND SOCIABILITY	P MS RS
A 1 PSEUDOTSUGA MENZIESII (ART.)	26 7 4 4 4-7
2 ALNUS RUBRA	• • • • • • • • • •	
3 SALIX SCOULERIANA	1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 .	
4 TSUGA HETEROPHYLLA		
81		
TSUGA HETEROPHYLLA	17.5 6.1 7.1 5.1 5.1 6.1 5.1 7.1 7.1 4.+ 3.+ 6.+ %.1 7.1 8.+ 	100.0 6.6 3-8
5 BETULA PAPYRIFERA	12.+1 . 1+.+1 . 1 . 1+.+1 . 14.+13.+15.+14.+1 . 13.+14.+15.+1 . 1 . 1 . 1 . 1	
6 ACER CIRCINATUM	15.6[.] .] . [.] + . + . 3.3 4.5 6.5 . 4.4 4.5 4.5 . 6.6 	
7 SALIX SITCHENSIS		
B RHAMNUS PURSHIANA	• • • • • • • 3.+ 4.+ 5.+ +.+ 2.+ 5.+ 3.+ • +.+ • • • • •	
PSEUDOTSUGA MENZIESTI (ART.)	• • • • • • • • • •	
9 THUJA PLICATA		
SALIX SCOULERIANA	• • • • 3.+ • • 3.+ • + • 2.1 3.1 • • • • • • • •	
ALNUS RUBRA		
13 VACCINIUM PARVIFOLIUM		20 0 2 0 4-5
14 SPIRAEA DOUGLASII	20.0 1.7 2-4
15 PRJNUS EMARGINATA		13.3 +.0 +-2
16 CORNUS NUTTALLII		6.7 +.6 3-3
B2		
17 GAULTHERIA SHALLON	14.6 6.5 7.4 4.4 5.4 6.5 6.4 6.5 5.5 3.1 4.4 2.1 3.1 4.3 5.3 	100.0 5.4 2-7
VACCINIUM PARVIFOLIUM	3.+ 4.+ 4.1 4.1 3.1 3.+ 3.+ 3.+ 3.1 3.1 . 1.1 3.+ 5.1 4.+ 	93.3 4.0 1-5
18 VACCINIUM ALASKAENSE	• 2•+ 3•+ 2•+ 2•+ 2•+ 4•1 3•1 4•1 3•+ 2•+ 2•+ 2•+ 2•+ 2•+ • • • •	93.3 3.1 2-4
TSUGA HETEROPHYLLA		86.7 5.2 3-6
RUBUS SPECTABILIS		86.7 5.1 2-7
THUJA PLICATA		80.0 3.1 2-4
19 VACCINIUM OVALIFOLIUM	• 3•+ 4•1 3•1 2•1 2•+ • 2•+ 2•+ • 2•+ • 2•+ 2•+ • • • • •	73.3 2.6 2-4
SPIRAEA DOUGLASII	[3.+[3.1]3.1]3.1[4.1] . [. [2.1]4.1] . [. [2.1]3.1]3.1[.] . [.] . [
21 MENZIESIA FERRUGINEA	- + • + • 3 • 1 2 • + • 3 • + 4 • + 3 • 1 3 • + • • • • • 5 • 1 4 • + • • • •	
	$[2 \cdot 1] \cdot 1 \cdot + [\cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot$	
	[3.+[3.+[3.+[4.+[2.1] .] .] .] .] .] .] . [.] . [.] .]	
SALIX SITCHENSIS ACER CIRCINATUM	[2.1]4.1]4.1]5.1[3.1]+.+ 	
PRUNUS EMARGINATA	15.6	40.0 2.9 +-5
		33.3 1.0 1-4
23 RUBUS LEUCODERMIS	- 2. + 2. + 2. + 2. 1 	
BETULA PAPYRIFERA	12.+12.+1 . 1 . 1 . 12.+1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 1	20 0 1 0 2-2
RHAMNUS PURSHIANA	- + + + - - - + + + 2 + + - - - - - - - - -	20.0 1.0 2-2
24 RIBES SANGUINEUM		13.3 +.9 1-3
		13.3 +.0 +-+
PSEUDOTSUGA MENZIESII (ART.)		13.3 +.0 +-+
26 BERBERIS AQUIFOLIUM	. 12-+1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	6.7 +.0 2-2

PLOT NUMBER	003 009 018 019 022 032 039 035 036 033 034 037 038 045 049	
ST ND. SPECIES	SPECIES SIGNIFICANCE AND SOCIABILITY	P MS RS
27 RUBUS LACINIATUS	1.	
28 TAXUS BREVIFOLIA	1 . + . + 	6.7 +.0 +-+
29 BLECHNUM SPICANT	13:+ 3.+ 3.+ 3.1 3.+ 4.+ 4.1 4.1 3.1 4.1 3.1 2.1 2.+ 4.1 6.4 	
TSUGA HETEROPHYLLA	3.+ 3.1 3.1 3.1 3.+ 3.+ 3.+ 3.+ 2.+ 2.+ 2.+ 2.+ 3.+ 3.+ 2.+ 	10,0.0 3.2 2-3
30 PTERIDIUM AQUILINUM	18.7 5.6 4.+ 4.+ 5.5 2.+ 6.5 4.1 4.1 2.+ 2.+ 1.+ . 2.+ 2.1 	
31 POLYSTICHUM MUNITUM	[3.+ 2.+ 2.+ 2.+ 2.+ 2.+ 4.+ 3.+ 2.+ 3.1 4.1 3.1 2.+ . 3.1 	
32 DRYOPTERIS AUSTRIACA	2.+ 2.+ 2.+ 2.+ 2.+ 3.+ 4.+ 2.1 3.1 3.+ 2.1 2.1 2.+ . 2.1 	
THUJA PLICATA	3.+ 3.+ 1.+ 2.+ 2.1 2.+ . 2.+ 1.+ . 1.+ +.+ 2.+ 2.+ 1.+ 	
33 RUBUS URSINUS	3.4 4.4 3.+ 2.+ 3.1 5.4 4.1 3.1 5.4 . 2.+ . . 2.1 3.1 	80.0 3.9 2-5
34 EPILOBIUM AUGUSTIFOLIUM	[2.1]4.5]4.+ . 2.+ 2.+ 2.+ 3.1 3.1 . 1.+ . . 2.+ 2.1 	73.3 2.9 1-4
35 ATHYRIUM FILIX-FEMINA	1.+ 2.+ 2.+ 2.+ 1.+ 1.+ 1.+ 	
36 LUZULA PARVIFLOKA		
37 ANAPHALIS MARGARITACEA	12.1 3.4 3.+ . 3.3 . . 2.+ 	40.0 2.1 2-3
38 TIARELLA TRIFOLIATA		33.3 2.2 2-4
39 LYCOPODIUM CLAVATUM	1 . . 1.1 . 3.3 3.1 . 3.3 3.1 	33.3 1.9 1-3
PSEUDOTSUGA MENZIESII (NAT.)		33.3 +.8 -+-2
40 TRILLIUM OVATUM	+ · +	26.7 +.0 +-+
41 LINNAEA BOREALIS	1 . 15.615.413.31 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 .	20.0 3.1 3-5
42 TRISETUM CERNUUM	1 1.+ 3.1 	20.0 1.0 1-3
43 CAREX DEWEYANA	2.2 2.1 2.1	20.0 1.0 2-2
44 CORNUS CANADENSIS 3.3 . 3.1 	13.3 1.2 3-3
45 GALIUM TRIFLORUM		
46 LACTUCA BIENNIS		13.3 +.0 1-1
47 POA PRATENSIS		6.7 +.6 3-3
48 VIOLA SEMPERVIRENS	13.31 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 .	6.7 +.6 3-3
49 CALAMAGROSTIS CANADENSIS	1 . 2-3 	6.7 +.0 2-2
50 CAREX INTERIOR	1.12.21.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1	6.7 +.0 2-2
51 HYPERICUM PERFORATUM		
52 POA PALUSTRIS		6.7 +.0 2-2
53 TRIENTALIS LATIFOLIA		6.7 +.0 2-2
54 DICENTRA FURMOSA		
55 GYMNOCARPIUM DRYDPTERIS		6.7 +.0 1-1
56 EQUISETUM ARVENSE	14.41 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 .	6.7 +.0 +-+
DH		•
57 RHYTIDIADELPHUS LOREUS	[3.3]2.2]2.2]2.3]2.3]3.2]3.2]2.2]2.2]2.2]	100.0 3.2 2-4
58 HYLOCOMIUM SPLENDENS	13.3 5.5 5.4 3.3 • 4.3 4.4 4.4 5.4 6.4 3.3 3.2 3.2 5.4 5.3 • • •	93.3 5.0 3-6
59 PLAGIOTHECIUM UNDULATUM	[2.2] . [. [.] . [.] . [1.1] . [. [2.2] 1.1[2.2] . [3.3[3.2] . [.] .] . [.]	46.7 1.8 1-3
60 EURHYNCHIUM DREGANUM		40.0 1.2 1-2
61 EURHYNCHIUM PRAELONGUM		6.7 +.0 2-2
62 ISOPTERYGIUM ELEGANS		
63 ISOTHECIUM STOLONIFERUM		
DM		
64 POLYTRICHUM JUNIPERINUM	12-215-315-513-314-413-412-213-41 - 12-312-212-21 - 15-314-31 - 1 - 1 - 1 - 1	86.7 4.1 2-5
		60.0 3.1 2-5
	1 • 1 • • 12•214•412•31 • 12•213•312•212•21 • 1 • 1 • 12•21 • 1 • 1 • 1 •	
67 POHLIA NUTANS	• • • 3.3 1.1 • • • • • • • • 2.2 • • • • •	
. OF FOILER HOTAITS	1. 4 1 4 1 4 1 5 5 5 1 7 6 7 1 4 1 4 1 4 1 6 1 6 1 6 1 6 1 6 1 6 1 6	20.0 1.1 1-3

PLOT NUMBER

ST ND.

DW

	1			
		ρ	MS	RS
•	!	13.3	_	
•		6.7	+.6 +.0 +.0	2-2
•	i	6.7	+.0	1-1
•	1		+.0 +.0	
	-			

LOT	NUMBER	1003100910181019102210321039103510361033103410371038104510491	1 .	
T N	D. SPECIES	SPECIES SIGNIFICANCE AND SOCIABILITY	P	MS RS
6 7 7 7	8 DICRANELLA HETERONALLA 9 POLYTRICHUM COMMUNE 0 CERATODON PURPUREUS EURHYNCHIUM PRAELONGUM 1 AULACOMNIUM ANDROGYNUM 2 DITRICHUM HETERUMALLUM 1 ISOTHECIUM STOLONIFERUM 3 POGONATUM URNIGERUM	. . 1.1 1.1 	6. 6. 6. 6.	.3 +.0 1- .7 +.6 3- .7 +.0 2- .7 +.0 1- .7 +.0 1- .7 +.0 1- .7 +.0 1-
7	PLAGIOTHECIUM UNDULATUM HYLOCOMIUM SPLENDENS RHYTIDIADELPHUS LOREUS EURHYNCHIUM OREGANUM 4 RHIZOMNIUM GLABRESCENS 5 PLAGIOMNIUM INSIGNE 6 RHYTIDIADELPHUS TRIQUETRUS	1.1 3.3 2.2 2.2 3.3 2.2 2.2 1.2 2.2 2.2 2.1 2.2 1.2 1.1	73	.3 2.3 1- .3 2.1 1- .3 1.8 1- .0 1.3 1- .3 +.5 2- .7 +.0 1- .7 +.0 1-
7	7 RHACOMITRIUM CANESCENS		I 4	7 + 0 1-

PLOT NUMBER 10051030103110011006102310071008102710281002102410251026100410291 SPECIES SIGNIFICANCE AND SOCIABILITY 1 ALNUS RUBRA 2 PSEUDOTSUGA MENZIESII (ART.) : 3 SALIX SITCHENSIS 4 SALIX SCOULERIANA 5 PRUNUS EMARGINATA .6 POPULUS TRICHOCARPA ALNUS RUBRA 15-1|6-1|6-1|6-1|3-1|5-+|4-1|3-+|4-1|+-+|3-1|6-1|6-1|4-1|4-1|+-+| - | - | - | 100-0 5-2 +-6 SALIX SITCHENSIS 1 . 1 . 1+.+13.115.512.116.112.+1 . 1 . 16.613.114.114.116.115.11 . 1 . 1 . 1 . 75.0 4.8 +-6 PSEUDOTSUGA MENZIESII (ART.) 1 . 1 . 1 + . + | 8 . + | 7 . + | 6 . + | 7 . + | . | . | . | . | 7 . + | 7 . + | 5 . + | 9 . + | 5 . + | 6 . + | . | . | . | . | 68 . 8 6 . 0 + - 9 POPULUS TRICHOCARPA 1 . | . | 2.+| . | 3.+| 4.+| 4.+| 2.+| . | +.+| 2.+| . | . | 2.1| 4.+| +.+| . | . | . | 62.5 2.8 +-4 7 TSUGA HETEROPHYLLA $| \cdot | \cdot | \cdot | 3.1 | \cdot | 3.1 | \cdot | 2.1 | \cdot | \cdot | \cdot | 1.1 | \cdot | 3.1 | \cdot | 2.4 | + 1.1 | \cdot | \cdot | \cdot | 43.8 | 1.8 | + 3.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1.1 | \cdot | 1$ PRUNUS EMARGINATA 1 - 1 - 1 - 1 - 1 - 11. | 3. + | 3. + | +. + | - | - | - | | - | | - | | - | | - | | - | | - | | 43.8 | 1.6 | +-3 8 PSEUDOTSUGA MENZIESII (NAT.) 9 ACER CIRCINATUM SALIX SCOULERIANA 10 BETULA PAPYRIFERA : 11 RUBUS SPECTABILIS 12 RHAMNUS PURSHIANA 13 RUBUS PARVIFLORUS 14 CORNUS NUTTALLII 15 PICEA SITCHENSIS 16 SAMBUCUS RACEMOSA 17 RUBUS DISCOLOR B2 . RUBUS SPECTABILIS 13.115.314.414.613.114.114.515.114.114.115.614.315.517.514.613.41 . 1 . 1 . 1100.0 5.0 3-7 18 SPIRAEA DOUGLASII 13.1|3.3|3.3|1.+|3.1|3.1|3.1|3.1|3.1|2.1|2.+|3.+|3.1|5.4|3.1|2.1| . | . | . | 100.0 3.5 1-5 RUBUS PARVIFLORUS · [4.1]4.1[5.4]1.1[4.1]3.1[3.1[4.1]3.1[3.1[3.1[3.1[4.1] . [3.1]4.1] . [.] .] .] 93.8 4.0 1-5 TSUGA HETEROPHYLLA 1 . 13.+12.114.111.+13.+12.+13.113.112.+11.+13.+12.+13.11+.+1+.+1 . 1 . 1 . 1 93.8 3.0 +-4 SALIX SITCHENSIS 14.4|4.1|3.1|4.1|6.6|3.1|2.+|2.+|1.+|2.1|3.4|4.1| . |2.+| . | . | . | . | . | . | 81.3 3.9 1-6 ACER CIRCINATUM . 13.3|1.1|3.4|1.+|3.3| . |4.5|5.6|3.1|4.3|2.1|6.6| . | . |1.+| . | . | . | . | . | . 75.0 3.9.1-6 · 19 GAULTHERIA SHALLON 1 . | . | . | 3.5|1.1|3.1|3.3|3.3|4.1|4.3|2.3|6.6|4.4|1.1| . | 1.1| . | . | . | 75.0 3.7 1-6 PRUNUS EMARGINATA 13.+13.112.+12.+13.112.+12.+15.+12.+13.+12.+13.+1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 1 . 75.0 3.1 2-5 POPULUS TRICHOCARPA 20 RIBES SANGUINEUM -13.+13.+12.111.+13.+1 . 1 . 14.114.113.111.+11.+13.11 . 1 . 1 . 1 . 1 . 1 . 1 . 68.8 3.0 1-4 21 RUBUS LEUCODERMIS |3.1|2.1|3.3| . |2.1|2.1|2.1|3.1|2.1|3.1| . |2.1|2.1| . | . | . | . | . | . | . | 68.8 2.4 2-3 22 THUJA PLICATA 1 • [+++] • [1.+]2.+]+.+[1.+]2.+|2.1] • [• [+.+]1.+|3.1|2.+| • [• 1 • 1 • 1 • 1 68.8 1.6 +-3 BETULA PAPYRIFERA SAMBUCUS RACEMOSA 12.+14.112.11 . 12.+1 . 12.+13.11 . 12.+1 . 1 . 12.+11.+1 . 13.11 . 1 . 1 . 1 62.5 2.4 1-4 23 VACCINIUM PARVIFOLIUM 11.+1 . | . | 1.+|1.+|2.+|4.+|3.+|2.1| . |3.+|3.+| . | . |1.+| . | . | . | . | . | 62.5 2.4 1-4 PSEUDOTSUGA MENZIESII (NAT.) 12.+1 . | 1.+|3.+|2.+|3.+| . | . | . | . | . | 3.+|3.+|3.+|+.+| . | . | . | . | . | . | . | 56.3 2.2 +-3 ALNUS RUBRA 24 RUBUS LACINIATUS 1 . | 1.+| . | . | 2.+| 1.+| 2.+| 2.+| . | 2.1| . | +.+| 1.+| . | . | . | . | . | . | . | . | 50.0 1.3 +-2 PSEUDOTSUGA MENZIESII (ART.) SALIX SCOULERIANA 25 SALIX LASIANDRA

10051030103110011006102310071008102710281002102410251026100410291 | | | SPECIES SIGNIFICANCE AND SOCIABILITY 26 ACER MACROPHYLLUM RHAMNUS PURSHIANA CORNUS NUTTALLII 27 OPLOPANAX HORRIDUM 28 LONICERA INVOLUCRATA 29 PYRUS FUSCA 30 MENZIESIA FERRUGINEA: 31 ACTAEA RUBRA 32 ROSA GYMNOCARPA 1. [+.+] . [.] . [.] . [.] . [.] . [.] . [.] . [.] . [.] . [.] . 6.3 +.0 +-+ 33 HOLODISCUS DISCULOR 34 POPULUS TREMULDIDES |3.1|3.+|3.1|4.+|3.+|2.+|4.+|4.+|5.4|2.+|3.+|3.+|5.+|3.+|4.+| . | . | . | . | 100.0 4.2 2-5 35 POLYSTICHUM MUNITUM |3.1|2.+|2.+|1.+|1.+|2.+|2.1|2.+|3.1|3.+|3.1|4.1|3.1|1.+|1.+|36 EPILOBIUM AUGUSTIFOLIUM 37 ANAPHALIS MARGARITACEA |3.1|2.+|2.+|3.+|2.+|2.+|1.+|3.+|2.1|2.+|2.1| . | . |3.1|2.+|+.+| . | . | . | 87.5 2.5 +-3 TSUGA HETEROPHYLLA 12.1|3.1|3.1|6.6|4.5|8.6|5.5|6.6|8.6|6.5|2.1|5.4|9.7| . | . | . | . | . | . | . | 81.3 5.8 2-9 38 PTERIDIUM AQUILINUM 12.+|2.+|2.+| . |3.+|2.+|6.1|2.+|1.+| . |2.+|3.1| . |4.+|2.+|2.+| . | . | . | 81.3 3.4 1-6 W 39 BLECHNUM SPICANT . |3.+|3.+|2.+| . |3.+|2.1|3.+|2.2|2.+|2.+| . |1.1| . |4.1|1.+|2.+| . | . | . | . | 81.3 2.8 1-4 40 LUZULA PARVIFLORA |2.+|3.1|2.1|3.1|2.+|2.+| . |3.+|3.1|3.1|1.+|1.+| . | . |2.+|1.+| . | . | . | 81.3 2.5 1-3 41 LACTUCA BIENNIS 42 DRYOPTERIS AUSTRIACA | . |2.+|2.+|2.+|2.+|2.+|2.+|2.+|3.+|3.+|2.+| . |1.+|1.+|2.+|1.+| . | . | . | . | . | 81.3 2.2 1-3 THUJA PLICATA -|2.+|2.1|2.+|1.+|1.+|1.+|2.+|. | . |2.+|1.+|1.+| . |2.+|1.+|2.+| . | . | . | 81.3 | 1.8 | 1-2 43 ATHYRIUM FILIX-FEMINA. 1 - 1 - 1 - 15-5 | 2-1 | 3-1 | 5-6 | 5-1 | 5-5 | 5-4 | 3-4 | 5-1 | 4-4 | 2-1 | - 1 - 1 - 1 - 1 - 1 - 1 - 75-0 4-5 1-5 44 RUBUS URSINUS |7.7|4.2|5.4|, |3.3|3.3|, |3.3|2.1|, |1.+|, |3.1|2.+|, |1.+|, |. |, |, | 68.8 4.0 1-7 45 GALIUM TRIFLORUM 46 HOLCUS LANATUS 1 . |3.1|3.1|2.+|2.1|2.+| . |3.3|3.1|4.1| . |2.+|2.1| . | . |1.+| . | . | . | 68.8 2.7 1-4 47 TRIENTALIS LATIFULIA . |3.2| . |3.1|1.1|2.1|4.3|3.3|2.+| . | . |1.1|2.+| . |1.+|2.1| . | . | . | . | . | 68.8 2.5 1-4 48 TIARELLA TRIFOLIATA 49 HYPOCHAERIS RADICATA 12.+|2.+| . | 2.+| . | 2.+|2.1|1.1|1.+| . | . | . | 1.+| . | . | . | . | . | . 56.3 1.5 1-2 50 EPILOBIUM WATSONII 1 . |3.3| . |1.1| . |2.2| . |2.2|3.1|2.2|2.1| . | . |2.2| . | . | . | . | . | . | 50.0 1.9 1-3 51 VIDLA SEMPERVIRENS PSEUDOTSUGA MENZIESII (NAT.) 52 CIRSIUM ARVENSE 1 . |3.4| . | . |2.1|1.+| . | . |1.1|1.+|3.3|1.1| . | . | . | . | . | . | . | 43.8 1.5 1-3 53 SOLIDAGO CANADENSIS 54 JUNCUS EFFUSUS [3.5]4.1[2.+] .] .] . [. [2.+[2.1] .] . [2.1] .] . [.] . [.] . [.] . [.] . 37.5 2.0 2-4 55 AGROSTIS SCABRA 15.5| . |7.6|1.+| . |2.1| . | . | . | . | . | . | . | . | 1.+| . | . | . | . | 31.3 3.5 1-7 56 EQUISETUM ARVENSE 57 CIRSIUM VULGARE 58 FESTUCA OCCIDENTALIS 59 LINNAEA BOREALIS 60 CIRCAEA ALPINA 61 GALIUM TRIFIDIUM . 62 SCIRPUS MICROCARPUS 63 DICENTRA FORMOSA 64 CAREX ROSSII 65 CORNUS CANADENSIS 66 CALAMAGROSTIS CANADENSIS 67 TRISETUM CERNUUM 6B CAREX DEWEYANA ...

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PLOT I	NUMBER	[005]030]031]001]006]023]007]008]027]028]002]024]025]026]004]029]	1 1	1 1	·	
ST NO	. SPECIES	SPECIES SIGNIFICANCE AND SOCIABILITY			ρ	MS RS
115 116 117	OLIGOTRICHUM ALIGERUM PLAGIOMNIUM INSIGNE POLYTRICHUM COMMUNE DICRANELLA HETEROMALLA LEPTOBRYUM PYRIFORME LEUCOLEPIS MENZIESII POHLIA NUTANS				6.3 6.3 6.3 6.3	+.0 2- +.0 2- +.0 2- +.0 1- +.0 1- +.0 1-
DW 119	HYLOCOMIUM SPLENDENS PLAGIOTHECIUM UNDULATUM EURHYNCHIUM OREGANUM RHYTIDIADELPHUS LGREUS 2.2 3.3 3.2 2.2 . . 3.3 	1 . 1		25.0 6.3	1.7 2- +.3 1- +.0 2- +.0 2-

EXECUTION TERMINATED

\$SIGNOFF

PART III. Tree and Stand Description

PLOT NO.: 1						NO. 0	F TRE	ES/AC	RE/HE!	IGHT	CLASS									
ISPECIES	1 0 1	1	2	3	4 1	5	6 1	7	8	9	10	11 !	12	13	14	15	16	17	18	19
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PAPER BIRCH	i i	i	- 1	i	i	1	1	1	1	l l	- 1	1	- 1	1	i				١	1
VINE MAPLE	501	401	ĺ	1	201	!	- 1	101	. 1	- 1 F	1	- 1	1	1	1	1				1
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RED ALDER	301	501	901	401	701	601	201	201	301	10	l	- 1	- 1	- 1	- 1	1	1			1
WILLOW SPP.	$-1 \rightarrow 1$	20	160	2901	160	290	1001	901	201	10	10	- 1	- 1	1	t	i				1
BIG-LEAF PAPLE	· 1 1	. 1	- 1	1	- 1	1	- 1	1	·	ŀ	1	1	1	1	- 1	1			l	ļ
PACIFIC DOGWOOD	1 1	- 1	ı	i	- 1	1.1	- 1	1	l	- 1	- 1		1	1	1	1	1		1	ļ
PLANTED DOUGLAS-FIR	` 1 1	- 1	1	1	101	10	401	701	501	401	401	2C	130	30	80	50	20	10	50	<u> </u>
LODGEPOLE PINE	1 - 1	- 1	ı	ŀ	-4	1		ı	1	1	- 1	1	1	i	1	l			}	!
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IRED ALDER	- 1	- 1	I	1	- 1	- 1	1	- 1	1	101	· 1	301	1	101	301	30	201	101	1	!	
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IVINE MAPLE	1 1	401	120	70	801	301	201	101	401	101	101	1	. 1		1	- 1				1	- 1	ı
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PLOT NO.: 9

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IWESTERN HEMLOCK	4301	2801	180	1101	1701	1901	401	501	401	201	301	501	30	201	201	301	101	401	201	
IWESTERN REDCEDAR	801	401	201	- 1	1	i	101	301	301	101	i	i	201	1	101		i	i	i	. i
INATURAL DOUGLAS-FIR	401	201	301	10	30	- 1 i	101	i	i	i	i	i	10	i	i	i	i	i	i	i
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IWESTERN REDCEDAR	1 37	101	1601	1001	110	301	201	30	301	101	- 1	201	i	- 1	1	- 1	101	- 1	1	. 1	
INATURAL DOUGLAS-FIR	1 3	30 j	501	501	601	5C]	. 1	10	10	201	- 1	101	. 1	1	1		1	- 1	- 1	1	
IPAPER BIRCH	1	1	. 1	. 1	10	10	101	1	101	i	- 1	1	. 1	1	1	1	1	- 1	1	1	
IVINE MAPLE	1.	- 1	i	į	ĺ	1	1	1	- 1	1	1	i	- 1	100	1	- 1	. 1	. 1	1	ı	
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PLOT NO.: 13	•			•	- 1	NO. DI	TRE	ES/AC	RE/HE	IGHT	CLASS									
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WESTERN REDCEDAR	430	130	30	101	101	401	20	50	501	201	101	201	10	101		1	!			1
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PLOT NO.: 14		•	 	NO.	0F	TREES/ACRE/HEIGHT CLASS

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IWESTERN H	EMLOCK		78	01	4101	5101	360	2601	1601	3101	701	501	201	301	501	701	201	201		1	1	- 1		ľ
IWESTERN R	EDCEDAR		27	01	401	1	1	10	1	- 1	- 1	- 1	ļ	l	1	1	l.	· 1		1	1 -	` 1		ł
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IBITTER CH	ERRY	-1	1		- 1	i	- 1	i -	- 1	- 1	- 1	1	1	· 1	1	- 1	- 1	.1		1	-1	1		1
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PLOT NO.: 15 NO. OF TREES/ACRE/HEIGHT CLASS

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IPAPER BIRCH	1	- 1	1	301	101	201	1	401	. 1	- 1	- 1	1	10	· 1	101	- 1	1	101	- 1	1	
IVINE MAPLE	i	i	101	20	ı	201	10	201	1	1	- 1	- 1	1	1	- 1	1	- 1	1	- 1	!	
ICASCARA	i i	20 İ	101	301	30	. 1	201	201	1	10	1	101	101	101	101	1	- 1	l l	- 1	1	
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IRED ALDER	İ	Ì	Ì	i	1	ĺ	. 1	ĺ	1	. 1	- 1	- 1	1	- 1	- 1	į	- 1	- 1	· 1	1	
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WESTERN REDCEDAR INATURAL DOUGLAS-FIR IPAPER BIRCH IVINE MAPLE ICASCARA IBITTER CHERRY IBLACK COTTONWOOD IBLACK COTTONWOOD INITION SPP.	SPECIES :	. [20	1	21	22	1	23	1	24	1	25	26	5	27	1	28	29	-1	30	31	i	32	1 33	1	34	1 3	35	1	36	37	1	38	1 39	_ [1	TOTAL
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PLOT NO.: 16	,			٠.	, ' jø	NO. 0	F TRE	ES/AC	RE/HE	I GHT	CLASS									
ISPECIES	1 0	1 1 1	2	3	4 1	5 I	6 I	7	8 j	9	10	11	12	13	14	15	16 I	17	18	19
WESTERN HEMLOCK	1 440	160	2801	2401	1601	-		801		120	120	. !	120	80	40	401	!	401	80!	80
IWESTERN REDCEDAR	1 400	160	401	401	- 1	801	801	401	801	120	.]	ļ	- !	1	. !	401	· . !	1	!	
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IWESTERN HI	EMLOCK	 1		1	801		1	1		į		1		ļ	إ		1		!	1		!		!	ļ	ļ		1	. [!	1		1 25601
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-PLOT	NC.:	28
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NO. OF TREES/ACRE/HEIGHT CLASS

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BITTER CHERRY	160	560	520	401	1		1 1	- 1	1		i .	ì	1	- 1	- 1		1	1	1		1	t
IBLACK COTTONWOOD	640	1960	2160	4401	801	40	1 1	. 1			1	1 .	1	- 1	!		1	1	- 1.	*	1	1
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PLOT NO.: 31									ES/AC												
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BLACK COTTONWOOD	- 1	- 1	80	520	480	240	80			- 1			!		!]	j .	1		- !	}
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WILLOW SPP.	- 1	160	840	1640	1840	1560	72C	480	120			40			!	ļ	!	!	1	1 .	1
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INO. OF TREES/HT. CLAS												 I	1			1				1			`}	i	i .	ı		ı		1 .	1	ł	1336

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VEGETATION-ENVIRONMENT TABLE - PART III - STAND AND TREE DESCRIPTION COASTAL WESTERN HEMLOCK ZONE - DRY SUBZONE - U.B.C.R.F. FOREST ASSOCIATION: MOSS - WESTERN HEMLOCK

LOT NO.: 32		·				NO. 0	F TRE	ES/AC	RE/HE	GHT	CLASS									
SPECIES	1. 0 1	1 1	2	3	4 1	5	6 1	7	8 1	9	10 l	11 !	12	13	1 14	1, 15	1 16 1	17	18	1 19
WESTERN HEMLOCK	120401	16801	12801	9201	5201	2801	2401	120	801	401	801	1	801		1	40	1 401	1	80	Į.
WESTERN REDCEDAR	360		1201	1	ĺ	1	ĺ	- 1	1	1	1	ł	- 1		ı	, 1	1 1	1	1	1
NATURAL DOUGLAS-FIR	أحا		1	i	ĺ	i	1	- 1	- 1	1	. 1	1	- 1		1	ı	1 !		Į.	!
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PACIFIC DOGROOD	1 1	F	i	i	l	· 1	- 1	1		ļ	ļ	ļ	. !		!	i i	!!		!	1
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PLANTED DOUGLAS-FIR	i		i	i	- 1	i		i	i		i	-		i	i		i	- i		i		i	i	· i	·i		i	í
LODGEPOLE PINE	i		i	·i	. i	i	•	i	i		i	i		i	. i		i	i		i		i	i	i	i	i	i	i i
PACIFIC SILVER FIR	i		j.	i	ĺ	. i		i	i		j.	i		ì	i		i	i		i		i	. i	į	j	İ	j	l
ISITKA SPRUCE	İ		İ	İ	; İ	j		İ	· į		l .	İ		l	1		ĺ	İ		1	٠.	l	1	ı	1	l	_	1
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VINE MAPLE	1		1		ı		1			-1		1	İ		1	1	l	1			ŀ		1			1		1	ŀ	. 1		1		1 !
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WILLOW SPP.	j		1		ı		1	1		1		1	ı		ł	1	i	- 1	- 1		- 1		-			1	40	1	- !	- 1	40	) [		120
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PLOT NO.: 34	•					ı	NO. 0	F TRE	ES/AC	RE/HE	I GHT	CLASS						· · ·			
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IPAPER BIRCH	Ĺ	1	ı i	1	1		- 1	1	- 1	- 1		1 1		1 801		l	1 80	1 40	1	1 40	l · ·
IVINE MAPLE	- 1		1	1	- 1	· · · 1	401	1601	801	401		401		1 801		1	1	1	1	1	1
ICASCARA	Ì		1	1	- 1	1	١ ١	- 1	1	- 1	٠.	401		401		l	1	1	1	1	1
BITTER CHERKY	- 1		i 1	!	1 1	1		1	. 1	- 1	•	1, 1		1'-1		1 .	1	1	ı	1 :	1
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BIG-LEAF MAPLE	- 1	!	1	- 1	1	- 1	i	- 1	- 1	- 1		1 1		1 1		1	j	1	1	1	1
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ISITKA SPRUCE	1		1	1	1	1	1	1	- 1	- 1		1 1		1 1		1	1.	1	1	i	l
INO. OF TREES/HT. CLA		360	2401	1201	801	801	801	2801	1601	401		2001		1 4001	40		1 320	1 40		1 280	1 40

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IWESTERN HEMLOCK	ا		!						ا		 	 	1	1	 	1	1	 			1 8401
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BIG-LEAF MAPLE				<u>'</u>			1				<b>.</b> .	1	1	1	1 .	1 .		1	1.	i	1 1
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LODGEPOLE PINE	200			i	701		1 2 0				i	i 75	i 00	ï	i	i	i	i	i	i	i
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IND. OF TREES/HT. CLASS	.240	80	80	801	401	80	1. 120	801	801		1 80	1 40	1 80	1	1	1	 	1	1	1	1 38401

PLOT NO.: 35	٠.						NO. 0	FITRE	ES/AC	RE/HE	IGHT	CLASS									
SPECIES	l [.]	0	1 1	2 1	3 I	,4 1	5	6 1	7	. 8 1	9	10	11	12	13	. 14	15	16	17	18	19
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IWESTERN HEMLOCK IWESTERN REDCEDAR INATURAL DOUGLAS-FIR IPAPER BIRCH IVINE MAPLE ICASCARA IBITTER CHERRY IBLACK COTTONHOOD IRED ALDER	1 401	40		1   401   1   1   1   1   1   1   1   1   1	401	40	40	1	         		  -  - 	 					 ! ! ! ! !	                 	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	6920    1520    40    80    1480    120    200
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#### NC. OF TREES/ACRE/HEIGHT CLASS **ISPECIES** | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | ITCTALI WESTERN HEMLOCK IWESTERN REDCEDAR INATURAL DOUGLAS-FIR IPAPER BIRCH 720 VINE MAPLE CASCARA . 3201 IBITTER CHERRY IBLACK COTTONWOOD IRED ALDER |WILLOW SPP. IBIG-LEAF MAPLE IPACIFIC DOGWOOD IPLANTED DOUGLAS-FIR ILODGEPOLE PINE IPACIFIC SILVER FIR ISITKA SPRUCE INO. OF TREES/HT. CLASSI

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PLOT NO.: 42					•	NO. 0	F TRE	ES/AC	RE/HE	IGHT	CLASS						·					· 	
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INO. OF TREES/HT. CLASS	 I		 1		1		 !		: !	1		<del></del>		- <i></i> -			· I		·							1		1			1		1	1	4920

PLOT	NO.:	43		
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WILLOW SPP.	i	Ì.	401	ĺ	i	40	·i	i	. i	401	i		i i		1	İ	İ	i	İ	1
BIG-LEAF MAPLE	i	i i	i	i	i	i	i	· i	i	ì	i		i i	i	ì	i	İ	i	i	1
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NO. OF TREES/HT. CLASS	1 400	1 200		1401			2001	401	801	401	401		120							

NC DE	TDEEC	/ACRE/HETCHT	CIACC

ISPECIES	1	20	1	21	. 1	- 2	2	23	1	24	1	25	1	26	1 2	7	28	3	29	1	30	3	1	32	1 3	3	34	1 3	5	36	1	37	l 38	1 39	1	TGTAL
IWESTERN HEMLOCK	1				1		1		1		1		 		 					1		: 	 I					 I	 I		1		- <b>-</b>		1	360
IWESTERN REDCEDAR	Ĺ		1		- 1		- 1		Ĺ		٠Ĺ		Ĺ		ĺ	.	·	j		Ì		ĺ	Ĺ		1	ı		ĺ	ĺ		1		1	1	- 1	
NATURAL DOUGLAS-FIR	1		- 1		- 1		1		-		1		1		1 1			1		1		ĺ	1		1	- í		Ι.	- 1		1		ı	1	-	160
IPAPER BIRCH	Ĺ		- 1		Ì		- i		Ė		Ĺ		i		İ	. [		İ		İ		İ	ĺ		į.	Ì		1	i		İ		İ	Ì	Ĺ	880
IVINE MAPLE	Ĺ		Ĺ		Ĺ		Ì		Ť		Ĺ		ĺ		ĺ			ĺ		ì		ĺ.	. Í		ĺ	1		ĺ	ĺ		į.		1 -	İ	1	80
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IBITTER CHERRY	1		- 1	•	- 1		- 1		1		1		1		l		, ·	- 1		1		1 :	- 1		1	- 1		ŀ	- 1		1		!	1.	- 1	
IBLACK COTTONWOOD	1		- 1		- 1		- 1		- 1	٠.	1		1		1			- 1		1		1	- 1		1	- 1		1	i		1		l .	1	1	80
RED ALDER	1		- 1		1		- 1		- 1		1		1		1	i	}	1		-1		١.	- 1		1	- 1		1	- 1		j		1 .	1	- 1	•
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IBIG-LEAF MAPLE	1		- 1	•	- 1	٠	- 1		- 1		1		1		ı	- 1		- 1		1		ĺ	- 1		1	ı		1	- 1		1		1	1	- 1	-
IPACIFIC DOGWOOD	1		1		- 1		- 1		- 1		1		1		ı		1	- 1		1		1	- 1		1	- 1		1	- 1		1		1 .	1 .	- 1	
IPLANTED DOUGLAS-FIR	1		- 1		- 1		`		- 1		1	•	1		1		1	- 1		-1		ł	- 1		1	1		1	1		1		1 .	- 1	.	840
ILODGEPOLE PINE	1		- 1		1	•	- 1		- 1		1		1		١.		Ι.	- 1		1		1	1		1	- 1		1	1		1		i i	1	- 1	40
PACIFIC SILVER FIR	t		- 1		_1		- 1		- 1		1		1		ı		)	- 1		1		1	1		1	- 1		1	- 1		1		1	1 .	1	
ISITKA SPRUCE	ı		İ		1		1		1		1		1		١.		1	ŀ		İ		1	.		İ	İ		l	1		1	-	I	1	Ì	
INO. OF TREES/HT. CLASS	1		 I		1		1		1		1		 I		 I			1							1	 1		 I	 I		1		- <b></b> 	 	1	2560

ISITKA SPRUCE - I

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|NO. OF TREES/HT. CLASS| 160| 200| 80| 120| | | 240| 80| 120| 80| 80| | | | | | | |

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ISPECIES	1	20	1	21.	1	22	4	23	ı	24	1	25	j 2	6	27	1	28	2	9	30	1	31	32	1	33	1 3	4	1 35	5 {	3.6	1	37	1 3	8	39	1	TOTAL
WESTERN HEMLOCK	 I		1		1		7		1		1		1 1	 I		1		1	.		1	!	- <b></b> -	1		1		 	۱		1	·	 I		 	<b>-</b>	2801
IWESTERN REDCEDAR	1		1		1		1		1		1		1	1		- 1		1	٠ ا			1	1	- 1		1	:	1		١.	1		1.		١	- 1	
INATURAL DOUGLAS-FIR	i		l		1		1		1		1		i i	- 1		- 1	٠.	1	٠ ١		-	. [		- 1		1	•	1	-		1		1	. 1		Ĺ	80
PAPER BIRCH	1		1.	٠.	1		1		1		1		1	1		1		1	. 1		-	.		- 1		i		1	- 1		1		1		•	1	120
IVINE MAPLE	1		ı		1		. 1		1		1		1	١		- 1	•	1	Į		-1	l		1		1		1	1		Ĺ		1		l	ı	i
I CASCARA	1		ļ		1		1		١		1		1 1	i		- 1		1	٠ ا		-		}	-1		1 -		1	1		j.		1		1	i	· i
! EITTER CHERRY	1		1		1		1		1		1		1	1		- 1		1 1	-		-	1	Ì	- İ	•	1		ĺ	İ	,	Ť	1	İ		į	i	40
IBLACK COTTONWOOD	1		1		1		1		L		1		1	i		-1		1	1		Ť	1	1	1		1		ĺ	İ		İ		İ		j	i	i
IRED ALDER	1		i		1		1		i		i		l	1		Ĺ		İ	ĺ		Ì	Ì	ĺ	ĺ		1		İ	Ì		Ĺ		i		i	i	Ì
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BIG-LEAF MAPLE	Ĺ		ĺ		Ĺ	٠.	Ĺ		İ		1		ĺ	i		- 1		1	i		Ĺ	Ì	ĺ	Ì		Ĺ		j.,	Ť		i		i		i .	- i	;-
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IPLANTED DOUGLAS-FIR	Ĺ		ĺ		Ť.		Ĺ		i		İ		i	Ì		Ì		Ĺ	i		Ĺ		i	i		Ĺ	e	ì	i		i		i		i	i	600
ILODGEPOLE PINE	Ĺ		ì		Ĺ		Ì		i		ì		Ĺ	i	,	Ĺ		İ	· i		Ì	ì	İ	i		i -		i	i		i		i		ĺ	i	
IPACIFIC SILVER FIR	İ		i		Ĺ		Ĺ		i		i	•	ĺ	ĺ		1		i	i		i	· i	ĺ	Ė		l i		i	i	i	i		i		i	i	· i
ISITKA SPRUCE	į.		İ		i		i		i		Ĭ		j	i		j		İ	i		i	į	į	i		i		İ	i		i		i.		i	i	i
INO. OF TREES/HT. CLASS	 I		ī		ī				1		1		 I	 I		1		 			1		 	 I		 I			i		1		 I		 I	 I	1160

VEGETATION-ENVIRONMENT TABLE - PART III - STAND AND TREE DESCRIPTION COASTAL WESTERN HEMLOCK ZONE - DRY SUBZONE - MISSION TREE FARM FOREST ASSOCIATION: MOSS - WESTERN HEMLOCK

PLOT NO.: 45				·	٠		NO. 0	F TRE	ES/AC	RE/HE	IGHT	CLASS				,		٠.			
SPECIES		1 0	1 1	2	3	4	5	6 1	7	8	9 1	10	11	12	13	14	15	16	17	18	19
INESTERN HEMLOCK		11320	1080	9601	6001	5601	5601	8801	3601	280	320	2001	1	160	1601		401		401		!
IWESTERN REDCEDAR		840	7201	2401	2001	120	401	ĺ	- 1	}	1	1	1				1 1	l	- 1		1
INATURAL DOUGLAS-FIR		1 160		401	401	40	i	i	ĺ	ĺ	1	ĺ	1		1	1	1 1		ŀ		1
IPAPER BIRCH		Ĺ.	401	1	i	401	1	801	1	160	801	120		120	1 1		1	ļ .	- 1	40	1
IVINE MAPLE		j	İ	i	. 1	1	. 1	- 1	- 1	- 1	- 1	1	- 4		1		<b>i</b> 1	1	- 1		i
ICASCARA		ĺ		ì	į	1	- 1	. 1		- 1	1	- 1	1		1	1	1 1	!	- 1		1.
IBITTER CHERRY		1.0	İ	ĺ	ĺ	1	1	- 1	- 1	ı	- 1	- 1	1				1 1	1	- 1		1
BLACK COTTONWOOD		1	İ	j	ĺ	1	- 1	. 1	- 1	1	- 1	- 1	1		1 .1	. 1	1 1	l 1	1		i
IRED ALDER		j	1	1	i	· 1	- ` 1	1	. 1	- 1	1	- 1	١		1		1	1	- 1		1
WILLOW SPP.	٠.	1	1 1	401	1			801	- 1	. 1	- 1	- 1	401	80		40		1	- 1		l
BIG-LEAF MAPLE		İ		1	. 1	· 1	- 1	1	1	1	- 1	- 1			1	- 1			· 1		l
[PACIFIC DOGWOOD		İ	l i	ł	1	- 1	1	- 1	1 4	1	- 1	- 1	- 1		1 1	1	1 1	1	1		l
PLANTED DOUGLAS-FIR		1	1 1		1	401	- 1	1601	801	1201	401	80	401	360	401	40	40	401	ı		1 .
LODGEPOLE PINE		1	1 1	1	- 1	1	1	- 1	1	1	. 1	1	1		1 . 1		1 1	1	ŀ		1
IPACIFIC SILVER FIR		1		401	- 1	1	- 1	1	1	ļ	1	I	- 1		1 1	. !	<b>!</b>	1	1		i
ISITKA SPRUCE	٠.	1 -	l I	- 1	1	- 1	- 1	1	1	1	ı	1		!							!
INO. OF TREES/HT. CL/	ASS	2320	20001	1320	8401	8001	6001	12001	4401	5601	4401	4001	801	720	2001	80	80	401	401	40	1

SPECIES	1	20	ŀ	21	1 2	22	23	1	24	25	<b>5</b> ]	26	1 2	7	28	1 - 2	9	30	31	1	32	3:	3	34	1 3	5	36	1	37	3	8	39	ITOTAL
INESTERN HEMLOCK	. <u></u> .		1		 	1		1		1			1	 I		1			 	1		1	1		1		•	t		1		1	1 7520
WESTERN REDCEDAR	- 1		1		١.	- 1		1		1	- 1	:	1.	1		1	- 1		1	-1	1	١.	. 1		1	į	1	1		ł		1	2160
NATURAL DOUGLAS-FIR	1		1		1.	- 1		1		1	- 1		1	1		1	- 1		1	-	. !		ļ			1		ļ		!		!	440
IPAPER BIRCH	1		i		ı	ł		1		ļ	- 1		!	ļ		!	!		!	!			1		1	. !	ļ	Į.		1		ļ	1 680
IVINE MAPLE	. Į		ļ		ļ	ļ		!		ļ	ļ		!	į		ļ	ļ		!	- !			Ų	•	Į.		!	- !		ļ		!	1
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IBITTER CHERRY	ļ		ļ		١.	·- !		!		1	- !		1	ļ		ļ	!		ļ .	!	;	ĺ	- !		!		ŀ	- !		!		1	!
BL'ACK COTTONWOOD	. !		!		1	. !	. 9	ł		!	- !		1	1		!	:		1	- !	- 1	,	-		!	1	!	1		1		!	-
IRED ALDER	- !		1			ļ	• :	.	•	1	- !		!	- !		I	-		i	ŀ	, ,				1	ľ		- 1		1		¦ `	280
WILLOW SPP.	- !		!		!	- , ;		1			1		1	- ¦		1	-		1	i					i	ľ		÷		i		1	1 200
BIG-LEAF MAPLE  PACIFIC DOGWOOD	- !		1	•	ŀ	¦		1		1	1		:			1	i		i	- 1			i		i	ľ	i	i		i			i
IPLANTED DOUGLAS-FIR	1		1		١.			i.		1 :	i		i	i		1	i		i	i	1		i i		i	i	i	i		i		i	1 1080
LODGEPOLE PINE	i		ï		i	i		i		i	i		i.	i		i	i		i	i			i		i		i	i		i		i	1
IPACIFIC SILVER FIR	i		i		i	i		i		i .	i		i	i		i	i		i .	i	٠. أ	ĺ	∵i		i		i	i		i		i	i 40
ISITKA SPRUCE	i		i		i	i		i		i	i		i	i		i	i		i	i		i	· i		i	i	İ	ij		İ		İ	ı

VEGETATION-ENVIRONMENT TABLE - PART III - STAND AND TREE DESCRIPTION COASTAL WESTERN HEMLOCK ZONE - DRY SUBZONE - MISSICN TREE FARM FOREST ASSOCIATION: SALAL-DOUGLAS-FIR

PLOT NO.: 46	a di Si		, .				NO. 10	F TRE	ES/AC	RE/HE	GHT :	CLASS	· .		,		· ·		٠.			
ISPECIES	·	1 0	1 1 1	2	3	4	5	6	7	8 !	9	10 1	11	12	13	14	1	5   1	6   1	17	18	19
IWESTERN HEMLOCK IWESTERN REDCEDA INATURAL DOUGLAS	R		2240  2   760    40	2400  40  80				360	801	401	!	40 l			     	1	     	!	1	. !	1	 
PAPER BIRCH  VINE MAPLE  CASCARA	· · · · · · · · · · · · · · · · · · ·		 	40 -   	40  	160	401	40 l	   	1	401 	}   		·   · 	1	1	1	.!	1	1	! !	
BITTER CHERRY   BLACK COTTONWOO   IRED ALDER	D	1		40		 		· .	1	1 1 1	1	. l			1	!			   		1   	,
WILLOW SPP.   BIG-LEAF MAPLE   PACIFIC DOGWOOD			! ! ! !	1	108	! !	108 [ [	40] .	    	} { 1	1	 		! ! !	1	† 	1	 	   	. 	1 1 1	
IPLANTED DOUGLAS ILODGEPOLE PINE IPACIFIC SILVER ISITKA SPRUCE			! ! ! !	120	2401	200	3601 1	280 l	40  	40	40	40		40	)   	7   					 	

INO. OF TREES/HT. CLASS|3880|3040|2720|1640|1240| 720| 720| 120| 80| 80| 80| | 40|

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SPECIES	. 1	20	<u> </u>	21	2	2	23	1	24	1 25	5 I	26	1	27	1 2	8	29	1	30	31	1	32	33	_ <u> </u>	34	35	1	36	:	37 ·	38	ı	39	!TOTAL!
IWESTERN HEMLOCK	1		  -		 1	1		1		<u>-</u>	1		1		1	1		1		l .	1			1		 I	-1		l	. 1		١		10280
WESTERN REDCEDAR	ļ	٠.	ļ	1	ĺ	1		1		! .	!		!		!	!		Ţ		ļ .	- !			ļ		ļ	!		ļ	!		!		1800
INATURAL DOUGLAS-FIR IPAPER BIRCH	!		!		ļ :	!		!		!	. Į		1		!	- ; }		1		!	- !		l	!			1		!	. [		!		1 280! 1 3601
VINE MAPLE	-		;		1	-		i	٠.	ł	·i		1			i		- 1			i		 	1		i	i		i	i	,	i.		1 3001
ICASCARA	i		į.	. '	i i	. i		i'		i .	i		i		į ·	i		i		j.	i	i	i	i		İ	i		İ	i		i		i i
BITTER CHERRY	!	•	İ		!	·		1.		!	- !		!		ļ	ļ		- !		ļ	Į.			ļ		ļ .	١		ļ.	!		!		.
PLACK COTTONWOOD	1		!		ļ	ŀ		-		!	- !		1		1	- 1		1		.	i		i i	1		1	ŀ		i			-		1 401
WILLOW SPP.	i		i	٠.	i	i		i		i	i		i		i	i		i		i	i		İ	i		i	i		i	i	•	i		200
BIG-LEAF MAPLE	i		i	- [	i	i		i		i	i		i		į.	i		i		i	i	.	i .	i		İ	i		i	j		1		j 1
PACIFIC DOGWOOD	ļ		!		1	1		!		!	. !		1		!	- !		- [		1	_!	!	!	!		ļ	!		1	!		!		1
IPLANTED DOUGLAS-FIR	i		1.		1	ļ.		!	• *	!	. !		1		1	- !		-		¦ .	٠ <u>[</u>	.	1	-		!	1		l	- 1		H		1400
PACIFIC SILVER FIR	i		i		i i	i	•	i		i .	٠		i		i	i		i			i	i	i	í		i	i		i	i		i.		i i
SITKA SPRUCE	į		İ		İ	Ė		İ	•	ŀ	İ		İ		Ì	į		İ		ĺ	İ	į	ı	1		i	İ		ŀ	١		l		1
INO. OF TREES/HT. CLAS	SSI		1		1	١		ı		l	1		1		1	1		1		1	1		I	١		I	 I		i	1		1		1143601

VEGETATION-ENVIRONMENT TABLE - PART III - STAND AND TREE DESCRIPTION COASTAL WESTERN HEMLOCK ZONE - DRY SUBZONE - MISSION TREE FARM FOREST ASSOCIATION: SALAL - DOUGLAS-FIR

PLOT NO.: 47		•				NO. 0	F TRE	ES/AC	RE/HE	IGHT	CLASS											
ISPECIES	1 0	1 1 1	2	3	4	5 i	, 6 l	7	8 1	9	10	11	12	13	14	15	1 1	5 1	17	18	19	1
IWESTERN HEMLOCK	11840	118801	1040	8001	9201	84 C I	B00	2801	4401	120	801		401	401		1	1	1		1	!	!
IWESTERN REDCEDAR	1 20	3201		801	Ĺ	401	į.	ı	- 1	- 1	1		1 1	ļ		1	1	- !		1	!	1
INATURAL DOUGLAS-FIR	- 1	80	·		1	1	1	- 1	1	- 1	· 1			!		į	ļ.	- !		1.	!	!
PAPER BIRCH	1	!!		l ' !	801		801	120	801	801	!		1 80	40		!	!	- !		!	!	į.
VINE MAPLE	- !	!!	l		280	160	!	. !	!	!	ŀ		!!!	!		!	!	- !		!	!	1
ICASCARA	!	į · ]		401	!	!	!	. !	!	!	. !		!!	!	1	!	!	- 1		!	ļ.	!
BITTER CHERRY	ļ.	!!		. !	!	. !	!	!	. !	ļ	!		! !			!	!	- !		1	1	- !
BLACK COTTONWOOD	!	!!		!!	!	!	!	!	!	1	· !		!!		!	1	1	- {		1	-	- 1
IRED ALDER	!	! !		! !	!	!	!	. !	!	!	!		i I	!		!	1	!		!	1.	-!
WILLOW SPP.	ļ.		80	. !	40	. !	!	!	. !	!	1			]	1	ļ ·	. !	- !		1	!	- !
.   BIG-LEAF MAPLE	1.	! !		. !	!	!	. !	1	- !	1	!	•	!!			!	-	:		1	1	- 1
IPACIFIC DOGWOOD	!	1 00	120	1 1 ( 0 )	1/0	- !	* 40	200	1.01	901	401		1 401	,	1	1	1	1		1	1	1
PLANTED DOUGLAS-FIR	1 .	1 80	120	160	160	1	160	200	40	801	401		40	<u></u>	ı	1 .	1	- 1		1	1 .	- 1
LODGEPOLE PINE	!	1 1			!	-	. :	1	-	-	-		1 1			;	-	- 1			1	- 1
PACIFIC SILVER FIR	į	! !		: :	!	- !	· :	- !	- 1	1	- 1		1 1				i	- :		1	1	- ;
SITKA SPRUCE		·		· •		١		ا						١							·	
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VEGETATION-ENVIRONMENT TABLE - PART III - STAND AND TREE DESCRIPTION COASTAL WESTERN HEMLOCK ZONE - DRY SUBZONE - MISSION TREE FARM FOREST ASSOCIATION: SALAL - DOUGLAS-FIR

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VEGETATION-ENVIRONMENT TABLE - PART III - STAND AND TREE DESCRIPTION.

COASTAL WESTERN HEMLOCK ZONE - DRY SUBZONE - MISSION TREE FARM
FOREST ASSOCIATION; MOSS - WESTERN HEMLOCK

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VEGETATION-ENVIRONMENT TABLE - PART III - STAND AND TREE DESCRIPTION COASTAL WESTERN HEMLOCK ZONE - DRY SUBZONE - MISSION TREE FARM FOREST ASSOCIATION: SALAL - DOUGLAS - FIR

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# APPENDIX II

Checklist of Species found in the Seral Associations

This checklist contains the species discussed in the text and vegetation synthesis tables. The nomenclature and identification of the species is according to the following manuals.

- Hitchcock, C.L., A. Cronquist, M. Owenby and J. W. Thompson. 1955-1969. Vascular plants of the Pacific Northwest. Part 5, Compositae, 343 p.; Part 4, Ericaceae to Campanulaceae, 510 p.; Part 3, Saxifragaceae to Ericaceae, 614 p.; Part 2, Salicaceae to Saxifragaceae, 579 p.; Part 1, Vascular cryptograms, Gymnosperms and Monocotyledons, 914 p.
- Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest an illustrated manual. University of Washington Press, Seattle and London. 730 p.
- Hubbard, W.A. 1969. The grasses of British Columbia. British Columbia Provincial Museum. Dept. of Recreation and Conservation, Victoria. Handbook No. 9 205 p.
- Lawton, E. 1971. Moss flora of the Pacific Northwest. The Hattori Bot. Lab., Nichinan, Miyazaki, Japan. 362 p. + 195 pl.
- Schofield, W. B. 1969. A selectively annotated checklist of British Columbia mosses. Syesis 1:156-162.
- British Columbia Provincial Museum. Dept. of Recreation and Conservation, Victoria. Handbook No. 28. 262 p.
- Szczawinski, A. F. 1970. The Heather family of British Columbia. Second edition. British Columbia Provincial Museum. Dept. of Recreation and Conservation, Victoria. Handbook No. 19. 205 p.
- Taylor, T.M.C. 1966. Vascular flora of British Columbia, a preliminary checklist. Botany Dept., Univ. of British Columbia. 31 p.
- . 1971. The ferns and fern-allies of British

  Columbia. British Columbia Provincial Museum. Dept. of
  Recreation and Conservation, Victoria. Handbook No. 12.
  172 p.

# Scientific and Common Names to the Tree Species

# Scientific Name

Abies amabilis (Dougl.) Forbes

Acer circinatum Pursh

Acer macrophyllum Pursh

Alnus rubra Bong.

Betula papyrifera Marsh.

Cornus nuttallii Aud.

Picea sitchensis (Bong.) Carr.

Pinus contorta Dougl.

Populus tremuloides Michx.

Populus trichocarpa T. & G.

Prunus emarginata (Dougl.) Walp.

Pseudotsuga menziesii (Mirb.) Franco

Rhamnus purshiana DC.

Salix lasiandra Benth.

Salix scouleriana Barratt

Salix sitchensis Sanson

Taxus brevifolia Nutt.

Thuja plicata Donn

Tsuga heterophylla (Raf.) Sarg.

# Common Name

Pacific silver fir

Vine maple

Big-leaf maple

Red alder

Paper birch

Pacific dogwood

Sitka spruce

Lodgepole pine

Quaking aspen

Black cottonwood

Bitter cherry

Douglas-fir

Cascara

Pacific willow

Scouler willow

Sitka willow

Western yew

Western redcedar

Western hemlock

# Vascular Plants

#### Aceraceae

Acer circinatum Pursh
Acer macrophyllum Pursh

#### Araceae

Lysichitum americanum Hultén & St. John

#### Araliaceae

Oplopanax horridum (Smith) Miq.

## Berberidaceae

Achlys triphylla (Smith) DC.

Berberis aquifolium Pursh

Berberis nervosa Pursh

#### Betulaceae

Alnus rubra Bong.
Betula papyrifera Marsh.

# Caprifoliaceae

Linnaea borealis L.
Lonicera involucrata (Rich.) Banks
Sambucus racemosa L.

## Compositae

Anaphalis margaritacea (L.) B. & H.
Cirsium arvense (L.) Scop.
Cirsium vulgare (Savi) Tenore
Crepis capillaris (L.) Wallr.
Erigeron annuus (L.) Pers.
Hieracium albiflorum Hook.
Hypochaeris radicata L.
Lactuca biennis (Moench) Fern.

Senecio sylvaticus L. Solidago canadensis L.

#### Cornaceae

Cornus canadensis L. Cornus nuttallii Aud.

# Cupressaceae

Thuja plicata Donn

# Cyperaceae

Carex aquatilis Wahl.

Carex deweyana Schw.

Carex hendersonii Bailey

Carex interior Bailey

Carex mertensii Prescott

Carex rossii Boott

Scirpus cyperinus (L.) Kunth

Scirpus microcarpus Presl

# Equisetaceae

Equisetum arvense L. Equisetum palustre L.

# Ericaceae

Gaultheria shallon Pursh.

Ledum groenlandicum Oeder

Menziesia ferruginea Smith

Vaccinium alaskaense Howell

Vaccinium ovalifolium Smith

Vaccinium parvifolium Smith

#### Fumariaceae

Dicentra formosa (Andr.) Walp.

#### Gramineae

Agrostis exarata Trin.

Agrostis scabra Willd.

Calamagrostis canadensis (Michx.) Beauv.

Danthonia spicata (L.) Beauv.

Festuca occidentalis Hook.

Holcus lanatus L.

Phalaris arundinacea L.

Poa palustris L.

Poa pratensis L.

Trisetum cernuum Trin.

#### Grossulariaceae

Ribes lacustre (Pres.) Poir.

Ribes sanguineum Pursh

# Hypericaceae

Hypericum perforatum L.

#### Juncaceae

Juncus effusus L.

Juncus ensifolius Wikst.

Juncus tenuis Willd.

Luzula campestris (L.) DC.

Luzula parviflora (Ehrh.) Desv.

#### Liliaceae

Trillium ovatum Pursh

## Lycopodiaceae

Lycopodium clavatum L.

#### Onagraceae

Circaea alpina L.

Epilobium angustifolium L.

Epilobium watsonii Barbey

#### Orchidaceae

Goodyera oblongifolia Raf.

#### Pinaceae

Abies amabilis (Dougl.) Forbes
Picea sitchensis (Bong.) Carr.
Pinus contorta Dougl.
Pseudotsuga menziesii (Mirb.) Franco
Tsuga heterophylla (Raf.) Sarg.

# Polygonaceae

Rumex acetosella L.

# Polypodiaceae

Athyrium filix-femina (L.) Roth.

Blechnum spicant (L.) Roth.

Dryopteris austriaca (Jacq.) Woynar

Gymnocarpium dryopteris (L.) Newm.

Polystichum munitum (Kaulf.) Presl

Pteridium aquilinum (L.) Kuhn

#### Portulacaceae

Montia sibirica (L.) Howell

#### Primulaceae

Trientalis latifolia Hook.

#### Ranunculaceae

Actaea rubra (Ait.) Willd.

#### Rhamnaceae

Rhamnus purshiana DC.

#### Rosaceae

Geum macrophyllum Willd.

Holodiscus discolor (Pursh) Maxim.

Prunus emarginata (Dougl.) Walp.

Pyrus fusca Raf.

Rosa gymnocarpa Nutt.

Rubus discolor Weihe & Nees

Rubus laciniatus Willd.

Rubus leucodermis Doug1.

Rubus parviflorus Nutt.

Rubus spectabilis Pursh

Rubus ursinus Cham. & Schlecht.

Sorbus aucuparia L.

Spiraea douglasii Hook.

#### Rubiaceae

Galium trifidum L.
Galium triflorum Michx.

#### Salicaceae

Populus tremuloides Michx.

Populus trichocarpa T. & G.

Salix lasiandra Benth.

Salix scouleriana Barratt

Salix sitchensis Sanson

# Saxifragaceae

Tiarella trifoliata L.

# Scrophulariaceae

Veronica americana Schwein. Veronica serpyllifolia L.

#### Taxaceae

Taxus brevifolia Nutt.

#### Umbelliferae

Oenanthe sarmentosa Presl

# Urticaceae

Urtica dioica L.

# Violaceae

Viola sempervirens Greene

# Bryophytes

#### Aulacomniaceae

Aulacomnium androgynum (Hedw.) Schwaegr.

## Brachytheciaceae

Eurhynchium oreganum (Sull.) Jaeg. Eurhynchium praelongum (Turn.) Dix. Isothecium stoloniferum Brid.

#### Bryaceae

Leptobryum pyriforme (Hedw.) Wils. Pohlia nutans (Hedw.) Lindb.

#### Dicranaceae

Dicranella heteromalla (Hedw.) Schimp.

Dicranoweisia cirrata (Hedw.) Lindb.

Dicranum fuscescens Turn.

Dicranum howellii Ren. & Card.

Dicranum tauricum Sapehin

#### Ditrichaceae

Ceratodon purpureus (Hedw.) Brid.
Ditrichum heteromallum (Hedw.) Britt.

#### Grimmiaceae

Rhacomitrium canescens (Hedw.) Brid.
Rhacomitrium heterostichum (Hedw.) Brid.

#### Hylocomiaceae

Hylocomium splendens (Hedw.) B.S.G.

## Mniaceae

Leucolepis menziesii (Hook.) Steer Mnium lycopodioides Schwaegr.

Mnium spinulosum B.S.G.

Plagiomnium insigne (Mitt.) Koponen

Rhizomnium glabrescens (Kindb.) Koponen

# Plagiotheciaceae

Isopterygium elegans (Brid.) Lindb. Plagiothecium undulatum (Hedw.) B.S.G.

# Polytrichaceae

Oligotrichum aligerum Mitt.

Pogonatum alpinum (Hedw.) Roehl.

Pogonatum contortum (Menz. ex Brid.) Lesq.

Pogonatum urnigerum (Hedw.) P. Beauv.

Polytrichum commune Hedw.

Polytrichum juniperinum Hedw.

#### Pottiaceae

Barbula sp. (Hedw.)

## Rhytidiaceae

Rhytidiadelphus loreus (Hedw.) Warnst.
Rhytidiadelphus triquetrus (Hedw.) Warnst.

## Sphagnaceae

Sphagnum palustre L.

#### Thuidiaceae

Claopodium crispifolium (Hook.) Ren. & Card.

APPENDIX III

Analysis of Variance Tables

Table III-1. Western hemlock.

Source of Variation	d.f.	s.s.	M.S.	F
Associations Treatments/associations Error TOTAL	2 5 42 49	6.6474 5.0200 6.5544 18.222	3.3237 1.0040 0.15606	3.31 N.S. 6.43 **
Table III-2. Western	redceda	r.		
Source of Variation	d.f.	S.S.	M.S.	F
Association Treatments/associations Error TOTAL	42	4.2059 22.146 34.832 61.184	2.1030 4.4291 0.82934	
Table III-3. Douglas-	fir.			
Source of Variation	d.f.	S.S.	M.S.	F
Association Treatments/associations Error TOTAL	2 5 42 49	2.6443 16.593 38.931 58.168	1.3222 3.3185 0.92694	0.40 N.S. 3.58 **
Table III-4. Conifero	us tree	es.		
Source of Variation	d.f.	S.S,	M.S.	F
Association Treatments/associations Error TOTAL	2 5 42 49	4.6070 5.2935 5.59920 15.893	2.3035 1.0587 0.14267	2.18 N.S. 7.42 **

Table III-5. Total number of naturally regenerated trees.

Source of Variation	d.f.	s.s.	M.S.	F
Association Treatment/associations Error TOTAL	2 5 42 49			7.63 **
Table III-6. Deciduou	s trees	•		
Source of Variation	d.f.	s.s.	M.S.	F
Association Treatment/associations Error TOTAL	5 42	5.4443 1.0874 5.3853 11.917		12.52 ** 1.70 N.S.
Table III-7. Establis	hed Wes	tern hemlo	ock.	
Source of Variation	d.f.	S.S.	M.S.	F
Association Treatment/associations Error TOTAL		13.091 7.1340 14.299 34.524	6.5454 1.4268 0.34045	4.59 N.S. 4.19 **
Table III-8. Establis	hed Wes	stern redce	edar.	
Source of Variation	d.f.	S.S.	M.S.	F
Association Treatment/associations Error TOTAL	2 5 42 49	15.623 33.266 23.777 72.666	7.8116 6.6532 0.56611	1.17 N.S. 11.75 **

Established Douglas-fir. Table III-9.

Source of Variation	d.f.	s.s.	M.S.	F
Association Treatment/associations Error TOTAL	2 5 42 49	2.4094 16.112 42.682 61.203	1.2047 3.2224 1.0162	0.37 N.S. 3.17 **

# Explanation of symbols used:

 $\begin{array}{lll} \text{d.f.} & \text{- degrees of freedom} \\ \text{S.S.} & \text{- sum of squares} \end{array}$ 

M.S. - mean square

F - F-ration N.S. - not significant

** - significant at the 1% level
* - significant at the 5% level

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# APPENDIX IV

Correlation Coefficients for Environmental Features

# DATA SUMMARY OF TREE SPECIES AND ENVIRONMENTAL VARIABLES

•												
CORRELATIO	N MATRIX		فسد						٠.			
· i		•										
ROW X 1	HEMLOCK							*		. *	•	
1.00000				•		•						
ROW X 2	CEDAR							•				
0.63350	1.00000										11.1	•
ROW X 3						e, i e e						
	0.40542 CONIFERS	1.00000					.*					
ROW X 4 0.97999	0.76565	0.52362	1.00000			4.5	•			•		
RDW X 5		0.52302	1.00000									***
0.63027	0.57609	0.33846	0.66198	1.00000		•				. *		
ROW X 6	DECIDUOS	0.33040	0.00170					•		•		
-0.19872	-0.04542	-0.10395	-0.17805	0.61968	1.00000				1.4			
ROW X 7	ALTITUDE		***			•	,					
0.33959	0.26374	0.65327	0.38251	0.08238	-0.29239	1.00000						
ROW X 8'	ASPECT		* .				-					
-0.00295	0.05552	0.22696	0.02688	-0.09346	-0.15084	0.06257	1.00000		100	14.5		
. ROW X 9	SLOPE	•							•	· · · · · · · · · · · · · · · · · · ·		· .
0.06086	0.10729	-0.11386	0.06527	-0.14516	-0.25893	-0.08796	0.05488	1.00000				٠. ٠
ROW X10	POSTONSL			-								
-0.26362	-0.10893	-0.42812	-0.26970	0.14376	0.47116	-0.56336	0.06249	-0.35154	1.00000	* * * * *	٠	
ROW X11								0 (30(0	0.20740	1 00000		
-0.13555	-0.23305	-0.40147	-0.19147	-0.29579	-0.18785	-0.26815	-0.22219	0.43949	-0.20760	1.00000		
ROW X12	AGE		. 0 20710	. 0 010/7	-0.30157	0.24602	0 11366	-0 19100	0.00288	-0.23567	- 1 - 00000	
0.41400	0.21768	0.20612	0.39710	0.01047	-0.39197	0.24002	0.11540	-0.17100	0.00200	-0.23501	1.0000	
ROW X13	DISTOSS -0.28355	-0 20050	-0.40536	-0 46455	-0.18542	-0.22671	0.00526	0.50318	-0.34388	0.64013	-0.25777	1.00000
-0.39824 ROW X14	DISTOSOU	-0.29039	-0.40230	-0.40422	-04,10342	-0.22011	0.00320	. 0.30310	14		00251,11	200000
-0.41738	-0.34609	-0 20726	-0.43488	-0-45355	-0-14006	-0-17372	0.00922	0.34179	-0.27136	0.65537	-0.23741	0.86343
	-0.34007	-3.27120	00.13.00	0013333	0011000			***			-,	
1.00000			00.3.00	001/222							•	
1.00C00 ROW X15	SSDF			0.06898							•	
1.00000			-0.04590								-0.02984	
1.00C00 RDW X15 -0.08914	. SSDF -0.05623		-0.04590	0.06898	0.13863	0.56335	0.07191	-0.19446	-0.34002	-0.42967	-0.02984	-0.17013
1.00000 ROW X15 -0.08914 -0.19847	SSDF -0.05623 1.00000 SSWH		-0.04590		0.13863	0.56335	0.07191	-0.19446	-0.34002	-0.42967	-0.02984	
1.00C00 RDW X15 -0.08914 -0.19847 RDW X16	SSDF -0.05623 1.00000 SSWH	0.50333	-0.04590	0.06898	0.13863	0.56335	0.07191	-0.19446	-0.34002	-0.42967	-0.02984	-0.17013
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC	0.50333 -0.46005 1.00000	-0.04590 0.09022	0.06898	0.13863	0.56335	0.07191	-0.19446	-0.34002 0.24615	-0.42967 0.50859	-0.02984	-0.17013 0.22257
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045	0.50333 -0.46005 1.00000 -0.26392	-0.04590 0.09022 -0.10233	0.06898	0.13863	0.56335	0.07191	-0.19446	-0.34002 0.24615	-0.42967 0.50859	-0.02984	-0.17013
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518	0.50333 -0.46005 1.00000	-0.04590 0.09022	0.06898	0.13863	0.56335	0.07191	-0.19446	-0.34002 0.24615	-0.42967 0.50859	-0.02984	-0.17013 0.22257
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM	0.50333 -0.46005 1.00000 -0.26392 0.12532	-0.04590 0.09022 -0.10233 1.00000	0.06898 -0.10445 0.07225	0.13863 -0.23160 0.20201	0.56335 -0.39988 -0.59662	0.07191 -0.11941 0.10287	-0.19446 0.19963 0.04463	-0.34002 0.24615 0.34754	-0.42967 0.50859 -0.07814	-0.02984 0.19286 -0.41800	-0.17013 0.22257 -0.08645
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110	0.50333 -0.46005 1.00000 -0.26392 0.12532 0.13682	-0.04590 0.09022 -0.10233 1.00000 0.27956	0.06898 -0.10445 0.07225 -0.04860	0.13863 -0.23160 0.20201	0.56335 -0.39988 -0.59662	0.07191	-0.19446 0.19963 0.04463	-0.34002 0.24615	-0.42967 0.50859 -0.07814	-0.02984 0.19286 -0.41800	-0.17013 0.22257
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842	SSOF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110 0.15347	0.50333 -0.46005 1.00000 -0.26392 0.12532 0.13682	-0.04590 0.09022 -0.10233 1.00000	0.06898 -0.10445 0.07225	0.13863 -0.23160 0.20201	0.56335 -0.39988 -0.59662	0.07191 -0.11941 0.10287	-0.19446 0.19963 0.04463	-0.34002 0.24615 0.34754	-0.42967 0.50859 -0.07814	-0.02984 0.19286 -0.41800	-0.17013 0.22257 -0.08645
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842 ROW X19	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110 0.15347 *ROCK	0.50333 -0.46005 1.00000 -0.26392 0.12532 0.13682 -0.08947	-0.04590 0.09022 -0.10233 1.00000 0.27956 -0.21350	0.06898 -0.10445 0.07225 -0.04860 1.00000	0.13863 -0.23160 0.20201 -0.35655	0.56335 -0.39988 -0.59662 0.37582	0.07191 -0.11941 0.10287 -0.16052	-0.19446 0.19963 0.04463 0.07918	-0.34002 0.24615 0.34754 -0.28901	-0.42967 0.50859 -0.07814 -0.34296	-0.02984 0.19286 -0.41800 0.33578	-0.17013 0.22257 -0.08645 -0.22629
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1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842 ROW 0.24024 0.18530	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110 0.15347 %ROCK 0.16451 0.26430	0.50333 -0.46005 1.00000 -0.26392 0.12532 0.13682 -0.08947 0.29123	-0.04590 0.09022 -0.10233 1.00000 0.27956 -0.21350	0.06898 -0.10445 0.07225 -0.04860 1.00000	0.13863 -0.23160 0.20201 -0.35655	0.56335 -0.39988 -0.59662 0.37582	0.07191 -0.11941 0.10287 -0.16052	-0.19446 0.19963 0.04463 0.07918	-0.34002 0.24615 0.34754 -0.28901	-0.42967 0.50859 -0.07814 -0.34296	-0.02984 0.19286 -0.41800 0.33578	-0.17013 0.22257 -0.08645 -0.22629
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1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842 ROW X19 0.24024 0.1820 ROW X20 0.36982	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110 0.15347 \$ROCK 0.16451 0.26430 \$\$LASH 0.24480	0.50333 -0.46005 1.00000 -0.26392 0.12532 0.13682 -0.08947 0.29123 -0.22372 0.12052	-0.04590  0.09022  -0.10233 1.00000  0.27956 -0.21350  0.25243 -0.18536	0.06898 -0.10445 0.07225 -0.04860 1.00000 -0.02853 0.13362 -0.04488	0.13863 -0.23160 0.20201 -0.35655 -0.30178 1.00000 -0.43778	0.56335 -0.39988 -0.59662 0.37582 0.30881 0.34575	0.07191 -0.11941 0.10287 -0.16052	-0.19446 0.19963 0.04463 0.07918	-0.34002 0.24615 0.34754 -0.28901	-0.42967 0.50859 -0.07814 -0.34296 0.04050	-0.02984 0.19286 -0.41800 0.33578 0.07264	-0.17013 0.22257 -0.08645 -0.22629
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842 ROW X19 0.24024 0.18530 ROW X20 0.36982 -0.27629	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110 0.15347 \$ROCK 0.16451 0.26430 \$SLASH 0.24480 -0.05918	0.50333 -0.46005 1.00000 -0.26392 0.12532 0.13682 -0.08947 0.29123 -0.22372 0.12052	-0.04590  0.09022  -0.10233 1.00000  0.27956 -0.21350  0.25243 -0.18536	0.06898 -0.10445 0.07225 -0.04860 1.00000 -0.02853 0.13362 -0.04488	0.13863 -0.23160 0.20201 -0.35655 -0.30178 1.00000 -0.43778	0.56335 -0.39988 -0.59662 0.37582 0.30881	0.07191 -0.11941 0.10287 -0.16052 0.09114	-0.19446 0.19963 0.04463 0.07918	-0.34002 0.24615 0.34754 -0.28901 -0.70100	-0.42967 0.50859 -0.07814 -0.34296 0.04050 -0.25808	-0.02984  0.19286  -0.41800  0.33578  0.07264  0.27179	-0.17013 0.22257 -0.08645 -0.22629 0.20784 -0.13348
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842 ROW X19 0.24024 0.1820 ROW X20 0.36982	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110 0.15347 \$ROCK 0.16451 0.26430 \$\$LASH 0.24480	0.50333 -0.46005 1.00000 -0.26392 0.12532 0.13682 -0.08947 0.29123 -0.22372 0.12052 0.08679	-0.04590  0.09022  -0.10233 1.00000  0.27956 -0.21350  0.25243 -0.18536	0.06898 -0.10445 0.07225 -0.04860 1.00000 -0.02853 0.13362 -0.04488 0.72398	0.13863 -0.23160 0.20201 -0.35655 -0.30178 1.00000 -0.43778 0.14409	0.56335 -0.39988 -0.59662 0.37582 0.30881 0.34575	0.07191 -0.11941 0.10287 -0.16052 0.09114	-0.19446 0.19963 0.04463 0.07918 0.08057	-0.34002 0.24615 0.34754 -0.28901 -0.70100	-0.42967 0.50859 -0.07814 -0.34296 0.04050 -0.25808	-0.02984 0.19286 -0.41800 0.33578 0.07264	-0.17013 0.22257 -0.08645 -0.22629 0.20784 -0.13348
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842 ROW X19 0.24024 0.18530 ROW X20 0.36982 -0.27629 ROW X21	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110 0.15347 %ROCK 0.16451 0.26430 %SLASH 0.24480 -0.05918 %DEPOFOM	0.50333 -0.46005 1.00000 -0.26392 0.12532 0.13682 -0.08947 0.29123 -0.22372 0.12052 0.08679 0.01814	-0.04590  0.09022  -0.10233 1.00000  0.27956 -0.21350  0.25243 -0.18536  0.36180 -0.05460	0.06898 -0.10445 0.07225 -0.04860 1.00000 -0.02853 0.13362 -0.04488 0.72398 0.31607	0.13863 -0.23160 0.20201 -0.35655 -0.30178 1.00000 -0.43778 0.14409 0.63815	0.56335 -0.39988 -0.59662 0.37582 0.30881 0.34575 1.00000	0.07191 -0.11941 0.10287 -0.16052 0.09114 -0.13645	-0.19446 0.19963 0.04463 0.07918 0.08057	-0.34002 0.24615 0.34754 -0.28901 -0.70100 -0.33002	-0.42967 0.50859 -0.07814 -0.34296 0.04050 -0.25808	-0.02984  0.19286  -0.41800  0.33578  0.07264  0.27179	-0.17013 0.22257 -0.08645 -0.22629 0.20784 -0.13348
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842 ROW X19 0.24024 0.18530 ROW X20 0.36982 -0.27629 ROW X21 -0.23860	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110 0.15347 %ROCK 0.16451 0.26430 %SLASH 0.24480 -0.05918 %DEPOFOM	0.50333 -0.46005 1.00000 -0.26392 0.12532 0.13682 -0.08947 0.29123 -0.22372 0.12052 0.08679 0.01814	-0.04590  0.09022  -0.10233 1.00000  0.27956 -0.21350  0.25243 -0.18536  0.36180 -0.05460 -0.21314	0.06898 -0.10445 0.07225 -0.04860 1.00000 -0.02853 0.13362 -0.04488 0.72398 0.31607	0.13863 -0.23160 0.20201 -0.35655 -0.30178 1.00000 -0.43778 0.14409 0.63815	0.56335 -0.39988 -0.59662 0.37582 0.30881 0.34575 1.00000 -0.02508	0.07191 -0.11941 0.10287 -0.16052 0.09114 -0.13645 -0.16680	-0.19446 0.19963 0.04463 0.07918 0.08057	-0.34002 0.24615 0.34754 -0.28901 -0.70100 -0.33002 -0.02109	-0.42967 0.50859 -0.07814 -0.34296 0.04050 -0.25808 0.28363	-0.02984  0.19286  -0.41800  0.33578  0.07264  0.27179  -0.56578	-0.17013 0.22257 -0.08645 -0.22629 0.20784 -0.13348 0.22645
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842 ROW X19 0.24024 0.18530 ROW X20 0.36982 -0.27629 ROW X21 -0.23660 0.24060	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110 0.15347 %ROCK 0.16451 0.26430 %SLASH 0.24480 -0.05918 %MS -0.10235 0.25647	0.50333 -0.46005 1.00000 -0.26392 0.12532 0.13682 -0.08947 0.29123 -0.22372 0.12052 0.08679 0.01814 -0.25341	-0.04590  0.09022  -0.10233 1.00000  0.27956 -0.21350  0.25243 -0.18536  0.36180 -0.05460 -0.21314 -0.08472 -0.20078	0.06898 -0.10445 0.07225 -0.04860 1.00000 -0.02853 0.13362 -0.04488 0.72398 0.31607 -0.46381 -0.23592	0.13863 -0.23160 0.20201 -0.35655 -0.30178 1.00000 -0.43778 0.14409 0.63815 0.04537 -0.09948	0.56335 -0.39988 -0.59662 0.37582 0.30881 0.34575 1.00000 -0.02508 -0.56695 -0.38484	0.07191 -0.11941 0.10287 -0.16052 0.09114 -0.13645 -0.16680 1.00000 0.26718	-0.19446 0.19963 0.04463 0.07918 0.08057 0.10528 -0.05089	-0.34002 0.24615 0.34754 -0.28901 -0.70100 -0.33002 -0.02109	-0.42967 0.50859 -0.07814 -0.34296 0.04050 -0.25808	-0.02984  0.19286  -0.41800  0.33578  0.07264  0.27179  -0.56578	-0.17013 0.22257 -0.08645 -0.22629 0.20784 -0.13348
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842 ROW X19 0.24024 0.18530 ROW X20 0.36982 -0.27629 ROW X21 -0.23860 0.24006 ROW X22	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110 0.15347 %ROCK 0.16451 0.26430 %SLASH 0.24480 -0.05918 %MS -0.10235 0.25647 %OM -0.16559	0.50333 -0.46005 1.00000 -0.26392 0.12532 0.13682 -0.08947 0.29123 -0.22372 0.12052 0.08679 0.01814 -0.25341	-0.04590  0.09022  -0.10233 1.00000  0.27956 -0.21350  0.25243 -0.18536  0.36180 -0.05460 -0.21314 -0.08472 -0.20078	0.06898 -0.10445 0.07225 -0.04860 1.00000 -0.02853 0.13362 -0.04488 0.72398 0.31607 -0.46381	0.13863 -0.23160 0.20201 -0.35655 -0.30178 1.00000 -0.43778 0.14409 0.63815 0.04537 -0.09948	0.56335 -0.39988 -0.59662 0.37582 0.30881 0.34575 1.00000 -0.02508 -0.56695 -0.38484	0.07191 -0.11941 0.10287 -0.16052 0.09114 -0.13645 -0.16680 1.00000 0.26718	-0.19446 0.19963 0.04463 0.07918 0.08057 0.10528 -0.05089	-0.34002 0.24615 0.34754 -0.28901 -0.70100 -0.33002 -0.02109	-0.42967 0.50859 -0.07814 -0.34296 0.04050 -0.25808 0.28363	-0.02984  0.19286  -0.41800  0.33578  0.07264  0.27179  -0.56578	-0.17013 0.22257 -0.08645 -0.22629 0.20784 -0.13348 0.22645
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842 ROW X19 0.24024 0.18530 ROW X20 0.36982 -0.27629 ROW X21 -0.23860 0.24060 ROW X22 -0.18175 -0.07541 ROW X23	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.00045 -0.45518 DEPOFOM 0.19110 0.15347 %ROCK 0.16451 0.26430 %SLASH 0.24480 -0.05918 %O.10235 0.25647 %OM -0.16559 -0.16559 -0.25113 %OVERBR	0.50333  -0.46005 1.00000  -0.26392 0.12532  0.13682 -0.08947  0.29123 -0.22372  0.12052 0.08679  0.01814 -0.25341  -0.22013 0.20231	-0.04590  0.09022  -0.10233 1.00000  0.27956 -0.21350  0.25243 -0.18536  0.36180 -0.05460  -0.21314 -0.08472 -0.20078 0.20296	0.06898 -0.10445 0.07225 -0.04860 1.00000 -0.02853 0.13362 -0.04488 0.72398 0.31607 -0.46381 -0.23592 -0.24237	0.13863 -0.23160 0.20201 -0.35655 -0.30178 1.00000 -0.43778 0.14409 0.63815 0.04537 -0.09948 -0.51011	0.56335 -0.39988 -0.59662 0.37582 0.30881 0.34575 1.00000 -0.02508 -0.56695 -0.38484 -0.38955	0.07191 -0.11941 0.10287 -0.16052 0.09114 -0.13645 -0.16680 1.00000 0.26718 -0.47412	-0.19446 0.19963 0.04463 0.07918 0.08057 0.10528 -0.05089 -0.06455 1.00000	-0.34002 0.24615 0.34754 -0.28901 -0.70100 -0.33002 -0.02109 0.55192	-0.42967 0.50859 -0.07814 -0.34296 0.04050 -0.25808 0.28363 -0.07811	-0.02984  0.19286  -0.41800  0.33578  0.07264  0.27179  -0.56578  0.25754	-0.17013  0.22257  -0.08645  -0.22629  0.20784  -0.13348  0.22645  -0.19465
1.00C00 ROW X15 -0.08914 -0.19847 ROW X16 0.13831 0.25651 ROW X17 -0.10210 -0.09261 ROW X18 0.28091 -0.31842 ROW X20 0.36982 -0.27629 ROW X21 -0.23860 0.24060 ROW X22 -0.218175 -0.07541	SSDF -0.05623 1.00000 SSWH 0.06283 -0.94042 SSWRC -0.45518 DEPOFOM 0.19110 0.15347 *ROCK 0.16451 0.26430 *SLASH 0.24480 -0.05918 *MS -0.10235 0.25647 *ROCK *O.16559 -0.16559 -0.25113	0.50333  -0.46005 1.00000  -0.26392 0.12532  0.13682 -0.08947  0.29123 -0.22372  0.12052 0.08679  0.01814 -0.25341 -0.22013	-0.04590  0.09022  -0.10233 1.00000  0.27956 -0.21350  0.25243 -0.18536  0.36180 -0.05460 -0.21314 -0.08472 -0.20078 0.20296	0.06898 -0.10445 0.07225 -0.04860 1.00000 -0.02853 0.13362 -0.04488 0.72398 0.31607 -0.46381 -0.23592 -0.24237 0.30600	0.13863 -0.23160 0.20201 -0.35655 -0.30178 1.00000 -0.43778 0.14409 0.63815 0.04537 -0.09948 -0.51011	0.56335 -0.39988 -0.59662 0.37582 0.30881 0.34575 1.00000 -0.02508 -0.56695 -0.38484 -0.38955 -0.02490	0.07191 -0.11941 0.10287 -0.16052 0.09114 -0.13645 -0.16680 1.00000 0.26718	-0.19446 0.19963 0.04463 0.07918 0.08057 0.10528 -0.05089 -0.06455 1.00000 -0.34203	-0.34002 0.24615 0.34754 -0.28901 -0.70100 -0.33002 -0.02109 0.55192	-0.42967 0.50859 -0.07814 -0.34296 0.04050 -0.25808 0.28363	-0.02984  0.19286  -0.41800  0.33578  0.07264  0.27179  -0.56578  0.25754	-0.17013 0.22257 -0.08645 -0.22629 0.20784 -0.13348 0.22645

ROW X24 %NOTOVER
-0.20233 -0.08099 -0.13900 -0.19122 -0.30600 -0.20150 0.02490 0.08825 0.34203 -0.12194 0.26927 -0.15040 0.32078
0.24074 0.14579 -0.04760 -0.30077 -0.06748 0.02743 -0.28846 0.08371 0.16561 -1.00000 1.00000