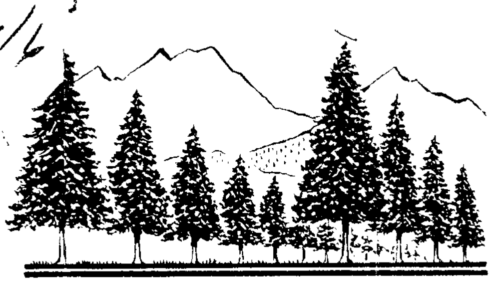

research notes

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A Method of Estimating Site Quality of Logged Land in the Coastal Douglas Fir Belt of British Columbia

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INTRODUCTION

In recent years there have been many advances towards the practice of forestry in British Columbia. Among these have been attempts at regulating the annual cut in accordance with the principles of sustained yield. This has drawn attention to methods of assessing the growth potentialities of logged lands.

Conventional methods of site assessment have been devised primarily for application in forest stands, where either sample trees are measured to obtain a site-index value, or the ground vegetation is assessed to determine the forest association. The changes brought about by logging, however, prevent full use of these methods on logged land, as the trees have been removed and the ground vegetation drastically changed. It is, therefore, evident that on logged land some other means of estimating site quality must be investigated.

The present study was initiated to determine if a relationship exists between site quality and diameter growth as measured on stumps of the previous stand.

THE APPROACH TO THE PROBLEM

Before the field methods for the study were decided upon, consideration was given to factors, other than those related to site quality, which could influence diameter growth. Controls subsequently were set up which might theoretically hold the influence of these factors to a minimum.

In addition to site factors, the diameter growth of individual trees is primarily affected by conditions which vary with age, the degree of shade tolerance, crown class, and stand density. In order to eliminate age as a variable, all stump diameters were related to standard ages which, in this study, were set at 100 and 150 years. In a large measure, the degree of shade tolerance as a variable was ignored, because coastal Douglas fir is rather intolerant. Therefore, the study was not complicated by such conditions as prolonged periods of suppressed growth during early life followed by later release. In order to control the effect of crown class upon diameter growth, stump-diameter measurements were confined to stumps which, by their relative size, had obviously supported dominant trees. Measurements were made of

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* Some of the initial data upon which this report is based were collected by R. H. Spilsbury and the late D. S. Smith.

at least 100 years of growth in order to decrease the influence of variations of stand-density characteristic in young stands. In this case it is assumed that both overstocked and understocked young stands will tend to have a condition approaching normal stocking by the time they are 100 years old.

The project, therefore, aimed at determining the relationship of site quality, in terms of site index and forest associations, to diameter growth measurements of stumps. The latter was expressed by three arbitrary measures, viz., growth for 100 years, 150 years, and from 100 to 150 years respectively.

THE ESTIMATION OF SITE QUALITY IN TERMS OF SITE INDEX

Thirty-seven plots were established on Vancouver Island in areas between Duncan and the Nimpkish Valley at elevations from 600 to 2,600 feet.

Each plot consisted of two sub-plots each approximately one acre in size, and these straddled a logging boundary where the site appeared to be identical on both sides. In this way one sub-plot gave a record of conditions in the mature timber, while the other, in the logged area, gave a record of conditions after logging. In the timber, vegetation was assessed and the height and diameter of Douglas fir sample trees measured. On each sub-plot in the logged area, five of the largest Douglas fir stumps were selected for measurement, abnormally large stumps being excluded. Annual-growth ring counts were made to 100 and 150 years, and these included an age adjustment for the tree to reach stump height as shown in Table V. The distances were then measured from the center of the stump to rings representing respectively 100 and 150 years of growth. Three radial measurements on individual stumps were averaged and converted to diameter, and the individual stump diameters were then averaged for each plot.

Site index / values as indicated by sample tree measurements from the undisturbed adjacent stand were plotted against stump diameter measurements, and freehand curves were constructed to fit the data. The diameter limits which indicate each site-index value are shown in Table I.

/ McArdle, R. E. and Meyer, W. H. The yield of Douglas fir in the Pacific Northwest. U.S.D.A. Technical Bulletin 201, 1949.

TABLE I - Limits of stump diameter in feet for each site-index class.

Site Index	Stump diam. at 100 years	Stump diam. at 150 years	Stump diam. growth from 100-150 years
	(Feet)	(Feet)	(Feet)
80	less then .94	less than 1.26	less than .28
110	.94 - 1.38	1.26 - 1.93	.28 - .41
140	1.39 - 1.66	1.94 - 2.21	.42 - .56
170	more than 1.66	more than 2.21	more than .56

An indication of the usefulness of each measure of stump-diameter growth was given when the diameter limits shown in Table I were applied to the original data. These results are shown in Table II.

TABLE II - Number of plots correctly estimated in each site-index class by applying limits defined in Table I to original data.

Actual No. of Plots in each Site-Index Class	Stump diam. at 100 years	Stump diam. at 150 years	Stump diam. growth from 100-150 years
SI 80 (5)	4	4	3
SI 110 (12)	6	6	1
SI 140 (6)	6	4	2
SI 170 (14)	11	11	10
Total 37	27	25	16
% Correctly classified	73.0	67.6	43.2

Results from Table II indicate that stump diameter at 100 years is the most satisfactory measure of site index. Of the 10 plots incorrectly predicted using stump diameter at 100 years, only three plots were in error by more than one site class. Further analysis indicates that no appreciable decrease of correct prediction occurs when the radius nearest the mean is used on each of three stumps instead of three radii on each of five stumps. There is, however, an appreciable increase in error if less than three stumps are sampled in estimating site quality.

ESTIMATION OF SITE QUALITY IN TERMS OF FOREST ASSOCIATIONS/

Seventy-two plots were established on Vancouver Island on areas between the San Juan and Nimpkish Valleys at elevations between 600 and 2,600 feet. Field methods were similar to those previously outlined. The plots were distributed as follows, with the average site indices being based on tree measurements from 37 plots.

Forest Association	Number of plots	Average site index
Douglas fir-salal	42	97
Douglas fir-moss	9	135
Douglas fir-sword fern	21	174

The diameter limits for the three associations are shown in Table III.

TABLE III - Limits of stump diameter in feet for each forest association.

Forest Association	Stump diam. at 100 years	Stump diam. at 150 years	Stump diam. growth from 100 - 150 years
	(Feet)	(Feet)	(Feet)
Salal	less than 1.45	less than 1.91	less than .46
Moss	1.45 - 1.67	1.91 - 2.22	.46 - .65
Sword fern	more than 1.67	more than 2.22	more than .65

/ These forest associations are described in a summary of manuscript, 1950, by V. Krajina and R. H. Spilsbury in Forestry Handbook for British Columbia, 1953. The Forest Club, University of British Columbia.

An indication of the usefulness of each measure of stump-diameter growth was determined by applying the limits shown in Table III to the original data. The results are presented in Table IV.

Results from Table IV indicate that stump diameter at 150 years is the most reliable method of predicting forest associations. In practice, however, it is probably sufficient to apply stump diameter at 100 years as it requires less time in the field and there is no appreciable loss of accuracy. Of the 13 plots incorrectly predicted using stump diameter at 100 years, only one plot was greatly in error, namely, one salal plot was classified as a sword fern association.

Further analysis indicated that there was no appreciable decrease in correct prediction when only the radius nearest the mean on each of three stumps was used instead of three radii on each of five stumps.

TABLE IV - Number of plots correctly estimated in each forest association by applying limits defined in Table III to original data.

Plots in each Forest association	Stump diam. at 100 years	Stump diam. at 150 years	Stump diam. growth from 100-150 years
Salal (42)	36	37	34
Moss (9)	6	8	6
Sword fern (21)	17	17	13
Totals 72	59	62	53
% Correctly classified	81.9	86.1	69.4

FIELD APPLICATION

Three of the largest Douglas fir stumps should be selected on an area of uniform site. Abnormally large stumps and those with eccentric growth rings should be avoided. An adjustment of age from Table V is required to allow for the time taken by the tree to grow from ground level to stump height. Annual-growth rings should be counted along a radial line where growth appears to be average. The radius of each stump is then converted to diameter, and the diameters of the three stumps are then averaged. This average diameter is applied to the diameter limits shown in either Table I or III depending upon whether the site index or forest association is required.

TABLE V - Growing period in years required by tree to grow from ground level to stump height.*

Stump Height (Feet)	Site Index Association	80 Salal	110 -	140 Moss	170 Sword fern
		(Years)	(Years)	(Years)	(Years)
1		5	4	3	3
2		7	6	6	5
3		9	8	7	6
4		10	9	8	7
5		11	10	9	8

It is suggested that site predictions be made systematically along survey lines which intersect the site gradient. In most instances this will place the sample lines at right angles to the contours. The degree of site variation and the intended use of the information should determine the sampling intensity.

In addition to the measurement of diameter growth on tree stumps, use should be made of other recognizable features which are related to site quality. The most important of these are soil depth and texture, topographic location, and soil drainage. The more productive sites are usually associated with deep, well-drained soils having a high proportion of fine-textured materials, and with well-drained soils of various textural classes receiving seepage water. The less productive soils are usually associated with either a surplus or a deficiency of soil moisture. They are characterized by either imperfectly drained soils receiving abundant water or those having a low moisture-holding capacity and no supply of seepage moisture, such as deep, coarse-textured soils or very shallow soils.

The composition of the ground vegetation may also provide some assistance in the site estimations of logged lands even though it has been changed drastically by logging. For example, it is highly probable that logged land with a cover of salal (Gaultheria shallon) has a site index of less than 120. Similarly, logged land probably has a site index in excess of 120 if any of the following species are in abundance: May

* This table is based upon data from "The yield of Douglas fir in the Pacific Northwest" (Op. cit.).

leaf (Achlys triphylla), Sword fern (Polystichum munitum), Lady fern (Athyrium felix-femina), Oak fern (Dryopteris Linnaeana), and Shield fern (Dryopteris austriaca). Abundant fireweed (Chamaenerion angustifolium), with a height in excess of 4 feet, also indicates a site index better than 120. Although evaluation of the ground vegetation can be useful in assessing site quality, care must be taken to avoid misinterpretation because the severity and number of fires since logging may cause floristic changes not related to site quality.

CONCLUSIONS

This report gives a practical method for estimating the site-quality of logged land in terms of site index and of forest associations, either of which may be of value to the forester. More field data have gone into the preparation of a method for predicting forest associations than into the site-index method, and the former has a higher degree of success in prediction. Four site classes, however, have been predicted in terms of site index as compared to three forest associations. It should be stressed that this method of estimating site-quality, by means of stump diameter-growth measurements, is not an exact one, but merely serves as a rough guide toward the mapping of logged land.