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GROUND VEGETATION AS AN INDEX OF SITE QUALITY IN WHITE SPRUCE PLANTATIONS

by
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Ground Vegetation as an Index of Site Quality in White Spruce Plantations

(Project Q-11)

BY

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INTRODUCTION

Reliable relationships between minor plant associations and site quality in the Boreal Forest Region have been established by Linteau (5). Similar relationships are believed to exist in the Adirondack region (4), and also in the Lake Edward Forest Experimental Area in the Great Lakes—St. Lawrence Forest Region (4, 6).

Recently it was observed in pure white spruce, *Picea glauca* (Moench) Voss, plantations on sandy old farm land at Grand'Mère, P.Q., that plant associations varied with site quality and productivity as interpreted by height growth and stand volume respectively.

This report describes a test of the validity of ground vegetation as an index of site quality in these plantations. Dominant height was used to verify the classification by ground vegetation. Height-diameter curves and volume data are presented to substantiate the correlation further.

THE AREA

The field work was done in late May and early June of 1957 in a part of the plantations established near Grand'Mère, P.Q., during the period 1920-1932 by the Laurentide Company. This region was opened for colonization in 1880 and farmed for some 40 years before being reforested. It is 20 miles north of the St. Lawrence River and just north of the boundary between Sections L-3 and L-4 of the Great Lakes—St. Lawrence Forest Region (3). The plantations, which are now owned and managed by the Consolidated Paper Corporation, were surveyed in 1946 by the Forestry Branch and a report was published in 1953 (2).

The 3,000-acre area in which this study was carried out is located east of the St. Maurice River and about six miles south of Grand'Mère. The plantations are largely pure white spruce, and known as the Proulx Block. According to Corporation records the planting stock was produced locally from local seed and was established in 1926. As yet no thinning has been done in these stands.

The soil consists of old marine sand deposits about 15 feet deep resting on a deep impervious deposit of blue clay. Occasionally the latter appears at the surface. The texture of the surface soil is a loamy fine sand. Field capacity measured *in situ* is about 20 per cent and total colloids 3 per cent.

[1] Forestry Officers, Forest Research Division, Forestry Branch, Quebec District Office, Valcartier, P.Q.

DESCRIPTION OF SITE TYPES

The site types identified were the same as those defined or suggested by Linteau when he carried out a fertilization experiment in another part of the same plantations.[1] These types are listed here and described briefly in decreasing order of quality: (1) Calliergon (Cal), (2) Calliergon-Polytrichum (Cal-Pol), and (3) Cladonia-Polytrichum (Cla-Pol).

(1) The Calliergon type consists of patches of *Calliergon schreberi* moss. The remainder of the forest floor is devoid of all vegetation. In extremely dense stands the moss appears as small scattered patches whereas in the more open stands it forms a more or less continuous carpet.

(2) The Calliergon-Polytrichum type consists principally of *Calliergon schreberi* and *Polytrichum commune* with scattered specimens of other plants. The two mosses exist in varying proportion but form a fairly continuous carpet.

(3) Cladonia-Polytrichum type consists of *Cladonia* Sp. and *Polytrichum commune*. Cladonia varies from small patches to an almost continuous carpet. Polytrichum and scattered specimens of other plants complete the ground cover.

Table 1 lists the plants present in the Calliergon-Polytrichum and Cladonia-Polytrichum types with cover degree, abundance and sociability values. The vegetation in the Calliergon type is omitted because it consists almost entirely of *Calliergon schreberi*. A few stems of Polytrichum are sometimes present.

Sociability 3 and 5 and abundance 4 and 5 are included as part of the scale to give the whole picture, even though they do not occur in the recorded data.

[1] Unpublished data.

TABLE 1.—CHARACTERISTIC VEGETATION OF CALLIERGON-POLYTRICHUM AND CLADONIA-POLYTRICHUM SITE TYPES*

Species	Calliergon-Polytrichum Type		Cladonia-Polytrichum Type	
	Abundance	Sociability	Abundance	Sociability
Cladonia Sp.	x	1	3	4
Calliergon schreberi	3	4	1	
Dicranum undulatum	x	2	x	
Hypnum crista-castrensis	x	1		
Polytrichum commune and juniperinum	2	4	3	4
Equisetum sylvaticum	x	1		
Lycopodium clavatum	x	2	x	1
Lycopodium complanatum	x	1	x	1
Osmunda cinnamomea	x	1	x	1
Pteridium aquilinum	x	1	x	1
Osmunda claytoniana			x	1
Achillaea millefolium	x	1		
Antennaria canadensis			x	1
Aster acuminatus	x	1	x	1
Clintonia borealis	x	1		
Corallorhiza maculata	x	1		
Coptis groenlandica	x	1		
Epilobium angustifolium	x	1		
Hieracium Sp.	x	1		
Monotropa uniflora	x	1		
Rubus Sp.	x	1		
Spiraea latifolia	x	1	x	1
Viola incognita	x	1		
Carex Sp.	x	1		
Chimaphila umbellata	x	1		
Kalmia angustifolia			x	1
Pyrola secunda	1	1	x	1
Vaccinium pensylvanicum	x		x	1
REGENERATION				
Abies balsamea	x	2		
Picea glauca	x	1		
Populus tremuloides	x	1		

SCALE OF ABUNDANCE

- x Sparse
- 1 Plentiful
- 2 Very numerous
- 3 Covering $\frac{1}{4}$ to $\frac{1}{2}$ of the area
- 4 Covering $\frac{1}{2}$ to $\frac{3}{4}$ of the area
- 5 Covering more than $\frac{3}{4}$ of the area

SCALE OF SOCIABILITY

- 1 Growing one in place, singly
- 2 Grouped or tufts
- 3 In groups, small patches
- 4 In small colonies, extensive patches or forming carpet
- 5 In great crowds or pure populations

* Unpublished data.

PROCEDURE

Field

Sixty-two square tenth-acre plots were established at 10-chain intervals along lines spaced 10 to 30 chains apart and permanently marked by holes one foot in diameter and two feet in depth at the plot corners.

As soon as established and before stand measurement, each plot was classified as to ground vegetation. Tree diameters were taken with calipers and recorded by inch classes. A horizontal scribe mark was made on each tree at the point of measurement. The ten largest trees in a plot were measured for height to the nearest foot with a sectional pole. These measurements were used to establish dominant height for each plot and were pooled with those of smaller trees to draw a height-diameter curve. Site classification and stand measurements were regarded as completely separate operations in the field, and once established the types were left unchanged.

Office

The plots were sorted by site type and later by quality class, i.e. good, medium, and poor. The average dominant height was calculated for each plot and site type. Local volume tables were derived from the height-diameter curves and the interpolated volume tables (1). Form class 65 was assumed for the three site types. Stand and stock tables were then calculated.

RESULTS

The number of plots in each site type was as follows: Cal, 6; Cal-Pol, 28; Cla-Pol, 28. The stand characteristics peculiar to each type are shown hereafter.

TABLE 2.—DOMINANT HEIGHT OF 31-YEAR-OLD WHITE SPRUCE

Site Type	Number of Plots	Average Dominant Height	Minimum and Maximum of Plots		Range
Cal	6	38.8	36.6	40.9	4.3
Cal-Pol	28	27.8	22.3	34.5	12.2
Cla-Pol	28	21.3	18.4	24.5	6.1

The data in Table 2 indicate that the three site types are distinct as to quality. The absence of overlap in Calliergon and Calliergon-Polytrichum may be due to the small number of plots in the Cal type, or there may be no real transition zone between them. Possibly all six plots fell in the better Cal stands but present quality may also be the result of past use of the land and therefore show sharp changes at old fence lines.

There is some overlapping of Cal-Pol over Cla-Pol with 3 Cal-Pol plots below the maximum Cla-Pol value and 7 Cla-Pol plots above the Cal-Pol minimum value.

As evidenced by the frequency distribution of the plots (Table 3), volume shows the same tendency as dominant height. Here again there is no overlap between the Cal and Cal-Pol, and only a slight one in Cal-Pol and Cla-Pol in the 26-50 cu. ft. class.

TABLE 3.—FREQUENCY DISTRIBUTION OF INDIVIDUAL PLOT VOLUMES

Volume Class Limits (cu. ft.)	Site Types		
	Cal	Cal-Pol	Cla-Pol
1 - 25			7
26 - 50		1	21
51 - 75		15	
76 - 100		8	
101 - 125		4	
126 - 150			
151 - 175	2		
176 - 200			
201 - 225	3		
226 - 250			
251 - 275	1		
Number of Plots	6	28	28
Range of Volumes	264 — 175	117 — 49	50 — 20

Further evidence of the close relationship between site quality, productivity and ground vegetation is provided by the comparison of several other growth characteristics of the stands (Table 4). These are expressed as averages per acre. Appreciable differences in survival, size and growth are observed among the three site types.

TABLE 4.—STAND CHARACTERISTICS IN 31-YEAR-OLD WHITE SPRUCE PLANTATIONS, 1957.

(per acre values—1" d.b.h. and up)

Stand Characteristics	Site Types		
	Cal	Cal-Pol	Cla-Pol
Number of trees	1,140	878	614
Basal area (square feet)	134	62	27
Average diameter (inches)	4.7	3.6	2.8
Average height (feet)	31	21	17
Total volume (cubic feet)	2,080	727	262
M.A.I. cubic feet 31 years	67	23	8

The height-diameter curves for the three site types are shown in Figure 1. The different levels of the curves could reflect a disparity of tree form between the site types. Therefore, the differences between actual volumes may be even greater than those indicated in Tables 3 and 4 which were calculated assuming form class to be constant for all three types.

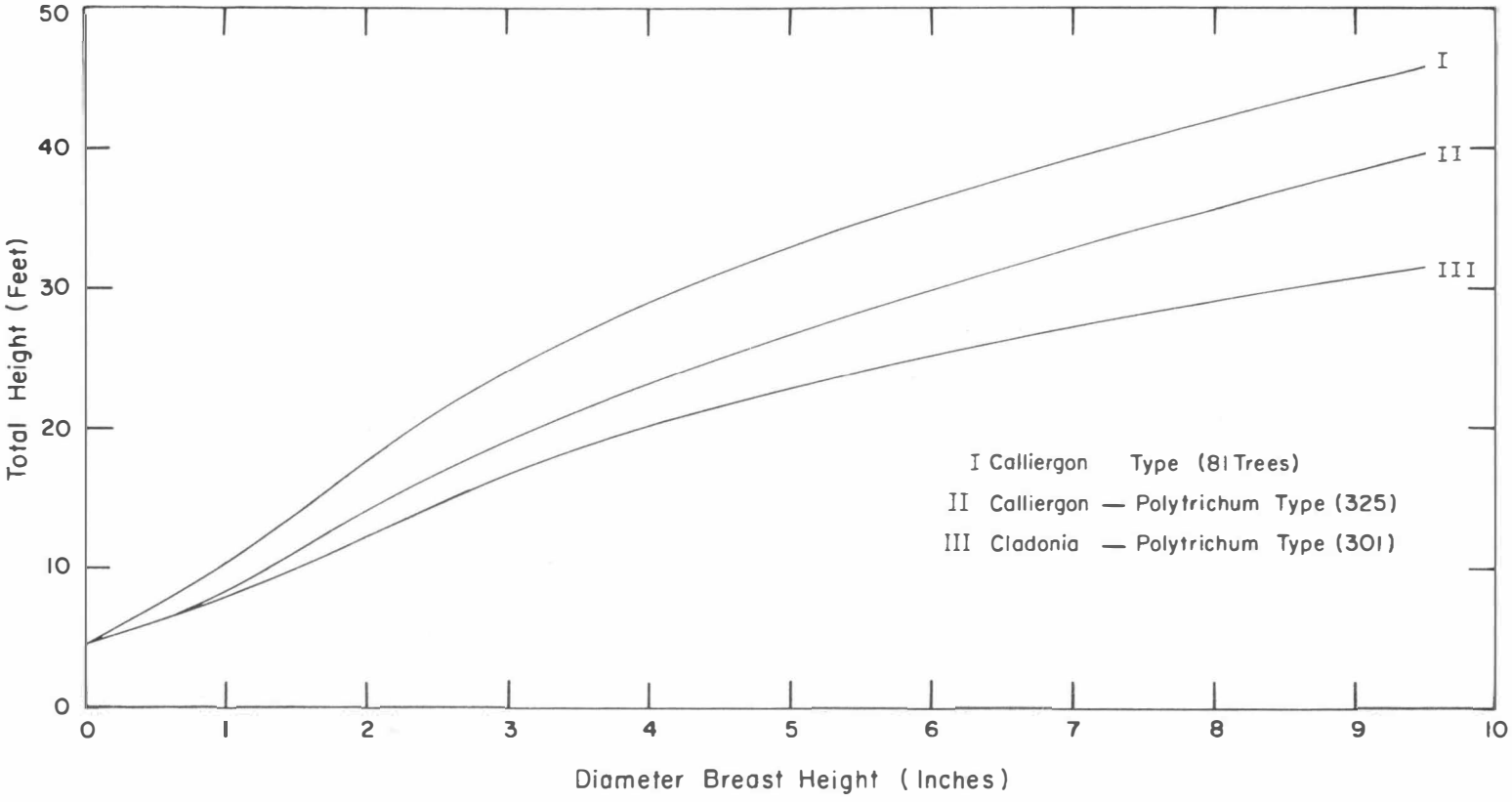

FIGURE 1. Height-diameter curves for 31-year-old white spruce in Grand'Mère plantations, 1957.

CONCLUSIONS

The results of this study strongly suggest that ground vegetation or temporary plant associations provide a satisfactory measure of the site quality on soil disturbed formerly by agricultural cropping. Variations in the rate of growth of planted white spruce at Grand'Mère are shown to be correlated with the presence of certain vegetation patterns. It is highly probable also that the effects of past use of the soil are still being felt and reflected in tree growth.

Despite some fluctuation in the abundance of certain plants, the site types as defined in this study are simple and easy to identify. For example, in the Proulx Block and elsewhere the moss, Calliergon, in the Calliergon type, varies in abundance inversely with stand density. Under an interrupted canopy in thinned stands a number of other plants becomes established; the latter do not greatly affect the abundance of Calliergon which remains the principal component of the ground vegetation. Conversely, in very dense stands the moss is present only in small scattered patches and the ground remains devoid of other vegetation.

In spite of a wide variation of the canopy density in Cal-Pol and Cla-Pol, there is little change in the lesser vegetation and these types are easy to identify.

The close relationship of the three types with stand productivity in white spruce plantations indicates the possibility of extending the site classification to other areas where the present vegetation arose following a major and relatively recent disturbance. The same types have been observed in points located far from Grand'Mère.

It must be added that some of the types defined here are associated with nutrient deficiencies in the soil and their occurrence is of diagnostic value since these are observed even before the deficiency symptoms themselves. Other types connected with old fields are found in other parts of the province. Their identification and correlation with growth, and study of the response of other tree species, would provide useful information for planting site classification, plantation management, and research.

SUMMARY

The stands on 62 tenth-acre permanent sample plots in a 31-year-old white spruce plantation on old farm land at Grand'Mère, P.Q. were assigned to good, medium and poor quality classes identified by ground vegetation.

Height measurements of dominant trees on the plots indicated that the quality classes revealed by vegetation were valid. Volume growth, basal area, average height and diameter, and survival all gave the same indication.

Several workers have shown that site quality can be evaluated on the basis of plant associations in undisturbed stands. The present study indicates that similar relationships hold for disturbed areas as well.

The need for a more complete knowledge of plant succession in disturbed areas as a guide to reforestation is suggested.

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