A PRELIMINARY STUDY TO ASSESS COMPETITION IN A WHITE SPRUCE - TREMBLING ASPEN STAND¹

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This note presents the results of a preliminary investigation made in 1961 in a white spruce-trembling aspen³ stand near Reserve, Saskatchewan. The purpose of the investigation was to determine how the diameter increment of individual white spruce trees is influenced by the proximity of surrounding trees. Aspen ranged from 60 to 70 years in age, 40 to 70 feet in height and 4 to 12 inches in diameter; white spruce ranged from 40 to 70 years in age, 20 to 50 feet in height and 1 to 10 inches in diameter.

Although the study was limited in scope, the procedures used have shown promise and they may provide a lead for the development of mathematical formulae to express competition in such stands.

Thirty-eight white spruce trees, 4 to 10 inches in diameter, were selected for study. Their total height, breast-height diameter and 10-year (1951-1961) diameter increment (range: 0.5 to 3.5 inches) were determined. Diameter

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³*Picea glauca* (Moench) Voss, *Populus tremuloides* Michx.

at breast height of all trees within a 25-foot radius of each sample tree and their distance (stem to stem) from the sample tree were measured. Competition indices were derived from the following formulae,

$$(1) \sum \frac{l-n}{D^2}, \quad (2) \sum \frac{l-n}{D^2}, \quad (3) \sum \frac{l-n}{D}, \quad (4) \sum \frac{l-n}{D} \text{ and} \\ (5) \sum BA$$

where d = breast-height diameter in inches of a surrounding tree, D = distance in feet from a sample tree to a surrounding tree, BA = basal area in square feet of a surrounding tree and n = number of surrounding trees within specific radii from a sample tree.

Sample trees were grouped into two diameter groups (4-6 and 7-10 inches), and the 10-year diameter increment of trees within each group was correlated with the competition indices derived from the above formulae. Correlation coefficients are shown in Table 1. For trees in the 7 to 10 inch-diameter group, all coefficients were significant at the 1 per cent level. However, for trees in the 4 to 6 inch-diameter group only some of the coefficients were significant at the 1 per cent level.

Coefficients of correlation for indices 1 and 2, which incorporate squared distances, were lower than those for the other indices. This would suggest that linear distance between trees rather than squared distance should be used in the development of mathematical methods to express competition.

Basal area summation (index 5) gave the best correlation. For the 4 to 6-inch trees, 7 per cent of the variation in diameter increment was accounted for by the basal area of surrounding trees within 10 feet. This percentage increased to 24, 46 and 56 respectively when surrounding trees within 15, 20 and 25 feet radii were used. For the 7 to 10-inch trees, 55 per cent of the variation in diameter increment was accounted for by the basal area of surrounding trees within 10 feet, and 76 per cent by the basal area of surrounding trees within 15 feet. When the basal area of trees beyond 15 feet was included the per cent variation accounted for decreased slightly. These results compare favourably with those of Spurr (1962)⁵, who found that basal area increment of individual trees in a Douglas fir⁶ plantation in New Zealand was correlated with basal area of the surrounding trees, as estimated by angle summation.

The relationship between 10-year diameter increment of sample trees and basal area (index 5) of surrounding trees within radii of 10, 15, 20 and 25 feet is expressed by the equations in Table 2. Diameter increment decreased with increasing basal area of surrounding trees within the specified distances.

The variation in diameter increment not accounted for by the indices may be attributed to inadequacies of the methods used. Also, had information been collected on crown size and vigour of sample and competing trees, perhaps a greater percentage of the variations in diameter increment could have been accounted for.

⁴ Equivalent to squared correlation coefficient.

⁵ Spurr, S. H. 1962. A measure of point density. Forest Science, Vol. 8, No. 1, pp. 85-96.

⁶ *Pseudotsuga menziesii* (Mirb.) Franco.

TABLE 1
COEFFICIENTS OF CORRELATION BETWEEN 10-YEAR INCREMENT (1951-1961)
OF SAMPLE TREES AND VARIOUS COMPETITION INDICES

radius (feet)	Competition indices				
	1	2	3	4	5
	1-n Σ d n²	1-n Σ d² n²	1-n Σ d n	1-n Σ d² n	1-n Σ BA
Maximum					
Sample trees 4-6 inches d.b.h. (basis — 20 trees)					
10	— .24	— .26	— .36	— .40	— .26
15	— .28	— .30	— .53*	— .56**	— .49*
20	— .30	— .33	— .58**	— .63**	— .68**
25	— .31	— .34	— .65**	— .68**	— .75**
Sample trees 7-10 inches d.b.h. (basis — 18 trees)					
10	— .60**	— .58**	— .69**	— .68**	— .74**
15	— .67**	— .67**	— .78**	— .84**	— .87**
20	— .68**	— .69**	— .78**	— .83**	— .86**
25	— .69**	— .70**	— .78**	— .82**	— .81**

* Significant at 5% level

** Significant at 1% level

TABLE 2
RELATIONSHIP BETWEEN 10-YEAR DIAMETER INCREMENT (1951-1961)
OF SAMPLES AND THE SUM OF THE BASAL AREAS OF SURROUNDING TREES

Maximum radius (feet)	Correlation coefficient (r)	Linear relationship	Standard error of estimate (Se)
Sample trees 4-6 inches d.b.h. (basis — 20 trees)			
10	— .26	y = — 7.69x + 6.41	± 3.14
15	— .49*	y = — 2.46x + 5.67	± 1.68
20	— .68**	y = — .87x + 4.60	± .915
25	— .75**	y = — .57x + 4.64	± .759
Sample trees 7-10 inches d.b.h. (basis — 18 trees)			
10	— .74**	y = — 1.78x + 3.26	± .670
15	— .87**	y = — 1.10x + 3.52	± .410
20	— .86**	y = — .68x + 3.73	± .442
25	— .81**	y = — .48x + 3.89	± .540

y = 10-year diameter increment in inches.

x = sum of the basal area of surrounding trees in sq. ft.