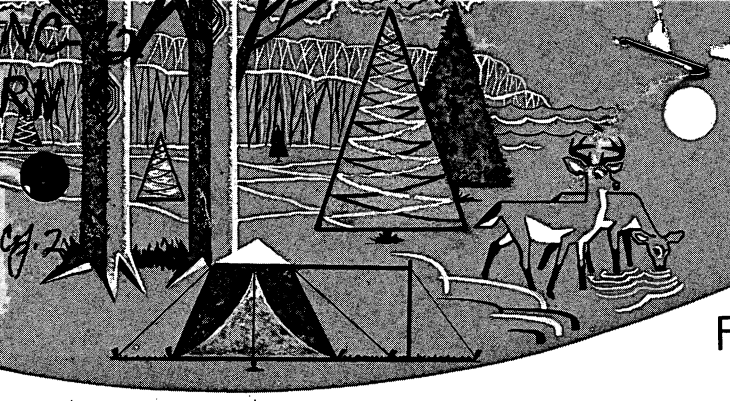

RESEARCH NOTE NC-72

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE
Folwell Avenue, St. Paul, Minnesota 55101

Fifteen-Year Growth of a Thinned White Spruce Plantation

ABSTRACT. — Mean annual increment at age 38 in a thinned white spruce plantation was 102 cubic feet or 0.85 cords per acre per year. Periodic annual increment during the 15 years after thinning seemed to be maximum for residual basal areas between 100 and 120 square feet per acre.
OXFORD: 562.2:174.7 *Picea glauca*: **(775):242**

White spruce does not occur naturally in pure stands, and most of the existing spruce plantations are still too young to provide useful yield estimates. However, growth following experimental thinning in a 23-year-old plantation on the Menominee Indian Reservation in northeastern Wisconsin gives some idea of their potential productivity. This is one of the oldest spruce plantations in the Lake States. The thinning study artificially created a range of stocking levels, and growth records were kept from 1949 to 1964.

The plantation was established in 1926 on a sandy loam soil which had previously been farmed. Initial spacing was extremely close, about 2 x 4 feet (5,400 trees per acre). The original intention of the planters was to thin the stand repeatedly for Christmas trees, but only a few trees were actually removed for this purpose. Survival was surprisingly good and in 1949 stocking still averaged more than 4,000 live trees per acre.

Method

The thinning treatments were installed during the 1948-49 dormant season in a 6 x 2 chain portion of the plantation which was subdivided into two blocks. Each block contained six 1/10-acre square plots. Treatments were assigned randomly within each block. In each block one plot was left unthinned and the other plots were thinned from below to one of five assigned densities, i.e. 750, 1,000, 1,250, 1,500, or 1,750 trees per acre. D.b.h. was measured on all trees to the nearest 1/10-inch, and total height was measured to the nearest foot on a large sample of the trees. The stand was measured in 1949, 1956, and 1964, but only the total 15-year growth will be discussed here.

No isolation strips were provided between the plots. This, together with limited replication and site variation within the study area makes a formalized statistical treatment of the data inappropriate. Summaries of the observations indicate the effect of thinning on growth, but the reader is not advised to generalize too broadly from these indications.

Results

Stand and growth data (tables 1 and 2) can be summarized briefly as follows:

1. During the 15-year period (23 to 38 years after planting) mortality was high in the unthinned stands. They were severely overcrowded at 23 years, and nearly half of the trees had died from suppression by the 38th year. Mortality in the thinned stands was much lighter, but there was no obvious or consistent relationship between mortality and thinning intensity.

2. Net basal area growth during the 15-year period averaged 8.3 square feet per acre per year on the thinned plots, but there was no clear relationship between growth and number of trees per acre. Net annual basal area growth on the unthinned plots averaged only 6.0 square feet per acre, indicating that there was not enough expression of dominance to offset the effects of overcrowding.

3. Diameter growth on thinned plots was inversely proportional to the number of trees per acre. By 1964, average d.b.h. ranged from 7.2 inches on one of the heavily thinned plots to 4.7 inches on one of the unthinned plots.

4. Height growth was apparently unaffected by thinning intensity. Much of the variation that was observed is probably due to site changes within the study area.

5. Net cubic foot volume growth averaged 180 cubic feet per acre per year from 1949 to 1964; mean annual increment averaged 102 cubic feet per acre.

6. Periodic annual increment for the 15-year period averaged 1.94 cords per acre. Mean annual increment was 0.85 cords per acre.

7. Volume growth appeared unaffected by the number of trees per acre, but there was some indication that volume growth was related to basal area after thinning (Figs. 1, 2). Actual observations were plotted, and curves were fitted by the least squares method. Much of the variation around the curves can be accounted for by the site variation on the study area. However, because of the small sample, no attempt was made to remove the effect of site. It appears that volume growth increased with higher residual basal area up to about 100 or 120 square feet and then dropped off. Much more information will be needed, of course, before the exact shape and level of these curves can be defined.

Table 1. — Stand conditions in 1949 and 1964; and 15-year growth in d.b.h., basal area, and height

Plot No.	Number of trees per acre: After thinning in 1949	Number of trees per acre: Still alive in 1964	Mortality (In percent)	Total basal area per acre (In sq. ft.): After thinning in 1949	Total basal area per acre (In sq. ft.): Live trees in 1964	Total basal area per acre (In sq. ft.): 15-yr. net growth	Average d.b.h. (In inches): After thinning in 1949	Average d.b.h. (In inches): 1964	Average d.b.h. (In inches): Net change	Average height (all trees) (In feet): After thinning in 1949	Average height (all trees) (In feet): 1964	Average height (all trees) (In feet): 15-yr. growth
THINNED												
1	740	690	6.8	67.9	192.9	125.0	4.1	7.2	3.1	24.9	50.1	25.2
2	760	660	13.2	54.7	161.6	106.9	3.6	6.7	3.1	23.2	46.6	23.4
3	910	850	6.6	44.8	165.6	120.8	3.0	6.0	3.0	19.0	40.4	21.4
4	1,000	970	3.0	41.4	157.5	116.1	2.8	5.5	2.7	18.9	43.2	24.3
5	1,230	1,140	7.3	51.8	173.8	122.0	2.8	5.3	2.5	18.8	42.5	23.7
6	1,250	1,210	3.2	60.0	195.4	135.4	3.0	5.4	2.4	18.5	45.3	26.8
7	1,500	1,400	6.7	75.4	194.3	118.9	3.0	5.0	2.0	20.2	42.0	21.8
8	1,500	1,390	7.3	101.6	235.4	133.8	3.5	5.6	2.1	22.5	46.2	23.7
9	1,740	1,500	13.8	103.2	229.7	126.5	3.3	5.3	2.0	21.1	44.5	23.4
10	1,760	1,640	6.8	95.8	236.0	140.2	3.2	5.1	1.9	21.4	44.0	22.6
UNTHINNED												
11	3,770	2,010	46.7	141.2	240.2	99.0	2.6	4.7	2.1	19.8	40.1	20.3
12	3,890	1,880	51.7	154.7	236.6	81.9	2.7	4.8	2.1	18.7	40.5	21.8

Table 2. — Standing volume in 1949 and 1964, and volume growth in cubic feet and cords[1]

Plot No.	Number trees per acre after thinning in 1949	Volume in cubic feet: After thinning in 1949	Standing in 1964	Net periodic annual growth 1949-1964	Net mean annual growth (for 38 years) 1/	Volume in cords: After thinning in 1949	Standing in 1964	Net periodic annual growth 1949-1964	Net mean annual growth (for 38 years) 2/
1	740	1,009	4,106	206	110	6.8	40.5	2.25	1.06
2	760	696	3,359	177	99	3.2	32.4	1.95	.85
3	910	532	3,189	177	99	1.1	29.2	1.87	.77
4	1,000	457	2,805	157	91	0.7	24.5	1.59	.65
5	1,230	576	3,049	165	94	0.8	26.1	1.69	.69
6	1,250	722	3,597	192	104	2.2	31.6	1.96	.83
7	1,500	869	3,354	166	94	1.8	28.1	1.75	.74
8	1,500	1,330	4,481	210	112	6.2	40.2	2.27	1.06
9	1,740	1,333	4,082	183	101	5.4	35.3	1.99	.93
10	1,760	1,156	4,140	199	107	3.6	35.0	2.09	.92
11	3,770	1,558	4,062	167	107	3.1	32.3	1.95	.85
12	3,890	1,721	4,121	160	108	4.5	33.5	1.93	.88
Average	--	--	--	180	102	--	--	1.94	0.85

1/ Cubic foot volume is total volume for the entire stem of all trees, and cordwood volume is in rough cords to a variable top diameter inside bark of not less than 3.0 inches for all trees 3.6 inches or larger at breast height based on volume tables 3 and 5 respectively, Gevorkiantz, S. R. and L. P. Olsen. Composite volume tables for timber and their application in the Lake States. U.S.D.A. Tech. Bull. 1104, 51 p.

2/ Mean annual growth = $\frac{\text{Standing volume in 1964 + Volume removed in 1949}}{38}$

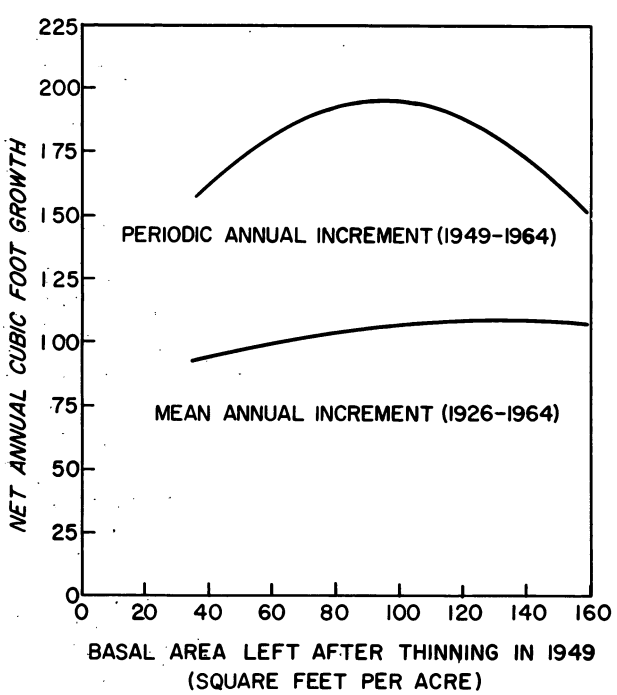

FIGURE 1. — Mean annual increment and periodic annual increment in cubic feet per acre, in relation to basal area stocking in 1949.

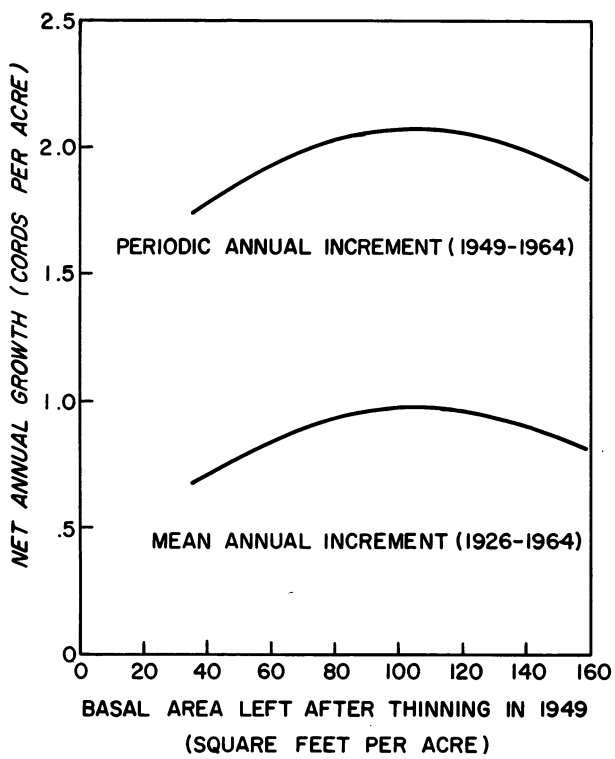

FIGURE 2. — Mean annual increment and periodic annual increment in cords per acre, in relation to basal area stocking in 1949.

Conclusions

White spruce is considered a slow grower when young, but the growth figures reported here indicate that this species is a better producer than was previously thought. Even though this plantation grew at high density for 23 years, the heavily thinned plots responded well and by 1964 (38 years after planting) many of the trees exceeded 8 inches in diameter and 50 feet in height. Merchantable volume per acre averaged about 36 cords. If volume production is our criterion, white spruce might be a good choice for reforestation on certain sites.

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