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INTRODUCTION

Mixedwood stands of white spruce (*Picea glauca* (Moench) Voss) and trembling aspen (*Populus tremuloides* Michaux) constitute about one-third of Saskatchewan's commercial forest area (Kirby 1962) and form the principal source of white spruce in that province.

Since the spruce component usually develops under an aspen canopy, it is often suppressed and exposed to mechanical injury. Consequently the growth of spruce may be reduced and much potential volume can be lost (Kagis 1952, Kabzems 1952, Cayford 1957).

Non-commercial experimental release cuttings to favor spruce in mixedwood stands up to age 60 (Steneker 1963, 1967) have resulted in marked increases in merchantable volume production and diameter growth. Lees (1966) also showed good response to release by white spruce, particularly in the 30- to 50-year age range.

In 1961 a study was initiated in cooperation with the Saskatchewan Department of Natural Resources to determine the effect of commercial release cuttings in 75- to 100-year-old mixedwood stands upon subsequent total and merchantable volume production of the residual white spruce.

This report presents growth data for two stands 10 years after release. Data are also presented on the relationship between diameter increment of spruce trees and the basal area and proximity of competitors.

STUDY AREAS

The two areas selected for the release cutting were located in western Saskatchewan in the B18a Mixedwood Forest Section (Rowe 1972). One area was selected near Sled Lake, about 120 miles northwest of Prince Albert, Saskatchewan. The stand was growing on a fresh loam

till. The aspen component had reached maturity and in various places the white spruce had broken through the aspen canopy.

A second area was selected in the Divide Forest Reserve, about 10 miles south of Meadow Lake, Saskatchewan, where the stand was growing on a moderately moist silty loam till. The aspen component was nearing maturity and showed better growth than the Sled Lake stand. Again the spruce had broken through the aspen canopy in various places. Average stand particulars per acre for both areas are given in Table 1.

To study the diameter increment of individual spruce trees in relation to the proximity and size of competitors, a third white spruce-trembling aspen stand was selected about 2 miles from the Divide stand. Stand conditions were approximately the same as for the Divide area, except that the stand contained a larger number of aspen per acre.

METHODS

The Saskatchewan Department of Natural Resources carried out a release cutting in the Divide stand in 1961-62 and in the Sled Lake stand in 1962-63. Objective of the cutting was to leave good quality spruce crop trees and provide for increased increment until rotation age at about 110-120 years. Spruce in the 10- to 14-in. (25-35 cm) diameter range were removed together with some good quality aspen. Subsequent to the cutting, remaining aspen trees in direct overhead competition with the residual spruce were either cut and left or girdled. A few additional smaller spruce were also removed. Portions of each stand were left uncut and served as controls. At Sled Lake the aspen and spruce basal areas were reduced by about 50% and 30% respectively. At Divide reduction in white spruce basal area averaged 25% and reduction in aspen stocking varied.

TABLE 1. Average Stand Data per Acre at Time of Release for the Divide and Sled Lake Areas

Locality	Age		Height (ft)		No. of trees		Dbh* (in)		Basal area (sq ft)		Total volume (cu ft)	
	wS	tA	wS	tA	wS	tA	wS	tA	wS	tA	wS	tA
Sled Lake	85	100	40-85 (12-26 m)	90 (27 m)	360	190	7.4 (18.8 cm)	9.0 (22.9 cm)	95 (8.8 m^2)	85 (7.9 m^2)	2700 (76 cm^3)	2450 (69 m^3)
Divide	75	85	50-80 (15-24 m)	80 (24 m)	390	35	7.7 (19.6 cm)	9.3 (23.6 cm)	125 (11.6 m)	16 (1.5 m^2)	3350 (95 m^3)	550 (16 m^3)

Stem diameter at 4.5 ft (1.37 m)

Four 1/5-acre permanent sample plots were established in each of the released and unreleased portions of each stand. All trees on these plots were tallied by 1-in. (2.54-cm) dbh classes before and after the cutting operation. Height measurements were taken for the construction of height-diameter curves for each species. Stand data per acre for each plot are presented in Tables 2A and 2B.

In 1971 trees on all plots were remeasured. In addition, increment cores were collected from a number of trees on the release and control plots in the Divide stand.

In the competitor study area 99 white spruce trees ranging in dbh from 8 to 16 in. (20-40 cm) were selected and tagged in 1965. Diameter at breast height of these trees was measured in addition to the dbh and proximity of all competitors within a radius of 30 ft (9.1 m). In 1971 the diameter of all tagged spruce was remeasured.

RESULTS AND DISCUSSION

The release cutting did not result in an increase in total cubic-foot or board-foot volume production of the white spruce (Table 3). In fact, the data indicate a slight loss in total production to 1971. Since spruce volumes before cutting varied on the different plots, cubic-foot and board-foot volume production to 1971 for each plot was related to initial volume before cutting (Fig. 1). Again, no increase in production was evident.

Average total volume production to 1971 on the control plots in the two areas (Table 3) did not differ greatly (4,068 and 4,327 cu ft or 115 and 122 m^2). Furthermore, average periodic annual total volume increment on these plots since the time of release averaged 76 and 80

DIVIDE AREA

Treatment	Plot No.	Species	Basal area (sq ft) 1961 BR*	1961 AR*	1971	1961 BR	1961 AR	1971	Total volume (cu ft) 1961 BR	1961 AR	1971	Merchantable volume (bd ft) 1961 BR	1961 AR	1971
Control	2	tA	40	40	40	21	21	24	671	671	790	2,678	2,678	3,385
		wS	355	355	325	119	119	134	3,182	3,182	3,960	12,563	12,563	17,184
Control	4	tA	80	80	70	25	25	28	760	760	829	2,232	2,232	2,802
		wS	380	380	320	119	119	125	3,098	3,098	3,578	11,434	11,434	14,073
Control	5	tA	5	5	5	2	2	3	78	78	97	292	292	408
		wS	490	490	425	132	132	148	3,432	3,432	4,320	12,878	12,878	18,784
Control	8	tA	10	10	5	9	9	6	300	300	216	1,445	1,445	1,151
		wS	495	495	445	139	139	158	3,511	3,511	4,414	11,262	11,262	16,674
Release	1	tA	20	20	0	6	6	0	226	226	0	769	769	0
		wS	365	250	245	136	92	109	3,553	2,561	3,161	13,500	10,423	14,177
Release	3	tA	35	5	5	31	5	5	1,063	163	163	806	806	806
		wS	280	255	240	110	94	113	3,026	2,569	3,399	12,535	10,458	15,600
Release	6	tA	90	55	55	38	18	22	1,113	546	651	3,762	1,515	2,084
		wS	400	290	265	136	101	112	3,521	2,648	3,192	12,408	9,920	13,951
Release	7	tA	10	10	10	6	6	7	218	218	247	959	959	1,137
		wS	380	290	270	125	90	108	3,398	2,464	3,234	14,148	10,368	14,676

*Before release; after release.

TABLE 28. STAND DATA PER ACRE FOR 1962 and 1971
SLED LAKE AREA*

Treatment	Plot No.	Species	No. of trees			Basal area (sq ft)			Total volume (cu ft)			Merchantable volume (bd ft)		
			1962		1971	1962		1971	1962		1971	1962		1971
			BR	AR		BR	AR		BR	AR		BR	AR	
Control	1	tA	215	215	150	93	93	87	3,021	3,021	2,844	11,139	11,139	11,942
		wS	385	385	370	104	104	126	2,788	2,788	3,908	9,250	9,250	15,056
Control	2	tA	175	175	110	71	71	62	2,284	2,284	2,063	8,273	8,273	8,659
		wS	410	410	365	137	137	148	4,189	4,189	4,856	15,964	15,964	20,796
Control	5	tA	145	145	85	67	67	50	2,224	2,224	1,653	8,751	8,751	7,098
		wS	410	410	365	124	124	142	3,747	3,747	4,647	14,180	14,180	19,718
Control	6	tA	180	180	110	82	82	68	2,715	2,715	2,265	10,492	10,492	9,834
		wS	310	310	255	105	105	115	3,289	3,289	3,896	13,348	13,348	17,172
Release	3	tA	250	120	40	104	52	24	3,340	1,673	814	11,790	6,098	3,470
		wS	320	210	175	84	56	64	2,385	1,591	1,982	7,034	4,228	7,975
Release	4	tA	170	95	65	84	38	36	2,844	1,227	1,179	11,176	4,394	4,827
		wS	380	250	240	98	66	76	2,770	1,858	2,356	8,142	5,572	8,552
Release	8	tA	215	130	50	97	55	31	3,176	1,783	1,015	11,962	6,436	4,398
		wS	295	240	215	89	75	85	2,685	2,268	2,800	8,892	7,928	11,564

*One release plot could not be used after the 1962 cutting.

TABLE 3. AVERAGE TOTAL CUBIC FOOT VOLUME PER ACRE OF WHITE SPRUCE AND ASPEN BEFORE RELEASE AND TOTAL CUBIC FOOT AND BOARD FOOT PRODUCTION OF WHITE SPRUCE TO 1971 BY TREATMENT AND AREA

Locality	Treatment	Volume before release (cu ft)		Total production to 1971 of wS	
		wS	tA	(cu ft)	(bd ft)
Divide	Control	3,305	452	4,068	16,679
	Release	3,374	655	4,060	17,456
Sled Lake	Control	3,503	2,561	4,327	18,186
	Release	2,613	1,561	3,087	11,477

cu ft (2.15 and 2.26 m^3) for the Divide and Sled Lake control plots respectively. This is interesting since residual aspen stocking was much lighter on the Divide plots (450 cu ft or 12.74 m^3) than on the Sled Lake plots (2,560 cu ft or 72.45 m^3).

Figure 2 shows the year-by-year radial stem increment of a number of spruce on release and control plots. The graphs suggest some stimulation of diameter increment on the release plots. However, the number of large-sized trees produced to 1971 on the release plots showed no increase.

Correlation between periodic diameter increment (1965-71) of the tagged spruce trees and the basal area of all competitors within radii of 10, 15, 20, 25, and 30 ft respectively (3.0, 4.6, 6.1, 7.6 m and 9.1 m), was very weak. It was not significant for increment and basal area of competitors within 10 ft (Table 4). Including all competitors up to 30 ft away (9.1 m) produced partial correlations (with tree size constant) which were significant at the 1% and 5% levels, but only a maximum of 9% (30-ft radius) of the variation in diameter increment could be accounted for by the basal area of competitors.

TABLE 4. PARTIAL CORRELATION COEFFICIENTS BETWEEN PERIODIC DIAMETER INCREMENT (1965-71) AND THE BASAL AREA OF ALL COMPETITORS WITHIN 10, 15, 20, 25 AND 30 FT

Radius (ft)	Partial corr. coeff. (n = 94)
10	-0.02
15	-0.28**
20	-0.21*
25	-0.23*
30	-0.30**

* 5% level of sign

In these analyses the basal areas of all competitors, whether spruce or aspen, were given the same weight. In an attempt to account for more of the variation in periodic increment of the spruce, the analyses were repeated for competitors within 25- and 30-ft radii (7.6 and 9.1 m), while giving the basal area of aspen competitors weights of 0, 0.5 and 1.5 (i.e. with a weight of 0, only the basal area of the spruce competitors within 25- and 30-ft radii (7.6 and 9.1 m) were correlated with diameter increment. The partial correlations thus obtained are given in Table 5.

TABLE 5. PARTIAL CORRELATION COEFFICIENTS BETWEEN PERIODIC DIAMETER INCREMENT (1965-71) AND THE WEIGHTED BASAL AREA OF ALL COMPETITORS WITHIN 25 AND 30 FT

	Partial corr. coeff. (n = 94)			
Radius	wS + otA	wS + 0.5 tA	wS + tA	wS + 1.5 tA
25'	-0.31**	-0.30**	-0.23*	-0.20
30'	-0.37**	-0.37**	-0.30**	-0.24

* 5% level of sign
** 1% level of sign

A stronger correlation between increment and basal area of competition was obtained by reducing the weight of all aspen competitors to 0.5 and 0.

CONCLUSIONS

The release cutting did not produce any noticeable increase in cubic-foot and board-foot volume production of the white spruce over the 9-10 years of observation. Furthermore, increment response of individual spruce trees was only slight. This is in contrast to data from white

spruce-aspen stands less than 60 years of age (Steneker 1967), where increment response was very marked and maximized 3 years after release. It is concluded that white spruce in the 70- to 80-year range is too old to significantly respond to release. This supports findings by Lees (1966) who recommended release cuttings for spruce only up to an age of about 70 years.

Only 14% of the variation in diameter increment of individual spruce trees could be accounted for by stem diameter and proximity of competitors, compared to a maximum of 75% in younger stands (Steneker and Jarvis 1963). Presumably at older ages diameter at breast height does not adequately represent such other variables as tree health, vigor, and effective crown size.

The study was not designed to provide information on the competitive ability of aspen relative to white spruce. However, results do suggest that in maturing mixedwood stands either the amount of lateral competition received by spruce trees from surrounding aspen trees varies a great deal more than that received from surrounding spruce trees, or lateral competition from aspen trees is less than that from spruce trees. Support for the latter hypothesis is the fact that periodic volume increment of the spruce for the two areas was quite similar although noticeable differences existed in aspen stocking.

REFERENCES

Cayford, J.H. 1957. Influence of the aspen overstorey on white spruce growth in Saskatchewan. Can. Dep. North. Aff. Nat. Resources, For. Br., For. Res. Div. Tech. Note No. 58.

Kabzems, A. 1952. Stand dynamics and development in the mixed forest. For. Chron. 28(1):7-22.

Kagis, I. 1952. Some problems in mixedwood stands. For. Chron. 28(2):6-18.

Kirby, C.L. 1962. The growth and yield of white spruce-aspen stands in Saskatchewan. Sask. Dep. Nat. Resources, For. Br. Tech. Bull. 4.

Lees, J.C. 1966. Release of white spruce from aspen competitors in Alberta's spruce-aspen forest. Can. Dep. For., For. Res. Br. Publ. 1163.

Rowe, J.S. 1972. Forest regions of Canada. Environ. Can. Publ. 1300.

Steneker, G.A. 1963. Results of a 1936 release cutting to favor white spruce in a 50-year-old white spruce-aspen stand in Manitoba. Can. Dep. For., For. Res. Br. Publ. 1005.

Steneker, G.A. and J.M. Jarvis. 1963. A preliminary study to assess competition in a white spruce-trembling aspen stand. For. Chron. 39:334-336.

Steneker, G.A. 1967. Growth of white spruce following release from trembling aspen. Can. Dep. For., For. Res. Br. Publ. 1183.

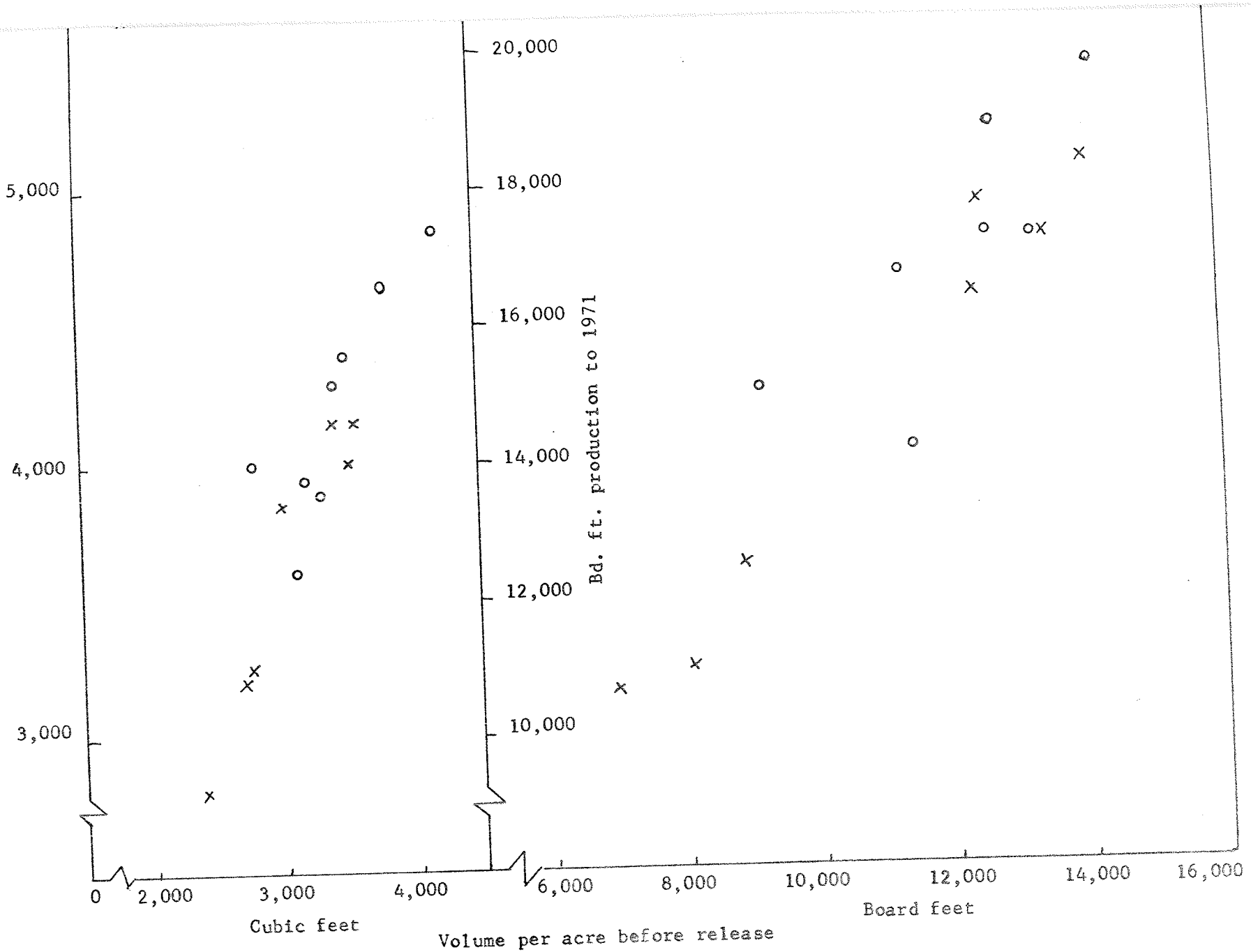

FIGURE 1. Cubic-foot and board-foot production of spruce to 1971 in relation to cubic-foot and board-foot volume per acre of spruce before release.

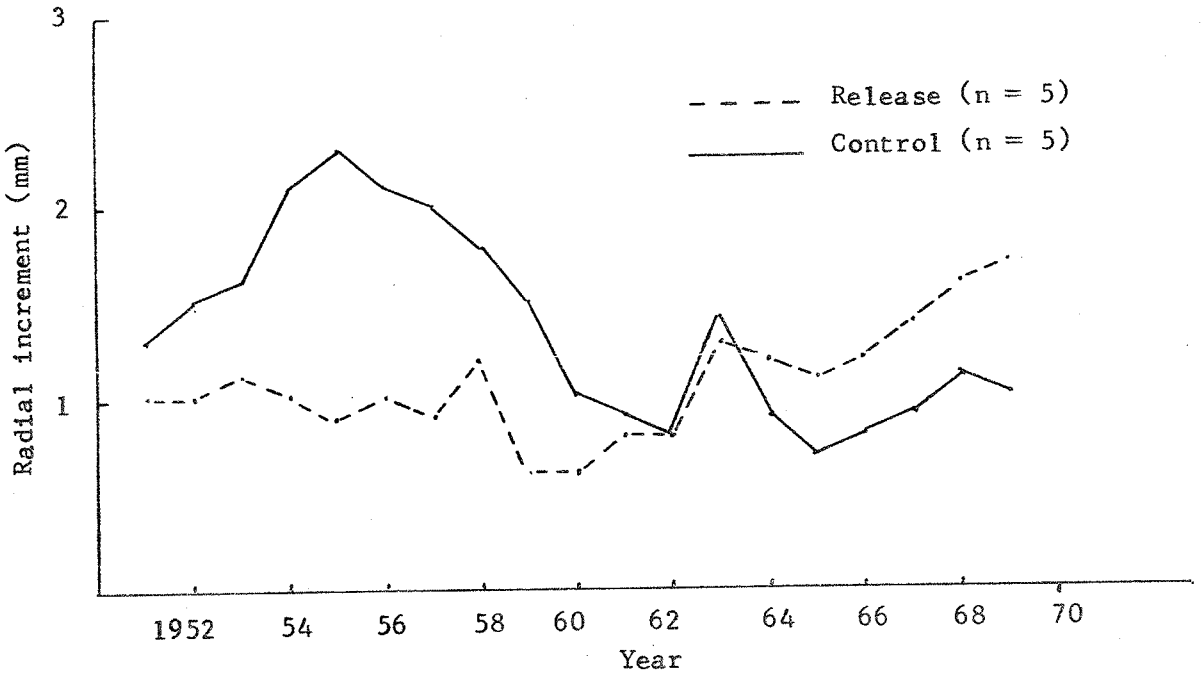

FIGURE 2. Annual radial increment of released and control white spruce trees before and after release cutting in 1961/62.