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RELEASE OF WHITE SPRUCE FROM ASPEN COMPETITION IN ALBERTA'S SPRUCE-ASPEN FOREST

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by

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Photo: Duffy 1957

Frontispiece: White spruce penetrating aspen overstorey.

ABSTRACT

Ten-year remeasurement of white spruce stems released from aspen competition in Alberta's spruce-aspen forest indicated that over a wide diameter and age range, growth of spruce increased significantly after treatment. Trees above a 5-inch breast height diameter limit increased in mean merchantable cubic foot volume by 20 - 40 per cent. Release of spruce from aspen competition should be carried out before the spruce grows into the aspen overstorey. Poisoning cut aspen stumps with ammonium sulphamate prevents regrowth of aspen suckers and sprouts.

Release of white spruce from aspen competition in Alberta's spruce-aspen forest[1]

by

J.C. Lees[2]

INTRODUCTION

Two-storied stands are typical of the spruce-aspen Mixedwood forest in Alberta. The aspen, a vigorous pioneer species forms the overstorey for most of the natural rotation of the stands. At about age 55 to 75 the spruce grows through the overstorey as the older aspen goes into an increasingly decadent stage. The competition factors at the co-dominant stage of the two species are: the mechanical damage to spruce crowns and competition for crown space as well as root space. Recent studies from Manitoba (Steneker 1963) illustrate that the spruce at age 50 shows a definite response to release over a wide diameter range and that a valuable increase in merchantable spruce volume results. However it is not known how early competition for the commercially important spruce begins, or how late the spruce will respond to release from aspen. This report deals with the results of a release study, initiated by J. Quaite[3], in 1951. Selected spruce stems under an aspen canopy were

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released and control stems were selected. Remeasurement in 1956 was carried out by G. Ontkean[4] and results reported by Ontkean and Smithers in 1959. The current remeasurement was carried out by the author in 1962.

DESCRIPTION OF THE AREA

Location

Spruce-aspen stands of varying age were selected for this study within a 30-mile radius of Smith, Alberta in the B-18a Mixedwood Section of the Boreal Forest Region (Rowe 1959). Sample stand locations are shown in Figure 1. The terrain is gently rolling. There are distinct low ridges and wide shallow depressions with grassy sloughs and seasonal watercourses. Physiography derives from extensive glacial deposits, lacustrine deposits from the Lesser Slave Lake basin, and from the recent river action in the Athabasca, Lesser Slave, Salteau and Fawcett river drainages.

Forest

The forest is white spruce (Picea glauca (Moench), Voss) and aspen (Populus tremuloides Michx.), of fire origin. Balsam poplar (Populus balsamifera L.) and black spruce (Picea mariana (Mill.) BSP) occur with white spruce and aspen on the wetter depressional sites.

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Occasional white birch (Betula papyrifera Marsh.), jack pine (Pinus banksiana Lamb.) and larch (Larix laricina (Du Roi) K. Koch) are found throughout the stands. In the sample stands selected for this study, aspen was the main stand component and was generally 10 to 20 years older than the spruce which appeared as an understorey.

Soils

Soil textures range from sandy loams with many small stones on the ridges to heavy clays with a shallow gley horizon in the depressions. A layer of raw humus varying from 2 to 3 inches on upland soils to more than one foot on wet bottomland overlies the soil profile. The soils on well drained glacial tills resemble Braeburn soils and have a well defined leached A_e layer and a dark brown clayey B_t horizon over a calcareous parent material; depressional podzolic soils with heavy clay B_t horizon, and gleying often close to the surface, resemble the Snipe soils; and the ponded stratified silts and clays resemble the Kathleen series as described by Odynsky, Wynnyk and Newton (1952).

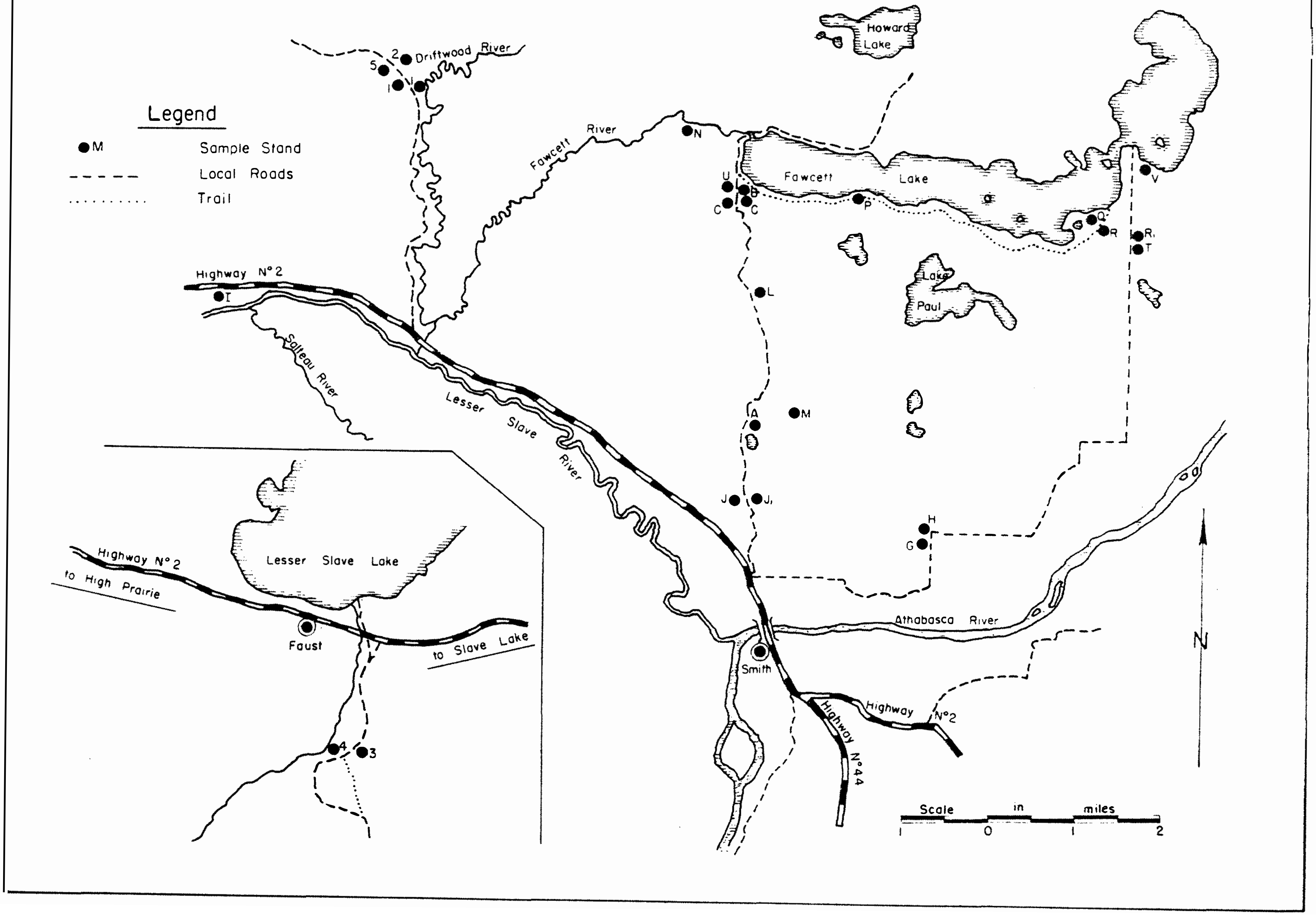
Sample stands

Brief description of the sample stands are presented in Table 1.

Table 1. Sample Stand Description

Stand	Average Age (1962) White Spruce	Aspen	Site Index Spruce Height at 80 yrs.	Parent Material	Soil Texture	Drainage
A	45	56	70	Lacustrine	Silty Clay	Moderate
B	45	56	70	Till, Fresh	Clay Loam	Moderate
C	45	56	70	Till, Moist	Clay	Mod./Slow
G	25	30	60	Till, Moist	Clay	Slow
H	35	40	70	Till, Fresh	Clay Loam	Moderate
I	45	56	80	Recent Alluvium	Silt	Mod./Rapid
J	45	56	70	Waterwashed Till	Sandy Loam	Mod./Rapid
L	15	20	80	Lacustrine	Sandy Silt	Mod./Rapid
M	45	56	70	Waterwashed Till	Sandy Loam	Mod./Rapid
N	65	85	80	Recent Alluvium	Silt	Moderate
P	15	20	70	Till, Fresh	Clay Loam	Moderate
Q	35	43	70	Till, Moist	Clay	Mod./Slow
T	35	43	70	Till, Fresh	Clay Loam	Moderate
U	75	99	70	Till, Fresh	Clay Loam	Moderate
V	45	56	80	Till, Fresh	Clay Loam	Moderate
1	65	77	70	Till, Moist	Clay Loam	Moderate
2	35	44	80	Till, Fresh	Clay Loam	Mod./Rapid
3	55	63	80	Recent Alluvium/ Till(variable)	Silt/ Clay Loam	Mod./Slow
4	25	39	70	Till, Moist	Clay Loam	Moderate
5	65	81	70	Till, Moist	Clay Loam	Moderate

Figure 1. Sample Stand Locations.



METHODS

In 25 stands a total of 333 spruce stems were individually released from aspen competition and 323 were left as controls covering the same age and diameter range.

The following treatment was carried out in 1951 and 1952:

1. Individual spruce trees having only aspen competition were selected subjectively.
2. All competition within a radius of twice the crown width of the treated spruce trees was removed by cutting. A minimum radius of 8 feet regardless of crown width was applied.
3. To prevent aspen suckering and root competition, all aspen stumps were treated with "ammate" crystals, (ammonium sulphamate).
4. In each stand, control trees comparable to the treated spruce in d.b.h., age, and height were selected.
5. Spruce sample trees were tagged, d.b.h. and total height were measured.
6. All aspen and other species with a radius of twice the crown width of each spruce sample tree were mapped and their diameter and height recorded.
7. The treated stands were segregated into three broad site classes; good, medium, and poor, as defined by site index

curves (MacLeod 1955) for spruce.

good - 80 feet at 80 years

medium - 70 feet at 80 years

poor - 60 feet at 80 years.

8. Additional stands were selected in 1952 to provide a more balanced range of diameter classes as shown in Table 2.

Table 2. Distribution of Spruce Sample Trees by Age and 2" classes-1952.

Spruce age	2 inch breast height diameter classes							
classes	< 0.8"	1-2	3-4	5-6	7-8	9-10	11-12	13-14
0-10	21							
10-20	43							
20-30	71	26	5					
30-40	46	46	14					
40-50			3	4	6	6	1	
50-60			1	8	15	8	3	
60-70					2	2	1	1
Total	181	72	23	12	23	16	5	1

A spruce sample tree is shown in Figures 2 and 3 before and after release.

Results of the 1956 remeasurement showed that all ages and diameters of spruce had responded to release but no differences were

Figure 2. Spruce Sample Tree Before Release

Figure 3. Spruce Sample Tree After Release

revealed between site index classes. It was then decided to reclassify the stands on a physiographic site basis using the classification developed for the region by J. Quaite[5].

By 1962 many of the stands had been lost to road construction and fire. However, a total of 461 stems were located in 20 stands and remeasured that year. The data for 10 years' growth were processed using IBM data cards and diameter and height increment were examined for released and control stems using "t" tests.[6]

RESULTS

Curves of mean annual diameter increment for treated and control stems are shown in Figure 4 for the 1956 and 1962 remeasurements. The effect of release on diameter increment has been sustained over the second five-year period. The differences between released and control stem values are significant at the 5 per cent probability level. Mean annual diameter increment values for the 1962 remeasurement were plotted over the logarithm of breast height diameter and the straight line regressions for released and control stems were developed using the weighted means for

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5 Quaite, J. 1953. The evaluation of site in the Mixedwood Section of Northern Alberta. Canada, Department of Resources and Development. Forestry Branch Unpubl. MS.

6 Analysis of data using appropriate "t" tests was carried out by T.G. Honer and the staff of the Data Processing Unit, Department of of Forestry, Ottawa.

Figure 4. MEAN ANNUAL DIAMETER INCREMENT 1956 and 1962.
(SITES AND AGE CLASSES COMBINED)

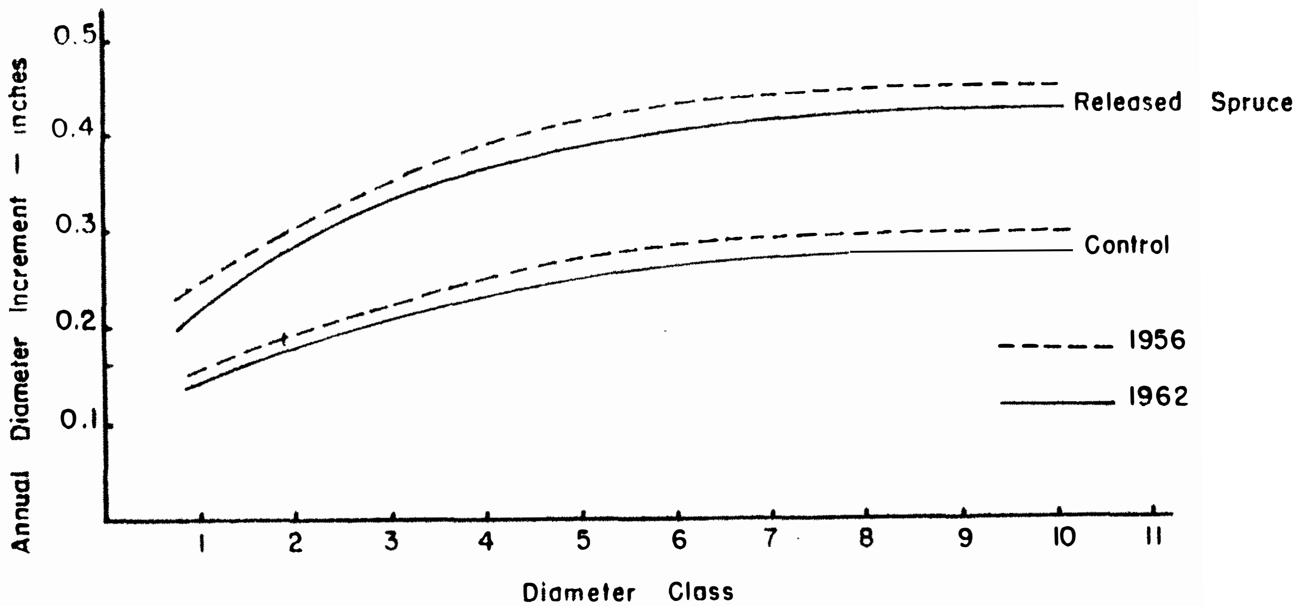
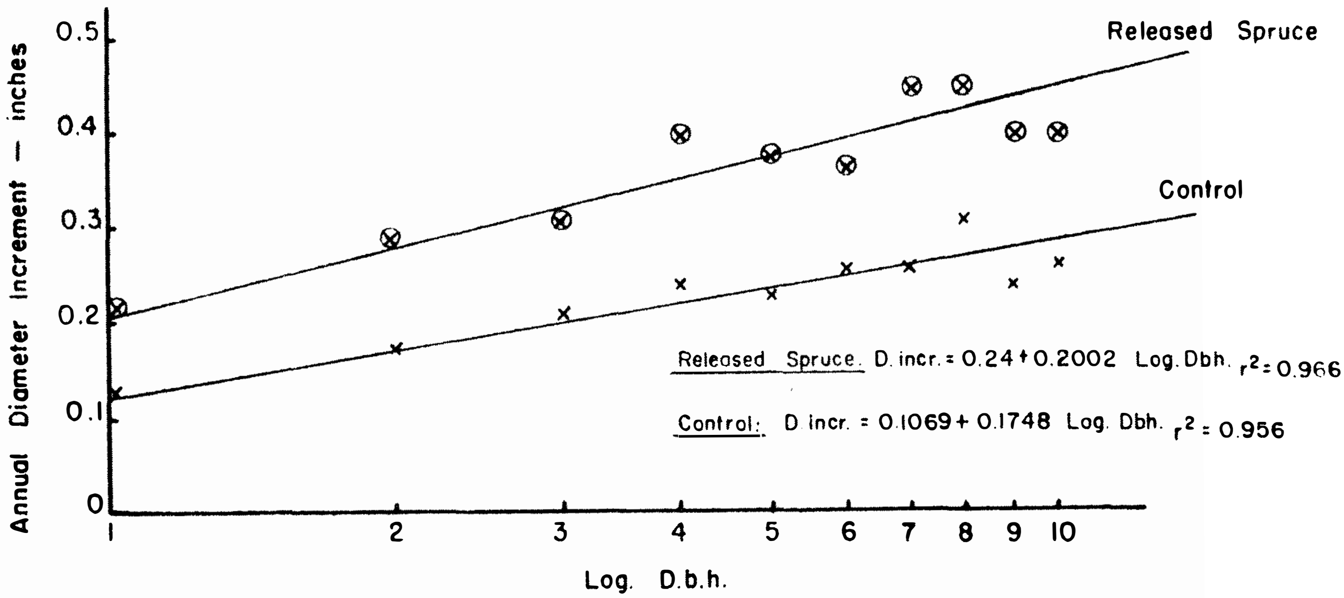


Figure 5. MEAN ANNUAL DIAMETER INCREMENT 1962 RELATED TO Log DBH.



each diameter class. The regressions are presented in Figure 5. Use of the weighted mean values gives a high estimate of correlation coefficient, however the difference between released and control stem regressions is distinct and the equation will be used in future comparisons.

Mean values of diameter increment are presented for each diameter class in Table 3 and for each age class in Table 4. The results of the "t" tests are indicated in these tables and they substantiate the trends observed in the graphical presentation. These values include all sites. In Figure 6 curves of diameter increment per cent are presented by age classes. Pressler's formula gives growth per cent based on the mid-period diameter. The greatest release occurs in the 20 to 40 year age class.

Curves of mean annual basal area increment by diameter classes are presented in Figure 7 for the 1956 and 1962 remeasurements. There is a slight decrease in basal area increment in the second five-year period.

Mean annual height increment by age classes is shown in Figure 8. Greatest release occurs in the 30 - 50 year age range. Beyond 50 years of age there is greater variation within the treated and control values. Tables 3 and 4 show that height differences in the diameter range 6 to 9 inches and age class 50 - 60 years are not significant. This is the result of extensive top damage to the spruce because of whipping by competing aspen and snow and ice damage. In 1962, 18 per cent of released and 22 per cent of control stems showed top damage, and at the time of measurement a few released spruce had been bent to the ground by a recent (May) snowstorm.

Figure 6. DIAMETER INCREMENT PER CENT 1962
(PRESSLER'S FORMULA)*

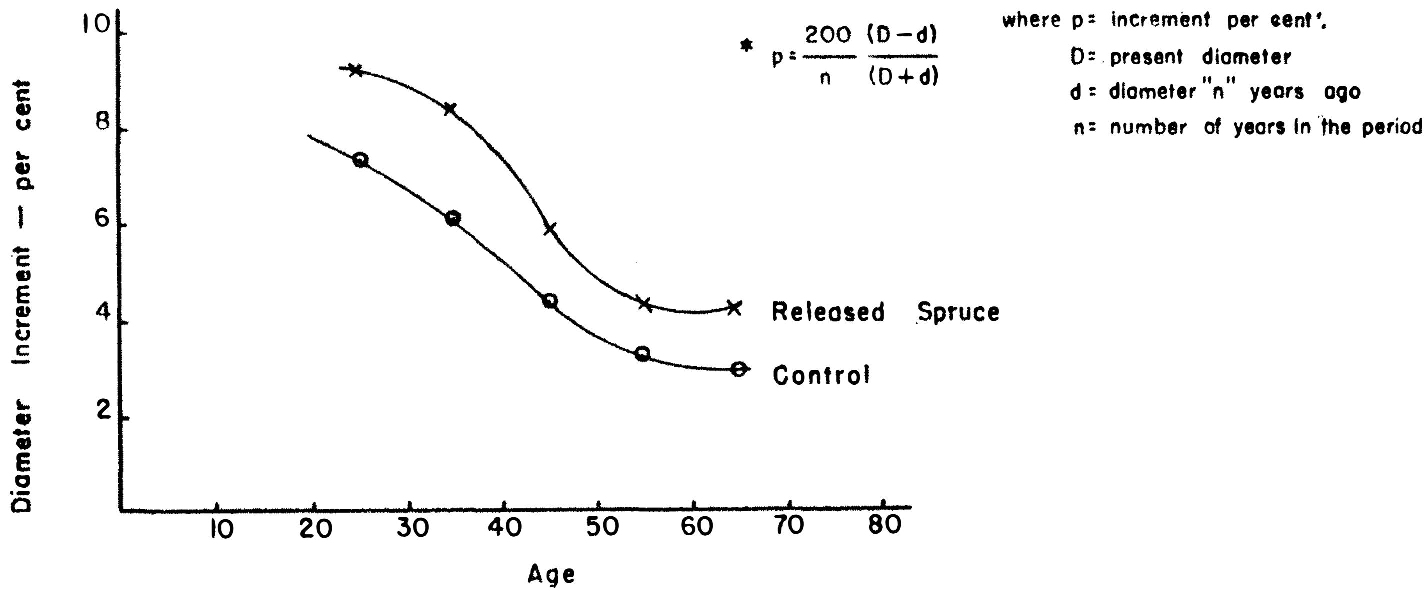


Figure 7. MEAN ANNUAL BASAL AREA INCREMENT 1956 AND 1962.

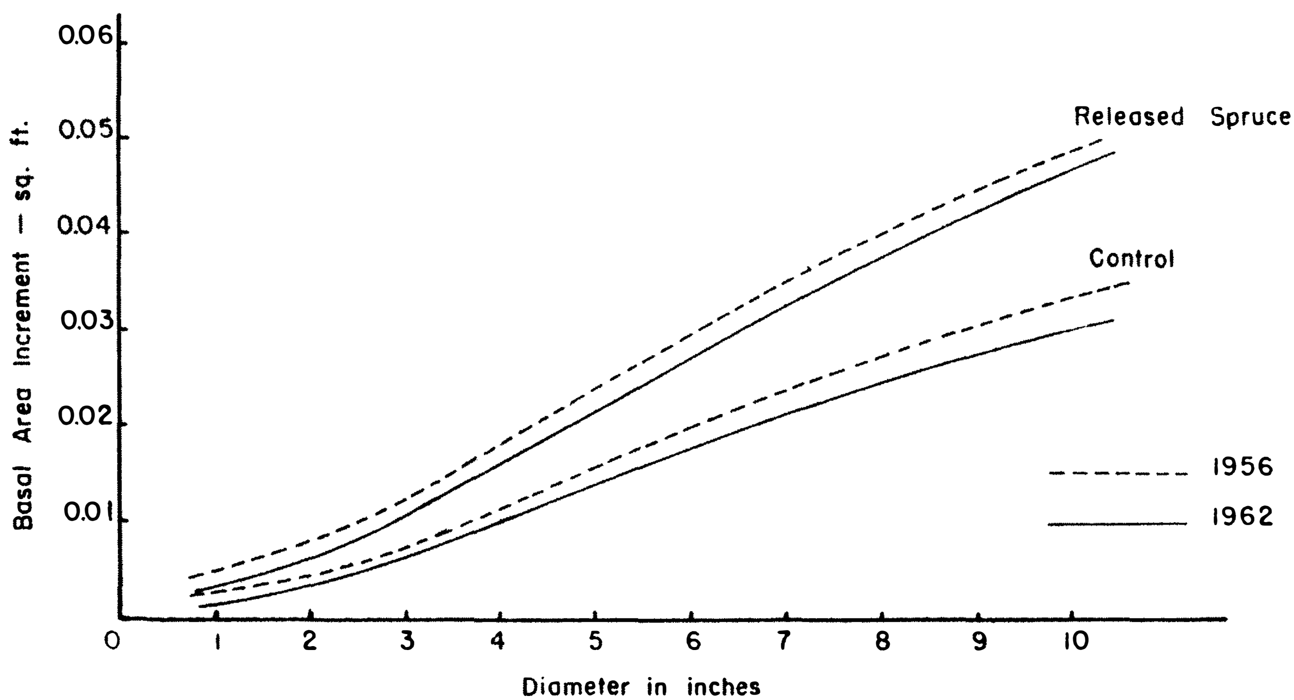


Table 3. Mean Annual Diameter and Height Increment for Treated and Control Stems by Diameter Classes

Diameter class	Diameter increment in inches: Treated		Diameter increment in inches: Control	Height increment in feet: Treated		Height increment in feet: Control
1	0.23	*	0.14	1.27	*	0.87
2	0.27	*	0.17	1.35	*	1.06
3	0.29	*	0.19	1.66	*	0.97
4	0.40	*	0.24	1.54	*	0.38
5	0.39	*	0.23	1.50	*	1.20
6	0.37	*	0.26	1.71	N.S.	1.08
7	0.44	*	0.26	1.56	N.S.	1.20
8	0.44	*	0.32	1.38	N.S.	0.85
9	0.40	*	0.24	1.21	N.S.	0.99
10	0.39	N.S.	0.26	1.38	*	0.80

* difference is significant at P = 0.05

N.S. difference is not significant at P = 0.05

Table 4. Mean Annual Diameter and Height Increment for Treated and Control Stems by Age Classes

Age class	Diameter increment in inches Treated		Control	Height increment in feet Treated		Control
20-30	0.27	*	0.18	0.94	*	0.62
30-40	0.26	*	0.16	1.18	*	0.82
40-50	0.35	*	0.22	1.37	*	0.87
50-60	0.42	*	0.28	1.42	N.S.	1.24
60-70	0.39	*	0.25	1.34	*	0.84

* difference is significant at P = 0.05

N.S. difference is not significant at P = 0.05

Table 5. Mean Merchantable Cubic Foot Volume, Trees over 5" d.b.h.

Age	Stand	No. of Stems		Volume Per Tree (cubic feet)	
		Released	Control	Released	Control
50	3	12	11	19.3	15.7
60	1	8	7	30.3	21.7
60	N	11	13	26.7	15.2
70	U	13	13	18.9	14.7

Table 5 shows mean merchantable cubic foot volume[7] for four of the stands in the older age classes. The merchantable volumes are presented to illustrate the value of the treatment to stems 5" d.b.h. and over in increased productivity. Mean volumes of released stems are from 20 to 40 per cent higher than control stems.

Ontkean and Smithers reported in 1959 that no significant trends could be established by graphical analysis with age or site index. The stands were therefore reclassified on a physiographic basis recognizing 6 types as follows:

Table 6. Physiographic Site Types

Parent Material*	Soil Texture	Moisture Status	Productivity Class*	No. of released Stems	Index height at 80 years
1. Recent Alluvium	sands and silts	Fresh-Moist	I	20	95
2. Till fresh	clay loams	Fresh	I	93	90
3. Waterwashed till	sandy loams	Fresh	I	7	87
4. Alluvium/ till (variable)	silts and clay loams	Moist-Wet	I	10	84
5. Lacustrine	clays	Moist-somewhat Wet	II	23	84
6. Till moist	clays	Moist	II	84	84

* Classification follows Duffy 1964, A proposed forest land classification for the Mixedwood Section of Alberta. Canada Department of Forestry, Forest Research Branch. Unpubl. MS.

7 Anon., 1962. Form class volume tables for white spruce and lodgepole pine in Alberta. Alberta Department Lands and Forest. Forest Surveys Branch.

Figure 8. MEAN ANNUAL HEIGHT INCREMENT 1962.

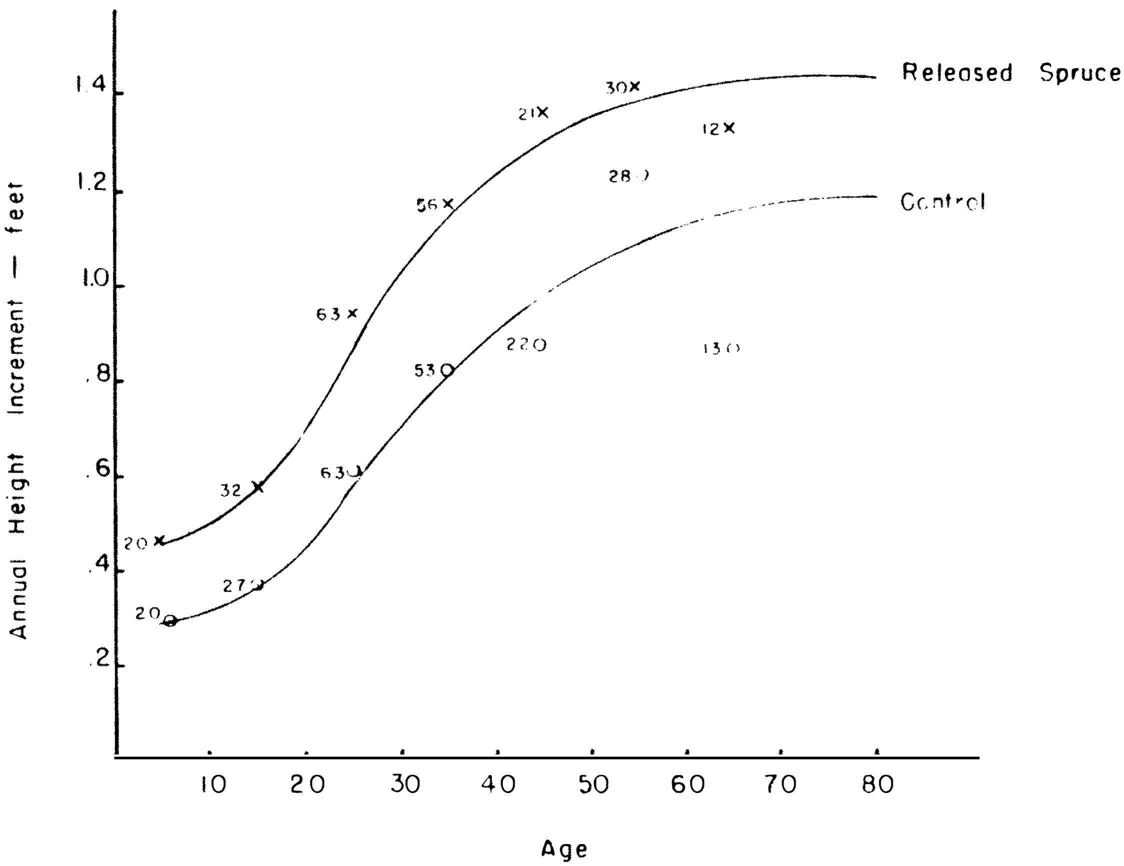
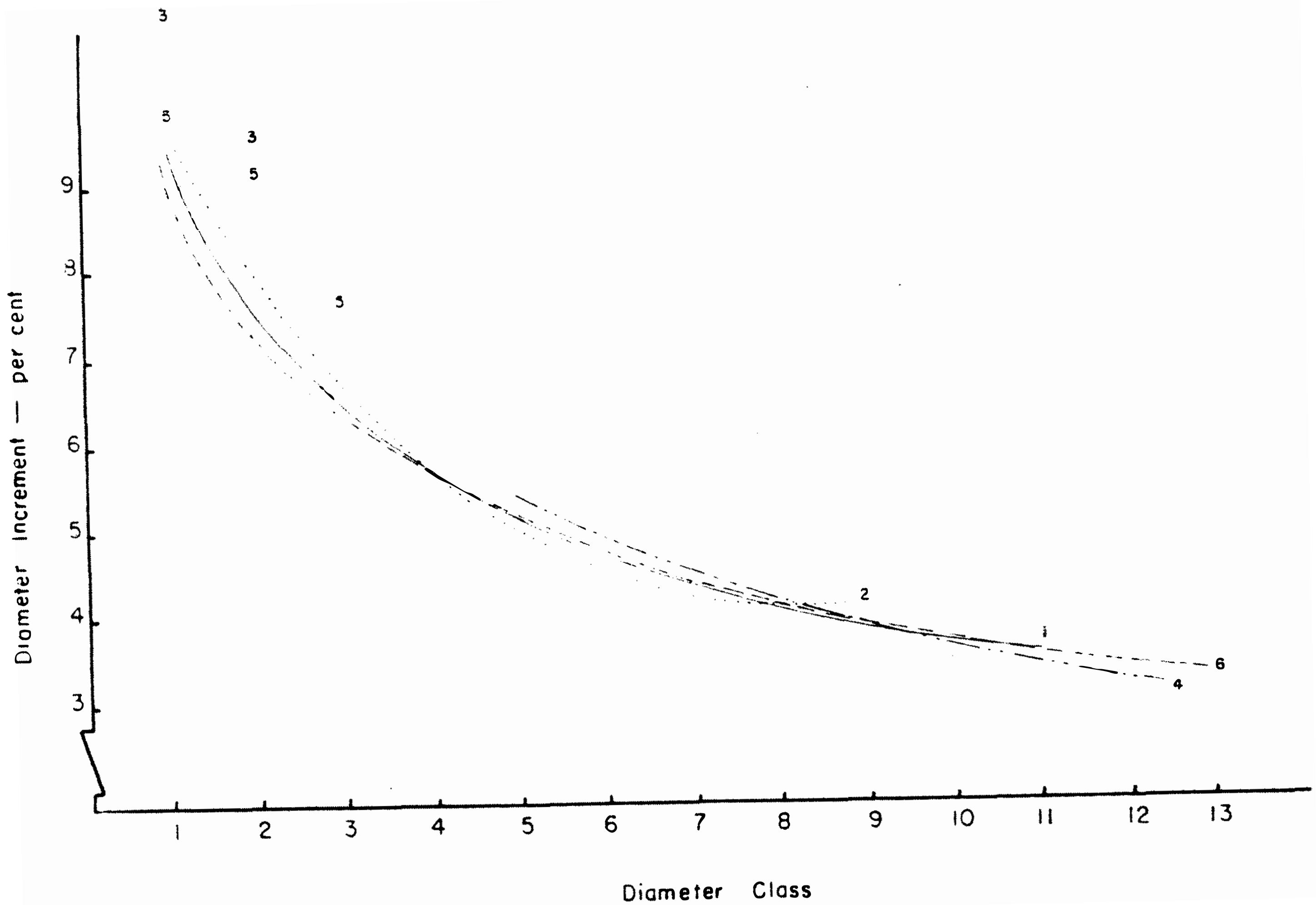


Figure 9. DIAMETER GROWTH PER CENT ON PHYSIOGRAPHIC SITES 1-6.
(Released trees)



Separate diameter growth curves were developed for each type and these are presented for treated stems in Figure 9. Unfortunately not all diameter classes are represented on all sites. However it is quite clear that there is no significant difference in diameter growth between the sites sampled. There are no extremes included in the sample and index height at 80 years for spruce ranges from 84-95 feet. Soil textures do not vary a great deal among the stands sampled and are mainly clay loams and clays. More than half of the sites in the region occur on glacial tills and most of the remainder occur on lacustrine deposits of the ancient Lesser Slave Lake basin. The site data were not analysed further.

Aspen poisoning

Ammonium sulphamate was applied in V-notches in the cut aspen stumps, in crystalline form, around the treated stems. Quaite (1953) reported that this was effective in inhibiting aspen sprouting and suckering within the treated circle and in killing additional standing stems on the circle perimeter. The treated areas re-examined in 1962 were still remarkably clear of aspen suckers although a stand of smaller stems 3 to 4 years old seemed to be quite vigorous and healthy. Among the small spruce of less than one inch in diameter this was sufficient to provide serious competition and as is mentioned briefly in later paragraphs, it is doubtful if release of such small spruce stems is worthwhile unless repeated treatments could be given.

DISCUSSION

The results of this study indicate that release of individual spruce stems from aspen competition will be successful on all the sites which were sampled and that the treatment will be widely applicable in the study region.

The treatment which was used suggests a method of thinning which emphasizes crown space and the relative crown position of the spruce and aspen stand components. Variation between individual stems within sample stands illustrates the need for treatment of single spruce crop trees rather than whole stands since each tree requires individual and different treatment based on crown characteristics. During the period when the spruce grows up through the hardwood overstorey, top damage from whipping is extensive. Height growth is checked and several years height growth may be lost. This effect may be explained in Table 3 in the diameter range 6 to 9 inches d.b.h. and in the age range 50 to 60 years where variation in height is so great that the effect of release is not significant.

The 10-year remeasurement shows that the effect of treatment is still favourable. However, in 1962 the crowns of many of the spruce crop trees were in contact with those of competing aspen and further release is warranted within the next five-year period.

At present the very small spruce stems up to 3 feet high which were treated are suffering from heavy and repeated browsing and from ground vegetation competition. These should not be treated in future thinnings unless more frequent release can be accomplished.

The release of the oldest stems in this study bears out the experience of other workers who note the ability of mature spruce to respond to release (Cayford 1957, Steneker 1963). Thinning in stands more than 70 years old is not recommended. However partial cutting from a commercial standpoint will lead to a valuable increase in growth of residual stems and an increase in merchantable volume production from the stands. These findings agree with results from associated studies of harvest cutting methods where partial cutting resulted in increased growth of residual spruce, (Lees, 1963, 1964). The most valuable age and diameter range for release of spruce from aspen competition indicated by this study is 20-40 years and 2.6 to 5.5 inches d.b.h.

It is recommended that stump poisoning of the cut aspen competition be carried out if economically feasible at the time of release treatment.

It may be possible to thin these stands twice; once in the range 20-40 years and again in the 40-60 age range. This would greatly increase the yield of quality spruce lumber and would prevent the crucial period of competition when the spruce is co-dominant with the aspen. Thinning of the aspen cannot be considered an economic improvement treatment for the hardwood as long as the vast areas of pure aspen in the region remains unexploited, however, it will always be worthwhile to remove as many poor and diseased aspen stems as possible in the release of spruce. It may be economical to poison or girdle the aspen if it is unmerchantable.

The results of this study closely parallel those in Saskatchewan. Growth rates are higher in Alberta but the effect of release may be more pronounced in the Saskatchewan studies. All studies indicate that the aspen overstorey in immature spruce-aspen stands inhibits the height and diameter growth and lowers the quality of the spruce. It is agreed that the release of the spruce is justified before it becomes co-dominant with aspen.

SUMMARY

Removal of competing aspen within twice the crown width of spruce crop trees in spruce-aspen stands resulted in a marked increase in height and diameter growth of the spruce. Poisoning of the cut aspen stumps with ammonium sulphamate prevented suckering and sprouting of the aspen for several years. Release was effective over a wide range of ages and diameters on all sites sampled. These represent the most extensive and commonly occuring fresh to moist sites with predominantly clay loam and clay soil textures. Results agree with those of parallel release studies in Manitoba and Saskatchewan within the same forest section. It is recommended that release of spruce be carried out before spruce and aspen crowns are co-dominant.

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