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Department of Northern Affairs and National Resources

Forestry Branch

FOREST RESEARCH DIVISION

GROWTH OF ALBERTA WHITE SPRUCE AFTER RELEASE FROM ASPEN COMPETITION

by

G. Ontkean and L. A. Smithers

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GROWTH OF ALBERTA WHITE SPRUCE AFTER RELEASE FROM ASPEN COMPETITION

(Project A-13)

by

G. Ontkean* and L.A. Smithers

INTRODUCTION

At the present time spruce sawtimber is the most important single commodity produced from the forests of Alberta. A high proportion of this sawtimber is contained in the spruce-aspen stands of the northern part of the province but the reserve of merchantable spruce of sawtimber size is not extensive. To maintain this industry in perpetuity it will be necessary to reduce the annual cut or to secure better white spruce regeneration and to shorten the rotation age required to produce sawtimber.

Silvicultural methods have been developed to secure better spruce regeneration in spruce-aspen stands (Blyth 1955, Crossley 1955, Quaite 1956). The rotation age could be reduced by removing the competition of the aspen overstorey. Since no work of this nature had been previously undertaken in Alberta, a project was established by Quaite* in 1951, near Smith, Alberta, to study the effect of removal of aspen overstorey on the growth response of white spruce.

This report provides an interim assessment of results during the period 1951 to 1956.

DESCRIPTION OF AREA

The spruce-aspen stands chosen for the study were typical of the mixedwood conditions found in northern Alberta. On the average aspen predominated and was a few years older than the spruce. Balsam poplar tended to replace the aspen on the wetter areas and occasionally a considerable portion of the volume of the stand on moist to wet sites consisted of black spruce (Quaite 1953).

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*Former Forestry Officer, Alberta District Office, Calgary, Alberta.

Generally, the topography of each area can be described as a series of prominent but gently rolling hills interspersed by many narrow winding creeks. Muskegs and grassy sloughs were present in the depressions. The soil, representative of the grey-wooded soil region of northern Alberta, was heavy clay-loam in texture. The typical soil profiles were characterized by a well defined ashy-grey friable platy A_2 and a dark brown-grey cheesy B_2 horizon over a calcareous parent material. The moisture regime ranged from 1 to 6 on a 4 pore pattern (Quaite 1953).

METHODS

A total of 656 individual spruce trees were sampled in 25 spruce-aspen stands. Of the 656 selected trees, 333 were released from aspen competition and the balance served as controls.

The selection and the treatment of sample trees were carried out in the following manner:

(1) Individual spruce trees having only aspen competition were selected.

(2) All competition within a radius of twice the crown width (Table 1) of the treated spruce trees was removed by cutting. To prevent aspen suckering and root competition all aspen stumps were treated with ammate.

(3) In each stand, control trees comparable in d.b.h., age and height to the treated spruce were selected.

(4) Since 80-year-old white spruce is currently being cut for sawlogs, no attempt was made to sample spruce older than 70 years of age.

(5) All spruce trees were segregated into three broad site classes - good, medium and poor - as defined by site index curves (MacLeod 1950).

(6) Spruce sample trees were tagged, d.b.h. was measured to the nearest hundredth of an inch, heights over six feet were measured to the nearest foot, and heights under six feet to the nearest tenth of a foot.

(7) All aspen and other species within a radius of twice the crown width (Table 1) of each spruce sample tree were mapped and their diameter and height recorded. However, these data are not used in the present analysis.

Table 1

Average Crown Width of Open-Grown Spruce

D.B.H. (inches)	Crown Width at Widest Point (feet)	D.B.H. (inches)	Crown Width at Widest Point (feet)
0.5	5	11	16
1	6	12	17
2	7	13	18
3	8	14	19
4	9	15	20
5	10	16	21
6	11	17	22
7	12	18	23
8	13	19	24
9	14	20	25
10	15		

Table 2 gives the distribution of treated trees by age and size classes. In the tree size classes, height classes were used for spruce less than 0.8" at d.b.h. The first remeasurement was made in 1956.

Table 2

Distribution of Treated Spruce Sample Trees by Age and Size Classes

Spruce Age Classes	Tree Size Classes								
	3"-3'	3'-0.8"*	1"-2"	3"-4"	5"-6"	7"-8"	9"-10"	11"-12"	13"-14"
0-10	21								
10-20	33	10							
20-30	29	42	26	5					
30-40	7	31	35	12					
35-45		8	11	2					
40-50				3	4	6	6	1	
50-60					4	8	4	2	
55-65				1	4	7	4	1	
60-70						2	2	1	1
Total	90	91	72	23	12	23	16	5	1

*Size range: 3' height to 0.8" D.B.H.

RESULTS

The diameter growth of released spruce was on the average 65 per cent greater than that of the unreleased control trees. Figure 1 shows that diameter increase on the released trees is roughly the same for all diameter classes above four inches. Below the four inch class the degree of response declines gradually. Site and age had no significant effect on the increased diameter growth.

The data on height increases showed considerable variation in each height class. A study of variation in height increase (Table 3) indicated that a large number of both released and unreleased trees had stunted or double leaders. No well substantiated explanation can be given although it is felt that the damage was the result of insect, squirrel or late spring frost damaging the terminal bud, thereby preventing normal leader growth. However, an equal per cent of released and unreleased spruce were affected, indicating that height variation in these instances was not due to treatment. These defective trees were therefore eliminated from the study.

Table 3

Trees with Irregular Height Growth

	Broken or Stunted Leaders Developed in 1956	Double Leaders Developed in 1956	Double Leaders Formed Between 1952 - 1955	Total Affected
	(%)	(%)	(%)	(%)
Released Spruce	24	13	5	42
Unreleased Spruce	29	8	4	41

On non-defective trees height growth on released spruce trees averaged 35 per cent better than that on unreleased spruce (Figure 3) with the greatest increase in the 20 to 30 foot height class. The effect of site and age was checked by graphical analysis and the results indicated that neither factor was responsible for the difference in height growth.

The volume increments for the five-year period of study were compiled using the White Spruce Standard Volume Tables for Boreal and Sub-Alpine Regions of Alberta, (Blyth 1952). The average increase in volume increment due to treatment was about 50 per cent, the greatest percentage increase being in the lower classes. In terms of actual volume increment, (Figure 4) however, the five-year periodic growth of 10-inch trees was roughly fifteen times as great as that of the released trees in the 2-inch diameter class.

Growth rates according to Pressler's formula were determined for the volume increments shown in Figure 4. The results (Table 4) show that the largest increase in growth rate due to treatment is in the smaller diameters. However, all diameter classes showed a marked increase in rate of volume increment as a result of treatment. This suggests that treatment in all diameters studied would be successful.

Table 4

Annual Growth Percentage per Tree

D.B.H.	Released Spruce (%)	Unreleased Spruce (%)
1	26	22
2	25	19
3	20	15
4	16	12
5	15	-
6	13	10
7	12	9
8	11	8
9	10	8
10	10	7

DISCUSSION AND CONCLUSIONS

Both the even-aged character and the appearance of the young spruce-aspen stands of northern Alberta indicate that they became established after a major disturbance - fire or logging. The rapid growth of the aspen enabled it to dominate the stands. Shirley (1941) observed that when conifers become well established at the same time as the aspen, even if they escaped being overtopped by undergrowth, they often persisted as an understorey until the aspen matured and was logged or decayed. From this study, it would appear that the recuperative powers of the young spruce have not been seriously affected by over-shadowing by the aspen and that given an opportunity the spruce will respond favourably to release from aspen competition. The pattern of spruce development indicates that spruce is not stagnated and that, regardless of age, the spruce has retained a thrifty, crown which has enabled it to respond rapidly to release.

The growth rate of the released spruce was not found to be strongly correlated with either age or site quality. This lack of relationship between site index and release was unexpected and is difficult to explain. During the next remeasurement the sites will be reclassified on a physiographic basis. This may clarify the effect of site on the degree of release.

The interim results of this study indicate that the growth of individual white spruce can be greatly increased by the removal of aspen competition and therefore the rotation age for spruce sawtimber in mixed stands can probably be reduced from roughly 150 years to 110 years. Two alternative methods are indicated depending upon whether the aspen content of the stands can be utilized or not. If the aspen is not merchantable, due either to the pathological tendencies of a particular site, or to a lack of demand for small aspen, the release treatment may be carried out when the aspen is young by cutting, or at ages of 50 to 60 years by girdling and poisoning. It is believed that the latter method will be ecologically and economically more satisfactory. If, however, the market for aspen pulpwood is good, the spruce portion of the stand should be released by removing roughly 50 per cent of the basal area in the form of aspen pulpwood. This treatment should take place at roughly 60 years of age. It may be possible to further increase yield by promoting the development of selected groups of root sucker aspen which can then be harvested for pulpwood at the same time as the spruce sawtimber is cut at roughly 110 years of age.

The results to date indicate the need for further investigations of the spruce-aspen complex in Alberta. These should include the determination of the possible relationships of site, age and aspen cull factor with a view to determining which sites lend themselves to the combined production of spruce and aspen and those on which pure spruce should be encouraged. The levels of thinning required to foster maximum spruce production must also be known. This includes optimum space depending on the size of the spruce crop trees as well as optimum levels of basal area per acre to attain the highest production per acre. The effect of aspen sucker competition for spruce crop trees must also be studied, and methods of controlling, both encouraging and discouraging, aspen suckering must be developed. The majority of these problems are beyond the scope of the present study and further investigations must be undertaken.

The findings of this report parallel those in the study of aspen influence on white spruce growth in Saskatchewan (Cayford, 1957). In both studies results indicate that the aspen overstorey in young and intermediate aged spruce-aspen stands retards the height and diameter growth and lowers the quality of the spruce. It is also agreed that silvicultural treatment such as releasing the white spruce as soon as it becomes well established, or alternatively releasing it when the aspen reaches pulpwood size, may be warranted.

SUMMARY

The removal of the competing aspen from young spruce-aspen stands in northern Alberta has produced a definite increase in diameter and height growth of the spruce. The increased growth was considered in terms of basal area, volume, and growth rate, and the results indicate that treatment in all diameter classes studied would be successful.

At this time, it would appear that a two-crop harvesting plan would be the most practical means of managing young spruce-aspen stands. The aspen should be removed when it has reached pulpwood sizes. The released spruce will show a substantial increase in basal area and will reach merchantable size in a shorter time.

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Figure 1

ANNUAL DIAMETER INCREASE BASED ON DIAMETER CLASSES

(SITE & AGE CLASSES COMBINED)

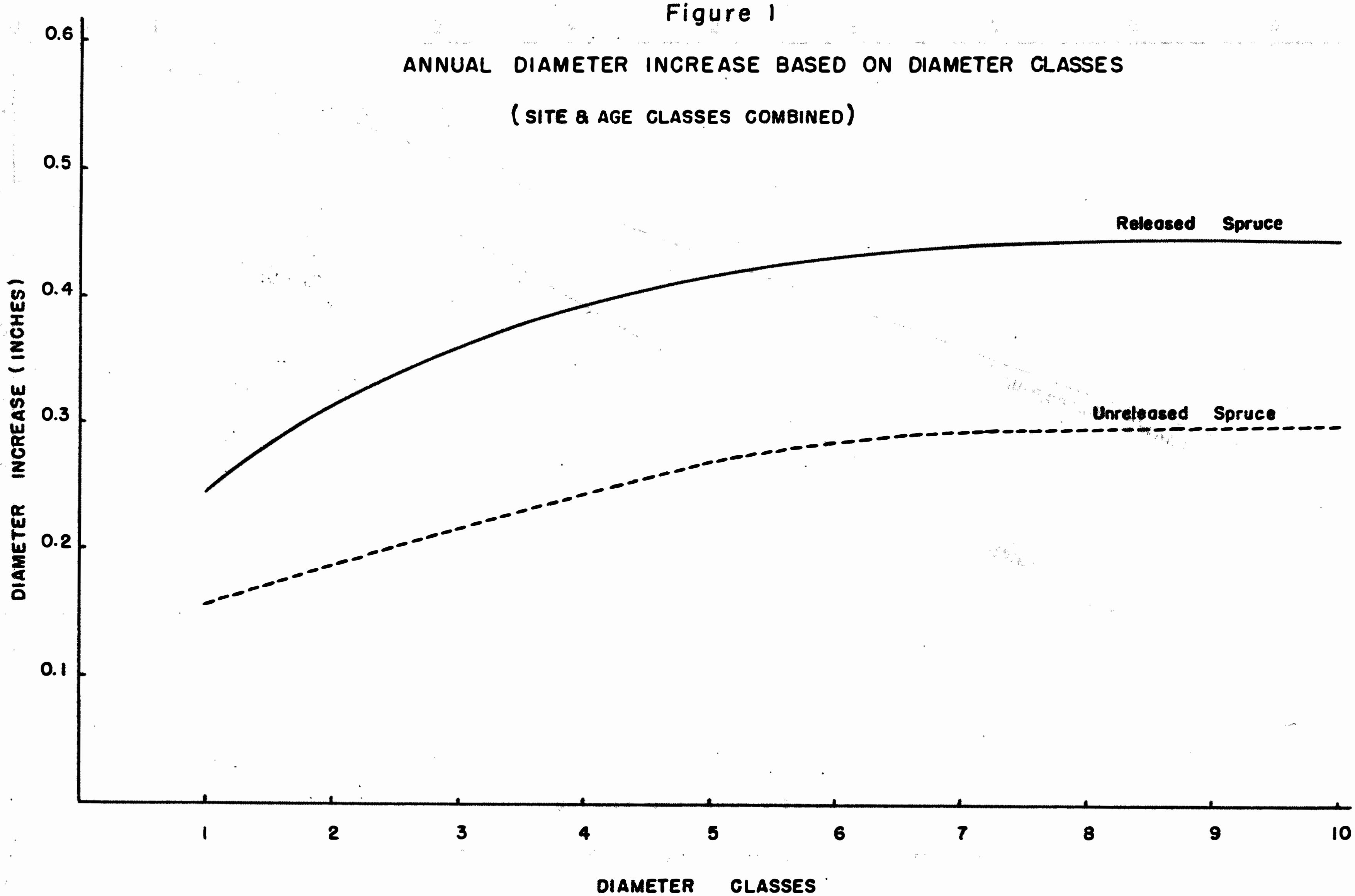

Figure 2

Annual basal area increment by diameter classes

All site and age classes

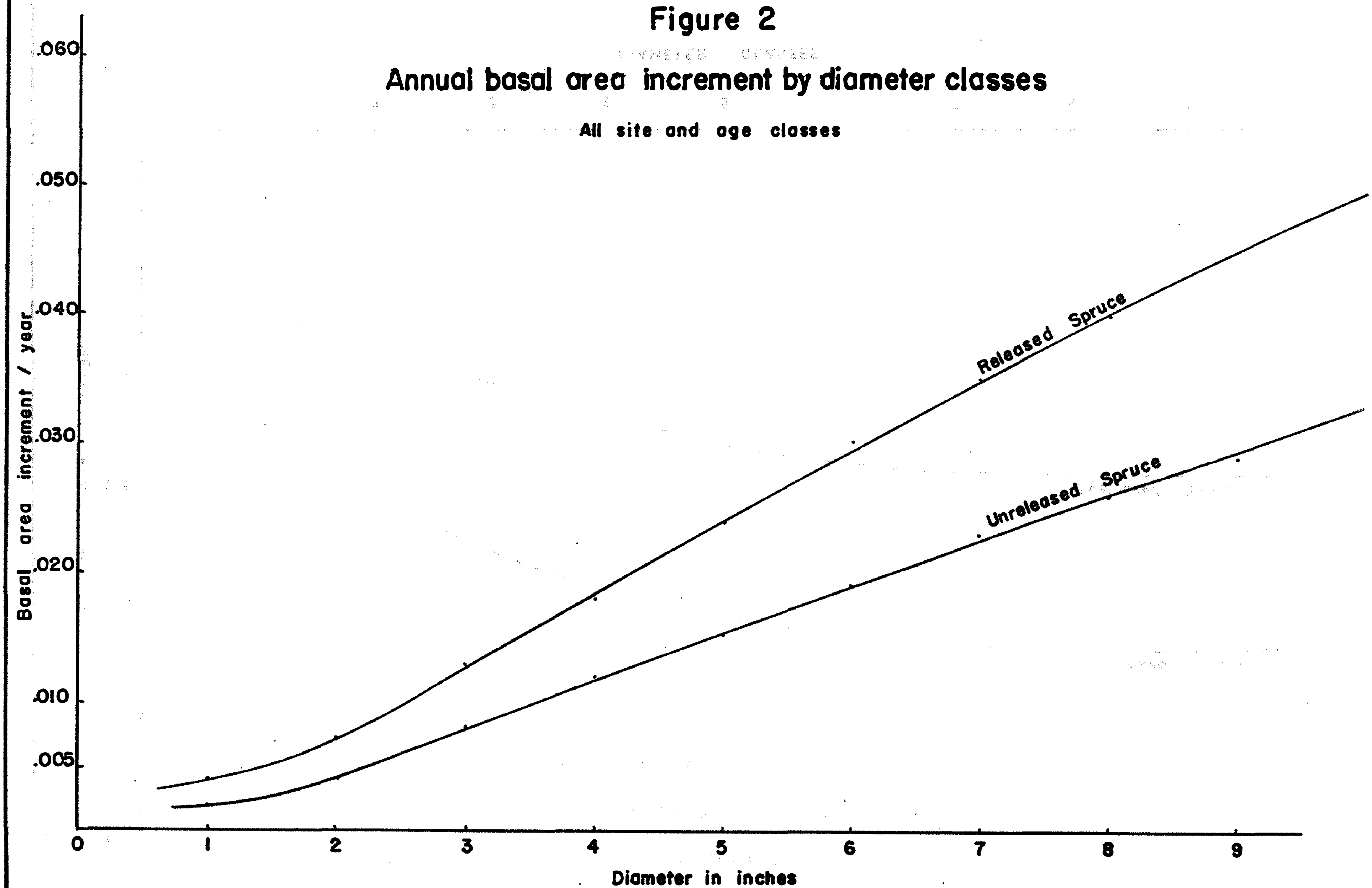

Figure 3

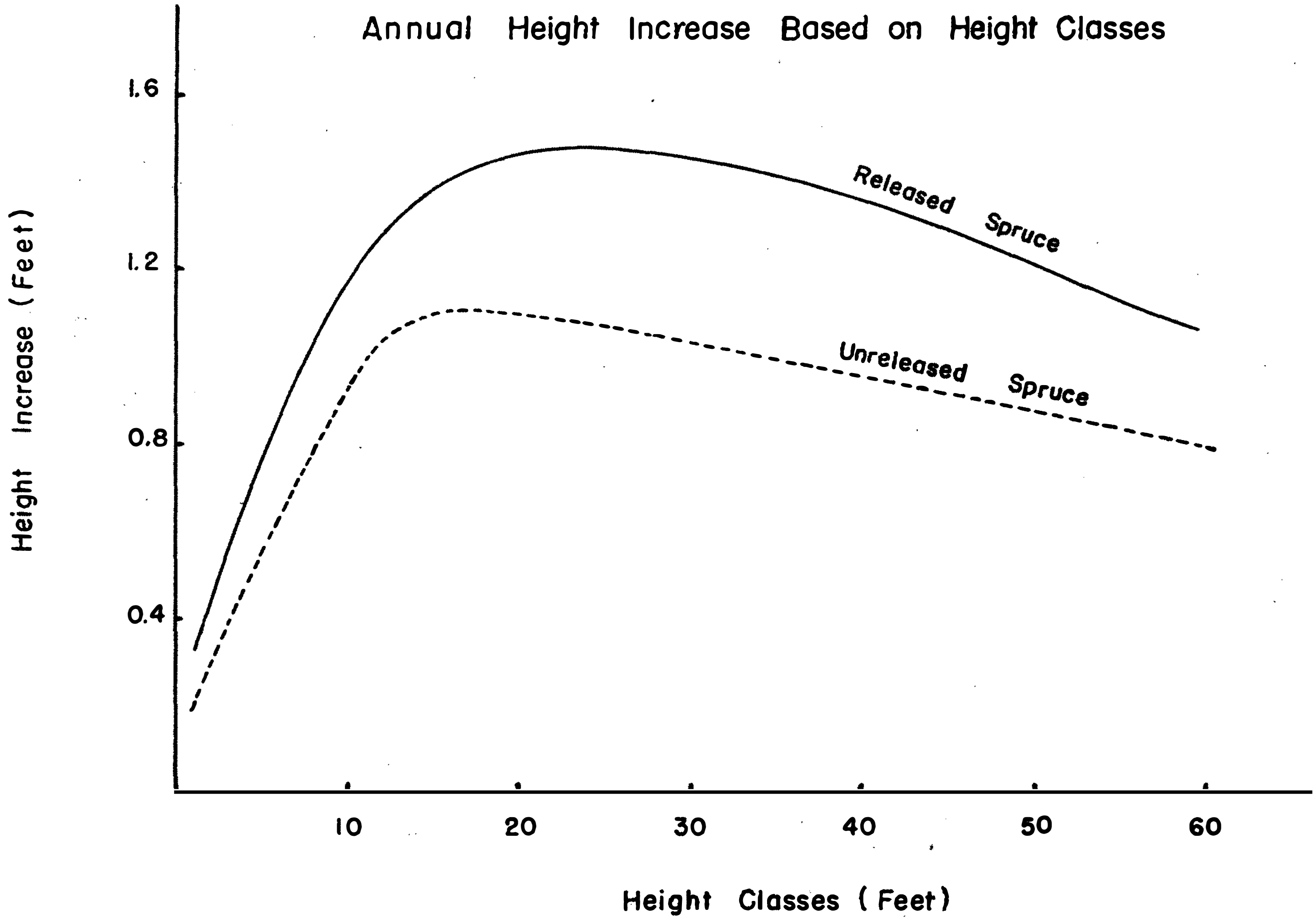
Annual Height Increase Based on Height Classes
1.6
1.2
0.8
0.4
Height Increase (Feet)
Released Spruce
Unreleased Spruce
10
20
30
40
50
60
Height Classes (Feet)

Figure 4

Five Year Volume Increment Per Tree