FOREST RESEARCH BRANCH

DEPARTMENT OF FORESTRY
CANADA

A RELEASE EXPERIMENT IN DENSE TEN-YEAR-OLD BALSAM FIR IN GASPÉ

(Project Q-40)

by

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The obvious solution to the overstocking problem is to release enough of the better trees to form a mature stand. This would be the easiest and the least expensive way when the trees to be cut are about one inch in diameter at breast height, but there is little information available on what response to expect from treatments or on how or when they might best be applied (Vincent 1962). Some cost data from a pilot experiment with various release methods in Gaspé have been published (Morais 1955) showing that release is expensive but they are difficult to interpret because growth data are lacking.

In 1951 an experiment to obtain information on the effect of release on growth and stand development was established in a dense ten-year-old logging origin stand of balsam fir on the Little Pabos River limits of the Gaspesia Pulp and Paper Company[4/], in Gaspé. In 1961, ten years after treatment, the sample plots were remeasured and the results are reported in this paper.

THE STAND

The forest is in Forest Section B.2 (Rowe 1959) and is part of a wide east-west band of highly productive coniferous forest occupying the southern half of the Gaspé upland. It is one of the best balsam fir regions in eastern Canada. The climate is cool and humid with an average frost free period of 80 to 120 days and mean annual precipitation of 36 to 43 inches (Villeneuve 1946).

The experimental stand originated from clear cutting in 1941-42 in an experiment in truck-haul logging (MacArthur 1963). There are no data

4/ Formerly the Gaspesia Sulphite Company.

on composition and yield of the parent stand but to judge by existing stands on similar sites in the vicinity and company records (Boynton 1953) it was average or better. The land is level, the soil texture uniform, and drainage good. Soil is a clay loam with a 60 to 70 per cent silt and clay content and a shallow well-defined podzol profile.

In 1951 there were about 31,000 trees per acre in the young stand: 28,500 fir, 2,000 white birch, and 500 spruce. The stand was separated into strips 60 to 80 feet wide by the roads bulldozed for the 1941-42 truck-haul operation. Although the stand was considered as being 10 years old many of the trees (60 to 70 per cent) were older having been present before cutting as advance growth. The establishment pattern of the stand was essentially the same as that found by Hatcher (1960) in Forest Section B.1 near Quebec City. In 1951 the average height of dominant trees was 7.5 feet.

THE EXPERIMENT

Observations in mature fir stands in Gaspé indicate that they consist of from 500 to 1,000 trees per acre (Webb 1957) and therefore the elimination of about 95 per cent of the trees in a dense ten-year-old stand must occur during the following 50 to 60 years. It is reasonable to expect the final stand to consist largely, if not completely, of trees that were dominant in youth. Accordingly the release methods in the experiment were intended to promote a more rapid expression of dominance of selected trees and to ease and hasten the process of elimination by suppression.

Two treatments were applied: 1) full release and 2) partial release. In full release potential crop trees spaced as evenly as possible were selected and all trees likely to impede their development during the next ten years were cut at ground level. In partial release the better trees were selected with less attention to spacing and were freed by cutting trees that offered serious competition at a convenient height. Many trees thus cut retained one or more basal whorls of branches. Partial release required slightly less than half the time required for full release. Four fifth-acre (1 by 2 chains) sample plots were established: one fully released, two partially released, and one untreated control.

In 1961, ten years after treatment, the plots were re-examined and measured. Estimates by plots of total numbers of trees per acre were based on 20 per cent samples (four 10-milacre transects per fifth-acre plot). Complete tallies of dominant and codominant trees were made on each plot by species and one-inch diameter classes. On each plot ten dominant trees were selected for special study of height and diameter growth during the 1951 to 1961 period. Along lines bisecting each plot longitudinally the dominant trees nearest each of the 10 twenty-link points was cut and the internodes were measured back from the tip to 1951 and beyond. Only trees that had been undamaged during the period were selected. Stem sections were removed at breast height for measurement of radial growth and at ground level for determination of total age. Age and radial growth were studied in the laboratory the latter being measured in arbitrary units. The two partial release plots are combined in the presentation of results.

RESULTS

The total number of trees per acre by species, and the numbers of potential crop trees per acre, in 1951 (Tables 1 and 2) show stand density and indicate the immediate changes caused by treatment. Although spacing of potential crop trees is similar in the two treatments it was in fact much more even in full than in partial release plots. This was a direct result of the methods used; as was also the greater average height of potential crop trees in the partial release plots.

Tables 1 and 2

Estimates of stand density in 1961 (Table 3 and Figure 1) indicate that decreases caused by treatment persisted and also that there was a decrease in the control plot. Evidently release affected stand density mainly by the removal of smaller trees (Figure 1) but reduction was also partly a result of natural mortality caused by suppression. The profiles show that more larger trees were kept in partial release and more smaller ones in full release.

Table 3
Figure 1

The study of growth responses to treatment is based on selected dominant trees for which some descriptive data are given (Table 4). Control and release are each represented by ten trees and partial release by 20 trees. Average ages of sample tree groups indicate that most of the trees were present before cutting. The greater height of partial release trees in 1951 is at least partly a result of the method of release and is in fact surprisingly small. Differences in live crown ratio are probably a result of treatment particularly between control and release plots.

Table 4

Analysis of variance (Snedecor 1956) of height growth of dominants from 1951 to 1961 showed that growth of both fully and partially released trees was significantly greater than that of control trees (Table 5) but the difference between release methods was not significant. A similar analysis of periodic diameter growth revealed that partially and fully released trees had significantly exceeded control trees and again the difference between methods of release was not significant (Table 6). Full release was apparently superior to partial release in both height and diameter growth however.

Tables 5 and 6

Growth trends (Figures 2 and 3) suggest that the effects of release are slow to appear but that they persist and increase for ten years and possibly longer. Divergence between the lines of cumulative height and diameter growth appeared to be still on the increase in 1961.

Figures 2 and 3

DISCUSSION AND CONCLUSIONS

Both full and partial release reduced stand density for ten years but full release had a greater effect because more trees were cut and also because in partial release many trees recovered from being topped or cut back. They re-entered competition and may have affected growth of selected trees. In view of the marked ability of young balsam fir to recover from being cut back it should always be cut at ground level in release operations.

Growth responses to release show that even dominant trees in a ten-year-old balsam fir stand can be stimulated. Responses are somewhat slow to develop, probably because under-developed branch and root systems need time to develop, but once they appear they persist. Dominant trees do not appear to need much help to increase their growth rate and, for the first ten years at least, might not benefit from greater liberation than was afforded by partial release.

The greater response of diameter growth was not unexpected but there was some doubt that height growth would be affected at all. Some studies have shown that density limits height growth only at extreme levels (Braathe 1957). This doubt was dispelled by the significant increases observed in this experiment. The critical density level for ten-year-old stands remains to be established however and would constitute an interesting study.

The response to release during the first ten years would certainly not warrant release on an operational scale but the existing growth trends suggest that important differences may develop in time. This can only be established by future study of this and other experiments. Costs of conventional release treatments run as high as $20. to $30. per acre (Morais 1955) and it is difficult to imagine increases in growth sufficient to justify such an expense but the results of this experiment suggest a possible alternative. Relatively light release may be sufficient to promote real increases in the growth of the dominant trees that will make up the future stand. Consequently one solution to the overstocking problem might be to apply partial release to 500 of the best dominants per acre and thus initiate a self-sustaining process of stand development that would be much more rapid than in an untreated stand. In this version of partial release trees removed should be cut at the ground of course. In view of the potential saving further study of this approach seems worthwhile.

SUMMARY

In 1951 two degrees of release were applied in a ten-year-old logging origin balsam fir stand with some 30 thousand trees per acre in Gaspé. In full release fairly evenly spaced dominant trees were liberated by cutting all competing trees at the ground. In partial release the best dominants were liberated from crown competition by slashing the tops off directly competing trees.

In 1961 it was found that: 1) reductions in density caused by treatments had persisted for ten years; 2) live crown ratios of dominant trees had been modified; 3) height and diameter growth of dominant trees were significantly greater on released plots than on the control; 4) responses in height and diameter growth to the two degrees of release were not significantly different; and 5) diameter and height growth trends suggested continuing, and possibly increasing, effects of treatments.

The results demonstrate that dominant trees in such a stand can be stimulated by release. They suggest that partial release applied to 500 of the best dominants per acre might be a relatively cheap and effective means of promoting more rapid stand development. Further study of this possibility is necessary and justified by the potential savings.

SOMMAIRE

En 1951, on a effectué des coupes de dépressage à deux intensités dans un peuplement de sapin baumier de la Gaspésie âgé de 10 ans et établi à la suite d'une coupe. Le peuplement comprenait environ 30,000 tiges à l'acre. La coupe forte a consisté à libérer des sujets dominants régulièrement espacés en coupant tous les concurrents au niveau du sol. Lors de la coupe faible on a libéré les sujets dominants de la concurrence exercée par les cimes des voisins immédiats en étêtant ceux-ci.

En 1961, on a trouvé que 1) les réductions dans la densité provoquées par les traitements persistaient encore dix ans après; 2) les pourcentages de cimes vivantes des sujets dominants avaient été modifiés; 3) la croissance tant en hauteur qu'en diamètre des sujets dominants était significativement plus grande dans les places traitées que chez les témoins;

4) les réactions des sujets libérés aux deux intensités de coupe, quant à la croissance en hauteur et en diamètre, n'ont pas été différentes; et 5) l'allure de l'accroissement en hauteur et en diamètre montre que les effets des traitements continuent à se faire sentir et vont même en augmentant.

Ces résultats montrent que les sapins dominants dans un tel peuplement peuvent être stimulés par une coupe de dépressage. Ils suggèrent en outre qu'une coupe partielle consistant à libérer 500 des meilleurs sujets dominants à l'acre pourrait constituer un moyen relativement bon marché et effectif pour promouvoir un développement plus rapide du peuplement. Cette possibilité devrait être étudiée plus à fond, d'autant plus que les économies qu'on peut en attendre le justifient.

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This paper is based on an experiment initiated by J.C. Boynton a former research officer with the Department of Resources and Development. His notes and establishment report have supplied much information and I wish to acknowledge his contribution.

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Table 1. Total numbers of trees per acre by species after treatment (1951)

Treatment	Trees per acre			
	Spruce	Fir	Birch	All species
Control	550	28,600	1,700	30,850
Full release	400	17,750	2,400	20,550
Partial release	250	20,250	2,450	22,950

Table 2. Numbers per acre, and average heights, of potential crop trees on the three released plots after treatment (1951).

Treatment	Trees per acre		Average height
	Spruce	Fir	feet
Full release	135	2,095	6.6
Partial release	115	2,162	8.4

Table 3. Numbers of dominant and codominant trees by species, and numbers of all trees of all species, per acre (1961).

Treatment	Trees per acre				all trees
	Spruce	Fir	Birch	All species	all species
Control	135	8,600	125	8,860	22,000
Full release	90	2,265	15	2,370	9,450
Partial release	95	2,172	32	2,300	11,950

Table 4. Descriptive details regarding the four 10-tree groups of dominant sample trees measured for height and diameter growth.

Item	Treatment		
	Control (10 trees)	Full release (10 trees)	Partial release (20 trees)
Average age 1951	18	18	19
Average height (feet)			
1951	4.7	4.5	5.6
1961	9.4	10.7	11.6
Height growth (feet)			
1951-1961	4.7	6.2	6.0
Live crown ratio*			
1961	0.53	0.70	0.67

* 1961 live crown length ÷ 1961 total height

Table 5. Height growth in feet of dominant trees (1951 to 1961), Analysis of variance with unequal repetition (Basis 40 trees.

Source	Degrees of freedom	Sum of squares	Variance	F. ratio
Total	39	77.62	1.99	
Between	2	13.70	6.85	3.96*
Within	37	63.92	1.73	

(Critical differences between height growth means)

1. Full release ~ Control ------------- 1.39*
2. Partial release ~ Control ------------- 1.26*
3. Full release ~ Partial release ------- 0.23 NS

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* Significant at the 5% level.

NS Non-significant.

Table 6. Diameter growth in arbitrary units of dominant trees (1951-1960)
Analysis of variance with unequal repetition (Basis 28 trees).

Source	Degrees of freedom	Sum of squares	Variance	F. ratio
Total	27	1323.21	49.01	
Between	2	472.94	236.47	6.97**
Within	25	850.28	34.01	

(Critical differences between diameter growth means)

1. Full release ~ Control ------------ 10.69**
2. Partial release ~ Control ------------ 8.59**
3. Full release ~ Partial release ---- 2.10 NS

** Significant at the 1% level.

NS Non-significant.

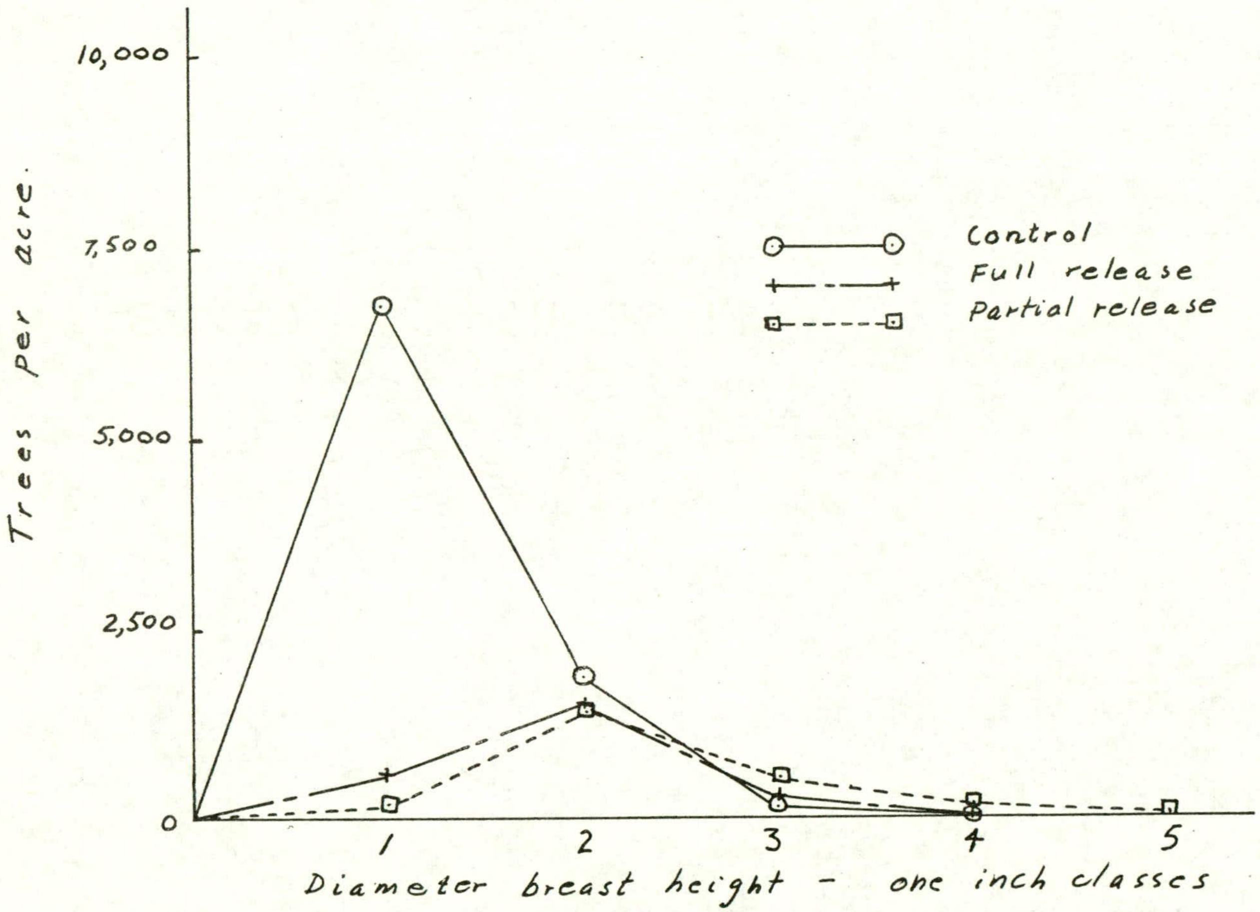

Figure 1. Distribution of dominant and codominant spruce and fir per acre by diameter classes on treated and control plots.

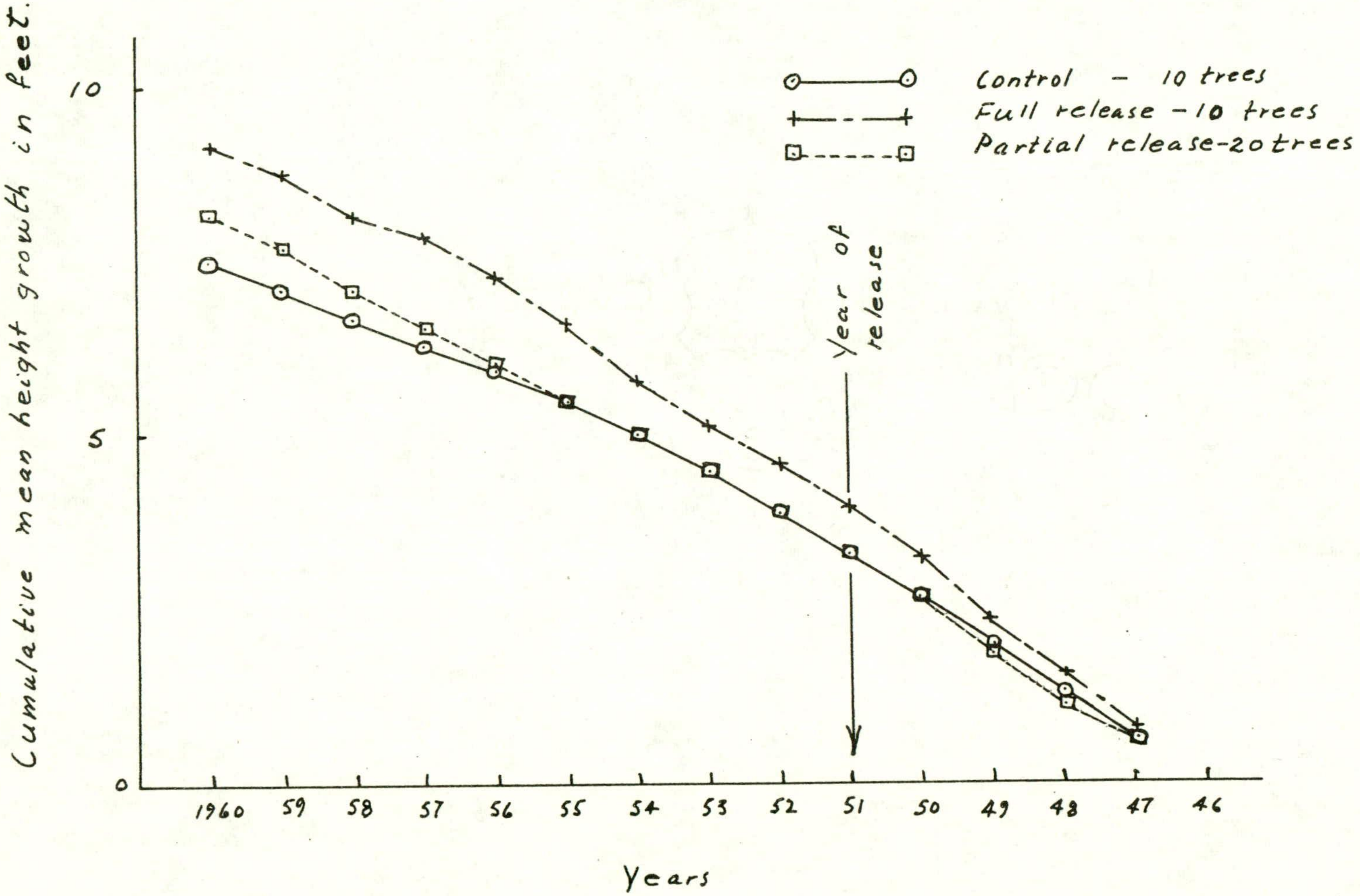

Figure 2. Cumulative mean height growth from 1947 to 1960 for treated and control plots.

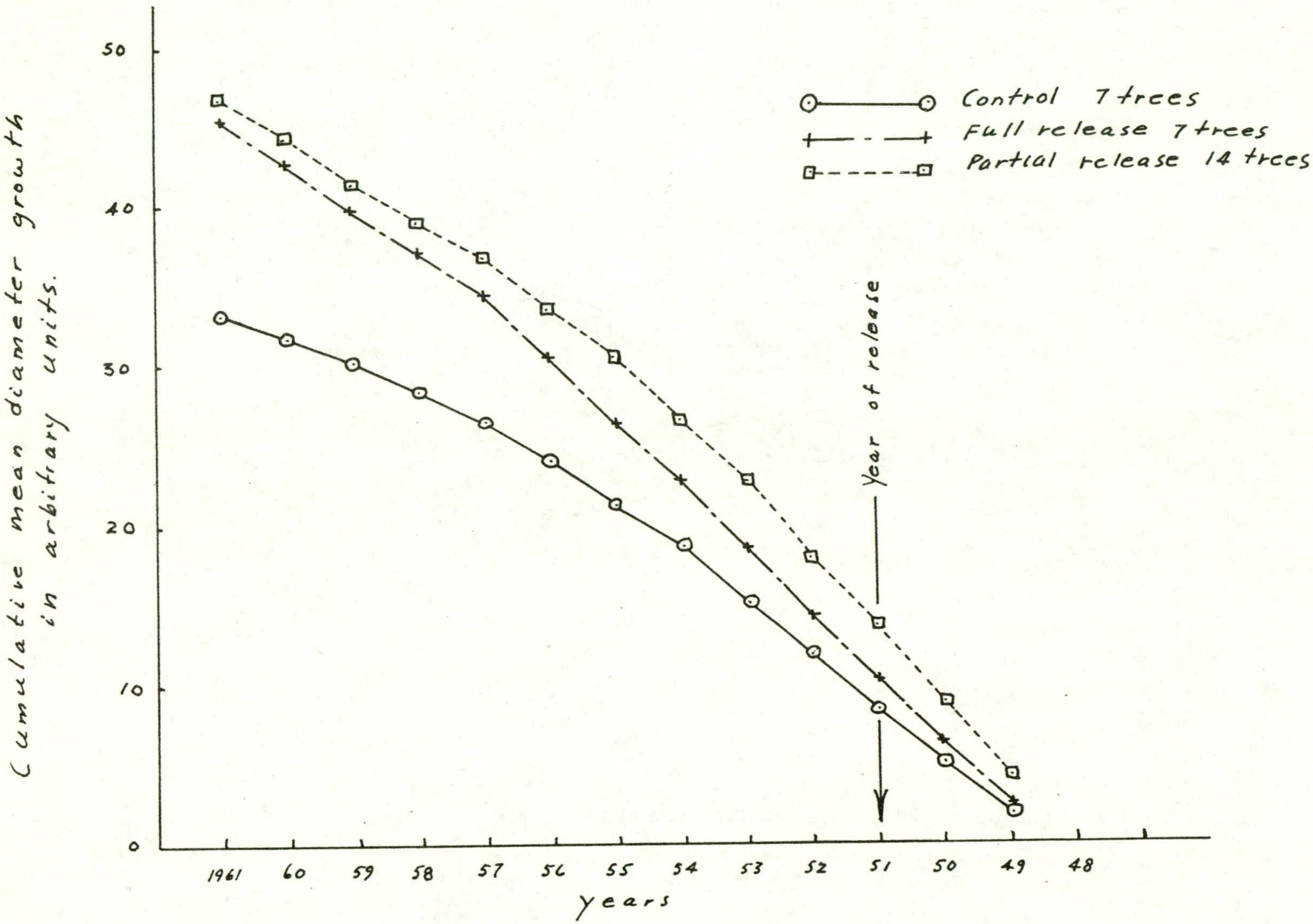

Figure 3. Cumulative mean diameter growth in arbitrary units from 1949 to 1961 for treated and control plots.