

CANADA  
Department of Forestry

**DEVELOPMENT OF BALSAM FIR THICKETS  
IN THE GREEN RIVER WATERSHED  
FOLLOWING THE SPRUCE  
BUDWORM OUTBREAK  
OF 1913-1919**

by

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## **FOREWORD**

Material in this report was used for a Master's Thesis accepted by the University of New Brunswick in 1954. The author gratefully acknowledges the advice and assistance given by members of the Forestry Faculty of that University during the preparation of the original manuscript.

# Development of Balsam Fir Thickets in the Green River Watershed following the Spruce Budworm Outbreak of 1913-1919

(Project M—426)

by

A. B. Vincent<sup>1</sup>

## INTRODUCTION

An outbreak of the spruce budworm (*Choristoneura fumiferana* Clem.) between 1910 and 1920 devastated large areas of spruce and fir forests in eastern Canada. This outbreak resulted in the establishment of dense young stands of balsam fir (*Abies balsamea* (L.) Mill.), white spruce (*Picea glauca* (Moench) Voss, and black spruce (*P. mariana* (Mill.) BSP.). According to Tohill<sup>2</sup>, more than 60 per cent of the forested lands of New Brunswick were attacked more or less severely. The patches and extensive areas of fir thickets which developed in these areas are a problem in forest management.

The widespread occurrence of these stands, the recent budworm threat to the mature spruce and fir stands, and the dependence of the pulp and paper industry on the areas involved for future raw materials make a knowledge of thicket development desirable.

Since a review of the literature provided little information on development and desirable management methods for fir thickets, a project was initiated in 1952 to study their structure and development since the spruce budworm outbreak. The fieldwork was conducted on the Green River watershed which was severely affected by the budworm in 1913-1919<sup>3</sup>. This report presents the findings of the investigation.

## DESCRIPTION OF THE AREA

The Green River Watershed is located in northwestern New Brunswick between latitudes 47° 25' and 47° 55' N. and longitudes 68° and 68° 30' W. The forested portion occupies about 400 square miles and is reasonably representative of much of the forested area of northern New Brunswick.

The relief of the watershed is strongly rolling with few very steep slopes, flats, or swamps. Six lakes and numerous streams drain southwards into the main

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<sup>2</sup> Tohill, J. D. 1921. An estimate of the damage done in New Brunswick by the spruce budworm. *Acadian Ent. Soc. Ann. Rep.* 1921, pp. 45-49.

<sup>3</sup> Green River Work Committee. 1948. The Green River Project for the study of forest management in relation to spruce bud worm control. *Pulp and Paper Magazine of Canada*, 49:136-144.

channel of the Green River. The soil is mainly moderately deep, dumped, loamy and stony tills over permeable shales and sandstones. In general drainage is good, and the deeply fractured bedrock is penetrated by tree roots. Such work as has been done on site classification has not indicated significant differences in height development of spruce and fir between sites supporting the thickets studied.

The study area is in a region of short, warm summers and long, cold, snowy winters. The mean annual temperature is 36°F. with July, the warmest month, having a mean temperature of 61°F. Annual precipitation is 42 inches, including an average 102-inch snowfall (10.2 ins. water equivalent). Twenty-five inches of rainfall occur between May and October. The growing season averages 86 days for radial growth of fir and 83 days for spruce.

The fir thickets usually occur as an understory in two-storeyed softwood and mixedwood stands which occupy about 47,000 acres (20 per cent) of the productive forested area in the watershed.

The overstorey contains mature to overmature balsam fir, white and black spruce, and white birch (*Betula papyrifera* Marsh.) in varying proportions. Fir is usually plentiful, with spruce and birch varying in quantity from stand to stand. The overstorey density is about 100 trees per acre.

The understory, mainly balsam fir with scattered white and black spruce, white birch, and pin cherry (*Prunus pensylvanica* L.f.), varies in density from about 1,000 to 8,000 or more stems per acre. Average age at breast height in 1952 was between 20 and 30 years, and few stems over six inches d.b.h. were found. Figures 1 to 5 show some of the stands sampled.



FIGURE 1: Thicket stand with 4,400 trees per acre—plot 2b.



FIGURE 2: Thicket stand with 3,360 trees per acre—plot 5a. Trees on ground were killed during the 1913-1919 bud worm outbreak.



FIGURE 3: Thicket stand with 3,240 trees per acre—plot 3b. Fir in right foreground is nearly 6 inches at breast height.



FIGURE 4: Thicket stand with 1,360 trees per acre—plot 4b.



FIGURE 5: Thicket stand with 960 trees per acre—plot 5b. Note heavy branches. Lowest branches were pruned for accessibility.



## METHODS

### Field Work

In 1952, five pairs of one-fortieth-acre square plots were established in representative immature stands. One plot of each pair was in the most dense and the other in a more open part of a stand.

Stem positions were mapped, crown sizes were measured, and detailed stem analyses were made of each tree in the plot. In addition, crown class and age were recorded for each tree.

In 1953, four 0.4-acre plots in older stands were examined to obtain information on how the immature stands might develop.

### Compilation

Stand and stock tables were prepared, crown ratio, crown volume, and crown area were computed, and volume, height, and diameter growth increments were calculated.

The data presented in the following sections were developed from these computations.

## RESULTS

### Condition of Fir Thickets in 1952

This section outlining the condition of the fir thickets as they were in 1952 is based on data from only a small sample of the total population. Although not strictly amenable to statistical analysis, the data are believed to present a reasonable picture of the growth and development of the thickets as a whole.

In this and in later sections, the term "stand density" is used interchangeably with "trees per acre" and has the same meaning.

#### *Trees per Acre and Basal Area*

Stand density on the thicket plots varied from 960 to 5,320 trees, with a mean of 3,112 trees per acre. Hardwoods are few in number and are not included in these data.

All thicket stands are patchy and have an uneven distribution of stems. The trees tend to be smaller where the stand is dense, and larger and fewer stems above a few smaller ones where the stand is more open.

Table 1 shows trees per acre and basal areas for the thicket plots.

TABLE 1—STAND DATA FROM 35- TO 40-YEAR-OLD FIR THICKET PLOTS

Trees per acre	Basal area per acre	Trees per acre	Basal area per acre
	(sq. ft.)		(sq. ft.)
5,320.....	175	3,000	146
4,400.....	168	2,680	125
4,160.....	147	2,640	124
3,360.....	134	1,360	148
3,240.....	194	960	100

Basal area per acre is reasonably well correlated with stand density (Figure 6). Regression lines (not shown) calculated for each 1-inch d.b.h. class indicate that the basal area of each class below five inches increases with density.

Basal areas of larger size classes decrease with increased stand density. For example, total basal area at 800 trees per acre is 115 sq. ft., of which 75 sq. ft. is contained in trees over four inches d.b.h.; at 5,000 trees per acre, total basal area is 166 sq. ft. and only 15 sq. ft. is contained in trees over four inches (these data from regression lines).

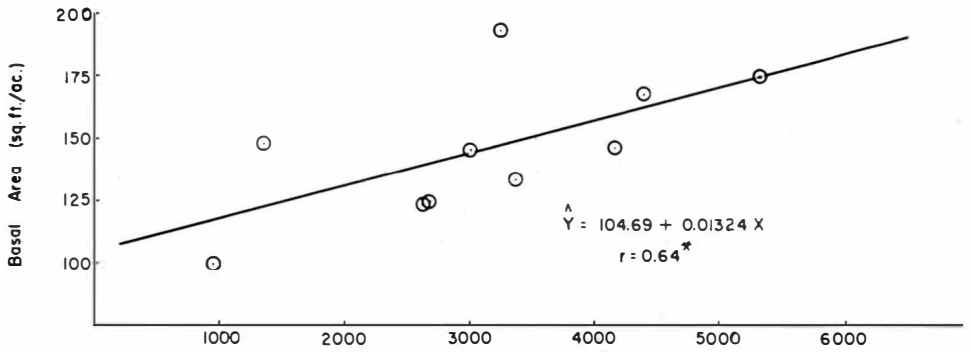


Figure 6. Relationship of Basal Area and Stand Density

### Stand Volumes

Table 2 shows total and merchantable volumes, listed in descending order of density as in Table 1, for the thicket plots.

TABLE 2—TOTAL AND MERCHANTABLE VOLUMES PER ACRE ON FIR THICKET PLOTS

Trees per acre	Total volume (cu. ft.)	Merch. volume (cu. ft.)	Trees per acre	Total volume (cu. ft.)	Merch. volume (cu. ft.)
5,320.....	2,409	0	3,000	2,135	604
4,400.....	2,346	496	2,680	1,669	316
4,160.....	1,955	272	2,640	1,825	488
3,360.....	1,869	112	1,360	2,766	1,560
3,240.....	2,778	808	960	1,634	1,060

Total volume per acre trends slightly towards greater volume with increased stand density, but the relationship is not statistically significant (Figure 7). Merchantable volume is closely correlated, an inverse relationship, with trees per acre (Figure 8).

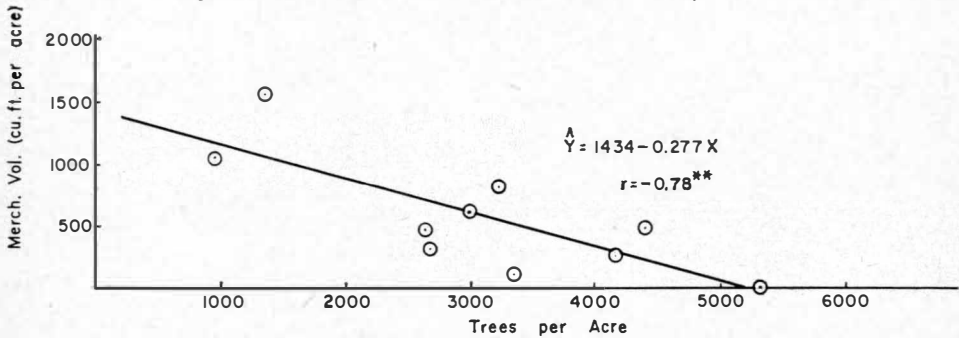
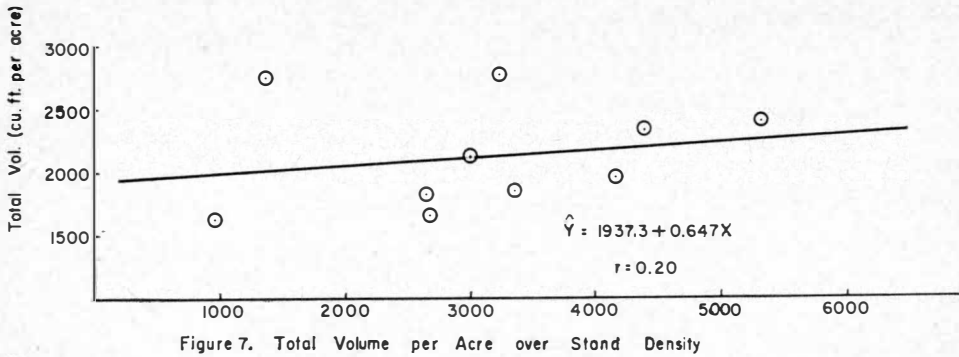
A further regression of merchantable volume over mean dominant height had a high correlation coefficient for these factors. The rate of change is an additional 857 cubic feet per acre for each increase of 10 feet in mean height of dominant trees. An interesting feature of this relationship is that the merchantable volume data from the older stands fit the regression line for thicket data.

### Crown Size

Crown volume of thicket trees was computed by treating the crown as a cone with height equal to crown length<sup>4</sup> and basal diameter equal to the greatest diameter of the crown. Crown volumes were as shown in Table 3.

Dominant crowns are about two to three times the size of co-dominant crowns on all except the least dense plot. There is an indication that, in the more

<sup>4</sup> The base of the crown is the point midway between the first partially complete living whorl and the first complete living whorl above the ground. Crowns of immature fir usually are conical in form except for irregularities at the base due to death of some branches.



\* Significant at 5% level.  
 \*\* Significant at 1% level.

TABLE 3—MEAN CROWN VOLUMES PER TREE OF DOMINANT AND CO-DOMINANT TREES IN THICKET STANDS

Trees per acre	Dom. crown volume (cu. ft.)	Co-dom. crown volume (cu. ft.)	Trees per acre	Dom. crown volume (cu. ft.)	Co-dom. crown volume (cu. ft.)
5,320.....	339	156	3,000	650	258
4,400.....	428	201	2,680	402	226
4,160.....	502	166	2,640	557	252
3,360.....	588	200	1,360	1,064	346
3,240.....	664	224	960	1,255	931

open stands, dominant trees attain maximum crown size rather early in life. For instance, the average dominant crown on a thicket plot (at 35 years) with 960 trees per acre is larger than the average dominant crown in the three oldest plots (at 76 years) sampled in mature stands in 1953.

The relationship of the mean crown volume per tree to stand density appears to be as follows: the curve of mean crown volume drops sharply with increased density up to approximately 2,500 trees per acre; above this density the slope is much less. For example, a balanced freehand curve<sup>5</sup> gives the following values:

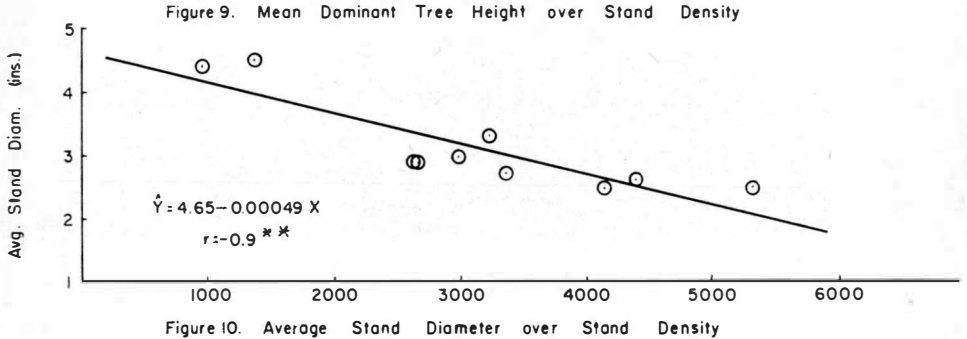
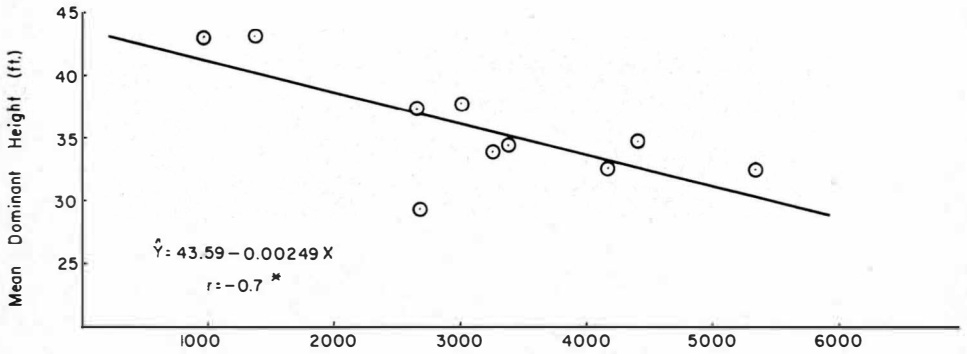
Trees per acre	Mean volume of individual tree crowns
1,000	495 cu. ft.
2,500	190 cu. ft.
5,000	70 cu. ft.

<sup>5</sup> Based on sample of more than 100 trees over all densities.

### Tree Diameter and Height

Dominant tree heights are well correlated with stand density (Figure 9). On the least dense plot—960 trees per acre—mean dominant height is 43 feet, while on the plot with 5,320 trees per acre it is 32 feet.

Average stand diameter (Figure 10) is even more closely correlated with density. Stand diameters at the densities mentioned above are 4.4" d.b.h. and 2.5" d.b.h., respectively.



### Stand Establishment and Early Development

For convenience, the data in this and following sections are presented in two density classes. The classes are 1) 3,000 and under trees per acre, and 2) over 3,000 trees per acre.

### Stand Age and Origin

Table 4 shows average stand ages at stump and breast heights.

TABLE 4—AGES AT STUMP AND BREAST HEIGHT OF STANDS IN TWO DENSITY GROUPS

Crown class	3,000 and less		More than 3,000	
	Age at B.H.	Age at S.H.	Age at B.H.	Age at S.H.
Dominant.....	30	36	26	34
Co-dominant.....	27	33	27	33
Intermediate.....	25	34	25	32
Suppressed.....	24	33	22	29

There is no great difference in the times required for the stands in the two density classes to grow from stump to breast height. This might be expected as competition, although a factor, would not be as great as it would be later in the life of the stands.

The tabulation below gives the percentages of trees living in 1952 which were one foot or more high at the dates shown.

Date	Less than 3,000 trees/acre	More than 3,000 trees/acre
1915	20	4
1920	61	52
1925	91	87
1930	100	98
1935	100	100

Spruce and fir reproduction on the watershed requires 10 to 50 years to reach a height of one foot under a canopy of mature trees. The above data indicate that the thicket stems were existing as advance growth at the beginning of the outbreak and were released when the main stand was thinned by the spruce budworm.

The existence of large numbers of reproduction under maturing balsam fir stands such as those attacked by the budworm during 1913-19 is a common occurrence in northern New Brunswick, and is also reported by Hatcher<sup>6</sup> as happening in Quebec. This reproduction, or advance growth, accumulates over a considerable number of years and provides most of the new stand when the old stand is cut or otherwise destroyed.

Response to release was slow—height growth rates determined by stem analyses indicate response to release during the period 1922-1927—probably because the reproduction suffered some defoliation during the outbreak. Normally, small, healthy spruce and fir reproduction should respond to release the second growing season after removal of competition.

The majority of the thickets appear to have developed as follows: the main stands were gradually defoliated as the outbreak progressed, allowing an increasing amount of light to reach the forest floor. The advance growth, chiefly balsam fir, although suffering some defoliation, was able to take advantage of the decreasing competition caused first by defoliation and later by mortality in the main stand. Regeneration during and immediately following the budworm attack has had little influence on composition of the fir thickets. This opinion is supported by the fact that severely attacked stands in a recent outbreak in the area produced little or no seed while under attack.

Variations in thicket density are attributed to density and age of the former stands, differences in intensity of the budworm attack, composition of the former stands, and initial stocking and size of advance growth.

## Later Stand Development

### *Diameter and Basal Area Growth*

Over-all diameter growth in the thickets has been strongly affected by stand density (Figure 11). Correlation analyses of diameter growth/density<sup>7</sup> indicate a strong relationship in the co-dominant and intermediate classes ( $r = -0.67$  and  $-0.75$  respectively). Correlation in the dominant and suppressed classes is less marked ( $r = -0.48$  and  $-0.50$ ), indicating that the present dominant trees have maintained sufficient dominance to partially overcome the effects of density. Conversely, "suppressed" trees have been suppressed at all densities.

<sup>6</sup> Hatcher, R. J. 1960. Development of balsam fir following a clearcut in Quebec. Can. Dept. of Northern Aff. and National Res., For. Br., For. Res. Div. Tech. Note No. 87.

<sup>7</sup> Growth, until 1952, from the time the trees first reached breast height.

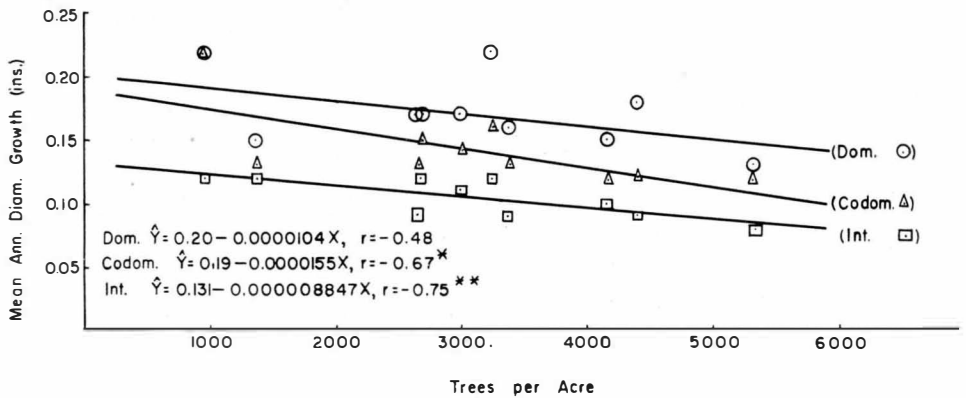


Figure 11. Mean Annual Diameter Growth by Crown Classes over Stand Density

TABLE 5—MEAN ANNUAL STUMP DIAMETER (O.B.) GROWTH BY CROWN CLASSES ON MOST AND LEAST DENSE PLOTS

Plot	Trees per acre	Dominant	Co-dominant	Intermediate	Suppressed
4a	5,320	0.12	0.11	0.08	0.06
5b	960	0.21	0.19	0.08	0.07

Table 5 shows the marked differences that occur with very different densities. Conversely, averaging the growth rates by the two broad density classes used previously (see Table 6) tends to obscure any effects density has had on diameter growth. This indicates that the effects of density vary, probably owing to minor differences in site and stand history.

TABLE 6—AVERAGE ANNUAL DIAMETER GROWTH (INCHES) AT STUMP HEIGHT FOR PERIODS INDICATED

Density class (trees per acre)	Dominant trees					Co-dominant trees				
	1928-1932	1933-1937	1938-1942	1943-1947	1948-1952	1928-1932	1933-1937	1938-1942	1943-1947	1948-1952
3,000 and less.....	0.10	0.19	0.20	0.19	0.14	0.09	0.16	0.16	0.14	0.11
More than 3,000..	0.14	0.19	0.19	0.19	0.16	0.10	0.12	0.12	0.11	0.13

Table 7 shows basal areas and increments by 5-year periods.

TABLE 7—BASAL AREA IN SQUARE FEET PER ACRE AT 5-YEAR INTERVALS

Date	3,000 and less trees per acre		More than 3,000 trees per acre	
	B.A. per acre	B.A. increment	B.A. per acre	B.A. increment
1922.....	2	—	1	—
1927.....	7	5	8	7
1932.....	21	14	23	15
1937.....	44	23	53	30
1942.....	72	28	83	30
1947.....	106	34	128	45
1952.....	129	23	164	36

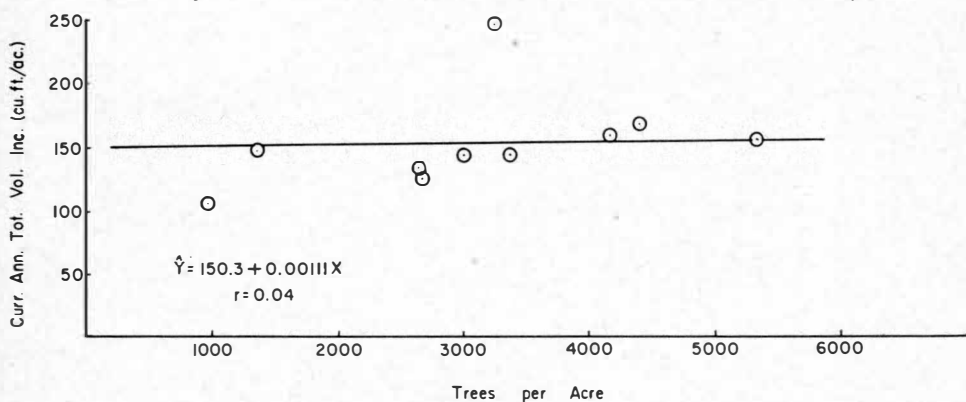
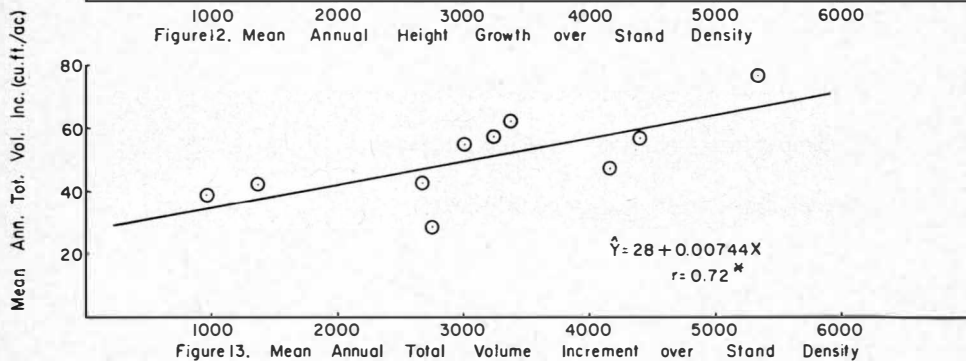
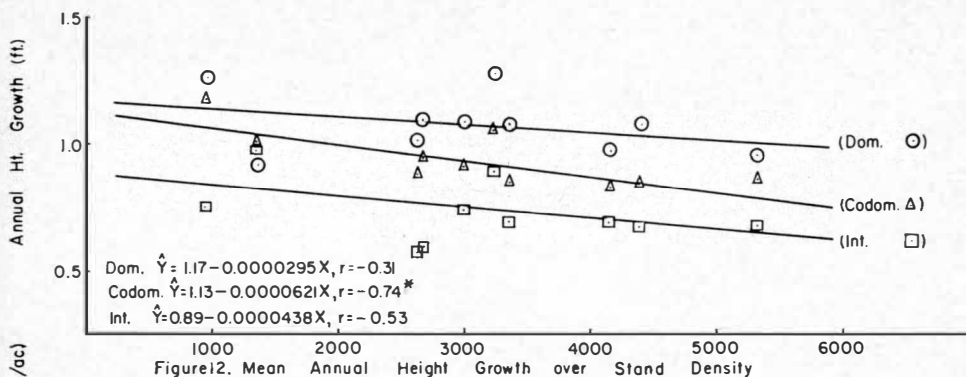


Figure 14. Current (1947-52) Annual Total Volume Increment over Stand Density

From 1942 to 1952 total basal area increment was 42 per cent greater in the denser stands. It was mentioned earlier that basal area increment in merchantable trees was less in denser stands.

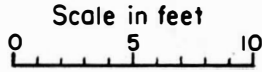
As no mortality data are available from this study, the above data do not take into account the trees which have died. It seems likely that heavy mortality occurred at all densities during the first 20 years after release, with more stems dying in the higher densities. A study in similar stands in Newfoundland<sup>8</sup>, and other studies in the Green River Watershed, indicate that most mortality occurs during the 20 years following release.

<sup>8</sup> Anon. Growth of balsam fir in Newfoundland. Pulp and Paper Mag. Can., 49(3): pp. 280-286, 1948.




FIGURE 15

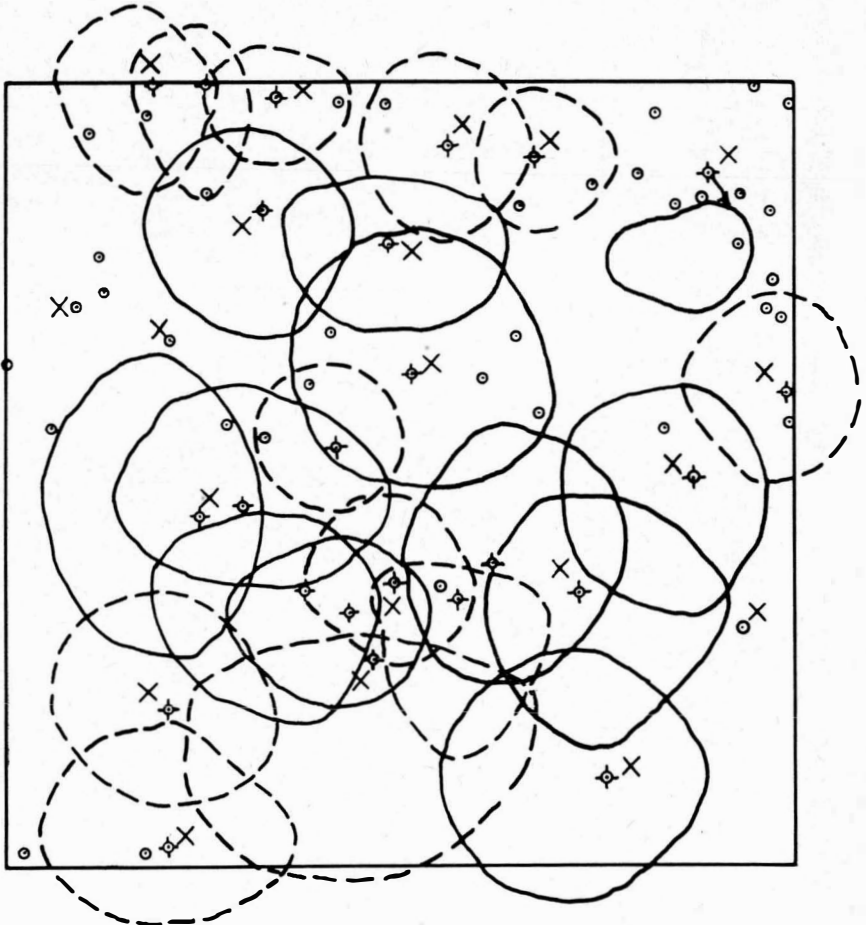
MAP OF ALL TREE POSITIONS, AND CROWN PROJECTIONS  
OF DOMINANT AND CODOMINANT TREES

Plot 3a



LEGEND

- Probable survivors at maturity . . . . . X
- Dominant trees and crown projections . . . . . 
- Codominant trees and crown projections . . . . . 
- Intermediate and suppressed trees . . . . . 





## Height Growth

In each crown class the average tree in the less dense stands is somewhat taller than its opposite number in the denser stands; the average dominant tree heights in 1952 were 36.5 and 32.8 feet respectively.

Mean annual height growth has a relationship (Figure 12) to stand density similar to that of diameter growth, i.e., height growth of dominants and intermediates is weakly correlated with density while growth of co-dominant trees is strongly correlated.

## Volume Growth

Table 8 shows mean and periodic annual increments of total volume.

TABLE 8—MEAN AND PERIODIC ANNUAL INCREMENT OF TOTAL VOLUME IN CUBIC FEET PER ACRE

	1922-1927	1927-1932	1932-1937	1937-1942	1942-1947	1947-1952
	3,000 and less trees per acre					
Mean ann. inc.....	2	5	11	21	32	42
Periodic ann. inc.....	7	21	48	87	111	132
	More than 3,000 trees per acre					
Mean ann. inc.....	2	8	16	31	45	60
Periodic ann. inc.....	5	21	51	106	138	176

Both mean and periodic annual increments are greater in the denser stands. Figures 13 and 14 show that mean annual increment is strongly correlated with present stand density but periodic increment is not.

No data are available from this study on periodic annual merchantable volume increment, but data from another study<sup>9</sup> show a periodic annual increment of 60 cubic feet per acre in a thicket stand of the same age with a density of 2,380 trees per acre. Mean annual merchantable volume increment is closely correlated with present density ( $r = -0.77^{**}$ ).

Although merchantable volume increment is low in the denser stands, current increment should show a sharp upturn owing to ingrowth. This is not likely to be matched in the less dense stands as they have fewer stems about to reach merchantable size. Growth of the individual tree in less dense stands will still be greater than in the denser stands, but the greater numbers of stems in the latter may well result in an equal or greater merchantable volume at maturity in all except the most dense stands.

## DISCUSSION

### Stand Development

It is apparent that advance growth present at the time of the 1913-19 spruce budworm outbreak has been a significant factor in the establishment and development of the balsam fir thickets on the Green River Watershed. As there was little regeneration subsequent to the attack, present stand densities are the result of: 1) the effects of the previous stand conditions on advance growth establishment, 2) the release afforded by the budworm outbreak, and 3) competition within the new stands. The residual overstoreys are so open that effective competition from them appears to have been confined to the relatively few thicket stems in close proximity to an individual overstorey tree. This is not believed to have been an important factor in the development of the thickets.

<sup>9</sup> Vincent, A. B. 1952. Report on 1951 remeasurement of Research Block 2. For. Br., Dept. Res. and Dev., Unpub. MS.

Competition within the immature stands has been important in their development. The effects of stand density on growth have been indicated previously. The struggle for light, moisture, and nutrients must have been intense during the 20 years after release when the heaviest mortality probably occurred. Mortality must have been greater in the denser stands and among the smaller and least thrifty stems.

Crowns are smaller in the denser stands, and this leads to slower per tree growth rates. While dominance was well expressed in all stands sampled, the percentages of dominants and co-dominants were less in the denser stands although their actual numbers were greater.

It is interesting to speculate as to the optimum stand structure in thicket stands of this age. The writer's opinion, based on this and other studies in the Green River watershed is that the optimum number of trees is about 1,500 per acre. This would give a spacing of about 5.4 feet, which may at first glance appear to be rather close. However, certain assumptions must be made and various factors considered. First, it is assumed that commercial thinnings in such stands would not normally be made before they are 35 years old, and secondly that the maximum growth rate compatible with high quality wood is desirable.

In determining the optimum growing space, or trees per acre, one must attempt to strike a balance between the spacing that would permit the most rapid growth of individual crop trees and of the stand as a whole, and the spacing which would give clean boles and wood of good density. Some intermingling of crowns near their bases, or the presence of smaller crowns to crowd the larger ones and promote natural pruning, is desirable. The plot with 960 trees per acre in 1952 had a merchantable volume of 1,060 cubic feet per acre (Table 2), and one with 1,360 trees per acre had a volume of 1,560 cubic feet. However, the trees on both plots had heavy branches extending close to the ground, and the latter plot had some trees older than the average thicket tree, thus an abnormally high merchantable volume. On the other hand, stands with more than 2,000 trees per acre have relatively low merchantable volumes. Thus the optimum stand at 35 years probably would fall between 1,000 and 2,000 trees per acre.

It could be argued that merchantable volume in stands 35 years old is unimportant. This is in part true, but only if there is no possibility of thinnings during the stand rotation. Interpretation of data from the study indicate that minimum values in a 35-year-old balsam fir stand of 1,500 trees per acre would be about as follows:

Basal area.....	125 sq ft./acre
Mean d.b.h. dominants.....	5.7 ins.
Mean annual d.b.h. growth.....	dominants 0.19 ins. average tree 0.16 ins.
Mean annual height growth.....	dominants 1.1 ft. average tree 0.9 ft.
Total volume.....	2,100 cu. ft./acre
Merchantable volume.....	1,000 cu. ft./acre
Dom. and co-dom. trees.....	600 per acre

### Necessity for Thinning

The problem of whether or not to thin normally arises when immature stands are being discussed. For the stands examined in this study, there can be little doubt that merchantable volume increment, at least in the denser stands, could be increased by careful thinning. However, it is uncertain whether this would be economically feasible.

In the Green River Watershed, indeed in much of northern New Brunswick, there are large areas of mature and overmature single-storeyed stands having balsam fir as the principal component. These stands are very susceptible to disease and insect infestations, thus they must receive priority in removal if great losses of wood are to be avoided. Without a greatly increased demand for raw materials over the next 20 years, industry cannot afford to practice high-yield silviculture in the large areas of immature stands. In view of this, the possibilities of thinnings in these stands may be only of academic interest. However, the thinning problem is not as serious as it might seem because the growth data indicate there is no danger of stagnation, and most of the thicket stands should provide good yields 30 to 40 years hence with no silvicultural assistance. While there is little doubt that intermediate cuttings would result in an improved stand structure and in better growth of the average tree, the need is not urgent.

There is, however, one aspect of the situation which should be given attention. This is that the sparse overstorey, which has received little mention previously in this report, should be removed along with the mature and overmature stands in which operations now are concentrated. The trees comprising the overstorey are 100+ years old and cannot last indefinitely. They would yield about 10 cords per acre now, but this is decreasing because mortality more than balances growth. Removal of the approximately 100 overstorey trees per acre, with the possible inclusion of some of the larger immature stems, would be of some benefit to the thickets. This would be effected by cutting yarding trails and haulroads, clearing around trees to be cut, and some breakage of understorey trees by the falling tree, resulting in a series of irregularly spaced openings. These would afford at least partial release to many immature trees and would probably increase the number and growth rate of potential crop trees.

## SUMMARY AND CONCLUSIONS

A study of the development of fir thickets arising after the 1913-19 spruce budworm outbreak was made in 1952 and 1953 on the Green River Watershed in northwestern New Brunswick. This information was needed because of the future importance of such stands.

Ten one-fortieth acre plots were set out in representative immature stands, and four 0.4-acre plots were located in older stands which appeared to have developed from dense young stands. Stem analyses and detailed crown measurements were made.

Age at a 1-foot stump ranged from 29 to 51 years with most trees around 32 to 34 years. The stands were even-aged, although the dominant trees usually were three to four years older than the others. The thickets developed mainly from advance growth released by the spruce budworm attack.

Density was the chief factor influencing the development of the stands. Diameter and height growth, crown size, and merchantable volume were depressed in higher density stands. Dominant trees were least affected.

Densities in the stands examined ranged from 960 to 5,320 with a mean of 3,112 trees per acre. Total volumes ranged from about 1,630 to 2,780, and merchantable volumes from 0 to 1,560 cubic feet per acre.

Conventional thinnings in the immature stands are not economically feasible now, but the removal of the scattered overstorey together with a few of the larger young stems would be profitable and would improve growing conditions in the residual stand.

## RÉSUMÉ ET CONCLUSIONS

En 1952 et 1953, dans le bassin hydrographique de la rivière Verte au nord-ouest du Nouveau-Brunswick, une étude était effectuée sur la croissance des bosquets de sapins à la suite d'une épidémie de la tordeuse des bourgeons de l'épinette entre 1913 et 1919. Ces renseignements étaient indispensables en raison de l'importance future de ces peuplements.

Dix places d'étude d'un quarantième d'acre furent délimitées dans des peuplements types et quatre places d'étude de quatre dixièmes d'acre furent établies dans des peuplements plus âgés qui semblaient s'être formés à partir de jeunes peuplements denses. Des analyses des tiges et des mesures détaillées du couvert furent effectuées.

L'âge des sujets d'un pied de diamètre à la souche s'échelonnait entre 29 et 51 ans, mais la plupart des arbres étaient âgés de 32 à 34 ans. Les peuplements étaient uniformes alors que les arbres dominants étaient âgés de trois ou quatre ans de plus que les autres. Les bosquets étaient principalement formés de semis préexistants dégagés par l'épidémie de tordeuse des bourgeons de l'épinette.

La densité était le principal facteur qui ait influé sur la croissance des peuplements. La croissance en diamètre et en hauteur, la taille du couvert et le volume marchand étaient restreints dans les peuplements de plus grande densité. Les arbres dominants avaient été les moins touchés.

La densité des peuplements examinés s'échelonnait entre 960 et 5,320 arbres, avec une moyenne de 3,112 arbres à l'acre. Les volumes globaux variaient entre 1,630 et 2,780 pieds cubes et les volumes marchands, entre 0 et 1,560 pieds cubes à l'acre.

Il ne serait pas rentable, actuellement, d'effectuer des éclaircies normales dans les jeunes peuplements, mais la coupe de l'étage supérieur formé de sujets épars, ainsi que quelques jeunes tiges parmi les plus fortes, serait avantageuse et améliorerait les conditions de croissance dans le peuplement résiduel.