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Forestry Branch

DEVELOPMENT OF A BALSAM FIR AND WHITE SPRUCE FOREST

in

Northwestern New Brunswick

by
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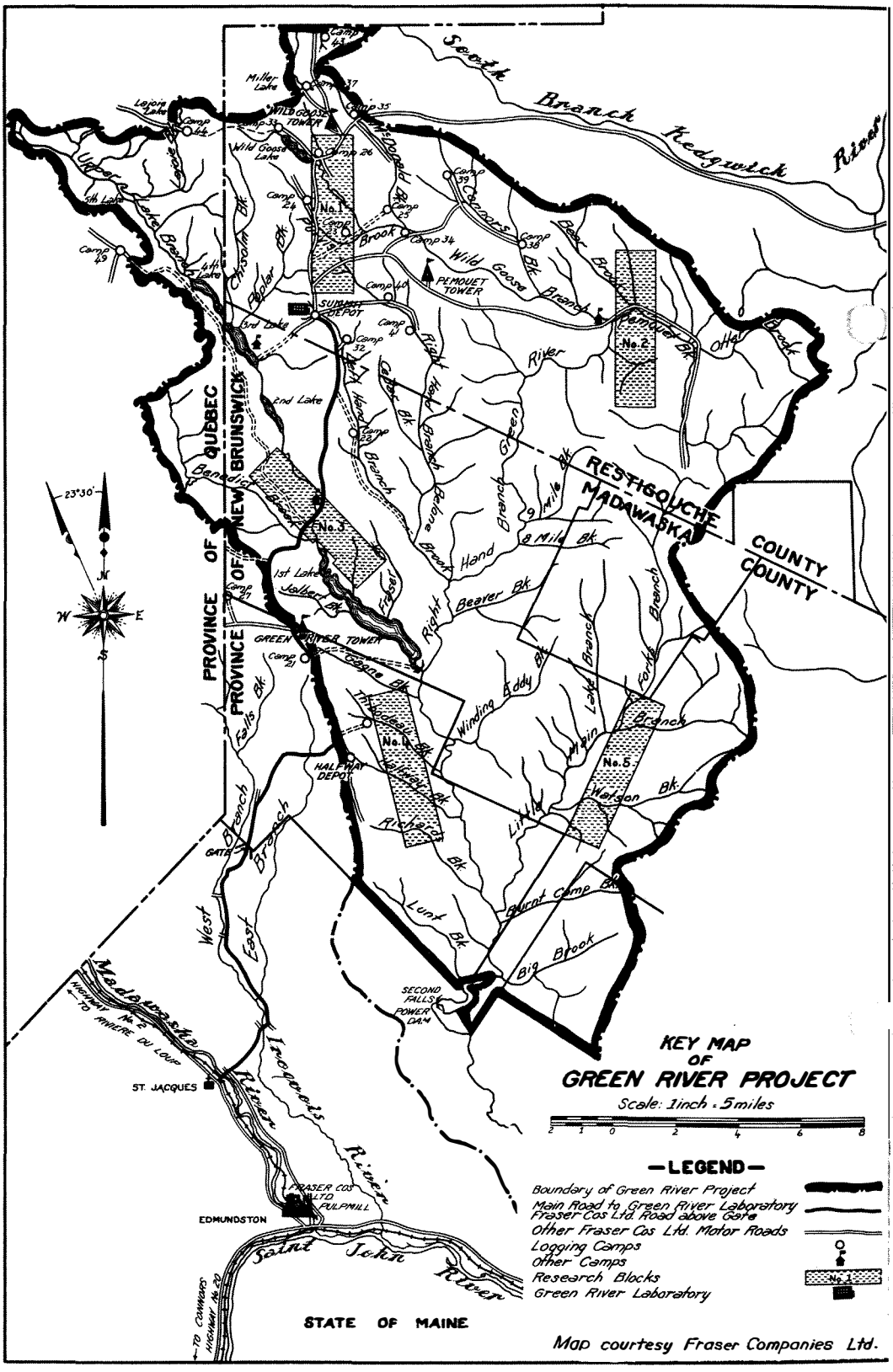

Map courtesy Fraser Companies Ltd.

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in

NORTHWESTERN NEW BRUNSWICK

Project M.401

by A.B. VINCENT*

INTRODUCTION

Toward the end of World War II the Advisory Committee on Forest Entomology and Pathology, Woodlands Section, Canadian Pulp and Paper Association, recommended setting up a project to investigate problems of managing a forest so as to prevent, or reduce to a minimum, loss from outbreaks of spruce budworm *(Choristoneura fumiferana* Clem.) (2). Fraser Companies, Limited, offered the use of the Green River watershed for the proposed project. In 1944, the Green River Work Committee, consisting of representatives of Fraser Companies, Limited, the Federal Department of Agriculture, the Federal Department of Resources and Development, and the New Brunswick Department of Lands and Mines, was set up to direct the project.

Detailed forestry investigations under the direction of D.E. Nickerson, of the Maritimes District Office, Forestry Branch, Department of Resources and Development, began in the autumn of 1945 when the first of a series of five 4,000-acre "research blocks", in representative stands in four minor drainage areas of the Green River watershed was established (see Map opposite).

They permit assessment of growth by cover types; determination of the adequacy of reproduction in uncut and cut-over stands; prediction of the probable density of re-stocking after cutting or other disturbance, and assessment of the effects on the stands of infestations of spruce budworm and birch dieback.

The condition and development of Research Block 1 during the 5-year period from 1945 to 1950 is described in this publication.

METHODS

Field Work

Six hundred and forty-one 0.1-acre semi-permanent line-plots were established on lines 10 chains apart, with the plots spaced 6 chains from centre to centre to give a 6-chain by 10-chain grid with a sampling intensity of 1.6 per cent.

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The following data were recorded on each plot at establishment:

(1) Diameter tally in 1-inch diameter classes at breast height by species for all trees, classified as living or dead, above 0.5-inch d.b.h.;

(2) Windfall which had occurred during the year preceding establishment;

(3) A total count of reproduction by species on a 1/200-acre (3.3' by 66') sub-plot within the plot;

(4) Notes on stand history and minor vegetation.

In addition, the topography, cover type boundaries, aspect and slope of plots were mapped along each cruise-line. All dead trees and windfalls on the plots were blazed prominently. Increment borings were made to tree centre at breast height, and total height measurements were taken, on fir and spruce trees selected mechanically throughout each forest type. The soil profile was examined on a few plots.

At the 1950 remeasurement, living trees and reproduction were measured as before, as well as mortality for the period 1945-50. A stocked quadrat tally of reproduction was taken on 10 one-milacre quadrats established within each plot. Soil profiles were also examined.

Compilation

Maps were prepared after each measurement to a scale of 10 chains to the inch. These were reduced photographically to a scale of 20 chains to the inch.

The cover-types shown on the maps are designated as follows:

	1950 Map*
SM	Mature softwood
SM-SS	Mature softwood over immature softwood
MM	Mature mixedwood
MM-SS	Mature mixedwood over immature softwood
C-SS	Cut-over with immature softwood
CN	Cut-over with no immature softwood

In 1950 diameter-height curves for spruce and fir showed no appreciable differences between types. For this reason the 1950 diameter-height data for spruce on the entire block were combined to make a curve for spruce in all types. Another diameter-height curve was prepared in a similar manner for balsam fir. These were used in conjunction with Dominion Forest Service "Form-Class Volume Tables" (Second Edition, 1948), Nos. 5 and 154, to provide volume tables for balsam fir and spruce on the entire research block.

Computations of volume and number of trees were made on an individual plot basis and then grouped for the various types. All volumes in this report are expressed in merchantable cubic feet and include only trees 3.6 inches in diameter

*See page 4.

or larger, outside bark, at breast height. Hardwood volumes were not computed; their representation in the various types is indicated by the number of trees per acre.

Diameter growth of spruce and fir at breast height was averaged by species in 3-inch d.b.h. classes for each cover type.

Net periodic softwood volume increment was computed by taking the difference between the 1945 and 1950 stand tables. The measured mortality and windfall were added to the net increment to obtain the gross increment. In this publication, "mortality" is used to indicate standing dead trees, and "windfall", trees which have blown down since establishment of the block.

The adequacy of the reproduction was judged on the following criteria: plots were classed as satisfactory (1) if at least 3 out of 10 quadrats contained one or more thrifty stems of spruce or fir reproduction, and (2) if the total count tally showed a stand reproduction of 1,000 or more spruce or fir per acre. The amount of reproduction per acre was computed for each type.

DESCRIPTION OF RESEARCH BLOCK ONE

Location, Physiography, and Climate

Research Block 1 is situated in the Wild Goose drainage area of the Green River watershed in Restigouche County, New Brunswick (Lat. 47°55' N., Long. 68°15' W.), and lies wholly within Section B2 of the Boreal Forest Region (3). It is rectangular in shape, approximately 400 by 100 chains, and contains 4,023 acres.

The block lies between 1,500 and 2,000 feet above sea level; slopes are gentle to moderate, and the relief is rolling. Its main part is drained by the Wild Goose Branch and its tributaries.

The bedrock is a deeply fractured shale, with no large out-crops, though a few small, weathered granite boulders occur on a slope on the east side of the block above Wild Goose Branch.

The soil over most of the block is a medium brown clay-loam derived from a well-decomposed shale or slate, with a humus layer seldom more than two inches thick. An A2 horizon varying from one-half to two inches in thickness is present over most of the block both in the valleys and on the heights.

The following climatic data,* for the period 1945 to 1950 inclusive, were recorded at the Green River Laboratory about one-half mile south and west of the lower end of the block.

The mean, and mean minimum, temperatures respectively for May to September inclusive, are 54°F. and 43°F. The precipitation for the same period is 22.6 inches. During the rest of the year the mean, and mean minimum, temperatures are 22°F. and 14°F.; precipitation is 15.6 inches. February is the coldest month with a mean minimum of –7°F. and July, the warmest, with a mean temperature of 61°F. and a mean minimum of 50°F. The yearly mean temperature is 35°F. and the yearly precipitation is 38.3 inches.

*Provided by the Federal Department of Agriculture.

The growing season is approximately 136 days, the frost-free period averaging 93 days from mid-June to mid-September. The prevailing wind is southwest during the summer and northwest during the winter.

Tree Species

Five important tree species occur on the block: balsam fir (*Abies balsamea* (L). Mill.); white spruce (*Picea glauca* (Moench) Voss); black spruce (*Picea mariana* Mill. B.S.P.); white birch (*Betula papyrifera* Marsh.); yellow birch (*Betula lutea* Michx. f.). Of these, balsam fir occurs throughout the block on all slopes and drainages. Spruce occurs in the valley bottoms, but its numbers dimish as the slopes are ascended. In general fir and spruce both grow well. White and yellow birch are the two most common hardwoods, and are most numerous on the hilltops, giving way to higher proportions of fir and spruce toward the lower slopes. White birch is the more abundant though both have suffered severely from birch dieback.

Eastern white cedar (*Thuja occidentalis* L.) occurs along the borders of streams but seldom elsewhere. The cedar on the block was observed to be in an unthrifty condition.

Red maple (*Acer rubrum* L.) is scattered sparsely over much of the block.

Mountain maple (*Acer spicatum* Lam.) grows in dense thickets on much of the cut-over area. It is scattered throughout uncut mixedwood stands and to a much smaller extent in uncut softwood stands.

Pin cherry (*Prunus pensylvanica* L.f.) forms dense clumps on many cut-over parts of the block. It does not appear to retard advance growth and regeneration as does mountain maple.

Cover Types

The cover types occurring on the block are varying mixtures of fir, spruce, and the birches. Uncut cover types are classified in this study wholly on the basis of the number of living trees. Stands were classed as two-storied if there were 400 or more living trees of all species in the 1- to 3-inch d.b.h. classes, and over 100 stems of larger sizes. Stands with less than 400 trees below 3.5 inches at breast height were classified as single-storied.

The mature softwood type (SM) consists of fir and spruce with less than 20 per cent hardwoods. Fir makes up from 60 to 80 per cent of the softwood content.

The two-storied softwood type (SM-SS) has an overstory of varying densities of spruce and fir, with a dense understory of fir and a few scattered spruce.

The mature mixedwood type (MM) contains from 21 to 80 per cent hardwoods of which white birch is by far the most numerous.

The two-storied mixedwood type (MM-SS) has a dense understory of fir. Spruce is very scattered in the overstory while fir is more numerous.

The two cut-over types (CN- and C-SS) are distinguished from each other mainly by the amount of softwood advance growth present in the sapling class immediately after cutting. The cut-over with immature softwood type has a stand

of over 400 sapling stems (0.5- to 3.5-inches d.b.h.) per acre, and the cut-over with no immature softwood type contains less than 400 sapling stems per acre.

Percentages of the total forested area of the block (3,875 acres), occupied by types undisturbed by cutting during the observation period are as follows (see Appendix for details):

SM	SM-SS	MM	MM-SS	C-SS	CN
4.7	4.6	4.4	0.9	14.4	55.7

The remaining 15.3 per cent of the forested area was cut between 1945 and 1950 and is excluded from type areas.

In all uncut types most of the spruce and fir above 3.5-inches d.b.h. are over 80 years old. The understory in the two-storied stands is chiefly from 20 to 40 years old. This younger age-class makes up 47 per cent of the total number of spruce and fir above 3.5 inches at breast height in the SM-SS type, but is poorly represented in the mature softwood and mixedwood types where less than 3 per cent of trees are of that age. Owing to the history of the stands in the area it is extremely difficult to relate size to age. For this reason all computations have been made on the basis of diameter at breast height rather than age.

History

There is no record or trace of fire on the research block, though insects or windfall apparently caused some opening up of the stands about 1850 and again about 1870.

The spruce budworm infestation of 1913 to 1919 has had a marked influence on the development of the stands. The two-storied stands, dense balsam fir thickets, and the presence of many undecomposed trees which succumbed to windfall following the attack can be attributed largely to this outbreak.

The birch dieback which became apparent about 1938, and is still active, resulted in the death or injury of most of the white and yellow birch but stimulated the growth of the residual coniferous stand.

Some white spruce logs were cut about 1900 and one may still find a few large stumps. This was the only logging operation in the area before 1941. Between 1941 and 1945 about 70 per cent of the block was cut over for spruce and fir pulpwood. Fifteen per cent was cut over after 1945, mainly in 1946 and 1947; in the autumn of the latter year an area of 80 acres (5) near the south end of the block along the east boundary was partially cut for spruce and fir pulpwood.

RESULTS AND DISCUSSION

Growth and Development of Forest Types

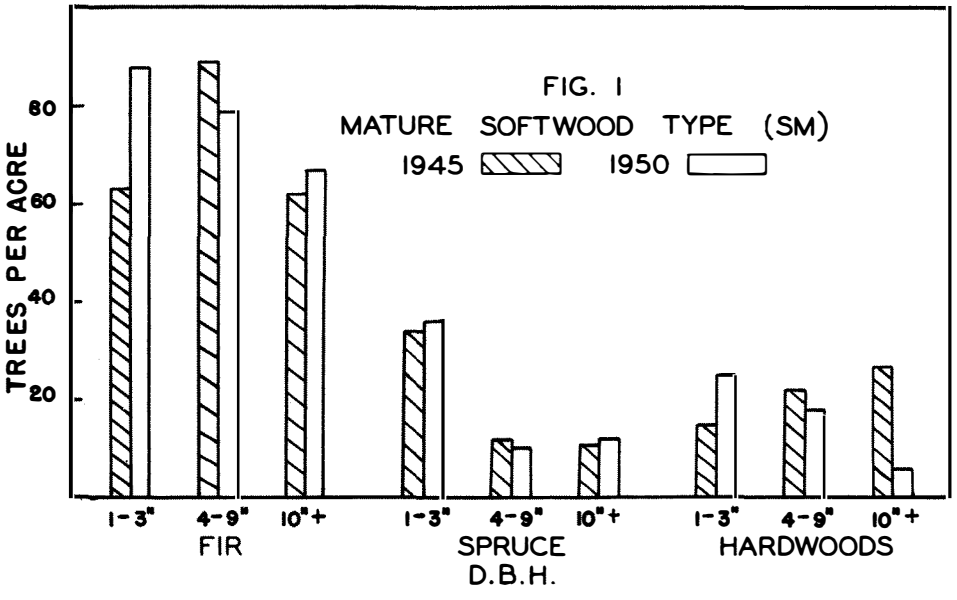
The forest types described in this section are those on areas in which no cutting took place between 1945 and 1950 – the observation period. Stands on the 590 acres-cut over since 1945 are not included.

Mature Softwood (SM)

The mature softwood type occupies about 4.7 per cent of the block area, with numbers of living trees per acre above 0.5-inch d.b.h. as follows:

Year	Fir	Spruce	Hardwoods
1945	208	57	50
1950	234	58	49

The only noteworthy changes between 1945 and 1950 were an increase of about 45 per cent in the number of fir saplings and a decrease in the number of large hardwoods because of dieback (see Fig. 1 and Table 2). During the 5-year period, normal mortality and windfall accounted for an average of two and five trees per acre respectively, in the softwoods above 10 inches in diameter; in the lower diameter classes, mortality was slightly greater than windfall.



The merchantable softwood volume in cubic feet per acre was:

Year	4-9" d.b.h.	10" & above d.b.h.	Total
1945	395	1,538	1,933
1950	353	1,744	2,097

The gross periodic annual increment was 77 cubic feet per acre; windfall and mortality accounted for 32 and 12 cubic feet respectively, leaving a net increment of about 33 cubic feet. As Davidson's studies (1) indicate that fir in the Green River watershed incurs serious losses from decay after the age of 90 years, the rate of loss is more likely to increase than decrease in the immediate future.

The stands have evidently passed the peak of mean and current annual increment, and, even if the present threat of the spruce budworm disappears, they should be utilized before many more years have elapsed.

Spruce and fir reproduction appears adequate (1,000 stems per acre or more) on all but 11 per cent of the plots. The following tabulation of stems per acre indicates that advance growth is maintaining itself despite a moderately dense overstory.

Year	Spruce	Fir	Hardwoods
1945	407	2,250	36
1950	239	2,193	382

Inclusion of pin cherry in the 1950 tally explains the increase of hardwoods.Birch, moreover, does not appear to be reproducing itself.

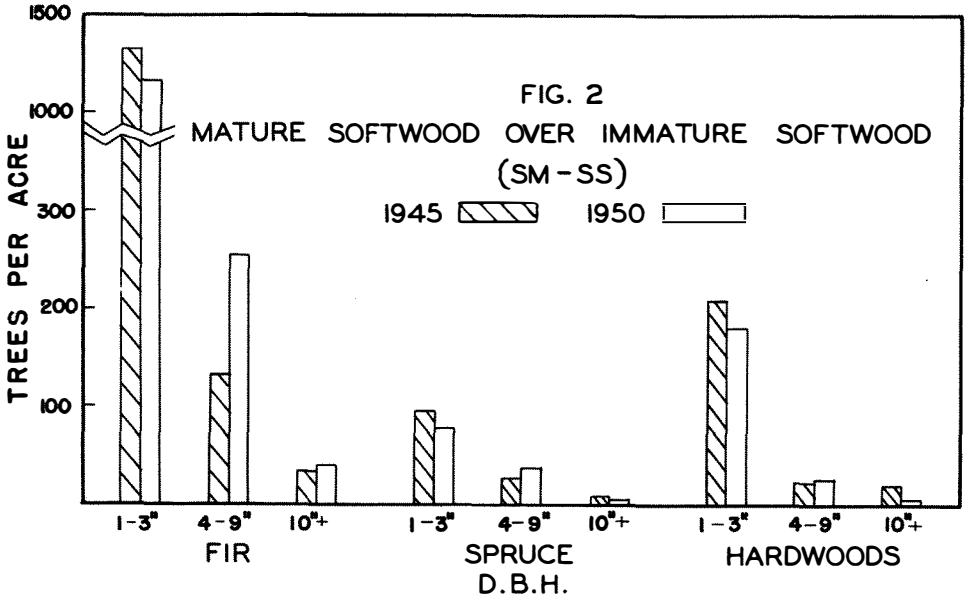
The advance growth plus the sapling stand should be adequate to reproduce the type unless logging damage is excessive. Diameter growth of spruce and fir has increased slightly during 1945 to 1950, indicating that judicious marking may make it feasible to harvest the stand in two cuts. The marking should be aimed at leaving a uniform canopy and removing defective and poorly formed trees. Harvesting in two cuts should lessen damage to advance growth, increase growth in the residual stand, and lessen the fire hazard on the cut-over area.

Mature Softwood over Immature Softwood (SM-SS)

This type occupies about 4.6 per cent of the block. The numbers of living stems per acre above 0.5-inch d.b.h. were as follows:

Year	Fir	Spruce	Hardwoods
1945	1,490	131	251
1950	1,453	123	210

The decrease in softwoods is chiefly through mortality of saplings (0.5- to 3.5-inches d.b.h.); that in hardwoods results from birch dieback (Fig. 2 and Table 2). The sapling stand is notable in that there is no evidence of stagnation despite the density of the stand. About 146 stems per acre died in the sapling stand and windfall accounted for only four; in the overstory, mortality and windfall accounted for three and six stems per acre respectively.



The merchantable softwood volume in cubic feet per acre was:

Year	4-9" d.b.h.	10" & above d.b.h.	Total
1945	309	878	1,187
1950	425	1,061	1,486

The gross periodic annual increment was 89 cubic feet. Mortality at 13 cubic feet and windfall at 16 cubic feet per acre leave an excellent net periodic annual increment of 60 cubic feet; two-thirds of this was contained in trees over 10 inches d.b.h. Diameter increment increased in all diameter classes.

The following tabulation of stems per acre indicates that the survival of spruce and fir reproduction is adequate even under a dense canopy.

Year	Fir	Spruce	Hardwoods
1945	2,323	192	338
1950	2,085	127	500

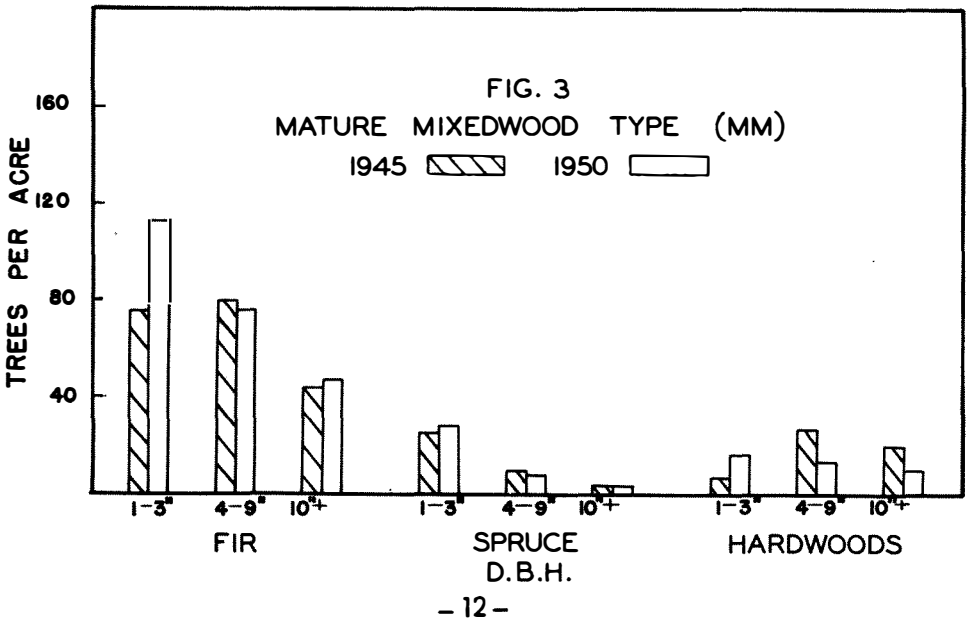
This type – mature softwood over immature softwood – with its dense stand of saplings should present no re-stocking problem under any system of cutting. The problem, if any, is to ensure that the residual stand would not be too dense. Should the overstory be clear-cut, thinnings are likely to be necessary as the residual stand would be far denser than is desirable.

Mature Mixedwood (MM)

This type occupies about 4.4 per cent of the area of the block. The number of living trees per acre above 0.5-inch d.b.h. is shown below.

Year	Fir	Spruce	Hardwoods
1945	200	40	58
1950	236	42	41

The increase in softwoods is encouraging, as only softwoods are utilized from this area (Fig. 3 and Table 2). Mortality and windfall accounted for 8 and 11 softwood trees per acre respectively, during the observation period.



The merchantable softwood volume in cubic feet per acre was:

Year	4-9" d.b.h.	10" & above d.b.h.	Total
1945	368	1,051	1,419
1950	335	1,134	1,469

The gross periodic annual increment of 46 cubic feet per acre consisted of mortality 16, windfall 20, and net increment 10, cubic feet per acre. These stands appear to be well past the peak of mean annual increment, the increase in volume of larger trees being almost offset by the decrease in trees under 10 inches d.b.h.

The diameter increment increased for all except the 4-inch to 6-inch d.b.h. classes, chiefly owing to opening of the stands by birch dieback.

Twenty-seven per cent of the plots in the mature mixedwood type support less than 1,000 stems of spruce and fir reproduction per acre. The average numbers per acre were:

Year	Spruce	Fir	Hardwoods
1945	136	1,582	127
1950	173	1.700	382

Softwood reproduction appears to be maintaining its representation in this type despite increased amounts of pin cherry and mountain maple which invade openings in the stands caused by the death of birch. Mountain maple is considered to be the reason for failure on most of the plots which lack adequate reproduction.

Although the softwood content of these stands is slowly increasing and may result eventually in the reversion to pure softwood if undisturbed, it is very difficult to obtain adequate reproduction following cutting. Unless some inexpensive method of controlling shrub growth is developed, it will likely be necessary to cut the merchantable softwood with the expectation that some productive area will be lost for a long regeneration period.

Mature Mixedwood over Immature Softwood (MM-SS)

This type occupies only 0.9 per cent of the block. The softwood understory (Fig. 4 and Table 2) is much less dense than in the mature softwood over immature softwood (SM-SS) stands. The numbers of trees per acre were as follows:

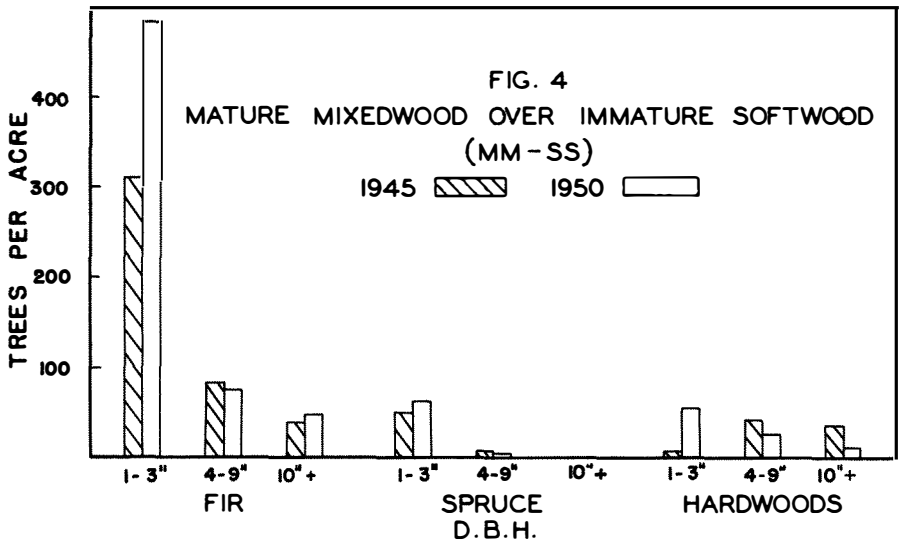
Year	Fir	Spruce	Hardwoods
1945	434	57	100
1950	609	68	89

The increase in all species is in the sapling class. The inclusion of pin cherry in the 1950 tally offset the loss in number of hardwoods through birch dieback (Table 2).

The merchantable softwood volumes in cubic feet per acre were:

Year	4-9" d.b.h.	10" & above d.b.h.	Total
1945	334	789	1,123
1950	279	974	1,253

This particular type, with the lowest volume among the undisturbed stands, is notable because of the lack of merchantable spruce volume; spruce makes up only one per cent of the softwood volume (Table 3). The gross periodic annual increment



of 55 cubic feet per acre is small but should increase as the understory develops. Mortality and windfall were 5 and 24 cubic feet per acre respectively, and the net periodic annual increment was 26 cubic feet. The diameter growth rate of softwoods increased during the five-year period except in the 4-inch to 6-inch d.b.h. classes.

The type contained 7 plots, all with more than 1,000 stems of softwood reproduction per acre.

Cut-over With No Immature Softwood (CN)

In 1945, this type occupied 55.7 per cent of the block. It was clear-cut between 1941 and 1945 by removing all softwood stems which would yield three 4-foot bolts to a 4-inch top inside bark.

The numbers of trees per acre were:

Year	Fir	Spruce	Hardwoods
1945	130	28	65
1950	298	57	413

Spruce and fir have doubled in number since 1945 (Fig. 5 and Table 2) with most of the increase being in the sapling class. The hardwood increase is a measure of the development of pin cherry. Although the average figures show a good picture of development, the area presents a patchy appearance with development of the new stand excellent in some places and very poor on others. Mortality (12 softwood stems per acre) was greatest in the small diameter classes, with windfall (6 stems) restricted to the larger sizes. The larger trees are those of merchantable size left during cutting – mainly those which were not considered worth the taking. Although there undoubtedly was some cull present, most of these trees are still growing vigorously and contain a good percentage of sound wood.

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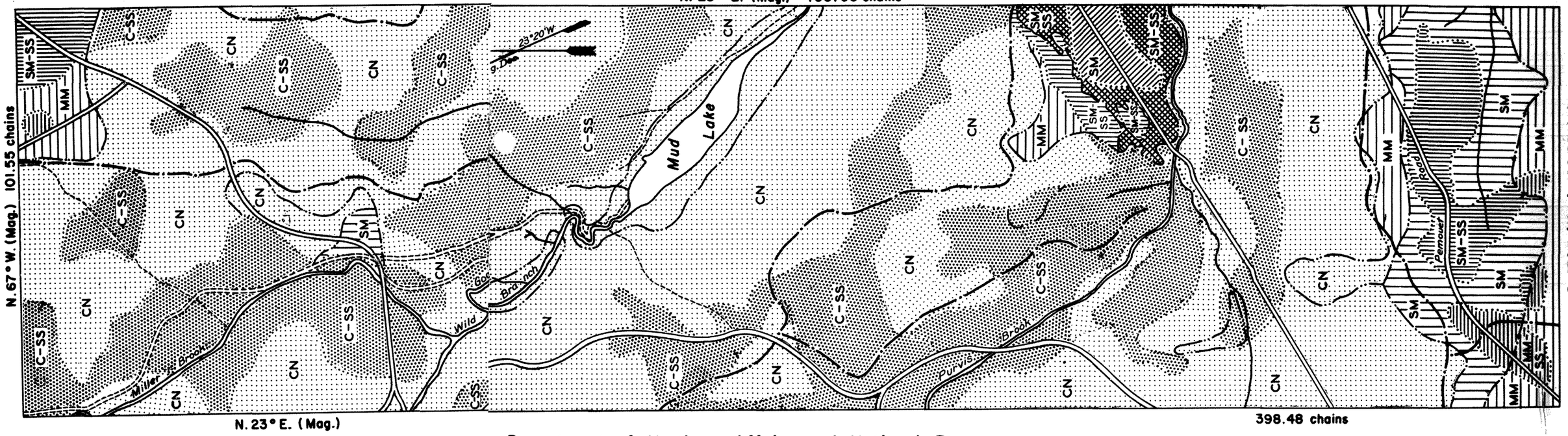


N. 23° E. (Mag.)

398.48 chains

Department of Northern Affairs and National Resources

FORESTRY BRANCH

Map showing

FOREST CONDITIONS

RESEARCH BLOCK No. 1 - 1950

GREEN RIVER WATERSHED - NEW BRUNSWICK

Scale

20 0 20 40 60 80

LEGEND

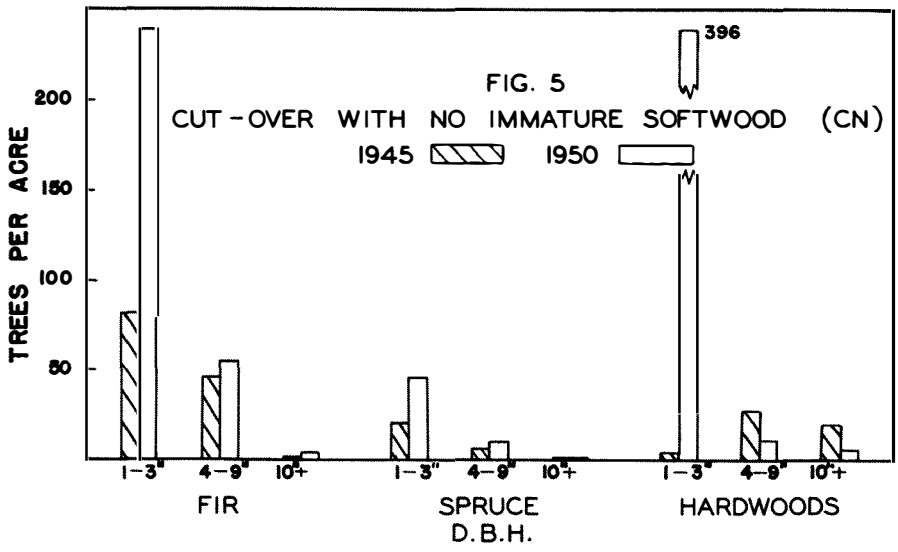
Mature softwood	SM
Mature softwood over softwood second	SM-SS
Mature mixedwood	MM
Mature mixedwood over softwood second	MM-SS
Cutover with softwood second	C-SS
Cutover with no softwood second	CN

LEGEND

Forest type boundary	
Forest sub type boundary	
Height of land	
Trails	
Portage roads	
Motor roads	

PURVIS BROOK EXPERIMENTAL AREA

Mature softwood	SM
Mature softwood over softwood second	SM-SS



The merchantable softwood volumes were:

Year	4-9" d.b.h.	10" & above d.b.h.	Total
1945	109	59	168
1950	160	75	235

The type had a gross periodic annual increment of 26 cubic feet per acre; mortality and windfall were four and nine cubic feet per acre respectively, and the net periodic annual increment, 13 cubic feet. This is not large (Pressler's per cent is 6.6), but should show a continuous increase as the sapling stand develops into trees of merchantable size.

Diameter increment has increased; the present rate for spruce and fir is about two inches in 10 years.

Forty per cent of the 298 plots in the type had inadequate reproduction. Of the failures, 66 per cent is attributed to mountain maple which has formed dense stands over much of the cut-over area and offers severe competition to the smaller reproduction.

The numbers of softwood reproduction stems per acre were:

Year	Spruce	Fir	Hardwoods
1945	298	1,977	88
1950	196	1,573	303

This indicates that ingrowth into the sapling stand is not being replaced by new regeneration. However, considering both the regeneration and the sapling stand there are a sufficient number of stands per acre to provide a reasonable stocking of spruce and fir. The resulting stand will show more variation in density than the original, but should, on the whole, develop quite satisfactorily.

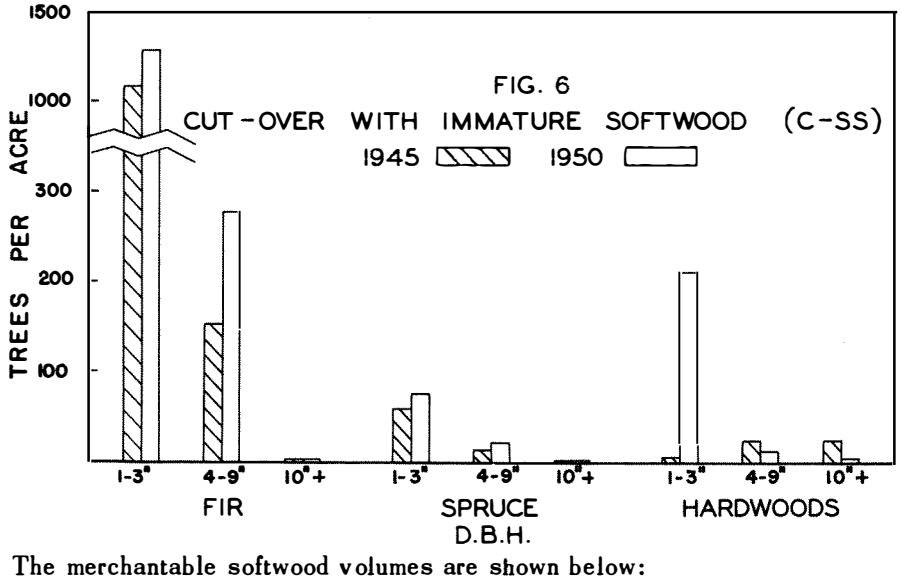
Cut-over With Immature Softwood (C-SS)

The area classed in this type was cut-over between 1941 and 1945 and in the latter year occupied 14.4 per cent of the block.

The numbers of stems per acre were as follows:

Year	Fir	Spruce	Hardwoods
1945	1,233	74	58
1950	1,551	100	228

The main problem posed by this type is the relatively high density of the stand (Fig. 6 and Table 2). It is growing well but the growth rate is almost certain to slow before maturity as competition will be greatly intensified.* Mortality (100 stems per acre) though high in the sapling stand is, however, less than the ingrowth from reproduction.



The merchantable softwood volumes are shown below:

Year	4-9" d.b.h.	10" & above d.b.h.	Total
1945	165	49	214
1950	302	41	343

The merchantable volume of residual softwoods under 10 inches doubled during the 5 years. The gross periodic annual increment was 42 cubic feet per acre; of this, net increment was 26 cubic feet per acre, and mortality and windfall were 6 and 10 cubic feet respectively. At the present rate of growth there should be a stand of about 10 cords per acre 40 years after cutting.

The diameter growth rate increased for all diameter classes except spruce over 7 inches d.b.h.

Softwood reproduction has remained nearly constant, suggesting that regeneration is replacing mortality and ingrowth to the sapling stand. Reproduction in this type is a problem because it will fill in openings caused by logging and so increase the density of an already overdense stand.

*Nickerson (4) found on Research Block No. 3 that a 40-year-old spruce-fir stand with 1,500 stems per acre was slowing in growth rate.

Comparison of Forest Types

The overall number of trees per acre increased in all uncut types, although it varied between diameter classes in each type, in some classes increasing and in others decreasing. The 4-inch to 9-inch d.b.h. group of both fir and spruce decreased in all except the mature soltwood over immature softwood (SM-SS) stands, though in these the number of saplings decreased through mortality and ingrowth to larger classes. The proportion of fir to spruce increased slightly in most types, noticeably in the sapling class.

The softwood volume increased in all types. Fir under 10 inches d.b.h. increased only in the mature softwood over immature softwood stands (SM-SS), and the cut-over types. Spruce, on the contrary, increased mainly in the smaller size classes.

Although the gross annual softwood merchantable volume increment for the remeasurement period is fairly large in most types, the net annual increment makes up a rather small part of it, because of mortality. The single-story stands (SM and SS) are past the peaks of mean volume increment. The SM-SS type appears to be in the best condition with a net periodic increment of 60 cubic feet per acre per year. Nearly half this increment is in the fir understory. The cut-over types (CN and C-SS) are growing very well.

Mortality and windfall were prevalent in all types with windfall generally being the greater. They are shown below as percentages of gross increment.

	SM	MM	SM-SS	MM-SS	CN	C-SS
Mortality	42	35	15	9	15	14
Windfall	16	43	18	44	35	24

Spruce volume in the SM type showed a much greater relative increase than in the other types, and this is attributed to the differing effects of windfall among the types. In this type, spruce are better protected from windfall than in the two-storied, and mixedwood, types. Spruce in the two-storied types are generally older and more exposed as a result of insect infestations acting on the stands in the past. The mixedwood stands have been thinned by the death of birch with a resulting increased exposure to wind action.

Softwood reproduction below 0.5 inch d.b.h., averages over 1,500 stems per acre. The number varies slightly from type to type. The noteworthy abundance of softwood reproduction in the two-storied stands indicates the ability of small fir and spruce to survive under a dense canopy. The CN type appears to be producing a satisfactory new stand when reproduction and saplings are considered together.

The general picture of development appears to be somewhat as follows: the mature softwood and mature mixedwood types are past the peaks of mean and current annual increment; the two-storied and mixedwood stands have dense understories which are growing well with no evidence of stagnation; the cut-over with no second growth softwood type, although the average acre area is developing favourably, presents a patchy appearance with an excellent new stand on parts of the area and a less promising new stand on other parts. The latter will develop into a stand that will vary more in density than did the original stand. The cut-over with immature softwood type with its large number of softwood saplings is producing a dense new stand which will probably require thinnings to obtain maximum returns.

About 21 per cent of the area of the block is considered to have inadequate reproduction of desirable species. Failure on half of this area is attributed to the dense stands of mountain maple which have formed since cutting. The death of birch in uncut stands has allowed mountain maple to invade the resulting openings in the mixedwood type so that it is in a position to spread rapidly after cutting. Pin cherry has increased rapidly on the cut-over types, growing mostly in dense clumps, though it does not appear to be hindering established reproduction. Areas with inadequate reproduction are expected eventually to produce a merchantable stand of spruce and fir, but a long regeneration period will be required for this.

CONCLUSIONS

From the foregoing it is concluded that

1. The forest types studied show an average net merchantable volume increment of 34 cubic feet per acre per year during the period 1945 to 1950;
2. Mortality and windfall have been serious for most types;
3. Diameter growth has increased during the period;
4. Reproduction, although improving, is inadequate on at least 21 per cent of the area; and
5. Mountain maple is a serious deterrent to reproduction.

SUMMARY

Research Block 1 was established in 1945 as a part of the "Creen River Project for the Studv of Forest Management in Relation to Spruce Budworm Control". It consists of 4,023 acres – 3,875 acres forested, and 148 acres water or waste-land – located in the drainage area of the Wild Goose Branch of the Green River in Restigouche County, New Brunswick.

Measurements of the main stand, reproduction, diameter growth rate, tree heights, and notes on minor vegetation, slope, soil, and aspect were made on one-tenth-acre line-plots laid out in a 6- by 10-chain grid of 40 lines, 10 chains apart, with the plots 6 chains from centre to centre. The plots were permanently marked.

The remeasurement in 1950 indicated that though there was an average net merchantable volume increment of 34 cubic feet per acre per year, in general this was unsatisfactory for most types, when compared with their gross increment.

Reproduction was inadequate on about 21 per cent of the plots in the types studied. About half of this was considered to be a result of the dense thickets of mountain maple prevalent on the area.

The diameter growth rate was found to have increased during the 5-year period.

Fig. 7 — *A road cut showing soft shale forming the bedrock over most of the Green River watershed. Note the inclined plane of splitting; this facilitates deeper rooting and better drainage.*

Fig. 8 — *An area cut over in 1942-43. The heavy growth of mountain maple, and dead birch which may be seen in background, are typical of large areas.*

Fig. 9 — *Area cut over in 1943-44 showing excellent fir reproduction. Pin cherry plentiful but does not overtop softwood reproduction.*

Fig. 10 — *Typical mature softwood type (SM) stand. Advance growth scattered; ground cover* Dryopteris *(Woodfern) spp.*

APPENDIX

Tables

TABLE 1. Land Classification

Forested Area	Acres	
UNCUT TYPES	1945	1950
SM	259	183
SM-SS	343	179
MM	398	170
MM-SS	157	35
Total uncut	**1,157**	**567**
CUT-OVER TYPES		
C-SS	558	1,192
CN	2,160	2,034
Purvis Brook Partial Cut		82
Total cut	**2,718**	**3,308**
Total Forested Area – 3,875 acres		
Non-forested Area		
Waste	101	101
Water	47	47
Total Non-forested Area	**148**	**148**
Total Area Research Block No. 1 – 4,023 acres		

TABLE 2. Living Trees Per Acre

Species	Year	Type and D.B.H.																	
		SM			SM–SS			MM			MM–SS			CN			C–SS		
		1-3"	4-9"	10"+	1-3"	4-9"	10"+	1-3"	4-9"	10"+	1-3"	4-9"	10"+	1-3"	4-9"	10"+	1-3"	4-9"	10"+
Fir	1945	61	85	62	1324	132	34	76	80	44	311	83	40	82	46	2	1078	153	2
	1950	88	79	67	1160	254	39	113	76	47	484	76	49	239	55	4	1272	277	2
Spruce	1945	34	12	11	96	27	8	26	10	4	50	7		21	6	1	60	13	1
	1950	36	10	12	78	38	7	29	9	4	63	5		46	10	1	77	22	1
Cedar	1945														1	1			
	1950														1	1			
Birch, W	1945	7	20	11	156	18	19	4	22	15	2	37	37	3	21	15	2	13	13
	1950	12	15	4	160	20	5	5	10	5	11	11	10	15	4	3	103	10	3
Birch, Y	1945	6	2	1	31	1	1	5	4	6	3	3		1	6	4	2	12	12
	1950	6	2	1	4	1		9	2	5	3			3	4	3		1	1
Maple, Red	1945			1					1						1				
	1950			1	2				1					2	1		5		
Ash, Mtn.	1945	2			10		1		1		15	2		3			2		
	1950	1	1		3		1	2	1		10	14		22	1		12	1	
Cherry, Pin	1945				10	4					1			11			2		
	1950	6			11	3		1			30			354	1		91	1	

TABLE 3. Merchantable Softwood Volume

Type	D.B.H.	Fir		Spruce	
		Cubic feet per acre		Cubic feet per acre	
		1945	1950	1945	1950
	Inches				
SM.....	4–6	56	48	14	8
	7–9	302	280	23	17
	10+	1220	1345	318	399
	Total	**1578**	**1673**	**355**	**424**
SM–SS	4–6	60	107	19	28
	7–9	201	246	29	44
	10+	663	900	215	161
	Total	**924**	**1253**	**263**	**233**
MM	4–6	41	40	6	4
	7–9	311	274	10	17
	10+	902	1018	149	116
	Total	**1254**	**1332**	**165**	**137**
MM–SS	4–6	49	25	0	4
	7–9	276	241	9	9
	10+	789	974	0	0
	Total	**1114**	**1240**	**9**	**13**
CN	4–6	41	44	5	8
	7–9	59	98	4	10
	10+	48	67	11	8
	Total	**148**	**209**	**20**	**26**
C–SS	4–6	78	159	8	16
	7–9	65	106	14	21
	10+	33	34	16	7
	Total	**176**	**299**	**38**	**44**

TABLE 4. Net Periodic Annual Increment*
(1945–1950)

Type	D.B.H.	Increment per acre per year	Pressler's per cent
	Inches	Merchantable cu. ft.	
SM.....	4–6	– 3	– 4.4
	7–9	– 5	– 1.8
	10+	41	2.5
	Total	**33**	**1.6**
SM–SS	4–6	11	10.5
	7–9	12	4.6
	10+	37	3.8
	Total	**60**	**4.5**
MM.....	4–6	– 1	– 1.3
	7–9	– 6	– 2.0
	10+	17	1.5
	Total	**10**	**0.7**
MM–SS	4–6	– 4	– 10.2
	7–9	– 7	– 2.6
	10+	37	4.2
	Total	**26**	**2.2**
CN.....	4–6	1	2.4
	7–9	9	10.5
	10+	3	4.8
	Total	**13**	**6.6**
C–SS.....	4–6	18	13.6
	7–9	10	9.3
	10+	– 2	– 3.6
	Total	**26**	**9.3**

*Softwood content only.

REFERENCES

1. Davidson, A.G. 1951. A study of decay in balsam fir (*Abies balsamea* (L.) Mill.) in the Green River watershed of New Brunswick. Canada, Dept. of Agriculture, Division of Forest Biology. Unpublished report. Ottawa.

2. Green River Work Committee. January, 1948. Report of the Work Committee on Green River Project re management and spruce budworm control. Unpublished report.

3. Halliday, W.E.D. 1937. A forest classification for Canada. Canada, Dept. of Mines and Resources, Dom. For. Serv. Bull. 89. (Reprinted 1950.) Ottawa.

4. Nickerson, D.E. 1948. Report on initial examination of Research Block 3. Canada, Dept. of Mines and Resources, Dom. For. Serv. Unpublished report. Ottawa.

5. Vincent, A.B. 1950. Partial cutting experiment, Purvis Brook. Canada, Dept. of Resources and Development, Forestry Branch. Unpublished report. Ottawa.

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