Commission of Conservation
Canada

COMMITTEE ON FORESTS

The Effect of Repeated Forest Fires upon the Reproduction of Commercial Species in Peterborough County, Ontario

BY

C. D. HOWE, Ph.D.

Reprinted from Forest Protection in Canada, 1913-1914,
Commission of Conservation

OTTAWA, 1915

Commission of Conservation Canada

COMMITTEE ON FORESTS

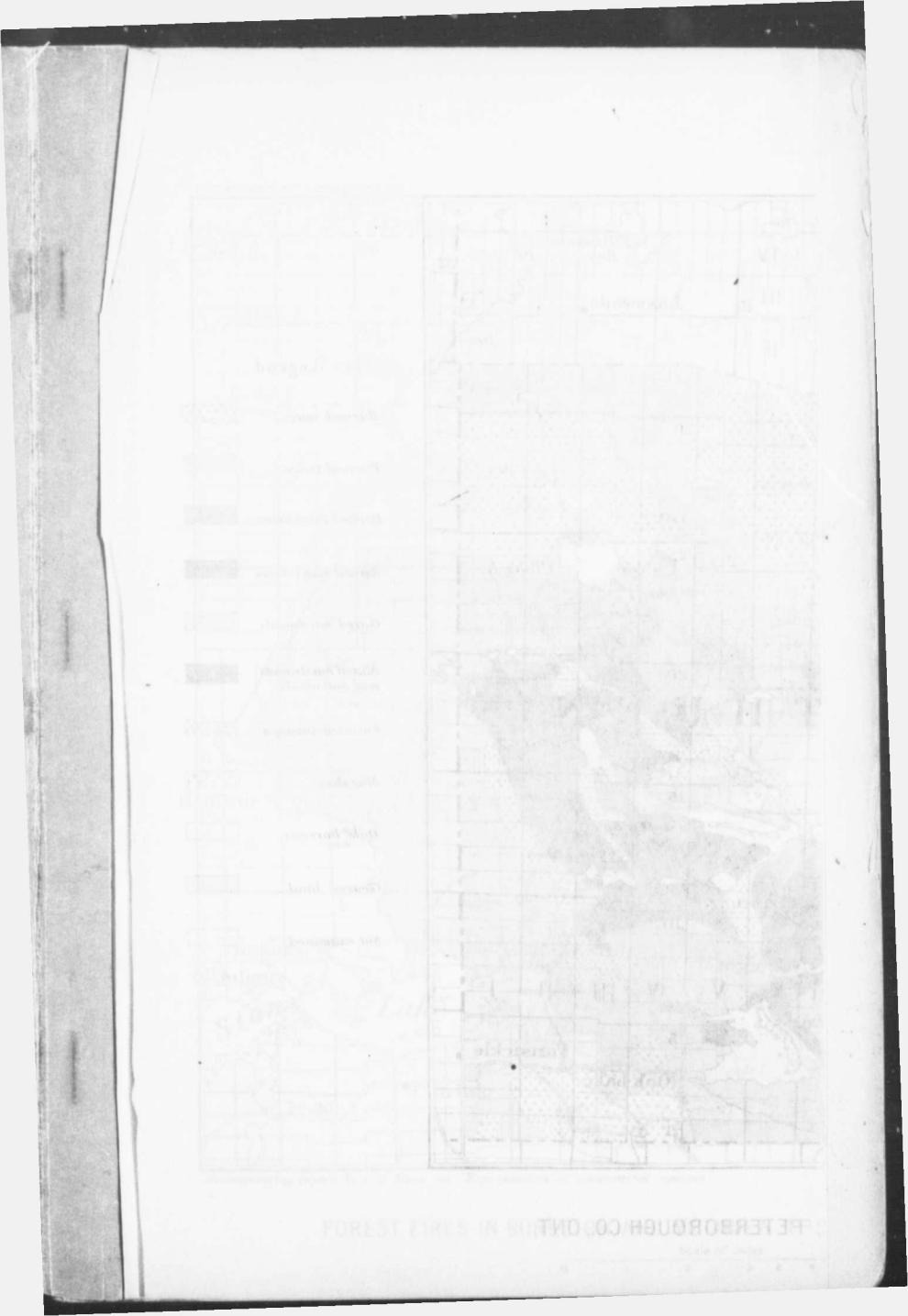
The Effect of Repeated Forest Fires upon the Reproduction of Commercial Species in Peterborough County, Ontario

BY

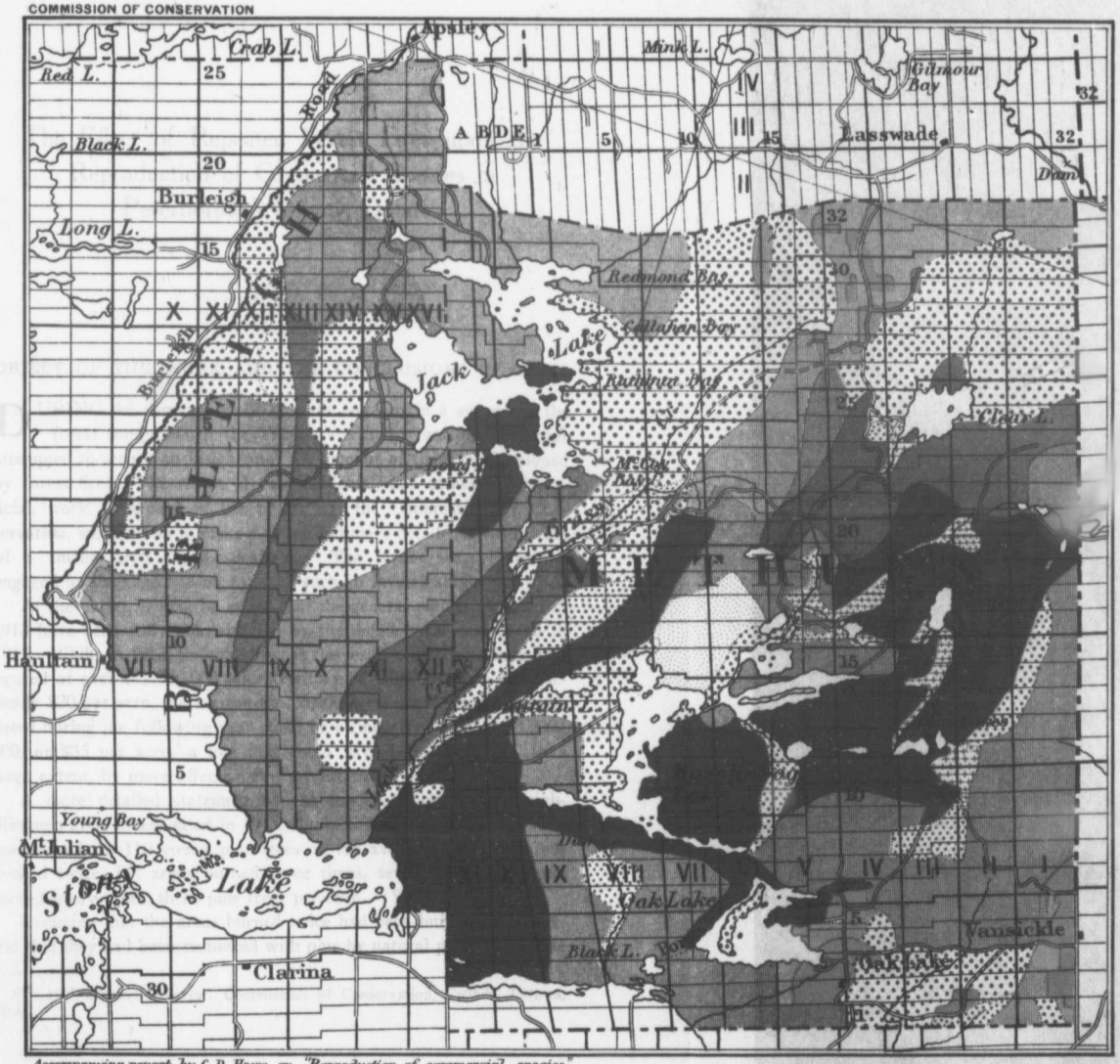
C. D. HOWE, Ph.D.

Reprinted from Forest Protection in Canada, 1913-1914,
Commission of Conservation

OTTAWA, 1915



COMMISSION OF CONSERVATION



Accompanying report by C. D. Howe on "Reproduction of commercial species"

FOREST FIRES IN BURLEIGH AND METHUEN TPS., PETERBOROUGH CO., ONT.

Scale of miles

0 1 2 3 4 5

OBJ

D

atten
by f
ficial
serva
of a
engag
A
1912
1913.
figure
tically
gated
000,
large
A
Methu
once
burne
burned
Ass
and th

*Tre
1913.

The Effect of Repeated Forest Fires upon the Reproduction of Commercial Species in Peterborough County, Ontario

BY

C. D. Howe, Ph.D.

OBJECT OF THE WORK AND THE CONCLUSIONS IN BRIEF

DURING the summer of 1912, while engaged in a survey of the forest conditions of the Trent watershed, Ontario, the writer attempted to secure an insight into the amount of damage occasioned by forest fires. The result of this incidental, and somewhat superficial, work, presented in the report* of the Commission of Conservation, was such as to make a closer and more detailed investigation of a smaller area appear desirable The writer was, therefore, engaged by the Commission to make such an investigation.

At the outset, it may be stated that the general results obtained in 1912 have been fully substantiated by the detail work carried on in 1913. While, in 1912, the total loss, as the result of repeated fires, was figured at over $12,000,000 on a territory of 620,000 acres, or practically $20 per acre, the loss on the 85,000 acres more closely investigated during the following year could be estimated at around $3,000,000, or $35 per acre—a loss that could have been prevented, to a large extent, by more effective fire protection.

A more detailed statement of the conditions on the Burleigh-Methuen area, investigated in 1913, shows that the areas burned only once now have 110 young pine trees on the average acre; the areas burned twice, 14; areas burned three times, seven trees, and those burned many times, three pine trees per acre. (See p. 190).

Assuming that the areas burned twice had been burned only once, and that they had been restocked with pine by natural processes at the

*_Trent Watershed Survey._ Commission of Conservation, Canada, Ottawa, 1913.

same rate as the areas burned once, then it will be seen that the second burning reduced the then existing potential stumpage and dues values of the pine by more than $1,500,000.

Under like assumptions, we find the financial loss on the much smaller total area burned three times to be $646,000, and that on the areas burned many times to be $891,000. Thus, as already stated, the repeated fires represent a loss already incurred, in previously existing potential values of pine, of approximately $3,000,000 (see p. 199).

The greater portion of the poplar on the area is less than 25 years old, consequently the amount of material now suitable for pulpwood is very small, being one cord per acre on the area burned once; one-fifth cord per acre on the area burned twice; one-eighteenth cord per acre on the area burned three times, and only one-forty-fifth cord per acre on the area burned many times (see p. 190).

According to the calculations given in table, p. 200, it is estimated that the area burned once will yield nine cords of pulpwood per acre in 30 years from the present date; the area burned twice five cords per acre; those burned three times 2.5 cords per acre, and the area burned many times will yield less than one-third cord per acre at the end of the next 30 years. The repeated fires have therefore occasioned a loss of nearly $200,000 in pulpwood.

Notwithstanding the tremendous loss already incurred, however, the investigation shows that the potential stumpage value of the remaining stock of pine is $1,563,540, and the potential value of the dues $446,718, or a total of over $2,000,000 potential value of existing pine (see p. 199). The potential value of the existing stand of poplar is $265,325 (see p. 200). Thus, with proper methods for the prevention of further fire damage, the existing young growth of pine and poplar is capable of producing a future value of more than $2,275,000. That it is worth while to make this saving should scarcely need argument.

The rate of occurrence of forest fires on the area under consideration has increased 300 per cent in the past eight years. More efficient fire protection is recommended. It is shown that the cost of adequate protection for the next 50 years would be less than $5 per acre, while the value of the crop at that time would be $33 per acre, a saving that would certainly justify the cost of protection (see p. 204).

The report concludes with the recommendation that the cut-over and burned-over lands in the region under discussion be turned over to the county of Peterborough under the Counties Reforestation Act, unless the wiser or the more practicable plan be adopted, viz., placing

these areas under the administration of the Dominion Government. This latter action would be fully justified by the importance of the area in question, as a portion of the watershed of the Trent canal, which is an enterprise of the Dominion Government.

An incidental advantage attaching to transfer to the Dominion Government, with administration by the Forestry Branch, Department of the Interior, would be the probable establishment of a forest experiment station. Such action would have for its object the securing of information calculated to furnish a solid scientific basis for the silvicultural handling of existing forests, as well as for the establishment of new forests, in order to secure the most economic use of the timber and forest products. A more exact knowledge of the indirect benefits of the forest, such as the influence of forest cover upon stream-flow, might result from the establishment of a forest experiment station. There is great need for the prosecution of such investigations, under Canadian conditions.

INTRODUCTION

That trees of relatively inferior value, such as birch and poplar, follow fires on areas previously occupied by pine, is a matter of common observation, but the amount of this material and its potential value are not so well known. It is also well known that repeated fires on former pine lands greatly retard, or completely exclude, the re-establishment of pine trees thereon, but the rate of this retardation in relation to the number of fires is not so well known. The financial losses involved in the replacement of valuable pine destroyed by fires, by the less valuable poplar, have been estimated in certain cases, but these estimates have been based upon relatively few actual measurements.

Three aspects of the problem of the burned pineries present themselves for solution, namely: (1) An estimate of the amount of young pine and poplar now present in relation to the number of times the area has been burned; (2) an inquiry as to whether the amount of the pine and poplar restocking the burned areas has sufficient present or potential value to justify care and protection; (3) an estimate of the financial losses, if any, incurred by allowing fires to replace pine forests with poplar or other inferior forests.

Area Under Investigation

The area examined in 1913, and covered by this report, comprises some 85,000 acres, and includes all of the township of Methuen and that portion of the township of Burleigh which lies east of Eels brook, both being situated in

the county of Peterborough, Ont. The region was selected because it contains, in a relatively compact space, considerable areas which have been burned once, twice, thrice and many times.

The work was carried on for three and one-half months by the writer and two student assistants, Messrs. J. D. Aiken and Miles Burford, of the Faculty of Forestry, University of Toronto, whose efficient co-operation made possible the gathering and the organization of the data for the report.

The original plan was to run parallel compass lines one-half mile apart through the burns of various ages, and to measure all of the trees one inch and more in diameter. This plan was adhered to for the first month, when it was found that the composition of the various types was so constant that the running of the lines so near together appeared to be unnecessary. None of the lines, however, were more than a mile apart. At least one line was run through each type in its longest direction and the trees were counted and measured with calipers. Then paced reconnaissance lines were run parallel or perpendicular to the calipered lines and in this way the boundaries of the various types were determined. The strips, a chain (66 feet) wide, on which the trees were actually counted and measured, aggregated nearly 25 miles, while the reconnaissance lines aggregated over 80 miles.

Basis of Classification

In the field work, the following types were found within the burns of various ages, and separately tallied: (1) Low amphibolite ridges; (2) low granite ridges; (3) low limestone ridges; (4) sand ridges; (5) depressions between ridges; and (6) sand plains. Upon compilation of the results, however, it was found that, while there were interesting differences botanically, there were not differences enough as regards the amount of second growth pine and poplar to justify such classification. Hence, the differences due to topography, soil, and attendant conditions have been neglected, and the areas have been classified alone according to the number of times burned.

In the field work, also, an area burned a certain number of times was sub-divided into several smaller areas, according to the amount of pine and poplar reproduction per acre, but, in the final tabulation, it seemed best for the purposes of this report, to group these areas and to strike the average in terms of the young pine and poplar for the entire area burned a stated number of times.

The number of times an area had been burned was determined in

two ways: (1) By the age of the stands of poplar, and (2) by the number and age of the fire scars on the old trees. For example, it would be found that the great majority of the young trees on a certain area fell into three age classes, of 8, 16, and 25 years. In addition, the poplars 25 years old would show that they had been burned at the base 8 and 16 years ago, while the poplars 16 years old would have fire scars eight years old. By counting the annual rings of the wood covering the fire scars on the few mature trees still standing, it would be found that they had been severely injured by fire approximately 8, 16 and 25 years ago. Therefore, the area would be classed as having been burned three times. Severe fires usually burn off the brush and duff down to the mineral soil. These areas form ideal germinating beds for poplar, which requires plenty of light, and whose seeds are easily and widely distributed and germinate quickly. The poplar grows rapidly for the first few years, and the young seedlings soon cover the ground. The seedlings from the seed crops of the few succeeding years are too much shaded to compete successfully with those already on the ground. The result is a pure or a nearly pure stand of even-aged trees. Fire is practically the only agent that can make the proper conditions for the development of such stands. Clean cutting without the usual subsequent fire might bring about pure stands in restricted patches, but, taking the area as a whole, it would be found that the poplar would not come among the brush piles until they decayed. The result would be "patchy" stands of different ages. In any case, the presence or absence of fire scars on the escaped mature trees would furnish the necessary corroborative evidence that we are dealing with burned areas.

One is, then, not dependent upon hearsay or tradition in determining the number of times an area has been severely burned. Every severe fire leaves its record burned into the trees not actually killed, and stamps its impress upon the succeeding generation of trees.

Many Smaller Fires

The designation *number of times burned,* in these discussions and on the accompanying map, means that the greater portion of the area so designated has been *severely* burned the number of times indicated; that is, burned sufficiently to scar the standing trees and to kill off portions of the young growth periodically, so that stands of different age classes have resulted where more than once burned. It will be seen that this method of designation takes no account of the ground fires, which did not develop

sufficient heat to burn into the wood of the trees or to kill the young trees in large quantities. Fires of this kind are frequent in the dry periods of the last week of April and the first week of May, when the leafage is not sufficiently developed to feed the flames and when only the upper layer of the vegetable *debris* on the ground is dry enough to burn. It is evident that fires of this kind are very destructive to the tender seedlings of pine and, on the other hand, that they stimulate the reproduction of birch and poplar, both because the fires make a clean seed-bed and because the birch and poplar sprout vigorously. The preponderance of birch or poplar of the smaller diameter classes on the areas burned once or twice, as indicated in the accompanying tables (see pp. 176-177, 180-181), is due to ground fires.

PHYSIOGRAPHIC CONDITIONS

The geology, topography, and soil conditions of the region in which the area under discussion lies were fully discussed in the report on the Trent Watershed Survey.* Only enough of the description will be repeated here to give the reader a general picture of the area now under consideration.

The portion of Burleigh township examined includes the territory lying east of Eels brook, and is drained into Stony lake by that brook and by Jack creek. The central and eastern portions of Methuen township drain through Kasshabog lake into North river, thence by the Crow river into Trent river. The waters in the north-western portion flow through Jack creek into Stony lake. The extreme south-eastern portion drains into Otter creek, a tributary of Deer river, whose waters also fall into the Trent through Crow river.

General Description of Territory

†The general elevation of the country is approximately 850 feet above sea level, and it has the appearance of a dissected plateau, sloping gently in a south-south-western direction. Between Eels brook, Jack creek and its tributary, Grassy brook, the underlying rock is mostly crystalline limestone, through which are frequent intrusions of granite, especially in the southern division of Burleigh. The topography, on the western side

Trent Watershed Survey. Commission of Conservation, Ottawa, 1913. Pp. 35-39; 75-76; 108-113.

†This description is summarized from Geological Survey Report, Memoir No. 6, *Geology of the Haliburton and Bancroft Areas*, Province of Ontario, by Frank D. Adams and Alfred E. Barlow, 1910.

near Eels brook, is quite flat, but becomes more diversified and rougher eastward to the Blue mountains, in Methuen township. These mountains are the most conspicuous objects in the topography of the area, and they are situated almost in the centre of the region under discussion. They rise abruptly on all sides to about 300 feet above the general level and extend about four miles in a northeast and southwest direction. The crest of these mountains is a bare ridge of syenite rock, and the "foothills" consist of numerous ridges of sharply inclined amphibolite or granitic ridges, with deep gullies between. The amphibolite, in a strip about a mile wide, is continued north-eastward to the extreme northeast corner of the township.

Eastward and southward from the Blue mountains, the country has the appearance of a granite plain, into which innumerable gullies and ravines have been worn by ice and water action. The result is a topography of low rounded ridges and depressions. The monotony of this plain is relieved by a few granite hills, rising from 100 feet to 150 feet above the general level. The highest of these hills lies half way between Clear lake and Bass lake. Another stands about a mile southeast of Sandy lake. Kasshabog lake, on the southern side, is hemmed in by a high granite ridge, which increases in elevation in going westward. The eastern and south-eastern margins of the granite outcrop are bordered by amphibolite rock, whose ridges are, for the most part, higher and sharper, and, as there are more of them, their topography is much rougher than that of the granitic areas. At Oak Lake and Van Sickle settlements there are two detached plateaus of sedimentary limestone of Trenton age.

The depressions between the ridges are a very noticeable phase of the topography. They are abundant in both townships, but are more abundant in Methuen. At least one-quarter of the region is occupied by these depressions, and they vary from a few yards to a thousand yards across. Some of them may be traced continuously for several miles and are evidently former stream channels; others are the bottoms of former small lakes and ponds.

Rapid Erosion of the Soil

The soil on the crests of the ridges is very thin, and often entirely lacking, although there are crevices and pockets on most of them with soil deep enough for scattered tree growth. In studying the conditions on these ridges, one cannot but be convinced that the soil was, at one time, much more generally distributed and deeper than at present. One frequently finds

stumps of trees from one foot to two feet in diameter on bare rock, in such a position that the roots could not have penetrated crevices. The trees could not have germinated and lived for many years on bare rock. Then, too, trees still standing on bare rock are held up by roots extending into crevices several feet from the base of the tree. There must have been soil at the base of the trees when they started in life. One needs only to note, after a heavy rain, the accumulations of soil washed down from above, to be impressed by the rapidity of the soil-erosion on these ridges. The soil-washing is the result of the repeated fires, which kill and loosen the natural retainers, the roots of the trees and shrubs, and the decaying vegetable matter.

The soil on the lower slopes and about the bases of the granite ridges varies in composition from gravel to sand, not uniformly distributed, but in alternate deep and shallow patches, owing to the minor undulations in the topography. The wider depressions between the ridges are often filled with sand to the depth of many feet, and there are also occasional sand ridges and sand plains. The soil on the amphibolite is often deeper and is almost invariably of finer texture than on the granite, frequently approaching a loam in composition. The crystalline-limestone soils are nearly all light sandy loams. While they are often very thin on the ridges and plains, as a whole, these areas are more deeply soil-covered than either the amphibolite or granite areas, because a larger percentage of the area is composed of broad, gentle slopes, where the soil accumulates, or where it has not been washed away as rapidly as on the steeper slopes of amphibolite and granite.

The soils of the depressions between the ridges are formed by the accumulated washings from the slopes. Only the finer material reaches them, the coarser being left above. Mixed with the decaying portions of a rank vegetation these soils become a very rich muck, usually three to four feet, or more, deep.

The only really good farm soils, with perhaps one or two exceptions, are to be found on the sedimentary limestones, in the south-eastern portion of Methuen township.

FOREST CONDITIONS

The total land area of Methuen township is 63,152 acres, and the portion of Burleigh township covered by this survey is 23,181 acres. This makes a total of 86,333 acres, of which approximately 2,000 acres have been cleared for farms. The remaining 84,333 acres are

partially or completely under forest cover. Of the forested portion, 15,000 acres are covered with mature forest. Seventy-seven per cent of this is the hardwood forest characteristic of the Trent Valley region, in composition approximately one-half being sugar maple and one-quarter beech, the remaining quarter consisting of basswood, yellow birch, elm, hemlock, balsam, white ash, red oak, large-toothed aspen, white pine and cherry, in occurrence in the order named. The remaining 23 per cent of the mature forest is represented by swamps.* The swamps bearing mature forest are practically all of the mixed type. Several sample lines run through them reveal the trees to be mostly black ash, balsam, red maple and elm, these entering into the composition in the proportion of 30, 23, 15 and 6 per cent, respectively. There are relatively few swamps of the undrained peat bog type.

The remaining forested portion, some 69,333 acres, was originally dominated by pine. It is evident that the red pine was the more abundant on the coarser granitic soils, while the white pine predominated on the deeper, finer-textured soils of the amphibolite and crystalline limestone. At present, single trees, or widely separated groves, constitute all the pine of commercial value. With the possible exception of the pine of the Blue mountain region, the cost of harvesting would be prohibitive. Fifty years ago lumbering operations were commenced on the area, and were continued for 25 years. Since these operations ceased, the area has been picked over twice, the last time three years ago. These former pine lands have all been burned at least once, and some of them eight times, since the lumbering was begun. It is the present condition on these burned pineries with which this report is chiefly concerned.

AREAS SEVERELY BURNED ONCE

So far as could be ascertained, there are no places in the former pineries, outside of the swamps, that have not been burned at least once since lumbering. The stands designated as burned once evidently followed a severe fire. Patches which escaped the fires in the areas burned more than once are included in this group, either because they were originally established after a fire, or because they were burned once since establishment, as revealed by a fire scar.

*Only the larger swamp areas were mapped. Small swamps containing commercial trees, swamps covered with non-commercial trees and open marshes, compose at least one-quarter of the total area. Proper deductions are made for these in estimating the amount of material in the different types given below.

The largest continuous area burned but once is found in the north-western corner of the township of Methuen. The best pine reproduction on lowland is found in the southern portion of the area, where the average stand is 94 white pine and 35 red pine per acre; of these 16 per cent of the white pine are from six inches to ten inches in diameter, while all of the red pine fall between the one-inch and six-inch diameter classes. The pine on the ridges is much less abundant, averaging only six trees per acre.

In the south-eastern portion of Burleigh township the best reproduction of pine was found, and it covers 365 acres, at the rate of 88 white pine and 173 red pine per acre, and single acres containing 350 trees could be picked out. On the average acre, 70 per cent of the trees belong to the one-inch and two-inch diameter classes, and the trees eight inches in diameter and above average only six to the acre. There is evidence that about 2,000 acres in this vicinity were once bearing young pine in similar quantities, but a fire about eight years ago cleared them off.

The other areas in Burleigh classed as burned but once, namely, the rather narrow strip east of Eels brook, in the north division, and west and south of the hardwoods, have good pine reproduction. Patches in these areas were burned 35 years ago, and other patches 16 years ago, but, as a whole, the areas were burned about 25 years ago. Patches, several acres in extent, containing 550 young pine from one inch to six inches in diameter, were frequently encountered, but the average is 125 white pine and 53 red pine per acre. In the area east of Eels brook there are occasional groups of pine, varying in extent from a few trees to those covering several acres, which apparently escaped the fire with only slight injury, and they are now approaching commercial value, one-half of the stands being from six inches to ten inches in diameter and averaging 70 trees to the acre. An area of similar character was found just west of Kasshabog lake, in Methuen township, and it covers about 800 acres; here the number of pine trees approaching commercial value averages 15 per acre. Scattered through this area are frequent groves, aggregating about 300 acres, which contain 30 trees from 9 inches to 15 inches in diameter per acre, and are, therefore, of commercial value.

TABLE Ia

PRESENT COMPOSITION AND AVERAGE NUMBER OF TREES PER ACRE ON 17,349 ACRES SEVERELY BURNED TWICE, BASED ON SAMPLE STRIPS TOTALING 40.4 ACRES

	Per cent	Per acre
Trembling aspen	26.3	164.8
Large-toothed aspen	14.8	92.8
White pine	10.4	64.8
Red pine	7.1	44.6
Jack pine	.2	1.3
White birch	17.0	106.9
White oak	.4	2.5
Red oak	2.4	15.0
Red maple	6.0	37.7
Sugar maple	1.7	10.2
Balsam	2.5	15.6
White spruce	1.4	8.8
Cedar	5.2	32.7
Hemlock	1.9	11.7
Hop-hornbeam	.7	4.0
Yellow birch	.2	1.3
Basswood	.8	4.7
White ash	.2	1.2
Beech	.4	2.6
Tamarack	.4	2.6
Total number of trees per acre	.....	625.8

TABLE Ib

DIAMETER CLASSES AND THE AVERAGE PROPORTION OF OCCURRENCE IN EACH ACRES SEVERELY BURNED ONCE

	Inches	Trembling aspen	Large-toothed aspen	White pine	Red pine	Jack pine	White birch	White oak	Red oak	Red maple
Per cent...	1	28.5	25.7	18.8	30.1	1.9	39.5	37.8	18.7	54.9
Per acre...		46.7	24.0	12.1	13.4	..	42.3	.9	2.9	20.7
Per cent...	2	30.2	37.6	23.5	26.1	..	31.7	16.8	16.2	25.8
Per acre...		50.0	34.9	15.2	11.6	..	33.8	.4	2.4	9.7
Per cent...	3	20.3	21.0	20.7	17.8	3.8	16.0	17.9	22.6	11.9
Per acre...		33.5	19.3	13.4	8.0	.05	17.1	.5	3.3	4.5
Per cent...	4	8.8	8.5	13.8	10.4	13.2	7.4	6.9	16.7	3.8
Per acre...		14.5	7.9	9.0	4.6	.2	7.9	.2	2.5	1.4
Per cent...	5	5.4	4.0	8.4	6.4	15.1	3.2	6.9	13.7	1.9
Per acre...		9.0	3.7	5.4	2.9	.2	3.4	.2	2.2	.7
Per cent...	6	3.2	1.6	5.8	4.7	28.3	1.2	2.9	7.4	.8
Per acre...		5.2	1.5	4.0	2.2	.4	1.3	.1	1.0	.3
Per cent...	7	1.4	.8	2.9	2.0	11.3	.5	3.9	3.3	.4
Per acre...		2.4	.8	1.9	.9	.1	.6	.1	.5	.2
Per cent...	8	1.0	.4	2.9	1.0	20.8	.2	3.9	.5	.2
Per acre...		1.6	.3	1.9	.4	.3	.2	.1	.1	.1
Per cent...	9	.6	.3	1.3	.5	5.6	.2	1.0	.7	..
Per acre...		1.0	.2	1.0	.2	.1	.2	..	.1	..
Per cent...	10	.3	.1	.7	.3	..	.05	1.0	..	.1
Per acre...		.5	.1	.4	.1	..	.05	..	..	.05
Per cent...	11	.2	..	.4	.4	..	.05	1.0	..	.1
Per acre...		.3	..	.2	.2	..	.05	..	..	.05
Per cent...	12	.1	..	.2	.2	..	..	..	.1	..
Per acre...		.1	.1	.1	.1	..	..	..	..	..
Per cent...	13	..	..	.1	..	..	..	..	..	..
Per acre...		..	..	.05	..	..	..	..	..	..
Per cent...	14	..	..	.1	..	..	..	..	..	.1
Per acre...		..	..	.05	..	..	..	..	..	.05
Per cent...	15	..	..	.2	.1	..	..	..	..	..
Per acre...		..	..	.1	..	..	..	..	..	..
Per cent...	16	..	..	..	..	..	..	..	..	..
Per acre...		..	..	..	..	..	..	..	..	..
Per cent...	17	..	..	.1	..	..	..	..	.1	..
Per acre...		..	..	.05	..	..	..	..	..	..
Per cent...	20	..	..	.05	..	..	..	..	..	..
Per acre...		..	..	..	..	..	..	..	..	..
Per cent...	21	..	..	.05	..	..	..	..	..	..
Per acre...		..	..	..	..	..	..	..	..	..
Total										
Per cent..		100.0	..	..	..	..	..	..	..	..
Per acre..		164.8	92.8	64.8	44.6	1.3	106.9	2.4	15.0	37.7

TABLE Ib

DIAMETER CLASS OF THE SPECIES ENUMERATED IN TABLE Ia, OCCURRING ON 17,349

Sugar maple	Balsam	White spruce	Cedar	Hemlock	Hop-hornbeam	Yellow birch	Basswood	White ash	Beech	Tamarack
60.9*	50.9	26.5	72.0	61.2	29.4	28.0	36.0	26.0	62.8	73.8
6.2	8.0	2.3	23.6	7.1	1.2	.4	1.7	.3	1.6	2.0
24.2	29.2	21.1	20.1	29.8	40.0	31.5	32.3	30.0	24.8	19.6
2.5	4.6	1.9	6.6	3.5	1.6	.4	1.5	.4	.7	.5
9.5	12.2	27.3	6.3	6.0	20.0	20.0	15.4	26.0	7.6	4.6
1.0	1.9	2.4	2.0	.7	.8	.3	.7	.3	.2	.1
1.7	3.0	10.5	1.2	1.0	5.6	7.4	6.4	12.0	4.8	..
.2	.5	.9	.4	.1	.2	.1	.3	.1	.1	..
1.0	1.9	8.2	.2	.2	3.7	3.7	3.2	6.0	..	2.0
.1	.3	.7	.1	..	.1	.05	.1	.1	..	..
1.0	1.0	3.1	..	.4	1.3	3.7	4.2	..	..	..
.1	.1	.3	..	.05	.05	.05	.2	..	..	..
.5	.7	1.1	..	.2	..	..	1.0	..	..	..
.05	.1	.1	..	..	..	..	.05	..	..	..
..	.8	.8	..	..	..	..	..	..	..	..
..	.1	.1	..	..	..	..	..	..	..	..
.2	..	.8	..	.2	..	..	.5	..	..	..
..	..	.1	..	..	..	..	.03	..	..	..
.8	.1	.6	.1	..	..	3.7	.5	..	..	..
.1	..	..	..	..	..	.05	.03	..	..	..
..	.1	..	..	..	..	2.0	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	.1	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	..	..	.1	.4	..	..	..	..	..	..
..	..	..	..	.05	..	..	..	..	..	..
.2	..	..	..	..	..	..	.5	..	..	..
..	..	..	..	..	..	..	.03	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	.4	..	..	..	..	..	..
..	..	..	..	.05	..	..	..	..	..	..
..	..	..	..	.2	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..
10.2	15.6	8.8	32.7	11.6	4.0	1.3	4.7	1.2	2.6	2.6

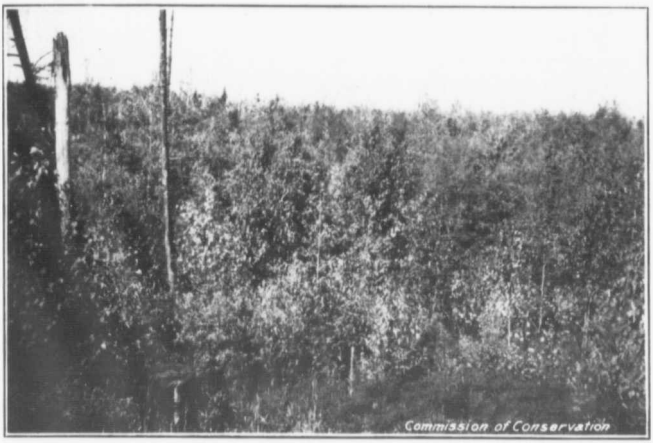
The areas burned once, as indicated on the map (facing page 166), aggregate 18,898 acres. Deducting one-quarter of these as areas occupied by marshes and swamps, there are left 14,174 acres occupied by poplar and pine. The patches that escaped the fire, in the areas burned more than once, total 3,175 acres. Therefore, the total number of acres burned but once is 17,349. It will be seen, by referring to the accompanying table (page 175), that white pine on this area averages 65 trees and red pine 45 trees per acre, or a total of 110 pine trees. Seventy-nine per cent of these trees are from one inch to three inches in diameter. Judging from the results of the growth studies, it takes about 25 years, on the average, to make a three-inch pine tree. These areas were burned about 25 years ago; therefore, practically four-fifths of the present quantity of pine has established itself since the last severe fire.

Regarding the trees eight inches in diameter and above as capable of producing viable seeds, there are on the average three seed trees per acre on the area as a whole, an ample quantity, if properly distributed, to fill up the open places and to replace the trees that die from natural causes. If the 110 trees per acre were allowed to come to maturity, the area would probably be more fully stocked with pine than it was at the time the first lumbering operations began, for the original forest was a very old one, with large trees, a condition under which the trees must necessarily have been scattered to have received light and food enough to reach large dimensions. But, with the present high price of pine lumber, and the consequent utilization of comparatively low grade stock, pine forests like the original will never be duplicated. Instead of cutting trees 200 to 300 years old, as was originally done, the trees will be harvested at 100 years, 80 years, and even, in some cases, 60 years of age. The pine trees standing at present will be cut at these ages, if not burned in the meantime, and the present number of trees per acre on the areas severely burned once is about right for proper development for harvest in that condition. It would seem, therefore, that one burning after lumbering does not seriously interfere with the reproduction of pine in commercial quantities. This statement, of course, is based on the assumption that the fire came very soon after lumbering, since otherwise it would destroy the first crop of seedlings established.

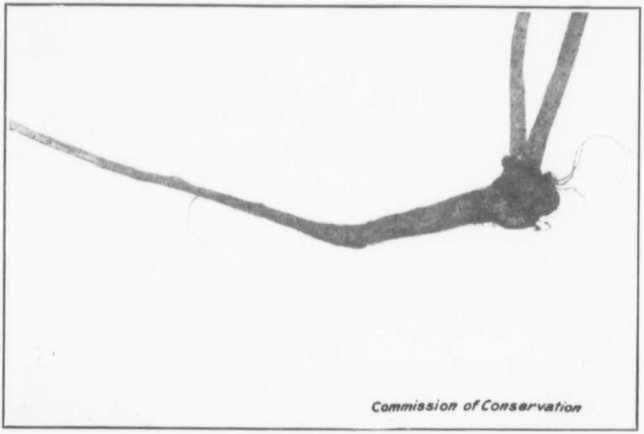
The pine trees above ten inches in diameter on the average acre would yield only 185 board feet, a very small amount, but when multiplied by the number of acres, it becomes 3,000,000 feet of commercial material.

It will be seen from the table (page 175) that the poplars contribute the largest number of trees per acre, the trembling aspen having

ROOT COLLAR



General View of an Area Burned Three Times
Poplar largely predominating.



Root Collars of Poplars Repeatedly Burned are Swollen and Tuberous
No commercial trees come from such roots.

165 and the
per acre, an
per cent of
regard thos
diameter at
measured.
the trees of
cord of pulp
burned once
the normal p
outlook for
more hopefu

The othe
the table (pa
original fore
cient quantit
form a valu

The area
aggregate 26
second fire, a
Deducting th
by swamps
twice. The
mately 25 ye
were burned
local ground
ago. The tv
and 8 years a
and only left

The large
eastern Meth
28 per cent o
6,300 acres.
were very se
burned, since
before the se
second fire th
area burned t
young pine tr
covered, and

165 and the large-toothed aspen 93, a total for the two species of 258 per acre, and they thus comprise 41 per cent of the stand. Nearly 90 per cent of these trees have not yet attained commercial size, if we regard those as non-commercial which are less than five inches in diameter at breast height, that is, the height at which the trees were measured. By using a volume table for poplar, it is calculated that the trees of this species now of commercial size, yielding only one cord of pulpwood per acre, would run 17,000 cords on the whole area burned once. Yet, if the 230 trees per acre under commercial size, or the normal percentage of them, were allowed to come to maturity, the outlook for pulpwood as a secondary product to the pine would be more hopeful.

The other commercial trees, whose rate of occurrence is given in the table (page 175), probably had only a scattering distribution in the original forest. The oak, cedar, balsam and hemlock occur in sufficient quantities—in the aggregate 100 trees of all kinds per acre—to form a valuable commercial adjunct if allowed to come to maturity.

AREAS SEVERELY BURNED TWICE

The areas indicated on the map (facing page 166) as burned twice aggregate 26,000 acres. In these are 1,750 acres which escaped the second fire, and hence these were classed among the areas burned once. Deducting this amount, and the 25 per cent estimated to be occupied by swamps of various kinds, there are 17,750 acres actually burned twice. The two severe fires on the Methuen areas occurred approximately 25 years and 16 years ago. Patches too small to be delimited were burned eight years ago, and there are indications of numerous local ground fires. One of these marked some of the trees five years ago. The two severe fires on the Burleigh areas occurred 25 years and 8 years ago, while the fires of 16 years and 5 years ago were light, and only left their scars in some places.

The largest area burned twice is found in southern and southeastern Methuen and comprises, exclusive of swamps, 8,760 acres, but 28 per cent of this escaped the fire, so that the area actually burned is 6,300 acres. Although a relatively large proportion escaped, the fires were very severe upon the pine reproduction on the areas actually burned, since it now averages only 1.3 pine trees per acre, whereas, before the second fire, the area averaged 33 pine trees per acre. The second fire then practically obliterated the potential pine stand. The area burned twice around Bottle and Barrette lakes now contains five young pine trees per acre. Only one small unburned patch was discovered, and this contained young pine at the rate of 50 to the acre.

TABLE IIA

DIAMETER CLASSES AND THE AVERAGE PROPORTION OF OCCURRENCE IN EACH ACRES SEVERELY BURNED TWICE

DIAMETER CLASS OF THE SPECIES ENUMERATED IN TABLE IIB, OCCURRING ON 17,750

	Inches	Trembling aspen	Large-toothed aspen	White pine	Red pine	White birch	White oak	Red oak	Red maple	Sugar maple	Balsam	White spruce	Cedar	Basswood	White ash
Per cent.....	1	55.5	54.7	19.3	27.8	69.3	56.2	67.6	93.7	86.0	46.1	37.7	76.8	58.8	90.1
Per acre.....		80.1	61.7	1.6	1.6	81.3	9.1	48.3	30.9	2.2	1.3	.6	1.6	1.7	1.4
Per cent.....	2	28.2	31.0	19.0	21.3	23.5	18.7	20.0	3.3	7.5	30.5	27.6	13.7	23.6	8.5
Per acre.....		40.8	35.2	1.6	1.2	27.4	3.0	14.3	1.1	.2	.8	.4	.3	.6	.1
Per cent.....	3	10.3	10.1	14.6	17.5	4.6	15.8	7.9	1.5	..	14.8	13.0	8.4	2.3	1.4
Per acre.....		14.8	11.4	1.2	1.0	5.5	2.6	5.6	.5	..	.4	.2	.2	.1	..
Per cent.....	4	3.3	2.5	11.0	12.2	1.5	4.5	2.7	.3	2.5	1.6	8.7	1.1	10.7	..
Per acre.....		4.8	2.8	1.0	.7	1.8	.8	1.9	.1	.1	.05	.1	..	.3	..
Per cent.....	5	1.3	.8	10.0	9.1	.8	3.0	1.0	.4	..	2.4	4.4	..	3.0	..
Per acre.....		1.9	.9	.9	.5	.9	.5	.7	.1	..	.1	.1	..	.1	..
Per cent.....	6	.7	.4	9.5	6.1	.2	.5	.3	.4	..	1.6	7.1	..	.8	..
Per acre.....		1.0	.5	.8	.4	.2	.1	.2	.1	..	.05	.1	..	..	..
Per cent.....	7	.3	.3	7.2	1.8	.04	.5	.2	.05	.8	1.6	..	..	..	..
Per acre.....		.4	.3	.6	.1	.1	.1	.1	..	.02	.05	..	..	..	..
Per cent.....	8	.2	.1	4.4	1.1	.04	.3	.2	.05	..	.8	..	..	.8	..
Per acre.....		.3	.1	.4	.1	.1	.05	.1	..	..	..	..	..	..	..
Per cent.....	9	.1	.08	2.1	.8	.02	..	.1	.05	.8	..	..	..	..	..
Per acre.....		.2	.1	.2	.05	..	..	.1	..	.02	..	..	..	..	..
Per cent.....	10	.05	..	1.8	.5	..	.1	..	..	..	..	1.5	..	..	..
Per acre.....		.1	..	.1	..	..	..	..	..	..	..	..	..	..	..
Per cent.....	11	.05	..	.5	.8	..	..	..	.05	.8	..	..	..	..	..
Per acre.....		.1	..	.05	.05	..	..	..	..	.02	..	..	..	..	..
Per cent.....	12	..	..	.2	.5	..	.3	..	.1	..	..	..	..	..	..
Per acre.....		..	..	..	..	..	.05	..	.05	..	..	..	..	..	..
Per cent.....	13	..	.02	..	.5	..	..	..	.1	.8	..	..	..	..	..
Per acre.....		..	..	..	..	..	..	..	.05	.02	..	..	..	..	..
Per cent.....	14	..	..	.2	..	..	..	..	..	..	..	..	..	..	..
Per acre.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
Per cent.....	16	..	..	..	..	..	.1	..	..	.8	..	..	..	..	..
Per acre.....		..	..	..	..	..	..	..	..	.02	..	..	..	..	..
Per cent.....	17	..	..	.2	..	..	..	..	..	..	.8	..	..	..	..
Per acre.....		..	..	..	..	..	..	..	..	..	..	..	..	..	..
Total															
Per cent..	....	100.00	..	..	..	..	..	..	..	..	..	..	..	..	..
Per acre..	....	144.5	113.0	8.4	5.7	117.3	16.3	71.3	33.0	2.6	2.8	1.5	2.1	2.8	1.5

TABLE IIb

PRESENT COMPOSITION AND AVERAGE NUMBER OF TREES PER ACRE ON 17,750 ACRES SEVERELY BURNED TWICE, BASED ON SAMPLE STRIPS TOTALING 46.2 ACRES

	Per cent	Per acre
Trembling aspen	27.6	144.5
Large-toothed aspen	21.6	113.0
White pine	1.6	8.4
Red pine	1.1	5.7
White birch	22.4	117.3
White oak	3.1	16.3
Red oak	13.7	71.4
Red maple	6.3	33.0
Sugar maple	.5	2.6
Balsam	.5	2.8
White spruce	.3	1.5
Cedar	.4	2.1
Basswood	.6	2.8
White ash	.3	1.5
Total number of trees per acre	.....	522.9

The areas burned twice in Burleigh township, after making the deductions for swamps, total 8,540 acres. The largest of these is along the east side of Eels brook, in the southern division. This limited area now averages 26 young pine per acre, a high average for an area burned twice, but the lower half of the area at least had a remarkably large stock of pine before the second burning, about eight years ago. This, as stated on page 174, was 260 trees per acre. The whole area burned twice has, on the average, two pine seed trees per acre, which, in the course of a long time, might bring back the pine, if protected from fire.

The area in the south-eastern portion of Burleigh township, lying between the areas marked as burned once and three times, respectively, on the north, and the area marked as burned three times, on the south, and extending up to Jack lake, in Methuen township, is mostly on granite. It differs in composition from all the other areas in its large amount of oak, about 50 per cent of the stand being red oak and 17 per cent white oak. While the soil is rather thin, and much of the oak naturally stunted, it is probable that considerable quantities would attain commercial size if protected from fire.

As a whole, the areas burned twice now support eight white pine and six red pine, a total of 14 pine trees per acre. The areas burned once contain 110 young pine trees per acre. Therefore, as a whole, the second burning reduced the amount of pine to one-eighth of that on the areas burned once.

The number of poplar trees on the average acre at present—it being 8 years or 16 years since the last burning—is practically the same as after the first burning. Eighty-five per cent of these trees, however, belong to the one-inch and two-inch diameter classes, and are not over 16 years old. They are mostly sprouts, stimulated to growth by the last fire. The number of commercial trees averages six per acre, while the number of like trees on the areas burned but once averages 27 per acre. There is one-fifth of a cord of poplar now fit for pulpwood on the average acre, while the pulpwood on the areas burned but once averages one cord per acre. Trees of other species of potential commercial value average practically the same (100 per acre) as on the areas burned but once.

AREAS SEVERELY BURNED THREE TIMES

The areas severely burned three times cover 9,300 cares. Deducting the usual one-fourth of the area for swamps, there are 6,975 acres actually occupied by this type. The area in Methuen township was burned approximately 25 years, 18 years and 5 years ago, while the areas in Burleigh township were swept by fires 25 years, 16 years and 10 years ago. One of the Burleigh areas extends into Methuen, near the point at which Jack creek leaves the township.

The last fire on the Methuen area was very severe. The dead trees resulting were counted on sample plots totalling eight acres. Before the fire there were 276 poplar trees; 23 pine trees and 41 oak trees per acre; after the fire there were only two living poplar trees, one pine and one oak tree per acre.

The area burned three times in south-eastern Burleigh is on crystalline limestone, and the stand is open and park-like in many places, where the three generations of trees, due to the three fires, are quite easily distinguished. Continued burnings on limestone areas stimulate the development of grass beneath the trees. The soil being thin, however, the grass completely dries up in the drier portions of the year, so that such areas would be of only temporary service for grazing purposes. The area burned three times in the central portion of Burleigh is chiefly composed of low granite ridges, the tops of which, in many cases, have been burned practically clear of trees.

TABLE IIIA

PRESENT COMPOSITION AND AVERAGE NUMBER OF TREES PER ACRE ON 6,973 ACRES SEVERELY BURNED THREE TIMES, BASED ON SAMPLE STRIPS TOTALING 34 ACRES

	Per cent	Per acre
Trembling aspen	35.2	96.9
Large-toothed aspen	26.1	71.8
White pine	1.1	3.0
Red pine	1.5	4.2
White birch	24.0	65.8
White oak	.5	1.3
Red oak	3.9	10.7
Red maple	5.3	14.7
Sugar maple	.5	1.4
Balsam	.8	2.0
White spruce	.7	2.0
Cedar	.4	1.1
Total number of trees per acre	....	274.9

General View of an Area Burned Many Times
Forest Growth Scattered. Note soil erosion.

Burned Many Times
Note the number of stumps and the absence of reproduction.

DIAMETER CI
DIAME
ON 6,97

Per cent.....	
Per acre.....	
Per cent.....	
Per acre.....	
Per cent.....	
Per acre.....	
Per cent.....	
Per acre.....	
Per cent.....	
Per acre.....	
Per cent.....	
Per acre.....	
Per cent.....	
Per acre.....	
Per cent.....	
Per acre.....	
Per cent.....	1
Per acre.....	
Per cent.....	1
Per acre.....	
Per cent.....	1
Per acre.....	
Per cent.....	1
Per acre.....	
Per cent.....	1
Per acre.....	
Per cent.....	1
Per acre.....	
Per cent.....	1
Per acre.....	
Total	
Per cent...	..
Per acre...	..

TABLE IIIB

DIAMETER CLASSES AND THE AVERAGE PROPORTION OF OCCURRENCE IN EACH DIAMETER CLASS OF THE SPECIES ENUMERATED IN TABLE IIIA, OCCURRING ON 6,975 ACRES SEVERELY BURNED THREE TIMES

	Inches	Trembling aspen	Large-toothed aspen	White pine	Red pine	White birch	White oak	Red oak	Red maple	Sugar maple	Balsam	White spruce	Cedar
Per cent.....	1	57.2	51.7	24.0	35.2	70.5	17.4	41.5	77.4	91.6	44.3	28.6	21.1
Per acre.....		55.5	37.1	.7	1.5	46.4	.2	4.4	11.4	1.3	.9	.5	.2
Per cent.....	2	25.4	33.5	14.0	28.1	21.4	34.8	30.0	15.2	6.3	24.3	22.2	47.4
Per acre.....		24.6	24.1	.3	1.2	14.	.4	3.1	2.3	.1	.5	.4	.5
Per cent.....	3	9.6	10.3	21.0	7.7	6.0	19.5	14.6	4.4	..	12.8	11.1	28.9
Per acre.....		9.3	7.4	.6	.3	3.9	.2	1.6	.6	..	.3	.2	.3
Per cent.....	4	4.9	2.8	18.0	9.1	1.3	4.3	7.7	1.4	..	8.6	22.2	2.6
Per acre.....		4.8	2.0	.5	.4	.9	.1	.8	.2	..	.2	.4	.05
Per cent.....	5	1.1	.7	6.9	4.2	.5	6.6	4.6	1.0	2.1	5.7	3.2	..
Per acre.....		1.0	.5	.2	.2	.4	.13	.5	.13	..	.1	.1	..
Per cent.....	6	1.0	.3	4.9	1.5	.2	2.2	.8	.4	..	2.9	3.2	..
Per acre.....		.9	.2	.1	.1	.1	..	.1	.1	..	..	.1	..
Per cent.....	7	.3	.5	2.9	3.5	..	..	.2	..	..	..	1.6	..
Per acre.....		.3	.3	.15	.13	..	..	.03	..	..	..	.05	..
Per cent.....	8	.2	.1	.9	3.5	.1	2.2	..	..	..	1.4	1.6	..
Per acre.....		.2	.1	.05	.13	..	..	..	..	..	..	.05	..
Per cent.....	9	.2	.1	.9	3.5	..	4.3	.2	.2	..	..	1.6	..
Per acre.....		.2	.1	.05	.13	..	.1	.03	.03	..	..	.05	..
Per cent.....	10	..	..	1.9	1.5	..	..	..	..	..	..	4.7	..
Per acre.....		..	..	.1	.1	..	..	..	..	..	..	.15	..
Per cent.....	11	.1	..	.9	..	..	..	..	..	..	..	..	..
Per acre.....		.1	..	.05	..	..	..	..	..	..	..	..	..
Per cent.....	12	..	..	1.9	.7	..	4.3	.2	..	..	..	..	..
Per acre.....		..	..	.1	..	..	.1	.03	..	..	..	..	..
Per cent.....	13	..	..	..	1.5	..	..	..	..	..	..	..	..
Per acre.....		..	..	..	.1	..	..	..	..	..	..	..	..
Per cent.....	14	..	..	.9	..	..	..	..	..	..	..	..	..
Per acre.....		..	..	.05	..	..	..	..	..	..	..	..	..
Per cent.....	16	..	..	..	..	..	2.2	..	..	..	..	..	..
Per acre.....		..	..	..	..	..	..	..	..	..	..	..	..
Per cent.....	18	..	..	.9	..	..	..	..	..	..	..	..	..
Per acre.....		..	..	.05	..	..	..	..	..	..	..	..	..
Per cent.....	19	..	..	..	..	..	2.2	.2	..	..	..	..	..
Per acre.....		..	..	..	..	..	..	.03	..	..	..	..	..
Total													
Per cent...	..	100.00	..	..	..	..	..	..	..	..	..	..	..
Per acre...	..	96.9	71.8	3.0	4.2	65.8	1.3	10.7	14.7	1.4	2.0	2.0	1.1

On the area burned three times there are, on the average, seven pine trees to the acre, three white pine and four red pine,—a reduction of one-half from the number on the areas burned twice, and approximately only one-sixteenth of the number on the areas burned but once. The reduction, in terms of the reproduction, is even greater than this indicates, for 30 per cent of the trees are of such size as to show that they antedate the first fire; that is, they are the larger trees which have withstood all the fires.

The trembling aspen is represented by 95 and the large-toothed aspen by 70, a total of 165 per acre, compared with 258 trees on the areas burned once and twice. Although the percentage ratio of the poplar of the one-inch and two-inch diameter class to the other diameters is practically the same as on the areas burned twice, as a matter of fact, the condition is really not as favourable as would appear, since a large proportion of the smaller material has been materially weakened as the result of the successive fires; it is crooked, deformed, and already attacked by disease. The lower illustration opposite shows two shoots springing from a root collar that has been injured by fires. The swollen portion on a similar stock was about 25 years old. It had sent forth shoots twice before, only to be burned to the ground. Shoots arising in this manner are weak and probably never make trees of commercial size. The amount of commercial pulpwood is reduced from one-fifth of a cord on the areas burned twice to one-eighth of a cord per acre on the areas burned three times.

The number of other species of potentially commercial trees, such as oak, basswood, balsam, cedar and spruce, reaches approximately 100 on the average acre on the areas burned once and twice, but the same or similar species total only 18 per acre on the areas burned three times.

AREAS SEVERELY BURNED MANY TIMES

Thirteen thousand acres of the region examined have been burned over many times. Making the usual deduction of one-quarter of the area for swamps, and a deduction of five per cent for patches which escaped most of the fires, there are still 9,260 acres actually included in this class. The greater portion of the area so designated has been severely burned seven times, five of which have occurred since lumbering operations began in the vicinity. Practically all of the few old pine trees still standing show from five to seven fire scars. One of these, which little by little had been severed at the base by fires, disclosed the fact that it had been fire-scarred when 25, 43, 55, 64, 82, 88 and 96 years old. It finally succumbed to the last fire at the age of 100 years. This means that the tree was burned, on the average, at

intervals of 12.5 years. These are only the recorded fires. There is much evidence that ground fires have been still more frequent. In fact, hardly a season passes that some portion of this area is not run over by ground fires.

There are three classes of persons principally responsible for these fires: Cattle rangers, marsh hay makers, and berry pickers; and the most careless of these are the berry pickers. The area is commonly called the huckleberry barrens. The term "barren," however, can be applied only to its present, not to its original condition, for it was once well covered with pine trees. The pine stumps were counted on sample plots aggregating 28 acres, and those eight inches and over in diameter averaged 17 per acre. This refers only to those that still show they had been cut for lumber. Those so far decayed or so severely burned as to leave this point in doubt were not included. Considering the length of time since lumbering began on the area, and the number of times it has been burned, it is fair to conclude that many of the stumps of former merchantable trees do not now exist; hence it is reasonable to assume that this area was originally well stocked with pine. At the present time, however, judging from sample plots aggregating 62 acres, there are only 0.7 white pine and 2.4 red pine an acre, on the average. Regarding the trees eight inches and more in diameter as capable of producing seed, one may find at present one such white pine seed tree to each seven acres and one red pine seed tree to each four acres. In fact, the average number per acre of all kinds of trees is only 22, without doubt considerably less than the original number of commercial pine trees per acre; and of these nearly one-half (48 per cent) are not over two inches in diameter.

Approximately five per cent of the area, exclusive of swamps, has escaped serious injury by fire. The average number per acre of trees of all kinds in these situations is 278, or over twelve times as many as on the adjacent areas burned many times. The pine on the patches that have not been badly burned averages 158 trees per acre, 53 white pine and 105 red pine, over 50 times as much as on the surrounding areas burned many times. This is an indication of what might have been, had the fires been prevented. The poplar also shows a similar increase, averaging 87 trees per acre on the unburned patches, compared with ten on the adjoining areas burned many times. The poplar large enough for pulpwood on the unburned areas at the present time averages 1.3 cords per acre; on the nearby areas burned many times, only one-forty-fifth of a cord per acre.

TABLE IVa

PRESENT COMPOSITION AND AVERAGE NUMBER OF TREES PER ACRE ON 9,260 ACRES SEVERELY BURNED MANY TIMES, BASED ON SAMPLE STRIPS TOTALING 62.3 ACRES

	Per cent	Per acre
Trembling aspen	38.9	8.7
Large-toothed aspen	6.0	1.3
White pine	3.2	0.7
Red pine	10.7	2.4
Jack pine	20.7	4.6
White birch	10.0	2.2
White oak	2.3	0.5
Red oak	4.3	1.0
Red maple	3.9	0.9
Total number of trees per acre		22.3

TABLE IVB

DIAMETER CLASSES AND THE AVERAGE PROPORTION OF OCCURRENCE IN EACH DIAMETER CLASS OF THE SPECIES ENUMERATED IN TABLE IVA, OCCURRING ON 9,260 ACRES SEVERELY BURNED MANY TIMES

	Inches	Trembling aspen	Large-toothed aspen	White pine	Red pine	Jack pine	White birch	White oak	Red oak	Red maple
Per cent.....	1	30.5	25.0	22.7	42.3	7.3	35.5	..	6.7	44.4
Per acre.....		2.6	.33	.16	1.01	.3	.8	..	.06	.38
Per cent.....	2	28.6	19.0	6.8	9.4	22.2	32.0	3.1	15.0	39.0
Per acre.....		2.5	.25	.04	.22	1.0	.7	.01	.14	.32
Per cent.....	3	20.5	21.4	9.5	5.4	24.0	22.4	12.5	23.3	5.6
Per acre.....		1.8	.28	.06	.13	1.1	.5	.06	.22	.04
Per cent.....	4	9.6	26.2	11.4	4.7	21.9	5.8	28.1	16.7	1.8
Per acre.....		.9	.35	.08	.11	1.0	.13	.14	.16	.01
Per cent.....	5	6.2	2.4	4.5	2.7	10.1	2.2	15.6	11.7	1.8
Per acre.....		.6	.02	.03	.07	.5	.04	.08	.11	.01
Per cent.....	6	1.7	3.6	16.0	8.0	7.6	0.7	21.9	8.3	5.6
Per acre.....		.1	.05	.11	.21	.4	.01	.11	.08	.04
Per cent.....	7	1.5	..	4.5	6.7	3.2	..	9.4	5.0	..
Per acre.....		.1	..	.03	.16	.14	..	.04	.05	..
Per cent.....	8	0.6	..	4.5	4.7	2.8	0.7	3.1	11.7	..
Per acre.....		.05	..	.03	.11	.13	.01	.01	.11	..
Per cent.....	9	0.4	1.2	4.5	6.0	0.3	..	..	1.6	..
Per acre.....		.03	.01	.03	.14	.01	..	..	.02	..
Per cent.....	10	0.2	1.2	2.2	2.0	0.3	..	..	..	..
Per acre.....		.01	.01	.01	.04	.01	..	..	..	..
Per cent.....	11	0.2	..	..	4.7	0.3	..	..	..	..
Per acre.....		.01	..	..	.11	.01	..	..	..	..
Per cent.....	12	..	..	..	0.7	..	..	..	..	..
Per acre.....		..	..	..	.01	..	..	..	..	..
Per cent.....	13	..	..	4.5	0.7	..	..	..	..	..
Per acre.....		..	..	.03	.01	..	..	..	..	..
Per cent.....	14	..	..	2.2	2.0	..	..	6.3	..	1.8
Per acre.....		..	..	.01	.04	..	..	.03	..	.1
Per cent.....	15	..	..	2.2	..	..	0.7	..	..	..
Per acre.....		..	..	.01	..	..	.01	..	..	..
Per cent.....	19	..	..	4.5	..	..	..	..	..	..
Per acre.....		..	..	.03	..	..	..	..	..	..
Total										
Per cent.....		100.00	..	..	..	..	..	..	..	..
Per acre.....		8.7	1.3	0.7	2.4	4.6	2.2	0.5	1.0	0.9

SUMMARY OF FOREST CONDITIONS

The forest conditions described on the preceding pages may be summarized as follows:

Partially or completely forested, 84,333 acres.

Unburned mature forest	15,000
Burned areas (second growth forest)	51,334
Unburned swamps within the burned areas	16,799
Oak barrens	1,200
Total	84,333

The areas actually burned over, with reference to the number of times burned, may be grouped as below:

Burned once	17,349
Burned twice	17,750
Burned three times	6,975
Burned many times	9,260
Total	51,334

Comparing the conditions, as a whole, on the areas burned many times with those burned once, twice, and three times, we find that the pine averages three trees per acre, in contrast to 7, 14, and 110 on the areas burned thrice, twice and once, respectively; the poplar ten per acre, in comparison with 169 on the areas burned three times, and to 258 on the areas burned once and twice; the amount of pulpwood ready to harvest, one-forty-fifth cord, in contrast to one-eighth cord on the areas burned three times, to one-fifth cord on the areas burned twice, and to one cord on the areas burned once.

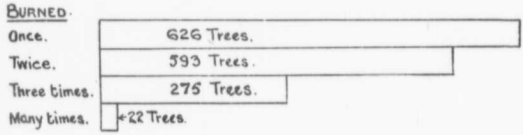
The condition of affairs in order of the number of times the area has been burned may be summarized in tabular form, as below:

TABLE V

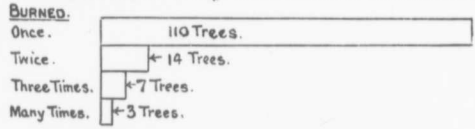
NUMERICAL PROPORTION OF REPRODUCTION OF VARIOUS SPECIES ON THE AVERAGE ACRE IN ORDER OF THE NUMBER OF TIMES BURNED, BASED ON SAMPLE PLOTS TOTALING 180 ACRES

	Burned once	Burned twice	Burned thrice	Burned many times
Whole number of trees at present	626	523	275	22
Pine	110	14	7	3
Poplar	258	257	169	10
Other commercial species	106	101	18	7
Cords of pulpwood now merchantable	1	1/5	1/8	1/45

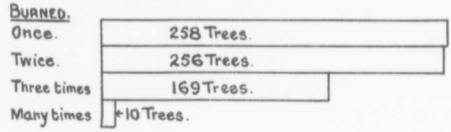
These conditions may be represented graphically by the following diagrams:



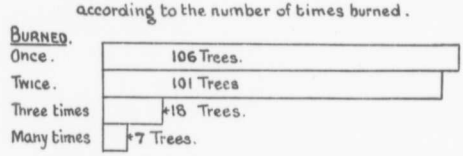
Whole number of trees of all species, one inch and above in diameter now present, according to the number of times burned.



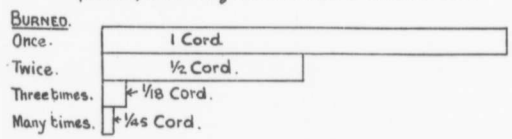
Young pine trees, one inch and above in diameter now present, according to the number of times burned



Young poplars, one inch and above in diameter now present, according to the number of times burned.



Other commercial species, one inch and above in diameter now present, according to the number of times burned.



Cords per acre of merchantable poplar pulpwood now present, according to the number of times burned.

The area marked "oak barrens" on the map consists of about 1,200 acres. It is situated in the "foothills" of the Blue mountains, and consists of bare ridges and deep gullies, the latter often only a few yards across and 15 yards to 25 yards deep. The ridges are covered with stunted oak trees, growing mostly in the crevices of the rocks, while the gullies are filled with poplar. Occasional stumps in the gullies indicate that pines of large size once grew there. The area has been burned several times, but it is so evidently a natural barren that it has been excluded from consideration of the burned areas.

GROWTH STUDIES

To secure data upon which to base an estimate of the financial losses involved in the fires, some growth studies were undertaken.

In the case of the pines it was found that their rate of growth was so variable that, to secure a satisfactory statement, a larger number would have had to be analyzed than time permitted and the object in view would have warranted. Moreover, reliable tables already exist for these species, and these have been used. The rate of growth of poplar has, however, been especially studied.

Growth studies of poplar were made in three places: In lot 15, concession II, and lot 25, concession III, in Methuen; also in lot 2, concession III, in Burleigh. The area on which the trees grew was of second quality for the locality, and was selected because it represented the average condition of the region as a whole. The soil would be classed as sand, and its depth was from 8 to 12 inches. The composition of the soil may be judged by the average of four samples, given below, which were taken from the areas where the growth studies were made.

	COMPOSITION PER CENT
Fine gravel	16.3
Coarse sand	24.5
Medium sand	10.6
Fine sand	18.1
Very fine sand	8.2
Clay	13.9
Silt	4.8
Organic matter	3.6
Total	100.0

In the table given on page 193 six per cent of the trees included are the large-toothed aspen. The growth of these was figured separately, but as practically no difference in the rate of growth from the trembling aspen was to be ascertained, and since for commercial purposes the two species are not distinguished, it was thought best

for the purposes of this report to group the two aspens together, under the designation of "poplar."

It is difficult to tell, after the first few years, whether a tree has come from a seedling or from a root sucker, but it is probable that most of the trees on which the growth studies were made came from seedlings.

TABLE VI

RATE OF GROWTH OF POPLAR, SITE QUALITY II, BASED ON 166 TREES

Age	Average diameter, inside bark, at ground, inches	Average height, feet
3	0.24	3.5
4	0.39	5.1
5	0.43	5.3
6	0.60	7.8
9	0.80	8.0
10	0.86	9.0
11	0.98	10.4

Average age	Diameter class, breast height	Average height, feet	Average merchantable volume, cubic feet
13	1	14	....
21	2	20	....
26	3	24	....
30	4	30	....
31	5	36	1,909
36	6	39	2,352
40	7	47	5,752
41	8	48	6,233
44	9	48	6,714
45	11	55	13,706

Rate of Growth of Poplar

The rate of growth, as indicated in Table VI above, may seem very slow to many, for poplar is generally considered one of the most rapidly growing trees. If these trees had been taken from the best soils, the rate of growth would have been considerably faster, but they were taken from the kind of soil in which the greater majority of the trees of the region were growing and this was of second quality. There is a tendency in the popular mind, however, to over-estimate the rate of growth of trees, for the judgment is usually made from trees growing in the most favourable soil, and other conditions, not from the average conditions actually found in the forest, where competition for food and light is generally severe.

The average height growth of the 166 poplar trees employed in table VI, is 10.8 inches in a year, and the average increase in diameter is one inch in six years. It will be noted that it takes approximately 30 years' growth to produce a poplar tree five inches in diameter, breast high, the lowest diameter at which trees are cut for pulpwood. Further, it takes 13 years, on the average, to produce a tree one inch in diameter, 26 years for a tree three inches in diameter and 36 years for a tree six inches in diameter. Growth studies were made on a few trees of larger diameter than those given above, but they were on a much better quality of soil and so were not included. Basing the statement upon growth studies of poplar from other sources, one may say that it does not reach its most rapid growth in volume until about the fiftieth year. Since none of the trees studied had reached that age, it is assumed, in forecasting the yield at the end of the next 30 years, that the trees will grow at the rates stated above.

Applying the rate of growth indicated above to the average number per acre of poplar trees of the various diameter classes on the areas burned once, as given in table 1B (pages 176-177), and assuming that all were to live, it would be found that, at the end of the next 30 years, the diameters, number of trees and their contents in cubic feet would be as indicated in the table below:

TABLE VII

NUMBER OF POPLAR TREES PER ACRE AND VOLUME TO BE EXPECTED ON THE AVERAGE ACRE AFTER THE NEXT 30 YEARS ON THE AREAS BURNED ONCE, ASSUMING ALL TREES SURVIVED

Number of trees	Diameter class, inches	Total volume, cubic feet, bark excluded
71	5	135.0
90	6	211.6
53	7	304.8
22	8	137.1
13	9	87.2
7	10	81.9
3	11	41.1
2	12	44.0
1	13	30.0
	Total	1,072.7

A cord of peeled pulpwood contains 90 cubic feet solid. This figure, used as a converting factor, gives 11.9 cords as the estimated yield per acre. If twenty-five per cent be deducted from this, as the amount that would die in the natural course of events in the next 30

years, the average yield per acre would be 9 cords. Multiplying this by the acreage, 17,350, we get 156,150 cords as the expected total yield of pulpwood at the end of 30 years, on the areas which have been burned but once.

Treating the poplar of the various sizes now present on the areas burned twice in the same manner, we find that the following conditions may be expected at the end of the next 30-year period:

TABLE VIII

NUMBER OF POPLAR TREES PER ACRE AND VOLUME TO BE EXPECTED ON THE AVERAGE ACRE AFTER THE NEXT 30 YEARS ON THE AREAS BURNED TWICE, ASSUMING ALL TREES SURVIVED

Number of trees	Diameter class, inches	Total volume, cubic feet, bark excluded
142	5	171.0
76	6	178.7
26	7	149.5
8	8	49.8
3	9	20.1
1	10	11.7
1	11	13.7
	Total	594.5

Using the converting factor given above, and subtracting twenty-five per cent for the normal decay, the average yield per acre to be expected at the end of the next 30 years, is five cords. The areas burned twice aggregate 17,750 acres, so the total expected yield on such areas becomes 88,750 cords of peeled pulpwood.

Following this assumption as to rate of growth, the following conditions would be found at the end of the next 30 years on the areas burned three times:

TABLE IX

NUMBER OF POPLAR TREES PER ACRE AND VOLUME TO BE EXPECTED ON THE AVERAGE ACRE AFTER THE NEXT 30 YEARS ON THE AREAS BURNED THREE TIMES, ASSUMING ALL TREES SURVIVED

Number of trees	Diameter class, inches	Total volume, cubic feet, bark excluded
90	5	171.8
47	6	110.5
16	7	92.0
7	8	43.6
1	9	6.7
1	10	11.7
1	11	13.7
	Total	450.0

Assuming the same converting factor as previously, the 450 cubic feet given above becomes an even five cords of pulpwood on the average acre, before deduction is made for decay. Because of the deformed and diseased condition of the young growth on the areas burned three times, as described on page 186 a much larger percentage of it will die, or at least will not make commercial pulpwood, than on the areas burned once and twice; consequently, 50 per cent is deducted on this account, making the estimated yield per acre 2·5 cords. The areas burned three times aggregate 6,970 acres, so the total estimated yield of pulpwood becomes 17,425 cords.

On the areas burned many times, the expected yield of poplar will be as follows:

TABLE X

NUMBER OF POPLAR TREES PER ACRE AND VOLUME TO BE EXPECTED ON THE AVERAGE ACRE AFTER THE NEXT 30 YEARS ON THE AREAS BURNED MANY TIMES, ASSUMING ALL TREES SURVIVED

Number of trees	Diameter class, inches	Total volume, cubic feet, bark excluded
3	5	5.7
3	6	7.0
2	7	11.5
1	8	6.2
1	9	6.7
	Total	37.1

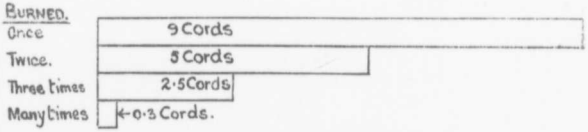
If the converting factor of 90 cubic feet to the cord be applied to the above, the average yield per acre becomes 0.4 cord. Since the trees on this area are not "crowded," a smaller deduction may be made for the normal death rate, say, 25 per cent. On this basis, the expected yield will be 0·3 cord per acre. There are 9,260 acres in the burned-many-times areas, so the expected yield on the whole area will be around 3,000 cords.

Probable Yield of Pulpwood

The forecasted yield of poplar 30 years from the present date, according to the number of times the area has been burned, may be summarized as follows:

	Number of acres	Average per acre, cords	Total, cords
Areas burned once.....	17,350	9	156,150
" " twice	17,750	5	88,750
" " thrice	6,970	2.5	17,425
" " many times.....	9,260	0.3	3,000
Total.....	.....	.....	265,325

This relationship may be expressed by the following diagram:



The forecasted yield of poplar per acre, 30 years from the present date, according to the number of times burned.

FINANCIAL LOSSES BY FOREST FIRES

There can be little doubt that, if the public understood the cost of forest fires in terms of the future yield, more efficient methods of protection would be demanded. People do not burn, nor allow to be burned, what they value. It is in the hope of securing a better understanding of this question that the following estimates of the financial losses due to repeated fires on the Burleigh-Methuen areas are presented.

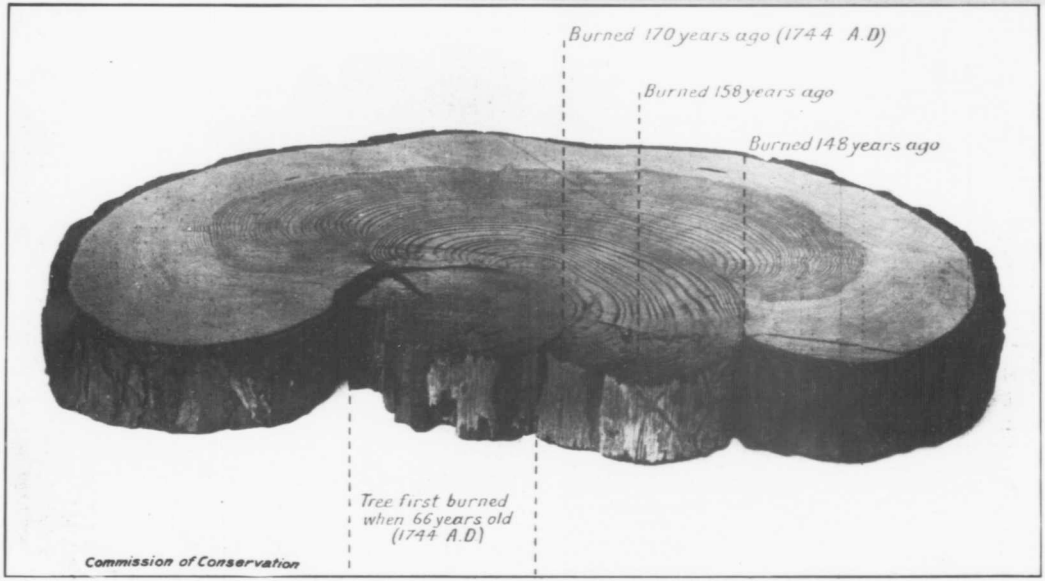
Repeated Fires Destroy Seed Trees

In most lumbering operations, in pine stands, a certain number of the larger trees, because of disease or deformation, escape the axe. Seed from these trees, together with the trees too small to be of commercial value at the time of lumbering, would, if left undisturbed, in time, restock the area to pine. When young, pine is very easily killed by fire. Only in the older stages, after a thick bark is formed and the crown has raised itself out of reach, does it become to any extent resistant to light fires. Large trees readily fall a prey to the heavy fires. The slash left behind lumbering operations is almost invariably burned accidentally, sooner or later. If seed trees are left, if the slash is burned within a year or two after lumbering, and especially if the fire comes in a year of a heavy yield of seed, the burning, by clearing the ground of *debris*, probably stimulates the reproduction of pine. Every fire after the

first one kills not only a large number of seedlings and young trees, but also many of the seed trees. Every severe fire reduces the number of seed trees, and so reduces by so much the reproductive capacity of the area. This process goes on until, with the death of seed trees, the remaining trees become so scattered that it would take several hundred years for them to bring the area back to its original stand of pine. As an example of this, the area burned many times, as indicated on the accompanying map, facing page 166, where there is only one seed tree to each five acres, may be cited. This does not mean that each five-acre plot actually has a seed tree on it. As a matter of fact, in the area under discussion, there are probably several hundred acres without any seed trees. It is merely a statement of the average condition.

Future Production of Pine

It will then be readily seen that successive fires result in a progressive diminution of the future yield of pine. From the data on the preceding pages of this report, it will be seen what is the numerical diminution of the future yield of pine on the areas under consideration, namely, 110, 14, 7, and 3 trees per acre on the areas burned once, twice, thrice and many times, respectively. It should be emphasized that the data have been obtained by actual measurement. Knowing, in this way, the number of pine trees per acre in relation to the number of times burned, knowing also, at least, their minimum value at maturity, in terms of stumpage values and of timber dues, we may compute with reasonable accuracy the money losses involved in the progressive diminution of future yield owing to successive fires. This computation is presented in the table below. The figures are derived from the assumption that each tree now present will grow to maturity and at maturity will yield 100 feet board measure. This is the yield of an ordinary pine tree from 12 inches to 13 inches in diameter, according to the Scribner rule. The stumpage value is placed at seven dollars per thousand, the present average value, and the dues at two dollars per thousand feet board measure, the present rate, although the price of the former at least will undoubtedly be much higher by the time these young trees produce saw logs.



SECTION OF A TREE TRUNK TO SHOW HOW THE DATES OF FIRES ARE ASCERTAINED FROM THE REMAINING SURVIVING TREES
Each fire which injures the tree leaves a permanent scar, and the date when it occurred can be determined, or at least very closely approximated, by counting the number of annual rings between the scar and the outer circumference of the tree.

PINE REPRO
FUTUR
ALREA
REPEA

Acres .....
Potential val
dues if burn
once .....

Potential valu
dues with
stock .....

Loss of dues
peated fires

Loss in previou

Potential stu
value if burn
once .....

Potential stu
value of p
stock .....

Loss of stumpag
ues by rep
fires .....

Loss in previousl

Total loss alread
isting potent

Potential value o
stumpage $1

Great Loss of Stumpage Values

as the present
ther destructi
at present pri
this estimate i
cally present
This condition

TABLE XI

PINE REPRODUCTION ON BURNED AREAS, WITH ESTIMATES OF THE PROSPECTIVE FUTURE VALUE OF PRESENT STOCK IF PROTECTED FROM FIRE, AND THE LOSS ALREADY INCURRED IN PREVIOUSLY EXISTING POTENTIAL VALUES, DUE TO REPEATED FIRES

	Burned once, average young pine trees per acre, 110	Burned twice, average young pine trees per acre, 14	Burned three times, average young pine trees per acre, 7	Burned many times, average young pine trees per acre, 3	Totals	Total losses
Acres	17,350	17,750	6,970	9,260	51,330	.....
Potential value of dues if burned but once	$381,700	$390,500	$153,340	$203,720	$1,129,260	.....
Potential value of dues with present stock	381,700	49,700	9,758	5,560	446,718	.....
Loss of dues by repeated fires	.....	340,800	143,582	198,160	682,542	.....
Loss in previously existing potential dues, at $2 per M					.....	$682,542
Potential stumpage value if burned but once	1,336,000	1,366,750	536,690	713,000	3,952,440	.....
Potential stumpage value of present stock	1,336,000	173,950	34,150	19,440	1,563,540	.....
Loss of stumpage values by repeated fires	.....	1,192,800	502,540	693,560	2,388,900	.....
Loss in previously existing potential stumpage values at $7 per M						$2,388,900
Total loss already incurred, on account of repeated fires, in previously existing potential dues and stumpage values						$3,071,442
Potential value of present stock, if protected from fire (dues $446,718, plus stumpage $1,563,540)						$2,010,258

Great Loss of Stumpage Values

It will be seen from the figures in the above table that if the entire area had been burned but once, if it had become stocked with young pine in the same quantities as the present area burned once, and if it were protected from further destruction by fire, the stumpage value of this pine at maturity at present prices would be over $3,900,000. As stated on page 198, this estimate is based on the assumption that each tree thus theoretically present would attain sufficient size to yield 100 feet of boards. This condition would be reached when the trees averaged between 12

and 13 inches in diameter. The numerous fires which have been allowed to run over this area have so reduced the stock that its stumpage value at maturity will be about $1,500,000, or, in other words, the fires have cost, in terms of pine stumpage, nearly $2,400,000, and the dues on the young pine burned would have amounted to $680,000. So the fires have destroyed more than $3,000,000 in potential pine values. As a result of the fires, however, we have sufficient poplar to make, at maturity, 265,000 cords of pulpwood. Considering this to be worth one dollar a cord when ready to harvest, we have $265,000 to deduct from the cost of the fires. So the final charge against the forest fires, in terms of potential value of pine destroyed, is, approximately, $2,800,000.

While the value of poplar is very much less than that of the pine, yet the successive fires have very materially lessened the potential value of its crop. Assuming the poplar to be worth one dollar a cord on the stump, for pulpwood, and that it could be harvested 30 years hence, the following data may be given in regard to the reduction of its value on the areas burned more than once:

TABLE XII

YIELD OF POPLAR 30 YEARS HENCE ON BURNED AREAS, WITH ESTIMATES OF ITS VALUE AND THE LOSS IN VALUE BY REPEATED FIRES

	Burned once, average cords per acre, 9	Burned twice, average cords per acre, 5	Burned three times, average cords per acre, 2.5	Burned many times, average cords per acre, 0.3	Total
Acres	17,350	17,750	6,970	9,260	51,330
Potential value of poplar 30 years hence if area burned but once	$156,150	$159,750	$62,730	$83,340	$461,970
Potential value of the present stock 30 years hence	156,150	88,750	17,425	3,000	265,325
Loss on each area	.....	71,000	45,305	80,340	.....
Total loss	.....	.....	.....	.....	196,645

From the figures in the above tables, it will be seen that the value of poplar on the whole area is reduced only 43 per cent by repeated fires, while the reduction in the case of the pine is 60 per cent. This is due to the well-known fact that fires make conditions favourable for the reproduction of poplar. But, in spite of this, some of the areas

have been so often and so severely burned that the value of the poplar is less by $196,645 than if there had been only one burning. This should be charged to the fire account, so that adding it to the $2,800,000 loss of pine, we have a total loss of practically $3,000,000 from fires which have occurred in the past 25 years on 85,000 acres (including swamps and other conditions), or $35 an acre.

FIRE PROTECTION

Adequate protection from fire is the necessary preliminary stage to any management of the area under consideration for future returns. There has been no lumbering on a large scale in this region for nearly 25 years. Since that time, judged by the number of fires, there has been little or no real fire protection. Deducting the swampy areas within the former pineries, it was found that, of the area actually burned, only one-third has escaped with a single burning since lumbering has been discontinued; another third has been burned twice; one-sixth has been burned three times, and one-sixth has been burned many times. The most severe and widespread fires occurred 25, 16, 8, 5, and 1 year ago, or in other words, there were three destructive fires in the past eight years and one each in the two former eight-year periods, an increase in rate of 300 per cent in the past eight years. If this rate continues, the young pine and poplar at present on the area will inevitably be destroyed. As shown on pages 199 and 200 this would involve a further loss of $2,275,000 in existing potential stumpage and dues values of pine and potential stumpage values of poplar, in addition to the above $3,000,000 loss already irrevocably incurred. It would seem worth while from a business point of view to save this $2,275,000 if possible.

Forest Protection Can be Secured

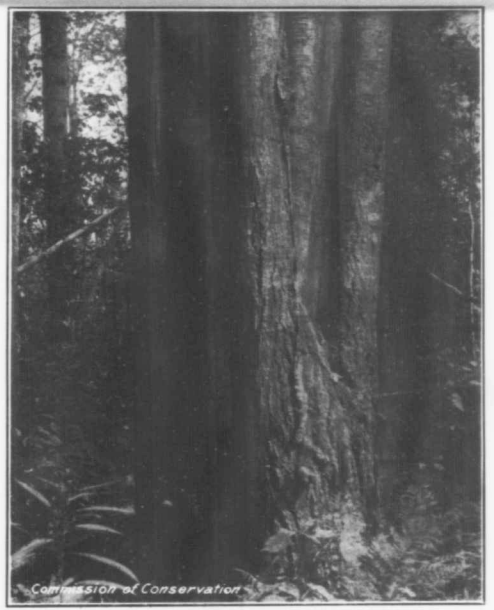
Officials, and the public in general, assume a rather fatalistic attitude toward the occurrence of forest fires. They are considered to be inevitable and unavoidable phenomena, like earthquakes and tornadoes. Such an attitude of mind perpetuates many an economic waste, one of the greatest of which is the destruction of forest wealth, present or potential, by fire. Experience has demonstrated that forest fires can be reduced to a minimum at a reasonable rate of expenditure, compared with the value of the property involved. As an example of this, the co-operative forest fire protective associations in the province of Quebec may be cited, where fairly efficient protection of large areas costs from one-quarter of a cent to one cent per acre per year. In order to accomplish this, however, two things are necessary: (1) An earnest desire to prevent fires, through a real appreciation of the value of the pro-

perty involved, and (2), efficient, business-like administration of the protective organization when once established. It will be seen that the area under consideration lacks both of these prerequisites. The territory has been cut over several times. One-half of it has been abandoned by the limit-holders and the remainder has been so far abandoned that it is not considered of sufficient value to be patrolled by a fire ranger. The latter condition is the logical result of throwing the entire cost of fire protection upon the limit-holder. He has usually no financial interest in the cut-over lands, because they will eventually revert to the Crown, since he can not, as a rule, afford to wait for the young growth to reach merchantable size. As a rule he is financially interested only in the timber of present commercial value; that gets the protection, and the cut-over lands are neglected. Fire on them receives attention only when it endangers standing timber.

Value of Protection Not Appreciated

Under the former regulations, when the Government paid one-half the cost of fire protection, the lessee could justly be required to patrol the cut-over areas as well as the timber areas, but, under the present regulations, this hardly seems practicable, unless it be assumed that limits are to be held in perpetuity, and this assumption is usually not justified. In the actual working out of the new regulations, then, the cut-over lands are abandoned to the ravages of fire, both by the Government and by the lessees. That such a condition of affairs could exist is due to the fact that the actual owners of the land, or, in other words, the people, do not appreciate the value of their property. "Waste land" is the common appellation applied to these cut-over and burned-over areas, yet the figures already given demonstrate that they are far from that. As has been pointed out, this relatively very small area contains sufficient young growth to be worth at maturity $2,275,000. The harvesting of this timber, and the many million dollars worth of material on similar areas in the province, would mean the employment of many people; with its destruction by fire, the opportunity for such prospective employment is removed. The dues received by the Government help to meet public expense; the removal by forest fires of the possibility of collecting such dues means that money for current public expenses must be raised in some other way, with the consequent increase in taxes, either direct or indirect. The people, therefore, have a direct financial interest in these cut-over lands. When they realize this, and appreciate their value, they will be efficiently protected from fire.

Where fire protection has been most efficient, it has been chiefly preventive. The means of prevention usually adopted are lookout



FIRE-SCARRED POPLARS

Value of timber largely destroyed, even where not killed outright.

STUMP SHOWING SIZE OF FORMER FOREST GROWTH ON AREA COVERED BY THIS REPORT

Little of the land is suited for anything except timber production.

towers, pa
the fire. T
before it g
in preventi
the forest
that has tc

Suggested Means of Protection

eration, it
out station
tory and c
should be c
to summon
operation c
along this li
tance of eig
materials.
foot of the
for the look
tion, could
$1,000 for
investment
on the grou

The cos
three cents
very good d
acre charge
than that di
reserve, or i
experiment
general wor
will be safe
per acre per

Results of Protection

acres, only
leaving appr
pineries and
burned swar
scheme for p

towers, patrolmen, trails, telephone lines, tools and men for fighting the fire. These are all accessories to reaching and putting out the fire before it gets beyond control. Another phase of efficient protection is in preventing the occurrence of fire, by educating the frequenters of the forest to be careful in the use of fire. This is the hardest task that has to be done.

Suggested Means of Protection

Turning to the phase of efficient protection, the object of which is the quick extinguishing of the fire when once started, and applying it to the area under consideration, it was found that it could be adequately protected by one lookout station on the Blue mountains, situated in the centre of the territory and commanding a view of nearly every acre of the area. It should be connected by telephone with the neighbouring communities, to summon help in case of fire. A rural telephone line is already in operation on two sides of the area and most of the inhabitants live along this line. It could be tapped from the Blue mountains for a distance of eight miles, and could be installed for $500, including cost of materials. The lookout man could be provided with a cottage at the foot of the mountains, not more than a half mile from the best position for the lookout station. Such a building, suitable for summer occupation, could be erected at a cost of $500, making a total outlay of $1,000 for the telephone line and the cottage. This initial capital investment could readily be made from the sale of mature material now on the ground.

The cost of patrol, fire-fighting and supervision need not exceed three cents per acre per year. For this sum it is possible to afford a very good degree of protection. The cost of overhead supervision per acre chargeable to fire protection would be reduced if a larger area than that discussed in this report were to be included in the proposed reserve, or if some line of scientific investigation, preferably a forest experiment station, were to be carried on, in connection with the general work of forest protection and administration. However, it will be safe to estimate the average cost of fire protection at three cents per acre per year.

Results of Protection

It has already been shown that the potential value of the existing young growth of pine and poplar is, in round figures, $2,275,000. Out of the total of 85,000 acres, only 15,000 acres are unburned mature forest (see p. 190), leaving approximately 70,000 acres which were occupied by the former pineries and have been more or less burned over. This includes unburned swamps and oak barrens, which must be included in any scheme for protection, being scattered in relatively small areas. Using

this figure of 70,000 acres, then, as a basis, the potential value of the existing young growth is approximately $33 per acre. If the period of maturity be taken as 50 years hence, then three cents per acre per year, at 4 per cent interest, compounded annually, becomes $4.58 at the end of 50 years. Therefore, after a total of less than $5 per acre had been spent, including interest, distributed over a period of 50 years, the province would have a property of 70,000 acres, worth $33 per acre, a clear profit of more than $28 an acre.

Fire Prevention and Education

Turning now to the second phase of efficient fire protection, namely, the actual prevention of the occurrence of fires, we come to the greatest need of fire protection propaganda, that is, a campaign of education and publicity. There is already considerable public sentiment in favour of fire protection, but it is mostly subconscious and non-expressive. It must be aroused and made virile and aggressive. This could be best accomplished by accentuating the financial results following fire protection. The common tendency is to think of the benefits resulting from fire protection as something remote—a sort of entailment in favour of future generations. But it should be emphasized that the present generation would reap the benefits of protection even on cut-over lands. While the value of the yields forecasted on page 199 would hardly be attained in one generation, yet in 30 to 50 years, at the present rate of growth, if protected from fire, the area under consideration will yield over $2,000,000 worth of pine lumber and $265,000 worth of poplar for pulpwood. The harvesting of this would give employment to many members of the community in which it is located, and, if the area were large enough, the employment would be permanent.

Permanent Benefits to be Derived

This, then, is the argument from the business standpoint: Effective fire protection leads to a stable and permanent lumber industry in the community, with consequent permanent employment of its members. Those who would not benefit directly by securing employment would serve or supply those who would so benefit. Contrast this with the present system, in which the lumberman removes all of the trees, and is steadily forced farther and farther from the markets in order to obtain merchantable timber, with the consequent increase in cost of production and transportation and, therefore, increased cost to the consumer. The present system leaves former timber lands open to recurring fires, greatly retarding or, in some cases, completely preventing the natural restocking of the area by commercial trees. It also results in increased taxation, abandoned farms, and a stranded population, often compelled to eke out a mere existence by hunting and fishing.

Communities not infrequently offer special inducements to certain industries to locate in their midst, and such industries often furnish, directly or indirectly, the means of livelihood for the greater portion of the inhabitants. They become such an integral part of the community that their withdrawal would be an economic calamity. A suggestion of such a thing would be fought vigorously by the citizens. If the citizens realized the value of the forest to the country as a source of permanent employment and permanent supply, they would fight against its removal just as vigorously and they would promote any means leading to its perpetuation.

So the work of the propagandist of fire protection is to present to the public the relation of the forests to the industries dependent upon their products, the relation of forest industries to other industries and the relations of the forests to the public treasury. The annual value of the products of the lumber industry in Canada is surpassed only by those of agriculture and manufactures. A large, but, in reality, diminishing, portion of the revenues of the eastern provinces is obtained from the forests. The taxpayer should be made to appreciate the relation of all this to his pocketbook. When he does, the unrestrained destruction of forests by fires will be regarded as an economic waste not to be tolerated.

RECOMMENDATIONS

In devising a policy for the proper management of this watershed there should first be made a classification and segregation of the lands which are capable of agricultural use from those which should be forever given over to timber culture.

Agricultural Possibilities

As has been shown in a previous report*, many farms which had been abandoned, and others which are still farmed, are really too poor for successful farming. Nevertheless, there are areas which are capable of agricultural use. Indeed, the richest and, probably, the most potentially profitable soils have been overlooked. These could be made useful for cattle ranching and specialized farming.

The area burned many times, as indicated on the accompanying map (facing page 166), is over 12,000 acres. At least one-quarter of this is composed of marshes and swamps. Many of these already have hay of such quality that cattle readily fatten on it, and many more could be made to do so without a prohibitive amount of work upon them. The more intractable portions could be fenced for grazing purposes, while the more easily managed areas could raise the hay to

**Trent Watershed Survey.* Commission of Conservation, 1913.

support the cattle in the winter. It is claimed, and probably with truth, that cattle can be brought to the "stocker" condition by free range in the forest. It is to be noticed, however, that in the later and drier portions of the season they do most of their grazing along the edges of the marshes, especially those along moving streams, where both food and water are accessible. Even under the most favourable conditions in the bush, cattle range over large areas in a day to find satisfying quantities of food. It is evident that they would fatten more readily if kept more closely confined in ranges, including areas of the more solid blue-joint grass-producing portions of the marshes (to avoid the danger of cattle being mired), and larger areas of the uplands. It is noticeable that white clover and blue grass grow luxuriantly along the margins of trails. It is also noticeable in cases of severe burning, where everything is killed and the litter burned down to the mineral soil, that pure stands of white clover and blue grass often cover patches several square rods in extent. It might be that pasturage could be materially increased in this way. If, by carefully managed trials, the cattle-raising industry should prove successful, it could be made a source of considerable profit through rentals of grazing areas. Indeed, it might well prove to be more profitable to utilize these semi-barren areas for permanent pasturage than for forest purposes.

Market Gardens from Swamps

Another alternative measure is the conversion of the marshes and swamps into market gardens. As stated above, many of them are already grass covered, and these vary in size from a few acres to those containing several hundred acres. Some would require but little drainage, others considerable. Nearly all of these marshes have streams flowing through them; they are not of the undrained peat bog type, and consequently are but slightly acid, a condition readily rectified by liming. An analysis of the soil of one of these marshes showed it to consist of decaying vegetable matter to the extent of 60 per cent of its dry weight, 25 per cent silt, 4 per cent clay, and the rest mostly of the finer grades of sand. Soils of this kind extend to the depth of three to twelve feet and if properly managed they would furnish a practically inexhaustible supply of plant food matter to garden crops.

The utilization of these soils would, of course, be a matter of provincial control. The beginnings could be small, without a great initial outlay of money. It would be very desirable to establish an experimental farm on these soils. If it were demonstrated that they could be successfully managed, then encouragement could be given settlers to take up these lands by aiding in drainage, the cost being

charged in the form of rent for a certain number of years, at the conclusion of which the settlers could be given title under the usual homesteading conditions. Ten acres of such soil devoted to garden crops would support a family. There are about 15,000 acres that might be eventually used for this purpose in the township of Methuen alone.

Reaching the Markets

The chief objection to such a plan is the present distance from markets, the average distance to a through railway being 20 miles. This could be met by a co-operative motor-truck service, and when the produce once reached the railway it could be brought to such a market as Toronto, for example, in two or three hours, so the distance from the field to the market would not be over six or seven hours. It may be argued that it is hopeless to offer inducements to utilize such soils, while better soils in other parts of the country remain yet to be occupied. It would be difficult, however, to find better soils from the standpoint of fertility. Only from the standpoint of mass and contiguous distribution are others superior. It is evident that the day of intensive and specialized farming has arrived, and the soils in question offer an opportunity for one line of development in that direction. It is to the advantage of the province to keep its farming population at home. Most of the depopulation of the rural districts has taken place in the regions of the poorer upland farms like this one. The opening up and successful utilization of the moist lowlands would undoubtedly induce most of the young men to stay at home, and would contribute to the up-building of their own communities.

Forest Policy Should be Devised

The bulk of the land, however, was designed by nature for wood crops; it is absolute forest soil, and the principal effort should be to devise a proper forest policy for the area.

It seems obvious to one who has studied the problem of the cut-over and burned-over lands in the Trent watershed that they should at least be placed under some kind of control which would ensure adequate protection from repeated forest fires. From the calculations on the preceding pages of this report, it is equally obvious that such protection would prove a highly profitable investment for some long-lived institution. This protection, as has been shown, would involve a relatively small outlay of funds, compared with the potential value of the young growth, since mere protection is about all that is needed on at least one-half of the area covered by this report. It has been conclusively proven by the figures on the preceding pages that

nature, in time, if not interfered with, would re-establish the pine on the cut-over pineries in commercial quantities. If man would do his part and remove the interference (forest fires), all would be well, and the former pine lands would continue to produce pine indefinitely.

Plans for Control of Area

Three plans* have been suggested for future action on the cut-over and burned-over lands in the Trent watershed, namely, (1) municipal ownership and management; (2) provincial management, and (3) co-operative management between the Dominion and the Provincial governments, the latter because of the interest which the Dominion has in the protection of the watersheds of the Trent canal. Of these three plans the first seems the most logical and desirable to the writer, if it could be inaugurated.†

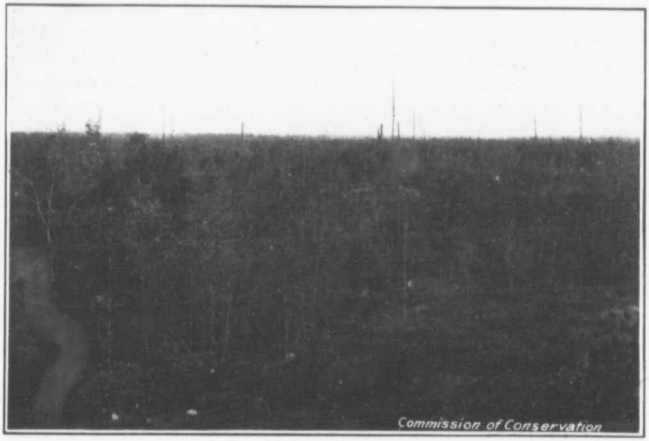
One of the chief arguments in favour of county ownership is the stimulation of local interest that would be created. Fire protection would be more effective under local management, for the inhabitants of the community would realize that they, and not some absentee landlord, would reap its benefits. On the other hand, one of the chief arguments against county ownership is that the financial backing of the enterprise would not be so strong as in the case of provincial or federal management, although the initial outlay of money need not be large, as has been shown on pp. 203-204. Moreover, most of the initial outlay, and, to some degree at least, the annual cost of protection, could be offset by the sales of merchantable material already on the area, such as is contained in the patches of hardwoods, scattered groups of pine, the elm in the swamps, and there are many places along the margins of swamps and in the gullies where 100 cords of poplar could be cut on a relatively small area. These operations would involve the establishment of a local sawmill, with its employment of local labour. Again, a local interest in the protection of the area from fire would be stimulated. At the end of 15 years the cutting of poplar on a fairly large scale could be begun and at the end of 30 years, according to the calculations on p. 200 some 328,000 cords of poplar could be harvested. By this time also, considerable young pine would have attained commercial size.

**Trent Watershed Survey.* Commission of Conservation, Canada, Ottawa, 1913. Pp. 15-20.

†It should be mentioned in this connection that Hastings county has already initiated a policy, through the Counties Reforestation Act, of acquiring cut-over and burned-over lands and holding them for their future timber yields. The councillors of Peterborough county, in which the area under discussion is situated, have a similar project under consideration.

Note scat

Reproduction of White Pine and Poplar on Area Burned Once



General View of an Area Burned Twice
Note scattering young growth of pine remaining. Contrast with reproduction on area burned once.

Re-Planting of Pine Necessary

On th
times,
a rest
forest management thi
be a waste of money
strated to be effective.
duced to the minimum
lived institution, but, if
planting could be de
assured, and other co

While then, theore
itself on account of the
it is open to question w
themselves with the re
for the poorer ones, w
ful, also, whether they
which is needful, to m
new business and req
attention, which only a

There are other pra
of these lands to the
participation of the co
which would come fron

The next logical pro
under management for
financial one.

It is realized that th
for public expenditure
interest, or because of o
take a management whi

Luckily, the interest
and, having in her For
take charge at once an
experienced in inaugura
ment for the entire wat

Since the province is
of the Burleigh-Methue
timber limits, and is rec
acre yearly, for the other
the province might with
the latter are cancelled,

This could be effected
ment and the counties

Re-Planting of Pine Necessary

On the greater portion of the 9,000 acres burned many times, there are not enough pine seed trees to insure a restocking of the area by natural processes. Under forest management this would eventually require planting, but it would be a waste of money to do so until fire protection had been demonstrated to be effective. There is no doubt that, where fire risk is reduced to the minimum, forest planting would be profitable for a long-lived institution, but, if this area were placed in the hands of the county, planting could be delayed until the harvesting of the crop was assured, and other conditions justified it.

While then, theoretically, county management would recommend itself on account of the local interest which it would create, practically, it is open to question whether the counties are financially able to burden themselves with the responsibility of caring for such lands, especially for the poorer ones, which do not promise early returns. It is doubtful, also, whether they could be expected to employ the technical advice which is needful, to make a success of forest management. This is a new business and requires careful planning and circumspect detail attention, which only a specially fitted manager can give.

There are other practical difficulties and objections to the transfer of these lands to the counties, which, however, do not preclude the participation of the counties in the benefits, indirect as well as direct, which would come from a provincial or federal management.

The next logical proposition is for the province to place these lands under management for continuity. The only objection to this is the financial one.

It is realized that the province, because of more insistent demands for public expenditure in other directions, absence of sufficient public interest, or because of other reasons, may not be in a position to undertake a management which cannot furnish returns for a series of years.

Luckily, the interest of the Dominion in this watershed is paramount and, having in her Forestry Branch a technical bureau which could take charge at once and efficiently, no practical difficulty would be experienced in inaugurating a broad, comprehensive policy of management for the entire watershed.

Since the province is already receiving no rent for nearly one-half of the Burleigh-Methuen area under consideration, it being abandoned timber limits, and is receiving only ground rent—less than one cent an acre yearly, for the other half, the commercial timber being all cut off—the province might without serious financial loss, when the licenses on the latter are cancelled, turn the area over to the Dominion *gratis*.

This could be effected under a condition that the Provincial government and the counties receive a stated proportion of the net or

gross receipts which may be derived from the management of these areas. Such an arrangement exists in the administration of the United States National Forests, where 25 per cent of the gross returns is turned over to the states in which the forests are situated, to aid in the maintenance of roads and schools.

Forest Experimental Station

An additional advantage that might be expected to follow the transfer of this area to the Dominion Forestry Branch, under any terms mutually acceptable, would be the local establishment of a forest experiment station, with one or more technically trained men, who would devote their whole time to investigating silvicultural problems. Such investigations would have for their object the securing of a thorough knowledge of the silvical characteristics and requirements of the various species of forest trees—a solid scientific basis for the silvicultural handling of existing forests, and for the establishment of new forests, to secure the most economic use of the timber and other products of the forest, and a more exact knowledge of its indirect benefits.

Scientific information can be secured only in a systematic manner and by intensive methods of study. So far as forestry work is concerned, such information can best be secured through the establishment of forest experiment stations. This idea has already been developed extensively in other countries, including France, Germany, India and the United States. The silvicultural investigations carried on by the United States Forest Service are classed under the following headings:

Forestation—

- General Studies
- Seed, production, fertility, methods of extraction, etc.
- Nursery practice
- Species, methods, and seasons for artificial forestation
- Sites—limits upon the growth of each species fixed by site conditions
- Introduction of exotics
- Species

Forest Influences Upon Climate, Stream Flow, Erosion, etc.

Management—

- General systems and their technical basis
- Methods of cutting
- Brush disposal
- Natural reproduction
- Thinnings
- Valuation—immature growth, merchantable timber, soil for forest production

Mensuration
Protection from—
- Fire
- Grazing
- Disease
- Insects
- Animals
- Snow

Regional Studies of Types and Forest Conditions
Silvical Studies—
- Distribution of forest trees and types
- Forest types—description, basis of tree associations, etc.
- Special studies.

Tree Studies—
- Growth, yield, silvical characteristics, methods of management, etc.

Utilization Studies

While the Dominion Forestry Branch could not be expected to undertake all the above lines of investigation immediately, the list will indicate the wide range of possibilities. Aside from the conduct of actual planting operations on a limited scale, by the provinces of Ontario and Quebec, and by various private interests in these and other provinces, but little systematic attempt has been made in eastern Canada to solve the class of forest problems indicated above. If forestry is to be placed on a permanent basis in Canada, a great deal of scientific investigation must be carried on, as in other countries, and the Dominion Forestry Branch is the most logical organization in Canada to undertake and prosecute such work. Forest experiment stations are needed at a number of points throughout the Dominion, where the results secured will apply to different conditions and have a wide general application. It is believed that the portion of the Trent watershed, discussed in this report, would be eminently suitable for the establishment of a forest experiment station, since the region is typical of very large areas of lands in eastern Canada, chiefly or only valuable for the permanent production of timber. Thus, the transfer of this area to the Dominion Forestry Branch, on any terms that might be agreed upon, would not only help to protect the large investment of the Dominion Government in the Trent canal, by furnishing adequate fire protection, but would also tend to greatly advance the general cause of forestry in eastern Canada, by facilitating the conduct of scientific investigations, and the establishment of a demonstration area for the elaboration of the various methods of handling forest properties.