CANADA

Department of Forestry

FOREST RESEARCH BRANCH

AGE RANGES OF POST-FIRE BLACK SPRUCE AND BALSAM FIR IN TWO POORLY STOCKED GASPÉ BURNS

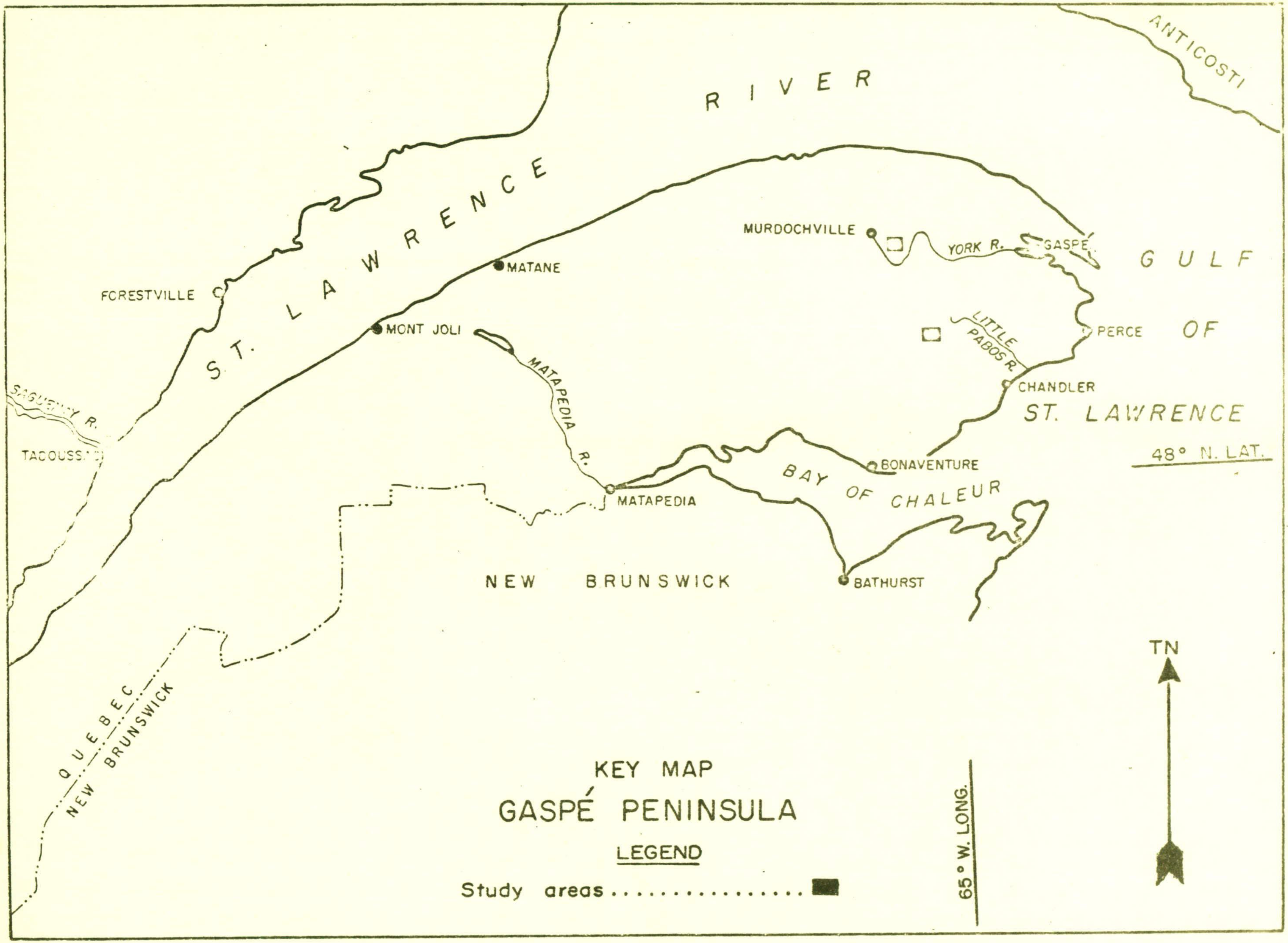
by

J.D. MacArthur and J.D. Gagnon

Mimeo 61-10

Ottawa
March, 1961

TABLE OF CONTENTS


RIVER
ANTICOSTI
ST. LAWRENCE
MURDOCHVILLE
YORK R.
GASPÉ
GULF
OF
ST. LAWRENCE
MATANE
FORESTVILLE
MONT JOLI
MATAPEDIA R.
LITTLE PABOS R.
PERCE
CHANDLER
48° N. LAT.
BONAVENTURE
BAY OF CHALEUR
MATAPEDIA
NEW BRUNSWICK
BATHURST
QUEBEC
NEW BRUNSWICK
TN
65° W. LONG.
KEY MAP
GASPÉ PENINSULA
LEGEND
Study areas ....

AGE RANGES OF POST-FIRE BLACK SPRUCE AND BALSAM FIR IN TWO POORLY STOCKED GASPÉ BURNS

by

J.D. MacArthur and J.D. Gagnon[1]

INTRODUCTION

Forest fire is frequently followed by a long period of time during which regeneration is extremely slow in becoming established. This may happen after fire in slash, in immature stands, or in seed-bearing stands. According to Candy (1951), poor regeneration is common after fire in the first and second conditions and may or may not follow fire in seed-bearing stands. Re-stocking is so slow in some large burns that they are described as non-reproducing, a term which is correct for all practical purposes. The condition is usually found in the wake of large fires where its extent and long duration combine to cause concern over the loss of forest production. This is particularly true when the burn is in an area where accessibility, topography, and productivity all favour economic exploitation.

Studies have been initiated recently in two such large non-reproducing burns in the Gaspé Peninsula. The objective has been to learn something of the natural processes which are taking place in order to develop further research on the role of reforestation as a corrective measure. So far work has been restricted to two burns which are unlike in several important ways but which are both sparsely stocked despite the passage of 20 years since fire.

Results presented here are from a preliminary study of the distribution by age of seedlings and saplings sparsely present in the burned-over areas. Samples collected at various distances from unburned seed-bearing stands are compared. The pattern of seedling establishment does not change appreciably with distance from seed source. Even more surprising is the similarity of the establishment patterns of the two study areas.

The results are discussed with reference to the literature and a tentative explanation of the pattern of seedling establishment is presented. Conclusions based on the available evidence are drawn and their possible importance is suggested.

DESCRIPTION

General

The Gaspé Peninsula is a roughly rectangular land mass about 80 miles wide and 150 miles long. The western end is delimited by the

---

1/ Research Officer, Forest Research Branch, Department of Forestry, Quebec District Office, Sillery, P. Q.

Matapédia River, the Peninsula extending eastward into the Gulf of St. Lawrence. The waters of the St. Lawrence River, the Gulf of St. Lawrence, and the Bay of Chaleur form the northern, eastern, and southern boundaries respectively.

A chain of high mountains (an eastern extension of the Appalachian system) runs roughly parallel to the long axis of the Peninsula about 20 miles south of the St. Lawrence River. North of the mountains the land descends rapidly, and often precipitously, to the coast. The southern descent to the Bay of Chaleur is more gradual and consequently the topography is less rugged.

Details of the regional geology have been given by Dresser and Denis (1946). Their maps show limestone and calcareous schists to occur prominently in the area so far surveyed. Soft sedimentary rocks are readily eroded by streams into deep valleys. Soils of glacial origin, and possibly some residual soils, are present. Soils are usually calcareous with high percentages of silt and clay. The mineral soil is normally deep and well-drained. Boulders or rock outcrops are rare. Poorly defined podzol profiles are formed (Halliday 1937).

Climatic data for the interior of the Gaspé Peninsula were published by Villeneuve (1946) and more recent data2/ are also available. Mean temperature for the four warmest months is 56 to 58 degrees F; mean annual precipitation is 38 to 41 inches; mean monthly summer precipitation at Murdochville (elevation 1,900 feet) is about 3.5 inches. The frost-free period is 80 to 120 days and the growing season 140 to 160 days (Anon. 1957).

Comparison of data from Murdochville with those from two sea level stations shows that annual precipitation is much higher in the interior because of the heavy snowfall. Summer precipitation is similar in volume in all three places, but its distribution is different in the interior where the available data indicate relatively low averages for May and October. These lows coincide with the beginning and end of the growing season and also with the periods of maximum fire danger.

That the climate varies widely is perhaps best shown by changes seen in the vegetation as the Peninsula is crossed from south to north. The land rises from sea level to an altitude of 1,800 feet within a distance of 20 miles, and the forest changes from the Great Lakes - St. Lawrence (L.6) at the coast to Boreal (B.2). The Boreal Forest extends up to timberline in the interior which occurs at 3,000 to 3,500 feet on south-facing slopes. North of the mountain chain there is another much narrower zone of Boreal Forest and finally a narrow and occasionally interrupted band of Great Lakes - St. Lawrence Forest along the north coast of the Peninsula.

The forests of the interior of the Gaspé Peninsula have been described by Halliday (1937) and by Rowe (1959).

2/ Meteorological Branch, Department of Transport, Canada, Cir. 3208, and

Bureau of Statistics, Department of Trade and Commerce, Province of Quebec, Meteorological Bulletins.

Balsam fir,[3] black spruce, white spruce, white pine, eastern white cedar, trembling aspen, balsam poplar, and white birch are found. Balsam fir forms extensive pure stands and also occurs in mixture with white and black spruce, aspen, poplar, and birch. Pure black spruce stands are generally found on high exposed ridges, upper slopes, and in poorly drained areas but may also occur on better sites. White spruce is usually restricted to better soils in stream valleys but may occur in mixtures over a wide range of sites. Eastern white cedar forms pure stands which may be at low or high elevations. Dansereau (1950) states that cedar grows to a greater size in Gaspé than anywhere else in its natural range. He also remarks that it behaves somewhat abnormally by growing in association with spruce and fir in quite mesic communities.

Study Areas

Sampling of reproduction was restricted to two distinct parts of the Peninsula: 1) the Upper York River area, burned over in 1938 and again in 1941, and 2) the Little Pabos River area, burned over in 1940. (See front map). The two burns differ in size, altitude, soil qualities, composition and quality of pre-fire forest, present density of competing vegetation, and probably also in fire intensity. Details of soil and vegetation differences have been published by MacArthur and Gagnon (1959).

In the York River area 200 square miles of forest were destroyed by fire in 1938 and 1941. Extensive tracts of black spruce on the upper slopes in the high country near Murdochville were destroyed. The 1958-59 sampling was done in an area originally stocked with black spruce and burned over in 1938 and again in 1941.

The pre-fire forest was described by Boutin and Goodfellow (1930) as sparse, clumped, slow-growing black spruce with ground vegetation of reindeer lichen and ericaceous plants. A similar description of the forest above 2,000 feet in this region by Dansereau (1950) likens it to the sub-arctic taiga. Both of the foregoing deal with an extreme condition. While the altitude of the study area was approximately 2,000 feet and in some places the forest verged on the taiga condition, there were large areas which had formerly been normally stocked with slow-growing black spruce. Throughout the area many trees killed by fire in 1938 were still standing in 1959.

At present the vegetation is a uniform but sparse cover of ericaceous dwarf shrubs with patches of hair-cap moss and reindeer lichen. The deep, well-drained soil contains 40-50 per cent silt and clay. A large part of the soil volume is made up of finely fragmented shale. The present condition of the area is shown by Figure 1.

In the Pabos River area 16 square miles were burned over in 1940. Mature and immature stands were destroyed and the fire ran through a recently cut area also.

The forest in this region of Gaspé consists mainly of balsam fir with admixtures of white and black spruce. White birch was also common prior

---

3/ Botanical names of plants mentioned in the text are given in the Appendix.

Figure 1. This condition is common in the 1941 York River burn. Vegetation consists mainly of dwarf shrubs. Coniferous seedlings are extremely sparse.

Figure 2. The 1940 Little Pabos River burn showing present vegetation and stumps of the former stand.

to its elimination by dieback. In the area of the burn yields of 25 cords per acre have been reported (Boynton 1953). Excellent stands consisting mainly of balsam fir can be seen adjacent to the burn.

The study area is about 20 miles inland from the Bay of Chaleur at an elevation of 1,000 feet. The general topography, soil, and vegetation conditions are different from those in the York River area. Relief is more gentle, slopes being less acute and stream valleys not so deep. The soil has a higher silt and clay content (as high as 70 per cent) and the fragmented shale which formed a large part of the soil volume in the York area is absent or nearly so in the Pabos. Vegetation is much denser and is dominated by herbaceous plants rather than dwarf shrubs. The latter occur sparsely and do not contribute greatly to the total lesser vegetation. Figure 2 shows the present condition of the area.

PROCEDURE

Preliminary sampling was done in the York and Pabos burns in the fall of 1958. More extensive sampling took place in the spring of 1959 to obtain additional information on age distribution of seedlings at various distances from seed source. In 1959 samples were collected at 10, 20 and 80+ chains from seed source in the York River burn and at 10, 20, 40, and 40+ chains in the Pabos River burn.

Each sample point was arbitrarily chosen in conditions of soil and topography similar to those existing in the nearest seed source area. Once a point was chosen an area of one square chain was laid out and each seedling present was uprooted and a section containing the root collar cut from the stem. When necessary the area was systematically enlarged by adding further square chain blocks until 50 or more seedlings had been collected. Special care was exercised to ensure that all seedlings present were collected in order to obtain a true picture of the population. The minimum limit of 50 seedlings per sample was suggested by study of the preliminary samples. It was found that 50 seedlings gave age distributions similar to those derived from larger numbers.

York River collections consisted almost entirely of black spruce while those from the Pabos River were mainly balsam fir. The latter collections contained some black spruce but the species were not kept separate.

Field sampling procedure and subsequent treatment of the material were the same for the 1958 and 1959 collections, but were carried out by different field and laboratory workers. Thus the 1958 and 1959 samplings were independent and were not cross-checked until they had been compiled.

In the laboratory each stem section was cut through at the root collar and the age was determined by counting annual rings under a binocular microscope. Each sample was compiled as a frequency distribution with one-year age classes. The average age, standard deviation, and standard error of the mean were then calculated. All the samples were then arranged graphically, according to a method employed by Critchfield (1957), in order to check on variation between and within the York and Pabos groups. Admittedly the comparisons are rough but they are adequate at this stage. On the basis of the foregoing graphical check it was decided that variation within the two groups was such as to permit each to be summarized in one frequency distribution.

In the two major frequency distributions, produced by combining samples, numbers of seedlings in each age class were stated as percentages of the total number in all classes. The distributions were then plotted 1) on a date of establishment scale, and 2) on a growing seasons since fire scale. The resulting graphs outline the processes of establishment of the existing seedling stands in the two burns.

RESULTS

The results of the preliminary analyses of the samples are given in Tables 1 and 2. Table 1 gives the age distribution of each sample and indicates the distance from seed source in each case. Summary distributions for the York and Pabos groups are included in the table (nos. 6 and 11). Table 2 lists the characteristics of each sample distribution and also the summary distributions.

TABLE 1a. AGE DISTRIBUTIONS OF SAMPLES

York River Area (Burned in 1938 and again in 1941)

Sample Number	1		2		3		4		5		All samples	
Chains to Seed Source	10		20		80+		80+		80+		10-80+	
Age	No. of seedlings	Percent of total	No. of seedlings	Percent of total	No. of seedlings	Percent of total	No. of seedlings	Percent of total	No. of seedlings	Percent of total	No. of seedlings	Percent of total
17	-	-	1	1.1	-	-	-	-	3	2.0	4	0.7
16	4	4.0	4	4.3	3	1.5	1	2.1	4	2.7	16	2.7
15	1	1.0	6	6.4	15	7.4	2	4.2	14	9.4	38	6.4
14	11	11.1	14	15.0	37	18.3	8	16.7	20	13.4	90	15.2
13	10	10.0	12	12.9	50	24.8	7	14.6	33	22.2	112	18.9
12	20	20.2	22	23.7	57	28.2	8	16.7	23	15.4	130	22.0
11	26	26.3	21	22.6	26	12.9	8	16.7	21	14.1	102	17.3
10	17	17.2	5	5.4	10	5.0	10	20.7	10	6.7	52	8.8
9	9	9.1	7	7.5	4	1.9	3	6.2	14	9.4	37	6.3
8	1	1.1	1	1.1	-	-	-	-	5	3.4	7	1.2
7	-	-	-	-	-	-	1	2.1	2	1.3	3	0.5
6	-	-	-	-	-	-	-	-	-	-	-	-
	99	100.0	93	100.0	202	100.0	48	100.0	149	100.0	591	100.0

TABLE 1b. AGE DISTRIBUTIONS OF SAMPLES

Pabos River Area (Burned in 1940)										
Sample Number	7		8		9		10		All samples	
Chains to Seed Source	10		20		30-40		40+		10-40+	
Age	No. of seedlings	Percent of total	No. of seedlings	Percent of total	No. of seedlings	Percent of total	No. of seedlings	Percent of total	No. of seedlings	Percent of total
17	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	1	1.0	1	0.4
15	-	-	-	-	-	-	2	2.0	2	0.8
14	1	2.0	-	-	2	4.0	7	7.0	10	4.0
13	4	7.8	1	2.0	5	10.0	8	8.0	18	7.2
12	5	9.8	16	32.0	7	14.0	14	14.0	42	16.7
11	8	15.7	17	34.0	8	16.0	30	30.0	63	25.1
10	19	37.3	8	16.0	13	26.0	14	14.0	54	21.5
9	9	17.6	7	14.0	14	28.0	14	14.0	44	17.5
8	5	9.8	1	2.0	1	2.0	7	7.0	14	5.6
7	-	-	-	-	-	-	2	2.0	2	0.8
6	-	-	-	-	-	-	1	1.0	1	0.4
	51	100.0	50	100.0	50	100.0	100	100.0	251	100.0

TABLE 2. SUMMARY OF SAMPLE ANALYSES

	Sample Number	Distance to Seed Source	Number of Seedlings	Max.-Min. Age	Age Range	Average Age	Standard Deviation	Standard Error
York (burned 1938 & 1941)	1	10 chains	99	16-8	8	11.6	1.7	.17
	2	20 chains	93	17-8	9	12.3	1.9	.20
	3	80+ chains	202	16-9	7	12.6	1.4	.10
	4[1]	80+ chains	48	16-7	9	11.8	1.9	.27
	5	80+ chains	149	17-7	10	12.2	2.1	.17
	All samples	10-80+ chains	591	17-7	10	12.2	1.8	.07
Pabos (burned 1940)	7	10 chains	51	14-8	6	10.3	1.4	.20
	8	20 chains	50	13-8	5	10.9	1.1	.15
	9	30-40 chains	50	14-8	6	10.6	1.5	.21
	10	40+ chains	100	16-6	10	10.9	1.9	.19
	All samples	10-40+ chains	251	16-6	10	10.7	1.6	.10

1/ Sample 4 is two seedlings short of the desired minimum of 50 owing to an error in the field.

The data in Table 2 are shown graphically in Figure 3, which provides a rough check of the significance of differences between samples, although inequalities in sample size limit the validity of the comparisons. Wide bars represent four ($\pm$ 2) standard errors of the mean. A horizontal overlap of any two wide bars suggests that the two populations are not significantly different. Conversely, a lack of overlap suggests a real difference in age. There is a general similarity between samples regardless of which area they come from or their distance from seed source. Each distribution exhibits a gradual increase to a maximum which is followed by a decline.

From Table 2 and Figure 3, it appears that there is a distinct difference in average age between the York and Pabos areas. There is a tendency to greater ranges in age in the York samples but maximum range (10 years) is the same in both areas. Finally, the data suggest that width of age range may be related to distance from seed source but distance from source does not appear to have a consistent effect on average age.

Of the York samples numbers 1 and 3 vary widely enough to suggest a real difference between them. The first three York samples suggest that an increase in average age coincides with an increase in distance from seed source but the other samples tend to contradict this. The same trend is weakly suggested by the Pabos samples. In view of the weak correlation with distance from seed source, the summary distributions for the York and Pabos areas are of considerable interest. These are shown in Figure 4 as graphs of the per cent of the total number of seedlings established by years. An age scale has been added to the horizontal axis to show age ranges.

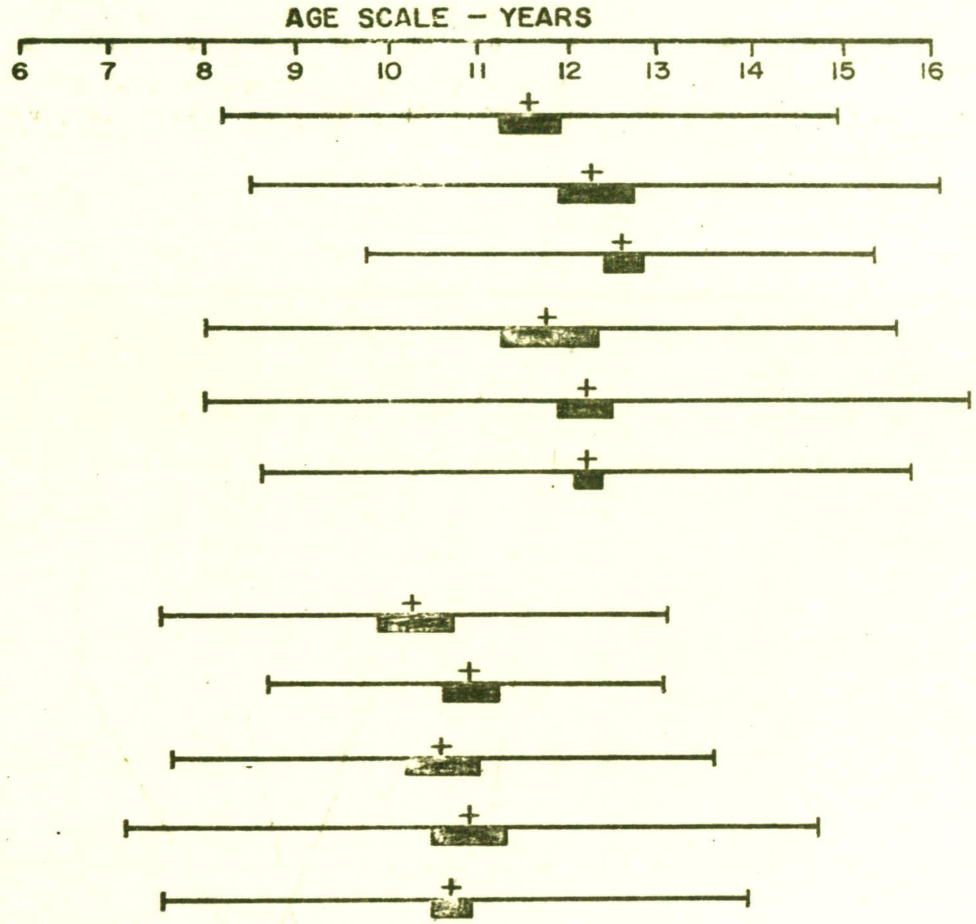
The frequency curves in Figure 4 have the same general form, both rising to a point of maximum establishment and descending at the same rate. In both cases rise and fall are symmetrical about the mean, the period of establishment is ten years, and maximum establishment comes five years after the appearance of the first seedlings to survive to 1959. Moreover, seedling establishment apparently ceased completely in both areas ten years after it began. When the same data are plotted by growing seasons after fire as in Figure 5, the curves coincide quite closely.

DISCUSSION

Despite the previously mentioned basic differences between the York and Pabos areas, the age structures of the seedling stands originating after fire are strikingly similar. The process of re-stocking began in the third or fourth growing season after fire, reached a peak five years later, and apparently ended or was at least temporarily interrupted after another five years. Distance from seed source seems to have had little if any effect on age structure although it had a pronounced effect on stand density.

The process of seedling establishment is largely controlled by a series of major factors such as seed supply, seedbed conditions, climate, soil, and competing vegetation. Other factors, normally of secondary importance such as insects, diseases, rodents, and browsing animals, might sometimes play a major role.

SAMPLE NUMBER	CHAINS TO SEED SOURCE	SEEDLINGS IN SAMPLE
1	10	99
2	20	93
3	80+	202
4	80+	48
5	80+	149
Σ 1-5		591
7	10	51
8	20	50
9	30-40	50
10	40+	100
Σ 7-10		251



LEGEND

+ AVERAGE AGE

± 2 STANDARD DEVIATIONS

± 2 STANDARD ERRORS

FIGURE 3. COMPARISON OF SAMPLES

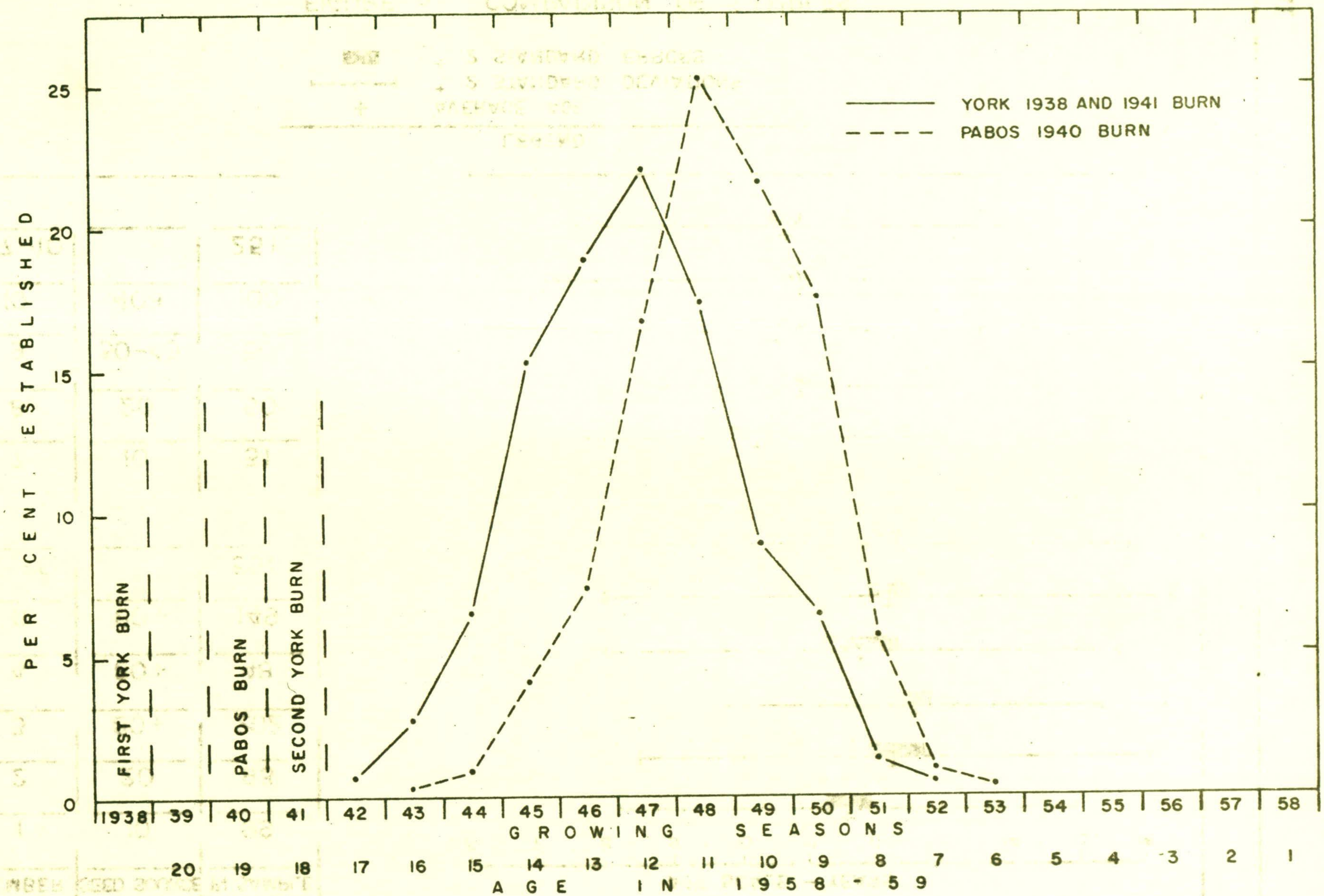


FIGURE 4. CHRONOLOGY OF ESTABLISHMENT AND AGE RANGES

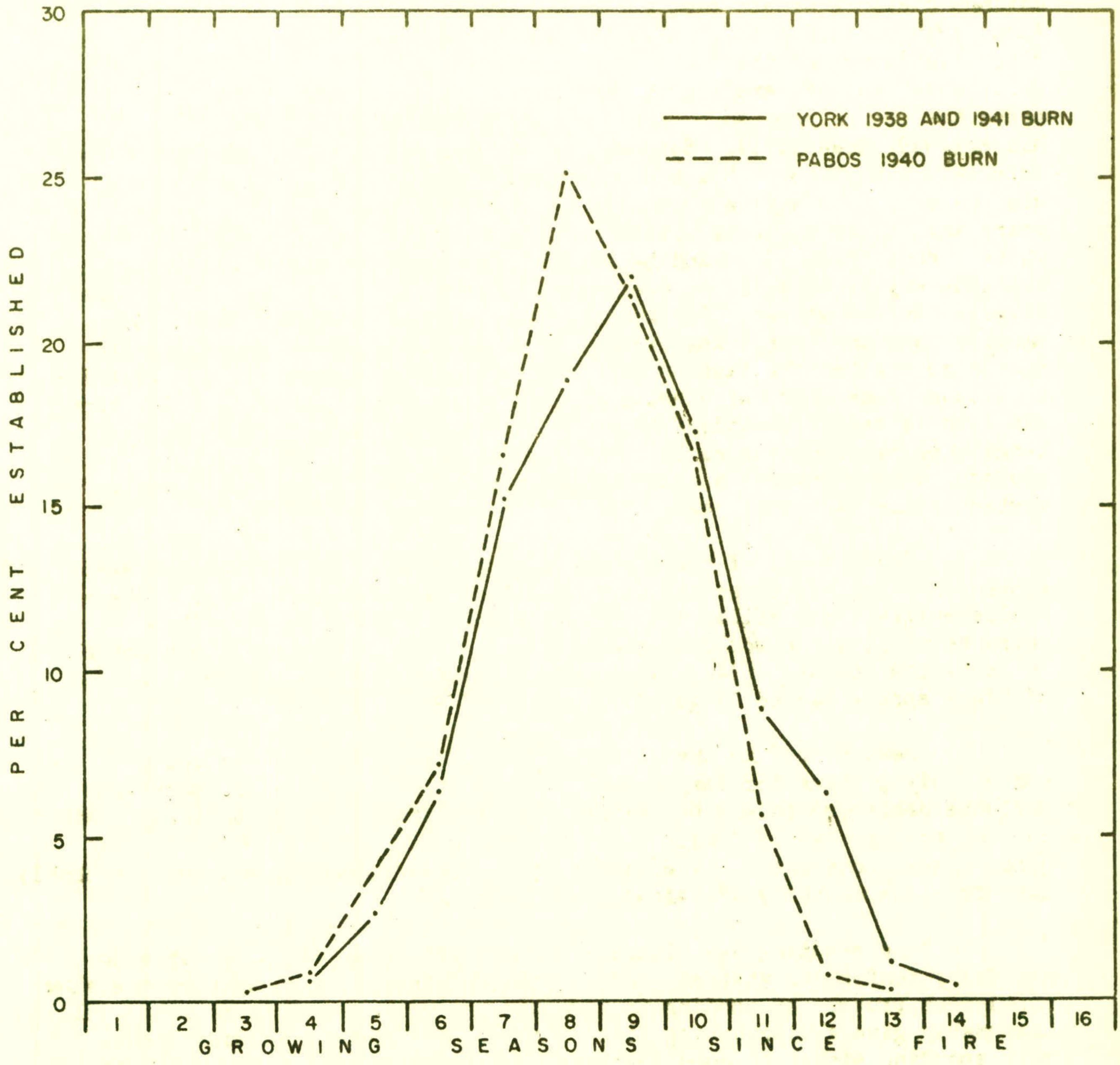


FIGURE 5. RATE OF ESTABLISHMENT BY GROWING SEASONS AFTER FIRE

Effective dispersal of seed from the source is limited to a maximum distance of 300 feet for black spruce and balsam fir (Siggins 1933, Anon. 1939). Thus seed from surrounding unburned stands can have only a slight influence on the re-stocking of large burns. The possibility of continuous, but extremely slow, seeding-in at great distances from seed trees has been suggested by some writers (Siggins 1933, Korstian 1937, Millar 1939, Rowe 1955). Seed may be carried for many miles by strong winds, especially in winter. Black spruce seed would be the most likely to be dispersed in this way because seed is stored in persistent cones for 2-3 years and released bit by bit throughout the year (LeBarron 1944). Both white spruce (Rowe 1955) and balsam fir (Roe 1946) could be dispersed in the same way because it has been found that small quantities of seed are released during winter. The amounts of seed would, of course, be much smaller than those of black spruce. Neither white spruce nor balsam fir stores seed after the fashion of black spruce, but balsam fir rarely fails to produce some seed, with heavy crops coming every two years. Even though fir seed is released early from the cones, the dispersal period may be lengthened by seed lodging in the trees instead of falling directly to the ground. Consequently small amounts of fir seed are probably available for distant dispersal every year.

The ability of black spruce to re-seed a burn by means of seed stored on trees killed by the fire has been discussed by several writers (Bellefeuille 1935, Millar 1939, Dickson and Nickerson 1958). This characteristic alone would presumably lead to an increase of black spruce in post-fire stands. Place (1955) has suggested that post-fire increases of black spruce may be largely a function of seed supply.

Seed stored in the surface layer of the forest floor could conceivably provide for some re-stocking after fire. However, such seed would be destroyed in any but extremely light fires. It is unlikely that duff-stored seed would remain viable for long except in unusual storage conditions. Consequently seedlings originating from such seed would probably date from one or two years after fire.

The seedling age distributions in the York and Pabos burns do not fully conform to what one would expect if regeneration were by the slow continuous process of seeding-in from distant sources. This process would presumably give a fluctuating line of horizontal trend with minor peaks corresponding either to good seed years or favourable weather, and with major peaks where both weather and seed supply were favourable. Rowe (1955) has observed this effect in white spruce reproduction in Western Canada.

Seeding from fire-killed black spruce would result in a narrow age range and would presumably all take place soon after fire. Duration of seed storage on fire-killed trees and the rate of seed dispersal from such trees are unknown factors. Millar (1939) got viable seed from cones on trees dead for a year. In 1959 the writers extracted seed from cones on trees killed in 1938 but the seeds failed to germinate in laboratory tests. Conceivably the seedlings in the York River burn could have developed from seed from fire-killed trees but this could not have happened in the Pabos burn where there is very little black spruce and few dead trees of any species standing in the burn.

The effect of seedbed conditions on the establishment of regeneration has been widely investigated. Several workers (Westveld 1931, LeBarron 1939 and 1945, Martin 1956) have observed that mineral soil is a favourable medium. However, Linteau (1957) observed greater numbers of black spruce seedlings on moss-covered than on bare mineral soil. This finding suggests that in some instances good germination may be followed by high mortality resulting from heat or cold injury owing to extreme surface temperature.

Removal or reduction of the humus layer by burning is a conversion of organic matter and it is accompanied by chemical as well as physical changes in the quality of the seedbed. The effects of physical and chemical changes would be difficult to separate and would probably vary in intensity and duration with the type of mineral soil. Mechanical removal of the humus would have the same physical effect as burning, i.e. baring of mineral soil, but the chemical effects would almost certainly be different on a given soil type.

LeBarron (1957) considers fire as a natural factor in the perpetuation of valuable fire species. While he considers controlled fire as a valuable silvicultural tool he states that there is a lack of basic knowledge of the effects of fire. That fire may have its limitations is suggested by adverse changes in site observed in its wake (Fabricius 1929, Austin and Baisinger 1955, Tarrant 1956, Ahlgren 1959).

It has been suggested that seedbed conditions in burns are most suitable soon after fire (Tamm 1950, Place 1955, Martin 1956) and tend to deteriorate in time. This would probably be due to the presence in greater quantity of the mineral nutrients released by burning of the humus. Moreover, even after severe fires, small patches of incompletely burned humus are found where establishment may be favoured for a short time before the humus disintergrates through exposure. Judging by fire scars in the York and Pabos areas, intensity was high and most of the organic matter was probably destroyed. In both areas, however, the peak of establishment of seedlings came in the eighth or ninth growing season after fire.

The establishment of seedlings after fire would almost certainly be affected by the degree of competition from other vegetation. It seems quite possible that increases in vegetation would favour the establishment of conifers initially. Beyond a certain degree, however, competition would tend to prevent further establishment. This could help to explain the establishment rates in the York and Pabos areas.

When seed is available and a receptive seedbed present, weather is the principal factor governing seedling establishment (Long 1946, Rowe 1955). Favourable or unfavourable conditions would be expressed in wide fluctuations in the establishment curve. No such fluctuations are evident in the York and Pabos rates of establishment. While climatic factors must be operating, their effects are presumably being masked by other stronger influences.

The establishment curves suggest that the most important controlling factor is one with a well-defined 10-year cycle. Rodent populations are believed to be subject to cyclic variation but not in 10-year periods. Furthermore, rodent damage would probably be heavier near unburned stands. There was no evidence of this being true in either burn.

Only one report of a post-fire age distribution where the delay in establishment was similar to that in Gaspé has been encountered in the literature. Kagis (1954) found that re-stocking of white spruce after fire in Saskatchewan had taken place in waves. A minor peak of establishment was reached roughly 10 years after fire while a second and much more pronounced peak appeared some 60 years later.

A plausible explanation of the mode of development of reproduction in the York and Pabos burns is not readily arrived at. Each trial hypothesis must in turn be rejected when confronted with the facts and in the light of other studies. The resemblance between the two rates of establishment developed under basically different conditions suggests that the controlling factors were similar. The two processes take the same course with relation to time of origin (time of fire). While fluctuations in climate and seed supply must have occurred, they do not appear to have had a decisive influence.

The following tentative explanation of the results is suggested. All, or nearly all, of the seedlings present arose from seed which came from a distance and fell in approximately equal amounts at a given point each year. Survival during the first years after fire was a function of seedbed conditions which gradually improved owing to favourable chemical and physical changes and possibly also to changes in the competing vegetation. At the maximum point of establishment the seedbed conditions became stabilized and competing vegetation began to impede seedling establishment more and more.

At the time of sampling the herbaceous vegetation in the Pabos area was extremely dense and varied over the area and was no doubt an obstacle to seedling establishment. In the York area vegetation was less dense but it probably occupied the most favourable spots.

The final cessation of establishment seems to have been caused by weather and an insect epidemic. The summer of 1955 was extremely dry and in 1956 an epidemic of the spruce budworm developed and persisted until 1959. Heavy budworm feeding destroys current shoots and thus precludes the formation of male and female flower buds. It would not be surprising therefore if seed production were at an extremely low level from 1955 to 1959.

CONCLUSIONS

The results indicate that under certain circumstances the re-stocking process of burns may be quite different from what would normally be expected. It seems that the same unexpected pattern of establishment may develop in two separate burns which differ in several important ways. Reproduction in still other burns might develop along similar lines but the present knowledge of what happens and why it happens is insufficient to support conclusions as to how common this particular establishment pattern may be.

Further study of the frequency and conditions of occurrence of this phenomenon is required to establish its importance. In addition to the intrinsic interest there may be important practical aspects involved. The results suggest that specially favourable conditions for seedling establishment occur seven to nine years after fire. If this were known to be true and a reasonably accurate prediction of the opportune moment were possible, the chances of successful seeding of non-regenerating burns would be greatly improved.

SUMMARY

Age distributions of seedlings present in two sparsely regenerated burns dating from 1938 and 1940 in the Gaspé Peninsula were studied by laboratory age counts on a total of 842 seedlings. The distributions were found to be similar despite differences in soil, climate, year of fire, and species composition between the two burns.

Results indicate that re-stocking began in the third or fourth growing season after fire, reached a peak in five years and ceased completely after another five years. Factors which may have contributed to the observed re-stocking pattern are discussed and a tentative explanation of the results is presented. The possibility of an important practical application of the findings is suggested.

REFERENCES

Ahlgren, G.E. 1959. Some effects of fire on forest reproduction in north-eastern Minnesota. J. For. 57 (3): 194-200.

Anon. 1959. Black spruce seed is a limited air traveller. Lake States Forest Exp. Sta. Tech. Note No. 147.

Anon. 1957. Atlas of Canada. Canada, Dept. of Mines and Technical Surveys, Geological Branch, Queen's Printer, Ottawa.

Austin, R.C. and D.H. Baisinger. 1955. Some effects of burning on forest soils of western Oregon and Washington. J. For. 53 (4): 275-280.

Bellefeuille, R. 1935. La reproduction des peuplements d'épinette noire dans les forêts du Nord-Québec. For. Chron. 11 (4): 323-340.

Boutin, F., and A.W. Goodfellow. 1930. Rapport au Sous-Ministre adjoint, M. J.E. Guay, sur les conditions de la forêt du bassin de la rivière York. Minis. des Terres et Forêts de la Province de Québec.

Boynton, J.C. 1953. A report on the establishment of Observation Area No. 8, Little Pabos River. Canada, Dept. of Northern Affairs and National Resources, Forestry Branch, For. Res. Div., unpublished MS.

Candy, R.H. 1951. Reproduction on cut-over and burned-over land in Canada. Canada, Dept. of Resources and Development, Forestry Branch, For. Res. Div., Silv. Res. Note No. 92.

Critchfield, W.B. 1957. Geographic variation in <u>Pinus contorta</u>. Maria Moors Cabot Foundation. Pub. No. 3. Harvard University, Cambridge, Mass., U.S.A.

Dansereau, Pierre, 1950. Flora and vegetation of the Gaspé Peninsula. Wild Flower. April 1950.

Dickson, W.A. 1956. Experimental seeding of black spruce on Cormack Burn, Newfoundland. Canada, Dept. of Northern Affairs and National Resources, Forestry Branch, For. Res. Div., Tech. Note No. 49.

Dickson, W.A. and D.E. Nickerson. 1958. Factors affecting natural regeneration on cut-over and burned-over lands, Newfoundland. Canada, Dept. of Northern Affairs and National Resources, Forestry Branch, For. Res. Div., S and M 58-3.

Dresser, John A., and T.C. Denis. 1946. La géologie de Québec, Vol. II, géologie descriptive. Rapport géologique No. 20, Ministère des Mines de la Province de Québec. XIV + 647. Redempti Paradis, Québec, P.Q.

Fabricius, L. 1929. (The effect of ashes from forest fires upon germination and early development of plants.) U.S. Forest Service translation 184.

Halliday, W.E.D. 1937. A forest classification for Canada. Canada, Dept. of Mines and Resources, Forest Service Bull. 89.

Kagis, I. 1954. The story of a cut-over. For. Chron. 30 (2): 158-182.

Korstian, Clarence F. 1937. Perpetuation of spruce on cut-over and burned lands in the higher southern Appalachian Mountains. Ecol. Monog. 7 (1): 125-167.

LeBarron, R.K. 1939. The role of forest fire in the reproduction of black spruce. Prog. Minn. Acad. of Sci. 7: 10-14.

LeBarron, R.K. 1944. Influence of controllable environmental conditions on regeneration of jack pine and black spruce. Jour. Agr. Res. 68 (3): 97-119.

LeBarron, R.K. 1945. Mineral soil is a favourable seed-bed for spruce and fir. Lake States Forest Exp. Sta. Tech. Note. No. 237.

LeBarron, R.K. 1957. Silvicultural possibilities of fire in northeastern Washington. J. For. 55 (9): 627-630.

Linteau, André. 1951. Black spruce reproduction on disturbed soil conditions. Canada, Dept. of Northern Affairs and National Resources, Forestry Branch, For. Res. Div., Tech. Note No. 54.

Long, H.D. 1946. Investigation of factors affecting the regeneration of spruce in eastern Canada. P.P.R.I.C., Woodlands Section Index No. 875 (F-2).

MacArthur, J.D. and D. Gagnon. 1959. Some observations of forest conditions after fire in the Gaspé Peninsula. Canada, Dept. of Northern Affairs and National Resources, For. Res. Div. Mimeo. 59-14.

Martin, J. Lynton, 1956. An ecological survey of burned-over forest land in southwestern Nova Scotia. For. Chron. 15 (2): 93-96.

Place, I.C.M. 1955. The influence of seed-bed conditions on the regeneration of spruce and balsam fir. Canada, Dept. of Northern Affairs and National Resources, Forestry Branch, For. Res. Div., Bull. 117.

Roe, Eugene I. 1946. Extended periods of seedfall of white spruce and balsam fir. Lake States Forest Exp. Sta. Tech. Note No. 261.

Rowe, J.S. 1955. Factors influencing white spruce reproduction in Manitoba and Saskatchewan. Canada, Dept. of Northern Affairs and National Resources, Forestry Branch, For. Res. Div., Tech. Note No. 3.

Rowe, J.S. 1959. Forest regions of Canada. Canada, Dept. of Northern Affairs and National Resources, Forestry Branch, Bull. 123.

Siggins, H.W. 1933. Distribution and rate of fall of conifer seed. Jour. Agr. Res. 47: 119-128.

Tarrant, Robert F. 1956. Effect of slash burning on some physical soil properties. For. Sci. 2 (1): 18-22.

Villeneuve, Y. Oscar. 1946. Climatic conditions of the Province of Quebec and their relationship to the forests. Quebec, Dept. of Lands and Forests, Meteorological Bureau Bull. No. 6.

Westveld, M. 1931. Reproduction on pulpwood lands in the Northeast. U.S. Dept. Agr. Bull. 233.

Millar, J.B. 1939. Spruce regeneration in Northern Ontario. For. Chron. 15 (2): 93-96.

Tamm, Carl Olaf. 1950. Northern coniferous forest soils. (Translation by Mark L. Anderson) XI + 253. The Scrivener Press, Oxford.

APPENDIX

List of Common and Botanical Names of Plants Mentioned in the Text

Trees

Black spruce	*Picea mariana* (Mill) BSP.
White spruce	*Picea glauca* (Moench) Voss
Balsam fir	*Abies balsamea* (L.) Mill.
White pine	*Pinus strobus* L.
Eastern white cedar	*Thuja occidentalis* L.
White birch	*Betula papyrifera* Marsh.
Trembling aspen	*Populus tremuloides* Michx.
Balsam poplar	*Populus balsamifera* L.

Mosses

Reindeer lichen	*Cladonia* sp.
Hair-cap moss	*Polytrichum commune* Hedw.