CANADA
Department of Northern Affairs and National Resources
FORESTRY BRANCH

CUTTING AND SEEDBED PREPARATION TO REGENERATE YELLOW BIRCH

Haliburton County, Ontario

by

J. M. Jarvis

Forest Research Division
Technical Note No. 53
1957

Published under the authority of
The Minister of Northern Affairs and National Resources
Ottawa, 1957

ACKNOWLEDGMENTS

The author wishes to thank the Ontario Department of Lands and Forests and Hay and Company, Limited, whose co-operation made this study possible.

Special mention should be made of Mr. D. Burton, Ontario Department of Lands and Forests, through whom the initial arrangements for carrying out the experiment were made, and Mr. Wm. McGarrity of Hay and Company, Limited, for his excellent co-operation and for supplying men and equipment as they were needed.

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Project H-92

J. M. Jarvis[1]

INTRODUCTION

Present cutting practices in the sugar maple-yellow birch-beech[2] forests of Ontario and Quebec do not favour regeneration to yellow birch. Previous investigations (3, 4) have shown that there are two main reasons for this unsatisfactory situation. First, undisturbed hardwood leaf litter is an unfavourable seedbed; and second, birch seedlings are so intolerant of shade that they do not compete favourably with other species, especially sugar maple, in the shade of the residual stands.

In 1953 the Forestry Branch undertook an experiment in co-operation with Hay and Company, Limited, to follow up the foregoing findings and to test the hypotheses that: (a) through heavy cutting and preparation of suitable seedbeds at the time of logging, a greatly improved stocking of yellow birch can be obtained in tolerant hardwood stands; and (b) by providing adequate growing space, a satisfactory proportion of the seedlings will achieve a dominant position in the new stand.

This report describes and gives the preliminary results of that experiment. To date, events show that yellow birch can be regenerated in large quantity in tolerant hardwood stands; also there are good indications that suitable methods of reproducing this species can be worked out, in conjunction with logging operations, to eventually guarantee continuous supplies of this valuable tree for the hardwood lumber industry.

THE EXPERIMENTAL AREA

Location

The experimental area which occupies 40 acres is located on private land belonging to Hay and Company, Limited, in adjoining portions of Havelock and Eyre Townships, Haliburton County, Ontario. These Townships lie within the Haliburton District (1, 3) of the Georgian Bay Forest Section[3], in the Great Lakes—St. Lawrence Forest Region (2).

Climate

The growing season begins the middle of April and ends the middle of October. The mean annual temperature is 41°F. with normals of 66°F. in July and 14°F. in January[4]. The average extremes of temperature are 93°F. and −30°F. The mean annual precipitation is 24 inches with an average of 10 inches for the three summer months, June, July, and August. This results in a slight moisture deficiency on some sites during the latter part of August. The average annual snowfall is 95 inches.

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[1] Research Forester, Forestry Branch Head Office, Ottawa, Ont.

[2] A list of species showing botanical name, common name, and abbreviation of the common name is given in the Appendix.

[3] Revisions of Halliday's Forest Classification for Canada (2) are to be published shortly.

[4] Figures are average for the whole Haliburton District.

Physiography

The topography of the Haliburton District is strongly rolling with elevations ranging from 1,000 to 1,400 feet above sea-level. Till soils cover the bedrock hills of granite, granite-gneiss, and crystalline limestone, and fluvial terraces are found in narrow valleys between the hills.

The experimental area is located on the upper and middle parts of an east slope between elevations of 1,100 and 1,300 feet above sea-level. The topography of the area is irregular and as a result many minor aspects are present even though the general aspect is east. Local climates vary from hot and dry (small ridges), through warm and dry (south aspects), normal (east aspects), to cool and moist (northeast aspects).

The soil varies in depth from less than one foot to about 5 feet over the bedrock; and the upper horizons have developed into a good loam with a well-defined melanized layer. Approximately 15 per cent of the area is excessively drained, 80 per cent is well drained, and 5 per cent is imperfectly drained.

The Forest

The forest in the Haliburton District is composed mostly of tolerant hardwood, tolerant mixedwood, and softwood cover types, but on areas disturbed by fire, white birch and trembling aspen are found usually in large numbers. The tolerant hardwoods are the most aggressive and occupy the slopes; the softwoods and mixedwoods are confined to valleys and ridge tops, where local climate, soil, and drainage create conditions unfavourable for hardwood development.

Figure 1—Looking along a haul road. Note the abundant sugar maple, the leaf litter on the road, and the softwoods in the background.

In the Haliburton District the tolerant hardwood type is composed of several associations; the most common are shown in Table I.

TABLE I

COMMON TOLERANT HARDWOOD ASSOCIATIONS, HALIBURTON DISTRICT

Ridge tops	Upper slopes	Middle slopes	Lower slopes
sM-Be(eH,wP)*	sM sM-Be sM-Be(eH,wP)	sM sM-Be sM-Be-yB(Ba) sM-yB(Ba) sM-yB(eH)	sM sM-Be sM-Be-yB(Ba) sM-yB sM-yB-eH yB(bAs, wE, rM)

*Associate species shown in brackets.

Figure 2—Note the large birch trees, the abundant maple, the heavy leaf litter, and the advance growth.

The forest on the experimental area (Figures 1 and 2) was typical of the uncut tolerant hardwood stands on upper and middle slopes in the District. It contained sugar maple, sugar maple-beech, sugar maple-beech-yellow birch (basswood), and sugar maple-beech (hemlock, white pine) associations. The stands were all-aged and averaged 3,115 cubic feet, total volume, per acre. Sugar maple with an average of 2,170 cubic feet per acre was the dominant tree on all sites and topographic positions. Beech was a major associate and averaged 390 cubic feet per acre. Yellow birch, found mainly on the imperfectly drained areas, averaged 445 cubic feet per acre. Softwoods and other hardwoods averaging 50 and 60 cubic feet per acre made up the remainder.

METHODS

The experimental area consists of 4 sections of approximately 10 acres each; two of the sections were chosen at random for treatment and two were reserved for control.

All merchantable trees on the area were logged in 1953 during the latter part of September and the early part of October. In this operation a total of 900 cubic feet per acre was harvested, of which 800 cubic feet was sugar maple, 60 cubic feet yellow birch, and the remainder spruce and beech. The residual stand, with a volume of 2,215 cubic feet per acre, was made up mainly of cull trees which were suitable only for such products as pulp and firewood.

After the logging was completed, many of the trees in the residual stand on the treated sections were girdled. This was done to provide more favourable light conditions for the development of yellow birch seedlings. In selecting the trees for removal, care was taken to ensure that the final stand would be made up of trees distributed more or less uniformly throughout the sections and that these trees would provide about 30 per cent shade at ground level. The final stand on the treated sections averaged 1,400 cubic feet per acre total volume.

The next step was the preparation of seedbeds on the two treated sections. This was done by scarifying the ground with a D-6 Caterpillar tractor, equipped with a bulldozer blade (Figure 3). A heavy tractor of this kind has several advantages over a lighter machine or a horse. In addition to preparing the seedbed, it can easily root out advance growth, push over small trees, and thus eliminate competition which would otherwise suppress the yellow birch regeneration. The bulldozer made a variety of seedbeds including: (1) loose mineral soil, (2) compacted mineral soil, (3) loose fermenting but still raw humus, (4) loose, finely divided, well decomposed humus, and (5) mixed mineral soil, humus and litter.

The scarification was done in patches because of the nature of the terrain and the presence of large trees, stumps, and slash piles which could not always be pushed out of the way. The patches are well distributed throughout the treated sections and vary in size, the largest being about one-quarter acre. A survey of the regeneration in 1954 showed that 72 per cent of the randomly distributed quadrats on the treated sections fell, at least partially, on scarified ground. Also from other data collected on each quadrat (estimated total area of each quadrat scarified) it has been calculated that 47 per cent of the total area of the treated sections was scarified. Skid trails and roads account for some of this but since the tractor worked back and forth over the area crossing roads and skid trails, often without lifting the blade, it was impractical to separate the roads and skid trails from the other scarified areas. However, the survey data show that 15 per cent of the controls were scarified and this was due almost entirely to roads and skid trails.

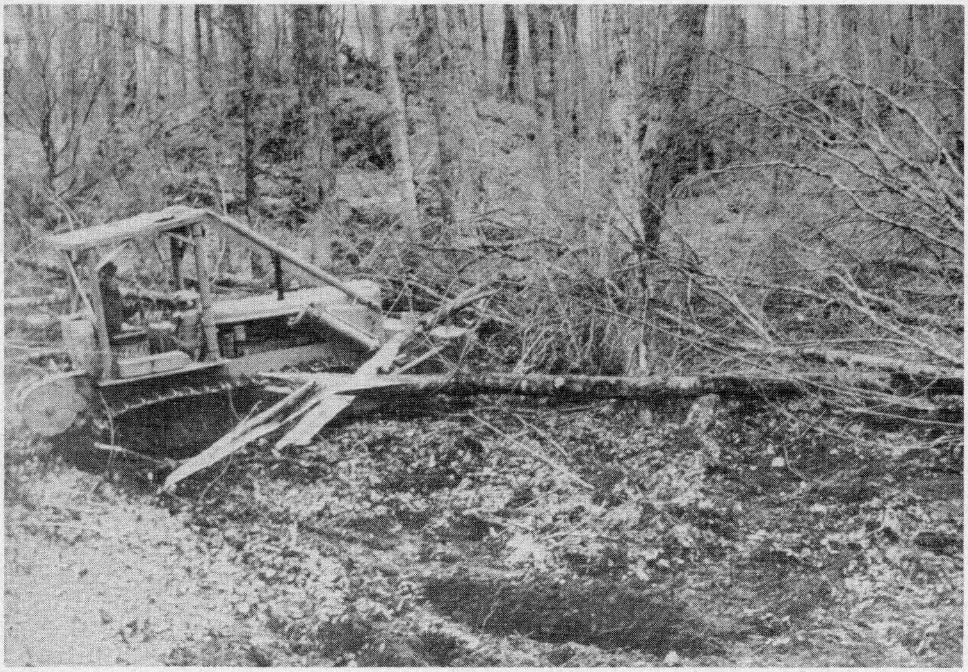

Figure 3—Bulldozer making seedbeds. Note how the soil is churned up, how the bulldozer has shoved over an 8-inch maple, and pushed aside tree tops.

In the spring of 1954, 29 observation stations were established on various sites and seedbeds on the treated sections. At these stations several yellow birch cotyledons were staked and measured. Annual remeasurements have provided information on seedling survival and development under various conditions.

The quantitative data required to determine the results were obtained by regeneration surveys in the autumn of 1954 and 1955. Seventy-five 1/100-acre plots, each divided into 10 milacre quadrats, were located at random in each section and tallied. This method of survey not only permits calculations of per cent stocking but also provides a means of estimating the proportion of areas stocked to various densities according to any specific criteria.

RESULTS

The results show that by creating suitable seedbeds with a bulldozer, yellow birch can be regenerated on tolerant hardwood sites. They also show that by providing adequate light (approximately 70 per cent full sunlight) the seedlings will grow rapidly.

The importance of seedbed in the establishment of yellow birch regeneration is illustrated in Table II which was compiled from the 1954 survey data. Three thousand quadrats were established during the survey and 1,507 of them fell on scarified ground; the remainder (1,493) fell on unscarified ground.

Ninety-eight per cent of the scarified quadrats were stocked compared with only 12 per cent of the unscarified quadrats. From this it is evident that scarification is essential if yellow birch is to be regenerated adequately on tolerant hardwood sites. It will be noted in Table II that 417 quadrats on the treated area were not scarified and of these only 77 were stocked to birch. Also, 424 quadrats in the controls were scarified and 407 of them were stocked.

TABLE II

STOCKING OF YELLOW BIRCH BY SEEDBED CONDITION, 1954

Area	Total number of quadrats	Quadrats scarified		Quadrats not scarified	
		Number stocked	Number not stocked	Number stocked	Number not stocked
Treated	1,500	1,063	20	77	340
Control	1,500	407	17	97	979
Total	3,000	1,470	37	174	1,319

The effectiveness of the treatment in inducing yellow birch to regenerate is indicated in Tables III and IV. On the treated areas, 76 per cent of the quadrats were stocked in 1954 and 71 per cent in 1955, but the stocking was only 34 and 36 per cent on the controls for these same years.

TABLE III

PERCENTAGE OF QUADRATS STOCKED TO YELLOW BIRCH, 1954 AND 1955

Year	Per cent stocking*	
	Treated	Control
1954	76	34
1955	71	36

*The differences in per cent stocking between 1954 and 1955 are due to both sampling error and mortality.

The data shown in Table III were obtained by using each milacre quadrat as a separate entity. The results show percentage of quadrats stocked and are useful for comparing differences between areas. Unfortunately, such a method of analysis gives little or no indication of stocking density, and it is therefore impossible to show what proportion of an area is well stocked, poorly stocked, and understocked. By using the 1/100-acre plots (each consisting of 10 milacre quadrats) as separate entities, the distribution of the stocking may be determined according to any criteria set up. The standards adopted for compiling the data showing the density of yellow birch stocking on the treated and control areas (Table IV) are as follows:

(1) A plot was considered to be well stocked if from 4 to 10 of the quadrats in it contained a birch seedling as tall or taller than the competing species.

(2) A plot was considered to be poorly stocked if from 1 to 3 quadrats in it contained a birch seedling as tall or taller than the competing species.

(3) A plot was considered to be unstocked if none of the quadrats contained a birch seedling as tall or taller than the competing species.

On this basis, 60 per cent of the plots on the treated areas are well stocked; this is almost five times the number of well-stocked plots on the controls. Also, it will be noted that nearly half the plots on the controls are unstocked, whereas the number of unstocked plots on the treated areas is almost negligible. Assuming that the random sample is truly representative of the whole experimental area, then the percentage of plots that are well stocked, poorly stocked, and unstocked is representative of the total area stocked to each of these densities.

TABLE IV

DENSITY OF YELLOW BIRCH STOCKING, 1955

Density	Treated		Control	
	No. of plots	Per cent of total	No. of plots	Per cent of total
Well stocked	90	60	20	13
Poorly stocked	56	37	58	39
Unstocked	4	3	72	48
Total	150	100	150	100

The development of the seedlings on both treated and control areas is compared in Table V. In the autumn of 1955, 10 per cent of the quadrats on the treated sections had at least one seedling more than 30 inches tall, and 39 per cent had at least one seedling more than 18 inches tall. On the control areas only 2 per cent of the quadrats were stocked with at least one seedling more than 30 inches tall and only 7 per cent with a seedling more than 18 inches tall.

TABLE V

PER CENT QUADRATS STOCKED TO YELLOW BIRCH BY SIZE CLASSES, 1954 AND 1955

Height* Class	Treated		Control	
	1954	1955	1954	1955
(inches)	(per cent quadrats stocked)			
1-2	25	2	13	3
3-4	25	1	9	3
5-18	26	29	12	23
19-30	—	29	—	5
31+	—	10	—	2
All Sizes	76	71	34	36

*Height of tallest seedling on quadrat.

It is evident that the treatment has favoured both the germination and subsequent development of yellow birch. Finely divided humus and mixed mineral soil and humus have been the most favourable seedbed media and compacted mineral soil has been the least favourable. Although compacted mineral soil did not restrict germination, it was not suitable for vigorous initial growth. This is illustrated in Figure 4 showing seedlings which were approximately 4 months old when removed from the soil; all four had received plenty of sunlight, but those on the left had been growing in mixed mineral soil and humus whereas those on the right had been growing on compacted mineral soil.

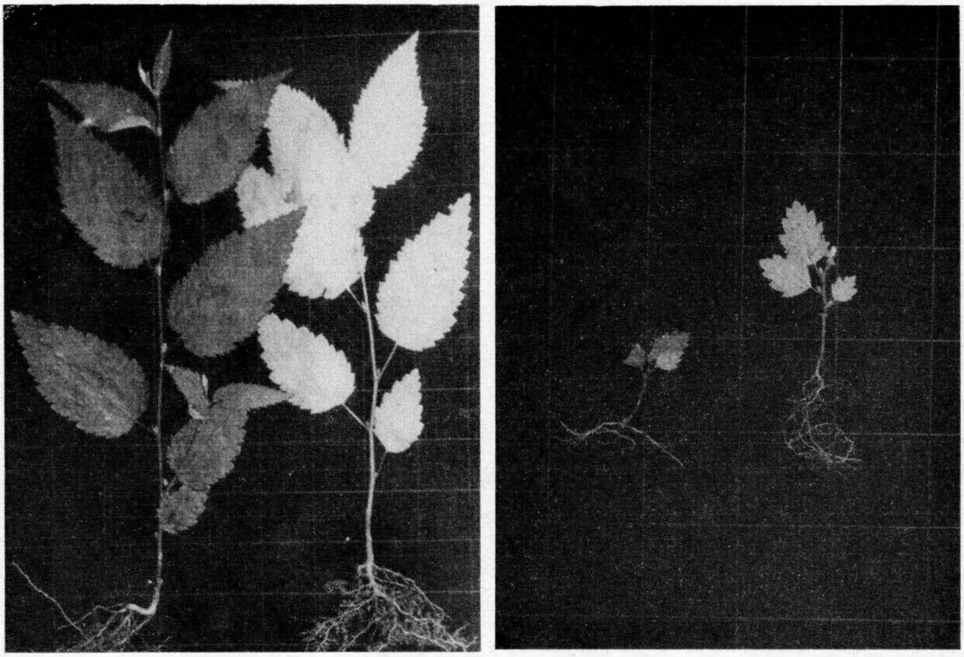

Figure 4—Relative development of 4-month-old yellow birch seedlings on mixed mineral soil and humus (left), and on compacted mineral soil (right). Grid in background is of 1-inch squares.

Other workers have found that yellow birch is adaptable to a wide range of conditions and will grow successfully in exposed conditions. This has certainly been substantiated by the excellent development of many of the seedlings during the second summer. The 1955 growing season was abnormally hot and dry (based on the Haliburton weather records for the past 46 years), but even so yellow birch seedlings on dry exposed sites put on excellent height growth (Figure 5). It would seem that the root systems developed the first season were adequate to withstand the drought and that the major requirement the second summer was plenty of light.

Although the treatment created favourable seedbeds for regeneration, other factors have had an important bearing on the excellent results obtained. For example, yellow birch produced an enormous seed crop in 1953 and as a result most seedbeds were liberally covered with seed. Also, during the first growing season (1954) when lack of moisture and excessively high temperatures could have been critical, the weather was cool and wet. Yellow birch germinated well on all sites and the seedlings flourished even on dry sites where one would expect high mortality. Of 604 yellow birch seedlings selected for study in the spring of 1954, 209 were dead by the autumn of the next year; 113 of these died during the first summer, 73 during the winter, and 23 during the summer of 1955.

Most of the mortality occurred on telluric sites with cool moist ecoclimates. On such sites, competition from lesser vegetations, mainly sedge, has been severe and seedlings slow in starting became suppressed. Some survived the first summer but were weak and many died either during the winter or the following summer. Fortunately, conditions such as this represent less than 5 per cent of the whole area.

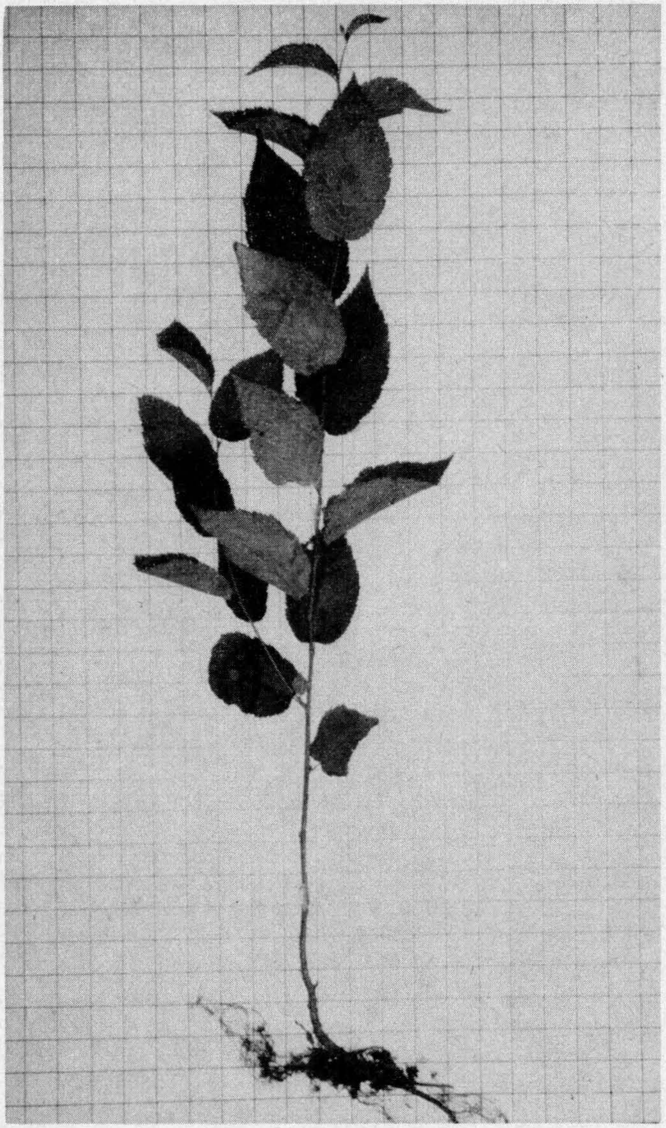

Figure 5—Two-year-old yellow birch which had been growing on a dry exposed site. One-inch grid in the background.

The excellent development of most of the birch seedlings indicates that this species should be well represented in the next stand. However, there is evidence of deer browsing on the area and if this becomes too severe the yellow birch regeneration could be ruined. Of the 3,000 quadrats established in 1955, browsing occurred on 34 per cent. The amount of browsing a yellow birch seedling can sustain without being killed is not known but it is apparent that even if seedlings are not killed, they become misshapen and are unlikely to develop into trees suitable for sawlogs or veneer.

No mention has been made previously of sugar maple regeneration; it is abundant on the area but the seedlings have not grown nearly as fast as the birch, especially on the treated sections where insolation is strong. Development of the sugar maple advance growth, however, has been good and many of the stems are putting on leaders more than 2 feet in length. Since practically none of the advance growth has been destroyed on the controls, it is expected that within a few years most of the birch seedlings on these sections will be completely overtopped and will die from suppression.

DISCUSSION

Management of tolerant hardwoods in Ontario and Quebec is just beginning and adequate information about the ecology of these forests and suitable silvicultural practices for them is lacking. This experiment has already yielded considerable information on the regeneration requirements of yellow birch and within a few years it should give much information on the development of the seedlings under various conditions.

It is obvious that yellow birch germinates well on seedbeds made by a bulldozer, and given sufficient light and favourable weather conditions, the seedlings will grow rapidly. The absence of birch seedlings on the unscarified areas indicates that undisturbed hardwood leaf litter is an unfavourable seedbed medium. Thus seedbed preparation is essential, if yellow birch is to be regenerated in quantity after logging.

Whether a satisfactory number of the birch seedlings will survive and form part of the next crop has not been established. The answer to this should be known within a few years. In addition, there should be good indications of what cultural treatments, if any, will be required to keep the birch in the stands. If the growth rate is as good in the future as in the past and the loss from browsing does not become acute, yellow birch should form a significant portion of the next cut on the treated sections.

The equipment and techniques used in this experiment for scarifying and opening up the stands worked reasonably well. Although the D-6 Caterpillar tractor experienced some difficulty because of the terrain and the presence of large trees, it proved to be an efficient tool. It made a variety of seedbeds most of which were suitable for the establishment and good development of birch. Therefore, until more effective machines are developed, this equipment or its equivalent is recommended for work of this nature.

Girdling is one means of removing cull trees, but it must be done carefully or the trees will survive; in addition, many hardwoods, especially sugar maple, take three or more years to die. Because of this, it is suggested that chemical frill girdling be used to destroy the cull trees in future work. This method induces a faster kill and allows more light to reach the ground during the first critical years when the birch seedlings are striving for a dominant position in the reproduction stand.

Although certain methods have been recommended, it should be noted that they are by no means the only ways in which favourable environments can be created for regenerating yellow birch. The important point is that suitable environments can be made and that yellow birch can be regenerated.

Since this experiment was established, two more have been undertaken in co-operation with Hay and Company, Limited. One was established in 1954 in a tolerant hardwood stand when it was being logged; the other was established in 1955 in a tolerant hardwood stand which had been cut in 1946-47 and had failed to regenerate satisfactorily to birch. Similar work is to be undertaken in the Maritimes and the first experiment is planned for this year.

SUMMARY

In 1953 the Forestry Branch established a cutting experiment in co-operation with Hay and Company, Limited, in Eyre and Havelock Townships, Haliburton County, Ontario. The experiment is being undertaken to follow up the results from studies already completed and to test on a large scale the hypothesis that: (a) through heavy cutting and the preparation of suitable seedbeds, a greatly improved stocking of yellow birch can be obtained on maple-beech-birch sites; and (b) a satisfactory proportion of the seedlings will achieve a dominant position in the new stand if adequate growing space is provided.

The experimental area consists of four 10-acre sections; two are treated and two are control. On the treated sections all merchantable timber was removed and enough defective trees girdled to provide a residual crown canopy as uniform as possible and giving about 30 per cent shade; on the control sections only the merchantable trees were removed. The treated sections were scarified with a D-6 Caterpillar tractor equipped with a bulldozer blade to prepare seedbeds and to reduce competition by destroying much of the sugar maple advance growth.

A variety of seedbeds were made by the bulldozer including loose mineral soil, compacted mineral soil, finely divided humus, raw fermenting humus, and mixed humus and mineral soil. Regeneration was good on all types of seedbeds; development was poor on the compacted mineral soil, but on all other seedbeds created development was excellent.

The results after two growing seasons are most promising and indicate that tolerant hardwood sites can be regenerated to yellow birch following logging. Stocking to yellow birch is 71 per cent on the treated sections whereas on the controls it is only 36 per cent. In addition, seedling development is much better on the treated sections than on the controls.

Although conditions are favourable for the development of birch there is evidence that deer browsing may become a serious problem and might eventually destroy most of the birch seedlings.

From the initial results the following can be concluded:

(a) Seedbed preparation is essential if yellow birch is to be regenerated in adequate numbers following logging.

(b) Although yellow birch will germinate well on compacted mineral soil, this medium does not favour seedling development.

(c) Most seedbeds made by a D-6 Caterpillar tractor equipped with a bulldozer blade are favourable media for regenerating yellow birch.

(d) Yellow birch will germinate and the seedlings will develop rapidly provided there are favourable weather conditions and provided the canopy has been opened up so that sufficient light will reach the seedlings.

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APPENDIX

List of Species

Common Name	Botanical Name	Abbreviation
Ash, black	*Fraxinus nigra* Marsh	bAs
Aspen	*Populus tremuloides* Michx	tA
Basswood	*Tilia americana* L.	Ba
Beech	*Fagus grandifolia* Ehrh	Be
Birch, yellow	*Betula lutea* Michx	yB
Birch, white	*Betula papyrifera* Marsh	wB
Elm	*Ulmus americana* L.	wE
Hemlock	*Tsuga canadensis* (L.) Carr	eH
Maple, sugar	*Acer saccharum* Marsh	sM
Maple, red	*Acer rubrum* L.	rM
Pine, white	*Pinus strobus* L	wP

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1957.