CANADA
Department of Northern Affairs and National Resources
FORESTRY BRANCH

THE TOLERANT HARDWOOD FORESTS OF NORTHERN NOVA SCOTIA

by
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Forest Research Division
Technical Note No. 57
1957

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

CORRECTIONS to Technical Note No. 57

Please correct your copy of Forest Research Division Technical Note No. 57,"The Tolerant Hardwood Forests of Northern Nova Scotia" by M.H. Drinkwater, as follows:

Page 5, last word on the page should read "uplands".

Page 13, paragraph 4, last sentence should read "The beech . . ."

Page 13, paragraph 5 should begin "Other old-growth stands . . ."

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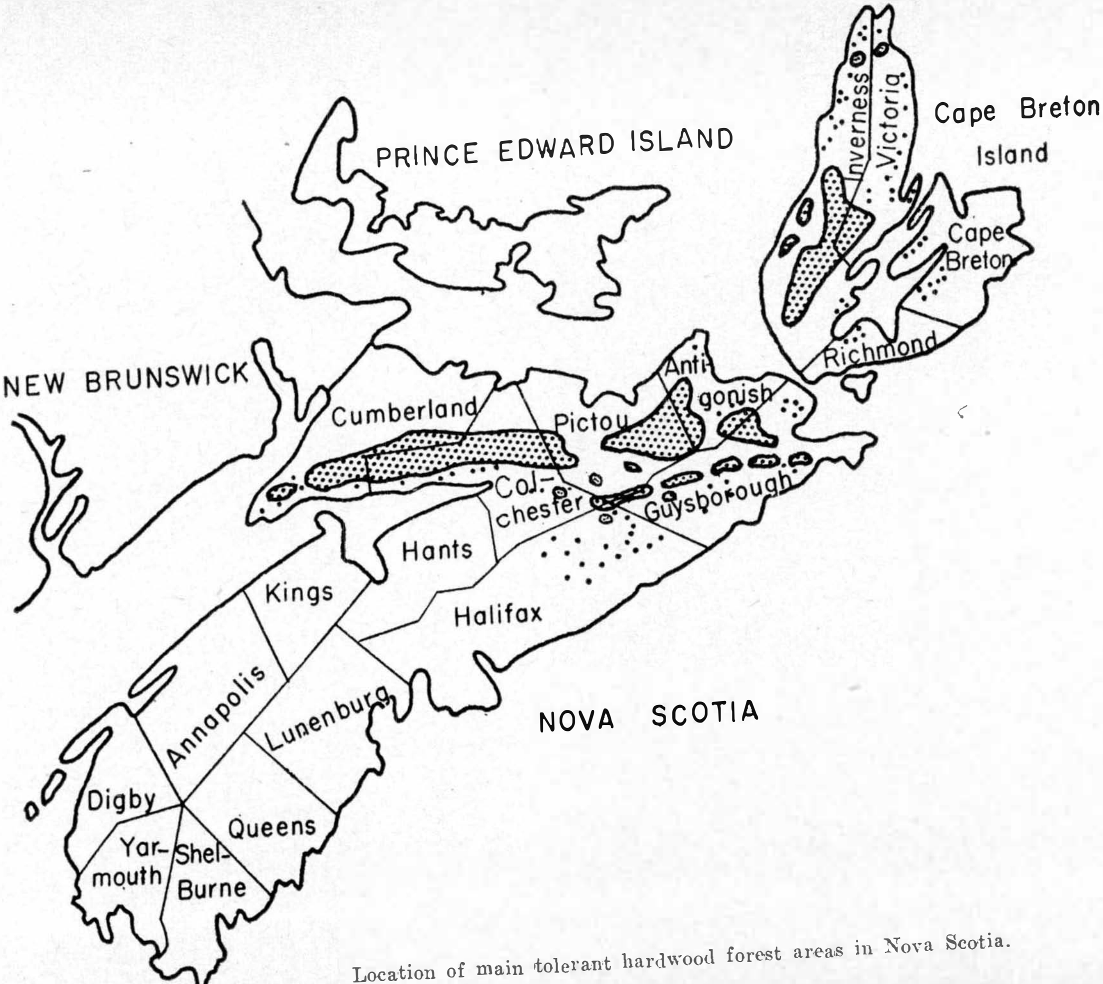

Location of main tolerant hardwood forest areas in Nova Scotia.

The Tolerant Hardwood Forests of Northern Nova Scotia

by

M. H. Drinkwater[1]

INTRODUCTION

The tolerant hardwoods, sugar maple, beech, and yellow birch[2], occur extensively throughout northern Nova Scotia (see map). On the mainland, they dominate the Cobequid Mountains, the Pictou Highlands, the hills in the lowlands of Antigonish, southern Pictou and central Guysborough Counties, and the upper slopes and ridges of the uplands in eastern Halifax and Guysborough Counties. On Cape Breton Island, they are abundant on the Craignish and Mabou Hills, and in the valleys of the rivers that drain the Northern Plateau. They also clothe the upper slopes and hilltops of the lesser uplands to the east. Elsewhere in the Province, the stands are generally small and the trees less desirable for timber. Statistics are not available, but 1,000,000 acres would be a conservative estimate of the total area of hardwood forest.

In the past, the tolerant hardwoods contributed much to the economy of Nova Scotia; they were an important source of raw material and revenue, and provided an opportunity for employment. Owing to recent heavy cutting, an infestation of beech scale (*Cryptococcus fagi Baer.*), and dieback of yellow birch, there has been a rapid transition from old-growth to second-growth stands consisting mainly of small and low-quality material.

In 1953, the total amount of hardwood lumber manufactured in Nova Scotia amounted to approximately 20,000,000 board feet, of which about 70 per cent was yellow birch, 28 per cent sugar maple and 2 per cent beech. In the same year, 8,000,000 board feet were used in mine packs and railway ties and 2,000,000 board feet (log measure) were cut for veneer.

In 1952 and 1953, the Forestry Branch conducted studies in northern Nova Scotia to obtain information on the condition of the tolerant hardwoods and to investigate techniques for their proper silvicultural management. This report summarizes the results of the study and makes recommendations for improving the management of the stands. A glossary of terms used appears in Appendix II.

The surveys were planned to cover as many different conditions as possible. The field work consisted mainly of recording visual observations although these were checked frequently by establishing temporary tenth-acre sample plots.

The condition of the stands for four areas believed representative of northern Nova Scotia are summarized in Tables 2 to 5 of Appendix III. These areas are distinguished mainly on the basis of their geographic position. The data are estimates, based on the descriptions and information from the sample plots.

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[2] A list of the botanical names of trees and plants is given in Appendix I.

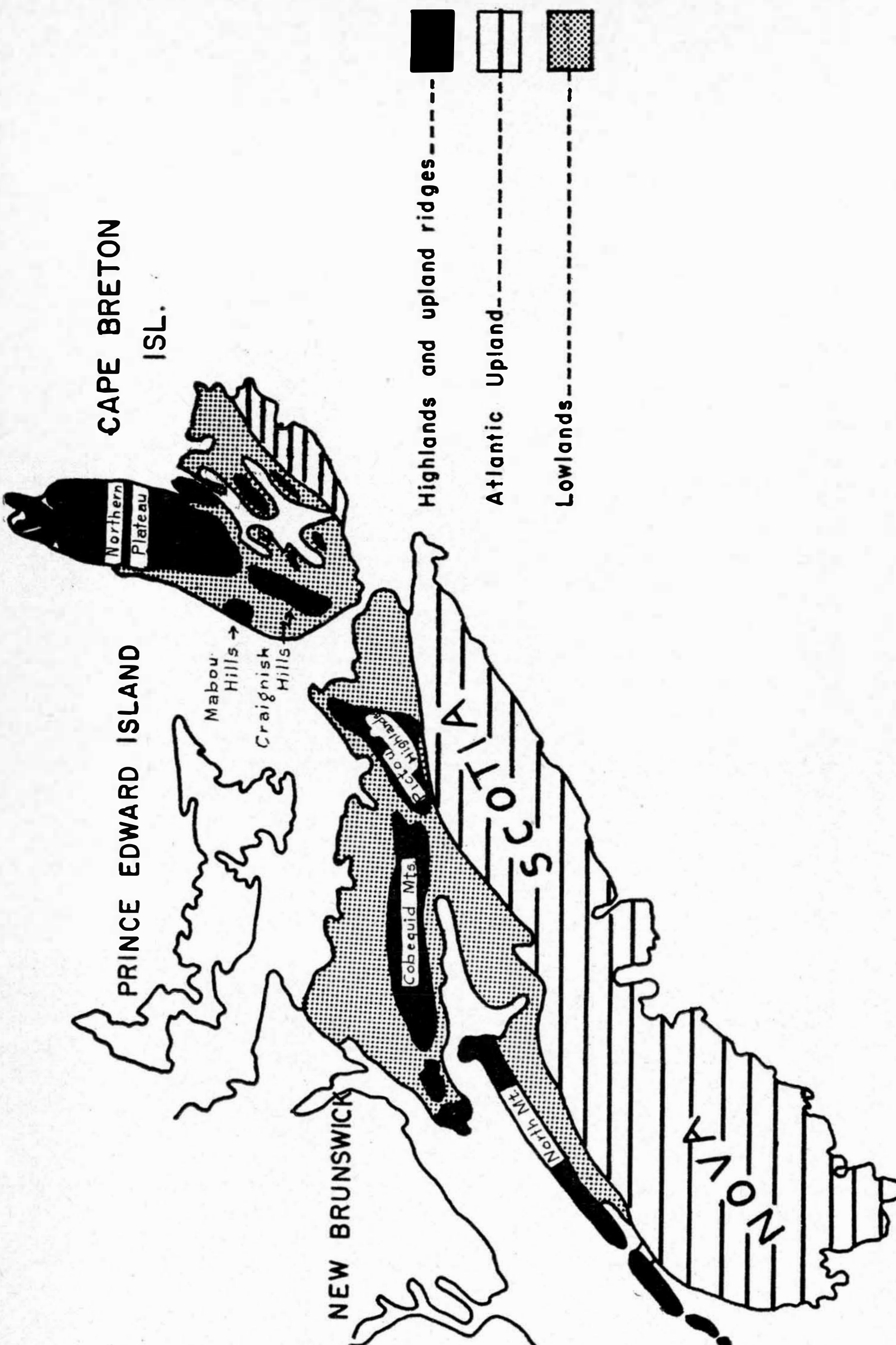

FIGURE 1.—Physiography of the Province of Nova Scotia.

REGIONAL DESCRIPTION

Physiography

Northern Nova Scotia is part of the eroded surface of an uplifted peneplain which stretches throughout the region (Goldthwaite, 1924). The upland remains of this peneplain consist mainly of Carboniferous or earlier igneous and metamorphic rocks and occur as ranges of hills and highlands from western Cumberland County (front map) to northern Cape Breton Island (Figure 1). Between the uplands and serving to emphasize them are the lowlands consisting of weaker Carboniferous sandstones, shales and limestones.

The Cobequid Mountains form a narrow range of hills stretching about 80 miles from western Cumberland County to western Pictou County. The continuity of the uplands is broken in central Pictou County, but the characteristic rocks reappear in eastern Pictou County and spread out into Antigonish County to form the Pictou Highlands. Although their flanks are often steep, both the Cobequid and Pictou Highlands are distinctly flat-topped; the broad rounded summits of the interior form a gently rolling surface with an average elevation of about 800 feet.

To the east, overspreading Halifax County and eastern Guysborough County, the northern extension of the less prominent Atlantic Upland rises gradually from the Atlantic Coast to an altitude of 400 to 600 feet, and terminates in a long escarpment overlooking the valleys of the West St. Mary and Salmon Rivers.

Northern Cape Breton Island consists mostly of a plateau averaging about 1,200 feet in altitude. The surface is flat, and the east and west margins end abruptly in a line of cliffs broken only by deep river valleys. South of the plateau the uplands are fragmented into a series of irregular, elongated hills running northeast-southwest; the summits gradually decrease in height as they approach the Atlantic Coast.

Soils

In northern Nova Scotia the soils under the hardwood forests are developed on three systems of rock:

(1) Crystalline rocks that form the uplands of the Cobequid Mountains and Pictou Highlands on the mainland, and the Craignish Hills, Mabou Hills and the slopes of the northern plateau on Cape Breton Island.

(2) Hard Mississippian sandstones, slates and quartzites that form the hills in the lowlands of southern Pictou and Antigonish and central Guysborough Counties on the mainland and in central Inverness County on Cape Breton Island.

(3) Devonian granites and Precambrian slates and quartzites which have given rise to the Atlantic Upland.

The soils from the crystalline rocks are mainly sandy loams, developed from gravelly sandy loam tills. They are rocky and usually shallow, but are porous enough to allow moderately deep root penetration to provide anchorage against windfall and to permit good drainage. The tolerant hardwoods probably reach their best development on these soils.

The soils underlain by hard Mississippian sandstones and quartzites are usually coarse sandy loams which are very rocky and often shallow. Because of the close association with the softer sandstones and shales of the valley bottoms, mixing of materials has occurred and patches of heavy soils are found on the slopes. Drainage depends on topography. Generally, rather poor stands of beech, yellow birch, red maple and sugar maple grow on the slopes, but sugar maple is much less aggressive than on the true lowlands.

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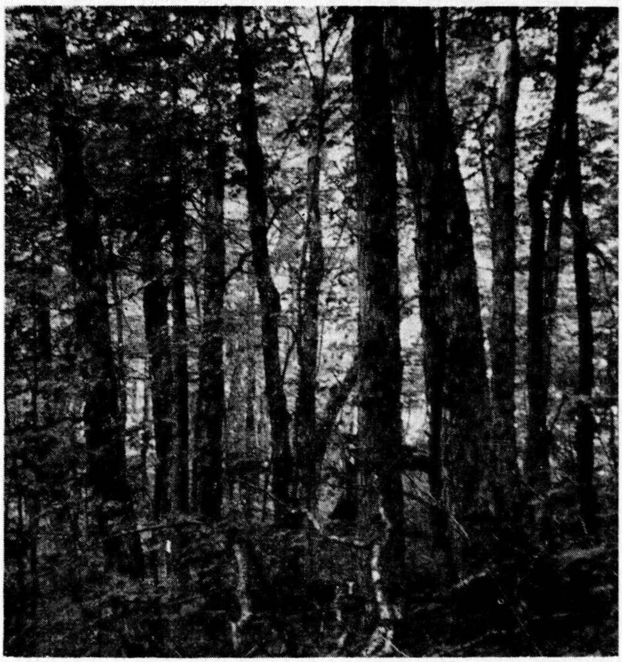

FIGURE 2.—An old-growth stand of sugar maple and yellow birch in which beech was once a co-dominant, Cape Breton Island. An abundance of sugar maple advance growth indicates that this species will probably become even more important.

FIGURE 3.—A second-growth stand of yellow birch and red maple which developed after logging and fire. Note regeneration of red spruce.

The soils on the slopes of the Atlantic Uplands are usually sandy loams, developed from coarse gritty tills. They are rocky and usually shallow. Drainage varies with the topography. The tolerant hardwoods occupy the upper slopes and hilltops inland but do not grow near the coast, except where high headlands afford protection from cold sea winds. The quality of sugar maple is low; and beech forms only a small part of the stand. Yellow birch and red maple are the most abundant hardwoods, particularly where drainage is poor.

Climate

Northern Nova Scotia is characterized by a humid temperate climate with short cool summers and long moderately cold winters. The weather is controlled by cyclonic storms. In winter these storms pass to the south drawing the cold air from the interior; in the summer they pass to the north, causing warm air to flow in from the south and southwest. Weather data, which unfortunately are available only from stations in the lowlands, appear in Table 1.

TABLE 1.—CLIMATIC DATA FOR NORTHERN NOVA SCOTIA (AFTER PUTNAM, 1940)

Item	Northern Counties[1]	Eastern Counties[2]
Mean annual temperature (F.)	41.4	41.6
January mean temperature (F.)	18.7	21.3
July mean temperature (F.)	63.9	62.1
Av. length growing period (days)	185	178
Av. length frost-free period (days)	118	125
Mean annual precipitation (inches)	41.9	50.9
Snowfall (inches)	72	75
Av. rainfall April 1 to Sept. 30 (inches)	19.14	23.00
Av. rainfall June, July, August (inches)	9.66	11.25
Mean annual humidity	78%	83%
Mean annual cloudiness	65%	74%
Number of rainy days per year	117	141

[1] Cumberland, Colchester, Pictou, and Antigonish.
[2] Guysborough County and lowlands of Cape Breton Island.

Precipitation is adequate and may at times be excessive. This is because the area is a meeting place for cold and warm moisture-laden air masses.

Because of the cold Labrador current, spring is later and temperatures are slightly lower in Halifax and Guysborough Counties and on Cape Breton Island than farther inland.

Weather records are not available, but the climate of the uplands differs in several respects from that of the lowlands. Because the rising land surface forces the air to ascend, causing it to cool and condense, the uplands have increased cloudiness and precipitation. Another effect of the rising land surface is the drainage of cold air down-slope at night, causing a temperature inversion with lower temperatures in the valleys than on the slopes above. Thus the slopes are less subject to night frosts than the lowlands, and this is an important factor in the occurrence of tolerant hardwoods on the uplands.

In northern Cape Breton Island the combined effect of the nature of the plateau and of high elevation causes appreciable adiabatic cooling and the nocturnal warm zone on the slope is passed. The result is that the tolerant hardwoods begin to drop out at about 800 feet and are replaced by intolerant hardwoods and conifers. On the mainland, the upland plateaus are neither high enough nor large enough to produce these macroclimatic effects and the tolerant hardwoods extend to the ridge tops.

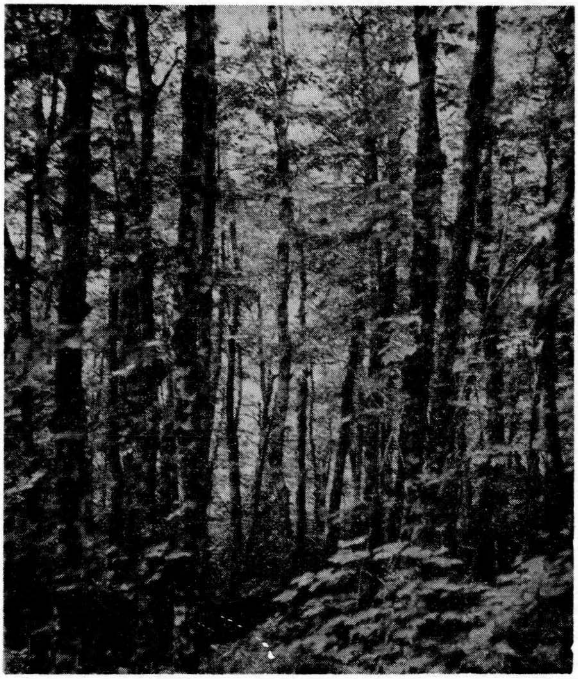

FIGURE 4.—A 65-year-old sugar maple stand in the Cobequid Mountains. Growth is slow and form is poor. Reproduction consists almost entirely of sugar maple.

FIGURE 5.—A 45-year-old stand of sugar maple. Poor quality trees can be removed in thinnings, but it would have been better to get rid of them during the sapling period.

CHARACTER OF THE TOLERANT HARDWOOD FOREST

General History

The first cuttings in the tolerant hardwood forests of Nova Scotia removed only the best trees, mainly large yellow birch, but as demand for hardwoods increased, cutting to a minimum diameter of nine or ten inches on the stump became standard practice. Fernow, in 1912, reported that much of the hardwood forest had been heavily logged. Because of high prices and the occurrence of insects and disease, most landowners followed a policy of liquidating their timber. Consequently Nova Scotia does not now possess any quantity of old-growth hardwood. Except in Cape Breton National Park where cutting is not permitted, in some less accessible areas elsewhere on the Island and in Guysborough County on the mainland, the stands are all second growth.

Insects and diseases have severely affected the tolerant hardwoods. About the year 1890, the beech scale was introduced from Europe. By 1934, nearly 50 per cent of the mature beech on the mainland was dead and the insect was established on Cape Breton Island (Ehrlich, 1934). Although it is doubtful if many trees were ever fit for quality sawlogs, beech is now little more than a weed.

By 1940 there was little doubt that the condition now known as dieback was present in Nova Scotia (Hawboldt, 1947). Between the years 1940 and 1947 the condition of the birch in both cut-over and uncut stands steadily degenerated. Mortality, particularly among mature and over-mature trees, was heavy and widespread and many of the survivors had abnormal numbers of dead and dying branches. However, by 1950 a general improvement was evident throughout the province and today many of the less severely damaged trees support large luxuriant crowns.

Despite the apparent improvement in the condition of the birch, there is still doubt as to whether dieback has actually ceased. Studies so far have failed to reveal a causal organism, although one investigation is exploring the possibility of a virus.

Stand Composition

Sugar Maple

Sugar maple, the dominant species on most sites supporting tolerant hardwoods, seldom comprises less than 30 per cent of the basal area and commonly occupies between 60 and 90 per cent. Because it is less dependent on special seedbeds and can withstand severe shade during all stages of growth, sugar maple has little difficulty in competing with its associates; and it is aggressive everywhere except on poorly drained sites. The ever-present mat of hardwood leaf litter under the tolerant hardwoods offers a good seedbed and reproduction is abundant. Although their growth may be retarded, the great tolerance of the seedlings to shade enables them to persist for many years and there is always a supply of reproduction to take advantage of any openings which occur in the canopy of the stands.

Beech

Beech occurs on a wide range of soil and moisture conditions and is found in nearly all tolerant hardwood stands, comprising between 10 and 30 per cent of the basal area. On occasion it may form pure stands on dry exposed ridges or following a light burn. Because of the decadence caused by the beech scale and nectria cankers, beech is now confined mostly to the understory.

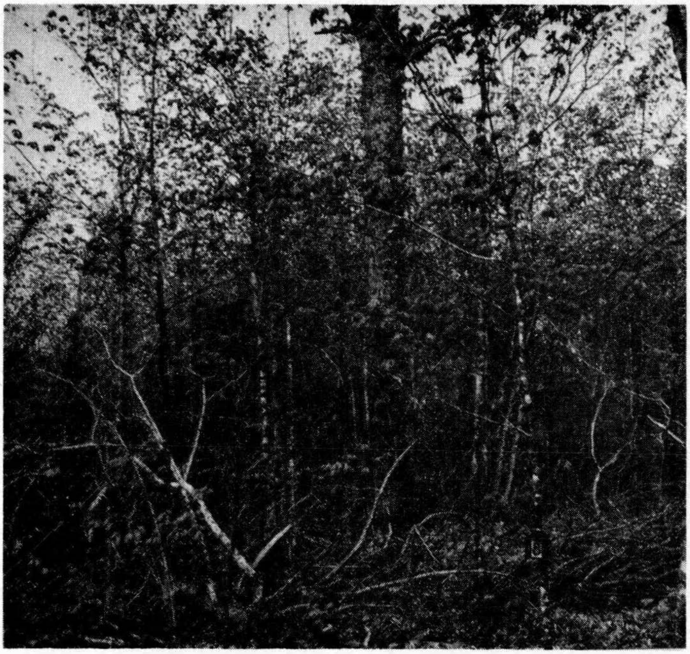

FIGURE 6.—A stand after a mine pack operation. Area offers good opportunity for seedbed treatment to promote yellow birch regeneration. The large birch in the background is an indication of the kind of tree which can be grown.

FIGURE 7.—A 20-year-old stand of sugar maple, beech, and mountain maple. Excessive density results in suppression and serious mechanical injuries.

Reproduction in most cases is from root suckers, though seedlings can become established on hardwood leaf litter with ease. Like sugar maple, young beech can withstand considerable shading and then recover when the stand is opened up. However, the period of normal development is short since most stems are heavily infested with the scale and nectria disease by the time they are three or four inches in diameter (Figure 10).

Yellow Birch

Yellow birch tolerates a wide range of soil and moisture conditions, but it is less abundant than either sugar maple or beech. Except after fire it never occurs in pure stands, but is found scattered or in small groups. It is most abundant on poorly drained sites and on the less fertile soils, conditions where sugar maple is least aggressive.

Although yellow birch is a prolific seeder and apparently is well adapted to the region, it does not reproduce satisfactorily. The explanation is that (a) the seedlings are unable to become established on undisturbed hardwood leaf litter, and (b) the seedlings are so intolerant of shade that they cannot grow under dense canopies and following cutting they cannot compete successfully with the older and more vigorous advance growth of sugar maple and beech.

Undoubtedly there are other factors which have contributed to the scarcity of yellow birch regeneration in Nova Scotia. Heavy recent mortality and excessive cutting have reduced the seed supply and there is evidence that the percentage of viable seed may be small in some years (Redmond and Robinson, 1954). Also the greatly increased deer populations of recent years may have helped curtail the numbers of seedlings in some areas.

Some situations do result in increased yellow birch reproduction. Seedlings may be abundant wherever the humus and mineral soil have been disturbed by logging. Such areas, however, are usually small and occur too infrequently to materially increase the stocking of birch.

The effect of fire is also evident in the almost pure stands of young birch which have become established after a burn. Apparently the fires were hot enough to destroy the leaf litter along with most of the sugar maple and beech. Observations indicate that light burns do not improve regeneration of birch but only promote more vigorous sprout growth of sugar maple and beech.

Stumps and other tree remnants of previous stands show that yellow birch was once more prominent than it is now. This may be attributed to catastrophes such as fire or wind damage. It is conceivable that large areas of formerly mature timber would become restocked following severe blowdown. The exposure of large patches of mineral soil and humus and the reduction of overhead shade would provide optimum conditions for the successful establishment and development of yellow birch.

Red Maple

Red maple is rarely absent from any stand, but it is abundant only on less fertile and poorly drained sites where sugar maple is least aggressive. It associates mainly with yellow birch. Favourable light intensities afforded by the thin birch crowns, combined with the fact that it is a prolific seeder with strong sprouting ability, enable red maple to maintain itself.

Other Tree Species

White ash occurs commonly on rich, moist loamy soils in Colchester, Pictou, and Antigonish Counties on the mainland and in Inverness County on Cape Breton Island. Although it is usually dominant, this tree never constitutes a significant portion of the basal area in any stand.

FIGURE 8.—A sapling stand about 25 years old. Sugar maple predominates.

FIGURE 9.—Cankers on sugar maple. Infections usually originate from branch stubs and mechanical injuries.

FIGURE 10.—Nectria cankers on young beech following the beech scale.

White elm is common on alluvial soils immediately adjacent to the larger streams. Red oak is locally abundant, notably in the valleys of the Aspey and Grande Anse Rivers in northern Cape Breton Island.

Among the conifers, balsam fir, white spruce, red spruce, hemlock, and the occasional white pine are found mixed with the hardwoods, but only where competition from sugar maple and beech is least.

Mountain maple quickly becomes established on cut-over forest land, and it is often abundant in young sapling stands (Figure 11). Although it is short-lived and its influence decreases rapidly once it is overtopped, mountain maple can be a serious hinderance to the development of hardwood reproduction for periods of 10 to 15 years.

Stand Structure

Most old-growth tolerant hardwood stands present an all-aged appearance. There is usually an excess of large trees, but several age classes and all size classes up to 36 inches d.b.h. or larger are represented. The canopy is closed with an inter-mixture of crown classes. Normally, the forest is a sugar maple-yellow birch complex (Figure 2). The birch, which is found now only in the lower stories, once occupied a co-dominant position.

The old-growth stands are even-aged in appearance, although a range of ages may be present in them. They occur most frequently on the low hills of eastern Guysborough County and consist mainly of yellow birch and red maple. They apparently originated following fire and blowdown.

Old-growth sugar maple and yellow birch are invariably decadent with low net merchantable volumes. Small portions of a stand may carry upwards of 5,000 board feet per acre but the average is seldom more than one or two thousand feet per acre. It is only the highly valuable yellow birch that makes commercial operations practicable. Statistics are not available, but stands of old-growth saw timber probably amount to less than 10 per cent of the area in hardwood forest.

Second-growth tolerant hardwood stands are essentially even-aged and most are too young to be merchantable. On recently logged areas or those devastated by dieback, advance growth of sugar maple, beech and mountain maple predominates and forms dense stands with upwards of 50,000 stems per acre (Figure 7). Yellow birch is an associate species but it occurs only sparingly. After the stands reach an average diameter at breast height of two to three inches, the stocking drops to between 1,000 and 6,000 stems per acre. Scattered overmature and cull trees generally form an irregular overstory. Many saplings are of seedling origin, but the percentage of defective stems is high owing to severe competition, browsing, and mechanical injuries from chafing and whipping.

Between 35 and 50 years of age, the stands enter the pole stage and sugar maple has become dominant (Figures 4 and 5). The mountain maple is overtopped, and most of the beech are either dead or dying as a result of beech scale and nectria canker.

When about 90 years of age, the dominant trees become merchantable for saw timber. In form and structure the stands are still even-aged, though some sugar maple and beech reproduction may have formed an understory of spindly saplings. The percentage of defective trees is high, few stems being suitable for the production of quality sawlogs. These stands are usually cut for mine packs, although sawlogs are taken whenever possible.

FIGURE 11.— A group of mountain maple. This species may outnumber all others in young sapling stands.

FIGURE 12.—The young sugar maple in the foreground has been browsed repeatedly. In areas where the concentration of game renders such damage usual, it is futile to try to raise thrifty hardwood stands.

Quality

Decay, poor form, abnormal wood colorations, and slow growth are chronic conditions in most hardwood stands, regardless of age. Observations in Nova Scotia show that even on fertile, fresh, well drained loams up to 70 per cent of the trees are defective and on less favourable sites up to 90 per cent are unfit for quality production. It is estimated that, on an average, only 10 per cent of the growing stock will produce quality timber at maturity. A further 60 per cent will be suitable for mine packs and railway ties; the remaining 30 per cent is so defective that it will be fit only for cordwood.

The immediate cause of defect is the many dead branches, branch stubs, scars, and damaged tops which lead to attacks by fungi. The fungi commonly produce deeply pitted or target cankers (Figure 9). Most cankers remain small enough not to girdle the tree but they deform the bole and usually indicate hidden decay or stain. The thin bark of the young trees makes them susceptible to mechanical injury and the slow growth is not conducive to rapid healing.

Several explanations of the colorations found in sugar maple (commonly termed 'black heart' and 'mineral stain') have been advanced. Good *et al.* (1955) believe that all colorations are associated with decay even where attempts at isolating a fungi have failed. The most striking properties of stained wood are its mineral content and high pH. Good *et al.* conclude that since most species of fungi thrive in a somewhat acid medium, the alkaline conditions inhibit most decay fungi. They suggest that the stain is "essentially a wound gum" and that its formation is a protective action.

It is a matter for conjecture whether an environmental factor is responsible for the poor quality of the sugar maple. Soil conditions may be important. For example, Cunningham (1953) reported that good quality sugar maple was confined mainly to calcareous and argillaceous soils in the Great Lakes-St. Lawrence Forest Region and that iron-bearing siliceous soils were unsuitable for the production of quality timber. No explanation was given, although Jarvis (1956) suggests that there may be a nutrient deficiency in the siliceous soils caused by the oxidation of iron which coats the soil particles and thus hinders base exchange. It is known that calcium influences tree growth and vigor directly as a plant nutrient and indirectly by affecting both the metabolism of the plant and the soil properties (Wilde, 1946; Russell, 1952).

The effect of the Maritime climate upon the quality of the tolerant hardwoods of northern Nova Scotia cannot be disregarded. Such climatic phenomena as cloudiness and low temperatures during the growing season and a continued fluctuation of thawing and freezing in the winter are all perhaps significant to the health and vigor of the hardwoods. One obvious effect is the breakage of tops and limbs by winter ice storms and wet heavy snows which deform the trees and provide entrances for decay fungi.

Data concerning yellow birch damaged by dieback indicate that light top injuries offer little hazard of decay (Stillwell, 1954). The future of yellow birch with approximately half or more of the crown dead is more uncertain. Stillwell found from 23 to 55 per cent of the trees in this group with some decay, although in most cases, the decay existed only in dead limbs. He points out that the rate of spread is not known but that it may be slow particularly if it is arrested periodically by the sloughing off of the dead limbs. Stillwell advises a cautious salvage program, removing only the badly damaged trees and leaving the healthier ones in the hope that they will recover.

Observations indicate that browsing by deer and moose is a cause of poor form and decay in hardwoods (Figure 12). Growth is probably retarded also. In areas where the deer population is unusually heavy, browsing could eliminate a species such as yellow birch which is a preferred food.

Finally, there are many factors associated with current and past methods of cutting which have contributed to the present condition of the tolerant hardwoods. In the past, the stands have been severely high-graded with no thought to the need for removing undesirable trees. Nor has any attention been given to the regeneration of desirable species or to controlling the composition of the second growth.

STAND IMPROVEMENT

For various technical, economic, and psychological reasons it is probably unpractical at present to advocate a comprehensive program of stand improvement for the tolerant hardwood forests of Nova Scotia. To begin with, knowledge of the silvics and management of these forests is limited. Research has increased greatly since 1945, but most investigations are in a preliminary stage and definite results are still not available. Many studies are under way in the United States, but because climate, soil, and species composition differ greatly, the results may not be applicable in Eastern Canada.

The solution to the problem of handling the hardwood forest will depend largely on the ability of industry to utilize the great quantity of low-quality material which is now present. Until this material can be removed profitably, any large-scale program of stand improvement is hardly possible.

Elsewhere in Canada and in the United States, low-grade hardwoods are being used, through improved processes, in the manufacture of sulphite and soda pulps and chemi-groundwood. For some purposes the hardwoods have been found superior to the softwoods. Low-quality hardwoods are also manufactured into chips as bedding for cattle and poultry and to produce fibre for roofing, fibreboard, chemicals, and soil mulches.

At present, none of these outlets are available in Nova Scotia, but it can be assumed that they will be developed before too long. Any new economic development, to be realistic, should aim either to improve the quality of the timber stands or to convert some of them to other species. Therefore, it is essential that proper silvicultural methods be known and understood beforehand. Otherwise, the stands will be degraded to an even greater degree than at present. For these reasons, means of stand improvement and conversion ought to receive some attention immediately.

Thinnings and Improvement Cuttings

The data in Tables 2 to 5 show adequate growing stock in the sapling and pole timber size-classes for the production of well stocked stands at maturity. If the stands on the better sites in Nova Scotia are to be managed for quality production, the potential values are great enough to permit expenditure of moderate sums on silvicultural improvement measures.

Basically, the production of quality hardwood timber is a matter of removing trees of undesirable form, condition and species so that the residual stems have adequate growing space and can develop without risk of mechanical injury. The treatments should begin at an early age for much serious damage from suppression and mechanical injury occurs during the thicket stage. Because of the cost of cultural measures, the objective should be to remove only enough trees to permit the development of an acceptable stand at maturity. The release of about 200 healthy, well-formed dominant and co-dominant saplings on each acre in stands up to 30 years of age would provide for a final crop of about 80 trees per acre with a margin for losses. Because of its abundance, sugar maple will comprise the bulk of the selected trees, but yellow birch should be favoured wherever it occurs. Beech should be discriminated against. Sufficient less desirable trees should be left to fill out the stand and to control the development of the crop trees.

Adequate growing space for the crop trees must be maintained. If the openings in the canopy are not to be excessive at any one time, the initial cut will need to be followed by others at approximately 10-year intervals. Crown thinnings are suggested with the crowns of reserve trees being given five to eight feet in which to expand during the intervals between treatments. Good form, absence of serious defects, and good dominance with normal crown development are criteria to use in selecting crop trees. Only stems which have come in as seedlings should be favoured as those of sprout origin are apt to be infected with decay. Care must be taken not to make too large openings, otherwise the trees will develop large limby crowns and put out epicormic branches along the bole. An excessive opening of the stand is also liable to cause sun scald.

The objectives of improvement cuttings in older stands will be the same, namely to find and to encourage good trees rather than to eliminate all the undesirable ones.

Where markets are available the weed trees and thinnings ordinarily can be cut. Other alternatives are available when the trees cannot be sold. Ammonium sulphamate, sodium arsenite, and the new hormone-type arboricides offer cheap means of developing hardwood stands through chemical thinning. Solutions of these poisons may be applied as a spray to the base of the trunk or introduced into frills cut in the bark. Girdling with an axe is another means of treatment but it is usually not as effective as poison in killing the tree the first year.

Killing a tree and allowing it to break up gradually greatly reduces the damage which might occur to adjacent stems in felling. This is especially important in removing large culls. Care is needed, however, not to leave dead trees with protruding branches which might injure the trunk or crown of potential crop trees.

Regeneration of Yellow Birch

Many tolerant hardwood stands are beyond the stage where it is possible to effect improvements to the present growing stock; in these cases it will be necessary to destroy the defective material and to encourage a new generation of seedlings. Because of its high value, yellow birch should be favoured but observations indicate that it cannot be regenerated satisfactorily by cutting alone. It has been found that besides reducing the canopy shade to between 30 and 40 per cent, it is also necessary to prepare seedbeds and to destroy enough sugar maple advance growth to ensure that the less tolerant birch seedlings are not suppressed. Investigations by Jarvis (1955) in Ontario showed that up to 75 per cent stocking could be obtained by using a D-6 tractor and bulldozer to scarify the ground and to reduce competition. This treatment, which was carried out on a commercial scale, proved economically feasible. There is no reason why the same method would not be effective in Nova Scotia.

Stand Conversion

The possibility of controlling hardwoods with chemicals or by machinery has made conversion of areas to conifers practical. Such treatment, however, would rarely be applicable under present conditions and probable intensity of management in the immediate future.

Attempts at stand conversion in Nova Scotia would probably be most successful with the tolerant red spruce or with the fast-growing pines. Hemlock would do well but the wood is not valuable enough to justify the cost.

Pruning

Good quality tolerant hardwood timber commands such high prices that pruning crop trees can be justified from an economic point of view. Success, however, will depend upon the scars healing with maximum speed and with minimum chances of infection. In Wisconsin, Stoeckler and Arbogast (1947) found that moderate pruning of young hardwoods had no influence on their growth and that it offered a way of reducing cull by removing small branches ahead of natural pruning. They recommended that pruning should be limited to live limbs less than one inch in diameter for maximum rate of healing. In Nova Scotia, yellow birch would probably be less susceptible to infection than sugar maple. Pruning should be confined to the first 16 or 18 feet of the bole and done when the bark is tight.

CONCLUSIONS

The tolerant hardwood stands in Nova Scotia are in a seriously decadent condition. Poor quality sugar maple and beech dominate nearly all sites and tend to increase as the more valuable yellow birch and sound sugar maple are either harvested or killed by disease and insects. It is also possible that the effects of past mismanagement and various diseases and insects are being compounded by unfavourable soil and climatic conditions.

Unless landowners are willing to accept extremely low returns per acre and to forgo a part of the productive capacity of their hardwood sites, it will be necessary to undertake cultural measures to improve the stands. The most logical species to favour is yellow birch since it is well adapted to the region and the high value of the timber will permit intensive treatments to ensure its establishment and future growth. If dieback continues, the alternatives are either to manage sugar maple, developing as much good quality timber as the species and site will permit, or to alter the composition of the stands in favour of softwoods.

A program of silvicultural management cannot be properly effected until outlets are developed for the large quantity of low-grade hardwood now present and which will continue to occur. Utilization of this material for pulp, fibreboard, wood chips, and chemical products is possible. However, this is no panacea, for low quality still means low return. The goal must be the production of quality timber.

REFERENCES

Cunningham, G. C. 1953. Research in tolerant hardwoods. *In* Report of the symposium on birch dieback, Part I. pp. 52-56. Canada, Dept. Agriculture, Science Service, For. Biol. Div.

Ehrlich, J. 1934. The beech bark disease: a *Nectria* disease of *Fagus* following *Cryptococcus fagi* Baer. Canadn. Jr. Res., 10: 593-692.

Fernow, B. E. 1912. Forest conditions of Nova Scotia. Canada, Commission on Conservation.

Goldthwaite, J. W. 1924. Physiography of Nova Scotia. Canada, Dept. Mines, Geological Survey, Memoir 140.

Good, H. M., P. M. Murray and H. M. Dale. 1955. Studies on heartwood and staining in sugar maple *Acer saccharum* Marsh. Canadn. J. Bot. 33: 31-41.

Hawboldt, L. S. 1947. Aspects of yellow birch dieback in Nova Scotia. J. For. 45: 414-422.

Jarvis, J. M. 1956. An ecological approach to tolerant hardwood silviculture. Canada, Dept. Northern Affairs and Natural Resources, Forestry Branch, For. Res. Div., Tech. Note No. 43.

Putnam, D. F. 1940. The climate of the Maritime Provinces. Canada, Geog. Jour. 21: 135-147.

Redmond, D. R. and R. C. Robinson. 1954. Viability and germination in yellow birch. For. Chron. 30: 79-87.

Russell, E. J. 1952. Soil conditions and plant growth. 635 pp. Longmans, Green and Co. Ltd. London. 8th ed.

Stoeckler, J. H. and C. F. Arbogast. 1947. Thinning and pruning in young second growth hardwoods in northeastern Wisconsin. Proc. Soc. Amer. Foresters 1947. pp. 326-347.

Stillwell, M. A. 1954. Progress of decay in decadent yellow birch trees. For. Chron., 30: 292-298.

Wilde, S. A. 1946. Forest soils and forest growth. 241 pp. Chronica Botanica Co., Waltham, Mass., U.S.A.

APPENDIX I

Common and Botanical Names of Trees

Ash, white	*Fraxinus americana* L.
Beech	*Fagus grandifolia* Ehrh.
Birch, yellow	*Betula lutea* Michx. f.
Elm, white	*Ulmus americana* L.
Fir, balsam	*Abies balsamea* (L.) Mill.
Hemlock, eastern	*Tsuga canadensis* (L.) Carr
Maple, mountain	*Acer spicatum* Lam.
Maple, red	*Acer rubrum* L.
Maple, striped	*Acer pensylvanicum* L.
Maple, sugar	*Acer saccharum* Marsh.
Oak, red	*Quercus rubra* L.
Pine, white	*Pinus strobus* L.
Spruce, red	*Picea rubens* Sarg.
Spruce, white	*Picea glauca* (Moench) Voss

APPENDIX II

Glossary of Terms

Advance growth	Reproduction which has become established before cutting.
Mine Pack	Hardwood block 6″ × 6″ × 2′ used in the collieries. Must be free of shake, rot and checks; knots and discolorations are acceptable if they are sound; wane not to exceed one inch per edge.
Regeneration	Stems which have become established after cutting or other disturbance.
Reproduction	New forest crop including regeneration and advance growth.
Root sucker	A shoot arising from the root of a woody plant.
Seedling	A stem grown from seed.
Stand, sapling	Young growth 0.5 to 3.5 inches in diameter at breast height.
Stand, pole-timber	Immature growth, 4 to 10 inches in diameter at breast height.
(a) *light*	Stands containing up to 1,000 cubic feet per acre.
(b) *heavy*	Stands containing more than 1,000 cubic feet per acre.
Stand, saw-timber	Mature or overmature growth with a volume of 1,000 board feet per acre or more in trees 11 inches in diameter at breast height.
(a) *light*	Stands containing 1,000 to 5,000 board feet per acre.
(b) *heavy*	Stands containing 6,000 board feet or more per acre.
Quality classes, tree	
Class 1	Good form, full crown; potential saw timber.
Class 2	Fair form, crooked or short main stem, some defects including bumps, branch stubs, seams, flutes; good only for mine packs and railway ties.
Class 3	Poor form, main stem with many deformities and serious defects; of no value except as fuelwood.

APPENDIX III

Condition of Tolerant Hardwoods

TABLE 2—CONDITION OF TOLERANT HARDWOODS ON THE COBEQUID MOUNTAINS

Item	Sapling Stands	Pole Timber Stands		Saw Timber Stands	
		Light	Heavy	Light	Heavy
1. Composition (per cent basal area).					
Overstory sM[1]		75	70	70	
Overstory Be		20	20	20	
Overstory yB		5	10	10	
Sapling understory sM	40	50	65	70	
Sapling understory Be	30	20	30	30	
Sapling understory yB	10	10	5	—	
Sapling understory moM	20	20	—	—	
2. Trees per acre.					
Overstory		200	450	240	
Saplings	2,500	900	450	425	
3. Av. diameter overstory (inches)		5	6	10	
4. Basal area per acre (square feet)		45	95	140	
5. Age (years)	25	50	60	100+	
6. Height (feet)	30	50	50	60	
7. Quality (per cent stems).					
Class 1	20	10	10	10	
Class 2	40	60	70	60	
Class 3	40	30	20	30	
8. Reproduction.					
sM	common	abundant	common	common	
Be	common	common	common	common	
yB	rare	rare	rare	rare	
moM	common	common	sparse	rare	

[1] sM—sugar maple
Be—beech
yB—yeellow birch
moM—mountain maple
rM—red maple
bF—balsam fir

TABLE 3.—CONDITION OF TOLERANT HARDWOODS IN THE PICTOU-ANTIGONISH HIGHLANDS

Item	Sapling Stands	Pole Timber Stands		Saw Timber Stands	
		Light	Heavy	Light	Heavy
1. Composition (per cent basal area).					
Overstory: sM		60	70	60	
Overstory: Be		30	10	10	
Overstory: yB		10	20	30	
Sapling understory: sM	40	50	60	60	
Sapling understory: Be	30	25	30	30	
Sapling understory: yB	5	5	10	10	
Sapling understory: moM	25	20	—	—	
2. Trees per acre.					
Overstory		200	500	300	
Saplings	2,000	900	500	400	
3. Av. diameter overstory (inches)		5	6	9	
4. Basal area per acre (square feet)		45	110	140	
5. Age (years)		50	60	100+	
6. Height (feet)		50	50	60	
7. Quality (per cent stems).					
Class 1	20	10	20	10	
Class 2	50	50	60	60	
Class 3	30	40	20	30	
8. Reproduction.					
sM	common	abundant	abundant	abundant	
Be	common	common	common	common	
yB	rare	rare	rare	sparse	
moM	common	common	rare	rare	

TABLE 4.—CONDITION OF TOLERANT HARDWOODS IN EASTERN ANTIGONISH AND GUYSBOROUGH COUNTIES

Item		Sapling Stands	Pole Timber Stands		Saw Timber Stands	
			Light	Heavy	Light	Heavy
1. Composition (per cent basal area).						
Overstory	sM	....	40	40	30	
	Be	....	20	10	10	
	yB	....	30	40	50	
	rM	....	10	10	10	
Sapling understory	sM	20	30	40	20	
	Be	20	10	20	30	
	yB	10	20	20	20	
	rM	30	20	10	20	
	bF	10	10	10	10	
	moM	10	10	—	—	
2. Trees per acre.						
Overstory		....	200	450	200	
Saplings		1,800	800	200	200	
3. Basal area per acre (square feet)		....	45	90	195	
4. Av. diameter overstory (inches)		....	5	6	9	
5. Age (years)		20	55	70	100+	
6. Height (feet)		30	50	50	60	
7. Quality (per cent stems).						
Class 1		20	10	20	10	
Class 2		40	50	50	50	
Class 3		40	40	30	40	
8. Reproduction.						
sM		common	common	common	common	
Be		sparse	common	common	common	
yB		rare	sparse	rare	sparse	
rM		common	common	sparse	sparse	
bF		sparse	common	rare	rare	
moM		common	common	sparse	rare	

TABLE 5.—CONDITION OF TOLERANT HARDWOODS ON CAPE BRETON ISLAND

Item	Sapling Stands	Pole Timber Stands		Saw Timber Stands	
		Light	Heavy	Light	Heavy
1. Composition (per cent basal area).					
Overstory sM		50	50	70	60
Overstory Be		30	20	10	10
Overstory yB		20	30	20	30
Sapling understory sM	40	40	40	40	60
Sapling understory Be	30	30	50	40	20
Sapling understory yB	15	10	10	20	20
Sapling understory moM	15	20	—	—	—
2. Trees per acre.					
Overstory		180	375	250	230
Saplings	2,500	800	500	400	400
3. Av. diameter overstory (inches)		5	6	9	12
4. Basal area per acre (square feet)		40	85	120	190
5. Age (years)	30	50	70	100+	120+
6. Height (feet)		50	50	60	60
7. Quality (per cent stems).					
Class 1	20	10	20	10	10
Class 2	30	50	50	70	60
Class 3	50	40	30	20	30
8. Reproduction.					
sM	common	abundant	common	abundant	common
Be	common	common	common	common	common
yB	rare	sparse	rare	sparse	rare
bF	sparse	sparse	sparse	sparse	rare
moM	sparse	common	rare	rare	rare

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QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1957.