HARDWOOD MANAGEMENT IN ONTARIO

AN ANALYSIS OF MANAGEMENT AND UTILIZATION PROBLEMS IN THE HARDWOOD FORESTS OF SOUTHERN ONTARIO

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INTRODUCTION

The hardwood forests of southern Ontario are probably the most potentially productive and most accessible forests of Ontario. For over 100 years they have been a source of high quality timber, and many industries are directly dependent upon them for their raw material needs. However, during the last 2 decades the greatly increased demand for high quality timber has resulted in a serious depletion of large trees of all commercially desirable species. One factor contributing to this situation is the ownership pattern. More than half the productive forest land, including most of the best growing sites, is owned privately and this has prevented government regulation of the cut on a sustained yield basis.

Aware of a growing shortage of high quality logs and recognizing that the yield from private land was only a fraction of the potential, in 1966 the provincial government passed the Woodlands Improvement Act, under which financial assistance may be provided for the expansion and improvement of privately-owned woodlots.

Development of the full potential of the southern Ontario hardwood forests will require expansion of all phases of management. Unfortunately much of the information required for such an expansion is currently not available. Although the results of agricultural research are evident on every farm, little is known of the growth requirements of even our most important hardwood species. More research is urgently required to supply management foresters with the necessary information to improve present management practices.

The purpose of this report is to provide background information for the development of a comprehensive hardwood research program through a description of the economic importance of the hardwood resource, a review of the present state of knowledge and a discussion of the most important management problems currently limiting hardwood management. The review of past research is intentionally restricted to studies carried out in Ontario, and no claim is laid to the completeness of the discussion of management problems. However, it is hoped that this report will draw attention to the existence of serious gaps in knowledge and that it will be useful in the formulation of plans for hardwood research in southern Ontario.

DESCRIPTION OF THE AREA

Area Classification

The area of study covered by this report is that part of Ontario which lies south of the French and Mattawa rivers and which is traditionally referred to as southern Ontario. Two distinct types of land are common in this area, namely the southern agricultural lands and the tolerant hardwood forests of the Canadian Shield. Together they cover an area of 31.2 million acres of which 11.2 million acres or 36 per cent are productive forest land, 1.6 million acres or 5 per cent are classified as non-productive forest and 1.1 million acres or 4 per cent are wooded pastures (Ontario 1953 a, b; 1957 a, b, c, d; 1958 a, b). The latter are low density stands, often comprised of a few large, open-grown trees with widespread crowns and, as the name implies, they are usually quite heavily grazed. Of the remaining 17.2 million acres, 15.5 million acres are non-forested land while 1.7 million acres are covered by lakes and streams. For administrative purposes, the area is divided into eight forest districts (Table 1).

Forest Soils

Along the shores of Lake Erie and Lake Ontario, a high proportion of the area is occupied by dark grey gleisolic soils (Hills 1959). Grey-brown podsolics are common on well drained sites, however, superimposed, brown podsolic profiles are not as well developed as in the adjacent area to the north, where the regional soil type is a grey-brown podsolic except in areas of stoney limestone till. In these latter areas, brown podsolic forest soils are common. Bisequia profiles are also common: brown podsolics are usually superimposed on the grey-brown podsolics under hardwoods and podsols under conifers. Farther north, brown podsolic and weakly developed podsols are the common soil types on the sandy soils of the upland areas supporting tolerant hardwood and pine-hemlock mixed woods. On the limy clays and silts of the lowlands, a podsol or brown podsolic profile is superimposed on a grey-brown podsolic presumably developed in the xerothermic period.

Cover Types

The climatic and soil conditions of the southern portion of the Niagara peninsula and the north shore of Lake Ontario have favoured the extension into Canada of the Deciduous Forest from the south (Rowe 1959). The characteristic association of the region consists primarily of beech[1] and sugar maple together with basswood, red maple and red, white and bur oak. White elm was also very common before the Dutch elm disease eliminated the species in many areas. Also within this Deciduous Forest Region is found the main distribution of black walnut, sycamore, swamp white oak and shagbark hickory. Present also are the more widely distributed butternut, bitternut hickory, rock elm, silver maple and blue beech. Other species find their northern limit here, including the tulip tree, mockernut and pignut hickories, chinquapin, scarlet and pin oaks, blue ash, black gum, magnolia, papaw, Kentucky coffee-tree, redbud, red mulberry and sassafras. Except in plantation, conifers are poorly represented.

The cover type of the remaining forest land of southern Ontario north of the Deciduous Forest belongs to the Great Lakes-St. Lawrence Forest Region. Sugar maple and beech are common over the whole region

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[1] Botanical names listed in Appendix.

and basswood, yellow and white birches, red and silver maples, white and red ashes, red, white and bur oaks, blue beech, ironwood, black cherry and aspen also occur frequently. Butternut, bitternut hickory, sycamore and cottonwood are found on more protected sites. The most common conifers are white pine, hemlock, balsam fir, jack and red pine and white spruce. Eastern white cedar, tamarack and black spruce usually grow in swampy depressions.

Ownership

In Ontario, a large percentage of forest land has been retained under public ownership and the right to cut or remove timber from this land has been granted by a licence. Lands suitable for agriculture have generally been granted or sold under the various land settlement regulations. Lands are also patented for mining purposes, summer resorts and other uses. All of these various types of ownership are grouped under "patented lands" which include all lands owned privately, in contrast to crown lands which include the "agreement forests" set up under various acts.

As shown in Table 2, 5.8 million acres or 51.8 per cent of all productive forest land of southern Ontario is owned privately. If the 1.1 million acres of wooded pasture are included, the percentage of privately owned, productive forest land increases to 56.1 per cent. But even more important is the fact that most of the land of highest site quality is in private ownership (Tables 3 and 4).

HISTORICAL BACKGROUND

Until the end of the eighteenth century, settlement of southern Ontario was restricted to the valleys of the St. Lawrence and Ottawa rivers and the shores of Lake Ontario and Lake Erie. By 1850 the southern watersheds were well populated and settlement proceeded rapidly inland along the river valleys. Although the early pioneers generally cleared the forest to provide land for agriculture, a logging industry soon developed to cut high quality white pine and oak timber for the Royal Navy. Sawmilling greatly increased with the opening of the American market, and by 1848 there were hundreds of sawmills located along the river banks and lake shores, cutting mainly white pine lumber. Hardwood logging during this period was generally restricted to a relatively small export of oak, elm and ash logs to Quebec. Maple and birch trees were burned and the ashes were sold for their potash content. But by 1910 the diminishing supply of readily available, high quality pine timber resulted in increased hardwood logging; and many stands were high-graded for their most valuable species.

Land clearing and lumbering were essential to the development of the region, but little attention was generally paid to the after effects of logging, repeated fires and indiscriminate land clearing.

The result has been the conversion of large areas of highly productive forest sites to infertile rock barrens with a secondary association of birch and aspen. During the initial period of settlement, land was often cleared that should have remained permanently devoted to forestry. Farms situated on such land have now been abandoned and the reforestation of these farms remains a problem.

In the more favourable farming regions, forests are now, for the most part, restricted to small woodlots situated on land unsuited for farming. Until recently these woodlots met the annual demand for raw material for most of the local wood-using industries. At the same time they provided fuelwood; sugar maple trees were often tapped for the production of maple syrup. The removal of a limited number of high quality trees was frequently balanced in these woodlots by the annual fuelwood cut, which removed the larger non-commercial trees, thereby providing increased growing space for the younger, potentially more valuable trees.

However, during the last 2 decades harvesting practices in the farm woodlots have changed drastically. The conversion of most farms to oil or gas heating has greatly reduced the removal of low quality trees. On the other hand the great demand for high quality timber has resulted in an enormous increase in the rate of cut of large trees belonging to the few commercially valuable species.

The change in logging methods also had a profound impact on the small hardwood woodlot. Although most logging was formerly carried out by property owners or small contractors who generally used light farm equipment, specialized operators with heavy equipment now log a large percentage of the timber. To employ this heavy equipment most effectively, the single tree selection system has frequently given way to the semi-clearcut, where all usable trees are removed, regardless of their potential for growth in volume or value. Although clear-cutting may be the best silvicultural practice in mature or overmature hardwood stands, removal of all usable trees, regardless of size and potential, has frequently created silvicultural slums. Since no income can be expected for many decades from such abused woodlots, many owners lose all interest in managing them, thereby further lengthening the period of recovery.

The diameter limit clause of The Trees Act, in effect in several counties, has prevented the total destruction of many woodlots but, unfortunately, this ordinance does not apply in all counties. At best it only prevents excessive exploitation and leaves much to be desired in regard to more intensive management.

FOREST RESOURCES

Total cubic foot volume of primary growing stock in southern Ontario, as reported by the Department of Lands and Forests (Ontario

1953 a, b; 1957 a, b, c, d; 1958 a, b; Dixon 1963) was 18.1 billion cubic feet with hardwood species accounting for 13.3 billion cubic feet or 74 per cent of total volume (Table 3). Sugar maple is by far the most common species, followed by poplar, yellow birch and white birch. Elm, which ranked third in volume at the time of inventory, is now greatly reduced as a result of Dutch elm disease. In the coniferous group, white pine is the most common tree, followed by hemlock, cedar and balsam fir.

Although patented land accounts for only 51 per cent of hardwood and 41 per cent of coniferous growing stock, its productivity is far greater than that of the crown land: 82 per cent of the total allowable cut for all species is located on patented land (Table 4).

Accurate statistics covering annual utilization by species are available only for crown land. A comparison of allowable cut by species with actual utilization for the period April 1, 1963 to March 31, 1964 (Table 5) indicates that utilization varied greatly between species (Ontario 1964); for example, only 39 per cent of the total allowable hardwood cut was actually utilized, while certain species such as butternut, oak, walnut and poplar were heavily overcut. In the coniferous group, only 8 per cent of the allowable cut of cedar was utilized while red and white pine were heavily overcut; this resulted in an average overcut of 37 per cent for all conifers.

In order to obtain an indication of the average intensity of utilization of the allowable cut on all productive forest land in southern Ontario, a summary of volume cut by species was compiled from the Mill Licence Returns for the year 1965. The data are shown in Table 6. These data, although not completely reliable, indicate nevertheless that only a very small percentage of the total allowable cut is currently utilized. But on the other hand, certain high value species such as black walnut are heavily overcut. If the percentages of Table 6 are compared with those of Table 5, it becomes apparent that the greatest deficiency in the utilization of the less desirable species occurs on patented land.

No figures of the import and export value of hardwood logs, lumber and veneer are available for Ontario: but data for Canada indicate that in 1964 and 1965 exports (Table 7) surpassed imports (Table 8) by a ratio of nearly 2 to 1. Birch veneer represented the single most valuable export commodity, followed by birch and maple lumber. The most important import commodity was oak lumber followed by logs of miscellaneous domestic hardwood species and figured veneer.

ECONOMIC IMPORTANCE OF THE FORESTS

According to the "Directory of primary wood-using industries in Ontario" (Ontario 1966), there were 941 such firms operating in the province. Of these, 646 or 69 per cent were located in southern Ontario (Table 9).

The Dominion Bureau of Statistics reported in 1963 that over 90 per cent of the secondary wood-using industries were located in southern Ontario. These industries employed over 20,000 people and the value of shipments of goods of own manufacture exceeded 243 million dollars (Table 10). The furniture industry was the most important user of lumber and veneer and although no detailed breakdown into species is available, hardwoods as a group accounted for the major share of all the wood used.

But the greatest, direct benefit from the hardwood forests of southern Ontario is probably derived by the many small woodlot owners from stumpage payments. According to a report of the Committee on Private Lands in Southern Ontario (Fingland *et al.* 1965), 167 million board feet of saw timber and veneer logs and 160,000 cords of pulpwood worth approximately 5 million dollars in stumpage were cut on patented land in 1961. This compares with a cut of approximately 490 million board feet of sawtimber and veneer logs cut on crown land in all of Ontario in 1960, which returned 4.1 million dollars stumpage to the crown.

The forests of southern Ontario are also important in many other ways. They protect farm fields from erosion by wind and water, help maintain ground water levels, provide a home for wildlife and supply recreational space for hunting, hiking, camping and picnicking. With the rapid development of the tourist trade and the need for space for recreation close to the large centers of population, many of the hardwood forests of southern Ontario may in time become more valuable for recreation than for the production of timber. However, with careful management these two uses may be compatible.

PRESENT STATE OF HARDWOOD RESEARCH IN ONTARIO

Silviculture

Stand improvement studies dealing with the removal of defective or overmature sugar maple trees have generally resulted in some improvement in the growth and stem quality of the residual trees (MacLean 1949 a, b; Jarvis 1956 b, 1960; Steneker 1960; Fayle 1961 c; Berry 1963; Wang 1963, 1964 a). But the heterogeneous nature of the stands and treatments applied has made evaluation of specific effects difficult. More detailed studies have investigated the relationship between growth rate and quality of sugar maple and have formed the basis of an individual tree value capability classification (Anderson 1960; McLean 1960). Studies correlating growth of various hardwood species with thinning, spacing, temperature, moisture and other site factors have been carried out by bi-monthly measurements using dendrometer tapes (Larsson *et al.* 1964; Larsson and Jaciw 1964). Thinning of second growth tolerant hardwood stands (Hill 1954; Anderson 1960) has shown an immediate response of the residual trees but further studies are needed to investigate fully the long range effects of thinning.

The use and application of various chemicals have been investigated in the elimination of defective trees, thinning of second growth stands and site preparation for subsequent reforestation. In the killing of defective hardwood trees, the effectiveness of the chemicals was found to vary between tree species and generally decreased as the diameter of the treated trees increased. Complete girdling appeared to be essential and 2,4,5-T in oil was found to be the most effective poison (Jarvis 1957 a; Fayle 1961 c; Tieman 1963). One heavy application or three medium applications in one growing season of 2,4,5-T ester in oil, applied as a basal spray, were very effective in the thinning of silver maple stands (Ontario 1965). Hawthorn and wild apple have been eliminated successfully by foliage spray of 2 pounds of 2,4-D ester in 2 gallons of water (Ontario 1963).

A feasibility study of artificial pruning of sugar maple has shown that trees 3 inches and less in diameter could be effectively pruned to a height of 18 feet, but larger trees required considerable effort (Fayle 1962 b).

Natural regeneration of yellow birch has received the widest attention. Several studies investigating the effect of canopy reduction and seedbed preparation have shown that yellow birch will establish itself well on prepared seedbeds and will develop satisfactorily under a light crown canopy (Linteau 1948; Burton 1953; Jarvis 1957 b, 1960; Burton and Sloane 1958; McEwen *et al.* 1958; Holowacz 1960; Fayle 1961 a; Sinclair 1962; Wang 1962, 1964 b, 1965; Anderson 1964; Sykes 1964; Hatcher 1966). But browsing by deer and hare may limit growth severely in areas with a high wildlife population (Jarvis 1956 a; Fayle 1961 b).

Very little work has been done in Ontario on species associated with maple and birch in tolerant hardwood stands (Fayle 1962 b).

The study of intolerant hardwood trees has been concentrated on problems connected with artificial regeneration. A literature review of hardwood planting (von Althen 1964) was followed by a survey of hardwood plantations in southern Ontario (von Althen 1965). Experimental plantings of basswood, white ash, red oak, black walnut, black locust and sugar and silver maples have been undertaken; but results are not yet available. An investigation of the importance of planting stock grades is nearing completion. Various herbicides have been tested in the elimination of herbs and grasses, and results have shown that high dosages will control weed growth (Ontario 1964) but that white ash and silver maple seedlings are very susceptible to such dosages (von Althen 1966).

The reforestation of swamps or poorly drained areas is being investigated using cottonwood, willow, silver maple and European alder (Ontario 1965). Silver maple is also receiving close attention as a possible replacement tree on sites formerly occupied by white elm (Ontario 1964).

A literature review has been completed for basswood (Fayle 1962 a) and seed studies have been carried out with regard to fruit collection, storage and germination of basswood seed (Stroempl 1965).

Several studies investigating the reproductive response of poplar species to various site preparation treatments have shown that removal of the overstorey, ground vegetation, litter and duff effectively stimulates suckering (Boekhoven 1962; Horton 1962; Horton and Hopkins 1963; Horton and Maini 1964; Boekhoven and Horton 1965). An increase in soil temperature was found to be the cardinal factor for sucker stimulation (Maini and Horton 1966 c, d).

Ecology and Physiology

A series of intensive ecological studies have been carried out in a hardwood stand of the Petawawa Forest Experiment Station. A study of tree species in relation to soil moisture has shown that yellow birch, sugar maple and basswood occurred on all moisture regimes; white birch and red oak were restricted to the drier sites and black ash and red maple to the wetter ones (Fraser 1954). The time of initiation of growth appeared to be controlled by winter and early spring temperatures; whereas cessation of growth appeared to be regulated by a shortened photoperiod acting through a growth hormone mechanism (Fraser 1956 a). A study of the annual and seasonal mark of soil moisture and soil temperature in the same hardwood stand showed large variations between years. Rates of change of soil temperature relative to changes of air temperature were greatest on the dry sites and least on the wet sites where the thicker organic layer near the soil surface acted as an insulation (Fraser 1957 a, b). A 9-year study of the crowns of 241 mature yellow birch trees gave no indication that changes in crown conditions were associated with site (Fraser 1959).

A field study of four native hardwood species growing in four levels of light intensity has shown that silver maple and white and yellow birch exhibited a marked preference for 45 per cent light, whereas sugar maple obtained its maximum height over a range from 13 to 45 per cent light (Logan 1965).

Intensive studies have also been carried out on the poplar species. A study of the sequential patterns of the internode, bud and branch-length of trembling aspen, largetooth aspen and balsam poplar indicated consistency within, but differences between species (Maini 1966 a). The growth potential of lateral buds on the stem of aspen suckers is related to the length of the buds so that decapitation of suckers in some cases resulted in greater height increment of the decapitated suckers than that of intact suckers (Maini 1966 b, c). The development of unusual tuberous roots and rapidly-tapering and cord-like roots has been described as part of a larger study of the organization and growth of aspen roots (Maini 1965 a, b). Investigation of the relationship between length of root cutting and production of suckers has shown that roots up to 5.0 cm long produced considerably fewer suckers than 7.5 to 10.0 cm long roots (Maini 1965 c). An anomalous floral organization occurring in trembling aspen was described (Maini and Coupland 1964).

Investigation of the rooting habits of sugar maple and yellow birch has shown that yellow birch is more adaptable to a range of soil depth conditions than sugar maple (Fayle 1965). Optimum rootlet development of yellow birch was found to be closely correlated with the nutrient content of the soil (Redmond 1954 b; 1957 b). A study of the layering habit of hardwood trees has revealed that natural layering of sugar maple is more common than generally realized (Fayle 1964) and that suckers on bitternut hickory may originate either from lateral roots located deep in the soil or from surface laterals originating from the stem at the groundline (Fayle 1966).

Studies in the physiology of hardwood trees have been restricted to yellow birch. A study of the translocation of minerals has provided evidence that either xylem or phloem may transport upwards the minerals required but that phloem may be more important for mineral translocation in trees (Fraser 1956 b). The study of internal water relations of healthy and decadent yellow birch has shown that decadent trees had a higher wood moisture content than healthy trees. Wood moisture was also generally higher in the trunk of trees on a dry site during a wet summer than on a wet site during a somewhat dry summer (Fraser and Dirks 1959). The movement of radioactive isotopes in yellow birch trees showed that the maximum rate of upward movement in the xylem was approximately 1 foot per minute along a narrow channel spiralling upward. The movement in decadent trees was much slower with an apparent increase of permeability of the bark tissue as indicated by lateral diffusion of the isotope (Fraser and Mawson 1953).

Tree Breeding

Research with aspen-like hybrids suitable for southern Ontario has been carried out for a number of years with the emphasis gradually changing from extensive testing of large quantities of average material to intensive testing of the most desirable types (Heimburger 1961, 1962; Ontario 1963, 1964, 1965). Production of hardy dwarf chestnut types, resistant to blight and suitable as dwarfing stock in a tree-breeding program with timber-type chestnuts has been investigated (Ontario 1963). The search for high quality silver maple trees is continuing with the aim of selecting phenotypes for the improvement of planting stock (Ontario 1965). Scions from selected yellow birch have been grafted for several years in preparation for outplanting in a seed orchard (Carmichael and Withers 1957).

Forest Land Classification

Site research in southern Ontario has been carried out by the Site Research unit of the Department of Lands and Forests (Hills, 1950, 1952, 1953, 1954, 1958, 1959, 1960 a, b, c, d, 1962, 1963; Hills and Brown 1955; Hills and Pierpoint 1960). Studies of land-forest relationships have been conducted within the framework of site regions with the aim of (i) describing the various physiographic conditions occurring in a site region so that foresters and land-use planners may recognize them and (ii) providing information regarding forest distribution, forest succession and the capability of these physiographic site types to produce forest and other crops.

Forest Pathology

The Dutch elm disease is presently the most important parasitic condition in southern Ontario and studies continue in the search for an effective control (Anon 1957; Reid and White 1961; Dance 1964, 1966; Reid 1964; Dance *et al.* 1965).

Maple dieback, a disease of unknown etiology affecting sugar maple and other hardwoods, has been under investigation for several years. Results to date indicate that dieback is the result of a number of factors of which improper stand management and adverse climatic conditions appear to be the most important (Griffin 1965).

Heartwood stain in sugar maple has been investigated and the results appear to support the generally accepted viewpoint that the stain is physiological, rather than fungal in origin (Anon. 1965a).

The effect of decay in sugar maple with special reference to its effect on recoverable volume has been investigated (Nordin and Cafley 1950; Nordin 1954).

The study of blue sap stain in hardwoods and conifers caused by the species of the genus *Ceratocystis* is continuing (Griffin 1964).

A study of heartwood defects associated with stem wounds and branch stubs on second-growth sugar maple has confirmed that practically all of the heart rot encountered in sample trees was associated with stem wounds (Vasiloff and Basham 1963; Basham and Taylor 1965).

Root development and root diseases of yellow birch have been studied in connection with "birch dieback". Studies have shown that yellow birch roots are highly susceptible to increased soil temperatures (Redmond 1951; 1954 a, b; 1957 a, b; Redmond and Robinson 1954).

The Ontario Department of Lands and Forests, in co-operation with the Department of Forestry and Rural Development, carried out a survey of a pathological condition in the forests of Ontario (Morawski *et al.* 1958); another study investigated the identity, frequency of occurrence and relative importance of the Basidiomycetes causing decay in living trees in Ontario (Basham and Morawski 1964).

The study of tree diseases in the poplar species is continuing with emphasis on field surveys and taxonomic studies of important pathogens (Basham 1958; Dance 1961; Boyer 1962; Herdy 1963; Dance *et al.* 1964; Maini and Dance 1965).

Forest Entomology

With the exception of the American elm, which is attacked by the elm bark beetle carrier of the fungus causing the Dutch elm disease (Finnigan 1957; Watson and Sippell 1961; Finnigan and Sippell 1964), native hardwood trees appear to be relatively free of serious insect problems. Work has, therefore, been concentrated on insect surveys and the identification of newly found insects (Ross 1958; Sippell 1962; Lindquist 1962, 1963, 1964, 1965; Lindquist and Jackson 1965).

Other problems studied have included the effect of defoliation on foliage production and radial growth of quaking aspen (Rose 1958) and the attack of an ambrosia beetle on sugar maple regeneration (Finnigan *et al.* 1959).

Forest Products

Forest products research in Ontario is mainly carried out by the Forest Products Research Branch of the Department of Forestry and Rural Development. Studies include basic and applied research in the mechanical, physical, chemical and anatomical properties of Canadian woods, the development of new and better uses for wood products and improved manufacturing techniques.

In the field of wood anatomy, the physical and anatomical characteristics of hardwoods have been studied (Wakefield 1937; Hale 1958). The effect of tension wood and reaction wood on the properties of trembling aspen, largetooth poplar, white birch, basswood, white elm and black walnut have been investigated (Perem 1963, 1964) as well as the longitudinal, tangential and transverse shrinkage of red oak and beech (McIntosh 1955, 1957).

Research into the chemical properties of deciduous trees has been concentrated mainly on the study of the pulping characteristics of aspen and some other species (Clermont and Bender 1958; Clermont 1961; Stranks 1961).

Properties and utilization of eight Canadian poplars have been studied (Irwin and Doyle 1961) and machining tests have been conducted on several hardwood species to study their machinability characteristics (Cantin 1965).

Research in the pathology of wood products has included the study of decay and discolourations in poplar pulpwood to determine the identity of the fungi, their viability and possible ability to increase the extent of decay and discolouration during storage (Atwell 1956). Another study has investigated the inhibiting action of a strain of the mold *Trichoderma viride* against four wood-decaying fungi attacking birch logs (Shields and Atwell 1963).

Two studies have investigated the problems connected with lumber seasoning and kiln-drying of yellow birch (Ladell 1956; Calvert 1963) and factors affecting the rotary cutting of curly yellow birch veneer have been studied in the laboratory and a commercial plywood mill (Feihl 1964). Factors affecting the manufacture of white elm veneer and plywood have also been investigated (Feihl 1956).

A series of utilization studies have been carried out to assess the factors contributing to tree, log and lumber quality with special reference to the influence of log size and visible defects. Log grading systems have been worked out for several classes of hardwood products, including factory lumber, construction lumber and veneer (Calvert 1957, 1960; Morowski 1958; Anon.1965b). Qualitative and quantitative factors used for grading logs by these grading systems have been discussed and the most common defects have been described (Petro 1962).

A study of hardwood dimension stock and its future in Canada has been carried out (Flann 1963) and the impact of wood utilization on the farm woodlot has been investigated (Doyle 1964).

The application of computer technology and statistical analyses for facilitating further comparisons of tree qualities has been studied and a digital computer program has been designed (Northcott 1965).

CURRENT MANAGEMENT PROBLEMS

The natural division of the southern Ontario hardwood forests into the tolerant hardwood forests of the Canadian Shield and the intolerant hardwood woodlots of the southern agricultural lands results in a logical division of the hardwood management problems. Much of the past research in Ontario has been concentrated in the tolerant hardwood forests of the Shield, future research must to a greater degree be aimed at solving the management problems of the southern Ontario woodlot owners. The following discussion of current management problems, therefore, refers to the intolerant hardwood forests of the agricultural areas of southern Ontario.

Regional Development, Land Classification, and Forest Inventory

The landscape of southern Ontario is continually changing. Industrial, residential and transportation developments swallow more open land each year. On fertile soils, woodlots are cleared and the land is converted to agriculture. On land of marginal productivity the reverse holds true. Increases in population and leisure time, together with great mobility, have resulted in an increased demand for public recreation and park land. At the same time, many farms are purchased by individuals and are converted into private tree farms or country retreats.

Since the production of hardwood timber requires a long-term investment, continuity of management is one of its major requirements. To assure a reasonable degree of continuity and to avoid the loss of forest investment because of changes in land use, regional surveys are required to study long-range area development and to determine the conditions most likely to assure continuity of forest land use.

Valuable site research has been carried out on the classification of southern Ontario lands for their agricultural potential, their forest growth capability and their recreation suitability. However, more detailed studies are still urgently required to provide the forest manager with the quantitative information necessary for intensive forest management, for example, a lack of detailed information exists on the potential productivity of forest sites for the production of high quality timber of individual tree species. Information is also lacking on the potential forest productivity of cleared land. Studies should provide information on the factors most limiting to plantation establishment and growth. Other studies should indicate how to maximize growth in existing woodlots.

One of the first steps in the development of a meaningful forest policy of hardwood management in southern Ontario must be an inventory of woodlots on a quality basis. The only data currently available are those of the inventory carried out from 1953 to 1957. Since quality was not sampled in this inventory, the data are of limited use. The emphasis on tree quality is based on the fact that only high quality trees have positive values: defective, poorly formed trees and those of commercially undesirable species have negative values. Inventory data expressed only in total volume have little meaning as long as there is no market for much of this volume. Furthermore, no reliable data are currently collected on the annual cut. Since patented land accounts for 82 per cent of the total allowable annual cut and since no law currently exists that requires the forest owner to report his timber sales, annual data on the timber cut are available only from land under government management. The maintenance of a reliable inventory will require continuous or periodic sampling, and forest owners should be required to report their annual cut, by species.

Woodlot Management

The hardwood forests of southern Ontario currently produce only a small percentage of the timber they are capable of growing. High grading and neglect have reduced many woodlots to the state of "silvicultural slums" with little potential for improvement under the current system of extensive management. This neglect has resulted in a drastic reduction in the supply of high quality timber of commercially desirable species and has made it necessary for the hardwood-using industry to import timber from the United States and overseas countries. To rectify this unsatisfactory situation, the Woodland Improvement Act, 1966, was passed. It provides for financial assistance to the forest land owner who agrees to manage his forests according to accepted silvicultural standards.

Unfortunately little information is currently available to the forester or woodlot manager on which to base his selection of the most appropriate silvicultural treatment, for example in order to realize the greatest possible benefit from an improvement cut, the response of the residual trees should be known. Although general information on the silvical characteristics of individual hardwood species has been assembled in the United States (Fowells 1965) for southern Ontario, little quantitative information is available regarding species reactions to various intensities of thinning, release or other silvicultural practices. Information is therefore urgently required on the autecology of our most important hardwood species, including the effect of site, species composition, stand age and other factors affecting tree growth and high quality timber production. With improved knowledge of the effects of various silvicultural treatments on the development of the residual trees, the management forester will be able to select the treatment most likely to produce the best results.

Unlike conifers, many hardwood species when released or pruned are subject to the development of quality-degrading epicormic branches. While it is generally acknowledged that either heavy release or heavy pruning stimulates the development of epicormic branches, little factual information is available on the degree of treatment that will produce this reaction on each of our native species.

Information is also urgently required on the moisture requirements and tolerances of native trees. Such information is vital for the selection of a replacement for the American elm, which Dutch elm disease is currently destroying. The general lowering of the water table in southern Ontario, caused by increased artificial drainage of agricultural land and the great industrial demand for water, may well result in a change of moisture conditions in many woodlots. A thorough knowledge of the moisture requirements of the various species is needed so that management practices may be adapted to changing site conditions.

Increased yield of desirable tree species and quality classes may be obtained through fertilization of selected trees. But before large scale fertilization can be recommended, more information is needed on the effect of all the variables involved, i.e., edaphic factors, kind of fertilizer, level and time of treatment, species and age of tree.

Careful manipulation of the forest canopy may be used to favour or suppress the establishment of natural regeneration and the growth of different tree species, depending on their degree of shade tolerance. Although the principle of these silvicultural treatments is well known, little factual information is available on the reaction of the intolerant southern Ontario hardwood species to different degrees of cutting intensity under various conditions of stand composition, climate and soil.

Artificial Regeneration

Artificial regeneration is one of the most important silvicultural tools because it is the only means of regenerating forest areas where poor harvesting practices or disease have resulted in the destruction of the original stand, where overcutting has eliminated valuable tree species or where the introduction of new species appears to be desirable. Artificial regeneration is also the only means of afforesting cleared land, of establishing shelterbelts or replacing individual shade trees.

The generally unsatisfactory results of artificial hardwood regeneration of southern Ontario resulted in a drastic curtailment of planting stock production in 1956, so that only a small number of seedlings has been available for planting during the last decade. Results of an extensive hardwood plantation survey in southern Ontario (von Althen 1965) showed that although the number of plantation failures was high, some excellent plantations did exist. The most important factors affecting plantation establishment and development were the fertility of the planting site, planting method, cultivation and protection against rodent damage. Because of a lack of knowledge of the growth requirements of different hardwood species, many plantings were made on unsuitable sites. Under these conditions failures could hardly be avoided.

The existence of fundamental differences between forest and agricultural soils is well recognized, but the exact nature and relative importance of the factors affecting tree growth are not yet fully known. Soil micro-organisms, for example, appear to affect tree growth, but little factual information is yet available about this effect. Other factors requiring intensive investigation on afforestation sites are changes in soil structure as the result of cultivation and compaction, the absence or low level of organic material and changes in soil fertility.

Successful reforestation and afforestation also depend on the quality of the planting stock. Insufficient information is available on such factors as age and size of the seedlings, the effect of root pruning, the effect of nursery fertilization, time of lifting and method of storing.

Experimental results have shown also that planting method greatly influences seedling survival and early growth and that methods developed for conifers are not equally applicable to hardwood. Planting methods should, therefore, be developed that meet the requirements of hardwood species and that are, at the same time, economically feasible for large scale plantation establishment.

On all fertile soils, which are the best hardwood planting sites, competition from weeds and grasses is very intense. To assure planting success, weed growth must be controlled during the first few years after planting. Intensive manual or mechanical cultivation has proven very successful, but these practices are much too expensive for ordinary plantation establishment. Recent developments in the field of chemical herbicides have offered the possibility of easier and cheaper methods of weed control. But before widespread use of herbicides can be recommended, more must be known about the susceptibility of different tree seedlings to type of herbicide, dosage, method and season of application, as well as the economic aspects of chemical weed control.

Rodent damage is a serious problem during the early life of all hardwood plantations. Girdling by mice and rabbit browsing, while not necessarily lethal, generally result in serious loss of growth and the development of poor stem form. Damage is most severe on heavily weed-infested sites where the ground cover provides excellent protection from predators. The most effective control method is the maintenance of clean cultivation, but high costs make this method economically unattractive. Poisoning of the mice and application of rabbit repellents will reduce the damage, but the duration of effectiveness is generally short and the necessity of frequent application greatly increases the cost of these methods. More economical protection methods should therefore be developed.

Seed pilferage and destruction by squirrels is a serious problem in the direct seeding of acrons, walnuts and other large seeds. No economically feasible control method has been developed; therefore, direct seeding of nuts is not practicable in squirrel-infested woodlots.

Little information is available on the test plantings of foreign hardwood tree species that may be suitable for forestry use in Ontario. The danger of wholesale planting of exotic species is well recognized, but careful estimation of the possibilities for success should eliminate a great many species and permit the testing of those few that show some prospect of being useful. The testing of foreign trees in Ontario should be carried out with the aim of discovering a suitable replacement for the American elm. The growing importance of the poplar species also suggests the desirability of test plantings of poplar hybrids and introduced poplar species, to test new strains and to provide the opportunity for genetic research.

Forest Pathology and Entomology

Destruction of the American elm by Dutch elm disease is the most important pathological problem in southern Ontario. Every effort should therefore be made to develop an effective control of the disease or at least develop an economic protection method for currently healthy trees.

Insufficient information is available on the identification of internal stem defects by external indicators. The identification of pathogens and the probable extent of internal defects by external indicators is of vital importance not only to the development of cutting practices, but also to the development of a reliable inventory system based on tree quality. However, the final goal of forest pathology must naturally be the development of control methods.

Little attention has been paid to date to the study of hardwood nursery diseases. For example, information is lacking on the importance of stem cankers and other diseases.

Forest Utilization

Under-utilization of most species and of all trees of small diameter or poor form is one of the greatest problems of the southern Ontario hardwood forests. While the supply of high quality timber of a few selected species is rapidly being exhausted, the supply of trees of currently low commercial value, small diameter, or poor form is steadily increasing. One aim of utilization research should therefore be the investigation of possibilities for the manufacture of the widest range of merchantable products from all available tree species, and the adjustment of conversion methods and uses to the requirements and limitations of sound hardwood silviculture (Doyle 1962). To obtain this objective more specific information is required on the comparative properties of species in relation to various end uses. The cause, relative importance and possible control of natural defects must be determined as well as the effect of silvicultural treatments on the wood properties of all commercially important hardwood species.

Forest Economics

Very little information is available on the economics of managing the southern Ontario hardwood forests. No specific information exists on the economic returns to be realized from the various alernative uses of the land or from the different intensities of management. The intangible values of esthetics, recreation, water preservation and erosion control have never been defined in objective terms. Woodlot productivity has only been expressed in terms of total volume which has very little meaning under the prevailing conditions of restricted utilization and extensive management. The economic importance of a hardwood-using industry to the local community and to the province as a whole has not been clearly determined. The annual income from privately owned woodlots is not known.

Therefore, information is urgently required to determine the economic returns from forest land utilization for the purpose of high quality timber production, watershed protection, wildlife conservation, recreation and the various combinations of these uses. Detailed surveys are required to assess the raw material requirements of the hardwood-using industry and to compare these requirements with existing wood supplies. Determination of the relative value of individual forest products is required for the development of grading and bucking rules to recover the highest wood value from individual trees. Cost-benefit analyses should be carried out to evaluate the success of individual silvicultural treatments and to provide the necessary information for the development of the most profitable silvicultural treatments. The principles of financial maturity (Duerr 1960; Duerr *et al.* 1956) should be tested in Ontario for their probable applicability in the determination of the most profitable length of rotation for individual hardwood species.

SUMMARY

The hardwood forests of southern Ontario cover a total area of 12.8 million acres and their total allowable annual cut is 281 million cubic feet. Sixty-nine per cent of all primary and 90 per cent of all secondary wood-using industries of the province are located in southern Ontario. Over 20,000 people are directly employed by these industries

and the value of goods produced exceeded 243 million dollars in 1963. The southern hardwood forests are also highly important for recreation, watershed protection and erosion control.

Excessive exploitation and poor management practices have resulted in a serious depletion of high quality timber and the destruction of much of the growth potential of these highly productive forests. Recognizing the serious raw material shortage and aware of the fact that the southern Ontario woodlots were producing only a small fraction of their potential, in 1966 the Ontario Legislature passed the Woodlands Improvement Act. Under the terms of this act, public funds may be provided for the expansion and improvement of privately-owned woodlots. Unfortunately, much of the information required for woodland improvement is not available. Past hardwood research in Ontario has been limited to the investigation of individual aspects of hardwood growth without a policy of comprehensive problem solution. To provide the information required for the intensification and improvement of southern Ontario management, a new, comprehensive research program is therefore required. The purpose of this report is to provide background information on the economic importance of the hardwood resource, review the present state of knowledge and indicate some of the problems currently limiting intensification of woodlot management. This information provides a basis for the development of a comprehensive plan for further research on the management of southern Ontario hardwoods.

APPENDIX

Botanical Names of Species Mentioned

English Name	Botanical Name
Speckled alder	*Alnus rugosa* (Du Roi) Spreng. var. *americana* (Regel) Fern.
Black ash	*Fraxinus nigra* Marsh.
Blue ash	*Fraxinus quadrangulata* Michx.
Green ash	*Fraxinus pennsylvanica* Marsh. var. *subintegerrima* (Vahl) Fern.
Red ash	*Fraxinus pennsylvanica* Marsh.
White ash	*Fraxinus americana* L.
Largetooth aspen	*Populus grandidentata* Michx.
Trembling aspen	*Populus tremuloides* Michx.
Basswood	*Tilia americana* L.
American beech	*Fagus grandifolia* Ehrh.
Blue beech	*Carpinus caroliniana* Walt.
Sweet birch	*Betula lenta* L.
Yellow birch	*Betula alleghaniensis* Britt.
White birch	*Betula papyrifera* Marsh.
Butternut	*Juglans cinerea* L.
Black cherry	*Prunus serotina* Ehrh.
Chestnut	*Castanea dentata* (Marsh.) Borkh.
Eastern cottonwood	*Populus deltoides* Marsh.
Rock elm	*Ulmus thomasii* Sarg.
Slippery elm	*Ulmus rubra* Muhl.
White elm	*Ulmus americana* L.
Black gum	*Nyssa sylvatica* Marsh.
Hawthorn spp.	*Crataegus* L.
Bitternut hickory	*Carya cordiformis* (Wang.) K. Koch
Mockernut hickory	*Carya tomentosa* Nutt.
Pignut hickory	*Carya glabra* (Mill.) Sweet
Shagbark hickory	*Carya ovata* (Mill.) K. Koch
Ironwood	*Ostrya virginiana* (Mill.) K. Koch
Kentucky coffee-tree	*Gymnocladus dioica* (L.) K. Koch
Black locust	*Robinia pseudoacacia* L.
Honey-locust	*Gleditsia triacanthos* L.
Magnolia	*Magnolia acuminata* L.
Black maple	*Acer nigrum* Michx. f.
Mountain maple	*Acer spicatum* Lam.
Red maple	*Acer rubrum* L.
Silver maple	*Acer saccharinum* L.
Striped maple	*Acer pensylvanicum* L.
Sugar maple	*Acer saccharum* Marsh.
Red mulberry	*Morus rubra* L.

Black oak	*Quercus velutina* Lam.
Burr oak	*Quercus macrocarpa* Michx.
Chestnut oak	*Quercus prinus* L.
Chinquapin oak	*Quercus muehlenbergii* Engelm.
Northern red oak	*Quercus rubra* L.
Pin oak	*Quercus palustris* Muenchh.
Scarlet oak	*Quercus coccinea* Muenchh.
Swamp white oak	*Quercus bicolor* Willd.
White oak	*Quercus alba* L.
Papaw	*Asimina triloba* (L.) Dunal
Balsam poplar	*Populus balsamifera* L.
Redbud	*Cercis canadensis* L.
Tulip tree	*Liriodendron tulipifera* L.
Sassafras	*Sassafras albidum* (Nutt.) Nees.
Sycamore	*Platanus occidentalis* L.
Black walnut	*Juglans nigra* L.
Willow spp.	*Salix* L.
Eastern white cedar	*Thuja occidentalis* L.
Balsam fir	*Abies balsamea* (L.) Mill.
Eastern hemlock	*Tusga canadensis* (L.) Carr.
Eastern white pine	*Pinus strobus* L.
Jack pine	*Pinus banksiana* Lamb.
Pitch pine	*Pinus rigida* Mill.
Red pine	*Pinus resinosa* Ait.
Short leaf pine	*Pinus echinata* Mill.
Black spruce	*Picea mariana* (Mill.) BSP.
Norway spruce	*Picea abies* (L.) Karst.
Red spruce	*Picea rubens* Sarg.
White spruce	*Picea glauca* (Moench) Voss
Tamarack	*Larix laricina* (Du Roi) K. Koch

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Table 1 Total area classification of the eight southern Ontario Forest Districts

Forest district	Productive forest Acres	%	Non-productive forest Acres	%	Wooded pasture Acres	%
Lake Erie	321,224	7.8	107,624	2.6	158,806	3.8
Lake Huron	738,188	13.0	225,234	4.0	327,532	5.8
Lake Simcoe	483,654	15.7	120,702	3.9	156,532	5.1
Lindsay	1,489,671	44.7	182,260	5.5	100,304	3.0
Tweed	2,243,907	50.4	333,430	7.5	140,272	3.1
Kemptville	516,880	15.5	224,178	6.7	217,976	6.5
Parry Sound	2,847,587	74.3	252,579	6.6	---	---
Pembroke	2,563,681	76.8	173,451	5.2	---	---
Total	11,204,792	36	1,619,458	5	1,101,422	4

Excluded are Indian Reserves and other areas under the administration of the Federal Government

(concluded)

Table 1 Total area classification of the eight southern Ontario Forest Districts (concluded)

Forest district	Non-forested land		Water		Total	
	Acres	%	Acres	%	Acres	%
Lake Erie	3,481,880	84.4	57,240	1.4	4,126,774	100
Lake Huron	4,304,720	75.9	73,630	1.3	5,669,304	100
Lake Simcoe	2,076,532	67.4	243,892	7.9	3,081,312	100
Lindsay	1,301,413	39.0	259,844	7.8	3,333,492	100
Tweed	1,481,303	33.2	257,758	5.8	4,456,670	100
Kemptville	2,275,198	68.4	95,256	2.9	3,329,488	100
Parry Sound	309,005	8.1	421,454	11.0	3,830,625	100
Pembroke	324,799	9.8	274,431	8.2	3,336,362	100
Total	15,554,850	50	1,683,505	5	31,164,027	100

Table 2 Classification of productive forest land into ownership groups

Forest district	Crown land		Patented land		Total
	Acres	%	Acres	%	Acres
Lake Erie	10,602	3.3	310,622	96.7	321,224
Lake Huron	19,002	2.6	719,186	97.4	738,188
Lake Simcoe	58,470	12.1	425,184	87.9	483,654
Lindsay	526,589	35.3	963,082	64.7	1,489,671
Tweed	959,352	42.8	1,284,555	57.2	2,243,907
Kemptville	13,192	2.6	503,688	97.4	516,880
Parry Sound	1,640,025	57.6	1,207,562	42.4	2,847,587
Pembroke	2,176,322	84.9	387,359	15.1	2,563,681
Total	5,403,554	48.2	5,801,238	51.8	11,204,792

Table 3 Cubic foot volumes of primary growing stock on productive forest land in southern Ontario by species and ownership groups

Species	Crown land		Patented land		Total	
	M cu.ft.	%	M cu.ft.	%	M cu.ft.	%
Pine, white	890,908	63	517,092	37	1,408,000	
Pine, red	191,865	75	64,956	25	256,821	
Pine, jack	127,856	87	18,435	13	146,291	
Pine, pitch	23	10	199	90	222	
Spruce, white	261,824	62	158,362	38	420,186	
Spruce, black	57,315	69	25,852	31	83,167	
Balsam	374,396	58	270,665	42	645,061	
Hemlock	641,815	64	360,802	36	1,002,617	
Cedar, white	249,717	32	524,480	68	774,197	
Cedar, red	14	1	2,169	99	2,183	
Larch	6,717	23	22,983	77	29,700	
Total conifers	2,802,450	59	1,965,995	41	4,768,445	26

(concluded)

Table 3 Cubic foot volumes of primary growing stock on productive forest land in southern Ontario by species and ownership groups (concluded)

Species	Crown land		Patented land		Total	
	M cu.ft.	%	M cu.ft.	%	M cu.ft.	%
Maple, sugar	2,287,291	53	2,000,739	47	4,288,030	
Maple, soft	185,622	26	533,705	74	719,327	
Birch, yellow	1,291,550	71	530,041	29	1,821,591	
Beech	259,447	41	368,631	59	628,078	
Elm	168,586	16	878,704	84	1,047,290	
Ironwood	77,929	43	102,478	57	180,407	
Oak, red	167,038	40	246,520	60	413,558	
Oak, white	2,381	4	53,841	96	56,222	
Birch, white	628,827	61	399,088	39	1,027,915	
Poplar	1,118,425	54	971,037	46	2,089,462	
Ash	183,686	36	332,404	64	516,090	
Basswood	119,255	32	254,725	68	373,980	
Cherry, black	29,743	34	58,775	66	88,518	
Butternut	102	2	4,887	98	4,989	
Hickory	845	2	38,872	98	39,717	
Other hardwoods	---	0	100	100	100	
Total hardwoods	6,520,727	49	6,774,557	51	13,295,284	74
Total all species	9,323,177	52	8,740,552	48	18,063,729	100

Table 4 Cubic foot volumes of the annual allowable cut on productive forest land in southern Ontario by species and ownership groups

Species	Crown land		Patented land		Total	
	M cu.ft.	%	M cu.ft.	%	M cu.ft.	%
Balsam	1,255		8,458		9,713	
Cedar	581		9,875		10,456	
Hemlock	3,140		4,510		7,650	
Pine, jack	981		864		1,845	
Pine, white	1,354		10,773		12,127	
Pine, red	179		2,030		2,209	
Pine, pitch	---		6		6	
Spruce, white	1,343		4,949		6,292	
Spruce, black	217		539		756	
Larch	7		574		581	
Total conifers	9,057	18	42,578	82	51,635	18

(concluded)

Table 4 Cubic foot volumes of the annual allowable cut on productive forest land in southern Ontario by species and ownership groups (concluded)

Species	Crown land		Patented land		Total	
	M cu.ft.	%	M cu.ft.	%	M cu.ft.	%
Ash	791		6,233		7,024	
Basswood	1,309		7,961		9,270	
Beech	1,681		4,607		6,288	
Birch, white	1,464		12,472		13,936	
Birch, yellow	15,789		8,282		24,071	
Butternut	---		92		92	
Cherry, black	115		1,102		1,217	
Elm	569		16,475		17,044	
Hickory	6		729		735	
Ironwood	483		1,921		2,404	
Maple, sugar	16,483		37,514		53,997	
Maple, soft	764		24,946		25,710	
Oak, red	87		4,622		4,709	
Oak, white	6		673		679	
Poplar	2,204		60,689		62,893	
Walnut, black	---		2		2	
Total hardwoods	41,751	18	188,320	82	230,071	100
Total all species	50,808	18	230,898	82	281,706	100

Table 5 Comparison of annual allowable cut by species with actual utilization on Crown land in southern Ontario for the period April 1, 1963 to March 31, 1964

Species	Cu.ft. volume of annual allowable cut	Actual cut	Actual cut as per cent of allowable cut 1963-64
	M cu.ft.	M cu.ft.	%
Balsam	1,255	439	35
Cedar	581	47	8
Hemlock	3,140	2,809	89
Pine, jack	981	880	90
Pine, white	1,354	5,238	387
Pine, red	179	1,590	888
Spruce, white	1,343	1,373	88
Spruce, black	217	0	0
Larch	7	4	57
Total conifers	9,057	12,380	37 overcut

(concluded)

Table 5 Comparison of annual allowable cut by species with acutal utilization on Crown land in southern Ontario for the period April 1, 1963 to March 31, 1964 (concluded)

Species	Cu.ft. volume of annual allowable cut	Actual cut	Actual cut as per cent of allowable cut 1963-64
	M cu.ft.	M cu.ft.	%
Ash	791	62	78
Basswood	1,309	558	43
Beech	1,681	476	28
Birch, white	1,464	623	43
Birch, yellow	15,789	3,870	25
Butternut	0	2	overcut
Cherry, black	115	22	19
Elm	569	236	41
Hickory	6	0	0
Ironwood	483	0	0
Maple, sugar	16,483	5,853	34
Maple, soft	764	0	0
Oak, red	87	257	276
Oak, white	6	0	0
Poplar	2,204	3,800	172
Miscellaneous hardwoods	0	334	overcut
Total hardwoods	41,751	16,093	39
Total all species	50,808	28,473	56

Table 6 Comparison of annual allowable cut by species with actual utilization according to Mill Licence Returns and exports for the year 1965, for all productive forest land in southern Ontario

Species	Total cu.ft. volume of annual allowable cut	Actual cut in 1965 according to Mill Licence Returns	Actual cut as per cent of allowable cut 1965
	M cu.ft.	M cu.ft.	%
Balsam	9,713	445	5
Cedar	10,456	1,295	12
Hemlock	7,650	5,488	72
Pine, jack	1,845	519	28
Pine, white Pine, red	14,336	13,110	91
Pine, pitch	6	0	0
Spruce white Spruce, black	7,048	3,672	52
Larch	581	1	0
Total conifers	51,635	24,530	48

(concluded)

Table 6 Comparison of annual allowable cut by species with actual utilization according to Mill Licence Returns and exports for the year 1965, for all productive forest land in southern Ontario (concluded)

Species	Total cu.ft. volume of annual allowable cut M cu.ft.	Actual cut in 1965 according to Mill Licence Returns M cu.ft.	Actual cut as per cent of allowable cut 1965 %
Ash	7,024	460	6
Basswood	9,270	1,966	21
Beech	6,288	1,279	20
Birch, white Birch, yellow	38,007	7,378	19
Butternut	92	5	5
Cherry, black	1,217	188	15
Elm	17,044	5,988	35
Hickory	735	32	4
Ironwood	2,404	0	0
Maple, sugar Maple, soft	79,707	18,078	23
Oak, red Oak, white	5,388	1,059	20
Poplar	62,893	8,739	14
Walnut, black	2	42	2100
Other hardwoods	0	347	overcut
Total hardwoods	230,071	45,561	20
Total all species	281,706	70,091	25

Table 7 Exports from Canada of hardwood logs, lumber and veneer for the years 1963 to 1965

Species and type of product		1963	
		Volume in M/bm.	Value in dollars
Logs	Birch	4,430	756,596
"	Maple	3,036	371,510
"	Poplar	8,069	695,761
"	Hardwood n.e.s.	594	148,826
	Total	16,129	1,972,693
Lumber	Basswood	2,035	386,712
"	Birch	69,782	13,050,262
"	Maple	44,970	7,858,204
"	Poplar	3,626	238,399
"	Hardwood n.e.s.	5,971	766,944
	Total	126,384	22,300,521
		M sq.ft.	
Veneer	Birch	651,840	20,788,596
"	Maple	17,873	660,930
"	Hardwood n.e.s	49,666	2,132,103
	Total	719,379	23,581,629
	Grand total		47,855,113

(continued)

Table 7 Exports from Canada of hardwood logs, lumber and veneer for the years 1963 to 1965 (continued)

Species and type of product		1964 Volume in M/bm.	1964 Value in dollars
Logs	Birch	6,145	1,019,513
"	Maple	2,355	307,747
"	Poplar	8,970	835,322
"	Hardwood n.e.s.	482	70,179
	Total	17,952	2,232,761
Lumber	Basswood	2,852	558,720
"	Birch	72,567	13,806,279
"	Maple	46,398	8,374,487
"	Poplar	3,037	186,402
"	Hardwood n.e.s.	5,161	647,275
	Total	130,015	23,573,163
		M sq.ft.	
Veneer	Birch	730,664	24,399,953
"	Maple	25,758	724,527
"	Hardwood n.e.s.	74,496	3,323,854
	Total	830,918	28,448,334
	Grand total		54,254,258

(concluded)

Table 7 Exports from Canada of hardwood logs, lumber and veneer for the years 1963 to 1965 (concluded)

Species and type of product		1965 Volume in M/bm.	1965 Value in dollars
Logs	Birch	4,400	777,158
"	Maple	2,620	331,626
"	Poplar	7,777	941,886
"	Hardwood n.e.s.	967	216,398
	Total	15,764	2,267,068
Lumber	Basswood	4,024	670,820
"	Birch	77,051	14,912,931
"	Maple	60,727	10,622,377
"	Poplar	3,113	213,983
"	Hardwood n.e.s.	10,670	1,494,999
	Total	155,585	27,915,110
		M sq.ft.	
Veneer	Birch	788,051	25,412,574
"	Maple	22,605	688,900
"	Hardwood n.e.s.	86,461	4,613,217
	Total	897,417	30,714,691
	Grand total		60,896,869

Table 8 Import into Canada of hardwood logs, lumber and veneer for the years 1963 to 1965

Species and type of product	1963	
	Volume in M/bm.	Value in dollars
Hickory billets	n.a.	110,975
Domestic hardwood logs	226,967	15,681,330
Exotic hardwood logs	unknown	1,114,223
Total	---	16,906,528
White ash lumber	2,134	400,914
oak "	54,082	7,171,450
poplar "	1,179	202,110
walnut "	6,542	2,382,518
Domestic hardwood n.e.s.	15,133	1,645,165
mahogany "	13,860	2,688,600
gumwood "	305	64,817
Exotic hardwood "	---	---
Total	93,235	14,555,574
	M sq.ft.	
Rosewood veneer	---	1,793,073
Australian blackwood veneer	---	483,133
Figured hardwood "	---	---
Miscellaneous hardwood "	---	3,422,079
Total		5,698,285
Grand total		37,160,387

(continued)

Table 8 Import into Canada of hardwood logs, lumber and veneer for the years 1963 to 1965 (continued)

Species and type of product	1964 Volume in M/bm.	Value in dollars
Hickory billets	---	---
Domestic hardwood logs	53,551	4,617,518
Exotic hardwood logs	2,223	277,583
Total	55,774	4,895,101
White ash lumber	2,641	520,700
oak "	67,166	8,891,076
poplar "	1,111	224,239
walnut "	5,980	2,291,863
Domestic hardwood n.e.s.	14,602	1,609,729
mahogany "	14,492	2,780,736
gumwood "	---	---
Exotic hardwood "	7,380	1,762,038
Total	133,372	18,080,381
	M sq.ft.	
Rosewood veneer	---	---
Australian blackwood veneer	---	---
Figured hardwood "	175,890	5,734,285
Miscellaneous hardwood "	20,979	953,942
Total	196,869	6,688,227
Grand total		29,663,709

(continued)

Table 8 Import into Canada of hardwood logs, lumber and veneer for the years 1963 to 1965 (concluded)

Species and type of product	1965 Volume in M/bm.	1965 Value in dollars
Hickory billets	---	---
Domestic hardwood logs	54,114	5,539,036
Exotic hardwood logs	892	202,282
Total	55,006	5,741,318
White ash lumber	1,646	328,958
oak "	63,023	8,534,448
poplar "	965	166,603
walnut "	7,735	2,967,824
Domestic hardwood n.e.s.	15,427	1,801,587
mahogany "	18,449	3,201,501
gumwood "	---	---
Exotic hardwood "	11,394	2,058,507
Total	118,639	19,059,428
	M sq.ft	
Rosewood veneer	---	---
Australian blackwood veneer	---	---
Figured hardwood "	150,930	5,401,913
Miscellaneous hardwood "	26,783	1,389,381
Total	177,713	6,791,294
Grand total		31,592,040

Table 9 Geographical location of primary wood-using industries in Ontario in 1966

	Eight southern forest districts		Fourteen northern forest districts	
	no.	%	no.	%
Sawmills	548	68	262	32
Veneer mills	20	69	9	31
Wooden box plants	34	97	1	3
Miscellaneous wood industries	39	89	5	11
Pulp mills	5	22	18	78
Total all industries	646	69	295	31

Table 10 Value of secondary wood-using industries in Ontario in 1963

	No. of people employed	Value of shipments of goods of own manufacture $'000
Household furniture industry	9,667	113,264
Sash, door and planing mills	3,969	52,366
Office furniture industry	2,234	27,237
Miscellaneous wood industries	1,834	23,978
Wooden box factories	1,436	15,056
Coffin and casket industry	615	4,799
Hardwood flooring industry	557	6,670
Total all industries	20,312	243,370