THE MANAGEMENT OF SOUTHWESTERN ONTARIO HARDWOODS

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FOREWORD

The hardwood forests of southwestern Ontario possess many features that together make them unique in Canada. They are fragmented into innumerable woodlots nearly all of which are privately owned; they contain valuable species such as black walnut, black cherry and white ash, some of which are near the northern limit of their ranges; they occupy land which is often nearly the best in Canada for either agricultural or forestry use; and they are easily accessible to densely populated areas. Thus there are heavy demands on the forests for the production of hardwood lumber and veneer, the production and protection of game, the provision of recreational facilities, and even the provision of more agricultural land. Yet their fragmented nature and pattern of ownership impose severe constraints on their active management for any of these purposes except the last.

There are also large areas of land that were injudiciously cleared for agriculture in the past and today are abandoned and non-productive of forests. On such areas the destruction of a forest environment and depletion of soil fertility continue to make reforestation difficult and expensive, especially where hardwoods are the preferred species.

The object of the Symposium was to bring together forest managers and research workers in order to present and exchange their views on the technical and social problems of managing the hardwood forests: to define present problems and to provide a comprehensive background for future research.

After presentation of the papers contained in these Proceedings the participants undertook a field trip that included inspections of operational and experimental thinning of hardwood stands, and experimental plantations of both decorative hardwoods and hybrid poplars.

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During the next 3 days you will have the opportunity of receiving and discussing a host of papers, each dealing with a specific aspect of the management of southwestern Ontario hardwoods. However, prior to that I would suggest that we attempt to look at some of the broad issues involved in this topic. I say "look at them" rather than "come to grips with them" because they are far too complex and crucial for adequate treatment at this relatively short symposium. Nevertheless, the resource manager must come to grips with them before he can effectively manage the forest and the forest land resources.

Basically I am asking you to direct your attention to the "what" and the "why" of southwestern Ontario hardwood management rather than the "how". There are essentially three questions which must be answered:

1) What is the resource with which we are dealing?
   - What is the tenure and distribution of the land base? Who are the owners?
   - Why do they own this land? What are their objectives for and attitudes toward management and utilization?

2) What benefits or potential benefits does the resource provide?
   - What are the potential benefits to timber, wildlife, recreation, landscaping, or environmental control?

3) What are the costs of allocating or allowing the resource to provide each of these benefits?
   - What are the real costs of providing growing stock, public or private hunting and fishing, greenbelts and scenic vistas?

Only after recognizing and coming to grips with these issues are we able to visualize exactly what and why we are managing. At that stage the secondary issues of management and utilization techniques and schedules will come into play. These are the "how" aspects which are largely the focus of this symposium.

What kinds of benefits and costs are we dealing with in southwestern Ontario? Most of us are largely aware of the economic benefits resulting from an activity such as commercial timber utilization. However, no one can logically assert that the industrial utilization of timber is a solely economic function. What of the immense social benefits afforded by providing newsprint and textbook papers for the dissemination of information and knowledge? What of the noneconomic contribution of a surgeon's disposable paper gown, a child's wooden crib, or the quiet creak of a pensioner's wooden rocking chair as he enjoys a winter's afternoon in front of his fireplace? People do in fact derive immense social and aesthetic benefits from the timber products (some trivial and fanciful, but a good many essential to their daily living) which surround them.

In all likelihood most people find that the social and aesthetic benefits of utilizing wood products are more important to them than are the economic benefits which they receive from the industrial production of these same goods.

Similarly, the utilization and management of resources for any alternative activity will not yield solely positive, aesthetic and social benefits. Whatever that activity may be, there are distinct and important economic benefits involved in its selection. Likewise, there are direct and indirect aesthetic and economic costs. For example, social and economic costs connected with outdoor recreation might take the form of increased public expenditure to provide roads, remove garbage and control vandalism. They might also take the form of repairs and compensation after accidents, injuries or mishaps occurring on the ski slopes, highways, campsites or waterways.

Surely, then, it is unreasonable and naive to talk of certain forms of forest land management and utilization as falling into either a "negative-value, industrial-economic" group or a "positive-value, environmental-social" group. There is no such utopian classification of benefits and costs. Alternative activities are not simple to analyze - they do not fall readily into either a positive or negative camp - and their effective analysis and management cannot be accomplished without employing a great deal of intelligence and insight.

Since it is not possible to come to grips with every aspect of resource management and utilization during a single symposium, my remarks will be restricted to the problems of utilization and management of southwestern hardwoods for timber products, and the benefits which are derived from that specific purpose of management.

The resources required to provide timber products which directly yield various social and economic benefits are land, labour, time, and money. Each of these is a bona-fide resource because it is available in limited quantities and because there are competing demands for its utilization.

The land base is limited. Furthermore, expertise is an extremely scarce commodity and, contrary to popular opinion, funds are critically limited. In the face of these shortages there is competition for each of the resources among recreation, wildlife, agriculture, timber, urban sprawl, and a host of other activities. Before land, staff, time and funds can be allocated to the management and utilization of southwestern Ontario hardwoods, it is necessary to ensure that such resources will be used to better advantage here than in other forest areas, in other natural resource divisions, and in other policy fields.

The forest industry of southwestern Ontario (where southwestern Ontario in this context refers to that portion of the Province south and west of the pre-Cambrian Shield) is a unique and extremely interesting entity in Canada, which is seldom analyzed or discussed from an entirely objective point of view.

The primary wood-using industry of this area presently consists of some 220 mills, including eight veneer mills and two major pulp mills. The industry, essentially a hardwood lumber industry, currently produces 85 million fbm of hardwood lumber annually, almost exclusively from patented lands. The wholesale market value of this lumber production is about $11 million. The two pulp mills consume a greater amount of fibre than the rest of the industry combined, but only about 5 percent of this is southwestern hardwood--again almost exclusively from patented lands.

Thus, from a generalized forest industry point of view, the current hardwood resource of southwestern Ontario supports a small but economically significant lumber industry, exclusively dependent on private land timber. The local resource further accounts for a part of the raw material base to support a small hardwood veneer industry (although most quality logs are derived from the Shield region or are imported from outside of Canada). This local resource provides essentially no raw material for pulp and paper activities at the present time.

Briefly, then, although the southwestern Ontario hardwood resource yields only about 2 percent of the Province's total raw material requirements, the area's primary industry accounts for up to 7 or 8 percent of the Province's total roundwood consumption by obtaining very substantial amounts of timber from outside the area.

The problems of the primary industry are quite complex, although essentially they all come down to timber availability and cost. In general, our southwestern primary industry will not be able to continue its tradition of purchasing high-quality, high-cost raw material and producing its traditional products. Although much of the industry's end product is relatively high-value hardwood lumber, the costs of procurement and manufacture are high and rapidly increasing, such that the continued allowance for a favourable return to the producer of raw material is questionable. Similarly, there is a marginal allowance for raw material transportation from other regions. If it should come about that southwestern hardwoods are not consciously managed and utilized for primary manufacture and if the industry does not discard its traditional methods of functioning, much of the present industry will disappear. This is especially true of the veneer mills and the large number of small sawmills and miscellaneous mills, which have neither the resources nor the initiative to relocate in other areas.

Recognition of the land tenure in southwestern Ontario is essential for understanding the forest and forest land resource. A full nine-tenths of the productive forest land is privately owned. This means that most timber production programmes are likely to be interrupted before harvestable age, since the average period of ownership on the larger woodlands is less than 20 years. The form of land tenure also guarantees that much of the timber that is produced will never be made available to the local industry, either because the owner is opposed to logging - he is producing timber for his own consumption - or because he is indifferent about making it commercially available. Furthermore, any timber which is produced on private lands is fully eligible for export as roundwood.

The reason for high operating costs is, largely, old age. The area's two pulp mills were built prior to the First World War, and one operated until after the Second World War - not on wood fibre at all, but on straw. Many of our present sawmill sites were established as early as 1850. It is not uncommon to find some of these still operating on antiquated or outdated equipment and systems. In many cases the primary industry is not large enough to obtain adequate economies of scale. It tends to be labour intensive, relatively slow, and badly in need of modernization--all of which result in high operating costs. Lumber-manufacturing technology in hardwoods has not kept pace with that in softwoods.

Perhaps the second major reason for high operating costs is the fact that this industry is located in Canada's highest-average-income area. Many primary wood-using plants must compete with high-wage secondary manufacturing industries, such as the petrochemical, metal-fabricating, and motor-vehicle-assembly industries, to obtain and maintain their labour force. Such an environment of high wages and salaries tends to act as a serious impediment to the development of the primary industry in this region.

A further factor which will directly burden the already-high cost of operation is the current demand for more rigid pollution-abatement standards covering the various stages of primary processing.

The value of the industry's output - although high in comparison with certain other areas and end products - is below its potential. Significant volumes of medium- and high-quality logs are not allocated to their highest-profit end use because of the limited size of many woodlots and mills, and the low degree of horizontal and vertical integration.

Finally, the upper limit to the return which primary hardwood products will receive is closely associated with the cost of obtaining alternative sources of wood or nonwood raw material, and the price indexes of several of these substitutes have not been climbing as quickly as those of wood-based material.

The high cost of stumpage in southwestern Ontario is a product of two compounding factors:

1) the high cost of land in the area

2) the traditional usage of long-rotation hardwood species

The high cost of land is a reasonable reflection of the soil, moisture, and climatic capability of the area for agricultural production - the same capabilities which provide a high biological potential for tree growth. Further influences giving rise to the high land values are urbanization in this area and the heavy demand for recreational lands. This dependence on long-rotation species from high-cost land has inevitably led to high costs of raw material for the established primary industry, and the problem will intensify as land values in southwestern Ontario continue to reflect the heavy demand for this resource.

The following trends can be seen in attempts to overcome the series of problems facing the management and utilization of southwestern hardwoods:

- Several firms are attempting to generate additional revenue by producing pulp chips from both roundwood and residues, largely for sale to nearby U.S.-based mills.

- Other firms are attempting to diversify and integrate their operations, as exemplified by Ontario Paper's multimillion-dollar venture into the large-scale production of industrial by-products at its Thorold pulping operation.

- Still other companies, resource owners and managers are refocusing their traditional industrial emphasis to such nontimber benefits and ventures as wildlife production, recreation, maple syrup production and the subdivision and sale of their forest lands.

The distribution of the secondary wood-using industry is quite different from that of the primary industry. A full 80 percent of the Province's total secondary activity - 1,100 establishments employing 27,000 persons directly - is located in southwestern Ontario. Originally the industry was located here to utilize the local resource. Today, although substantial quantities of wood raw material are not obtained locally, the bulk is still southwestern hardwood.

The secondary plants, in addition to being major employers in many of the communities, give rise to substantial direct and indirect economic and social impact. The result is a strong dependence, both locally and regionally, on the activities of this industry.

If these benefits derived from a thriving secondary wood-using industry are deemed desirable, how will we ensure that they are realized? Actually, the problems of maintaining the secondary industry in southwestern Ontario do not appear that complex. In fact, it is apparent that a good opportunity exists to maintain it or even to expand it substantially. Plant locations are relatively fixed. They have well-established labour forces, and are advantageously located close to the United States and the Golden Horseshoe - their major markets. Whereas the future of the primary industry is delicately hinged on the local resource, our secondary plants are not entirely dependent on the supply and cost of local hardwoods. The relative proportion of these raw materials to total raw material is declining because of the favourable cost and consumer preference for nonlocal components and substitute materials such as fibreboard, plywood, imported hardwoods, softwoods and poplar, plastics, glass, aluminum and other metals.

Thus, in contrast to that of the primary industry, the viability of Ontario's secondary wood-using industry will, for the most part, be unaffected by southwest hardwoods management. If material is produced for the use of the industry it will be absorbed readily and profits will likely be high. If, however, the resource is managed for alternative purposes, the industry will likely continue the present trend towards higher transportation costs for acquiring materials from the Shield and other regions, and substitute raw materials will be sought. Profitability will definitely be affected; but the industry's future will not likely be destroyed.

This has been but a brief overview of the problems relating directly to the management and utilization of southwestern hardwoods for commercial timber - only one of the many possible uses of southwestern Ontario's forest and forest land resource.

Clearly, the management and utilization options for this area are many, and the potential benefits and costs are of enormous magnitude. There is absolutely no question that the forester, biologist, researcher, industry representative, landowner, recreationist, and many, many others are going to have to make some important management decisions. In this respect, the greatest problem is that too many managers consider the utilization of resources for their own specific field of management or concern to be a desirable end in itself. Management is a tool - and, if rationally employed, an effective one with which to generate social and economic benefits - but it is not an end in itself. It should not be employed without full consideration of the exact nature of the resource, all of the potential options and the likely magnitude and effect of the total costs and benefits.

IMPLEMENTATION OF FOREST MANAGEMENT ON PRIVATE LANDS

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Private-land forest management began in the early 1920's when several extension foresters working out of Toronto were providing a service for the entire Province. The woodlot owner could write and ask for assistance, and in time the forester would arrive at the nearest station by train and take a horse and buggy from the station to the farm. Guidance on improvement cuts and harvesting was offered, but markets were limited by hauling distance. The demonstration woodlot was popular during this period. Of necessity, on-site inspections were available to only a few people and usually once in a lifetime. The owner cut selectively, using farm labour, and even skidded and hauled the material to the mill. The management of the property was always in his hands. Today the timber is sold on the stump and the contractor does all the logging and hauling, often to mills 200 miles away.

With the establishment of district offices throughout southern Ontario in 1946 and 1947 and the appointment of zone foresters, management advice became more readily available. Most improvement work was carried out in conjunction with harvest cuts, although some cleaning and thinning was done with the object of producing fuel wood. With the decline of wood as a fuel, improvement work in young stands was reduced proportionately. It was not until the introduction of the Woodlands Improvement Act in 1966 that stand improvement became popular in tolerant hardwoods on private land.

Under WIA, there are now approximately 1,300 agreements, with 40,000 acres of hardwood under management of various forms in southwestern Ontario. This work has been concentrated in polewood stands in the 3-10-in.-diameter class where there was a need for cleaning and thinning, but the material was too small to produce a worthwhile merchantable product.

"The Survey of Rural Lands and Landowners of Southern Ontario", published in 1971, provides a wealth of statistics on the physical aspects of the private woodlot and the characteristics of the owner. A brief look at this indicates that we are dealing with a woodlot having an average size of 20 acres owned by a man who is engaged in the farming operation. This owner is 50 years of age and has held the property for 20 years. One-quarter of the owners would like to reduce the area of their forest land, one-quarter would like to expand, and the remaining 50 percent seem to be willing to tolerate the present status with a marked degree of indifference. It is only the county tree-cutting bylaws that are preserving 50 percent of our forests in southwestern Ontario.

An ideal rotation age for the maple-beech working group in southern Ontario would be 125 years, but because of economic pressure, a 100-year rotation would be acceptable. The average owner, faced with this century of time required to grow the crop, decides that life is too short and he must cut as soon as possible. The rotation is often shortened to whatever time is required to grow a merchantable product, and for the Lake Erie District, this could be as short as 50 years.

The timber buyer has a very short-term outlook and can only see ahead to the day when the trees will be cut and loaded onto the trucks. His interest ceases at this time, and he moves on to a new woodlot and new owner, never expecting to return. The silviculture of the stand is the furthest thing from his mind, even though he may have a good understanding of how stands develop and is certainly more "silviculturally aware" than the landowner. This results in the timber buyer's having a greater control than the owner or the forester over the silviculture of the stand.

The financial return from the woodlot has been low, owing in part to a good supply of mature timber, both on private and on crown land. The price of hard maple in 1950 in Bruce County ranged from $40/M to $80/M, depending on quality. Twenty years later, the price was about the same at a time when all the costs associated with the woodlot had risen sharply. If there was an opportunity to cultivate the land on which the forest stood, the pressure to clear was great. The woodlot owner did not receive a fair price for his timber, and the nefarious practices within the trade reduced the return even further. These would include loose scaling practices, grading rules which were never clearly defined, outright fraud when the material was never paid for, and variations of these shady practices. The woodlot owner was an easy mark, since not only was he unaware of scaling, grading, and marketing techniques, but he was reluctant to ask for expert advice, even though it was free of charge. If the farmer had practised good management and had received a fair price for his product, it could have been shown that forest crops compete favourably with agricultural crops, and the woodlot owner would have held his trees in much higher regard.

I would like to tell you of a case occurring near Aylmer in the winter of 1971-1972 which illustrates many of the abovenoted points.

A tobacco farmer had 35 acres of forest on two tobacco farms, and since he had been approached by a local timber buyer, he contacted The Ontario Department of Lands and Forests (now the Ontario Ministry of Natural Resources) for marketing assistance. One of our technicians looked at the timber and observed that it was a two-age stand of red oak, red maple, black cherry, white ash, beech, and hard maple. The old age class was a remnant from a heavy cut in 1911, and the resultant regeneration had become an excellent polewood stand 60 years of age. Our marker discussed the management objectives with the owner, who said he wanted to remove some of the mature timber, but would like to leave a productive stand. It was further agreed that most of the older age class would be cut and problem stems would be salvaged from the 60-year-old red oak (which was up to 24 in. on the stump) and the odd tree of other species.

After the commercial cut there was to be a WIA agreement to remove the cull material by girdling. The technician marked 72,000 ft. of timber and recorded the species and volume. A price per thousand was attached to this and a lump sum figure of $4,600 was established as a fair market price. We recommended that the owner ask $5,000 and take not less than $4,000. A list of four buyers who would be interested in this class of timber was provided. The original buyer, because of the proximity of the timber to his mill, showed more interest in the logs than any other buyer, and quickly raised his initial bid from $2,800 to $4,000 for the marked timber, but was reluctant to go any higher. He then suggested that if the owner wanted more money for the bush, the only way he could get it would be to sell all of the timber down to the minimum diameter limit established by the county tree-cutting bylaw; for the best species this limit was 14 in. measured 18 in. above the ground. The buyer's term for all timber above 14 in. was "the legal timber". This term had a nice ring and implied everything was right and good and safe for the owner. Most of us are aware of the shortcomings of diameter-limit cutting techniques, to say nothing of trees 14 in. on the stump which produce one butt log 12 ft. long with an 8-10-in. top. The buyer said that if the owner were to disregard the mark and sell all the timber which should go anyway, he would pay $4,400, and a contract stating these conditions was signed. The buyer moved the skidder in immediately and began to log. Because of the nature of the stand, much damage was done to the young age class in falling and skidding. The buyer was not satisfied with "the legal timber" and took 200-300 trees which were actually illegal and below the minimum diameter limit. This fact was picked up by the county tree commissioner, a charge was laid, and the company subsequently convicted. The fine was $150. This is no deterrent to marginal and fraudulent practices. There may be some damage to the public image of the company, but in this case, there was no newspaper publicity, and we in the Ministry cannot publicize the misdemeanors of certain operators. The owner is planning to launch a civil suit to recover the value of the 200-300 trees which were taken illegally.

By breaking the timber-marketing arrangement, the buyer was able to get 83,000 ft. of additional timber for a sum of $400. The company admitted to extracting 155,000 ft. from the total operation. There are many variations of this buying technique, and they add up to the fact that the owner does not get a fair return for the timber unless he has some assistance in marketing. We are involved in marketing only 5-10 percent of the volume of forest products sold. This is far too low, and a great opportunity to protect growing stock and control the silvicultural development of the stand is being missed. This can be explained in several ways. For example, the owner may be unaware of our service; he may not have planned a timber sale and may be cutting only on the pressure of the buyer; he may be strongly independent and may feel capable of running his own affairs; the buyer may be an excellent practical psychologist and may successfully discourage the owner from obtaining advice; our people are often busy at other important tasks, particularly during the tree planting rush, and may have no time to mark timber; the buyer may successfully establish a need for quick action because of equipment in the area, a one-shot market, seasonable pressures, and a host of other reasons.

To improve the level of forest management on private lands in southwestern Ontario, we recommend the implementation of the following techniques and improvements:

1) increasing trained staff, at both the technical and professional level, to implement forest management in southern Ontario (More and more demands are made on forestry people, and less time is available for the vital job of resource management.);

2) utilizing seasonal employment programs to carry

out stand improvement on private lands on a massive scale (This would benefit the private sector of the economy in faster-growing and higher-quality timber, and would provide winter jobs.);

3) strengthening the tree-cutting bylaws by raising diameter limits and increasing the penalty for bylaw infractions (A committee should be appointed to consider applications for changes in forest land use, and give judges the power to order that bulldozed land be replanted.);

4) informing the public of the marketing service available from the Ontario Ministry of Natural Resources and preparing booklets as guides to selling forest crops;

5) expanding the WIA program in the hardwood management segment, tree planting, and crop-tree pruning of red and white pine (Productive seasonal jobs would be created in this program.);

6) encouraging the wood-using industry, both sawmilling and secondary manufacturing, to take a more responsible approach to the forest resource on private lands;

7) legislating for the preservation and management of the hardwood resource in southern Ontario (Adequate payment or assistance for the woodlot should be assured in any legislation.);

8) holding more meetings, tours and field days to inform the forest land owners of up-to-date management methods in an effort to deal with the public in groups, rather than on an individual basis (This is one method whereby we can contact more people with our limited staff.).

RESEARCH STUDIES ON THE UPLANDS AND LOWLANDS OF SOUTHERN ONTARIO

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INTRODUCTION

The purpose of the forest research studies being conducted by the Southern Silvicultural Research Unit is to develop practical techniques for the selection, mass production, establishment and management of superior trees on a variety of sites in an attempt to meet the forestry, agricultural, wildlife and environmental requirements of the Ministry in southwestern Ontario.

Because of the rapid social and economic changes in land ownership, our unit has attempted to move with the times by selecting multipurpose trees and shrubs capable of supplying not only high-quality timber products but also such byproducts as nectar and pollen for the bee industry, sap for the maple syrup producers, and nuts for the confectionery trade, wildlife, and the weekend farmer. As you can see, our approach requires a diversity of sites and tree species. To handle such an ecological conundrum more effectively we have made a topographical separation of our studies into those on the lowlands and those on the uplands. Mr. Peter Jaciw is confining most of his efforts to the uplands and I am spending most of my time in the swamps. However, our paths sometimes cross on both these sites and we find ourselves sharing the same project.

I will now briefly outline the overall studies of the Southern Silvicultural Research Unit by describing each of the main programs on the lowland and on the upland sites.

LOWLAND SILVICULTURAL RESEARCH

This program was initiated in 1953 following the advent of the Dutch elm disease in Ontario. The measurements of the effects of intensity, method and degree of thinning on growth of silver maple and companion species were started that year. In 1958, a survey for the location and selection of lumber phenotypes of high-quality silver maple, eastern cottonwood and Jackii poplar was initiated. Since that date 19 fast-growing, high-quality silver maple, six wavy-grained silver maple, nine eastern cottonwood and two Jackii poplar have been located in southwestern Ontario and are being propagated.

In 1967 the silver maple studies consisted of crossing five parents to produce six strains; in 1968, seven parents were crossed to produce 16 strains; in 1969, three hybrid strains of red and silver were produced, as well as 18 strains of pure silver maple, from eight parents. In 1970, a reciprocal cross was made between silver and red maple with little success. It was noted that it was easier to cross silver maple to red maple than vice versa.

All of the silver maple progeny was outplanted between 1970 and 1972 in the Ellice, Puslinch, Luther, Elderslie and Minising swamps. Since 1970, 16 of the best silver maple phenotypes have been successfully rooted in the misting beds at Maple. These will be clonal tested in the same swamps as are the progeny. In conjunction with the silver maple studies, nine eastern cottonwood and two Jackii poplar have been located, rooted and outplanted in the aforementioned swamps. Lumber-type European willow and European alder have also been tested on the same sites.

This establishment program has been greatly assisted by the use of a large mounding plow which was built in 1970-1971 by the Mechanical Section of the Research Branch from an earlier model used at La Rose Forest.

BLACK LOCUST AND AMERICAN BASSWOOD FOR HONEY PRODUCTION

Professor Gordon Townsend of the Agriculture Department, University of Guelph, initiated a program in 1969 for the propagation of black locust in Ontario for honey production. He was able to import from Europe and the United States almost 100 clonal and progeny selections. These were established in a nectar arboretum at Guelph. He contacted the Ministry for assistance in the propagation and distribution of this valuable stock. Mr. P. Jaciw and I are assisting in the propagation studies by testing rooting techniques on greenwood and dormant cuttings of several clones both in the misting bed and in the greenhouse at Maple. In conjunction with this study 15 local selections of early- and late-flowering black locust from over 1,000 trees were made as a potential source of nectar. These ortets are now being reproduced asexually by root and stem cuttings and we hope to have a nectar grove established by 1974 for further evaluation.

The most promising clones will then be given to Professor Townsend for ultimate distribution to the bee keepers of Ontario.

This year we have embarked on a program for the selection of heavy nectar-producing basswood which flower continuously for at least 3 years. At present 66 trees have been marked, and of these, three have been located which already meet the specifications. They are now being propagated by cuttings and by budding at Maple.

SELECTION AND PROPAGATION OF NUT-BEARING TREES AND SHRUBS

Today there is a great change in land ownership in southern Ontario. We hear of the weekend farmer, hobby farmer, etc., who, instead of making a living on the land, are using their farms for their own whims. Some of these land owners are interested in wildlife, others in trees and shrubs, etc. In many cases the land which they purchased is marginal or even submarginal agricultural land which is usually partially forested.

Earlier tests have indicated that certain hardy nut trees and shrubs are capable of growing on such land with minimal care. For example, the filazel, a cross between the European filbert and the American hazel, is as hardy as or even hardier than some of our native species. Throughout Canada, there is a hardy and persistent group of nut "hounds" who have been selecting and propagating high-quality and high-yielding butternuts, walnuts, filberts, and hickories. Such a man was Mr. J. Gellatly who was engaged in such studies for over 40 years. We are now attempting to get this material to Ontario and to place it in a nut bank until required. The Ministry has been approached and we hope to be able to preserve these valuable selections. Another good example is the Burns walnut which has commercial possibilities. Mr. Burns notified the Ministry of this unusual tree in 1969. Since that date every effort has been made to reproduce this tree on its own root system. In cooperation with the Tree Breeding Section of the Forest Research Branch, four trees were grafted this spring to serve as a future source of cutting and scion material.

As you can see we have a most diversified program related not only to lowland silvicultural studies but also to such specialized projects on the uplands as sap for the maple syrup producers, nectar and pollen for the honey industry and nuts for the confectionery trade, weekend farmer and wildlife.

Although all four programs are different, our overall philosophy is based primarily on selection, propagation, establishment and management of superior trees whether they be for lumber and/or sap, nectar, or nuts. Our ultimate aim is to propagate multipurpose trees that will meet the future demands of the landowner in southern Ontario.

To date our progress in the following fields is as follows:

I Lowland Silviculture Research

1. Selection: A total of 19 high-quality, timber-type silver maple, six wavy-grained silver maple, nine eastern cottonwood, two eastern Jackii poplar, one western cottonwood, three black poplar and two western Jackii have been selected for forestry use in southern Ontario.

2. Acquisitions: A total of seven strains of lumber-type European alder and 18 lumber-type European willow selections have been acquired both from Europe and from the United States for testing on the lowlands of southern Ontario.

3. Propagation: Since 1967, 18 strains of silver maple progeny from eight parents, three hybrid strains of red maple female x three silver maple males, and one reciprocal cross of silver x red maple have been made at Maple for evaluation under swamp conditions and, of course, for further selection.

In conjunction with the breeding program 16 of the high-quality, lumber-type silver maple phenotypes, six of the wavy-grained silver maple, nine eastern cottonwood, two eastern Jackii, two western Jackii, two black poplar and one western cottonwood, 18 European willow and three European alder selections have been propagated by cuttings for future evaluation.

All silver maple progeny as well as the eastern cottonwood, eastern Jackii poplar, European willow and European alder have been established on mounds in five of the main swamps in southwestern Ontario.

SEED ORCHARDS

A silver maple seed orchard consisting of 12 clones of a total of 96 ortets was established at Orono in the spring of 1971 and a European alder seed orchard of three clones and 16 ortets was planted at Orono in the spring of 1972.

BLACK LOCUST AND AMERICAN BASSWOOD FOR THE HONEY INDUSTRY

A total of 15 black locust of early- and later-flowering selections (June 9 - July 10) have been made in southwestern Ontario. In addition, 66 heavily flowered American basswood were located in 1972. However, a final selection of these trees will not be made until 1974 when those that have flowered continuously each year for 3 years have been identified.

GROWING NUTS FOR LOCAL USE

This program was initiated in 1969 after the discovery of the Burns walnut. To date, four filazel, one black walnut and three hybrid sweet chestnut have been established in the nursery at Maple. Contact has been made this year with Gellatly Nurseries in British Columbia to purchase their most promising filazels, tree hazels, butternuts, walnuts and chestnuts and establish these selections in a nut bank in Ontario.

In conclusion, I would like to state that our future plans are as follows:

1) to evaluate the potential of each of the silver maple, cottonwood, Jackii, European alder and willow clones on each of the main sites (Further selections will be made on those silver maple progeny which show above-average growth. These will be established as ortets in a seed orchard.);

2) to develop practical techniques to reforest the decimated elm types with superior clones of maple, poplar, alder and willow (This project will be started in the spring of 1974.);

3) to establish by 1974 a clonal seed orchard of the six wavy-grained silver maple selections;

4) to complete the planting of the European alder seed orchard by the spring of 1974;

5) to locate and select progeny and clones of high-quality ash selections (These will be outplanted in the spring of 1974.);

6) to continue locating and selecting high-yielding

black locust and American basswood for nectar production;

7) to establish by 1974 a clonal seed orchard of superior, black-locust nectar producers of local origin;

8) to establish by 1976 a stooling bed for the high-nectar-yielding American basswood;

9) to establish by 1976 a clonal seed orchard of high-yielding, nectar-producing American basswood;

10) to select silver maple with exceptionally rich sap for the maple syrup industry and establish clones of each in a clonal seed orchard and stooling bed;

11) to establish a nut bank of selected trees and shrubs from local sources and from importations from other provinces and countries.

HARDWOOD WOODLOT SILVICULTURE

(THINNING AND FERTILIZER EXPERIMENTS)

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INTRODUCTION

The problems associated with the implementation of silviculture in southern Ontario's hardwood woodlots were well presented by R. J. K. Murphy in the Ontario Department of Lands and Forests Manual on Lake Huron District Hardwoods (1). The recommendations contained therein for the treatment of immature stands were based on observations made in southern Ontario and on published findings from the neighbouring American states. They are consistent with successful European practice.

It has been general experience that rather severe opening of the canopy is necessary to secure a marked increase in the rate of diameter growth of sugar maple and the associated hardwoods white ash, black cherry, and basswood. This usually means the removal of up to one-third or more of the basal area of a stand at any one thinning.

In practice such an intensity of thinning is seldom achieved unless it be in association with a commercial cut. In some cases this may be due to a density of good crop trees that is too low to warrant a heavy general thinning, and in others to a high density of good stems coupled with a forester's natural reluctance to fell such trees to waste - particularly on private land. For instance, in Grey County six stands were examined that had received TSI treatment 5-10 years before. In each stand five plots were enumerated, each of which contained about 100 trees. The proportion of basal area removed by the treatment varied from 4 to 44 percent, but in only six plots did it exceed 30 percent. Nearly all the trees removed were from the codominant and lower tree classes. There was little apparent effect upon the subsequent growth of the dominant stems (2).

The heterogeneous nature of most woodlots favours the application of treatments on an individual tree basis: the selective release by thinning and stimulation by fertilizing of single high-quality trees whenever they may occur in a stand. While this approach is simple in concept it presents difficulties in the evaluation of different "levels" of treatment: What constitutes an effective local reduction in competition to the favoured trees, and how should fertilizer be applied? This subject has been the basis of a research study by the Great Lakes Forest Research Centre. Sugar maple has been the main species studied, but black cherry and white ash were included in some woodlots.

CALCULATION OF THINNING INTENSITY

Thinning seeks to reduce the competition that selected trees suffer from their neighbours. Such competition will be related to the number of competitors within the sphere of influence of the selected tree, the squares of their distances from, and their sizes relative to that of, the selected tree. The sphere of influence of a tree is somewhat conjectural, but observations on trees in pastures and hedgerows suggested that the area of intense influence extends from the bole of a tree to a distance of about 1½ times the radius of its crown. On this basis two trees that were separated by a distance equal to 1½ times the sum of the radii of their crowns would each be little affected by the other. Such conditions of "free growth" would obtain if there were about 15 dominant trees of 10 inches DBH per acre. In practice, of course, a much higher overall stocking than this was accepted. We were concerned with releasing a few selected trees: three or four per acre.

In the course of the thinning, competitors were considered for removal if they were within a distance equal to three times the radius of the crown of a selected tree. The DBH in inches was found to be nearly numerically equal to the radius of the crown in feet, and this simplified field measurements. The competitive effect of a tree was assumed to be proportional to its basal area and inversely proportional to its distance away, and the relative effects of removing various neighbours were compared on this basis.

Two levels of thinning were adopted. These aimed to reduce the level of competition by 50 percent (light) and 75 percent (heavy), respectively. In practice light thinning left the crown of a selected tree free of contact with competitors for between one-third and one-half of its circumference. Heavy thinning relieved the crown of the selected tree of all, or nearly all, contact with competitors. Trees that were killed were felled if they were of merchantable size, or were deeply notched (sap rung) with an axe if too small for sale. The work was done in July and nearly all the notched trees were dead within 1 year.

CHOICE OF FERTILIZER AND RATE OF APPLICATION

1) Choice of Fertilizer

Foliar analyses of sugar maple from a wide range of sites showed that diminishing growth of the maple was accompanied by generally diminishing concentrations of N, P, and Mn in the leaves: Mg, K, Fe and Zn remained approximately constant (Table 1). The few fertilizer experiments that have been conducted in hardwoods have generally shown a growth response to nitrogen; hence it was decided to investigate first the effect of nitrogenous fertilizer.

In the laboratory experiments it was found that the nitrogen in urea and ammonium sulphate was very rapidly converted to nitrate in woodlot soils. In this form it is readily leached from the soil. From urea formaldehyde nitrogen is converted only slowly into nitrate and the process continues for several months. Therefore, urea formaldehyde was the fertilizer used.

2) Rates of Application

Samples of woodlot soil were incubated in the laboratory with varying amounts of urea formaldehyde. It was found that a certain amount of nitrate was produced, even without added fertilizer. When fertilizer was added the increase in the quantity of nitrate produced was found to be proportional to the amount of fertilizer added. If one assumes that in the field most of the biological activity that converts organic forms of nitrogen to inorganic forms takes place in the upper 3 inches of the soil, and if one measures its bulk density, then it is possible from the laboratory experiments to calculate the approximate weight of fertilizer that should be added in order to double or increase by one-half the amount of mineral nitrogen (mainly as nitrate) available to the trees. In this way it was calculated that 520 lb of urea formaldehyde per acre (590 kg/hectare) would double the supply of nitrate. The actual rates adopted were 260 and 520 lb of urea formaldehyde per acre. It was applied by hand within a distance of 1½ crown radii from each selected tree (i.e., within its approximate zone of influence). Thus at the low rate of application a tree of 10 inches DBH received 4¼ lb of fertilizer; at the high rate it was 8½ lb of fertilizer.

Thinning and fertilizer treatments were applied as a three x three factorial experiment to selected, well-formed, dominant trees in five stands. Four of these were even-aged stands of maple that ranged in age from 35 to 70 years, and one was a stand of black cherry and white ash. In addition fertilizer only was applied to two stands of mature maple. All the stands were growing on stony calcareous till. There were five trees per treatment and 45 trees per block in the factorial experiments, and 15 trees per treatment for 45 trees per block in the fertilizer only experiments.

RESULTS

Foliar analyses that were carried out before and after treatment in one stand each of maple, cherry, and ash showed that the foliage of all the species had increased concentrations of nitrogen during the year after they were fertilized. The two levels of fertilizer that were applied caused the leaves of ash to increase in size by 34 and 50 percent, respectively, in the year after treatment, but by the second year this effect had nearly disappeared.

In the factorial experiment fertilizing increased the diameter growth of all three species during the first and second year after treatment (Table 2). However, only with black cherry was the increase over zero fertilizer statistically significant. The lower level of fertilizer gave the greatest response in each species.

In the mature stands of sugar maple fertilizing produced only small increases in diameter growth over the control. These amounted to 8 and 16 percent over the 2-year period for the low and high rates of application, respectively. However, tree-to-tree variation was such that these increases were not statistically significant.

Thinning significantly increased the diameter growth of sugar maple during the first and second years after treatment (Table 3). Over the 2-year period the 50 and 75 percent thinning intensities increased diameter growth by 22 and 30 percent respectively, compared with the control.

Black cherry and white ash showed little or no response to thinning.

DISCUSSION

The supply of nitrogen does not appear to be a factor limiting the growth of sugar maple or white ash in these calcareous woodlot soils. In fact the addition of 520 lb of fertilizer per acre (170 lb of nitrogen) slightly depressed the growth of sugar maple. Even with black cherry, from which a significant response was obtained, the high level of application was less effective than was the low level.

Thinning was of undoubted benefit to the tolerant sugar maple but had no effect upon the intolerant species. The relative effect of thinning on sugar maple was greater in the second than in the first year after treatment. We will continue to monitor this response during the next few years.

When the response to thinning shows an appreciable diminution in magnitude the stands will be thinned again. At that time phosphatic fertilizer will be applied to test whether or not the availability of that element is a limitation to growth.

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Table 1. Concentrations of elements in foliage of sugar maple from four sites, ranked from good to poor in descending order

Stand	Foliar concentrations of elements						
	N%	P%	Mg%	K%	Mn ppm	Fe ppm	Zn ppm
Vigorous 40-yr-old stand (pure maple)	1.95	0.120	0.27	0.52	212	111	15.6
Mixed 20-yr-old stand (maple dominant)	1.76	0.105	0.31	0.49	323	110	12.5
Mixed 35-yr-old stand (ash and cherry dominant)	1.83	0.103	0.29	0.58	85	112	15.5
Poor volunteer stand of mixed age on old field	1.30	0.091	0.25	0.59	57	111	9.5

Table 2. Effect of nitrogenous fertilizer upon the diameter growth of three hardwood species in polewood stands (fertilized April 1971)

	1971 mean increase in diam (in.)			1972 mean increase in diam (in.)		
	Amount of N added			Amount of N added		
Species	0	260 lb/acre	520 lb/acre	0	260 lb/acre	520 lb/acre
Sugar maple (60 trees/treatment)	0.154	0.164	0.149	0.219	0.235	0.214
Black cherry (15 trees/treatment)	0.055	0.117*	0.081	0.108	0.184*	0.147
White ash (15 trees/treatment)	0.109	0.155	0.131	0.165	0.220	0.183

*Increase over nil fertilizer significant at 5% level of probability.

Table 3. Effect of two levels of thinning upon the diameter growth of three hardwood species in polewood stands (thinned August 1970)

Species	1971 mean increase in diam (in.)			1972 mean increase in diam (in.)		
	Degree of thinning (% release)			Degree of thinning (% release)		
	0	50	75	0	50	75
Sugar maple (60 trees/treatment)	0.136	0.160	0.172*	0.186	0.234*	0.246*
Black cherry (15 trees/treatment)	0.085	0.088	0.080	0.128	0.153	0.158
White ash (15 trees/treatment)	0.118	0.154	0.124	0.184	0.195	0.188

*Increase over nil thinning significant at 5% level of probability.

AESTHETIC AND AMENITY VALUES IN THE MANAGEMENT OF HARDWOOD FORESTS

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I've been puzzling for quite some time about what aesthetics is, and what it means to people when applied to the forest. On a recent trip to northern Ontario during the preparation of our manual on forest aesthetics, I happened to meet the foreman of a logging company. He was an enormous Paul Bunyan type of man with hands that gave me the impression that he was pretty used to lifting tree-length logs on his own, without the aid of the fancy equipment that was grunting and roaring all around us. When we were introduced, he looked down at me and said, "So you're the guy who's going to tell us where we should plant flowers." Having got used to this reaction I was about to retort, "Yes and the first place will be on top of you - six feet under", when I took another look at him and decided that a smart-alec answer like that was probably not in my best interests. However, the whole question of forest aesthetics has got me thinking about our attitudes toward the environment in general. It is intriguing to reflect on different people's perceptions of aesthetics and nature. For instance, as a layman, I have never got used to the forester's fear of overmature trees; the image is conjured up of an old forest that will come crashing down in a cloud of dust the moment you turn your head away. The conflicts that often occur between citizens and forest managers are in many cases directly attributable to this view. Similarly, there is the citizen who on the one hand opposes all logging, yet on the other quite happily buys wood from the local lumber yard. He may also be unresponsive to the idea of a whole woodland being cut down in the name of development, but quite content to replant Korean sky-rocket junipers in its place. As William Whyte has said, development has an uncanny urge to adopt the names of the places it destroys: e.g., Don Valley Woods, Orchard Grove Apartments.

To most people aesthetics is man imposed. Some think of it as a red pine plantation, or as a woodlot where just the maple and the oak have been left to grow tall and straight. Others think of it as a wilderness experience, which more often than not depends on what one thinks wilderness is. I have heard people describe Algonquin Park as wilderness, or some local woodlots, and even places like Wilcott Creek Park in Toronto.

Wilderness to a few is the completely untouched forest, where one survives on one's own resources; but to most of us it has overtones of human intervention, because few of us can be far from the umbilical cord of civilization.

One way or another, however, the forest is the symbol of the natural world with emotional ties that go back to antiquity. Our present-day attitudes to what is beautiful and what is not, and the conflicts among various users of the forest that assume political proportions can, perhaps, best be understood by delving into the past, since these attitudes are consciously or unconsciously dictated by our culture and history.

The pantheistic beliefs of early cultures involved the theory that the entire world had God-like attributes. Nature became absorbed into religion and superstition, and men lived in harmony with their environment, and survived because of it.

Sir James George Frazer's classical book "The Golden Bough" makes some fascinating references to the forest. He has shown that from earliest times the worship of trees has played an important part in religion. The ancient Druids worshipped the oak. The varieties of mistletoe that grow on some European varieties were the object of superstitious veneration. They believed that it had great healing powers, and that what grew on the oak was sent from heaven. The Swiss believed that mistletoe was a panacaea for all children's diseases; in Sweden it was believed to have power over evil. A sprig attached to the ceiling made the evil spirit powerless to injure man or beast. It was also believed to possess the power to extinguish fire. Frazer relates the myth of the mistletoe as the seat of life of the oak. Primitive observers would have noticed that the evergreen mistletoe maintained its leaves during winter when the oak was bare, and this is probably why they hailed it as a sign of divine life. This notion, of course, has come down to us today in the custom of kissing under the mistletoe at Christmas.

Sacred groves were common among the ancient Greeks and Germans. In fact the penalty in Germany afforded those who dared to peel the bark of a standing tree was to cut out the culprit's navel and nail it to the tree while he was driven round and round the tree until all his guts were wound round its trunk.

To primitive men the world in general was animate. The felling of an oak or fir was no less a wrong than the slaughter of an ox or a sheep, since it too had a spirit. Trees were not only animate, they were sensitive. A tree when felled gave shrieks and groans that could be heard miles away. Trees that bleed and cry in pain also occur in Chinese literature. Frazer says that peasants in some more primitive areas still beg the tree's pardon before cutting it down.

In German and French customs, the Harvest May was a time when a large branch or tree was decked with ears of corn and brought home on the last wagon from the field. The branch embodied the tree spirit whose influence was beneficial to the future harvest.

The May tree in Europe had powers to encourage fertility in women and cattle (the two were apparently synonymous in those days). Cutting branches and bringing them to the village, where they were fastened onto houses, brought blessings which the tree spirit had power to bestow. The present custom of bringing blossoming branches inside the house in spring must certainly be a remnant of these early beliefs.

In more recent history it is interesting to examine the attitudes that have more directly influenced contemporary views of nature and aesthetics.

In classical Italy and France of the 16th and 17th centuries, the Renaissance garden represented the concept of the aesthetic. The garden itself became an ordered pattern of shapes and forms within a rigid set of artistic rules. The natural forest out of which this man-made environment was carved represented chaos and ugliness. It had to be tamed and subjected to classical rules of order and geometry. Its primary use throughout Europe was, of course, as a source of fuel. One tends to forget that wood was the only easily available source of fuel and building material until the Industrial Revolution.

Art and functional necessity came to be considered as two entirely separate things. Trees were an extension of architecture, analogous to domestic pets, dependent on man, and conforming to the shapes he gave them. No one understood ecological concepts of plant communities, or succession; their primary role was ornamental. Pleaching, topiaries, clipped hedges, and potted plants developed at this time, and allowed the designer to select whatever forms were suitable for his work, the aesthetic appeal of the plant resting on its man-made, not its natural form.

The 18th century in England brought a revolution against the rigid formality of the Renaissance. It gave rise to the English landscape garden. It was a movement generated by the painting and literature of an educated elite who admired the landscape paintings of the Italian countryside by Poussin, Salvador Rosa and others. They thought that they could simulate in their own gardens the landscapes expressed in these paintings. Thus, the picturesque style developed in which the old barriers to nature were thrown down, and all nature became a garden. The dislike of geometry and classical order gave rise to a declaration of war on regularity of every kind. The landscape gardeners of the time tried to show that nature has no regularity. The picturesque garden, with its evolution in the work of Capability Brown and Humphrey Repton, represented essentially a romantic view of nature. "Nature abhors a straight line" was an artistic concept that was confirmed with the discovery of an established landscape aesthetic in the Orient. At the same time it achieved the same results. Nature herself provided the aesthetic; there was beauty to be found in the natural form of a tree, in woodlands, meadows and streams.

Functionally the objective of the 18th century was economic, but it resulted in a productive and working landscape. First of all, there was a desperate need for trees for ship building and fuel. By that time practically all the forests, with the exception of a few owned by royalty, had been leveled. Secondly, there were changes in agricultural technology that demanded a new consolidation of land holdings. Therefore, hillsides were planted to woodland, meadows occupied valley bottoms, and lakes were built: the English countryside, denuded by lumbering and a backward medieval agriculture, became prosperous and beautiful. The forests were planted to provide timber and support game; woodlands provided shade for grazing animals. The ruling principle was that nature is man's best designer, an empirical ecological insight that was valid whether the aim was artistic or functional.

The Industrial Revolution replaced this rural economy with an urban one. The increased exploitation of natural resources and landscape as a necessary part of technological progress led to a form of escapism in which writers such as Ruskin in England and Thoreau in America began praising wild nature as the only source of beauty. The discovery of new exotic plants abroad stimulated an interest in horticulture and an enthusiasm for plants as isolated objects to be admired like furniture or paintings, rather than as a part of a larger forest community.

In North America the early European settlers came with two conflicting views. One was that trees were a threat to settlement, and this gave rise to the image of the woodman as the pioneer of progress. The other was the image of the continent as an utopian garden: a realization of their idealized and imaginary worlds.

These conflicting views, which Leo Marx describes in "The Machine in the Garden", allowed people to accept technology as a part of their life and at the same time to ignore its effects. This dichotomy is best illustrated in modern advertisements for cars. The yearning for utopian nature, and the acceptance of industrialization are both satisfied by those images of shiny automobiles in woodland settings or by unspoiled sea shores. The physical reality of the one destroying the other is obscured by the image of how one would like it to be.

Inside of us is this utopian ideal of the garden that we look for every time we leave the city in search of nature. We create images of woodland glades and sparkling streams with the aid of Walt Disney documentaries, and live at the same time in urban and environmental squalor.

The purpose of the preceding historical synopsis was to show that our responses to aesthetics have been conditioned by events. The emphasis of our economy has for a long time been on resource exploitation as the dominating objective of management, and this has resulted in an inability to think holistically. Aesthetics still represents the flowers beautifying the clear cut, as my company foreman friend implied, or the artificial tree decorating the city street.

The legacy of the past and our whole cultural background have led us to believe that aesthetics and functional necessity are two separate things - that aesthetics is something applied to the cake after it has been made if there's money left over, rather than an integral part of the whole process of forest management. Thus the term has connotations of emotional appeal and personal preference, and is not helped by the dictionary definition, i.e., "the study of beauty and ugliness and the judgement thereof." My definition would therefore be as follows: "When applied to forest landscape problems, as opposed to abstract art, aesthetics should involve those factors of ecology, visual response, wildlife habitat, and recreational activities that when integrated into normal silvicultural objectives will produce a forest landscape that is healthy, productive, visually pleasing and responsive to social as well as to economic uses." This means that forest management that accommodates a diversity of uses and forest types, that protects the site and encourages a mixture of cover and edge will produce an aesthetic that renders beautification after the fact irrelevant. In other words, good management also tends to look good. In this sense it follows the ecological principle of diversity, and is therefore capable of objective evaluation. Thus, the new approach to aesthetics has planning as well as design implications. It involves the efforts of a team, with wildlife, recreation, scenic and natural values having an equal input into forest management. At the wider planning level, it can be said that while the production of timber remains a major objective of southern Ontario woodlots, they are becoming increasingly important, as we all know, for recreation, nature reserves and interpretation, particularly in the light of their relative uniqueness and closeness to population centres.

Long-range planning, then, may indicate the need to manage an increasing number of woodlots for noneconomic purposes which, in the future, may supercede economic purposes in importance.

The need to identify unique resources before management plans are drawn up is, therefore, of critical importance, particularly since only a small percentage of the woodlots come under Ontario Ministry of Natural Resources management.

Maybe one of the most useful roles that southern woodlots can play is in the area of public interpretation. There is no doubt that interpretation of integrated forest management is a sadly neglected aspect of our management programs and it is at this level that the design implications of aesthetics can be demonstrated. There is a very real need to show people what is meant by good management to enable them to separate fact from fiction. This to my mind should involve all aspects of the forest including:

1) commercial timber - description of silvicultural systems, cutting techniques, regeneration, the benefits of good management to wildlife habitat and so on;

2) wildlife management - programs for various species, wildlife viewing, protection of endangered species;

3) recreation - including interpretive trail systems, development of public codes of behavior in the forest environment;

4) preservation and interpretation of natural areas, and historic sites;

5) interpretation of how the various forest uses can and should be integrated.

On this basis a good start could be made in overcoming general public ignorance of management, and in developing an aesthetic or land ethic that is relevant today and that has its roots in an understanding of how natural systems work, and how their manipulation can be beneficial environmentally, socially, and economically. It is really this all-encompassing framework based on an environmental view that has to be exploited. Southern Ontario is in a unique position to achieve this.

HARDWOOD PROGRAM OF THE MENSURATION UNIT

FOREST RESEARCH BRANCH, ONTARIO MINISTRY OF NATURAL RESOURCES

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A number of projects related directly or indirectly to the management of hardwoods in Ontario are now in progress or are actively being considered. Data collected in many of these projects are complementary to several purposes and the successful application of their results to management depends upon the extent of cooperation achieved between sponsoring agencies.

A fair example of this type of cooperation is the report (1) published this year by D. V. Love, A. F. Beckwith and Z. J. R. Morawski under the auspices of the Canada Land Inventory ARDA program. Most of the work involved was accomplished by Ontario Ministry of Natural Resources staff with overall direction and special assistance from the Faculty of Forestry, University of Toronto. Since much of the information to be provided from this work was to be of use in the interpretation of use-capability maps made by the Canada Land Inventory, funds for the project were provided through that channel.

These hardwood studies were oriented toward the determination of the yield potential of various classes of land in southern Ontario. The yield was measured on fully stocked stands with the object of determining the capability of the land rather than the anticipated production under existing conditions of stand density.

Basic land classification requires a capability rating, and the study of fully stocked stands was a desirable starting point for such a purpose. However, as a guide to management operations in existing stands, very few of which represent the full capability of the site, it is highly desirable to have some means of estimating the yields to be expected from partially stocked stands. Consequently, a proposal for the production of variable-density yield tables is under way and is a logical outcome of the normal yield tables for hardwoods produced by the mensuration unit. Many of the plots established for the ARDA project would be suitable also for inclusion in a variable-density yield study. In addition, the plots set up by the Canadian Forestry Service some 5 years ago would be suitable for this study.

A technique for the measurement of periodic increment similar to that used in the ARDA project might be used in the new study. This involved stem analysis, which was rather difficult in the often-overstocked stands previously measured. However, with the identification marker rings most of the guesswork was removed and trees that had registered no growth at breast height for 10-15 years were readily distinguished.

How many of those present today have considered that an intermediate hard maple could show almost no measurable growth for such an extended period?

How many would know that the weather or soil-moisture conditions in a particular year would create an extra narrow growth ring in, for example, white ash and a not particularly narrow one in maple?

It is doubtful whether the latest techniques for the making of yield tables could adequately embrace these problems.

Quite a large percentage of the total of 205 plots established in the ARDA study were on private land where they have received some level of stand improvement. Although they were not specifically intended for comparison, some interesting comparisons of thinning levels are possible on the District level. For instance, stands we have measured which were treated under WIA projects in Simcoe District have received medium thinning on the whole, those from Peterborough through to Kemptville have received lighter thinning, while some of those around Hespeler have been relatively heavily thinned. These, together with experimental thinnings set out in county forest stands will provide a fairly broad assessment of the effectiveness of the WIA program for the management of southern Ontario hardwoods.

At this point I would like to emphasize that the work of our mensuration unit has been and will be correlated with the silvicultural conditions desirable for timber management objectives or for experimental stands or treatments.

The management objectives for tolerant hardwoods in Ontario must continue to stress quality of individual stems and to this end it will be necessary for us to observe, classify and measure the individual tree growth and quality characteristics. Since the crop trees in any stand are the most valuable it will be increasingly necessary to find ways to measure growth, branch size, defects, etc., in the standing tree. To this end the proposed new staff of the Mensuration Unit will have to include (in the absence of specially trained technicians) a band of individuals which might be known as "bandarloge" or in more modern computer terminology "simian simulation".

Experimental stands fall into a variety of pigeonholes. The obvious ones which we have been measuring for growth are concerned with:

1) differences between natural mixtures such as hard maple-beech; semitolerant combinations of white ash, black cherry, basswood and maple; and red oak-poplar stands;

2) differences due to site conditions (a very complex problem);

3) thinnings and improvement cuttings as they are implemented on different levels by the various timber foresters in charge;

4) progeny or clonal tests mainly in conjunction with the Tree Breeding Unit;

5) underplantings, cover crops, releases, and other treatments given by silvicultural units to natural or plantation hardwoods.

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SOME ECOLOGICAL ASPECTS OF AMERICAN BASSWOOD

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INTRODUCTION

The following account of the ecology of basswood is based upon our own observations in Ontario, supplemented by an extensive review of the literature. A complete reference list can be supplied on request.

American basswood is found throughout the southern districts of the Great Lakes-St. Lawrence regions. It grows in mixture with other tolerant hardwood species, such as sugar maple, beech and yellow birch, primarily on middle and lower slopes. It prefers slightly acid or neutral soils (pH 5.5-7.3) and is considered a "soil-binder", because of the high calcium content of its foliage.

Basswood is an important species in the lumber industry since it is capable of producing high-quality saw logs over a rotation shorter than that required by many other hardwoods. To increase the production of basswood of high quality, we must first secure its reproduction.

SEED SUPPLY AND SEEDLING GROWTH

Natural reproduction seldom produces a desired level of stocking, even on the most suitable sites. There are several reasons for this. Once the overmature, large-crowned trees are removed in a cutting operation, the seed source is eliminated. Leaving such trees standing as standards for seed production is not common practice. Moreover, a heavy seed crop must be secured at least 2 years before the cutting, because of the prolonged after-ripening process of the seed. A considerable amount of seed also succumbs to rodents and decay. The second growth is unable to produce a satisfactory seed crop under crowded conditions of the crown.

Crown thinning to various intensities in sugar maple-basswood stand, 60 years of age, did not improve the reproduction of basswood from seed. Observations on 134 trees showed that 34 and 24 percent of trees produced seed in the first 2 years after cutting. However, the seed crop per tree was very poor. There was only 4.8 percent of sound seed found in the litter samples collected throughout the stand. None of the trees produced seed in the following 5 years (14).

A second reason that basswood is seldom the dominant tree in hardwood forests is that it does not grow well beneath a complete canopy of sugar maple. Basswood is rated as tolerant to moderately tolerant, because of its ability to persist for many years under shade; but it needs considerable light for proper development.

Basswood is a poor competitor with sugar maple, owing to the dense and more vigorous reproduction of the latter species, and in mixture with other hardwoods it usually becomes suppressed (2). Over a 10-year period, the mortality of unthinned, 1-3 in. basswood saplings was higher than that of sugar maple (2). Nevertheless, dominant basswood of moderate size were found to thrive best under conditions too crowded for sugar maple (7).

Even a small opening in the canopy will improve the conditions for basswood reproduction and growth, and in openings with favourable conditions the species is reported to compete successfully with sugar maple and white ash (5). Tree size, species, site and other conditions all determine the degree of crowding that will be detrimental to maximum growth.

REPRODUCTION FROM SPROUTS

Basswood is an exceptionally good sprouter. While the majority of hardwoods do not sprout vigorously beyond the age of 60 years, basswood can sprout well from stumps of healthy trees cut at ages up to 100 years with diameters as large as 2 or 3 feet (4). Basswood sprouts even after repeated burns, as opposed to sugar maple which is fire sensitive. Sprouts play an important role in forest management, particularly if the objective is maximum volume production in short rotations. The coppice method of regeneration is considerably simpler than that of seedlings; it is rapid and inexpensive, and the early rate of growth of the sprouts is faster than that of seedlings. The response in diameter growth and volume production to thinning clumps of sprouts has been found to be excellent. The method could lend itself to mechanized cutting under certain conditions, as suggested for other hardwood species. As the trees will be cut before they are

20 years old, the danger of rot developing from wounds left after cutting is negligible.

After several generations of vegetative reproduction through sprouts, it becomes necessary to secure reproduction by seedlings. Sprouts produced from the third or fourth generation become weak and decrepit (11).

Best results from managing sprouts can be obtained by keeping in mind the following points which apply to most hardwoods:

1) Trees should be cut during the dormant season, i.e., from late fall to early spring, in order that the subsequent sprouts may have sufficient time to become hardy, because such stumps produce a greater number of more vigorous sprouts.

2) Stumps should be cut as low as possible and at an angle; bark damage should be avoided; an axe should never be used.

3) Felled trees produce more sprouts than girdled trees.

4) While the number of sprouts declines as stump diameter increases above 8 inches for most hardwoods, basswood is an exception.

5) Poorly formed, advanced seedlings should be cut so that they will produce the desired seedling-sprouts[1]. Seedling-sprouts are superior to sprouts from clumps with respect to size, quality and age (4).

6) The most vigorous sprouts originate at the root collar and are the least liable to be reached by decay from the old stump. This has a particular bearing on the height of cutting.

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[1] A seedling-sprout is a tree that has grown from a stump 2 inches or less in diameter. It usually originates from a seedling which is cut or accidentally broken off. A sprout is a tree that has grown from a stump over 2 inches in diameter. It usually grows in association with other sprouts.

7) Sprouts originating highest on the stump are those most susceptible to decay, windthrow and snow breakage; they are less vigorous than those originating at the base of the stump.

8) Thinning of clumps so as to leave only two or three stems should be done at an early age, preferably before they reach 20 years. If not thinned, sprouts become decayed through the advancing rot from dying companion sprouts. Severe competition among sprouts causes them to lean and become crooked.

9) Preference should be given to the best-formed, most widely spaced sprouts. The U-type companion sprouts can be thinned without creating a decay hazard. The V-type sprouts, larger than 3 inches in diameter, should be treated as a unit--either all cut or all left.

10) Full sunlight is important for fast growth of sprouts.

GROWTH OF POLES AND OLDER TREES

Basswood has been found by several investigators to grow faster than associated hardwood or coniferous species. A superior height and diameter growth of basswood, as compared with sugar maple and yellow birch, was reported in hardwood stands of the Lake States (4) and in Ontario (3, 9), from the age of 20 and 40 years, respectively, and in mature hardwood-coniferous stands (9). Basswood produced a better diameter growth than associated white ash and sugar maple (6).

Basswood, black cherry, red oak and white ash were found to require 75-95 years to reach 16 inches of diameter growth, as opposed to beech, hemlock, hickory, sugar maple, white birch, white oak and yellow birch which need 95-125+ years to reach the same size. Basswood was found to increase by 3.3 inches in diameter growth between the ages of 70 and 80 years, a most productive period, not to be overlooked when implementing silvicultural measures. The diameter growth of basswood subsequent to thinning was found to surpass that of several commercially important hardwood species (2).

A sudden reduction (the only one) of a stand basal area by 35-50 percent showed that crown vigour affected subsequent diameter growth. Measurements on 378 basswood trees indicated that crowns classified as "good" and "fair" produced on the average 0.63 in. and 0.36 in. of diameter growth in 5 years, respectively. Trees with good and fair crowns produced a diameter growth of 0.20 in. in uncut stands (14).

Several investigators have found that basswood produces 1 inch of diameter growth in a shorter period of time than most hardwoods. For instance, in New York State, aspen, red oak, walnut and white ash need 4-7 years, basswood, hickory, white birch and white oak 6-9 years, and beech, sugar maple and yellow birch 9-18 years to produce 1 inch of diameter growth (8). In Michigan, basswood requires 7 years, sugar maple 10 years, beech 11 years and yellow birch 12 years to produce 1 inch of diameter growth (16).

PRUNING

An early release to encourage good development of the upper crown and, conjointly, pruning of lateral branches, will improve diameter growth and stem quality in dense hardwood stands.

Since growth response is directly related to crown volume, a reduction of the leaf material through pruning causes a reduction in the growth. If too little top is left, the growth of the tree is seriously retarded; therefore, not more than one-third of the live crown should be removed. Two or three of the lowest branches less than 2 inches in diameter should be taken off every 3 or 4 years (10).

Pruning of lower lateral branches is recommended only after a leading shoot becomes evident. Apparently, there will be no serious formation of epicormic branches if pruning is applied to vigorous dominant and codominant crop trees (12).

INTERPLANTING AND UNDERPLANTING

A few plantations of basswood mostly, and probably exclusively, established with other species on former agricultural land, are known to have succeeded in southern Ontario. Data on the performance of some of them were reported (15).

Interplanting of basswood to supplement natural regeneration in partially stocked stands of desirable species or underplanting of fairly well-stocked stands of undesirable species is advocated. Basswood is sufficiently tolerant to withstand severe competition for long periods, but this eventually must be removed to allow satisfactory growth (13).

The use of hardwoods that are able to withstand shade in softwood plantations is also recommended (4, 11). There is value in planting a few hardwood trees in softwood plantations to obtain humus from leaf drop and an uneven crown level to prevent or at least minimize crown damage from snow, ice and storm (11).

Mixed plantations of coniferous and hardwood species may produce heavier yields of better quality, and present less risk than pure stands of total loss from various sources.

The successful establishment of basswood requires simultaneous planting of other hardwoods because pure stands are likely to undergo deterioration. The species is especially well adapted to underplanting of white pine stands and oak stands, and mixtures of basswood in combination with other hardwoods and white pine are recommended (10).

Basswood is recommended for underplanting in openings 1 acre in size and less in hardwood cutover stands (5, 13).

One example of a successful underplanting of basswood in a hardwood cutover stand is presented here, with more details described elsewhere (13). The stand was cut in 1963 to a basal area of about 30 square feet, creating an opening of about 1 acre in size. Two blocks of 500 trees (2-0 stock) were planted 5 feet apart in rows 12 feet apart. The survival in 1969 was 89 percent but dropped to 85 percent because of severe breakage of basswood stems caused by the fall of girdled trees. After the tenth growing season the average height is 13 feet, as measured on a 15-percent sample. Fifty-eight percent of the trees are 9.6 feet in height and above, with an average height of 14 feet and a diameter of 1 3/16 inches at breast height. The tallest tree on the plantation measured 22 feet with a diameter of 2 inches at breast height. The largest diameter of 2½ inches was attained by a tree measuring 18.7 feet in height.

Weeding operations consisting in the cutting back of sugar maple, ironwood, ash, cherry and striped maple to release basswood were carried out in 1969 and 1972.

In 1963, two blocks of 500 basswood nursery stock (2-0) were underplanted in a thinned Scots pine plantation; average diameter of the pine was 9 inches and average age was 30 years. There were on the average 187 Scots pine trees per acre subsequent to row thinning in 1958 and selective thinning in 1963. Weeding of the dense, natural regeneration of Scots pine was carried out in 1969 and 1971.

The average height of basswood is about 5 feet after the tenth growing season. This is much below its capacity as about 5 percent of the trees are 7 feet or more in height. The tallest tree measures 16.5 feet in height and 2 inches in diameter at breast height. Trees of the best quality will be top-pruned at the age of about 15 years to encourage maximum crown development for fruit production.

Pruning and fertilization tests are in progress. Cutting of poorly growing saplings to encourage sprouting is also planned.

RECOMMENDATIONS

The following recommendations are drawn from this presentation:

1) Silvicultural treatment to encourage crown development and seed production should be introduced early and gradually in the life of a stand to satisfy requirements for both the natural regeneration and growth of basswood.

2) The coppice method of regenerating basswood requires the application of a large number of refined silvicultural measures. A post-cutting operation directed to correcting the stumps for selected sprout production should be introduced in hardwood stands.

3) Interplanting and underplanting of basswood in both hardwood and coniferous stands are highly beneficial and should be extended.

4) Both the intensity and timing of pruning basswood and growing at various spacings at the nursery or after outplanting require more care and further research.

5) Harvesting seed from selected and easily accessible basswood trees should be introduced.[1]

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HARDWOODS AND WILDLIFE HABITAT

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I would like to discuss hardwoods, not as individual tree species or even as stands, but rather as a part of the total unit of the woodlot as it affects wildlife. Other parts of the woodlot unit include such things as associated shrubs and herbaceous understory vegetation, edge vegetation, and the surrounding field or open lands, including fencerows.

Some wildlife species such as ruffed grouse or grey squirrels live almost entirely within the wooded portion of the woodlot. Others such as pheasants and quail are largely open-land species but require the cover of trees or shrubs for protection from predators and the elements.

All species need suitable areas for nesting, denning or raising their young, sufficient food both in summer and in winter, cover as a protection from the elements, and escape cover as a protection from predators, all in a relatively small area. The key to wildlife populations is good habitat, and the key to good habitat is diversity.

There is a popular but erroneous conception that the land in its original condition (i.e., before settlement by the white man) held great populations of desirable wildlife everywhere. However, there are many early records of hunger and starvation. Men who lived off the land tell both of abundance and scarcity of game, depending on time and place. There are many legends of Indian starvation, as in Longfellow's "Hiawatha" for example, which antedates the advent of the white man.

All evidence that can be found indicates that most of the wildlife presently found in southwestern Ontario increased with logging and settlement. These activities produced early successional-stage forest and a diversity in habitat, resulting in increased numbers and varieties of wildlife.

In southwestern Ontario we have long since passed through the transitional stage from woodland to agricultural land. The present land pattern is largely open agricultural land dotted with small woodlots. It is these scattered small woodlots which must support much of our wildlife.

While it could be argued that wildlife populations can be improved by increasing the acreage of woodlots a similar result could be obtained by making better use of the existing woodlots. As was mentioned earlier, diversity is the key to quality habitat. A woodlot containing a homogeneous, fully stocked polewood or mature stand of trees will not be nearly as productive of wildlife as one containing a mixture of species, age classes and newly cut patches; in short, a woodlot under intensive management.

The first step in considering management of a woodlot is to establish the objective of management. If, for example, the prime objective is to maximize timber production, the techniques used will differ from those adopted if the objective were maximum production of wildlife. If, on the other hand, the objective were to be a compromise between these two, the techniques used would also be a compromise. The end result or product would not be a maximum of either timber or wildlife production, but an acceptable crop of both.

Since all the people here are familiar with managing woodlots for timber production I won't pursue this aspect. Rather, those techniques which are useful for wildlife production will be outlined. The woodlot manager, of course, will mix or modify the various methods to achieve his mix of desired end product.

The first thing required is an inventory. This will indicate which conditions are contributing to or detracting from favourable habitat conditions. The next stage is to encourage the desirable situations and discourage the undesirable ones. For example, climbing vines such as wild grape or Virginia creeper are desirable components of wildlife habitat because of their cover value. These plants will not grow well in shade. If these species are present they can be encouraged by a drastic opening of the canopy. Most shrubs which form good wildlife cover need full sunlight for best growth. Where they are present in the woodlot they can be encouraged by removing competing or overtopping vegetation. If desirable shrub species are not present, they can be planted. This, of course, is expensive and the economics of such a venture must be assessed by each manager.

Regular cutting in the woodlot is desirable for wildlife. Such cutting may be either commercial or noncommercial. The important thing is that it should be done in such a way as to create openings scattered throughout the woodlot. This results in a diverse canopy composed of newly made openings, and older patches progressing from the seedling to mature tree stages. The trees which have been cut or, in the case of commercial operations, the tops of the cut trees can be used to create brush piles. These brush piles scattered strategically throughout the woodlot make excellent cover for cottontails and other mammals.

Den trees are other important items which attract wildlife to the woodlot. These are usually old, partly hollow trees which are of limited value for wood production. They provide dens and nesting areas for a great variety of birds and animals such as wood ducks, raccoons, pileated woodpeckers or squirrels. From one to three such trees per acre should be left standing in each woodlot. If the trees in the woodlot are immature and none is hollow, and if funds permit, nest boxes may be erected as a substitute.

For wildlife, probably the most important part of the woodlot is the edge. The transition area between the trees and the open fields contains the greatest variety of insect and plant life. It is here that both the insectivores and herbivores find most of their food. If the transition from trees to open field is abrupt, there is very little area of "edge" and very little cover for wildlife. On the other hand, if the transition from open field to trees is gradual and, progressing through tall grass and other herbaceous plants, brambles, vines, and shrubs, extends several feet in width, the area used by wildlife will be considerable. Not only will such an edge be a source of food in itself, but it will provide travel cover for the wildlife which venture into the open field to feed.

Brushy fencerows can be considered an extension of the "edge" into the open field and, ideally, will link other woodlots. Such fencerows will be actively used travel corridors, allowing wildlife to move from one woodlot to another in relative safety. In addition, the brushy condition of such fencerows makes excellent nesting sites for many species of songbirds. The value of fencerows for cover is well illustrated in a study carried out by Kabat and Thompson (1) in Wisconsin. This showed a direct correlation between the downward trend of quail population and loss of hedgerows. When the ratio of acres of land to miles of hedgerow cover increased beyond a certain point, the quail disappeared altogether.

The selection of tree species in the woodlot will affect wildlife. In addition to a full range of age classes, it is desirable to have several species represented in each age class. Some species, of course, are more desirable than others as far as wildlife is concerned. Mast-producing trees such as oaks, walnut and beech provide a tremendous amount of rich food in the fall. Probably the single most important winter food of ruffed grouse is the male flower bud of aspen. Therefore, a representation of aspen in the woodlot will almost guarantee the presence of grouse in winter.

Apples are eaten by deer, raccoons, hares and rabbits, squirrels, and many species of birds. A few apple trees scattered throughout the woodlot will reward the manager with a variety of wildlife. The fruit of hawthorn is also sought after by a number of birds. Grouse hunters are aware of this and it is a rare grove of hawthorn from which a grouse or two cannot be flushed just before dusk.

In addition to the production of fruit, apple, hawthorn, and other fruit-bearing species contribute indirectly to feeding many species of birds. Insects are attracted to the flowers and later to the developing fruit. This in turn attracts insect-eating birds.

Wildlife management in southwestern Ontario is basically woodlot management. The person who is interested in wildlife in general or in some particular species should create a good habitat in the woodlot. The general habitat requirements of most species are easily learned and usually are easy to create. Even without knowledge of specific habitat requirements of individual species, the manager can improve habitat conditions and consequently wildlife populations by adhering to the general habitat requirement - diversity.

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HARDWOOD PLANTATION ESTABLISHMENT

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INTRODUCTION

Our hardwood afforestation research was initiated in 1963 in response to a request from the Ontario Department of Lands and Forests. After an extensive literature review, 296 hardwood plantations were surveyed in southern Ontario to determine the factors affecting plantation establishment and growth. The information gained from the literature review and the plantation survey provided the background for the establishment of 55 individual but interrelated studies designed to determine the relative importance to tree establishment and growth of such factors as selection of the planting site, site preparation, weed control, age and quality of planting stock, planting method, direct seeding, fertilization and rodent control.

In 1972 the first phase of the hardwood afforestation program was completed with the publication entitled "Preliminary guide to hardwood planting in southern Ontario". This publication combines all information gained from the individual studies and shows that hardwood plantations can be successfully established on old-field sites as long as the following requirements are met.

SELECTION OF THE PLANTING SITE

The most important single factor in establishing successful hardwood plantations is the selection of a suitable planting site. Good hardwood plantations are more difficult to produce than good softwood plantations, because most hardwood species are very demanding in their growth requirements. For satisfactory growth, hardwood species demand a deep, fertile, moist, but well-drained soil; and even land that may produce fair farm crops is not always suited to good hardwood growth. In southern Ontario, good hardwood sites will usually be found along creeks and streams, on lower slopes and in depressions where topsoil has accumulated, in abandoned orchards or gardens, and in agricultural fields where the A and B horizons are at least 18 inches deep. Hardwoods will never produce high-quality timber when planted on dry, exposed slopes and ridges or in areas where the topsoil is shallow and the subsoil consists of heavy compacted clay.

Since most afforestation sites in southern Ontario are available only because the land is unsuited to agriculture, it would be unrealistic to envision the establishment of large hardwood plantations. At the same time, most available afforestation sites contain some small areas that are perfectly capable of growing good hardwood timber. These are the sites on which hardwoods should be planted.

SITE PREPARATION

The second most important factor in hardwood plantation establishment is the preparation of the planting site. Site preparation may be in the form of plowing and disking or chemical eradication of competing vegetation. The choice of method will depend on the condition of the soil, topography and accessibility, density and composition of the existing cover and, last but not least, the cost of the various methods under consideration. Under no circumstances, however, should the success of a plantation be sacrificed for an initial saving in establishment costs, because initial high costs may prove to be the cheapest in the long run.

Plowing and disking of the total plantation area is by far the best method of site preparation because it offers the following advantages not obtainable by any other method: it destroys all weeds including the deep-rooted perennial species; it stimulates microbial activity; it loosens the soil and provides improved aeration and water infiltration; and it adds plant material which improves the nutrient status and organic content of the soil.

In an experiment near Richmond Hill, it was found that plowing and disking were prerequisites to successful hardwood afforestation of a weed-infested clay soil. After eight growing seasons, the respective height growth of black locust, silver maple and white ash was 15, 10 and 10 feet on plowed land in comparison with 5, 4 and 2 feet on scalps 18 inches in diameter.

Complete mechanical site preparation also provides the most favorable conditions for subsequent chemical weed control because regrowth of weeds can generally be prevented by applying herbicides in doses small enough to be tolerated by the highly susceptible hardwood seedlings.

Where plowing and disking of the total area are not feasible, strips several feet wide should be prepared and the trees planted along the middle of these strips. On light-textured soils or those with few weeds, site preparation may take the form of chemical eradication of weeds on the total area or in strips at least 5 feet wide. However, these methods are generally much less effective in the promotion of seedling growth than is complete mechanical site preparation.

Hardwood seedlings should never be planted in the bottom of furrows, because the temporary relief from competition seldom compensates for the loss of growth owing to lower fertility of the subsoil, loss of the seedling's height advantage and the increased danger of flooding and frost damage. Planting on individual scalps prepared by either mechanical or chemical methods should also be avoided, because weed control on patches smaller than 3 feet in diameter is generally insufficient to promote satisfactory seedling growth.

WEED CONTROL

The effectiveness of weed control during the first few years after planting depends largely on the intensity of site preparation, with the most intensively prepared sites requiring the least weed control. The additional cost of intensive site preparation may, therefore, be partly or totally offset by reduced weeding costs. Manual and mechanical weed control methods have proven very successful, but the frequency of operations required for effective control makes these methods rather expensive. Herbicides offer a more economical control, but many hardwood species are highly susceptible to damage by the doses necessary for effective control. Although many herbicides are currently available and new chemicals are marketed every year, Simazine remains one of the most useful and reliable herbicides in forestry. It is a pregermination herbicide and is taken up only through the roots. Its toxic effect is predominantly the result of interference in the photosynthetic process. Simazine may be applied at any time of the year without the necessity of shielding the tree seedlings. It is very effective in preventing new weed growth and for best results should be applied to weed-free surfaces in early spring before weed growth has started. Simazine may also be used to control established weeds, but here it is most effective in combination with such herbicides as Gramoxone, Amino-triazole or Dalapon. Use of these herbicides, however, necessitates shielding the trees or directing the spray away from the trees, to avoid damage.

Since each tree species has its own herbicide tolerance which is modified by the texture and moisture of the planting soil, seedling age, length of establishment and time and method of application, doses must be carefully metered to provide the best possible weed control without causing seedling damage. A preliminary guide to the application of Simazine in hardwood plantations is listed in Table 1. Simazine must be mixed well and during application needs continuous agitation in the tank to prevent settling, if correct doses are to be achieved.

PLANTING STOCK

The success of any plantation will also depend on the quality and suitability of the planting stock. Good planting stock should be sturdy and have a well-branched root system. In a study of hardwood planting stock quality, I found that seedling size was much more important than seedling age. Not only did the largest trees of either 1+0 or 2+0 seedlings always grow faster than the smaller trees, but the 1+0 seedlings with large root-collar diameters generally survived and grew better than 2+0 seedlings of equal size. Table 2 lists my recommendations for planting stock grades for the most commonly planted hardwood species in Ontario. Tree planters have often expressed a preference for large transplant stock, believing that planting large trees would eliminate the need for site preparation and weed control. Although this probably holds true for the planting of individual, large trees, I found in my experiments that trees 3-4 feet high and up to 5 years old grew very poorly when planted in a weed-infested soil without prior site preparation or without subsequent weed control. Since transplant stock is very expensive to produce, transport and plant, and since growth on unprepared sites was always inferior to that of seedlings planted in soil that was plowed and disked and treated with herbicides, it is much more economical to spend the available money on site preparation and weed control, than on producing large transplant stock.

PLANTING METHOD

Although most hardwood seedlings are currently planted with a spade by the wedge or slit method, planting machines suitable for hardwood planting have recently been developed. To improve the efficiency of large-tree planting, I tested the suitability of portable, motorized post-hole diggers with soil bits of 6 and 10 inches in diameter. I found that the preparation of planting holes with the post-hole digger is the most economical method of planting large trees. However, little growth advantage was gained by seedlings planted in holes prepared by the auger as against those planted by the wedge method. Currently the most economical method of plantation establishment is the planting of seedlings by wedge method or with a planting machine.

DIRECT SEEDING

Hardwood establishment by direct seeding has been investigated as an alternative method to planting of nursery-grown stock. Advantages of direct seeding are the reduction in planting costs and the elimination of planting injury. The greatest disadvantage is the uncertainty of satisfactory establishment. Hardwood species with relatively small seeds such as ash and birch were generally found to be unsuitable for direct seeding and only the oaks and black walnut showed any promise of success. However, in areas where squirrels were common, successful seeding of black walnut was impossible without protecting the seed spots by screens or hardware cloth. Until more successful seeding methods are developed, planting of nursery-grown seedlings guarantees better establishment than direct seeding.

FERTILIZATION

Since low fertility is one of the characteristics of land withdrawn from agriculture, fertilization may be necessary for successful hardwood afforestation on nutrient-deficient sites. However, fertilization will never compensate for unfavorable site conditions, such as shallow topsoil, imperfect drainage, excessive exposure or other conditions detrimental to quality hardwood growth. Although it is well known that hardwood growth depends to a large degree on the level of nutrient availability in the soil, exact values of nutrient requirements of individual hardwood species have not yet been determined. In my experiment near Richmond Hill, fertilization improved 8-year height growth of white ash, silver maple and black locust by 100, 33 and 20 percent, respectively. In other experiments fertilization at time of establishment failed to improve 3-year height growth of planted black walnut, silver maple, red oak and basswood. This indicates that nutrient availability was not a limiting factor on these sites. While fertilization with a balanced fertilizer may be expected to benefit planted hardwood seedlings on all sites, a significant return on an investment in fertilization will be obtained only on sites with known mineral deficiencies. In other words, fertilization is a prerequisite to quality hardwood growth on marginal planting sites. On good sites fertilization will do little to improve hardwood growth and the money available for afforestation may be spent more profitably on intensive site preparation and weed control.

The success of any fertilization will depend on the effectiveness of weed control. Where weed control is ineffective, fertilization may do more harm than good because the newly planted tree seedlings will soon be suppressed by the fertilized weeds.

RODENT CONTROL

Tree girdling by mice and browsing by rabbits can cause heavy damage in hardwood plantations. Poisoning the mice and applying rabbit repellents, such as Arasan 42 S or Thiram, can provide some protection but these methods are rather expensive for the degree of protection they afford. By far the best protection against rodent damage is the elimination of weeds; this deprives the animals of shelter and food and makes the plantation a hostile environment for rodent survival and reproduction. Also, weed control generally increases tree growth, and fast-growing trees are less vulnerable to rodent damage because they soon outgrow the danger.

FUTURE RESEARCH

While research on the major plantation species will be continued, special emphasis will be placed on solving the establishment problems of sugar maple and on the development of planting practices for such minor plantation species as white oak, red maple, butternut, shagbark and bitternut hickory.

Fertilization research will be intensified with emphasis on the determination of the effects of fertilizer placement and time of application on tree establishment and early growth.

Cooperation with Dr. Zufa of the Ontario Ministry of Natural Resources in the planting of selected poplar clones will be expanded.

Research into the feasibility of stand conversion from red and Scots pine to hardwoods will be intensified.

Table 1. Preliminary guide to applying active Princep in hardwood plantations established on fully cultivated, former agricultural land

		Maximum allowable application of active Princep[a]		Application of water	
Species	Soil texture	Shortly after planting lb/acre	In the spring of the 2nd year lb/acre	In the 1st year gal/acre	In the 2nd year gal/acre
Black walnut	loam	6	4	50	50
	clay-loam	8	4	50	50
	clay	8	4	50	50
Silver maple	loam	4	3	50	30
	clay-loam	5	3	50	30
	clay	6	3	50	30
Black locust	loam	4	3	50	30
	clay-loam	5	3	50	30
	clay	6	3	50	30
White ash	loam	3	3	30	30
	clay-loam	3	3	30	30
	clay	4	3	50	30
Basswood	sand	4	3	50	30
	loam	4	3	50	30
	clay-loam	5	3	50	30
Red oak	sand	6	3	50	30
	loam	6	3	50	30
Black cherry	sand	3	3	30	30
	loam	3	3	30	30

[a] Commercial grade of Princep (Simazine) is available at 50 and 80 percent active chemical. NOTE: 1 pound active Princep = 2 pounds Princep 50W; 1 pound active Princep = 1.25 pounds Princep 80W.

Table 2. Recommended planting stock grades for hardwood planted in Ontario

Species	Length of stem		Root-collar diameter	
	Minimum (in.)	Preferred (in.)	Minimum (in.)	Preferred (in.)
Silver maple	8	12	0.20	0.25
Basswood	8	12	0.20	0.25
Red oak	8	12	0.20	0.25
White ash	8	12	0.20	0.25
Black walnut	8	12	0.25	0.35

HERBICIDES IN FOREST TREE ESTABLISHMENT

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INTRODUCTION

Competition from vegetation, particularly from the grass species, has long been recognized as a major factor in mortality of planted forest tree seedlings in southwestern Ontario. The control of vegetation by chemicals has become a useful and effective forestry practice.

The traditional approach to the competition problem has been scalping, i.e., removal of a thin layer of vegetation and roots to expose mineral soil, but this has several inherent disadvantages. Even the thinnest scalp results in the formation of a trench. Such trenches are inevitably used as runways by small mammals. The scalp technique also tends to displace the richest portion of the soil. Improper scalper settings, as well as uneven ground, may result in relatively deep trenches. Small planted trees may be crushed by competing vegetation, which falls into the openings. In most cases, the scalps soon fill up with broad-leaved weeds. They may also fill with water.

Herbicide that is properly applied, with reliable equipment, by trained workers under intensive supervision, in most cases is far superior to scalping as a method of vegetation control.

The advantages of using herbicides are several. A strip of dead vegetation on either side of the planted tree tends to discourage mammal invasion. The dead vegetation acts as a mulch, thereby preserving valuable moisture. The removal of competing vegetation allows rainwater to penetrate to the tree root zone.

Herbicides which will control competing vegetation for 2 years will generally permit planted trees to become vigorous and well established. The exception, of course, when nothing will help planted trees, is an extended period of drought any time during the first year or early in the second year after planting.

APPLICATION OF HERBICIDE

Herbicides may be applied either by hand or by machine.

Hand application is usually done with small, relatively inexpensive, garden-type, 3-gallon hand sprayers. Hand applications can also be made with a hand spray gun and hose attachment on any tractor- or trailer-mounted sprayer. The key to successful hand application of any herbicide is knowledge of the quantity of spray applied. The easiest way to ascertain this quantity is to fix the nozzle size, pressure, quantity of herbicide per unit of water, and area to be treated, and to vary the application time: i.e., with a Tee Jet 8003 nozzle at 40 P.S.I. to cover 4 square feet at 5 lb of active Simazine per acre in 50 lb of water, squeeze the sprayer trigger for 1 second per spot.

Machine applications may be made in one of two ways also. If preplanting or postplanting treatments are required, a boom sprayer may be adapted to spray directly over the planted rows of trees, or where the rows of trees will be. Again, nozzles and pressure are fixed, as are the quantities of herbicide and water. The speed of the machine will determine the application rate. If the speed is fixed the nozzle size must be changed.

The second mechanical application method is the use of the specially modified, sprayer tree planter. Simply stated, sprayer equipment consisting of pump, tank, filters, gauges, shut-off valves and nozzles is adapted to conventional tree planters.

The idea is to apply a 12-15-inch band of vegetation-controlling herbicide on either side of the tree seedling at the time of planting.

CHOICE OF CHEMICAL

To date the most effective chemicals in use operationally have been Simazine alone or Simazine in combination with Amino-triazole (Amitrol-T) or Paraquat (Gramoxone).

Simazine is a pre-emergence soil sterilant which must be applied before the competing vegetation reaches about 4 inches in height. Amino-triazole and Paraquat are "knock-down" chemicals which destroy established vegetation through uptake by the plant and by contact, respectively.

Thus, Simazine may be used alone in the early spring (until approximately May 1 in southwestern Ontario). A combination of Simazine/Amino-triazole is required to kill vegetation that has reached approximately 4 inches in height, when uptake of chemicals is necessary. Late in the spring planting season, when a relatively large volume of plant tissue can be killed by contact only, Simazine and Paraquat are the most effective.

PROTECTION OF THE TREES

There are some problems associated with the use of herbicides in tree planting. Trees may be damaged by contact with the spray or by absorption of herbicide through the root. In extreme cases trees may be killed.

Because of the "contact kill" properties of Amino-triazole and Paraquat, the planted trees must be protected from the herbicide spray. In hand spraying this is easily done with a directed spray or by covering the tree with a stovepipe or large plastic bottle before spraying. When spraying accompanies machine planting, heavy rubber guards are placed on the planter between the nozzles and the planted tree to prevent contact with the spray.

RATES OF APPLICATION

Application rates of the various chemicals will vary with the species being planted and the soil type. The use of insufficient herbicide may result in mortality from heavy vegetation competition. Species that will not tolerate certain chemicals may be killed en masse if accidentally treated. Simazine application will vary from 4 lb active ingredient per acre on sandy soils to 6 lb active ingredient per acre on heavy clay soils. Amino-triazole at 1/2 gallon of liquid product per acre and Paraquat at 2 quarts of liquid product per acre are effective in combination with Simazine.

CONCLUSION

The equipment and the techniques of herbicide application are sound. The key to success is the training of those who are responsible for the actual spraying operation, and adequate supervision by knowledgeable technical staff. With few exceptions, and when properly applied, the herbicides will do the job of controlling competing vegetation adequately.

SOME GROWTH CHARACTERISTICS
OF SEEDLING SUGAR MAPLE

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Outplantings of sugar maple nursery stock commonly fail to become established or to produce satisfactory growth on abandoned farmland in southern Ontario. Intensive site preparation has proven effective for establishing other hardwood species on such sites, but failure to establish sugar maple by using these same cultural methods suggests that factors other than competition for water, light and mineral nutrients are involved. The development of practical recommendations necessary to resolve this problem necessitates identification and evaluation of some of the physiological characteristics and requirements of this species.

The present work has centered on those characteristics and changes specific to the overwintering and early spring periods. Attempts were made to correlate the state of dormancy with root growth, seasonal temperatures, and changes in the moisture content and growth regulators found in dormant buds.

Three-year-old sugar maple seedlings were heeled-in on October 20, 1970 and remained exposed to normal winter conditions. At approximately monthly intervals, 50 plants were harvested, their roots examined and their buds extracted for bioassay of growth regulators. An additional nine plants were potted and placed in the greenhouse at 27°C and a 16-hour photoperiod and time to bud-break were recorded. A group of seedlings not exposed to winter conditions was placed in the greenhouse from the beginning of the experiment, and samples from this group were also harvested and analyzed at monthly intervals. In order to confirm the results of the assays for growth regulators larger samples of buds obtained from forest trees were gathered and bioassayed at several intervals during the overwintering period of the following year.

Seedlings that were brought to the greenhouse in the fall and never exposed to normal winter conditions did not break dormancy by the time observations were concluded in midspring. The number of days required to induce bud-break in the greenhouse subsequent to various periods of winter exposure decreased from a high of 60 or more in November to a stabilized low of 6-8 days in March. Thereafter, at least 6-8 days, with warm temperatures and extended daylengths, were required for active growth to begin.

The first flush of growth that did occur in plants brought to the greenhouse in November, December and January was most often a function of the axillary buds, but with additional exposure to winter conditions, the potential for bud-break showed a marked shift from the axillary to the terminal buds. If we assume that all temperatures of 5°C and below were effective in meeting the chilling requirements, then it appears that over 2,000 hours of chilling are required for the normal overwintering process by sugar maple in this climatic region.

The roots did not enter a dormant state during the entire winter period, and the production and subsequent elongation of new roots ceased or was markedly inhibited only during a few weeks in January when the ground was actually frozen. Active growth resumed by early February, and a rapid burst of growth began in late March or early April some 4 weeks before normal bud-break occurred in early May.

The water content of the buds exposed to winter conditions followed a pattern similar, in some respects, to root activity. It dropped from 57 percent of total fresh weight on October 20 to 38 percent on November 20 and remained relatively constant until late January, which marked the beginning of a steady increase: e.g., February 20, 44 percent; March 20, 50 percent; April 17, 65 percent; and May 3, 72 percent. During the entire winter and early spring period, the seedlings held in the greenhouse under warm-weather conditions remained dormant, and the water content of their buds remained in the region of 44 percent.

The results of the growth regulator studies showed good agreement over both years. Inhibitory substances present in the buds did not exhibit any marked changes during the overwintering period. However, increases in a growth stimulator, tentatively identified as a cytokinin, were observed beginning in late February, and its activity showed an apparent positive correlation with the other indicators of physiological activity through early May when bud-break occurred.

HARDWOOD STAIN AND DECAY

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Decay in living trees is caused by fungi which convert various wood components into substances suited to fungal nourishment. This conversion is carried out by enzymes secreted by the vegetative fungus strands, or hyphae, which ramify through the wood, penetrating and eventually destroying the cell walls. Soft, weakened wood is the result. It is much more difficult to describe the process known in hardwoods as stain, which is really discolored wood as hard as, or harder than, clear wood. Although some forest pathologists maintain that it, too, is the direct result of fungus action, the idea that stain is initially a physiological-biochemical reaction of the tree to various stimuli is gaining in popularity. Research recently conducted by Harvey Anderson of the Ontario Ministry of Natural Resources and myself supports this view as far as sugar maple in the Muskoka-Haliburton region is concerned. Stained wood is very rapidly invaded by microorganisms, mainly fungi and bacteria. The fungi that invade and colonize stained wood are not the same as those that are capable of causing decay. A brief, oversimplified hypothesis of the staining and decaying process in hardwoods, then, would be as follows: exposure of the xylem via branch stubs, broken tops, trunk wounds, etc.; aeration, desiccation and staining of the wood; invasion of stained wood by microorganisms; finally, if substrate and environmental conditions are suitable and the right decay-causing fungus arrives on the scene, replacement of some of the stain by decay.

In the mid-1950's I was involved with John Morawski in an extensive survey of cull necessitated by the presence of decay and stain in all of the commercially important tree species of Ontario--another cooperative study by the Provincial and Federal governments. Although province wide, this survey did not include that part of Ontario south of the Precambrian Shield. Many of the important hardwoods south of the Shield were included in the cull survey, but because of the very different soil and climatic conditions, stand histories, etc., it would be very dangerous to assume that the same cull factors apply on and off the Shield. On the other hand, because of the high proportion of privately owned forest land, and the relatively high value of individual trees, particularly certain species, it would be impractical to attempt a cull survey in this area as was carried out in the north.

As a preliminary step in pinpointing hardwood stain and decay problems south of the Shield, about 1 year ago I mailed 192 questionnaires to the industries in this region that process hardwoods, as indicated by the 1971 directory of primary wood-using industries in Ontario. The questionnaire allowed respondents to indicate which hardwood species they processed and in which species their serious stain or decay problems occurred, to describe stains or decays they considered serious, and to outline problems (other than stains or decays) related to hardwood quality. A total of 93 useable replies was received. Over 50 percent of the respondents indicated that they utilize sugar maple, soft maple, ash, basswood, beech and red oak, in that order. Between 20 and 50 percent of the respondents handled black cherry, elm, white oak, poplar, yellow birch, white birch, and black walnut.

Forty-three respondents, or 46 percent, indicated that they had no serious hardwood stain or decay problems. The other 50 suggested that the maples, beech and basswood were the species most frequently encountered with serious stain or decay problems. However, because of the way in which the questionnaire was worded, care must be taken in drawing conclusions from the replies. For example, we asked only for indications of <u>serious</u> stain or decay problems. Therefore it was possible for an industry to encounter a high proportion of defective logs in a certain species, but the defect was not considered serious enough to include on the questionnaire because the species was not of much value in that operation or because it was potentially valuable but scarce. Furthermore, what might constitute a serious problem for one mill is not necessarily a serious problem for another mill. For these and other reasons the questionnaire replies were augmented by personal visits made this spring to 14 of the questionnaire respondents.

As a result of the questionnaire replies and the personal interviews, it is possible to draw some tentative conclusions concerning the extent of stains and decays in southern hardwoods. For example, there is no doubt that of all the hardwood species growing south of the Shield, the highest proportion of stained or decayed wood is encountered in beech. Much of this is advanced decay, either as a butt rot or as trunk rot generally associated with rough, swollen bark or numerous branch stubs. Although beech has many other non-pathological drawbacks, and is not regarded as a desirable hardwood, the fact is that 21 of the 55 respondents who handle this species felt that beech decay was a serious problem. Basswood is another species in which stain and decay are quite often regarded as serious. Although not as defective as beech, basswood is a more highly regarded species and this fact must be considered in equating the relative importance of decay and stain in the two species. Only seven of the 43 respondents who handled black cherry indicated that stain or decay was a serious problem in this species. However, all mill operators visited who handled this species spoke of a yellow-brown, very dry decay. Apparently many respondents did not include black cherry as a serious stain or decay problem only because of the relative scarcity of the species in their regions. The visits to sawmills confirmed the questionnaire conclusions that stain and decay are seldom problems in black walnut, ash, white birch, white or red oak.

Twelve respondents mentioned under "other defects besides stain and rot" a condition they referred to as "wormy soft maple". My entomological colleagues in Sault Ste. Marie were not aware of any major boring insect problem in living soft maple. Nevertheless, my trip this spring to southern Ontario convinced me that this is a widespread problem, since all 14 persons contacted said that much of their soft maple was wormy (only three of these had so indicated on the questionnaire). Worm holes (small tunnels 1-2 mm in diameter) can occur throughout the xylem, from the pith area to the bark. They are associated with a greenish-brown stain, particularly in the central zones. It appears that one or more species of ambrosia beetle cause the holes; the stain is very likely caused by the fungi introduced into the trees by the beetles. Only one of the 14 persons contacted indicated that he was aware that soft maple included silver and red maple; he had observed that red maple was never wormy. Most of the others had noticed that soft maple growing in wet, lowland areas was more subject to worms than upland trees. From this and from the observations of C. Larsson and C. Kirby of Ontario Ministry of Natural Resources, it is fairly safe to conclude that it is a silver maple, not a red maple, problem. Nevertheless, it is apparently so widespread and reduces the value of trees so drastically that from what I have seen I would have to rate this as one of the major internal quality problems in southern hardwoods.

According to the replies received from the questionnaire, not only is sugar maple the most widely cut hardwood species in southern Ontario, but it ranks slightly ahead of beech as the species in which stain and decay problems are most commonly reported. However, my visit to the 14 respondents last May convinced me that this is an inaccurate conclusion. Most sawmill operators said that hard maple growing nearby was of good quality; with few exceptions badly stained or decayed sugar maple was obtained from north of the Shield border. Some mentioned stain resulting from tap holes where maple sugar operations have been carried out. From my observations of sugar maple logs in mill yards, it is apparent that while some sugar maple growing in southern Ontario, particularly large, overmature trees, do have some stain and decay, on the whole it is not a serious problem in this species. From the work Harvey Anderson and I have done on sugar maple on the Shield, it is safe to say that with any kind of intelligent management, it will become even less significant in the future.

An opportunity to observe at first hand the extent of stain and decay in sugar maple south of the Shield came in connection with the thinning-fertilizing experiment near Chatsworth in Grey County which Dr. Ellis referred to yesterday. The thinning involved the felling of 299 sugar maple trees ranging in diameter from 3.5 to 18 inches in two adjacent stands, and subsequent bucking into lengths corresponding to an actual commercial operation. In addition, 15 hardwood trees other than maple were felled. The trees were carefully examined before they were felled, and any abnormalities or injuries in the merchantable stems were recorded so that we could determine the reliability of various potential external signs of internal defectiveness.

Considering that the best-looking maple stems in the stand were not felled and therefore not examined, it was immediately evident that the extent of stain and decay in sugar maple was far less than in the average stand encountered on the Shield during the cull survey of 15 years ago. The average age of the maple was 65 years, and the average diameter was 8½ inches. Sugar maple stands sampled during the cull survey on the Shield averaged only 5½ inches DBH at this age, and about 22 percent of their merchantable volume was defective. Only 5 percent of the volume of these 299 maple in Grey County was defective.

To determine the influence of external signs and symptoms on defectiveness, the average cross-section diameter of stain and decay at various heights above the ground was determined for trees with no abnormalities other than the ever-present dead branch stubs, and at cuts made far enough away from any abnormalities that they were considered to have little or no effect. These calculations showed a steadily decreasing average diameter of defect (stain) from stump height to the last cut; from 1¼ inches at stump height, to ½ inch at 17 feet, to practically nothing at 41 feet. This was used as a base for comparison with possible external symptoms of defectiveness.

Branch stubs or dead branches, of course, were present on all 299 trees. It is very difficult to assess the direct effect of branch stubs on defectiveness since most trees had one or more other potential sources of defect as well, such as a fork or stem wound. It was found that stubs 1 inch or less in diameter had virtually no effect. Stubs 1½ inches or larger generally were associated with lateral pockets of stain and occasionally decay; however, these were obvious only if the cuts were made not more than 4 feet below the stubs. A total of 181 such lateral defects from stubs was observed in the 299 sample trees, half of them being situated between 20 and 30 feet. These defects generally ranged from ¼ to 1 inch in diameter, and 25 percent of them contained some decay. Trees with more than one branch stub of 2 or more inches in diameter were inclined to have more stain than those with no stubs this large--this ties in with Harvey Anderson's and my observations on sugar maple in Haliburton-Muskoka where the size and number of branch stubs are related to the extent of stain in the merchantable stem.

Of the other possible external symptoms of defect, forks were the most common, being present within the merchantable length of 120 of the 299 sugar maple examined or 40 percent of the trees. These were followed in order of frequency of occurrence by crooks (55 trees), healed-over stem wounds (39 trees), open stem wounds (30 trees), local pronounced increases in stem diameters (swellings) (17 trees), cankers (15 trees) and dead trees joined at or near the stump (9 trees). Only a few trees were encountered with broken or dead tops and maple borer wounds. External abnormalities not associated with any significant increase in internal defect included mild-to-moderate sweeps, burls, and scattered small bark lesions.

All seven of the frequently encountered abnormalities listed above were associated with significant increases in the "normal" amounts of internal stain or decay. Dead trees joined at the base increased the average defect diameter at the basal cut from 1¼ inches to 4 inches, with decay being present in all nine trees. Cankers, generally limited to the lowermost 15 feet, were associated with up to six times the normal diameters of defective wood, which is roughly 36 times the normal cross-section at area of defect; many of these included decay.

The next most serious indicator of stain and decay was stem wounds that were not completely healed over. Some decay was present in heartwood adjacent to the majority of these wounds, particularly when they occurred near the basal region of the trunk. Healed-over wounds, or seams, indicated a less pronounced increase in internal defect than open wounds, although again decay was almost invariably present. Local stem swellings or diameter increases were generally indications of moderate increases in the occurrence of defect; however, decay was very seldom encountered.

Crooks, generally indications of old dead leaders, and forks were almost identical as far as associated defects were concerned. At heights of 25 feet or more they resulted in almost negligible increases in stain extent. Below 25 feet their effects gradually increased until at 9 feet they accounted for 2½ inches of defect compared with the "normal" 3/4 inch; however, even here the incidence of decay was relatively low in both cases.

To sum up, then, the 299 sugar maple examined in two stands near Chatsworth in Grey County were considerably faster growing and had only about one-fourth as much stain and decay as did maple stands of a similar age studied north of the Shield boundary. What little decay was observed was generally associated with cankers, dead trees joined at the base, or trunk wounds, although some decay present at stump height appeared to originate in the root systems. These abnormalities plus forks, crooks, large branch stubs and local stem swellings appreciably increased the diameter of stain and decay present within the bole.

THE CURRENT STATE OF POPLAR BREEDING IN ONTARIO

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INTRODUCTION

The utilization of poplar timber in Ontario does not show any sign of increasing at the present time. However, the consumption of conifers is increasing and is expected to reach the allowable cut of 750 million net merchantable cubic feet by 1980. Thus, future industrial expansion will, of necessity, have to utilize more hardwoods.

In the locations where large wood-using industries have operated for some time, regional deficiencies have already developed. Such is the situation in southeastern Ontario. Other areas may face local shortages of timber in the near future. An increasing number of industries are therefore searching for ways of meeting future raw material requirements at an acceptable price. The use of poplar on short rotations close to the mills and under conditions that permit mechanized harvesting appears to be a most promising approach to the problem.

Poplars are well suited to short-rotation, high-yield plantations. They are among the fastest growing trees in Canada; their juvenile growth is especially rapid and vigorous. Poplars react readily to improved site conditions, soil cultivation and fertilization. They have a great ecological amplitude, for they grow on a wide variety of soils and under varied climatic conditions.

Poplar timber has several uses. It is utilized for a number of fiber, pulp and paper products; for lumber, veneer and plywood products. It is becoming an increasingly important raw material in the world.

Studies of natural variation, crossing experiments and estimates of heritability indicate outstanding possibilities for the improvement of growth, form, and a number of wood properties of poplar. Rapid improvement can be obtained by selection and breeding, followed by vegetative propagation. Thus, the money invested in poplar research will give fast and significant returns.

THE POPLAR-BREEDING PROJECT

Poplar-breeding work in Ontario was initiated by Dr. C. Heimburger in 1935 at the Petawawa Forest Experiment Station and since 1946 has been continued at the Southern Research Station in Maple. The objective of the poplar-breeding work was to develop suitable aspen poplars for southern Ontario. Raising aspen seedlings on an industrial scale presented a problem. Therefore, the main aim was to produce new strains whose stem cuttings possessed good rooting ability. The silver poplar was the only tree in the aspen group with good rooting qualities. Therefore, great emphasis was put on breeding silver poplar with various aspen species. Vigorous hybrid progenies were produced, tested in the nursery, and outplanted in the field. This work has now reached the stage in which strains of superior growth and clones that are easily propagated vegetatively are being reproduced and put into pilot test plantations.

Since 1967, the work has expanded to breeding aspen for northern Ontario and also to breeding cottonwood and balsam poplar.

The main work with aspen in northern Ontario at present consists of selection in native stands, propagation of selected trees, production of *P. tremuloides* x *tremula* and *P. tremuloides* x *sieboldii* hybrids of chosen origin, and their field testing.

In the field of cottonwood and balsam poplar breeding, the work started with plus-tree selection. Outstanding trees of these two species, as well as of Jackii poplar, a cottonwood x balsam poplar hybrid, were located. The selected trees were vegetatively propagated and used for breeding. Crosses were made between these species and with *P. nigra*. Comparative nursery and field plantations are being established with the new selections. To fill the gap until they can be proven suitable for commercial planting, selected hybrid cottonwood clones (Euramerican poplars) were imported from European countries. These are being field tested in Ontario. The aim is to select the clones which are adaptable to our conditions and to demonstrate the potential of the hybrid poplars in Ontario.

Another project comprises testing for frost hardiness in northern Ontario. This work involves hybrid cottonwood and native cottonwood clones, and hybrid aspen clones developed for southern Ontario. A northern extension of the cottonwood is attempted by crossing the frost-hardy varieties of plains cottonwood with eastern cottonwood and by selecting and breeding Jackii poplar varieties.

THE YIELD OF HYBRID POPLAR IN ONTARIO

A recent survey of six plantations established in southern and central Ontario for the purpose of making comparisons among species showed fast growth and high yields of hybrid aspen (Table 1). The plantations were 7-15 years of age. They were established on good sites that were prepared by ploughing.

The yield of hybrid aspen was compared with the yield of native aspen on Site Class I (Table 2). The average heights and diameters (DBH) of trees in 7-15-year-old plantations were equivalent to those in natural stands at 35-50 years of age. The mean annual increments (MAI) in the plantations were between 103 and 292 cubic ft/acre, while the MAI of the unmanaged natural stands reached a maximum of 109 cubic ft/acre at 55 years of age.

Test plantations of hybrid cottonwoods showed satisfactory growth (Table 3). In a plantation established on fresh sandy loam, the best Euramerican poplar clones reached an average height of 15 ft and measured 1.9 in. DBH at the end of the third growing season. The 7- and 9-year-old plantations were adversely affected by weed competition and overcrowding. Notwithstanding these negative effects, the average annual diameter growth was between 0.50 and 0.69 in. DBH and the average annual height growth between 4.4 and 5.7 ft. The mean annual increments of the best clones were 196 cubic ft/acre and 254 cubic ft/acre. Five trees of Euramerican poplar clone "I-214" were planted with 20-ft spacing at the Maple Arboretum. These trees measured an average of 14.8 in. DBH and 59 ft in height at 12 years of age. The average annual growth was 1.23 in. DBH and 4.9 ft in height.

Wood samples from these plantations were sent to Domtar Laboratories in 1971. The samples were pulped by the magnesium-bisulphite (Magnefite) and refiner groundwood processes and gave very satisfactory results. The pulp yield and quality proved to be similar or superior to the pulp made of locally grown poplar and mixed hardwoods typical of the mill's present furnish. The consensus of Domtar Laboratories was that the wood samples proved to be of acceptable pulping quality and that they produced worthy products. No particular problems are expected if similar material is used on a much larger scale.

These observations indicate that the concept of poplar timber production on short rotations justifies large-scale experiments.

PILOT PRODUCTION TESTS

In fact, the large-scale experiments have already begun with test plantations in southeastern Ontario. A pilot project was initiated in the Kemptville District to study the feasibility of poplar pulpwood production in short rotations. The pulpmills in the area are interested and do support the project. The first 75 acres were planted in the spring of 1972 and stock will be available for more than 100 acres of planting in 1973.

The site of these plantations is prepared by ploughing. One-foot-long unrooted cuttings of selected hybrid cottonwood clones are used as planting stock. The spacing is 9 x 9 ft. The site will be cultivated for at least 3 years after planting. It is hoped that trees of 6-8 in. DBH and 40-50 ft in height can be produced in 6-10 year rotation. The plantations will be regenerated by coppices or suckers.

The planting stock for these plantations is propagated in a forest nursery. At present it consists of stools of seven hybrid and native cottonwood clones selected on the basis of performance in various clonal tests.

Year after year new clonal tests are being established. An increasing number of cottonwood and aspen clones and strains is being tested under various site and management conditions. More and more information will be gathered on their performance. This will allow for a continuous change to new and better poplar clones and to better management practices.

Table 1. The yield of hybrid aspen in plantations in Ontario (examples of good growth)

Hybrid	Location	Spacing (ft)	Age (yr)	Height (ft)	DBH (in.)	Total volume (cubic ft per acre)	Mean annual increment (cubic ft per acre)
P. canescens (alba x *grandidentata)*	Huron County	8	7	35	3.6	721	103
P. alba x *davidiana*	Welland County	8	9	51	5.5	2721	292
P. tremuloides x *tremula*	Simcoe County	10	11	54	5.9	1422	129
P. grandidentata x *alba*	Manitoulin Island	8	12	57	6.5	3048	254
P. alba x *grandidentata*	Algonquin Park	9	15	50	8.0	2683	179
P. canescens	Algonquin Park	9	15	53	8.1	3488	232

NOTE: The hybrid aspens were developed and the plantations established by the Tree Breeding Unit, Research Branch, Ontario Department of Lands and Forests, under the guidance of Dr. C. Heimburger. (The information in this table is partly from Beckwith, 1970.)

Table 2. Comparison between the yield of hybrid aspen in plantations and the yield of native aspen on Site Class I in unmanaged aspen stands (on the basis of figures from Table 1 and yield tables by Plonski, 1960)

	Hybrid aspen plantations	Unmanaged aspen stands
Average annual diameter growth (DBH)		
at 7-15 years of age	0.50-0.61 in.	
at 20 years of age		0.18 in.
Average annual height growth		
at 7-15 years of age	3.3-5.7 ft	
at 20 years of age		1.9 ft
Mean annual increment (MAI)		
at 7-15 years of age	103-292 cubic ft/acre	
at 20 years of age		65 cubic ft/acre
at 55 years of age (maximum)		109 cubic ft/acre

Table 3. The growth and yield of hybrid cottonwoods (Euramerican poplars) in southern Ontario (examples of good growth)

Clone	Plantation	Spacing (ft)	Age (yr)	DBH (in.)	Height (ft)	Volume (cubic ft/acre)	Mean annual increment (cubic ft/acre)
Regenerata	Flos	10	3	1.9	15		
I-214	Grand Bend	8	7	4.8	40	1371	196
Carolina	Grand Bend	8	7	4.0	35	866	124
I-45/51	Wainfleet	8	9	5.2	48	2065	229
I-65/A	Wainfleet	8	9	5.8	49	2287	254
I-214	Maple	20	12	14.8	59	(5 trees only)	

RESEARCH ON UPLANDS IN SOUTHERN ONTARIO

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(read by H. C. Larsson)

INTRODUCTION

Essentially, the upland studies are directed at problems relating to the management of mixed hardwood stands in balanced communities. The program emphasizes quality, ecological requirements and interrelationships of some economically important species. At the same time, attention is directed to current industrial, conservational and recreational demands for multiple-use stands, including such items as preservation and development of suitable habitats for selected wildlife species.

In our approach to the reforestation of open sites we are guided mainly by the principles of species association and succession. More often than not, we have to deal with marginal agricultural sites and it is our conviction that many of these depleted areas require at least some degree of ecological rehabilitation prior to the introduction of climax hardwoods. In nature, this is generally accomplished by a series of successional stages involving the establishment of a variety of pioneer species both in the open and around the edges of expanding woodlots.

Poplar appears as an important pioneer component in many of our natural hardwood associations. For this reason, in experimental hardwood plantings we are concentrating on the use of quality poplar and poplar hybrids as nurse-crop species. Much of our poplar stock was developed from materials donated by the Tree Breeding Unit of the Northeastern Forest Experiment Station and from our own collections of native phenotypes. Other species included in cover-crop studies are: select white birch, European alder, black locust, European larch and native aspen.

There are indications that, in short-rotation, dual-crop systems composed of a variety of valuable hardwood species, a number of nurse-crop components have the potential to develop into important revenue producers in their own right, particularly during the early stages of stand formation.

In the upland woodlots, work is concerned mainly with a study of stand density in relation to stand development, sanitation, and the establishment of natural and artificial regeneration of the preferred species. Within this framework a dendrometer study of seasonal diameter growth patterns was begun in 1958 on several hundred sugar maple, white ash, and American basswood trees.

We are also examining the possibility of accelerating the natural expansion of the existing woodlots. This could be accomplished by establishing narrow belts of aspen-type poplar around woodlot perimeters. Aspen, being naturally adapted to vegetative reproduction by suckers, might expand rapidly, thus pioneering the way for other species. It would also create a favourable habitat for many of our game animals as well as nongame species as these are often products of a forest margin of this type.

CURRENT ACTIVITIES

The following is a review of some of the more recent work which can be summarized under the following headings:

1) Location and selection of high-quality phenotypes

2) Propagation techniques

3) Establishment methods

4) Management methods

1) Location and selection of high-quality phenotypes

In this work we hope to preserve quality trees as valuable "gene pools" for the production of superior planting stock. A series of individual "plus" trees has been selected, often with the assistance of the staffs of the various districts. To date our collection includes specimens of red oak, black cherry, sugar maple, basswood, walnut, and select aspen and natural aspen hybrids.

The trees are of the best possible quality: for instance one of the aspen (Mansfield) is 22 inches in diameter and 120 feet in height; it contains three 16-foot logs and has white wood throughout. Two of the black walnut are 27 inches and 22 inches in diameter, respectively. Both are about 100 feet high and contain two clear 16-foot veneer logs each.

Also, a number of hardwood stands have been located to provide quality material for propagation.

2) Propagation techniques

During the past season, hardwoods were propagated by both sexual and vegetative methods. Tubeling techniques are being used for production of experimental hardwood planting stock. The method facilitates efficient use of limited seedlots, generally accelerates production, and permits retention of the entire root system at the time of planting.

Tubelings were used for growing European alder, Karelian birch, largetooth aspen (using both free- and control-pollinated seed), and black locust. Black locust, started in tubes early in the season, was used successfully in direct field planting during the current year. Horizontal stem layering of black locust was also tested with a view to developing a vegetative propagation technique for selected clones. Layers of 1-year-old seedlings in sandy loam, topped with peat moss, on the average produced 5.5 suckers per layer. Severed from the mother stem and planted individually, the suckers showed 100% survival and vigorous development in their first independent growing season.

An advanced test was initiated on methods of stratifying walnut seed. Preliminary trials indicated that, by a proper adjustment of both temperature and moisture levels during stratification, virtually all viable seed could be germinated after about 6 months' stratification. The stratification of walnut in central pits would assure a high degree of control over stratification conditions and pilferage by rodents.

Several thousand poplar cuttings were set out in the nursery to produce stock required in future field trials. Tests on performance of stock in relation to planting dates showed that early outplanting of both cuttings and seedlings produced appreciably larger stock at the end of the season than did late planting. In some instances, although the plantings were established only 2 weeks apart, the size differences persisted for at least 2 years after planting. Variation in the initial sizes of tubelings induced by greenhouse application of fertilizers or the use of large containers generally disappeared towards the end of the first growing season in the field.

3) Establishment methods

Plantings carried out during the past 2 seasons have consisted of the establishment of nurse crops on several sites for which soil analyses were completed by the Research Site Unit. In 1971 cover-crop stock was made up of 35 clones of Euramerican poplar hybrids and in 1972 further additions were made of select progenies of European alder, black locust and European larch. The experimental treatments consisted of several techniques of planting, site preparation, spacing, and different types of planting stock.

The results are summarized as follows:

One-year-old rooted poplar cuttings (1/1 stock), planted as entire trees, survived best under all conditions. However, current growth of this stock was not the best and varied according to site (2.8 ft-0.5 ft).

Excellent performance in terms of current height growth (up to 5.2 ft) was obtained from decapitated 1-year-old rooted cuttings (0/1 stock) which also showed satisfactory survival (97%).

Intermediate survival (67%) and good growth (3.7 ft) was registered for the 7-inch sectional cuttings planted flush with the ground on rich clay loam. This method of deep planting generally resulted in the production of single rather than multiple stems.

Poorest survival and growth were observed for unrooted cuttings on light soils. Auger planting of such cuttings gave higher survival (68%) than the more rapid dibble technique (40%).

The process of lifting and transplanting 1-year-old rooted cuttings caused considerable setback in the development of the planting stock. Second-year height increments of the trees left *in situ* were, on the average, 25% greater (in terms of their initial total heights) than those of the transplanted trees.

There was an indication that long poplar cuttings planted to a depth of 1.5 feet were less subject to lean and to injuries by some soil-applied herbicides than were the short, 7-inch cuttings. Excessive cultivation also appeared to contribute to the "lean problems".

General cultivation and hoeing were superior to spot control of weeds by herbicides, which in turn was significantly better than the use of polythene in local weed control. The latter treatment did not appear to be of any benefit to tree development during the first year.

Application of a mulch of cocoabean shells to newly planted trees tended to control or appreciably reduce weed growth around those trees and seemed to add to their general vigour. A nutrient analysis contributed by Mr. R.H. Leech indicated uncommonly high levels of N, P, K and Mg in the mulch in comparison with foliar concentrations of mature red pine, black spruce and hybrid poplar.

Black locust tubelings raised during the current year from selected seed sources appeared to be suitable for direct field establishment. After an initial check in development subsequent to planting in May, the trees showed good survival (over 90%) and satisfactory growth during the rest of the season. There was some indication that earlier outplanting would result in a less disruptive transition from the greenhouse to the field.

4) Management methods

In Flesherton, seasonal diameter-growth studies were continued with dendrometer tapes on hybrid poplar progeny (*Populus canescens* x [*P. alba* x *P. grandidentata*]) planted in 1962 as a cover crop for red oak. At that time, pure oak plots were also established for comparison and the entire planting was lightly cultivated for 3 consecutive years. After 9 growing seasons a number of poplars have attained a height of about 40 feet and a diameter of about 4 inches. The current annual diameter increment is about 0.5 inches for most trees. Generally the interplanted oak has good form and fine limbs, and reaches heights of up to 19 feet. The openplanted trees show greater vigour which, however, is more than offset by the formation of multiple stems, forking, and frequent occurrence of snow damage, sunscald, spreading infections, and dieback. Partial pruning was carried out to correct snow and browsing damage.

Corrective pruning was also carried out in a 1968 cover-crop study of largetooth aspen which were interplanted in 1970 with sugar maple, white ash and walnut. During the winter of 1970/71 white ash and walnut suffered severely from snow and ice damage and again in 1972 from late frost on June 11. However, sugar maple seedlings appeared more resistant to these conditions.

The aspen that originated from seed shows considerable variation in growth and morphological characteristics, whereas in nature such variation is quite limited owing to clonal spread of this species by suckering and sprouting. The two tests mentioned above were carried out in cooperation with Mr. E.B. Bentham of Flesherton and are scheduled for the forthcoming field inspection.

Stand development studies were continued in a 50-year-old, even-aged woodlot thinned experimentally in 1957. A paper was prepared on the 10-year development of this hardwood stand and copies are available for distribution at this meeting.

This unit was invited to participate in a cooperative study of food and habitat preferences of the American grouse initiated by Mr. H. Lumsden of the Fish and Wildlife Research Branch. Preparations are being made to test several potential hardwood species in this multiple-use project in collaboration with Mr. Lumsden and Dr. Zufa. In addition the unit acted in an advisory capacity in a cooperative project initiated by the Maple Syrup Producers Association. The study was designed to determine the effects of fertilization on the sugar content and yield of maple sap.