# PLANTATION ESTABLISHMENT SYMPOSIUM

*Proceedings of a Symposium sponsored by*
*Ontario Ministry of Natural Resources*
*and*
*Great Lakes Forest Research Centre*
*Kirkland Lake, Ontario*
*September 21-23, 1976*

R. F. Sutton, Editor

GREAT LAKES FOREST RESEARCH CENTRE

SAULT STE. MARIE, ONTARIO

SYMPOSIUM PROCEEDINGS O-P-5

CANADIAN FORESTRY SERVICE

DEPARTMENT OF THE ENVIRONMENT

DECEMBER 1977

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## *FOREWORD*

*A symposium on plantation establishment was held at Kirkland Lake, Ontario, September 21-23, 1976. It was cosponsored by the Ontario Ministry of Natural Resources (OMNR) and the Great Lakes Forest Research Centre (GLFRC). This symposium is part of a series initiated in 1972 by the Canada-Ontario Joint Forestry Research Committee (COJFRC) and designed to provide a forum where forest managers, forest research managers, and forest researchers can discuss topics of importance to forest management in Ontario. Armson (Forest Management in Ontario 1976. Ont. Min. Nat. Resour.) considered that the series has been "effective in bringing field management foresters and others into contact with research workers".*

*The terms of reference were conveyed to the organizing committee by an extract from COJFRC minutes: "Symposium 1976. Reforestation, to cover lifting through to outplanting including survival and growth with the possible inclusion of site preparation. The emphasis will be placed on...northern Ontario...".*

*Attendance, by invitation, was limited to 150 because larger numbers would have been rather difficult to accommodate at Kirkland Lake and would have detracted from the intimacy of the discussions. The affiliations represented included OMNR Forest Management (58%), OMNR Research (4%), Canadian Forestry Service—GLFRC (7%), Canadian Forestry Service—Other (7%), Industry (11%), Forest Services, Other Provinces (5%), and Universities and Colleges (6%). A complete list of participants is given in the Appendix.*

*For this symposium, a format was devised with a view to increasing the pool of "primed expertise" and raising the level of discussions. The means by which these objectives were sought included: securing papers on several aspects of each main topic (in order to cover the subject matter more thoroughly than would be possible with fewer papers as well as to obtain different viewpoints); pre-circulating all papers to all participants for study prior to the symposium; explaining to all participants the need for this prior study and the benefits to be obtained from it; encouraging participants to prepare written questions and comments for discussion at the symposium; allowing authors only 5 minutes per paper for their formal presentations at the symposium, to eliminate unnecessary detail and thereby highlight the main points; having a long discussion period for each main topic following the highlight presentations by the several authors addressing that topic; and having these authors act as a panel of experts for the ensuing discussion of that topic. This format was well received by all the delegates.*

*The agenda included the keynote address and 36 papers. It followed conventional lines, considering sequentially the main topics of stock production, stock quality, holding and distribution, site preparation, planting and tending. The final session, however, was conceived* *as one in which questions of policy and evaluation of performance would be discussed up to the policy making level.*

*A field trip to the Englehart Management Unit on September 22 provided the opportunity to see variously prepared sites for jack pine regeneration as well as examples of young established stands developed from both bare-root and tubeling plantings.*

*Although the full text of the 36 papers could not be published in these Proceedings, photocopies of individual papers are available on request from the Information Office, Canadian Forestry Service, Great Lakes Forest Research Centre, Box 490, Sault Ste. Marie, Ontario, Canada, P6A 5M7. In the Proceedings, abstracts of each paper, in English and in French, are provided, as well as summaries of the oral presentations and of the discussions that followed.*

*Participants were welcomed by A. J. Herridge, Assistant Deputy Minister, Resources and Recreation, on behalf of OMNR and by J. H. Cayford both as Director of GLFRC and as Chairman of COJFRC.*

*The organizing committee acknowledges with thanks its indebtedness to the local (Kirkland Lake) committee of Jack Minor (Chairman), Brian Thompson, and Ron Magee, all of OMNR's Kirkland Lake District; Bob Brandes the OMNR Regional Coordinator; D. Allan Cameron of GLFRC who coordinated the accommodation arrangements; Constance Plexman, Mary Rouse and Lise Cormier of GLFRC Editorial and Information Services; all authors and speakers; Jim Scott and Bob Haig for presenting their impressions of forestry in the USSR; rapporteurs Dys Burger and Bill Bunting; and Ed Markus who so ably chaired the symposium.*

## TABLE OF CONTENTS



(continued)

TABLE OF CONTENTS (continued)

Page

SITE PREPARATION

*Abstracts, Résumés, Supporting Oral Presentation, and Discussion*



PLANTING

*Abstracts, Résumés, Supporting Oral Presentation, and Discussion*



(continued)

TABLE OF CONTENTS (continued)



(continued)

TABLE OF CONTENTS (concluded)



Cover photo: Professor K. A. Armson, keynote speaker at the symposium, talks to participants during a field trip to the Englehart Management Unit. (Photo courtesy of the Northern Daily News, Kirkland Lake).

# KEYNOTE ADDRESS

K. A. Armson
Professor of Forestry
Faculty of Forestry and
Landscape Architecture
University of Toronto
Toronto, Ontario

## *Introduction*

The purpose of this symposium is, primarily, to discuss plantation establishment using bare-root stock in the boreal forest of Ontario. Much of what I say, while related to these conditions, will have application to the general area of plantation establishment. The scale of planting in Ontario on Crown land may be seen from the fact that during the past five years (1971-1975 inclusive) a total of 148,364 hectares (366,617 acres) were planted. I am not, here, concerned with whether that represents an appropriate effort in relation to forest management policy, but rather with the professional and technical aspects of such activity and areas. Let us visit in our mind's eye--and many of you here have a first-hand knowledge--some part of these planted areas and ask certain questions.

Why was this or that particular area planted? The processes of forest management include regeneration but must not be skewed or warped by an overwhelming obsession with it. Too often we focus unreasonably upon the establishment of new stands without realistically envisaging the stands that they may or may not become, within the overall objectives of management. These can be very specific, even today. For example, if the objective is primarily to produce fibre, is the aim 1 $m^3$/ha (14.3 $ft^3$/acre), 2 $m^3$/ha (28.6 $ft^3$/acre), or more, mean annual increment at some specified rotation age? Our position in the forest of today is to initiate the management process rather than act as a collector of cutovers to be planted. I believe we are beginning to make some progress, albeit in a small way, by precutting surveys and related information.

Just as there is a need for forest inventory, so also is there a need for an objective inventory of the land and soils on which we are growing our forests. We must attempt to reach the point at which, with positive rationale rather than negative fulfillment, we are able to justify the planting of an area professionally and technically.

Why was a particular species or type of stock planted? The choice of species must relate primarily to the objectives of management, not its availability. Obviously, this calls for a large measure of effective coordination between those responsible for management and those providing the planting stock. Too often in the past we have lost ourselves, professionally, in the chasms of ignorance and expediency and the darkness of mythology which includes such inanities as "the species to plant is the one that was present in the original stand".

Who is responsible for the success or failure of a plantation and its management? Too frequently, foresters have delegated both authority and responsibility for their actions in order to sit back and stuff the sausage machines of their own bureaucracy with administrative trivia. Within the present system in Ontario it has been far too commonplace for foresters to evade responsibility for the decisions and actions related to plantation establishment for which they were responsible. There is a consensus that much of this problem relates to the short time, usually less than five years, that management foresters spend in one area. If this is so, remedial action is long overdue.

What are the quantifiable measures of survival and growth by which our plantations should be assessed? The setting of such standards has to derive from both a conscious, perhaps even rather arbitrary, set of decisions, and those based on experience and past performance. Thus, an arbitrary decision that 90% survival after one growing season is the acceptable level, should require that all plantations failing to meet this standard would be very closely examined in order to determine causes of failure. The setting of standards of annual growth is more likely to be based on past experience, but here I would issue a clear warning. Set those growth standards on the basis of the best growth attained, not on the average; otherwise mediocrity will result.

What are the tending treatments planned for the established plantation? Fortunately, there is increasing evidence that foresters recognize the need to schedule tending treatments. Obviously the type of treatment must relate to the overall objective of management, but the decision as to whether a specific treatment should be undertaken can be made only after constant monitoring by the forester and his staff. What is crucial is that the treatment be undertaken *before*, not *after*, it has become necessary so as to anticipate and thereby avoid some detrimental development. Let me illustrate: a herbicide treatment on a white spruce plantation to control competing hardwoods should be made *before* spruce height growth is reduced, not *after*. A spacing or thinning should occur, in relation to maintaining or improving growth rates of residual trees, not to effect a release after several years of suppression.

In terms of stand development, there is a final question: how will the plantation be harvested and what new forest will replace it? This question is not as futuristic as it may sound. The alignment and geometry of trees planted today may well be a major factor in future mechanized harvesting, especially for fibre. I haven't noted any random planting of fruit, vegetable and other crops in agriculture, and the efficiency of linear movement, particularly where high yields per unit area are involved, would seem to have future economic benefits. This becomes particularly important when tree diameter frequency distributions are considered. Thus the more uniform the diameters, the more effective harvesting machinery and subsequent operations may become. Another matter relates to stand structure, succession, and the overall objectives of management. In northern Ontario, we do not have as vivid an example as in southern Ontario where many of the older red pine plantations are being invaded by hardwoods, and management foresters are passively stating that because of this the next forest will have to be hardwoods--because they are "more natural" or "the climax". Strangely, this often occurs on sandy soils that supported pine forests, maintained by natural fire; these subsequently were cleared for agriculture, were eroded, and were then planted to red pine and white pine for erosion control and other reasons. If pine plantations have successfully met the management objectives of 30 or 40 years ago, there should be some very hard thinking and considerations before we nonchalantly change them, just because some hardwoods happen to invade the area. I am not unaware of certain boreal forests where, because some species other than the desired one fortuitously occurs in greater abundance, the forester takes the line of least resistance and instead of objectively assessing the pros and cons of establishing the desired species, passively opts out of such decision-making. I am not suggesting that management plans should be etched in stone, or that changes in species and practices should not be made. What I do wish to emphasize is that too frequently we have not thoughtfully pursued the implications of our actions in establishing plantations in relation to both present management objectives and future stand developments. The former usually include decisions by others than professional foresters but the knowledge and decisions regarding the latter are fully the responsibility of the forester--he can neither escape nor delegate it.

The six questions I have posed should help in focusing our attention upon what we are about in plantation establishment. The next matter is that of the technical knowledge, and details of practice, much of which will be your concern here at this meeting. Such knowledge and practice are essential if successful plantations are to be established, but I would reiterate that they are only of consequence insofar as they are seen within the context of forest management and silviculture of a particular forest estate. Frequently, when we face a problem, we cry out that we need "more research". I am constantly reminded, however, that sufficient relevant information is often available which, combined with the foresters' own experience and knowledge, leavened with a portion of logic, and spiced with a dash of imagination, will produce a morsel of innovation which frequently goes a long way to solving or bypassing the original problem. Research is best when applied to elucidating principles and processes. There is also a major role to be played in collating and synthesizing knowledge and experience in such fields as plantation establishment. This function is needed now and in the near future to a very great degree, yet much of the knowledge and experience is never formally documented. Those who can, do; those who can't, teach and write research papers!

If I appear overly critical, it is not done with a sense of discouragement. Rather, I believe that in Ontario we have reached an impasse in our state of forest management, particularly in terms of regeneration. If Ontario is to have a viable forest economy 40 and 50 years from now, it will depend to a large degree on the forests we have created and are establishing now. The future is bleak if we look back at what has been done, but if we learn from our mistakes and apply our knowledge and skills to the best of our ability then we can at least say that the future forests will not fail because of us.

# STOCK PRODUCTION

## [1] Objectives and Criteria for Planting Stock Production in Ontario.

J. B. Scarratt, Research Scientist, Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario, and K. H. Reese, Planting Stock Specialist, Forest Management Branch, Ontario Ministry of Natural Resources, Toronto, Ontario.

*Planting stock production technology in Ontario is going through a period of transition. The need to improve early plantation performance leads us to question current nursery production standards, while the increasing use of greenhouses in planting stock production opens the way to greater diversity of product options. More intensive growing techniques offer the prospect not only of greater production flexibility and potential savings in time and cost, but also of greater efficiency for the planting system as a whole through the increased opportunity for matching nursery product to planting chance.*

*While the aim is to develop a range of nursery products that can be planted throughout the season and have similar performance, bare-root stock is likely to remain the basic element in the planting system for the foreseeable future. Container planting, though regarded largely as a summer supplement to bare-root planting in Ontario, will undoubtedly increase in importance over the next few years and, with the trend to larger seedlings, will probably find successful application over a broader spectrum of site conditions.*

*Although the nurseryman has attempted to relate production rotations and product specifications to the need for satisfying an ultimate field performance standard, greater efforts are needed to match planting stock specifications to specific site conditions. Through greenhousing the nurseryman may be in a better position to meet this need. However, no matter how sophisticated the technology, nursery production can meet its objectives only when the nurseryman receives adequate feedback on the field performance of planting stock. To ensure that nursery stock specifications are appropriate for the range of sites to be planted, more attention needs to be given to developing an efficient system for monitoring outplanting performance from the nursery through to the field.*

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*La technologie de la production de matériel de reproduction connaît actuellement une période de transition. Le besoin d'améliorer le rendement hâtif de la plantation nous incite à nous enquérir des normes courantes de production en pépinière, alors que l'utilisation croissante des serres dans la production de matériel de reproduction ouvre la voie à une diversité beaucoup plus grande du choix des produits.*

*Les techniques de croissance plus intensives offrent la perspective non seulement d'une souplesse de production accrue et d'une possibilité d'épargner sur le temps et les coûts, mais aussi d'une plus grande efficacité du système global de plantage, grâce à une meilleure chance de concilier les produits de pépinière et les hasards d'une plantation.*

*Alors que l'on cherche à mettre au point une gamme de produits de pépinières pouvant être plantés durant toute la saison avec un rendement similaire, les plants à racines nues demeureront vraisemblablement l'élément de base du système de plantage dans un avenir prévisible. Le plantage en potets, même s'il est considéré surtout comme supplément d'été au plantage de matériel à racines nues en Ontario, grandira sûrement en importance au cours des quelques prochaines années puis, avec la tendance à utiliser des semis de plus grande taille, il se pratiquera probablement avec succès dans un rayon plus vaste de conditions de stations.*

*Malgré les efforts du pépiniériste pour tenter de rallier les cycles de production aux spécifications du produit afin de satisfaire les besoins d'une norme de rendement maximum sur le terrain, il existe aussi un besoin évident de déployer de plus grands efforts en vue d'associer le matériel de reproduction aux conditions spécifiques des stations. Par des pratiques de serre, le pépiniériste serait mieux en mesure de satisfaire ce besoin. Toutefois, peu importe à quel point la technologie sera perfectionnée, la production en pépinière n'arrivera à ses fins que lorsque le pépiniériste recevra une rétroaction adéquate sur le terrain même. Afin de s'assurer que les spécifications du matériel de pépinière sont appropriées à l'éventail de stations de plantage, il faut insister sur une plus grande attention à porter à la mise au point d'un régime efficace pour suivre de près le rendement des plantations à partir de la pépinière jusqu'à la mise en place sur le terrain.*

## Supporting Oral Presentation

Illustrating his presentation with slides, Reese began by discussing standards for stock production. The present planting system in Ontario places the nurseryman in a very difficult position. The basic question he is asking, said Reese, is "What kind of stock do people want?" Nowhere in the planting system can one find the planting objectives for expected growth for the broad planting chances much less for the particular projects with which we are dealing. Each new replacement forester usually makes a new set of demands. And in the nurseries, techniques have been changing, so that it is almost impossible to follow through on the traditional products and old rotation ages. Also, new products are being evolved; therefore, some rationalization was required for this developing situation.

The basic step taken was to develop heavy, medium, and small grades of planting stock, and to slot the various products into these size ranges depending on their outplanting performance. Much of this is speculative, Reese said, but the first step has been taken and the values can be confirmed by testing. The table was not new: it had been developed for bare-root stock and is now available for each species. For containerized stock, 350 mg seedlings are equated with the small grade, and 700 mg seedlings with the medium grade. No containerized stock comes close to the heavy grade.

The next step was to choose rotation ages at each nursery which would give the required sizes of stock. Not all grades are included for all species, e.g., no heavy grade jack pine, no small grade white pine. In some species different rotations are needed for the northern and southern nurseries. The container schedules are less definite than the bare-root schedules because of the variation between growers, who have less experience with containers. Container size is included because of its influence on seedling quality.

Examples of growth curves used by the nurseryman to monitor the results being obtained were shown by Reese. Growth curves had been produced for both containerized and bare-root stock from start to shipping.

Reese also showed estimates of the size that should be reached by various stock 3 years after outplanting. That lack of concrete information on performance is at the root of the nursery problem. Without it, the nurseryman cannot work back from the size of the shipping stock to develop his growing regimes.

Reese also made the point that no matter what sort of nursery product is used, it should give the required results if properly used. Scarratt's part of the paper showed that stock can be developed with a wide range of physical dimensions and growth characteristics. Root form, weight, and diameter of nursery stock can be altered to influence outplant performance.

It must be remembered, concluded Reese, that some kinds of stock, e.g., 2+2 transplants and large containers, are very expensive to produce. Also, the planter must be willing to change his practices so that the best blend can be developed for the planting system as a whole.

[2] Lifting Bare-root Nursery Stock.

H. H. deVries, Nursery Superintendent, Kemptville Provincial Nursery, Ontario Ministry of Natural Resources, Kemptville, Ontario.

*Proper procedures for lifting bare-root nursery stock must assure adequate protection to prevent roots from drying out, minimal mechanical damage to roots and tops, and retention of maximum root fibre.*

*Two separate operations constitute lifting: loosening and removing. In both, organization and careful training of nursery staff are an integral part of an efficient and quality-conscious program. Seedlings should be dormant, soil conditions favorable, and roots protected, during the lifting process.*

*Tractor-drawn mechanical lifters are employed as standard practice to prepare soil and seedlings for safe, efficient hand lifting of bare-root stock preparatory to grading and packing either at the field location or under cover in a central packing shed.*

*In recent years, mechanical harvesting equipment has been developed to speed up the lifting process during which seedlings are loosened, removed, and freed of soil in one continuous operation. Bulk handling equipment effects the safe transfer of lifted plants to the packing shed for processing.*

*Nursery stock, ready for outplanting, represents a considerable investment, direct and indirect, that has accrued over a period of years. Great importance, therefore, must be attached to all phases of stock handling.*

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*De bonnes méthodes d'arrachage des semis à racines nues de pépinières doivent assurer une protection adéquate contre l'assèchement des racines, minimiser les dégâts mécaniques aux racines et aux parties aériennes des semis et permettre une rétention maximum des radicelles.*

*L'arrachage s'effectue en deux opérations distinctes: le déchaussage et l'enlevage des semis. Pour les deux opérations, l'organisation et la formation soignée du personnel des pépinières sont partie intégrante d'un programme qui se veut efficace et conscient de la qualité. Les semis doivent être dans un état de dormance, les conditions du sol seront favorables, et les racines protégées au cours du processus d'arrachage.*

*Des arracheuses mécaniques, tirées par tracteur, sont utilisées couramment pour préparer le sol et les semis en vue de l'arrachage manuel efficace des plantes à racines nues, en vue du classement et de l'emballage que l'on fera sur le terrain même, ou à l'abri dans un hangar central d'emballage.*

*Au cours des dernières années, on a mis au point tout un équipement mécanisé de récolte qui accélère l'arrachage pendant lequel les semis sont déchaussés, enlevés et nettoyés en une seule opération continue. Des appareils de manutention en vrac effectuent en toute sûreté le transport des semis arrachés vers le hangar d'emballage.*

*Les stocks de pépinières, prêts à planter, représentent une mise de fonds considérable, directe et indirecte, qui s'est accumulée sur une période de plusieurs années. Par conséquent, il faut attacher une grande importance à toutes les étapes de manutention des plantes.*

## Supporting Oral Presentation

In the absence of deVries, L. Forcier made a few comments on the paper and mentioned a few points relating to his own Swastika nursery.

There are two basic methods of lifting bare-root stock, Forcier said, digging and mechanical lifting. In the past, digging used various hand tools, including the tine fork which was probably the best. This has evolved into mechanical harvesters such as the Grayco used by deVries. The Grayco uses a large, wide steel blade which passes with a shaking motion beneath stock at a depth of about 20 cm, lifting the stock onto a conveyor on a side loader right into boxes which are taken to the shipping barn for grading.

At the Swastika nursery, two systems are used. In one, Forcier explained, the Egonall Lifting Blade is used. It passes with a shaking motion under the seedbed and loosens the stock but, unlike the Grayco, does not lift it out of the ground. The trees are then pulled manually and placed in orderly fashion in boxes, taken to the shipping barn and graded. In the second system, the same lifters are used but the stock is graded in the field. Half of the stock is graded indoors, half in the field.

In lifting stock, many factors must be kept in mind. Speed is essential. Not more than half an hour, less on a dry, windy day, should elapse between lifting, packing, and placement in storage for shipping.

Forcier has found that root dipping immediately after lifting helps keep roots in good condition.

The original model of the 6-row mechanical seedling harvester is at Swastika, and the second is with de Vries at Kemptville. Both are under development. At Swastika, for example, the pitch of the blade and the whole system are being varied. The aim is to obviate manual lifting. Working properly, this machine should be lifting upwards of 1 million trees daily.

## Discussion

The discussion centred on aspects of stock quality, the subject matter of the next section. But the point to be made here is that planting stock specifications and field performance cannot usefully be considered separately from site conditions (including modifications obtained or obtainable by site preparation), holding and distribution effects, workmanship standards and enforcement (especially in planting), and tending. These matters are so closely interrelated that discussion of any one will inevitably range into others; hence the need for a systems approach in plantation establishment.

### *Mechanized Lifting*

An unidentified speaker was interested in how the new seedling harvester machine under development in Ontario compares with the Grayco. Forcier and Wynia agreed that the main difference is that the new machine harvests seedlings in a more orderly fashion, with the seedlings in an upright position all oriented the same way.

The rate of harvesting of the two machines is probably about the same, but Wynia was concerned about the "stranglehold" that the new machine puts on the root collar in order to carry the seedling up to the point of deposition: he felt that severe damage could be done to any seedling that is not completely dormant.

Forcier was of the opinion that any problem with the stranglehold could be solved by reducing the angle of lift and thereby reducing the tension needed to hold the seedling. Reese noted that in fact there had been no problems with the tight tension belts on the Weyerhaeuser and similar machines, on which the Ontario seedling harvester is patterned.

### *Containerization*

The generally marked improvement in survival rates among containerized outplants in recent years, noted by Scarratt and Reese in their paper, seems at least in part to result from increased avoidance of unfavorable sites, notwithstanding the problems of matching stock to site discussed under "Matching Stock and Site" below.

In reply to Swan, who asked about current trends in Ontario, Reese said that about 20 million bare-root trees and 8 million containers are being planted annually: bare-root and containerized jack pine are planted in about equal numbers. All current development and investment in equipment are tending towards a paper tube of some sort, added Reese, but some 1.5 million Spencer-Lemaires, about 10% of the total containers, are being used, the rest being a mix of plastic tubes and paperpots.

Growth rates of outplanted containerized stock were mentioned by Scarratt and Reese: Scarratt had obtained encouraging results in a small trial in which black spruce and white spruce paperpot seedlings put on considerably greater height increment during their first full season in the field than did bare-root stock. Fayle, however, drew attention to Heikurinen's Figure 4 which, although it showed a similar relationship in the first year also showed that after 4 years the height increment of bare-root stock exceeded that of tubeling stock. Fayle also wondered at what point "maximum field performance", referred to by Scarratt and Reese, should be assessed. He questioned whether paperpot stock could be expected to continue to outgrow bare-root stock.

*Matching Stock and Site*

Both in formal papers and in discussion, consideration was given to the question of matching variously specified nursery stock with various outplanting conditions.

Robinson suggested that too much emphasis was being put on this, for "even matching species to site at times seems to be beyond our ability".

Scarratt noted that stock specifications have generally not been matched to site conditions: some very small stock is raised and planted on some of the most difficult sites where it has no chance of performing satisfactorily.

The point was pursued by Reese. He observed that containerized white spruce by the million now being grown would be equivalent to small grade stock. What justification could there be for planting small grade containerized stock on white spruce sites for which heavy grade bare-root stock is considered necessary?

*Seed Source*

In answer to questions by Yeatman, Reese saw no problem in sowing and keeping separate small lots of seed provided that whole nurseries did not have to be hand seeded. Seed drills are available to handle small lots of seed.

But, said Reese, there is considerable difficulty in returning all stock to the area from which the seed was collected. Seed collection in some districts is not sufficient for their plant requirements, and seed must therefore be imported.

*Time of Lifting/Planting*

Offord pointed out that Scarratt and Reese in their paper had recommended that outplanting be terminated by the end of August in view of the reduction in growth and quality found in late summer plantings. Offord coupled this with the observation that Day et al. in their paper contended that fall lifting of bare-root stock should not be started before mid-September, when root regeneration is vigorous. Did this mean, Offord wanted to know, that fall planting should be avoided unless poor performance is acceptable for at least the first few years?

Scarratt replied in the affirmative. He had found that performance was much poorer in stock planted after the first week of August than in stock planted earlier in the season. In his experiments the effect is still pronounced in all growth parameters even after 9 years.

An unidentified speaker cited similar relationships with 2+2 bare-root stock. It seemed to him that there is a general relationship between time of planting and performance, survival and height increment declining progressively with increasingly late plantings. Such an effect was still evident after 13 years, there being a vast difference in annual height increment between trees planted in the July-August period and those planted in May and early June.

Armson referred to clear documentation in a paper by Mullin and Bunting of the same effect being maintained after 15 years in plantings of jack pine at different times through the growing season. Armson, however, knew of some midsummer plantings of spruce which had been satisfactory. [For another example of successful midsummer planting, see Armson's comments under "Documentation", p. 15: For further discussion of planting dates, see the section on Planting, beginning on p. 56.]

*Root Regeneration Periodicity*

Reese led the discussion into a consideration of the relationship between poor performance of late plantings and root regeneration periodicity. What, he asked, happens to the so-called summer surge of root regeneration?

Day responded that the surge occurs on occasion but is not invariable. He recalled an instance in which a bed of transplanted larch had failed to regenerate new roots in 3 months. Root regeneration may not occur in certain soil moisture conditions, and its occurrence may depend on pre-conditioning in the nursery. Information is lacking on the levels of root regeneration that might be obtained if plant moisture stress were not allowed to rise to fairly high levels at times through the growing season. The decision has to be made, said Day, to monitor compartment moisture and to control irrigation within narrow limits if root periodicity is to be understood in the nursery as it relates to transplanting. Day concluded that at Thunder Bay, where his work had been done, moisture conditions have been too heterogeneous to allow pulses of root regeneration to be predicted with confidence.

*Greenhouse—Nursery Coordination*

White commended Scarratt and Reese on their suggestion that greenhouse and nursery should be coordinated. He asked whether they had considered modifying the greenhouse environment to secure better and bigger trees more quickly. What about increasing daylength and prolonging the period of juvenile growth, etc.? Perhaps spruce equivalent to 3+0 stock could be grown in 9 months.

Scarratt replied that what White was suggesting was being done up to a point but the level of technical sophistication in the greenhouses precluded using highly sophisticated techniques right away. Nursery culture, he continued, attempts to improve on nature and to manipulate growth by fertilizing, irrigating, transplanting, etc. One area that has been missed and remains primitive is the critical seedbed stage. If the seedbed is moved into the greenhouse, we secure not only greater control over germination and better chances of manipulating growth, but also the potential to accelerate growth.

Two approaches to growth acceleration are being taken in Ontario, said Scarratt. With bare-root stock, the seedbed is transferred to the greenhouse, as has been done at the Swastika nursery for the last 2 years. Growth acceleration has been marked, and the aim is to produce usable transplants at ½+1.

The second approach is to fertilize container stock. At the Thessalon nursery, for instance, Scarratt had obtained marked increases in height and, especially, dry weight production to obtain ½+1 spruce superior to conventional 2+0, and ½+2 superior to 3+0.

*Stock Size, Type, and Quality*

White was pleased to see that Scarratt and Reese were calling for bigger and more vigorous planting stock. He had been promoting this for as long as he could remember. Let's get rid of these little trees in Ontario tubes if we want successful plantation establishment, he said.

Gilbert called for greater recognition of the fact that the cost of nursery stock is really a minor part of the total cost of establishment. What is needed in Cambridge District, for instance, is good, uniform, heavy grade white spruce. Gilbert added that he did not mean that stock should be chest high. He thought it inefficient and expensive when nurseries, in order to cut costs, are forced to produce and supply stock that performs so poorly in the field that sometimes three, four, or five replantings are necessary. The total cost picture should be considered.

Referring to Table 1 of Scarratt and Reese's paper, Wynia said that not to separate spruce and pine by top:root specifications is unrealistic. The young spruce is a different sort of tree from the young pine. The dry weight top:root ratio of spruce will have to be between 2 and 3, but pine with a ratio of beteen 4 and 5 should be just as satisfactory.

The decline in average survival in plantations of bare-root stock during the period 1966-1971 was attributed by Scarratt and Reese in their paper partly to "a certain laxity in planting practices, particularly stock handling"; but they also recognized the possibility that increased use of seedlings as opposed to transplants may have contributed to the decline. G. Brown believed that the trouble centred on the sort of seedling stock that had replaced the good quality transplants which were used almost exclusively up to the 1960s. Increases in the number of seedlings per unit length decreased the quality of the product: with the former transplant stock, Brown said, we knew that the quality was good, and any failure of outplantings was due to mishandling or competition. He called for "standard stock", beginning perhaps with precision sowing to control sowing densities whose quality could be relied on; but he emphasized that this cannot be done unless Ontario is willing to invest the money to enable the production people to grow the type, quantity, and quality of stock needed.

Bunting presumed that although all nurseries could not use the same sowing rates, because of variation in seed quality, the rates used were calculated to give a standard number of shippable trees per unit area.

Reese disagreed with Brown's premise. Seeding densities have in fact tended to decrease during the period of his (Reese's) association with nurseries, to 50, 40, or 30/sq ft (538, 431, or 323/$m^2$) and even to 15 or 20/sq ft (161 or 215/$m^2$) for red pine in some cases.

Another point, continued Reese, is that for the next decade at least, there will not be just one standard tree to plant. We began with seedling stock, then went to transplants, which received a mixed reception. The planters have not in fact determined the sort of tree they want. The improvements in greenhousing and horticulture that have taken place in recent years are being studied with a view to growing an acceptable 1+0 tree, but at present no one type of tree seems to be indicated.

Bunting confirmed Reese's contention in respect to sowing densities: he used about 40 seeds/sq ft (431/$m^2$) for about 25 shippable white spruce.

*Documentation*

Perhaps the dominant theme throughout the symposium was the need to monitor and document significant characteristics of planting stock, the environment, and performance. Scarratt and Reese maintained in their paper that the regeneration effort was unsatisfactory in the past largely because of a "lack of clearly defined plantation performance standards and the absence of a sound field monitoring system". They added that, "[i]n view of the complex interactions involved, it is vitally important that a system be set up to monitor and quantify plant response from the nursery through to plantation establishment". If either planting stock potential or performance in the field is not determined, then successes will be achieved by accident or not at all, and we will not learn from our failures.

Scarratt and Reese concluded that the absence of reliable field growth data has forced nurserymen "to assume arbitrary performance standards when drawing up stock production specifications". Nevertheless, the setting of standards is in itself encouraging and must enhance the likelihood of obtaining feedback on field performance.

The need for feedback to the nurseries from the field was stressed by Groves. He said that very little constructive criticism is received. An occasional letter comes back from a district or region reporting mortality of such and such, but there has never been any indication of how survival may have been affected by factors other than the quality and condition of the stock as it left the nursery. Groves felt sure that nurserymen would take steps to remedy problems of stock condition if they had the appropriate information.

Fayle, commenting on the keynote address, supported Armson's point that documentation is needed as a basis for decision making. Armson elaborated the point, decrying the common situation in which good information is not made available to others who might benefit from it. What is even sadder, Armson continued, is that the system does not recognize that internal transfers of knowledge are the key not only to improving management but also to providing the researcher with proper motivation and helping him identify the significant problems. Armson gave an example: he had seen a plantation of hemlock in Lanark District that, to everyone's surprise, had been eminently successful after summer underplanting. Similar success was achieved the following year. What obviously happens is that vigorous root regeneration occurs in hemlock in those conditions at that time of year. But the information remained local: the system is not designed to capitalize on good information deriving from successes or failures.

## STOCK QUALITY

### [3] Stock Quality and Grading.

R. F. Sutton, Research Scientist, Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario.

*Stock quality is fitness for purpose, and the act of grading presupposes that purpose. The central problem in grading has been that criteria have seldom been securely related to outplanted performance. The grade of planting stock at any time other than at the time of outplanting is immaterial.*

*Two sets of criteria are implicit in grading: external (morphological), and internal (physiological). Morphology has been virtually the sole basis for grading planting stock in the past. This has worked reasonably well for conventional spring and fall lifting and planting, but there have been problems, and the longer the period between lifting and outplanting, particularly if cold storage and other practices disrupt growth rhythms, the greater the inadequacy of solely morphological grading.*

*Physiological factors, especially those influencing root regeneration, winter vigor, dormancy, disease resistance, etc., become increasingly important as the storage period is lengthened, or as wider departures are attempted from the conventional spring lift/spring plant sequence.*

*Monitoring of performance in characterized environments and the establishment of reference plantations (using stock that although not physiologically characterized is yet physiologically homogeneous as a result of rigid adherence to cultural schedules) is the only way of providing the data needed to establish the essential relationships.*

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*La qualité des plants est leur faculté d'aptation à une fin et leur classement présuppose cette fin. Le problème central lié au classement fut que les critères établis ont rarement été associés au rendement des plants. Le classement du matériel de reproduction en tout temps autre que celui du plantage est de peu d'importance.*

*Deux genres de critères sont impliqués dans le classement: les critères externes (morphologiques) et internes (physiologiques). Dans les années passées, on n'a tenu compte que de la morphologie lors du classement du matériel de reproduction. Cela allait assez bien pour l'arrachage et le plantage printanier et automnal classiques, mais des problèmes ont surgi, et plus la période entre l'arrachage et* *le plantage était longue (particulièrement lorsque l'entreposage au froid et d'autres pratiques dérèglent le rythme de croissance), plus s'accentuait l'imperfection du seul classement morphologique.*

*Les facteurs physiologiques, spécialement ceux qui influent sur la restauration des racines, la vigueur hivernale, l'état de dormance, la résistance aux maladies, etc., prennent de plus en plus d'importance à mesure que s'allonge la période d'entreposage, ou que l'on tente de s'éloigner davantage de la scène classique de l'arrachage-plantage printanier.*

*Le seul moyen de fournir les données nécessaires à l'établissement des rapports essentiels consiste à suivre de près le progrès des plants en des milieux bien analysés et connus, et à établir des plantations-témoins (en se servant de plants qui, sans présenter de caractéristiques physiologiques connues, n'en sont pas moins physiologiquement homogènes, suite à une stricte adhérence aux programmes de soins culturaux établis).*



## Supporting Oral Presentation

After stressing that the whole purpose of grading is to separate planting stock into classes within which the trees will perform alike in the field when treated alike, Sutton made three main points.

First, it is useless to allocate a grade to a tree unless it is the operative grade when it counts, i.e., *at the time of outplanting.*

Second, it is necessary to characterize both the grades and the performance they can be expected to give in the field. Much of the regeneration effort will be wasted as long as we remain unaware of the suitability of designated grades of stock for specific purposes. We need to know what we are dealing with and how it performs before we can draw up specifications and standards.

Third, the more we depart from the conventional spring-lift/spring-plant situation, and specifically the more we use cold storage systems, the greater is the need for this characterization, documentation, and monitoring. Extended storage, unconventional lifting times, etc., affect stock quality (e.g., by physical deterioration and physiological disruption, especially of plant hormone systems) in ways that cannot be detected by the eye. Two plants (or lots) may be morphologically identical, and yet, when outplanted, one may survive and grow well, while the other fails utterly (cf. Day et al., paper [5]). Morphological grading, never fully satisfactory, is completely inadequate for stored stock.

[4] Determination of the Readiness of Coniferous Seedlings for Overwinter Cold Storage.

C. Glerum, Research Scientist, Ontario Ministry of Natural Resources, Division of Forests, Forest Research Branch, Maple, Ontario.

*Conifers should be dormant and frost hardy when lifted in the autumn for overwinter cold storage. Electrical impedance may help in determining optimum autumn lifting dates. Therefore, a mathematical model was developed from 3 years of impedance measurements to predict these lifting dates in advance. This model is being tested by overwinter storage and subsequent outplanting. Twenty-five impedance measurements per species (white spruce, white pine, and red pine) are taken once a week and adjusted for diameter; the impedance is predicted 2 and 4 weeks ahead. In general the discrepancies between predicted and actual impedance decrease from September to the end of November. To obtain an indication of the impedance levels appropriate to time of lifting, two lifting dates were selected on the basis of date and actual impedance. Trees were lifted on Oct. 30 and Nov. 13, 1975, packed in kraft bags, and placed in cold storage at -5°C. These trees were outplanted and compared with freshly lifted stock in April 1976.*

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*Lors du déterrement des semis de conifères en automne pour les entreposer au froid pour l'hiver, ils devraient être à l'état de dormance et résistants au gel. L'impédance ou résistance électrique peut aider à fixer les dates optimales. Ainsi donc, un modèle mathématique fut élaboré, fondé sur 3 années de mesurage d'impédance afin de prédire les dates propices. Ce modèle est mis à l'essai par l'entreposage d'hiver, puis le plantage. Une fois par semaine, on prend 25 mesurages d'impédance par espèce d'arbres (Epinette blanche, Pin blanc et Pin rouge) et on corrige selon le diamètre; l'impédance est prévue 2 à 4 semaines à l'avance. De façon générale, les différences entre l'impédance réelle et celle qu'on avait prévue, diminuent à partir de septembre jusqu'à la fin de novembre. Afin d'obtenir une indication des niveaux d'impédance appropriés au temps du déterrement, deux dates de déterrement furent choisies en se fondant sur la date et l'impédance réelle. Des arbres furent déterrés le 30 octobre et le 13 novembre 1975, ils furent emballés dans des sacs de papier kraft, puis entreposés au froid (-5°C). Puis ils furent plantés et on les a comparés aux plants fraîchement déterrés en avril 1976.*

## Supporting Oral Presentation

There is general agreement that stock has to be dormant before it is put into cold storage, which, Glerum noted, is being used increasingly by nurseries in Ontario for overwintering. The stock should also be frost hardy, contended Glerum, for both dormancy and frost hardiness affect the results given by overwinter cold storage.

Dormancy, however, is not a single physiological state, and the degree of dormancy is difficult to determine. Thus Glerum established the seasonal trend in frost hardiness as an aid to determining when trees should be lifted in the fall for overwinter cold storage. In a southern Ontario nursery, white spruce, for instance, increased in frost hardiness from about -4°C to -40°C during the period from August to November. Glerum argued that when a tree is fully frost hardy it is also fully dormant and can be stored satisfactorily in that condition. White spruce plants should not be lifted until their frost hardiness is well below -20°C. This is a very pertinent illustration of the inadequacy of morphological grading as a basis for assessing fitness.

A 3-year study at three nurseries showed that electrical impedance in nursery stock followed trends similar to those exhibited by frost resistance, with low values in summer, high values in winter. Some good correlations were found, particularly with time of year, stem diameter, and minimum temperature. Attempts are being made to develop equations that would enable the nurseryman to predict, one or two weeks in advance, when stock would be ready for lifting for cold storage.

[5] Root Periodicity and Root Regeneration Potential are Keys to Successful Plantation Establishment.

R. J. Day, J. T. Stupendick, and J. M. Butler, Professor and Research Assistants, Lakehead University, School of Forestry, Thunder Bay, Ontario.

*The root periodicities and root regeneration potentials of 2+0 (rising to 3+0) black spruce* (Picea mariana *[Mill.] B.S.P.) and white spruce* (Picea glauca *[Moench] Voss) nursery stock were studied in 1972, 1973, and 1974.*

*The stock was lifted, measured, potted, and grown in controlled environment for 21-day periods after each lifting. Root regeneration potential was then assessed from increase or decrease in root area index (RAI), and from root elongation.*

*An increase in RAI over the 21-day postplanting period was always accompanied by root elongation. A decrease in RAI of up to 1 cm$^2$ in black spruce and 2.5 cm$^2$ in white spruce occurred even when roots grew to 30 cm, and a decrease in RAI always occurred when root elongation was absent. The maximum variation in root regeneration potential of black spruce was from an RAI of +30% to -25% and from an elongation of 38 cm to 0 cm. The maximum variation in root regeneration potential of white spruce was from an RAI of +16% to -15% and from an elongation*

*of 13 cm to 0 cm. Thus, RAI 21 days after transplanting is a function of the decrease in area of the old root system and increase in area of the newly elongated roots.*

*Both black spruce and white spruce have well developed inherent root periodicity patterns, but these vary with seasonal differences in climate and soil moisture in the nursery. Both species regenerated roots well when soil moisture was adequate before and during the spring lifting period (May 25 to June 5). Root regeneration was erratic and often poor both in the period between spring and summer lifting and in the summer lifting period (July 21 to August 21) regardless of the adequacy of soil moisture. In the early part of the fall lifting period (August 21 to the end of the growing season), root regeneration was very poor, but by mid-September it was again improving.*

*The following recommendations are given: (i) lifting in the spring should be restricted to the period between spring thaw and May 31; (ii) in years with early spring drought the seedbeds should be irrigated before lifting; (iii) lifting in the fall should not be started before mid-September.*

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*On a étudié en 1972, 1973 et 1974 les possibilités de périodicités et de régénération en pépinière des racines d'Épinette noire* (**Picea mariana** [*Mill.*] *B.S.P.*) *et d'Épinette blanche* (**Picea glauca** [*Moench*] *Voss*) *2+0 (croissant à 3+0).*

*Les semis furent arrachés, mesurés, empotés et cultivés en milieu contrôlé pendant des périodes de 21 jours après chaque arrachage. On évalua alors le potentiel de régénération des racines selon l'augmentation ou la diminution de l'indice de surface des racines (ISR) et selon l'allongement des racines.*

*Une augmentation de l'ISR pour la période de 21 jours après le plantage fut toujours accompagnée d'allongement des racines. Une diminution de l'ISR allant jusqu'à 1 cm$^2$ chez l'Épinette noire et jusqu'à 2.5 cm$^2$ chez l'Épinette blanche se manifesta même si les racines s'allongeaient jusqu'à 30 cm; et, une diminution de l'ISR fut constatée chaque fois qu'il n'y eut aucun allongement des racines. Voici la variation maximum dans le potentiel de régénération des racines d'Épinette noire: ISR de +30% à -25% et allongement de 38 cm à 0 cm. La même variation pour l'Épinette blanche fut: ISR de +16% à -15% et allongement de 13 cm à 0 cm. Donc, l'ISR, 21 jours après le plantage est fonction de la diminution de la surface des anciennes racines et de l'augmentation de la surface des nouvelles racines allongées.*

*Les deux espèces, l'Épinette noire et l'Épinette blanche ont des modes inhérents de périodicité des racines bien développés, mais ils varient selon les différences saisonnières du climat et la teneur en humidité du* *sol de la pépinière. Les deux espèces ont bien régénéré les racines lorsque l'humidité du sol était appropriée avant et durant la période d'arrachage printannier (du 25 mai au 5 juin). La régénération des racines fut erratique et souvent pauvre, à la fois durant la période entre l'arrachage printannier et l'arrachage estival et durant la période d'arrachage estival (du 21 juillet au 21 août) peu importe que la teneur humide du sol ait été ou non adéquate. Au début de la période d'arrachage automnal, (du 21 août à la fin de la saison de croissance), la régénération des racines s'avéra très pauvre, mais vers la mi-septembre, elle commença à s'améliorer.*

*L'auteur propose les recommandations suivantes: (i) l'arrachage printanier devrait être limité à la période comprise entre la fonte des neiges et le 31 mai; (ii) au cours des années de dessiccation printanière hâtive, les planches de semis devraient être irriguées avant l'arrachage; (iii) on ne devrait pas commencer l'arrachage d'automne avant la mi-septembre.*

## Supporting Oral Presentation

It is well established that forest tree outplants (and, for that matter, transplants) vary a great deal within species in the vigor and amount of their new root production, even in favorable environments, depending, among other things, on the physiological state of the stock at the time of lifting. Day's results, from his and his co-workers' studies of root regeneration in rising 3+0 black spruce and white spruce grown at Thunder Bay Forest Station, provided clear confirmation of this seasonal variation, and also demonstrated a strong year to year variation. Soil moisture levels strongly influenced not only actual root regeneration, as might be expected, but also root regeneration potential (RRP), presumably by affecting the rate of change of physiological sequences.

The silvicultural significance of these findings is considerable. In a dry spring season, in the absence of irrigation, the RRP can be expected to decline to dangerously low levels even during the normal spring lifting period. In the fall lifting period (from August 21 to the end of the season), RRP levels were very low at the beginning and became satisfactory or better only in mid-September.

This is not to say that morphology is unimportant. Initial root system size is very important, but root system size in itself is probably less critical in maintaining the tree through the establishment phase than is a high level of root regeneration, both potential and actual. Clearly apparent is the danger of assuming that morphologically attractive planting stock in good physical condition is also in good physiological condition and able to grow well when planted in favorable conditions.

[6] Seed Origin--First, Last, and Always.

C. W. Yeatman, Research Scientist, Department of the Environment, Canadian Forestry Service, Petawawa Forest Experiment Station, Chalk River, Ontario.

*The proper genetic makeup of seed and plants used in reforestation is a basic requirement for success in plantation management. Natural evolutionary forces of mutation, selection, migration, and isolation result in tree populations that differ genetically across and along major environmental gradients. In the rigorous Canadian environment, climatic adaptation is of paramount importance to survival and growth.*

*Planting and direct seeding both incur the risk of failure because of ignorance or laxity in control of seed origin and create the opportunity to use only genetically appropriate material. Progressively better choices will be possible as experience and information accumulate and genetically improved seed becomes available. Provenance studies in commercial pine and spruce species have shown that both good and poor sources can be identified in a given climatic region. However, in the absence of strong evidence to the contrary, it remains a safe rule to use seed of local origin. The essential and critical point is to* know *the true origin of seed and seedlings used in reforestation.*

*Evidence in support of strict control of seed collection and distribution is reviewed for black spruce* (Picea mariana [*Mill.*] *B.S.P.*) *and white spruce* (P. glauca [*Moench*] *Voss*) *and jack pine* (Pinus banksiana *Lamb.*)*, red pine* (P. resinosa *Ait.*)*, and white pine* (P. strobus *L.*)*. Each species exhibits its own well defined variation on the general pattern of climatic adaptation.*

*Delineation of seed zones on the basis of ecological criteria is the first approximation to seed control. The boundaries of a zone are useful to practical management by setting outer limits for seed movement. Seed zones are not adequate for identification of seed origin. Systems of seed zones need to be under constant review and subject to modification, species by species. An example is given from data on jack pine provenances growing at two sites in northern Ontario.*

*Good seed management calls for long-term planning of supply, control of seed collection, and knowledge of seed origin through the nurseries to the forest. Designation and management of natural stands for seed production are particularly urgent in major commercial forest areas. Future supplies of genetically improved seed must be built on this foundation if breeding is to be successful. Responsibility needs to be shared by all levels of management, administration, and research.*

Pour faire un succès de l'aménagement d'une plantation, il est fondamentalement nécessaire de posséder, au point de vue génétique, les semences et les plants appropriés au reboisement. Les forces d'évolution naturelle que sont la mutation, la sélection, la migration et l'isolation produisent des peuplements génétiquement différents à travers et le long des principaux milieux. A cause du climat rigoureux que l'on connaît au Canada, l'adaptation au climat est d'une importance primordiale à la survie et à la croissance.

Le plantage et le semis direct risquent tous deux d'engendrer des faillites à cause de l'ignorance ou du mauvais aménagement de l'origine des semences et aussi parce qu'on ne s'assure pas que l'on emploie seulement du matériel génétiquement approprié. Progressivement, de meilleurs choix seront possibles à mesure que l'expérience et l'information s'accumuleront et que des semences génétiquement améliorées seront disponibles. Des études sur la provenance de Pin et d'Épinette employés dans le commerce ont démontré qu'il est possible d'identifier de bonnes et de pauvres sources dans une région climatique donnée. Cependant, à moins de fortes preuves du contraire, l'utilisation locale de semences récoltées sur place demeurera une règle sûre. Le point essentiel et critique est de connaître la véritable origine des semences et des semis utilisés en restauration forestière.

L'auteur étaye par des preuves le contrôle sévère de la récolte et de la distribution des semences d'Épinettes noire et blanche et de Pins gris, rouge et blanc. Chaque essence affiche ses propres variations bien définies, quant à sa manière générale d'adaptation au climat.

Le tracé des zones de semences selon des critères écologiques constitue le premier pas à considérer dans le contrôle des semences. L'aménagement pratique exige qu'une zone soit délimitée par l'établissement de limites au mouvement des semences. Les zones de semence ne sont pas appropriées pour identifier l'origine des semences. Les systèmes de zones de semences doivent être constamment revisés et pouvoir être modifiés, espèce par espèce. Des données sur des provenances de Pin gris en deux stations du nord de l'Ontario en sont un exemple.

L'aménagement éclairé des semences exige une planification à long terme des approvisionnements, du contrôle de la récolte des semences et une connaissance de leur origine à partir de la pépinière jusqu'à la forêt. La désignation et l'aménagement de peuplements naturels pour la production de semences sont des facteurs particulièrement urgents pour les grands secteurs de forêts commerciales. Si l'on veut faire un succès de nos croisements, les futurs approvisionnements de semences génétiquement améliorées devront reposer sur cette base. Tous les cadres et les chercheurs devront se partager cette responsabilite.

## Supporting Oral Presentation

Yeatman's message was clear: the choice of seed vitally affects the results achieved by the regeneration effort. Planting provides an opportunity to use a good seed source for any given plantation. It also provides an opportunity to improve through selection and breeding. Here again, documentation is the key, for seed source must be identified from collection through to established plantation and preferably to harvest (cf. Heikurinen's paper). The information deriving from this will reveal the best sources which can then be used to additional advantage.

The present basis of seed source selection must be ecoclimatic. All the indications from Petawawa's provenance tests with the major spruces and pines are that climatic adaptation is the dominant genetic factor that differentiates populations.

Yeatman illustrated some extreme effects of seed source in jack pine growing at Swastika. A Michigan provenance suffered pronounced winter injury and desiccation, whereas the local provenance was unaffected by frost and winter chilling. In another case, a provenance from the Great Lakes—St. Lawrence Forest Region just 130 km south of Swastika showed low survival and high susceptibility to Scleroderris. The need to avoid unsatisfactory seed sources is obvious.

Foresters at all levels, but particularly at the unit and district levels, must exercise strict seed control. It is the foresters' responsibility to secure and maintain genetic quality, physiological quality, and adequate gene pools. The policy makers must see that these resources are kept for us and for future generations.

## [7] Practical Guidelines to Nursery Stock Quality.

R. E. Mullin, Research Scientist, Ontario Ministry of Natural Resources, Forest Research Branch, Midhurst Research Centre, Midhurst, Ontario.

*Concern for nursery stock and plantation quality was expressed by Ontario Ministry of Natural Resources staff prior to a review of changes in nursery stock in Ontario over 15 years. Species were compared for size and balance (top:root ratio) from 1960 on. Top:root ratios were found to have increased and to be much above the maximum acceptable standards published by the Ministry's forerunner in 1961. The result is poorly balanced, poor-quality planting stock.*

*A review of changes in nursery operations showed possible sources of imbalance: sprays, fertilizers, irrigation, continuous cropping, seedbed drills, new harvesting equipment. Semihydroponic growing systems have been established on poor, depleted nursery soils.*

STOCK QUALITY

*Experiments on seedbed density and fertilization have shown that the use of plants grown at 160 trees/m$^2$ (15/sq. ft) or fewer have been of great advantage to plantations. Fertilizers (top-dressings) were sometimes found to have been wasted or even harmful. Nurserymen were unaware of this and planters were given poor-quality stock as a result. Test plots both in the nursery and in outplantings are required to correct this problem.*

*For improved planting success it is recommended that transplants be used for adverse sites, seedbed drilling be stopped, seedbed densities be reduced, and rotational procedures be used on good nursery soils.*

*A quick test for nursery stock quality, using a fast volumetric method, is given to assist planters. It is based on top-length, stem diameter, and top:root ratio. A set of standards based on material compiled from many sources is given.*

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*Le personnel du Ministère des richesses naturelles de l'Ontario s'était préoccupé de la qualité des plants de pépinières et de la plantation, avant d'effectuer une série de changements dans les stocks de pépinière de l'Ontario, échelonnés sur 15 ans. On a comparé les espèces quant à la taille et à l'équilibre (proportion tête-racine) à compter de 1960. Les proportions tête-racine avaient augmenté et étaient bien au-dessus des normes maximales acceptables publiées dans les prévisions du Ministère en 1961, et comme résultat, on a constaté que les plants sont mal équilibrés et de piètre qualité.*

*Une étude des changements dans les opérations des pépinières a indiqué les sources probables du déséquilibre: les vaporisations, les fertilisants, l'irrigation, les récoltes continuelles, les semoirs mécaniques en ligne, les nouvelles machines à récolter. Des methodes de culture semihydroponiques ont été mises sur pied en des sols pauvres, épuisés.*

*Des expériences sur la densité des planches de semis et sur la fertilisation ont démontré que l'emploi de plants cultivés à raison de 160 arbres/m$^2$ (15 pi$^2$) ou moins fut très avantageux pour les plantations. Les fertilisants (en surface) se sont révélés une perte et parfois même une nuisance. Les pépiniéristes n'étaient pas au courant de cette situation et par conséquent, les planteurs ont reçu des plants de qualité médiocre. Des parcelles d'essai et à l'intérieur de la pépinière et des plants à l'extérieur sont nécessaires pour corriger une telle situation.*

*Pour améliorer le succès de plantage, on recommande d'utiliser des plants repiqués dans les stations pauvres, de cesser de semer en ligne, de diminuer la densité des planches de semis et de procéder par rotation sur les sols de pépinière de bonne qualité.*

## Supporting Oral Presentation

Mullin's paper was presented by his technician Bob Hutchison who cited several expressions of concern that had developed in recent years about the quality of planting stock in Ontario as supplied by the nurseries: the 1974 MacKinnon report, the 1975 paper by Fry, and the establishment in 1975 by OMNR head office of a team to investigate failure of red pine plantings.

Production-run stock used in experimental work during the 15 years from 1960 showed declining top:root ratios; and whereas at the beginning of the period all stock qualified as acceptable on the basis of the standards suggested by Armson and Carman, by 1974 not one species was within that 3:1 ratio, and jack pine and red pine at 6:1 were almost twice the desirable ratio. These ratios have increased over the years because aboveground size of all seedling stock has increased while the below-ground size has decreased relatively and often absolutely. The result is that root surface areas are too small to absorb enough moisture except under the most favorable planting conditions.

A possible cause of stock inferiority might be that nursery soils have been depleted after continuous heavy cropping, using heavy fertilization and irrigation to produce trees that may be "soft, weak, and unnatural". Seedbed density also affects top:root ratios, survival, and growth, improvements in all of these being obtained when 3+0 stock was grown at $160/m^2$ or fewer.

Three suggestions were offered to overcome problems of imbalance and poor performance: produce large transplants for adverse conditions; control seedbed densities to a maximum of $160/m^2$, evenly spaced; and return to "natural" rotation systems in the nursery.

The only way that the nurseryman can check on the quality of the stock he produces is through his own annual test plot system.

In the absence of a dependable specification sheet accompanying a shipment, the receiving forester will have to examine the trees and judge whether they should be planted, culled and only some planted, or rejected. Assessed stock quality may affect choice of planting site, method and degree of site preparation, spacing of plants, and even planting method. To assist the forester in making this decision, quick tests of stock quality, as described in the full paper, can be made easily.

## Discussion

### *Top:Root Ratios*

Discussion of morphological aspects of stock grading centred on top:root ratios. One view, expressed by G. Brown, was that this ratio is wholly without significance. The more general view was that the top:root ratio is useful in helping to characterize planting stock although it should not be used as an inflexible arbiter of quality.

There were reservations. Bax commented that Mullin and Svaton (Commonw. For. Rev. 51(1):62-69, 1972) had found top:root ratios of white spruce at outplanting to be an unreliable indicator of survival and growth 10 years later. Fayle pointed out that the ratio gave undue weight to large roots at the expense of fibrous roots. Both Bunting and Hutchison remarked on the susceptibility of the ratio to radical change by pruning in the nursery or by abuse in the field as, for example, when planters use their planting shovels to chop off part of the root system to reduce the labor required in planting. Such uncontrolled pruning would of course vitiate correlations between field performance and the top:root ratio of stock when shipped.

Bunting suggested that much of the deterioration in top:root ratios had been caused by root pruning in the nursery in response to the demands of field foresters, normal pruning now being to 23 cm. Bunting also countered the charge that nurseries had become worked out and were maintaining their productivity only by massive fertilization and irrigation: he gave figures for one compartment at Orono where organic carbon in the Ap horizon had increased from 0.61% in 1962 to 2.62% in 1975 under continuous cropping.

Wynia had already questioned the wisdom of using a common top:root ratio for the pines and spruces in OMNR specifications. He added that compared with the ratios cited in Mullin's paper those of root-pruned shipping stock from Thunder Bay in the spring of 1976 were low, averaging 3:1 for 3+0, and 2.5:1 for 2+2 white spruce.

The statement in Day et al.'s paper that top:root ratios can be improved (reduced) if seedbed densities are decreased was challenged by Bunting, who stated that his tests did not seem to indicate this, and that significant effects were obtained only at the very low rate of $55/m^2$.

The importance of the root fibrousness question raised by Fayle was supported by Day who thought that an outplant's existing fine roots play a critical role in the absence of vigorous root regeneration. Differences in fibrousness could well affect performance (Day, Fayle) and would presumably affect the care needed in handling stock (Fayle).

Reese objected to statements that top:root ratios had been increasing and that this had caused stock quality to deteriorate. He supported his view with data for 3+0 red pine and black spruce averaged over all nurseries for the period 1959-1975. Red pine had increased in total dry weight 2.5 times in the period, and there had been an increase in root area, but the top:root ratio had not increased. Similarly for black spruce, total tree weights had almost doubled, root areas had increased, but top:root ratios had remained stable. While there may be exceptions, the data indicate no general deterioration. Data for other species would indicate a similar situation.

*Stock Balance*

Kim sought the criteria for balanced stock, and G. Brown wondered why Sutton had not spelled out the parameters to define balanced stock. Sutton replied that definition of criteria will become possible only when the relevant characters affecting performance have been determined and when stock lots can be rated in terms of these characters. This is the point at which morphology and physiology meet: and since balance has to reflect ability to perform, it is the suitability of the resultant meld of stock characters in any given outplanting environment that determines whether a plant is or is not balanced. The general concept is easily described, but to define balance specifically is difficult, perhaps impossible.

Day commented that the loss of fine root tips after outplanting averages about 30% in black spruce and 15% in white spruce, and if top and root are in balance to begin with, then root regeneration is needed at the same rate as root loss takes place if that balance is to be maintained.

*Physiological Aspects*

Physiological aspects of stock quality are becoming increasingly important (cf. Sutton, paper [3]). Still apparently unappreciated by many is the fact that the eye cannot differentiate between good planting stock and planting stock that just looks good. Sutton, for instance, was challenged to say what was wrong with some good-looking seedlings that Scarratt had illustrated with slides: he agreed that they looked fine but that, short of testing and monitoring, there is no way of determining their physiological strengths or limitations. Root regeneration potential (cf. Day et al., paper [5]), dormancy and frost hardiness (cf. Glerum, paper [4]), and genotype (cf. Yeatman, paper [6]) were cited as factors that do not have morphological expression. Characterization of planting stock and documentation of performance are more important than ever before because of the increasing amount of look-alike stock that nevertheless has vastly different potentials for survival and growth.

*Root Regeneration*

Considerable discussion of RRP and periodicity took place. For instance, Robinson wanted to know the relative effects of fall lifting + overwinter storage + spring planting as opposed to spring lifting + 2 to 4 weeks of storage before planting, in terms of performance in general and of RRP in particular. In reply, Day said that, if the stock is completely dormant when lifted and placed in freezing storage, then the RRP of both white spruce and black spruce improves progressively through the winter, and the stock is in good condition for spring planting. No depression in RRP has been detected in stock stored for 2 to 4 weeks after spring lifting. Day added that in prolonged cold storage, during which respiration would continue, the RRP would decline. The most dangerous thing is to lift stock in the spring after dormancy has been broken and then put the stock into freezing cold storage.

*Fall Planting*

G. Brown congratulated Day on his paper which provided the physiological basis for the sort of results that had caused him (Brown) to refuse to plant trees in the fall of the year. The data raised questions as to the validity of all fall planting in the boreal forest. Day agreed that the practice of fall planting should be looked at carefully. If stock is lifted when RRP is low and then exposed to moisture stress, problems can be expected. If planting is left late, soil temperatures become too low for effective establishment. In latish outplantings not subjected to severe moisture stress, however, stock may benefit from what seems to be a progressive induction of RRP, with overwinter cooling in the field equivalent to artificial cold storage, and root regeneration taking place in the following spring.

Armson spoke about the year to year variation in stages of development among nursery stock. Day agreed that hesitations and pulses in development do occur in response to weather: plant moisture stress should be monitored in the nursery.

*Seed Collection Zones*

R. Brown noted that in British Columbia seed zones are fairly small and based on climatic zones: seed is collected and identified from these zones on the basis of elevation, and stock is planted in the zone from which the seed was collected. Yeatman said that British Columbia is leading Canada in seed control at present, setting an example for the other provinces.

## HOLDING AND DISTRIBUTION

### [8] Packing and Packaging.

W. R. Bunting, Nursery Superintendent, Ontario Ministry of Natural Resources, Orono, Ontario.

*The process of lifting, packing, packaging, and subsequent field planting of nursery stock is an unnatural occurrence in the life of a tree. However, it is a necessary disturbance if the needs of reforestation are to be met. The method of packing and packaging, particularly as it affects the exposure of seedlings to drying, may have serious effects on survival and growth after outplanting. One might assume that, if trees were mishandled during one of these operations, even though survival might be lower, those trees that did manage to survive would recover and go on to grow as well as if they had not been mishandled. This does not seem to be the case; any treatment that reduces survival and growth at the time of planting still seems to be restricting 5, 10, and even 20 years after planting.*

*At the Orono Nursery, in order to minimize the exposure of seedling trees to the drying effects of the atmosphere, we have moved our packing operations to the field. There the trees are pulled, culled, and tied in bundles of 25, the roots are pruned manually to about 23 cm (9 in.), and the tree roots are then dipped in water and the seedlings placed in a multiwalled kraft bag with a 0.002 poly liner. When the bag is full (5 to 15 bundles of trees, depending on age class and species) the bag is sewn shut with a portable bag closer.*

*Exposure to drying, from the time the first tree in a bundle is pulled until the bundle is tied, root-pruned, dipped in water and placed in the bag, does not exceed three minutes.*

*Seedlings packaged in this manner may be stored, at ambient temperature, without loss of condition, for at least a week.*

*We believe that this packaging and packing procedure assures maximum potential survival and growth of trees as outplants. We also feel that the system is flexible enough to fit into any packaging system, mechanical or otherwise, whether the packaging is done in the field or at a centrally located packing shed.*

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*Le processus d'arrachage, d'emballage et de conditionnement des semis, puis le plantage subséquent sur le terrain n'est pas naturel dans la vie d'un arbre. Cependant, il s'agit d'un dérangement nécessaire si l'on veut reboiser nos forêts. La méthode d'emballage et de conditionnement, surtout du fait qu'elle expose les semis à la dessiccation, peut avoir de sérieux effets sur la survie et la croissance après le plantage.*

*On pourrait croire que si des arbres sont manutentionnés sans précautions durant l'une de ces opérations, malgré une survie peut-être faible, ceux qui ont réussi à survivre et à croître le feront tout aussi bien que s'ils avaient été bien manutentionnés. Mais cela ne semble pas être le cas; tout traitement qui diminue la survie et la croissance durant la période du plantage semble restreindre la croissance 5, 10 et même 20 ans après celui-ci.*

*A la pépinière d'Orono, afin de minimiser l'exposition des semis aux effets dessiccants de l'atmosphère, nous avons procédé à l'emballage sur le terrain. Sur place, les arbres sont arrachés, triés, et attachés en paquets de 25, les racines sont élaguées à la main jusqu'à environ 23 cm (9 po) et trempées dans l'eau; puis, on place les semis dans des sacs kraft à multiépaisseurs avec doublure de polyéthylène de calibre 0.002. Lorsque le sac est rempli (5 à 16 paquets, selon l'âge et l'espèce), il est fermé au moyen d'un appareil à coudre portatif.*

*L'exposition à la dessiccation ne dépasse pas trois minutes à compter du moment où le premier arbre d'un paquet est arraché, jusqu'au moment où le paquet est lié, les racines élaguées, trempées dans l'eau et où la mise en sacs est terminée.*

*Les semis emballés de cette façon pourront être entreposés, à la température ambiante, sans perdre leur humidité durant une semaine au moins.*

*Nous croyons que cette méthode d'emballage et conditionnement assure le meilleur potentiel de survie et de croissance des plants. Nous croyons aussi que la méthode est assez souple pour s'adapter à n'importe quel régime d'emballage, mécanisé ou autre, peu importe que celui-ci soit fait sur le terrain ou dans un hangar central.*



## Supporting Oral Presentation

Bunting's first point was that the performance of outplanted stock is determined largely by the way that the stock is handled between lifting and planting. Furthermore, whereas one might logically assume that a mishandled tree, if it survived, would recover and thereafter grow as well as a tree that had not been mishandled, this does not seem to be the case. For example, in a series of jack pine plantings through the growing season from May 2 to October 18, the growth of trees planted after the normal planting season was continuing, 15 years later, to fall behind that of trees planted during the conventional planting season. It is thus important at every stage to avoid mishandling.

Methods are now under development at Orono to minimize the period between lifting and packing. With the help of slides, Bunting described how packaging operations had been moved to the field. Plants are lifted normally, culled, tied in bundles of 25, and taken to a mini-packing shed right in the nursery field. Here they are root pruned, have their roots dipped into water, and then immediately put into either Plant-fresh® or polykraft bags, which are machine-tied. The lapsed time from lifting to bagging has not been more than 3 minutes at Orono. Avoidance of drying out of roots is very important in maintaining quality. Losses in root regeneration potential (RRP), similar to those described by Day et al. (paper [5]) among stock lifted from dry soil, can be expected to occur among stock whose roots have been allowed to dry.

Another nursery to eschew sophisticated mechanical lifter-packer systems is the Irving Nursery at Juniper, New Brunswick from which about 10 million trees are shipped annually. Again Bunting used slides to illustrate the Irving system: lifting is done manually, and packing is done in the field on a 6m x 6m wooden platform that, pushed slowly by tractor, closely follows the lifters. The trees are said to be delivered to the planting site and planted within 48 hours of lifting. The Irving people are growing trees for their own use, and they obviously use the best system they have been able to devise.

## [9] Nursery Storage of Spring-lifted Planting Stock[1].

S. Navratil, School of Forestry, Lakehead University, Thunder Bay, Ontario.

*The effects of spring storaging on planting stock can be both beneficial and detrimental. Stock quality as affected by the storage conditions and duration of storage was monitored. Respiration consumption of food reserves in seedlings (dry weight losses) varied with temperature, type of container and seedling species. With storage temperature averaging 2.5°C and 4°C, dry weight losses over the 8-week period were 6.5-17%. It was estimated that about half of the available energy reserves (carbohydrates) can be depleted after 40-70 days of storage. With storage temperature averaging 2°C higher, dry weight losses doubled. Detrimental dehydration of stock occurred in the crates and boxes without moisture-retaining material. Water content losses were three times as great in black spruce (*Picea mariana *[Mill.] B.S.P.) seedlings as in white spruce (*P. glauca *[Moench] Voss). In the boxes containing moisture-retaining material, there was an increase in the actual moisture content (6- 7%) of the seedlings. Post-lifting (prestorage) dehydration of stock can be self-adjusted by storaging in the latter container. The potential for damage by epidemic outbreaks of bacterial and fungal pathogens exists*

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[1] A cooperative study of the School of Forestry, Lakehead University and the Division of Forests, Ontario Ministry of Natural Resources. Acknowledgment is due to OMNR and K. W. Reese, J. Flowers and D. Wynia for the support given to this project.

*in all facilities where the temperature cannot be maintained below +2°C. Black spots on needles and chlorotic needles were the most frequent symptoms.* **Botrytis cinerea** *was the fastest growing fungus among those isolated at low temperatures.*

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*Les effets de l'entreposage printanier du matériel de reproduction peuvent être avantageux mais aussi nuisibles. L'auteur a suivi de près la qualité du matériel affecté par les conditions et la durée d'entreposage. La consommation des réserves nutritives par la respiration des semis (pertes du poids anhydre) varia selon la température, le type de récipients et l'espèce de semis. Les pertes du poids anhydre pendant une période de 8 semaines furent de 6.5 à 17% à une température d'entreposage moyenne de 2.5° et 4°C. L'auteur estima que la moitié des réserves d'énergie disponibles (carbohydrates) peuvent être perdues après une période de 40 à 70 jours d'entreposage. A une température moyenne de 2°C supérieure, les pertes en poids anhydre doublèrent. La déshydratation nuisible aux plants eut lieu dans les caisses à claire-voie et les boîtes ne contenant aucun produit de rétention d'humidité. Les pertes en humidité furent trois fois plus élevées chez les semis d'Épinette noire* (**Picea mariana** *(Mill.) B.S.P.) que chez l'Épinette blanche* (**P. glauca** *(Moench) Voss). Dans les boîtes contenant un produit retenant l'humidité, les semis bénéficièrent d'une augmentation (6 à 17%) de la teneur en humidité. La déshydratation des plants après arrachage (préstorage) pourra s'auto-régler grâce à l'entreposage dans des boîtes contenant un produit retenant l'humidité. La possibilité de dommages causés par la prolifération de bactéries et de Champignons pathogènes existe partout où la température ne peut être maintenue sous +2°C. Des taches noires sur les aiguilles ainsi que des aiguilles chlorotiques furent les symptômes les plus communs.* **Botrytis cinerea** *fut le Champignon le plus prolifique parmi ceux isolés à basse température.*

## Supporting Oral Presentation

Unlike the Irving operation, Ontario is unable to use without delay all of its spring-lifted stock. Storage is playing an increasing role in nursery management. Navratil stressed the delicate biological nature of planting stock and said that changes induced by storage stress can drastically affect the survival potential. Interim storage is one phase in a chain of operations that directly affect planting stock quality.

Navratil went on to say that, whereas in 1972 storage may have been risky and one of the main sources of stock deterioration, much subsequent progress has been made in technique, facilities, and knowledge. Storage remains somewhat tricky, however, because there are still unknowns, and what we don't know *can* hurt.

Navratil, on the evidence from his studies and from the literature, estimated that seedlings can lose 50% of their energy reserves after 40 days in refrigerated storage or after only 12+ days in unrefrigerated storage. The only logical answer, therefore, is to have refrigerated storage everywhere in the field as well as in the nursery.

Physiological deterioration by dehydration is probably better recognized than that caused by loss of energy reserves. All Navratil's experiments have shown that packaged storage needs moisture-retaining material. Desiccation can occur *prior* to cold storage, e.g., prior to lifting, and should be avoided by watering the nursery beds before lifting. To some degree, a beneficial self adjustment of water stress takes place in packaged stock.

Navratil cautioned against dipping roots into water prior to packaging, and advised the practice followed at Orono nursery and described in Bunting's paper [8].

Water stress of stored stock should be monitored, said Navratil, and adjusted as necessary by the techniques described in his paper.

The quality of storage has improved in recent years. Guidelines have been prepared by Mullin, by Navratil's group, and by Hocking in Alberta, but separate guidelines need to be developed for each species. Black spruce and white spruce, for instance, vary greatly in their reaction to cold storage.

Storage stresses cannot be minimized, Navratil quite rightly contended "unless we know exactly what is going on in the seedlings from the physiological point of view".

## [10] Cold Storage Units in the Field: A Report on the Different Systems Used in the Northern Region.

P. K. Bidwell, R.P.F., Unit Forester, Ontario Ministry of Natural Resources, Hearst, Ontario and R. L. MacNaughton, Unit Forester, Ontario Ministry of Natural Resources, Cochrane, Ontario.

*In the Northern Forest Region of the Ontario Ministry of Natural Resources, three types of cold storage facilities are being used at present to hold nursery stock trees: (i)* Root Houses, *the original holding method for cool storage. Because of difficulties with sanitation and with maintaining the desirable holding temperatures (3°C) these facilities have gradually disappeared; (ii)* Refrigerated Trailers, *highly versatile cool and cold (-4°C) storage units which can hold up to 400,000 trees right at the planting site. The main disadvantage of these units is the maintenance required on their diesel operated refrigerating plants; (iii)* Refrigerated Buildings, *insulated buildings of various designs which are run by*

*refrigeration plants capable of holding stock under constant cool or cold temperatures. The capacity of the existing buildings for normal planting stock is from 800,000 to 1,000,000 trees.*

*These two types of refrigerated cold storage unit are highly recommended because of their ease of sanitation and control of temperature and humidity. They relieve nursery storage problems and give the districts more flexibility in the organization of their planting programs.*

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*Le Ministère des richesses naturelles de l'Ontario utilise actuellement trois types d'installations d'entreposage à froid pour conserver ses plants de pépinière dans la région forestière du nord de la province: (i) les* Glacières, *représentant la méthode originale de conservation par entreposage au frais. A cause de problèmes d'hygiène et des difficultés rencontrées dans le maintien de la température appropriée (3°C), ces installations ont disparu graduellement; (ii) les* Remorques Réfrigérées, *très versatiles, fraîches ou froides (-4°C), qui sont des unités d'entreposage pouvant contenir jusqu'à 400,000 plants sur les lieux mêmes de la station. Le principal inconvénient de ces unités réside dans l'entretien exigé par leur machinerie fonctionnant au diésel; (iii) les* Bâtiments Réfrigérés, *qui sont des constructions isolées, de divers modèles, fonctionnant au moyen d'usines de réfrigération et pouvant conserver les plants sous des températures constantes fraîches ou froides. La capacité des bâtiments actuels pour les stocks de pépinières est de 800,000 à 1,000,000 d'arbres.*

*On recommande fortement ces deux types d'unités réfrigérées à cause de leur facilité de pourvoir aux mesures d'hygiène et de contrôler la température et l'humidité. C'est un moyen de soulager les pépinières du problème que représente l'entreposage et de donner aux districts une plus grande souplesse dans la planification de leurs programmes de plantage.*

## Supporting Oral Presentation

Bidwell, giving the supporting presentation for the paper he coauthored with MacNaughton, emphasized the importance to survival of proper handling of nursery stock between nursery and field. Nursery storage, properly done, certainly does not impair, and in certain cases improves, the chances of survival, Bidwell said. The critical link, therefore, is in the holding of stock in field storage. In the Hearst District, "plantation survival has improved noticeably" since its refrigerated cold storage building became available.

Illustrating his talk with slides, Bidwell mentioned that in addition to the three current types of cold storage listed in his paper (root house, refrigerated trailer, and refrigerated building), a fourth type, "rented space", should be added.

Proper storage temperatures are hard to maintain in the root house. The 1972 refrigerated trailer, purchased in 1975, can hold about 1/3 million trees and has no difficulty in holding the required temperature in any weather. It can provide storage right onto the planting site: limited capacity is its main drawback.

The refrigerated building has proved satisfactory for cool or cold storage and is most useful for overwintering frozen stock: fall lifting is not without its problems, but overwinter storage of fall-lifted stock relieves pressures in the spring on both the nursery and the District. The initial cost is high, but maintenance and operating costs are relatively low. There is no problem in maintaining a temperature of -4°C during winter and the spring planting period. Capacity is about 1 million plants.

Rented space in the Hearst Curling Club was used to store freshly (spring) lifted trees. Storage temperatures of 1 to 2°C at 90% relative humidity could be held in all but the hottest weather. This stock was planted before any of the overwintered stock was used.

The survival rate of frozen stock that was planted in the spring of 1976 was 70%. This was considered satisfactory considering the lateness of the planting and the dryness of the season.

## Discussion

A lively, varied discussion reflected the interest in and concern for the problems of holding and distributing planting stock.

*Storage Temperatures*

Referring to Navratil's report of dry weight losses in spring-lifted seedlings stored at 2.5°C to 4.0°C, and in particular to the finding that white spruce in boxes lost more weight than did white spruce in crates, whereas in black spruce the reverse relationship occurred, Offord wanted to know whether these same relationships were to be expected if storage temperatures were maintained between 1.0°C and 2.5°C: could black spruce and white spruce be stored safely in cardboard boxes for 3 weeks at those temperatures? Navratil replied that experiments had not been carried out at those temperatures, but he would guess that differences would be smaller because the respiration rate would be lower; Navratil thought that he recollected that in one of his experiments a difference of 2°C doubled the respiration rate [although this would have been an unusually large biological response to such a small temperature difference.] At any rate, every degree would count.

To a further question by Offord, Navratil replied that temperatures inside cold storage containers are slightly higher than those outside because of respiration. The temperatures indicated in Navratil's paper are outside temperatures.

*Moisture Problems*

Gilbert raised the question of quality of stock going into storage, citing Day's comments about the effect of moisture stress (on seedlings in beds before lifting) in reducing regeneration potential. Regardless of the speed of lifting and packing, e.g., by procedures such as described by Bunting, stock in some nurseries is under stress before it is packaged, and Gilbert wanted to know what proportion of planting stock this represented. Day observed that average moisture relations in spring vary among nurseries, and conceded that some stock might not grow regardless of how it is lifted and shipped, although he had no information on what percentage of shipped stock might be so affected.

The question of whether or not to dip roots of lifted stock into water prior to packaging was discussed. Smith asked why Navratil in his paper had recommended that roots not be dipped before packaging: Navratil said he had found that pronounced deterioration of roots occurred with 3 or 4 weeks in root-dipped stock placed in closed, plastic-lined containers. Bunting mentioned that at Orono nursery, roots of stock packed for storage are not dipped: trees are put into the bag dry with a handful of wet Sphagnum moss on top of them to raise the relative humidity quickly to 100%. Roots are not dipped at Thunder Bay, either, said Wynia, in spite of dry beds: studies had shown that plant moisture stress, as measured by Scholander pressure bomb (cf. Scholander et al. 1965. Science 148, 339), actually decreased in cold-stored stock; the first 10 days of cold storage, with the trees fully exposed, made no difference to the initial year's growth when outplanted in unirrigated nursery beds. Wynia hoped to write up further results. He thought that, as long as stock is "reasonably dormant", it can stand a lot of stress provided the stress is reduced before outplanting.

Burger cautioned that care is needed in interpreting data from the pressure bomb to evaluate physiological condition; as Pierpoint has found, the history of the stock has to be considered.

Offord, referring to a recommendation published elsewhere by Navratil, asked what would be the maximum desirable time beyond which the immersion of roots in water prior to outplanting (i.e., after unpacking) would be detrimental. Navratil had no information on that but guessed that 2 or 3 hours would be all right, and that 24 hours would be too much.

*Expression of Results*

Observing that the figures in Navratil's paper were based on only five observations, Payandeh suggested that rather than just giving equations it would have been better to discuss trends: there are only three degrees of freedom, and regardless of any F value obtained, there would be no basis for any useful judgment.

*Refrigerated Storage*

Bidwell replied to a number of questions relating to refrigerated storage. He told Offord that the refrigerated trailer described in his and MacNaughton's paper was cleaned by steam plus a Javex wash: it was not fumigated. Scott, in reference to the capacity of the refrigerated trailer, said that the trailer had cost $16,000, but that similar trailers are now available for $4,000, and if Ontario follows the lead of the southern states of the United States there would be a fleet of such trailers and several tractors to move them around: this might be a very attractive method of storage.

Supplementing the information given in his paper, Bidwell said that, in the first year of operation, costs, including the cost of all material used in modifying the trailer, were less that $1 per thousand trees stored.

The Alberta Forest Service has been using refrigerated trailers for some years, Ferdinand said, adding that although they are a boon they may lead to complacency in the people who have them and thereby to deterioration in quality in stock that is not planted as soon as it might have been.

Answering a question by Perrin about the Hearst Curling Club storage, Bidwell said that it had cost $30 a day. Nolan wanted to know how high the temperature had risen in this storage during the warmest weather experienced: Bidwell said that it had exceeded 4.5°C after delays caused by loss of planting crews to fire duty; molding had not been much of a problem, and the stock had been planted as soon as possible.

*"Shock" Subsequent to Cold Storage*

Turmel initiated a useful discussion on the question of the need for stock coming out of cold storage to have a period of adjustment before being outplanted. Was there, he asked, any difference in performance attributable to the different lengths of time elapsing in the different methods described by Bidwell between removal from cold storage and outplanting? There was no information on this point, but Bidwell said that a delay of 12 to 24 hours is all that is needed before planting cold-stored trees. Navratil offered the opinion that if trees are stored above freezing point there is no danger of "shock" and no need for a period of adjustment: for frozen stock it may be different.

Bunting cited a case in which 100 white spruce at -2°C were taken out of cold storage at Orono and planted the same day in 33°C temperatures at the end of June; without mentioning growth rate, he said that survival had been high and that about 90% had broken bud by that same fall.

Glerum spoke of the considerable body of information available on the subject not only for horticultural and vegetable crops but also for forest trees; he said that trees could be taken from cold storage at -10°C to -20°C and outplanted at +10°C to +20°C without any significant shock, but he added that trees may be damaged excessively unless they are allowed to thaw and lose their brittleness, a point that was also made by R. Brown. Repeated freezing and thawing, said Glerum, is very detrimental, but in a once-only transfer, trees can be moved from cold storage at any time of the year without detrimental effect.

Wynia, however, countered with the Thunder Bay experience of having total kill of potted trees within 2 or 3 days of their being moved into greenhouses at 21°C to 27°C from -29°C to -34°C outside temperatures. Also, Wynia added, there seemed to be big differences between site regions (provenances), with northern provenances being less susceptible to this kind of shock than southern provenances.

Dr. Heimburger used to move his Scots pine grafting stock into the greenhouse in January and February, Glerum said, and never lost any although the temperature might have been -20°C outside and +20°C inside.

Yeatman reported that on the basis of the Petawawa Forest Experiment Station experience, care was obviously needed, and grafting stock would certainly not be taken into the greenhouse when the outside temperature is -30°C; stock would not be moved until temperatures moderated somewhat, and it would be taken into a cool greenhouse; "the problems of desiccation, crystallization, and shock, or call it what you will, are very real".

Day rounded off discussion on this topic with the observation that it must be remembered that grafting stock is potted in a ball of soil which, at a low temperature such as -20°C, might take 4 or 5 days to thaw after it is taken into the greenhouse; moisture uptake could not take place during this time. The effect would not be as severe with bare-root stock, which, both top and root, would warm up more rapidly.

# SITE PREPARATION

## [11] SITE PREPARATION: BIOLOGICAL EXPECTATIONS.

R. G. McMinn, Research Scientist, Department of the Environment, Canadian Forestry Service, Pacific Forest Research Centre, Victoria, British Columbia.

*Site preparation that removes duff and the uppermost mineral soil horizons may promote seedling establishment by controlling competing vegetation and beneficially increasing soil temperature. Soils insulated by duff and shaded by dense brush are generally cooler than optimum for seedling root growth in northern coniferous climates. Moisture may also be more consistently available to seedlings in exposed mineral soil than in duff because duff dries more readily during hot, dry weather.*

*A disadvantageous consequence of scalping and removal of surface horizons beyond immediate reach of freshly planted or newly germinated seedlings may be reduced soil fertility. Subsurface soils are generally poorer in nitrogen and, in fine-textured soils especially, have less favorable structure for root development than do the uppermost horizons.*

*Alternatives that retain the fertility inherent in duff and the uppermost mineral horizons accessible to recently planted seedlings are being tested in British Columbia's North Central Interior. The dry weight of spruce* (**Picea glauca** *[Moench] Voss) seedlings 3 years after planting where duff was rotovated into underlying mineral soil was 60% greater than that of seedlings planted in scalped spots. First-year measurements showed that lodgepole pine* (**Pinus contorta** *Dougl. var.* **latifolia** *Engelm.) seedlings were 20% heavier when the soil of planting spots was inverted rather than scalped. In another experiment, nitrogen fertilization at time of planting increased the dry weight of lodgepole pine seedlings in bare mineral soil by 70%, more than compensating for loss of fertility resulting from scalping alone. Other results suggest that controlled burning may be preferable to poorly conducted mechanical site preparation. Burning can be less harmful to soil fertility, constitute less erosion hazard and even enhance seedling growth. The use of larger seedlings without duff disturbance was found to increase seedling weight by 90%, suggesting that more vigorous planting stock may be less costly than site preparation.*

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*Lorsque l'on prépare une station, l'enlèvement de l'humus et des horizons supérieurs du sol minéral peut avoir pour effet de promouvoir l'établissement des semis par la répression de la vegetation concurrente et par l'augmentation favorable de la température du sol. Les sols qui sont isolés par l'humus et ombragés par des broussailles denses sont habituellement plus frais que la température optimale requise pour la croissance des racines de semis des climats nordiques où poussent les*

*résineux. L'humidité peut aussi être plus constante chez les semis croissants dans un sol minéral plutôt que dans l'humus parce que l'humus se dessèche plus rapidement par temps chaud et sec.*

*Une conséquence défavorable du dégazonnement et de l'enlèvement des horizons superficiels serait de réduire la fertilité du sol. Les couches inférieures sont généralement plus pauvres en azote et, particulièrement dans les sols à texture fine, ont une structure moins favorable au développement des racines que les couches superficielles.*

*On étudie, dans le centre-nord intérieur de la Colombie-Britannique, d'autres moyens de conserver la fertilité inhérente de l'humus et des couches supérieures minérales accessibles aux semis récemment plantés. Le poids anhydre des semis de l'Epinette blanche* (Picea glauca *[Moench] Voss) trois ans après le plantage où l'humus fut remué jusque dans le sol minéral sous-jacent était de 60% supérieur à celui des semis plantés dans les placeaux dégazonnés. Les mesurages de la première année indiquèrent que les semis de Pin tordu latifolié* (Pinus contorta *Dougl. var.* latifolia *Engelm.) étaient de 20% plus lourds lorsque le sol des placeaux à planter fut retourné plutôt que dégazonné. Au cours d'une autre expérience, la fertilisation à l'azote au moment du plantage augmenta le poids anhydre des semis de Pin tordu de 70% en sols minéraux à découvert, ce qui a plus que compensé la perte de fertilité causée par le dégazonnement. D'autres résultats indiquent que le brûlage dirigé serait préférable à une mauvaise préparation mécanique de la station. Le brûlage serait moins nuisible à la fertilité du sol, car il produit moins de dangers d'érosion et favorise même la croissance des semis. L'emploi de semis plus gros sans remuer l'humus a produit une augmentation de 90% du poids des semis, ce qui porte à croire que planter des semis plus vigoureux serait moins coûteux que de préparer la station.*



## Supporting Oral Presentation

McMinn illustrated points from his paper with slides so as to help the audience assess the relevancy of his work to Ontario. The fact that competition from vegetation is a major factor affecting outplant performance in his area suggests that soil fertility there is higher than that of the outwash sands and gravels typical of the sites in boreal Ontario on which regeneration efforts are being concentrated.

Site preparation, said McMinn, not only removes unwanted vegetation but may also confer the additional benefit of raising soil temperatures, thereby improving the root growth of seedlings.

With the common method of site preparation in British Columbia, scalping with a land-clearing blade, much top soil can be removed. McMinn illustrated the point by showing how the removal by scalping of the fertile and friable surface layer left heavy, compact, and relatively infertile clay, an inhospitable soil for seedlings. Blade scarification also leads to flooding and frost heaving.

In looking at alternatives, McMinn has aimed at retaining the fertility of the upper horizons, e.g., by using the Madge Landbreaker to prepare a surface layer of mixed duff and mineral soil ideal for planting. Inversion of the upper part of the soil profile is also under evaluation, as is the Bräcke Cultivator which prepares a variety of planting chances, from the scalp to the hump of inverted duff. Lodgepole pine seedlings growing on a site that had been bulldozed lightly enough to leave some duff were much greener than seedlings growing on the (more usual) "completely scarified" sites.

Probably the best way of maintaining soil fertility is not to push aside the fertile material at all but to plant seedlings able to grow on untreated sites. In one recent trial, large plug seedlings on untreated sites outperformed 2+0 bare-root spruce on the same sites and they performed almost as well as did large 2+1 stock on prepared sites.

There is, McMinn concluded, "a good deal of future" in using good seedlings--when we find out what these are.

[12] Powered Site Preparation Equipment.

J. D. Scott, Development Specialist, Forest Management Branch, Division of Forests, Ontario Ministry of Natural Resources, Toronto, Ontario.

*Site preparation in Ontario began with the use of simple, hand tools and standard tractor attachments such as blades, rakes, and cultivators. It went through a stage of improvisation where rocks, stumps, trees, and concrete-filled barrels were used. Today the most common mechanical devices are finned barrels and used tractor pads in combination with spiked barrels and chains. The trend now is toward powered equipment to obtain greater efficiency in the use of energy and greater flexibility. A powered-barrel scarifier is suggested as one means of realizing these objectives.*

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*Les premiers instruments qui servirent à la préparation des stations en Ontario étaient de simples outils manuels et des accessoires de tracteurs ordinaires tels que des lames, râteaux et cultivateurs. Vint ensuite l'ère de l'improvisation où on utilisait des cailloux, des souches, des arbres, puis des barils remplis de béton. De nos jours, les dispositifs mécaniques les plus communs sont les barils à ailerons et des chenilles sectionnées de tracteurs usagés, combinées à des barils à pointes et des chaînes. La tendance actuelle converge vers l'emploi d'équipement motorisé en vue d'une plus grande efficacité dans l'utilisation de l'énergie et d'une plus grande flexibilité. Afin d'atteindre ces objectifs, on a proposé un autre moyen: l'emploi d'un scarificateur motorisé, à barils.*

## Supporting Oral Presentation

Scott's first point was that equipment may operate fully satisfactorily on certain sites and yet on others may be quite inadequate. He then referred to points made by several other participants in their papers. He agreed with Riley that the shark-fin barrel, though widely accepted as an all-purpose tool, has often given less than adequate results; he supported George Brown's view that poor site preparation will increase thinning problems and may cause complete failure; and he supported O'Donnell's observation that it is time for another breakthrough in the development of new equipment. All this, said Scott, underscores the fact that the present range of equipment is insufficient to meet the full range of our site preparation needs. We have just about exhausted the range of configurations, sizes, and hookups with the drag type equipment (e.g., barrels, chains, pads, etc.) that has been the mainstay of OMNR's site preparation work over the last 15 years. Moreover, we have by now reached the limit of horsepower on the prime movers needed to move this equipment.

For some years, Scott continued, engineers have been saying that site preparation could be accomplished much more efficiently by the use of powered rather than dead weight scarifying devices. Making this same point in a 1975 symposium paper, Heikurinen wrote of the marked improvement in energy efficiency that could be achieved by using powered equipment such as the flail scarifier instead of dragging around dead weight.

Engineering know-how is necessary for building equipment but by itself is not enough: biological requirements must also be met.

Scott suggested that a powered barrel scarifier be developed, combining the principle of the shark-fin barrel with the advantage of variable down pressure enabling the tractor operator to lift the unit and so avoid obstacles when backing or turning.

Scott concluded with some slides (taken during a recent trip to Finland) of a powered site preparation unit developed from the TTS disc trencher: the unit, which was being used for the first time, seemed to be doing a good job although the wheeled skidder was having some difficulty in pulling it. Another unit, self-powered and riding on four wheels, was under development in northern Finland.



## [13] Cultivation and Herbicide Use in Forest Tree Establishment in Southern Ontario.

R. C. A. Gilbert, Supervisor, Ontario Ministry of Natural Resources, Cambridge, Ontario.

*Southern Ontario's most valuable forest is the upland hardwood complex of climax and intermediate hardwood species. The greatest economic return from the forests of southern Ontario is from high-quality hardwood sawtimber. Nature defies man's attempts to reintroduce most of*

*the hardwood species directly onto abandoned agricultural land. There are thus two distinct aspects of hardwood afforestation: a rotation of conifers, conventionally planted, using herbicides to control vegetation, and subsequent silvicultural conversion to hardwoods; and the introduction of the upland hardwoods to "open" land with complete site preparation by cultivation and control of vegetation by herbicides.*

*Properly applied, the herbicides simazine, amitrole, and paraquat have been shown to be safe and effective in a standard vegetation control system for use in conventional hand or machine plantings. The same herbicides can be used as a follow-up treatment for hardwood plantings. Until vegetation reaches a height of approximately 10 cm (4 in.) in the spring, simazine, a soil sterilant, is applied by hand or machine at rates of 4.48 kg a.i./sprayed ha (4 lb/acre) on sandy soils and up to 6.71 kg a.i./ha (6 lb/acre) on heavy soils in 227 L (50 gal) of water. Thereafter amitrole or paraquat are added to this same dose of simazine at 2.3 L (0.5 gal) of liquid product. In machine spraying, a 30-38 cm (12-15 in.) band on either side of the planted tree, and in hand spraying a 0.4 $m^2$ (4 $ft^2$) patch, are treated.*

*Preplanting site preparation for hardwoods consists of complete plowing, discing, and harrowing in the previous summer to remove all competition. Alternate rows of hardwood and nurse crop species are planted in spring by conventional machine planter at 3.7 m (12 ft) spacing with trees 2.4 m (8 ft) apart in the rows. Ideally, the nurse crop row would be alternate hardwood and nurse crop species also.*

*Follow-up cultivation should begin soon after planting. Three cultivations will be required the first year. Two techniques are possible at this point. The entire area could be boom sprayed after the first growing season at the rates suggested. This should maintain a "sterile" condition for 2 years. Or, a boom spraying into the planted rows only could be done after the first growing season, followed by 2 additional years of cultivation approximately three times per year. The overall cost of these two cultivation systems would be similar, and either system should produce a well-established hardwood/nurse crop after 3 growing seasons.*

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*Les plus riches forêts du sud de l'Ontario se révèlent un complexe des meilleurs feuillus des hautes terres formés d'espèces feuillues climaciques et intermédiaires. Le plus grand retour d'investissement des forêts de l'Ontario-sud provient du bois de sciage des feuillus. La nature défie l'homme dans ses efforts visant à réintroduire la plupart des espèces de feuillus directement dans des terres agricoles abandonnées. Ainsi, on distingue deux aspects dans le reboisement de feuillus: une période de révolution des résineux, plantés à la manière classique, en utilisant les herbicides pour la répression de la végétation concurrente, puis une conversion sylvicole ultérieure aux espèces feuillues; ou, l'introduction immédiate de feuillus des hautes terres dans les* *terres "libres" avec le souci de préparer à fond la station par le truchement de soins culturaux et le contrôle de la végétation à l'aide d'herbicides.*

*Lorsqu'on les applique adéquatement, les herbicides simazine, amitrole et paraquat se révèlent sûrs et efficaces dans un système standard de lutte contre la végétation à utiliser lors de plantages manuels ou mécanisés. On peut se servir des mêmes herbicides pour un traitement complémentaire des plantations de feuillus. Jusqu'à ce que la végétation atteigne une hauteur approximative de 10 cm (4 po) au printemps, on applique la simazine, qui stérilise le sol, soit à la main ou à la machine, au taux de 4.48 kg de i.a. (ingrédient actif) par hectare vaporisée (4 lb/acre) sur les sols sablonneux et jusqu'à 6.71 kg de i.a./ha (6 lb/acre) sur les sols lourds dans 227 L (50 gal) d'eau. Par la suite, on ajoute l'amitrole ou le paraquat à cette même dose de simazine à 2.3 L (0.5 gal) de substance liquide. Pour la vaporisation à la machine, le traitement s'effectue sur une bande de 30 à 38 cm (12 à 15 po) d'un côté ou l'autre de l'arbre planté et pour vaporiser manuellement, on traite des aires de 0.4 $m^2$ (4 $pi^2$).*

*Préparer une station avant de planter des feuillus exige une opération complète, c'est-à-dire passer la charrue, ameublir et herser le sol au cours de l'été précédent pour éliminer toute plante concurrente. On plante des rangées alternantes de feuillus et d'arbres-abris au printemps à l'aide de plantoirs mécaniques classiques, par rangées écartées de 3.7 m (12 pi) et en espaçant les arbres de 2.4 m (8 pi) l'un de l'autre dans les rangées. Idéalement, la rangée d'arbres-abris serait formée de feuillus alternant avec des espèces formant les arbres-abris.*

*On devrait commencer les soins culturaux complémentaires peu après le plantage. Pour la première année, il faudra trois traitements culturaux. A ce point, on peut employer deux techniques. On peut vaporiser par traitement-choc la surface entière après la première saison de croissance, selon les taux suggérés. Voilà qui devrait conserver un état de "stérilité" pendant 2 ans. Ou bien, vaporiser par traitement-choc seulement les rangées d'arbres plantés, après la première saison de croissance, puis faire suivre ce traitement de 2 années de soins culturaux administrés approximativement trois fois l'an. Le coût global de ces deux techniques de culture serait similaire et chaque technique produirait une plantation bien établie de feuillus/arbres-abris après trois saisons de croissance.*



## Supporting Oral Presentation

Gilbert credited the audience with having read his paper. He illustrated his supporting talk with slides.

Gilbert referred to the substantial areas of hardwood forest in southern Ontario and suggested that forest managers in that area should work primarily with hardwood species, which are the most valuable.

To get from the unforested condition to hardwood forest, it is usual to proceed via a softwood stage, generally red pine in the past and now to some extent also white pine and white spruce. High quality hardwood timber is the objective of management, but the softwoods will yield interim material.

Trees planted on open land suitable for hardwoods face very heavy competition from grasses and other vegetation. Without weed control, outplants do not survive. Effective herbicides and techniques are available, but problems can arise from misapplication. Here Gilbert showed a particularly good series of slides.

Problems may also arise in connection with soil (e.g., cracking and heaving in heavy clay), machinery that is unsuitable either because of type or condition, and inadequacy of supervision.

Spruce, said Gilbert, does not go into check [on fertile sites] when herbicides are properly used to give good control of weeds.

A technique for planting hardwoods directly without going through the conifer stage involves cultivating the soil cleanly, plowing and disking to the same degree that would be needed for a field of corn.

Gilbert's last slide showed a mature black walnut that fetched $5,050 at public auction.

[14] Site Preparation.

G. Brown, Regional Forester, Ontario Ministry of Natural Resources, Kenora, Ontario.

*Some site preparation is required with every method of artificial regeneration, but the intensity of site preparation required for seeding on the same site must be more intense than that required for the planting of tree seedlings. The intensity of site preparation is also governed by the production capacity of the site, the kind of vegetation, the season of the year, the technique, the kind of equipment, and the economics of establishing the new crop.*

*The objectives of site preparation will also affect the intensity of site preparation needed to eliminate competition for light and competition from roots. Spacing and stocking to attain early crown closure, to overcome competition, and to initiate self-pruning vary with the silvicultural characteristics of the species planted. Research and practical experience would indicate that the objectives of site preparation for planting are attained if the width of the prepared strip or the scalp is twice the height of the surrounding perennial competition and remains clean for at least 3 years for hard pines and 5 years for spruces.*

*Five methods of site preparation for tree planting are reviewed by technique, singly or in combination, in relation to the productive capacity of the site. The techniques are compared as ratios of the costs of the most economical technique (burning) for each site capacity, on the basis of actual experience.*

*In addition to realizing the objectives of site preparation for tree planting, a prescribed burn, singly or in combination with other treatment, produces side benefits that are unattainable by any other method of site preparation.*

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*Chaque méthode de régénération artificielle nécessite une certaine forme de préparation de la station, mais l'intensité de la préparation qu'exige l'ensemencement de cette même station doit être plus grande que l'intensité nécessaire au plantage des semis. L'intensité de la préparation d'une station est aussi régie par la capacité de production de la station, la sorte de végétation, la saison de l'année, la technique, le genre d'équipement et la rentabilité d'établir la nouvelle récolte.*

*Les buts visés lors de la préparation d'une station modifieront aussi l'intensité de la préparation d'une station nécessaire pour éliminer la concurrence de la lumière et celle des racines. L'espacement et le reboisement en vue d'atteindre la fermeture hâtive du couvert, de vaincre la concurrence et d'amorcer l'auto-élagage, varient selon les caractéristiques des espèces à planter. La recherche et l'expérience pratique sembleraient indiquer qu'on atteindra les objectifs de la préparation d'une station en vue due plantage lorsque la largeur de la bande préparée ou le dégazonnement seront de deux fois la hauteur des plantes vivaces concurrentes voisines et demeureront nettes durant au moins 3 ans pour les Pins à bois dur et 5 ans pour les Epinettes.*

*On examine cinq méthodes (selon leur technique) de préparation des stations pour le plantage d'arbres, soit isolément ou en combinaison, relativement à la capacité productive de la station. En se fondant sur l'expérience actuelle on compare les techniques en utilisant comme base les coûts de la technique la plus économique (le brûlage) et comme critère la capacité de chaque station.*

*En plus d'atteindre les objectifs de la préparation des stations en vue du plantage, un brûlage dirigé, seul ou combiné à quelque autre traitement, produira des gains secondaires qu'aucune autre méthode de préparation des stations ne peut produire.*

## Supporting Oral Presentation

In Ontario, G. Brown observed, site preparation in forestry has come to mean the preparation of soil to receive the tree seed or tree seedlings from which the future crop is to be regenerated: most of us, he said, seem to forget this basic principle in our preoccupation with site preparation for the sake of churning up the ground.

Site preparation for seeding is more intensive than site preparation for planting, and therefore requires much more effort. Brown suggested that the intensity of site preparation should also vary with the productive capacity of the site and with the economics of establishing a new crop, regardless of the particular method or technique of site preparation to be used. He has also come to realize that tending is as much a part of the regeneration scheme as are site preparation and planting.

Two objectives of site preparation--elimination of competition for light and elimination of competition for soil moisture and soil nutrients--can be accomplished simultaneously by the forest manager if competition is eliminated around each tree to a distance equal to twice the height of the surrounding perennials, said Brown. Failure to provide relief from competition for the first three years after planting or the first five years after seeding can necessitate expenditures totalling more than twice or three times the combined cost of site preparation and planting.

A third objective of site preparation is to optimize stocking and spacing which affect crown closure and thus competition, self pruning, and early height increment. Stocking standards in Ontario have not been spelled out by species as they have in the Lake States. Furthermore, Brown added, the present standard is retrograde compared with the 1958 standards that at least intimated that we should be planting 2,500 trees/ha in order to obtain full stocking.

Brown referred participants to his paper for a comparison of various site preparation techniques including prescribed burning. Cost of treatment was expressed as a ratio relative to "the least used and most natural and economic method of site preparation--prescribed burning". "If you want value for your site preparation money," Brown concluded, "all I can say to you is 'Burn, baby, burn!'."

[15] Applied Techniques in Site Preparation for Forest Plantation Establishment.

W. A. O'Donnell, Unit Manager, Ontario Ministry of Natural Resources, Timmins, Ontario.

*Site preparation in the Timmins District is done mostly on medium- to well-drained sites that have carried predominantly jack pine* (Pinus banksiana *Lamb.*)*, white spruce* (Picea glauca [*Moench*] *Voss*)*, and, to a lesser extent, black spruce* (P. mariana [*Mill.*] *B.S.P.*).

*Mechanical site preparation has been used with considerable success in a variety of situations. The first and widely used piece of equipment is the shark-fin barrel, which finds application where slash is light to moderate, topography flat to gently rolling, and sites no* *moister than fresh. Young's teeth, heavier barrels, or anchor chains have been used successfully to deal with heavier slash. In very heavy slash on steep terrain, angle-blading with D-8 prime movers has, for $94/ha, prepared sites well for tree planting. Hand scalping is still used on small projects where heavy equipment cannot be used economically.*

*One-pass planting with the Lowther tree planting machine has been satisfactory on certain sites. Up to 8,000 trees/day have been planted by this machine.*

*Prescribed burning is another method of site preparation that has given good results at reasonable cost, e.g., $10.28/ha and $12.38/ha in two cases cited.*

*The chemical method of site preparation is used to a very limited degree in the District. The cost:benefit ratio seems too high if spraying is done solely for site preparation.*

*Recommendations to improve the effectiveness of site preparation techniques are discussed. Research must be accelerated to produce scarifying tools of greater sophistication in the near future.*

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*Dans le district de Timmins, on prépare principalement des stations qui sont moyennement à bien drainées, qui ont déjà produit des Pins gris* (**Pinus banksiana** *Lamb.*)*, des Épinettes blanches* (**Picea glauca** *[Moench] Voss) et, dans une moindre mesure, des Épinettes noires* (**P. mariana** *[Mill.] B.S.P.*

*On a utilisé de l'équipement mécanisé avec un succès considérable pour aménager de nombreuses stations. Le premier engin très utilisé est le baril à ailerons de requins, convenable pour les endroits peu à modérément couverts de rémanents, dont la topographie varie de nivelée à légèrement garnie de collines et en des stations pas plus humides que fraîches. Pour des rémanents plus gros, on a successivement employé les "dents Young", des barils plus lourds ou des chaînes à ancres. Sur des terrains à pentes escarpées et couverts de rémanents très lourds, on a utilisé des bouteurs-biais D-8, au coût de $94/ha, pour préparer les stations au plantage des arbres. On utilise encore le dégazonnement manuel pour de petits projets qui ne sauraient supporter les frais d'équipement lourd.*

*Pour certaines stations, la machine à planter Lowther, à parcours (ou passage) unique s'est avérée satisfaisante. On a planté jusqu'à 8,000 arbres par jour avec cette machine.*

*Le brûlage dirigé constitue une autre méthode d'aménagement de stations, qui a donné des résultats satisfaisants moyennant $10.28/ha et $12.38/ha respectivement au cours de deux essais.*

*Dans ce district, la préparation des stations à l'aide de produits chimiques a servi dans une certaine mesure. La proportion coût/bénéfice semble trop élevée lorsqu'on utilise l'arrosage uniquement pour préparer la station.*

*On propose des recommandations pour améliorer l'efficacité des méthodes de préparation des stations. Il faudra accélérer la recherche à brève échéance afin de produire des scarificateurs plus perfectionnés.*

## Supporting Oral Presentation

O'Donnell listed the main points he wished to emphasize in his paper:

- A new breakthrough is needed in the development of equipment and techniques for getting forest land back into full production as soon as possible after harvesting.

- Existing equipment and techniques in various combinations should be used in situations most suited to them.

- Greater site preparation efforts are needed on our most productive sites.

- Prescribed burning should be expanded.

- Fire control philosophy and the instant suppression concept should be reviewed.

- Industry should be encouraged to capitalize on its sophisticated harvesting equipment and perhaps develop a simultaneous capacity for site preparation.

- Field research trials studying site preparation should be continued with similar interest groups.

- Information exchange should be fostered. O'Donnell noted an improvement in the past four to five years, with research agencies making contact with the actual forest manager, and with improvements in the pooling of research information.

- In the jack pine working group, the use of paperpots should be promoted in conjunction with the development of a planting machine to handle them.

- The amount of jack pine seeding should be increased, especially of burns.

- On an operational scale, a harvesting trial should be implemented in black spruce on shallow soil over bedrock whereby stumps are uprooted as mechanical harvesting proceeds, and new microsites are thereby prepared for regeneration.

- Also in the black spruce working group, a two-stage harvesting system should be implemented on a trial basis, leaving circular 2 ha-8 ha patches of uncut stands and removing 50% of the merchantable material in stage 1 and the remainder when adequate regeneration has been established on sites that were prepared by the operation of heavy equipment during harvesting.

The various types of equipment and methodologies, said O'Donnell, have both limitations and advantages: no one system can be used with universal success. Consequently it will be necessary in the future to utilize more fully the abilities of our academics, research people, industrial colleagues, and especially the field foresters, in a combined effort to upgrade site preparation techniques, to produce sufficient wood fibre, and to provide for satisfactory protection of our environment, and to do all this at reasonable cost.

SITE PREPARATION

## [16] Site Preparation: Now and Then?!

L. F. Riley, Forestry Officer, Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario.

*Site preparation in many forms is used for and is essential to the successful regeneration of much of Ontario's forest land. Much research and operational information is available to the forest manager, but there is concern that the existing knowledge is not being used to best advantage. Site preparation could be much improved if the wide variety of existing tools were put to greater use instead of placing heavy reliance on so-called "all-purpose" tools; if existing tools were used as designed or as intended; if forest managers innovated where existing tools are inadequate; and if information on all aspects of site preparation equipment, from new designs to operational methods, were freely and effectively communicated. There is an urgent need for innovation, both in the development of new equipment and in the introduction of existing equipment that is new to Ontario. There is an urgent need to understand thoroughly the capabilities and applications of existing equipment and to employ that equipment in a manner that will produce results most effectively. Foresters, engineers, and researchers must combine efforts to ensure that suitable equipment is available to achieve operationally and biologically optimum site preparation. Equipment must receive thorough operational evaluation, including consideration of cost-effectiveness, while results must receive thorough biological evaluation. An energetic, enthusiastic, and dynamic program needs to be instituted. Foresters must accept responsibility for the initiation of this action and*

*administrators must provide the necessary support and guidance if the available talents are to be utilized fully and if Ontario is to be a driving force in forest management.*

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*La préparation variée des stations est utilisée et est essentielle au succès de la régénération dans la plupart des terrains forestiers de l'Ontario. L'aménagiste forestier peut compter sur une imposante quantité de renseignements sur la recherche et les méthodes d'opération, mais on s'inquiète du fait que les connaissances existantes ne sont pas employées pleinement. On pourrait de beaucoup améliorer la préparation des stations si la grande variété d'outils existants était utilisée à meilleur escient, car on compte beaucoup trop sur des soi-disant outils à "usage multiple"; si on utilisait les outils existants d'après les fins de leur conception; si les aménagistes forestiers avaient le souci d'innover lorsque leurs outils sont inadéquats; et si l'information touchant tous les aspects relatifs à l'équipement requis pour la préparation des stations, à partir des nouveaux modèles jusqu'aux méthodes d'opération, était communiquée amplement et effectivement. Le besoin d'innover est urgent, aussi bien pour la mise au point d'équipements nouveaux que pour l'introduction d'équipements existants qui sont nouveaux pour l'Ontario. Il est urgent de comprendre parfaitement les possibilités et applications de l'outillage existant et de s'en servir de manière à ce qu'il donne les résultats les plus efficaces. Les forestiers, les ingénieurs et les chercheurs devront unir leurs efforts pour s'assurer la disponibilité d'un équipement approprié s'ils veulent procéder à la préparation optimale des stations tant du point de vue opérationnel que biologique. Il faut que l'équipement soit évalué à fond sur la base opérationnelle, y compris les considérations d'ordre coût-efficacité, tandis que les résultats doivent être évalués à fond au point de vue biologique. Un programme énergique, "enthousiaste" et dynamique sera nécessaire à ces fins. Les forestiers devront accepter la responsabilité d'amorcer un tel geste et les administrateurs devront fournir le soutien et l'orientation nécessaires si l'on veut que l'Ontario prenne la tête dans le domaine de l'aménagement forestier.*

## Supporting Oral Presentation

Riley described the objective of his paper thus: "to cause managers, researchers, and administrators, to continuously review critically and decisively the accepted dogmas of the profession."

Forest managers, he went on to say, are generally agreed that some form of site preparation is essential to the success of most regeneration methods. The next step, therefore, is "to treat the areas [to be regenerated] as best you can to get the best possible results for the purpose intended". To do this we require the best information available including the knowledge gained from operational experience.

Riley's "exhortation to action" used mechanization ("which is essential and inevitable") as an example: be aware, he said, of the equipment that is available, whether or not it is in your own district; know the equipment you are working with, and its limitations; get the most out of it but, when limits to effectiveness are reached, know when to stop; know your sites and species, and know alternative options for a given site; be innovative and creative; do not quit if a tool does not perform as first expected, but buckle down and make it work; be open-minded and do not reject anything out of hand; be prepared to change and accept change; communicate; see the value of something that works or of finding a practicable solution to a problem, and promote it; be receptive to ideas; avoid the negativism that Art Herridge was talking about; above all, pursue quality; determine cost-effectiveness and compare techniques.

Ontario is blessed with talented, competent staff: let's use them to the fullest advantage, Riley said.



## DISCUSSION

In a discussion session, curtailed somewhat by unscheduled presentations, interest centred on the use of fire in site preparation.

### *Prescribed Fire*

Ferguson asked G. Brown how and by whom an expanded program of prescribed burning could be implemented in Ontario in view of the fact that the Forest Protection Branch obviously cannot handle it while the Timber Branch has not enough expertise. Brown conceded that "it is a little difficult to say who should do it because even if *I* say, if we burn for a silvicultural purpose, it should be done by Timber,...[the training] job could be enormous and take a lot of time; I cannot give a clear-cut answer...because it is more of a policy decision than anything else."

Asked whether the expertise exists to use prescribed burning, Brown said that he had written a paper for the Timber Certificate Course on controlled burning in which he tried to preach to the two solitudes. Any prescription has to be very specific and "you have to be prepared to go in and burn at the drop of a hat." Brown went on to say that he had written up prescriptions to cover almost any situation in the boreal forest from northwestern Ontario to the Quebec border.

Returning to the question of who might implement prescriptions, Brown thought that the fire people in Protection would not have the time. He described a case from his own experience while concurrently he was acting district forester, acting protection supervisor, and actual timber supervisor: the fire hazard was extremely high, but realizing that fires break out between about noon and 1600 hr and that the danger is pretty well over by 1800 or 2000 hr, he detailed his favorite burning crew and between 1600 and 1900 hr burned 680 or 690 acres in something like 2.75 hr. The situation was unique in that the crew--incidentally a protection crew he had trained in back burning--had had about 10 years' experience in burning and was under his direct control.

MacHattie, referring to O'Donnell's recommendation to increase the use of burning, asked how specific a prescription is used to define the degree of drought and burning conditions (especially wind and humidity) on the day of the burn. O'Donnell answered that in the Timmins District the fire control people have absolute jurisdiction over any burn. The silvicultural prescription is discussed with the fire people who then determine the conditions of index and wind velocity under which the burn can achieve the desired result.

MacHattie also wanted to know how long one had to wait for suitable weather. O'Donnell replied that this has always been indeterminate: you have to be ready to go in and burn, as George Brown put it, at the drop of a hat. Brown, commenting unspecifically on useful work going on in Minnesota, added that researchers in Ontario find that on the average there are about 25 burning days annually in Ontario as a whole, and 42 days in the northeastern and 21 days in the northern regions, so that there are ample opportunities for burning.

Yeatman asked G. Brown to comment on the role of fire in reducing the risk of infection by Gremmeniella. The only thing that Brown had noticed about Gremmeniella was that the disease would reach epidemic proportions on sites of the lowest capacity. This is in fact what happened northwest of Kirkland Lake, almost due west of Matheson, where plantings of the two spruces and three pines up to five years old were completely wiped out by Gremmeniella in 1967 after consistently good survival and growth had been obtained up to that point. The same thing happened, Brown continued, in the 10-year-old plantation just north of Kirkland Lake. If these low productivity sites are burned in the spring of the year when the humus is wet, preferably with a slow fire, a scalding effect is obtained which, Brown believed, inhibits Gremmeniella.

Nolan questioned G. Brown on the need for scalping after a burn with particular reference to soils of low productive capacity: would it not be enough (and less costly) to follow prescribed burning merely with hand planting and associated scalping? Brown agreed that burning could by itself provide all the preparation needed on some sites, but he emphasized that some form of site preparation is necessary on all sites.

Information on current trends in the use of fire for site preparation in British Columbia was sought by Cayford. McMinn, who admitted that he had not been in close touch with the situation, said that fire had become rather unpopular for a while following the big Salmon Arm burn of a few years ago: this had caused a surge of mechanical site preparation, but he thought that perspectives are being regained and that fire is in fairly general and effective use for site preparation. R. Brown added that British Columbia does not use fire at all on lodgepole pine sites on which drag scarification only is used in order to conserve the very shallow duff layer and its nutrients.

Robinson, though agreeing with most of G. Brown's ideas on burning, raised this question of the effect of fire on the limited nutrient reserves on jack pine sites of low site capacity in Ontario: would Brown still recommend burning for site preparation even on poor sites? Brown said that on poor sites he would recommend a spring fire when the humus is at least 60-80% of field moisture capacity, just a light sanitation fire, and this will not remove the nutrients, even from sites where the humus may be only half an inch thick.

*Site Preparation on Heavy Clays*

Asked by Robinson to comment on the effect of various mechanical site preparation techniques used on heavy clay soils with respect to compaction and grass competition, O'Donnell said that his paper had been limited to the vicinity of Timmins, an area where clay and grass competition were not important.

*Choice of Method*

How much emphasis, Fayle wanted to know, is placed on ease of planting, need for follow-up treatment, and biological suitability (in respect of both initial survival and subsequent growth to crown closure and beyond) when the method of site preparation to be used on an area is being chosen? Efforts are made to accomplish the impossible, O'Donnell replied, in that all factors are considered: but the question turns on the point of where the money is best spent across the spectrum from tree seed through site preparation and planting to tending. At some point, O'Donnell said, action has to be taken, e.g., as described in his paper, a ball park type of site preparation to remove as much debris as possible not only reduces competition but also eases the job and "eliminates subsequent tending"; choice of method depends on the species to be grown, the site to be treated, and the condition of that site.

*TTS Disc Trencher*

Bax said that he had with him a Eurocan Pulp and Paper report from British Columbia giving their results of 2 years' work with the TTS, including planting quality, spacing, and production rates. He offered to send a copy to anyone who was interested.

## PLANTING

[17] To Seed or to Plant and What to Plant: A Computer Simulation Approach to Regeneration Problems.

Bijan Payandeh, Research Scientist and Biometrician, Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario.

*An economic evaluation of several regeneration systems is simulated based on a recently developed model employing subjective probability estimates. Results of three examples based on current cost structure and/or future price estimates are presented and discussed.*

*Results from the first example indicate that, of the four regeneration systems compared, planting white spruce* (**Picea glauca** [*Moench*] *Voss*) *will be the most economical method (in terms of future cost/m*$^3$*), followed by seeding jack pine* (**Pinus banksiana** *Lamb.*)*, planting jack pine, and planting black spruce* (**Picea mariana** [*Mill.*] *B.S.P.*)*. In terms of total present cost/ha, however, seeding jack pine will be the cheapest, planting jack pine, black spruce, and white spruce will rank second, third, and fourth, respectively. Therefore, if the objective is to regenerate the greatest possible area with a given annual budget, seeding jack pine should be chosen over the other three methods, on the basis of the data used in this example.*

*Similarly, results from the second example indicate that, of the three regeneration systems compared, planting white spruce transplants will produce the highest present net worth/ha, followed by planting white spruce seedlings and jack pine. In terms of total present cost/ha, planting white spruce 2+2 will also be the cheapest method, followed by planting jack pine and white spruce 3+0. Results of the third example indicate that the expected rate of return on planting white spruce 2+2 will be 1-3% higher than that of white spruce 3+0 and jack pine.*

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*Une évaluation économique de plusieurs systèmes de régénération est simulée d'après un modèle récemment élaboré qui emploie des estimations de probabilité subjective. On disserte sur trois exemples fondés sur les prix courants de restauration et/ou des estimations des prix futurs.*

*Les résultats du premier exemple indiquent que, des quatre systemes de régénération qu'on a comparés, le plantage de l'Épinette blanche* (**Picea glauca** [*Moench*] *Voss*) *sera la méthode la plus économique (en termes de coûts futurs/m*$^3$*). Viennent ensuite l'ensemencement du Pin gris* (**Pinus banksiana** *Lamb.*)*, le plantage du Pin gris, et enfin le plantage de L'Épinette noire* (**Picea mariana** [*Mill.*] *B.S.P.*)*. En termes de coût/ha actuel, cependant, l'ensemencement du Pin gris sera le meilleur marché,*

*puis le plantage du Pin gris, de l'Épinette noire et de l'Épinette blanche seront classés deuxième, troisième et quatrième, respectivement. Donc, si on vise à régénérer la plus grande superficie possible selon un budget annuel donné, l'ensemencement du Pin gris devrait être préféré aux trois autres méthodes, si l'on se fonde sur les données de cet exemple.*

*De même, les résultats du deuxième exemple indiquent que, des trois systèmes de régénération qu'on a comparés, le "repiquage" de l'Épinette blanche produira la meilleur valeur/ha actuel, suiva du plantage de semis de l'Épinette blanche 2+2 aussi le moins cher, suivi du plantage du Pin gris et de l'Épinette blanche 3+0. Les résultats du troisième exemple indiquent que le taux prévu de gains provenant du plantage de l'Épinette blanche 2+2 sera de 1 à 3% plus élevé que celui de l'Épinette blanche 3+0 et de Pin gris.*

## Supporting Oral Presentation

Different reforestation systems have different costs and different probabilities of success associated with them. From this point of departure, Payandeh went on to show how a forest manager can be helped to decide between various options that might be open to him. Options may vary in cost of establishment, probability of success, requirements for tending, and amount and quality of product. It is difficult to make mental comparisons, especially when several systems are being compared at the same time because: future selling prices of products are unknown; accurate estimates of the relative probabilities of success are lacking; cost estimates may not be precise. The model developed at the Great Lakes Forest Research Centre can help the forest manager compare the various options.

The model is very simple to use. It can handle several species, rotation lengths, and interest rates. The economic analysis is carried out on any or all of four economic criteria.

Three examples are given in Payandeh's paper. He stressed that these are intended mainly to show how the model works and how the results are interpreted.

Several major features of the model are unique. First, the model capitalizes on the forest manager's experience and opinion. Second, the manager's estimates have to be neither exact nor based entirely on actual data: the estimates must be free of bias, of course, but they may be purely subjective. Third, the results indicate the probability that one option is better or worse than another and by how much. Therefore, the manager can look at the results given by the various options and then decide which one to use, knowing the degree of risk and uncertainty involved.

For the forest manager who does not wish to consider any of the regular economic criteria, and whose main concern is the present cost of regeneration, the model offers a way of choosing the option that gives the maximum area that can be regenerated with the current budget.

[18] Long-term Plantation Planning: An Ecological and Biological Point of View.

J. K. K. Heikurinen, Regional Forestry Specialist, Ontario Ministry of Natural Resources, Sudbury, Ontario.

*The incorporation of long-term plantation plans into the operating plan for a management unit is suggested. The cutting plan, contained in the operating plan, should provide the schedule for the planting plan, and specific soil-site data will determine the species, type, and size of stock required for a given area.*

*In Ontario, existing sources for soil-site data are inadequate. A rationalized soil-site classification of at least those stands allocated for cutting is suggested. Since soil texture, texture stratification, soil depth, and soil moisture play important roles in the development of both above- and below-ground portions of trees, these factors should be used to determine what a given site will yield. The stock type used for regeneration should be matched to the site. The site determines the end product; and both site and end product will determine the stock type (i.e., seed, container stock, or bare-root stock) to be used for regeneration.*

*The species selection for an area should be based on the soil data along with topographic, vegetational, and other features affecting the microsite.*

*Stock size requirements are found to depend largely on the competing vegetation and soil features, which determine the planting method best suited to the situation. Soil "rockiness", for instance, is a constraint on planting method and stock size selection: excessively shallow or rocky soils will limit stock to sizes with root systems that can be placed properly into the ground; and, logically, such stock must be small if it is to have a reasonable top:root ratio.*

*It is concluded that the soil-site data required for long-term plantation plans must include: soil texture (including stratification), soil depth, drainage, slope aspects of topography, and a measure of soil rockiness.*

*A brief description of a soil-site classification system used on the Englehart Management Unit is given, and suggestions for improvements are made.*

*On propose d'incorporer la planification à long terme des plantations au programme d'aménagement d'une région. Le plan de coupe, inclus dans le plan des opérations, devraît fournir un programme de plantations, ainsi que des données précises touchant le sol et la station pour déterminer les espèces, le type et la taille des stocks de plantation (matériels de reproduction) à choisir pour la région donnée.*

*En Ontario, les sources actuelles de données sur le sol et les stations ne sont pas adéquates. On propose un classement rationnel sol/station au moins pour les peuplements destinés à la coupe. Étant donné que la texture, les horizons (le profil), la profondeur et l'humidité du sol jouent un rôle important dans le développement des portions aériennes et souterraines de l'arbre, il faut utiliser ces facteurs pour déterminer la production d'une station donnée. Les types de matériel de reproduction devraient convenir à la station. Celle-ci détermine le produit final; puis, la station tout comme le produit final déterminent le type de matériel, c'est-à-dire la graine, le stock en récipients ou à racine nue à utiliser pour la régénération.*

*Le choix des espèces pour une région devrait dépendre des données que l'on a du sol, de la topographie et d'autres facteurs affectant la microstation.*

*La végétation concurrente et les qualités du sol sont des facteurs importants qui influent sur la taille des matériels, et qui déterminent le meilleur choix de méthode de plantage à employer dans telle ou telle situation. Par exemple, un sol "pierreux" sera une entrave à certaines méthodes et au choix de la taille des matériels; des sols très peu profonds ou pierreux auront pour conséquence d'exiger des materiels d'une grosseur dont les racines pourront être placées convenablement dans le sol; et, logiquement, un tel matériel sera nécessairement petit pour présenter une proportion tête-racine raisonnable.*

*Pour conclure, disons que les données sol/station exigées pour planifier à long terme une plantation doivent comprendre: la texture du sol (y inclus les horizons), la profondeur du sol, le drainage, la pente du terrain et les roches.*

*L'auteur décrit brièvement une méthode de classement des sols et des stations dont on s'est servi dans la région d'aménagement d'Englehart et il propose des moyens pour l'améliorer.*



## Supporting Oral Presentation

Heikurienen's job is to improve the ecological and biological basis of planning for plantation establishment. He observed that the only information available at present for planning purposes is the five-year forecast. The problem with this forecast is that it does not rest on a sound ecological basis. Generally a guess is made of the planting stock that might be needed in five years' time.

To illustrate how biological and ecological aspects can be brought into the planning process to determine future planting stock requirements, Heikurinen showed first a series of slides of root system forms and then a series of soil profiles.

The "natural" root system, well developed both vertically and laterally, of a seven-year-old jack pine, can be obtained primarily through seeding or, perhaps, by very careful planting of nursery stock: such a root system is necessary for full development in deep soil.

The root systems of jack pine nursery stock characteristically are "rather mixed up" and distorted in planting.

A third type of root system development is that found in some container stock: the example shown was that of a seedling raised in an Ontario tube and dibble planted. A very strong characteristic of this type of stock when outplanted is its pronounced tendency not to develop a vertical root system: the typical form is a shallow, well distributed horizontal root system.

Looking next at soils, Heikurinen showed a slide of a deep profile, able, he said, to sustain the growth of a deep rooted tree for a long period of time, at least 95 years, although annual growth increments may not be spectacular.

Another soil profile, showing a 60-cm layer of fairly fine sand overlying coarser material, indicated a site, Heikurinen suggested, that can probably sustain growth for a long time but not as long as the first site.

Growth conditions would not be good on the shallow soil shown next: here fine surface material was underlain by 45 cm of coarse material which limited downward penetration of roots. Even natural root systems were found to "fan" and terminate their downward development in this coarse material.

Planting stock should, if possible, be matched with the soils to be planted, Heikurinen said. The three types of stock mentioned will give us three depths of root penetration: the natural root system will go very deep provided that there is no structural barrier; nursery stock is unpredictable but has the potential to penetrate deeply; and dibble-planted container stock will generally produce a flat root system.

Such considerations should determine the kind of planting stock we really need. If not, we shall be unable to predict the kind of plantations that will be obtained. The soil along with other site factors such as topography and vegetation cover should determine what should be planted in an area, emphasized Heikurinen, and what to plant should be determined when the long-term nursery stock forecast is prepared, not when the stock is received for planting. A rational system of planning and a reliable inventory of sites that will need to be regenerated are prerequisite to rational long-term planning.

## [19) Preliminary Planning of the Silvicultural Work Program.

R. P. Smith, Unit Forester, Ontario Ministry of Natural Resources, Chapleau, Ontario (see Appendix for present address).

*Good silvicultural planning is not possible unless accurate records are maintained. No regeneration project should be planned without considering all aspects of silviculture; therefore, the term "preliminary planning" is used to designate the planning done up to one year before planting begins.*

*Goals and objectives must be clearly stated. These are, in essence: why, where, and how, should we regenerate? Feasible alternatives are next determined. A silvicultural treatment file with a map, site description, and silvicultural prescription for each potential site can be used to establish treatment priorities. The forester must be able to predict the success of each technique under varying conditions. The plantation file contains complete information about work done on that site. By studying these files, the forester should be able to find clues that will help predict results. A knowledge of local limiting factors, e.g., budgetary or labor constraints, completes the information needed to develop possible alternatives.*

*The choice of treatment area and technique to be used is made after all factors have been considered. More detailed information has to be provided to the technical staff who will actually carry out the work. Up-to-date aerial photography plus a traverse of the area provides the information needed to make a prescription map. A detailed description of the site, plantation objectives, supervisory staff and equipment needed, and a budget estimate are made at the same time. The implementation description plus the prescription map will enable the field staff to complete the planting project correctly.*

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*Il n'est pas possible de bien planifier des projets de sylviculture si on ne possède pas d'archives précises. Aucun projet sylvicole ne devrait être planifié sans étudier tous les aspects de la sylviculture; donc l'expression "planification préliminaire" signifie la planification faite jusqu'à un an avant que ne commence le plantage.*

*Il faut établir clairement les buts et objectifs qui sont essentiellement: pourquoi, où et comment doit-on restaurer. On détermine alors d'autres solutions réalisables. On pourra utiliser une fiche de traitements sylvicoles, comprenant une carte, la description de la* *station, et les prescriptions sylvicoles pour chaque station possible, pour établir les priorités de traitements. Le forestier doit pouvoir prévoir le succès de chaque méthode dans des conditions instables. Le fichier d'une plantation contient tous les renseignements touchant les travaux accomplis sur la station. En étudiant ces fiches, le forestier devrait pouvoir trouver des indices qui lui aideront à prévoir les résultats. La connaissance des facteurs restrictifs locaux, tels les contraintes budgétaires ou de main-d'oeuvre, complétera l'information nécessaire pour développer des solutions de remplacement.*

*Le choix des secteurs à traiter et des méthodes à employer se fait seulement après l'étude de tous les facteurs pertinents. Des renseignements plus détaillés sont nécessaires aux techniciens qui devront réaliser les travaux. Des photographies aériennes récentes ainsi qu'un parcours du secteur procureront les renseignements nécessaires à la création d'une carte de prescriptions. Une description détaillée de la station, les objectifs de la plantation, les besoins en personnel dirigeant et en équipement ainsi qu'une estimation budgétaire se feront au même moment. La description de la mise à exécution du projet et la carte de prescriptions permettront aux travailleurs sur le terrain de compléter correctement le programme de plantage.*

## Supporting Oral Presentation

The steps undertaken in the Chapleau District immediately prior to carrying out the annual silvicultural program were outlined by Smith, with particular emphasis on (a) pre-cut and post-cut inspections by foresters and technicians, and (b) strip sampling.

The principles of sound silvicultural planning, stated in his paper, were worth repeating, said Smith: set goals and objectives; establish standards of success; evaluate limiting operational factors; generate feasible alternative courses of action; anticipate the results of these alternatives; choose the appropriate technique; and, finally, describe the plan to be followed.

Smith considered that the first step--setting of goals and objectives--is the most under-emphasized aspect of silvicultural planning, at all levels and throughout OMNR. There are objectives, but they are not emphasized enough, and often silvicultural decisions are taken without reference to them. Furthermore, such things as cost-effectivness criteria and standards for plantation establishment have not been spelled out.

In Chapleau District, the last four basic steps in silvicultural planning are facilitated by collecting and recording certain kinds of information. First, a silvicultural treatment file was developed to show the kind of treatment required for each area. All areas not meeting the stocking standard, e.g., recent cutovers, backlog cutovers, and failed plantations, are included in this file. Second, plantation files are maintained, and all records such as maps, site descriptions, silvicultural cards, assessments, and tending information for individual plantations were organized into a single small booklet, which provides a comprehensive history of what was done and how it turned out. Third, prescription maps are prepared to detail the area and treatment finally selected. Smith admitted his initial skepticism as to the value of prescription maps but said he soon realized it was a common sense approach and absolutely necessary. The prescription map is made after the forester traverses the area, and plots the data on supplementary aerial photographs. It must be done before any work on the area is begun. The map and plans together guide the technical staff to the successful completion of the operation.

Recapitulating, Smith said that the main points he wanted to make were: detailed objectives must be established for a plantation; alternatives must be considered with the help of a silvicultural potential treatment file for all areas not regenerating satisfactorily; the ability to predict results of certain treatments and methods in given situations must be developed, and, for this, complete and well organized plantation files would be a great help; and the plan to be followed should be described carefully with the help of prescription maps and detailed implementation schedules.

[20] Operation Planning for Planting in Thunder Bay District.

Hans Weiher, Forest Operations Manager, Ontario Ministry of Natural Resources, Thunder Bay, Ontario.

*An overall improvement in planting and other related work can be achieved if those in the key manpower sector, the forest technicians in charge of projects, are given the opportunity to grow and develop into experienced, motivated, and professional leaders.*

*Forest Operations Management in Thunder Bay has taken a "three-dimensional" approach to manpower organization in order to attract and keep the best technicians available for a period of up to 4 years.*

*The step by step preparation for planting, involving project leaders and all cooperative services for the 1976 projects, is also briefly discussed.*

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*On pourra s'attendre à une amélioration générale du plantage et des autres travaux connexes lorsque les hommes-clés du secteur de la main-d'oeuvre, les techniciens forestiers chargés des programmes,*

PLANTING

*auront la chance d'apprendre et de se développer au contact de professionnels motivés et expérimentés.*

*Les gestionnaires des opérations forestières de Thunder Bay ont adopté une approche "tridimentionnelle" quant à l'organisation de la main-d'oeuvre afin d'attirer et de garder les meilleurs techniciens disponibles pendant une période de 4 ans.*

*La préparation au plantage étape par étape, englobant les directeurs de projets et tous les services coopératifs pour les projets de 1976 fait aussi l'objet d'une brève étude.*

## Supporting Oral Presentation

If planning for successful regeneration is a relatively easy matter, as seems to have been suggested, why then, Weiher wanted to know, is it so difficult to achieve success? He conceded that natural causes such as drought or too much rain account to some extent for regeneration failures in spite of the efforts of so many concerned people. Other reasons include high turnover rates among planting crews. But the biggest single problem of the forest regeneration effort in the past, at present, and, as far as Weiher could see, in the future too, has always been and will remain man himself. More specifically it is the green man, the unprepared man, the inexperienced man.

The tale is told by senior technicians of how they train the green forester, who then, after completing this training at the grass roots level, disappears into a desk job. This is a serious problem. But equally important and equally disastrous in its consequences is the case of the green technician who is put in charge of major regeneration projects without proper training and without sufficient experience.

To correct this fault and furthermore to attract the best possible technicians in the business to the Ministry's regeneration program, the Thunder Bay forest operation has adopted a program of personnel management that allows for the training and development of personnel over a four-year period. Weiher added that the program, still in its initial stages, has received a severe setback in consequence of the Ontario government's latest personnel policy which will require casual staff to be laid off for up to three months of each year. In addition, technicians in tree planting have been singled out and will be required to compress their activities into an eight-hour day. We know, said Weiher, that the available planting time is short and critical and that every effort must be made to get the trees into the ground as soon as possible.

Weiher hoped that the new policy would be replaced very shortly by a more progressive one. "Otherwise we might as well stop worrying about how to improve regeneration schemes by new techniques and methods."

[21] Weather Information Relevant to Plantation Establishment.

L. B. MacHattie, Research Scientist, Department of the Environment, Canadian Forestry Service, Forest Fire Research Institute, Ottawa, Ontario.

*The publications of the Atmospheric Environment Service (4905 Dufferin Street, Downsview, Ontario), which give standard climatic normals for some 300 stations in Ontario, are listed. Of equal interest is information on probable deviations of actual weather from the average.*

*A series of bulletins prepared by the Agrometeorology Section, Research Branch, Canada Department of Agriculture, Ottawa, gives the probabilities of various amounts of departure from weekly average temperature, precipitation, and evaporation for some 60 individual stations across Canada. Each bulletin, entitled* **Risk Analyses of Weekly Climatic Data for Agriculture and Irrigation Planning,** *is for an individual station. A broader source of climatic probability will be the* **Handbook on Agricultural and Forest Meteorology** *being edited by Dr. R. A. Treidl for publication by the Atmospheric Environment Service; this will include several chapters of text as well as tabular data.*

*The effects of local topography on climatic elements are so variable and numerous that it is left to the individual to make allowance for them in his own area.* **Fire Weather** *by Schroeder and Buck, published in 1970 by the United States Department of Agriculture as Agriculture Handbook 360, gives illustrations of typical topographic effects.* **An Introduction to Agrotopoclimatology** *by MacHattie and Schnelle, published in 1974 as World Meteorological Organization Technical Note 133, may interest research personnel.*

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*Les publications du Service de l'Environnement Atmosphérique (4905 Dufferin Street, Downsview, Ontario) qui donnent les normales standards de conditions atmosphériques à quelque 300 stations en Ontario sont répertoriées dans la présente publication. Le lecteur trouvera, en plus, des renseignements d'une égale importance touchant les déviations probables de la moyenne des conditions existantes.*

*Une série de bulletins préparés par la Division d'Agrométéorologie, Direction de la recherche du ministère fédéral de l'Agriculture à Ottawa, donne les probabilités des diverses différences, i.e., déviations des moyennes hebdomadaires de température, précipitations, évaporation pour environ 60 stations individuelles réparties sur le territoire canadien. Chaque bulletin, intitulé* **Risk Analyses of Weekly Climatic Data for Agriculture and Irrigation Planning** *provient d'une station donnée. On pourra trouver une plus grande source de renseignements sur les probabilités climatiques dans le* **Handbook on Agricultural and Forest Meteorology,** *édité par Dr. R. A. Treidl et publié par le*

PLANTING

*Service de l'environnement atmosphérique; il contiendra plusieurs chapitres de matière courante ainsi que des données sous forme tabulaire.*

*Les influences de la topographie locale sur les éléments climatiques sont si variables et nombreuses que chacun est libre de les interpréter dans sa propre région.* Fire Weather *par Schroeder et Buck, publié en 1970 par le United States Department of Agriculture (sous-titre: Agriculture Handbook 360) illustre des effets typiques de la topographie.* An Introduction to Agrotopoclimatology *par MacHattie et Schnelle, publié en 1974 (sous-titre: World Meteorological Organization Technical Note 133) pourrait se révéler intéressant pour le personnel de recherche.*

## Supporting Oral Presentation

Weather is always around us and our plantations, observed MacHattie, and therefore we may as well make the best of it. He displayed a selection of publications that would help the forester find weather information that might be relevant to his work and interests.

New handbooks, using SI units, for temperature and precipitation, give such information as means, monthly averages for the daily maximum and minimum temperatures, numbers of frost-free days, rainfall, number of days receiving more than 1 mm of precipitation, etc. Other volumes for temperature, precipitation, and wind use degrees Fahrenheit, inches, etc.

The volume on wind contains much useful information: it gives the frequency by time of the winds from different directions, and average wind speeds for 16 directions at many stations and for eight directions at others. Prevailing winds are given and also the direction from which the strong winds come, and how this varies month by month.

There are about 300 weather stations in Ontario and their data are all 30-year averages (1941-1970).

The two volumes, "The Climate of Northern Ontario" and "The Climate of Southern Ontario", are for those who want to look at climate in more than average terms for a set period. Details of these (and the other) publications are given in MacHattie's full symposium paper.

Another item to which MacHattie drew attention was an unpublished handbook on agricultural and forest meteorology: it was being edited at the Atmospheric Environment Service. It describes how meteorology affects agriculture and forestry, and includes a series of tables that give much additional relevant information, such as the frequency of droughts and floods, the duration of the dry periods, the frequency of two-week droughts, etc.

Publications put out annually by the Department of Agriculture show how much irrigation water to add week by week through the season for various soil moisture storage capacities, but the same tables can be used to show what moisture stresses would develop in the absence of irrigation. Also given are maximum and minimum temperatures and the 90%, 10%, and 1% risks of frost after given dates in spring and before given dates in fall. Unfortunately the only forested places in Ontario for which these volumes are available are Kapuskasing and Ottawa.

The effect of topography on weather is considerable and is not revealed by weather stations that by and large are established on level terrain open to wind and sun. Some of the effects have been summarized in a World Meteorological Organization publication, which also contains a good bibliography on the subject. The publication will interest research people but is a little too far from practice to satisfy others.

"Fire Weather" published by the United States Department of Agriculture gives a lot of pictures and descriptions of the effect of topography on weather. The usefulness of this publication is not confined to fire meteorology: it can supply clues about weather effects generally.

[22] Soil is What You Plant in.

Geoffrey Pierpoint, Forest Research Branch, Ontario Ministry of Natural Resources, Maple, Ontario.

*Comments are given about the general influence of certain soil and site factors on the establishment of planted seedlings and how the management forester might help in providing favorable conditions.*

*Survival and establishment of newly planted trees depend on growth. Root growth initially is more important than top growth. Anything that we do to encourage root growth is likely to improve survival and subsequent top growth.*

*Root growth is better in well-drained than in imperfectly drained soil, in loose than in compacted soil, and in the weathered upper soil horizons than in the unweathered parent material. The establishment of planted seedlings on fine-textured soils which are particularly susceptible to compaction requires careful preservation of the structure of the weathered soil horizons. Root elongation slows down when the values of soil moisture stress are surprisingly moderate. We cannot augment precipitation, but we can help to utilize and conserve what water there is. Planting should be done in the weathered horizons and on the shade side of any object. Competition from other vegetation should be reduced and mulching should be done with slash or anything else. Precautions take man-hours, but improved survival and growth are worth money, too.*

*L'auteur commente l'influence générale de certains facteurs relatifs aux sols et aux stations sur l'établissement de plants et indique comment l'aménagiste forestier pourrait aider en fournissant des conditions favorables.*

*La survie et l'établissement d'arbres nouvellement plantés dépendent de la croissance. Initialement, la croissance des racines est plus importante que celle de la cime. Tout ce qui est fait pour promouvoir la croissance des racines devrait améliorer la survie et la croissance des cimes, qui suivra.*

*La croissance des racines est meilleure en sols bien drainés qu'en sols imparfaitement drainés, meilleure en sols meubles que compacts, et meilleure dans les horizons supérieurs mûris par le climat que dans les horizons sous-jacents. L'établissement de plants en sols à texture fine et particulièrement vulnérables à la compacité, exige la préservation soignée de la structure des horizons supérieurs mûris par le climat. L'allongement des racines diminue lorsque les valeurs de rétention d'humidité du sol sont étonnamment modérées. Personne ne peut augmenter la pluviosité mais on peut aider à l'utilisation et à la conservation de l'eau existante. On devrait planter dans les horizons mûris par le climat et à l'ombre de tout objet. Il faudrait réduire la concurrence d'autre végétation et faire des abris (mulch) avec les rémanents ou toute autre matière disponible. De telles précautions exigent des heures-hommes mais l'amélioration de la survie et de la croissance a aussi sa valeur monétaire.*

The oral presentation supporting Pierpoint's paper was given by Burger. After noting that the paper stresses the importance of root development and the limitations that soil may put on this development, Burger went on to say that, before the silvicultural experience gained in one area can be applied in another, a system of site classification is needed. And because the requirements of trees differ from those of agricultural crops, the classification should be based on silvicultural, not agricultural, criteria. The Research Branch has a physiographic site classification that does the job. The factors used include: texture of the rooting zone soil; moisture regime (a somewhat different thing from drainage in agricultural terminology); depth of soil; nutrients; and eco-climate or local climate as influenced by slope, etc.

This physiographic site classification is stable and can be used for various purposes. Potential competition can be estimated, for example, as well as chances of regeneration success, potential growth, and potential cull. The concept of site regions has been developed to allow comparison among similar soils.

The scale at which this physiographic site classification can be used varies. Most of the audience would be familiar with the Ontario Land Inventory Maps, thought Burger, but these are only a very limited part of it: "you can start right down at the base map level...go up to the land type or land unit patterns".

Mapping techniques have been developed and the Forest Research Branch knows how to use aerial photographs and surface geology.

Burger concluded with three suggestions: that field staff ask the Forest Research Branch for help in methodology and for whatever information might be available; that field units make known to Regional and Head Offices their needs for soil information; and that the universities teach their students more about this physiographic site classification.

## [23] Hand Planting in Eastern Ontario.

A. J. Campbell, Ontario Ministry of Natural Resources, Brockville, Ontario.

*Basically, we in eastern Ontario still hand plant trees because mechanization has not overcome many field planting problems. Gains in production and savings in cost from the use of the machines currently available have been insignificant. Labor input has changed from rural "farm type" to that of university students, from total male to mixed male and female crews.*

*Some form of shovel or spade is the principal tool used to plant trees by the wedge, L, or slit methods. The large day-rated crew has given way to some form of piecework planting which necessitates increased supervision and smaller crews (8-12 persons).*

*In the special hybrid poplar programs, trees are planted at 3 m x 3 m spacing in a right-angled pattern using special planting dibbles. To make the gains necessary to keep pace with the regeneration goals in eastern Ontario, we may need a container stock program combined with a compatible, economic, high-output mechanized planting system.*

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*Fondamentalement, nous dans l'est de l'Ontario, plantons encore manuellement parce que la mécanisation n'a pas encore résolu bon nombre des problèmes de plantage que l'on retrouve sur le terrain. Les gains dans la production et les épargnes dans les coûts dus à l'emploi des machines actuellement disponibles ont été insignifiants. La main-d'oeuvre a changé, du "type fermier" rural, à celui d'étudiants d'universités, des équipes composées d'hommes seulement aux équipes mixtes d'hommes et de femmes.*

*Quelque forme de pelle ou de bêche constitue le principal outil qu'on utilise pour le plantage par les méthodes en coin, en L ou en fente. L'ancienne grosse équipe, payée à la journée, a fait place à une certaine forme de plantage à l'unité, ce qui exige une surveillance accrue et des équipes plus petites (8 à 12 personnes).*

*Dans les programmes spéciaux pour Peupliers hybrides, on plante les arbres distancés de 3 m x 3 m, suivant un modèle perpendiculaire, à l'aide de plantoirs spéciaux. Pour faire les gains nécessaires pour aller de pair avec les objectifs de la régénération dans l'est de l'Ontario, il nous faut peut-être un programme de plantage en conteneurs, combiné à un système de plantage mécanique compatible, économique et à grand rendement.*

## Supporting Oral Presentation

The social importance of tree planting was emphasized by Campbell. In doing so he very ably created a vignette that would be instantly recognizable by anyone who has ever had anything to do with forest tree planting: "When management foresters get together and after they have talked about the weather, they begin to talk about tree planting, and everyone has had experience in tree planting, and so we can all talk about it. All you have to say is: 'John, how did tree planting go this spring?', and immediately John launches into how the weather was either too hot and too dry or too wet and too cold, never just right; and the labor supply dried up. There are terrible tales of how the transport truck got lost, and of overheating of trees. And the stock is always too large or too small--this is a good time to take a swipe at the nurseries. 'And oh yes, there were no roots on some of the stock we got!'" All this makes good conversation, observed Campbell, so socially it is a very important subject.

Campbell went on to make a number of points, the first of which was that in eastern Ontario, hand planting is still heavily relied on. He said that trees are still being planted by this oldest method in the world because mechanization has not really broken through in this field.

In his paper, Campbell had tried to describe the organization and methods used for tree planting in eastern Ontario. There were differences within the Region, but they were differences of technique only, not of principle.

Campbell's final point was that everything possible has been done in eastern Ontario to decrease costs and increase efficiency, and no further economies can be expected in hand planting with the possible but unexplored exception of going to container stock. From now on, costs will continue to rise in proportion to wages, and we must hope that a breakthrough in mechanization will put tree planting on a more efficient basis. As a forester who has been in the planting program for many years, Campbell wanted to encourage any company, organization, or individual to take a close look at new techniques or new systems of planting to try to make the breakthrough necessary if the job of tree planting is to be done in Ontario.

[24] Hand Planting in the Atikokan District.

O. R. Carlson, Resource Technician Senior I, Ontario Ministry of Natural Resources, Atikokan, Ontario.

*The first recorded hand planting in the Atikokan District took place in 1950, when Atikokan was not a district but a division of the Fort Frances District. During the intervening 25 years, changes in techniques, organization, record keeping, quantities, species, and types (e.g., container stock), have taken place. Because very few data are available for the period prior to 1967, the substance of the text will encompass the period 1967 to 1975, primarily, and the material from that period is based on personal experience.*

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*Le premier plantage manuel inscrit aux archives dans le district d'Atikokan eut lieu en 1950 alors qu'Atikokan n'était pas encore un district mais plutôt une division du district de Fort Frances. Au cours des 25 années suivantes, il s'est produit plusieurs changements dans les techniques, l'organisation, la tenue des archives, les quantités, les espèces et types (e.g., les plants conteneurisés). A cause des très rares données disponibles pour la période antérieure à 1967, la teneur du texte englobe principalement la période située entre 1967 et 1975 et elle est fondée sur des expériences personnelles.*

## Supporting Oral Presentation

O. Carlson described how planting is carried out in the Atikokan District, an area of rough topography. He acknowledged that the problems encountered in Atikokan and the solutions devised to combat them do not necessarily apply to other parts of Ontario. Basic guidelines (leaving Regions and Districts free to seek and apply their own solutions to problems) rather than hard and fast province-wide rules are therefore needed.

The rough topography, with its rock outcrops, wet depressions, shallow over bedrock soils, etc., and the slash left after cutting have precluded much in the way of site preparation. Mostly spot planting has been done in an attempt to get the desired spacing among the rocks and slash.

One problem, labor supply, may be common to most parts of Ontario. It was a problem in the Atikokan District until 1967 when women were first hired to plant trees. By 1972 about 130 women tree planters per season were being hired. The population of Atikokan is only about 6,000, and now each year some 200 to 250 applications are received, virtually all from housewives. It seems that even smaller towns would be able to supply such labor.

Some of the advantages of hiring women are low turnover, dependability ("they don't miss work the day after pay day"), and they are not lost to fire crew duties in bad fire seasons.

Carlson noted that, in Atikokan, spring planting is considered to be best. It usually starts in the first week of May (or as soon as possible thereafter) and continues until the first week in June. The number of planters hired is determined on the basis of how many trees are to be planted, and a good supply of workers is secured to ensure that planting is completed within this period. There have never been any problems with this system. It works well.

The whole question of planting reminded Carlson of the story about the young lad explaining how his father had taught him to swim: his father took him in a boat out into a lake about a mile from shore and threw him into the water. The lad said that swimming wasn't really difficult--the problem was getting out of the bag. Carlson left his audience with the suggestion that with regard to planting we know what to do but cannot get out of the bag.

[25] Tree Planting in the Chapleau District.

Ken LeClaire and R. H. Dunne, Senior Resource Technicians, Ontario Ministry of Natural Resources, Chapleau, Ontario.

*Three labor forces were used by the Chapleau District of the Ontario Ministry of Natural Resources to plant 4.2 million trees in the spring of 1976: 1) Indian families from the James Bay area camping on site, costing $49/M trees; 2) planters working out of an established Ministry camp at $66/M; and 3) local residents commuting to the site daily at $57/M. Hand planting was at 1.8 m spacing using the L-method.*

*In 1), each family was assigned an area of 2-4 ha and supplied with sufficient trees to stock the area to standard density, the optimum being 2 470 trees/ha. The area planted had to balance trees issued. The planters, under general supervision, worked at their own pace. Periodic checks with .0004 ha (milli-acre) plots determined planting quality and trees per unit area. This system provided adequate supervision at minimum cost without being obvious or offensive.*

*In 2), Manitoulin Island Indians worked out of a Ministry camp, using a gang system. A crew boss supervised each gang of 6-8 men planting one area. The planters were issued equal numbers of trees and paid the group average.*

*In 3), commuters working in gangs were bussed to the site daily, but inconsistent attendance prolonged the operations and created problems in overhead staffing and tree delivery from day to day.*

*Higher costs and increased supervisory requirements limit the use of camp and commuter operations, while the higher production, lower costs, and better quality of work done by the families favor their use at Chapleau. Accurate records of the trees received, daily planting total, individual totals, and all expenditures charged to each operation were recorded in one book to facilitate later reference.*

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*La main-d'oeuvre utilisée dans le district de Chapleau par le Ministère des richesses naturelles de l'Ontario pour planter 4,2 millions d'arbres au printemps de 1976 était répartie comme suit: 1) des familles amérindiennes de la région de la Baie James, campées sur place; le coût, $49/M arbres; 2) des planteurs travaillant à partir d'un camp établi par le Ministère, le coût, $66/M; et 3) des résidents locaux transportés quotidiennement sur les lieux de travail, le coût, $57/M. Le plantage fut effectué à la main, selon la méthode L (à angle droit), selon un écartement de 1.8 m entre les arbres.*

*Dans le cas n° 1, chaque famille se vit assigner un secteur de 2-4 ha et un approvisionnement de plants suffisant pour satisfaire aux normes de densité, l'optimum étant de 2 470 arbres/ha. Les arbres fournis devaient s'équilibrer sur une superficie donnée. Les planteurs, sous surveillance générale, travaillaient selon leur propre rythme. Des vérifications périodiques sur des placeaux de .0004 ha (1 milli-acre) pouvaient déterminer la qualité du plantage et le nombre d'arbres par surface unitaire. Cette méthode permettait de surveiller les travaux de façon discrète et adéquate, ce moyennant un coût minimum.*

*Dans le cas n° 2, les Amérindiens de l'île Manitoulin partaient d'un camp établi par le Ministère et travaillaient en équipes. Un surveillant de group avait la charge d'une équipe de 6 à 8 hommes, qui plantaient dans un secteur. Les planteurs avaient tous un même nombre d'arbres à planter et étaient payés selon la moyenne de l'équipe.*

*Dans le cas n° 3, on transportait par autobus à tous les jours les travailleurs "abonnés" qui formaient des équipes de travail, mais les absences répétées de certains membres ont eu pour effet de prolonger les travaux et de créer des problèmes de personnel et de livraison au jour le jour.*

*L'accroissement des coûts et le besoin de surveillance supplémentaire sont des facteurs limitant l'emploi des gens des catégories 2 et 3 pour effectuer les travaux; d'autre part, une meilleure production, à moins cher, et un travail de meilleure qualité, attribués aux familles, favorisaient leur utilisation, du moins à Chapleau. Pour fins de références ultérieures, on enregistra avec précision le nombre d'arbres reçus, le nombre total d'arbres plantés quotidiennement, les totaux individuels, et toutes les dépenses imputées à chaque opération.*

## Supporting Oral Presentation

LeClaire gave the supporting oral presentation for the paper he coauthored with Dunne. The lack of literature covering the actual details of planting organization caused LeClaire and Dunne to prepare "a basic nitty-gritty paper describing the 1976 spring tree planting in the Chapleau District".

LeClaire expressed the hope that the paper would have some effect on senior management "whose decision to add or subtract X number of trees to or from a district's program has a monumental effect on planting and even on morale in the tree planting camp."

The main point in the paper is that the different labor forces used--Indian families camped on site, gangs from established OMNR camps, and commuters from nearby communities--each requires a different supervisory setup. And, as Hans Weiher has already made clear, trained seasonal supervisory staff is becoming increasingly hard to find.

In Chapleau, the Indian family work force from the James Bay coast is used whenever possible.[2] Costs are lower, quality much better, and overall control easier because of the block system used.

The method of planting is described in the paper with the help of diagrams taken from an anonymous publication found in the District library.

The value of prescription maps is stressed: they are used very extensively and are a great help to planter and supervisor alike.

Record keeping and quality control are also stressed. Emphasis must be on quality, not quantity.

## [26] Planting Machine Operation in Northeastern Ontario.

H. A. Erickson, Unit Forester, Ontario Ministry of Natural Resources, Kirkland Lake, Ontario.

*Tree planting machines which can site-prepare and plant their own ground offer savings in time, money, and labor. To achieve these savings, however, an effective tree planting unit has to be used sensibly on a properly chosen area. This tree planting unit consists of : (i) a 100-140 horsepower crawler tractor to pull the planter, to which is attached: (ii) a front-mounted V-blade for clearing standing trees out past the tractor pads and, in the middle of the V-blade, a scalping foot for moving stumps and slash from the path of the planting shoe and packing wheels; (iii) the tree planting machine whose planting*

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[2] See remarks by Erickson in his oral presentation, p. 76.

*shoe makes a slit in the soil into which the tree is planted, and whose packing wheels follow to firm the soil around the tree roots. This unit should be used only on relatively flat, rock-free sites with deep, uniform soils, and few residual trees.*

*Some potential cost savings may be lost through low productivity (650 to 800 trees per hour) and the cost of the large tractor needed to pull the planter. This machine necessitates wider inter-row spacing (2.4 m - 2.7 m), and consequently closer intra-row planting (1.2 m - 1.5 m) or a reduced number of trees per unit area. A final disadvantage is the uncomfortable and sometimes hazardous ride of the planter. However, in areas of chronic labor shortage or poor-quality labor, planting machines can offer the best utilization of existing manpower.*

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*Les machines à planter qui peuvent à la fois préparer la station et planter offrent des épargnes de temps, d'argent et de main-d'oeuvre. Pour profiter de ces épargnes, cependant, il faut utiliser une bonne machine et de manière sensée, dans un secteur approprié. Une telle unité mecanique comprend: (i) un tracteur à chenilles de 100 à 140 chevaux pouvant tirer le plantoir à qui est rattaché: (ii) une lame en V montée à l'avant-train pour dégager les arbres encore debout, hors des chenilles du tracteur et, au centre de la lame en V, un pied à dégazonner pour repousser les souches et rémanents qui obstruent la voie au plantoir et aux roues remblayeuses; (iii) la machine à planter dont la semelle planteuse (plantoir) fait une rainure dans le sol, dans laquelle l'arbre est planté et dont les roues remblayeuses suivent pour raffermir le sol autour des racines des arbres. Cette machine devrait servir seulement pour des stations relativement unies, libres de pierres et à sols profonds, uniformes et ayant peu d'arbres résiduaires.*

*Il peut se produire une baisse des épargnes de coûts à cause d'une productivité amoindrie (650 à 800 arbres à l'heure) et à cause du coût du tracteur assez lourd pour tirer la planteuse. Cette machine nécessite un espacement plus large entre les rangées (2.4 à 2.7 m), et par conséquent, un plantage intra-rangs plus rapproché (1.2 à 1.5 m) ou encore un nombre réduit d'arbres par unité de surface. Enfin le planteur se sent inconfortable et court parfois certains dangers. Toutefois, dans les régions où la rareté de la main-d'oeuvre et sa qualité inférieure constituent un mal chronique, les machines à planter peuvent permettre la meilleure utilisation de la main-d'oeuvre dont on dispose.*



## Supporting Oral Presentation

Machine planting in the boreal forest has not progressed beyond the use of machines, such as the Reynolds-Lowther Crank Axle Planter and the Taylor Drum Colter, that were designed for use on abandoned agricultural land. This was the first point made by Erickson, who went on to say that the effect of the new V-blade is to prepare a mini-site more or less duplicating the old field conditions for which the planting machines were designed. The Ontario Mark III Planter might be different, but Erickson had no recent information on its development.

Only the easiest sites should be considered for planting by machine. Machines are not magical and they do not work in stony soils or where there is heavy residual slash. At least 30 cm of soil of fairly uniform texture is needed for satisfactory machine operation. Runs should be as long as possible. Soil moisture conditions should also be as uniform as possible especially on clays, where packing pressure has to be adjusted with changes in moisture condition.

Because the planter unit is pulled by a large tractor that clears its own path, planting rows will be further apart. Rows will not be 1.8 m apart, Erickson said, but with luck might be 2.4 m or more likely 2.7 m apart. Spacing in the rows may then be 1.2 m to 1.5 m, although even a spacing of 1.8 m x 1.8 m may result in jack pine that are too limby, suitable only for railway ties.

High production rates should not be expected from tree planting machines. Erickson considered that one would be lucky to get a planting rate of 800 trees/hour: it would have to be a phenomenally well organized operation to get a rate of 1 000 trees/hour. And when the machine cost is probably $35/hour, costs of planting are not going to drop substantially. Sites similar to those seen on the field trip that could be planted by machine could be treated by the Bräcke or Young's teeth and seeded or perhaps even hand planted with bare-root stock for about the same cost as machine planting.

One of the chief advantages of machine planting would be in areas of chronic labor shortage. In this regard, Erickson mentioned his impression that the James Bay Indian labor source referred to in LeClaire and Dunne's paper is about to dry up because of Quebec's settlement with the native people which guarantees every family a certain amount of money, something like $1 000/person/annum plus $2 000/annum for the head of the family.

Finally, tree planting machines are not safe, and in spite of modifications are still quite hazardous, as well as uncomfortable. The Mark III Ontario Planter with its large tires might be better, but then a wider clearance path will be needed.

## [27] Planting Machines in the Boreal Forest.

D. A. Cameron, Forestry Officer, Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario.

*Tree planting machines are not widely accepted or used in the boreal forest owing to lack of firsthand experience and ignorance of*

*machinery available, site limitations, machine characteristics, and operating procedures.*

*An estimated 40% of the total productive forest area of eastern Canada is deemed machine plantable by virtue of its gentle topography, shallow humus, and deep soil characteristics.*

*The key to economical machine use in a single-pass site preparation and plant operation is the effective use of a V-blade with attached scalping foot mounted on the bulldozer C frame. It is common sense to use the V-blade to obtain the minimum clearing required for planter operation.*

*Bulldozers are noted for their steady yet slow speeds, an essential requirement for safe, comfortable, and effective planting machine operation. They must be capable of towing the planter while pushing aside slash and debris encountered on the planting chance.*

*Strict attention should be paid to planter operator safety through use of a horn, safety padding, and other protective devices.*

*Economical machine planting occurs where the site is 20 ha or more in size and initial planning is done to ensure that the planter is spending as much time as possible planting trees rather than in nonproductive maneuvering for short runs.*

*Servicing and maintenance on a regular basis are necessary for a smooth and efficient operation.*

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*Les machines à planter ne sont pas grandement acceptées ou utilisées dans la forêt boréale à cause d'un manque d'expérience de première main et de l'ignorance de certains facteurs tels l'outillage disponible, les limites d'utilisation dues à la topographie, etc., des stations, les caractéristiques des machines, enfin les méthodes d'opération.*

*On estime que 40% de la superficie des secteurs forestiers productifs dans l'est du Canada seraient plantables à la machine car à titre de caractéristiques ils présentent une topographie souple, un humus peu profond et un sol profond.*

*La clé de l'utilisation économique de la machine réside dans la préparation des stations et le plantage en une seule opération, qu'on effectue par l'emploi efficace d'une lame en V munie d'un pied à dégazonnement, monté sur le cadre en C d'un bulldozer. Il est bien logique d'utiliser la lame en V pour obtenir l'espace minimum requis par la planteuse.*

*Les bulldozers sont reconnus pour leur vitesse réduite mais régulière, facteur essentiel à une opération sûre, confortable et efficace de* *la machine à planter. Ils doivent pouvoir touer la planteuse et en même temps, repousser les rémanents et autres débris qu'ils rencontrent sur leur parcours.*

*La sécurité de l'opérateur de la planteuse doit faire l'objet d'une attention sérieuse obtenue par l'emploi d'un avertisseur sonore (klaxon), de coussins de sûreté et d'autres dispositifs de protection.*

*Le plantage économique à la machine est réalisable sur des stations mesurant 20 ha ou plus et on procède à une planification initiale pour s'assurer que le planteur passera le plus de temps possible à planter des arbres plutôt qu'à faire des manoeuvres improductives sur de petits parcours.*

*L'entretien et les réparations doivent être effectués régulièrement si l'on veut profiter d'un rendement souple et efficace des machines.*

## Supporting Oral Presentation

Posing the question, "What is a tree planting machine required to do?", Cameron said that it must plant tree seedlings firmly, at root collar depth, at specified spacing in the planting chance. A number of machines already on the market "will perform adequately on that 40% of the productive forest area in Canada which fits the following three physical site requirements: deep soils, thin humus layer, and flat to gently rolling terrain." The snag is that the planting sites meeting these requirements still have the remains of the productive forests--stumps, slash, residuals--on the site. How to deal with these remains is a primary problem facing mechanized planting.

Regardless of the type of planting machine, Cameron said, planting quality and production efficiency are directly related to the preparation of a suitable planting microsite, the area of debris-free mineral soil (with or without a thin duff layer) within the operating width of the planting machine component. To date, this condition has been obtained cheaply and effectively with V-blades front-mounted on bulldozers pulling mechanical tree planters.

The V-blade has advantages over other methods of site preparation which make it suitable for single-pass operations: its front mounting eliminates interference with planter hookup; the V-blade is self clearing; and it is rugged and easy to operate. The V-blade is thus well suited to the boreal cutover.

Tree planting machines already on the market should be able satisfactorily and economically to plant a good portion of the area now done by hand. Are they being given a chance? Cameron feared that they were not. The mere mention of a mechanical planter, he said, seems to many people to imply that it can go where no man has gone and work where no man is prepared to go. But the greatest benefits are to be gained by using machines on the easier sites. The often scarce hand planting labor can then be directed to the more difficult sites that might otherwise need sophisticated and therefore expensive machinery. The reverse happens all too often, and under these conditions machine planting is very often disappointing. Disenchantment leads to abandonment, and repeated failure of basically sound planting machines hardly encourages further development.

Properly used, however, planting machines would be successful. Continued use together with increasing experience would foster improvements.

## Discussion

Discussion ranged over a useful range of topics vigorously if not always deeply.

*Preplanting Planning*

Flowers asked Smith whether he thought that the planning outline given in Smith's paper, if properly followed, would eliminate most of the complaints listed in Hearnden's paper. Smith had not had the opportunity of reading Hearnden's paper, so all he could say was that the system of planning developed and used in the Chapleau District has been successful.

Bax asked how far the planning directives are transmitted down the hierarchy: are the actual operators informed, for instance? Smith replied that whenever possible work is supervised by a permanent staff member who was involved with the initial planning. LeClaire added that the prescription maps are supplied to all staff involved in the work: also, bulldozer operators themselves were shown the maps as an experiment, but with one exception this did not help.

Answering a question by Brandes, LeClaire said that the development of a prescription map usually begins with supplementary aerial photography as soon as the hardwoods flush in the spring: the areas are then walked and mapped using the photographs, keeping in mind what treatments are to be applied. For example, if site preparation is to be done, areas on which a bulldozer cannot be operated are delineated. Prescription maps should be done properly or not at all, said LeClaire: badly done maps are worse than useless.

*Modelling*

G. Brown was upset that in Payandeh's model jack pine seeding is given as the most economical method and white spruce is rated much higher than jack pine in some cases, while black spruce is omitted entirely.

Payandeh repeated what he had emphasized both in his oral presentation and in his paper: While the costs and prices given in the model realistically reflect the best current information available, the point of the examples is to show how the model works, to illustrate what sort of information can go into the model, and to explain how the results are to be interpreted.

The main objective, Payandeh continued, was to get across to the forest manager that here is a methodology, a tool, that is very easy to use, since it is based on simple facts or estimates that the forest manager can readily supply. Anyone not agreeing with an estimate used in a model is free to substitute his own. Incidentally, the model also offers a simple way of determining how changes in an estimate will affect the results obtained and conclusions reached.

Vyse of the British Columbia Forest Service asked the OMNR panel members whether they thought that modelling is useful. His experience, to his chagrin, suggested that using such models is rather like fixing the kitchen tap while the watermain is flooding the basement.

Smith commented that he was interested in the model and had found it useful, but the idea of modelling is not easily conveyed to many people.

Burger was assured by Payandeh that the site index value used in the model can be varied according to circumstances.

*Site Classification*

Burger noted that Heikurinen had made no reference in his paper to 30 years of soil-site research by OMNR: was Heikurinen aware that the Forest Research Branch already has available for unit managers the kind of site classification system he was proposing? Heikurinen replied that he had recently become aware of much of the work of the Forest Research Branch but that it still did not give him exactly what he was looking for.

Another question was directed to Heikurinen by Burger to ascertain the possibility of unit foresters participating in and executing soil-site surveys with the cooperation of the Forest Research Branch. Heikurinen thought that unit foresters would have neither the time nor the expertise to participate in soil survey work. He thought that what was needed was a permanent, stable, well qualified group for this kind of work.

Offord wanted to know how one goes about collecting site classification data during an operational cruise: are soil pits needed in every stand, for instance? Heikurinen thought not, because stands do not necessarily indicate what is under the forest floor.

Depth may not be as important as the exchange capacity of the soil, suggested G. Brown. He asked Heikurinen to explain why phenomenal growth occurs on some of the shallow soils in northwestern Ontario and why some of the best jack pine on the Englehart Management Unit (EMU) is in Sheba Township and on rocky outcrops in Labelle Township. Heikurinen commented that his paper covered only part of the picture, concentrating as it did on Sid Shay's work on soil moisture on the EMU. All the relevant factors have to be ascertained before growth rates on shallow soils can be explained. Also, many shallow soils have pockets of deeper soil that tend to be fertile. Tap roots obviously cannot penetrate deeply on a shallow soil, but on deep soils it makes sense to use planting stock that can exploit the "full depth", explained Heikurinen. Planting stock had to be selected.

G. Brown commented that in effect this was what he himself had said: to utilize a deep soil poor in nutrients, a deep root system is needed, whereas in a shallow soil with a high exchange capacity, there is absolutely nothing the matter with a shallow root system.

*One-pass Versus Two-pass Operations*

Haig raised for reconsideration the concept of the one-pass site preparation-planting operation. It had, he said, been a basic premise all along in the mechanization program that a one-pass operation was essential because the cost of going over the same ground twice with heavy machinery is too great. However, might there not be advantages, economic and otherwise, in the flexibility that derives from simple single-purpose as opposed to complex all-purpose machines? Haig wondered whether a two-pass system might be viable, with one simple machine covering the planting site quickly just to clear the slash and make paths to be followed later by a planting operation: conceivably, site preparation could go ahead all summer, perhaps all year, with fast single-purpose planting machines operating on the prepared ground during the planting season.

Cameron agreed that this sort of thing should be looked at. In fact there was a paper at the 1976 CPPA meeting comparing the Koehring-Waterous harvester, "which does everything", with smaller machines that together did the same job. In that particular study, Cameron said, the harvester was less mechanically available than each of the individual machines, but over all on a job basis it was more available.

In Sweden, Scott added, many planting machine studies have been carried out with the help of simulation modelling. Scott had received a paper from Bakström recently saying that the Swedes are favoring an all-purpose machine plus the two machines on which they are currently working.

*Site Preparation and Subsequent Cycles of Regeneration*

Sutton asked the panel what effect they thought deep furrowing during site preparation, as for example by the Marttinni Plow, might have on harvesting and subsequent regeneration options.

Cameron recalled that the Marttinni had been used at Manitouwadge on a rocky knoll that would not otherwise have been treated: the site was prepared with difficulty but well enough to enable it to be planted by hand. The Marttinni does not always make such a mess as it did on that particular site. Cameron thought that mechanical harvesting of a crop established after Marttinni site preparation would present no great problem.

Erickson said that after he had used a Marttinni on a silt loam soil the "great windrows" that were created had "settled probably 50-60% after three years", and although they will persist and might resemble the early furrowing for planting of red pine and white pine in southern Ontario, he did not think there would be much problem in harvesting.

*Labor*

Glatz asked LeClaire and Dunne whether, in view of their problem with commuter labor for planting, they had tried to hire local women as planters. Since 1968 almost all planting in the Dryden District has been done by women planters: they are more productive and more reliable than the men.

LeClaire said that two crews of women had been used on the Foleyet plantings in 1976. They did well and lasted the whole planting season, and did not have to go off on fire duty. But the Foleyet labor force is small.

Jovic said that he understood that the Indian family planters, while working in the Chapleau District, lived in what looked like a big village of tents in a cutover: how did this fit in with health regulations?

Good sites are picked for the tent camps, LeClaire explained: outside toilets are provided, there's good running water (checked), garbage pits are dug, and the site is left clean afterwards.

*Contract Planting*

R. Brown (British Columbia Forest Service) asked whether thought had been given in Ontario to doing tree planting by contract: in British Columbia some 250 contracts were entered into last year for plantings of from 20 000 to 550 000 trees.

Tree planting had at one time been contracted out in what used to be the Geraldton District, Jovic replied: the biggest problem had been quality control, aggravated by lack of competition for contracts, and the practice had ceased

All machine planting is done by contract in the Eastern Region, Campbell said, and it seems to be going well. Hand planting by contract was discontinued after problems of quality control arose.

Bax observed that, as a contractor with a consulting firm which for the past three years has been hand planting up to 300 000 trees per year for OMNR, he would like to point out that quality is totally under the control of the contract issuer; quality can be controlled to any degree simply by writing into the contract the terms desired. Contractors have no option but to accept those terms if they take the contract. The amount of monitoring of quality carried out depends on the effort the contract issuer is willing to put into it.

Bax also made the point that small contractors are able to survive only because of their flexibility; they could not survive if conditions rendering them inflexible were imposed on them. In particular, an enforced 8-hour day would kill the small contractor.

If the OMNR planting program is going to be expanded according to production policy, Innes observed, there is no way of doing this without contractors. If OMNR does not start now to cultivate and develop contractors, they will not be available when needed.

Amplifying his earlier remarks, R. Brown referred to the British Columbia contract document in which the terms of contract (including quality control standards and penalties for failure to observe them) are clearly laid out. Unless the contractor achieves 75% planting quality, he receives absolutely no payment; he is paid in full only if he achieves full quality.

R. Brown commented that he has found that contract work, including planting, is far less trouble for British Columbia Forest Service staff. If the work is not done by contract, then crews have to be hired, transportation provided, and all manner of paper work must be done: "We prefer to leave all that to the contractor." No conditions, e.g., regarding hours of work, are imposed; that is left up to the contractor. He advised against lightly giving up the idea of contracting, although he was sure that tight contracts were needed.

*Planting Hazard Index*

R. Brown asked whether any work has been done on developing a planting hazard index for Ontario; Sherry Hambly in British Columbia has been doing some work on that subject, as has Weyerhaeuser. What we need to know, he said, is during what weather conditions (in terms of windspeed, temperature, soil moisture, etc. at the planting site) planting should be avoided. MacHattie did not know of any such work in Ontario, where fire hazard index development had been emphasized, but he thought that something along those lines could be developed. A critical factor would be the determination of the effect on plants of given weather conditions. And we need to find out soon, he said, what effect a slight change in climate might have. Considerable work is going on to develop a model for forecasting climate which could parallel the model used in forecasting daily weather. Even if such a model is developed, however, unless we know what effect a 1°C change in temperature, for example, has on a plant, the information cannot be applied. This is a field that needs a lot of work, MacHattie concluded, for the outcome is not at all obvious.

In this regard, Burger commented that Geoff Pierpoint at Maple is working on the relationship between fire index and soil moisture conditions, observing that the latter is obviously related to survival chances among young stock. One advantage of this approach is that past survival performance can perhaps be related to past soil moisture conditions.

The importance of soil temperature in tree establishment was emphasized by Wynia, who suspected that cold soils in hot weather, a common situation in the boreal forest in summer, may be one of the more detrimental factors militating against plantation establishment.

Agreeing on the importance of soil temperature and its role in forest site relationships, Burger noted that competition is tied in with not only soil moisture but also local climate, which in turn affects soil temperature.

Reese commented that part of Bob Mullin's OMNR work with refrigerated storage involved lifting stock at several dates in the fall as winter approached and the planting of this stock at different dates through the spring. Almost without exception the first planting in the spring gave poorer results than did the second and third plantings; the poorer result of the first planting which goes in as soon as the frost is out of the ground is apparently related to the coldness of the soil.

Hutchison confirmed that Bob Mullin has been working with soil temperature in spring planting. With red pine especially, Hutchison said, Mullin believes that planting can be too early, and suggests that, as a rule of thumb, planting should not be done when the soil temperature is less than 5°C. He added that the work referred to by Reese had been done some years ago. Replying to G. Brown, Hutchison said that he knew that the stock used in that work had not been overwintered frozen, spring frozen, or spring cooled, but apart from that he could not comment on its condition.

G. Brown observed that the condition of stock when it is lifted makes a big difference in terms both of planting site conditions tolerated and root regeneration potential.

However, G. Brown added, important as soil temperature is, the biggest planting disasters that he had experienced had been due to rapid rises in air temperature which induced flushing and increased moisture requirements beyond the ability of the root system to take up moisture even from soils that might be soaking wet.

Glerum believed that the main problem in such cases is that roots do not regenerate and grow out into the soil; there can be plenty of moisture in the soil but if a tree transpires without replacing that moisture by uptake, it becomes desiccated and goes into "shock".

*Root Development in Containerized Pine*

Vyse found difficulty in understanding Heikurinen's suggestion that containerized stock has no tendency to resume elongation of its taproots. Heikurinen replied that not all containerized plants remained without a taproot: the effect is found mainly in dibble-planted stock. With jack pine and red pine, taproots when present seem to be offset, and sinkers are few in the central part of the root system.

*Planting Method*

Dolhy, referring to O. Carlson's use of the L method of planting wherever possible, asked what alternative method is used on the "predominantly terrible" sites, and does it give acceptable results? Carlson said that trees are planted by what might be called a slit method. The shovel is put into the ground, pulled back, shoved in deeper, and pushed forward a bit so there is no air pocket in the bottom but the ground is opened enough to permit insertion of the tree.



*Fall Planting*

Dolhy observed that Campbell had stated in his paper that fall planting gives erratic results ranging from 20% survival to complete failure: could Campbell, he asked, give any reasons for Districts to continue fall planting?

Campbell first made clear that he did not favor fall planting, and said he thought the fact that fall planting is unreliable had been rightly emphasized earlier in the symposium. In eastern Ontario, even in years with seemingly favorable weather and on good planting chances, "terrible losses" were experienced for no reason that could be determined. It was therefore advisable to get the planting done in the spring.

Replying to a question from Sutton, Campbell said that fresh stock, not stored, had been used in the fall plantings; in one case it was white spruce, and 90% of it died. In another fall planting, red pine was planted on an excellent site with good soil moisture conditions, and again disaster resulted.

Bunting commented that those who like to begin their fall planting in the first part of September are sadly mistaken if they think that the planting stock they use is the same as the stock they would get in the spring if it were left until then. Work at Orono, Bunting explained, showed that by September 1, a tree has amassed only about half the dry weight that it would have the following spring. It is not the same tree at all. In test plantings at Orono to try to assess when stock should be lifted in the fall, Bunting has found untrue the old story that, in fall planting, trees should be planted early so that they have time to regenerate roots before the onset of winter: plantings in the first three weeks of September have been much poorer than plantings in the following three weeks. This most likely is the same sort of problem relating to stock lifted for storage. Stock has to be dormant or frost hardy or something else before it is ready for fall lifting, Bunting said.

*Double-leadered Spruce Planting Stock*

To what extent, asked Myland, are forked (double leadered) spruce nursery trees acceptable as planting stock?

Campbell had had no real problem in his District, but in the Eastern Region opinion was sharply divided as to whether or not double leaders constituted a problem, some foresters believing that one of the two leaders would take over, and others feeling that the problem was real.

LeClaire had had one shipment of spruce containing a fair proportion of double-leadered trees, but he felt unqualified to say how these trees might develop.

Wynia thought that Myland's question should be addressed not to the panel but to those responsible for planting, because if some foresters or districts would accept double-leadered stock, it would make a big difference to nursery output, at least in the north. Wynia wanted to take a vote later to ascertain the position.

*Planting Machines*

With regard to the Ontario Planter, testing and development have been going on for 5 years, Scott said; last year, OMNR had three planting machines in the field and the Canadian Forestry Service one. These were thoroughly tested and, with the experience gained, one machine was stripped, modified, and completely rebuilt at Maple. The Mark III was tested just in the last couple of weeks before the symposium and will be further tested. The results of this latest testing were not, of course, available when papers were being prepared for the symposium. The Mark III has now been brought very close to what is required, and the machine is probably as advanced as any in the world in respect of operating in rough boreal conditions, Scott said. Two companies with rough terrain expertise are prepared to undertake completion of the development. Scott thought that planting machine development has reached the same stage as had skidders in 1957. Walters in British Columbia has a machine, also built to operate in rough conditions, designed to plant containerized stock only, but as far as Scott knew, the Soviet Union has no machine comparable to the Mark III, and Finland is not working on any. Sweden, however, has something that looks interesting.

Glatz asked Cameron whether, with the planting machine used at Dryden in 1972, the packing wheel problem on heavy clay had been solved. Affirming that it had, Cameron said that corrective action had been taken before the machine left Dryden: two posts were welded onto the machine and lengths of steel rail added to increase the weight on the packing wheel which then effectively closed the slit.

*Servicing and Maintaining Machinery*

Innes questioned whether forestry schools impart enough technical mechanical knowledge to foresters and technicians to equip them to look after sophisticated planting machines and their hydraulics.

Cameron thought not, at least for anyone involved in machine development, although for developed machines he felt that servicing and maintenance could be handled without additional schooling. One does not have to be a mechanic in order to be able to use a car, he said.

Citro commented that machines, sent to the field for testing, had not been looked after properly. No one had been trained in this, a fact that is causing second thoughts about the advisability of the practice. This year machines are being sent to skilled hydraulic engineering technologists who will iron out problems until, eventually, reliability has been secured.

However, if such machines come to be used in large numbers, OMNR would have to have an organization to look after them in the field: *now* may be the time to start training technicians for that purpose, suggested Citro.

Scott mentioned that about 4 years ago he had visited three colleges in the province that grant diplomas in forestry just to make them aware of the sort of developments expected in forestry machinery and to alert them as to possible forthcoming employment opportunities for suitably trained technicians.

In his experience, Bax said, it is unrealistic because of the complexity of today's equipment and machinery to expect the two roles of forester and mechanic in general to be combined in the same individual. Too often the attempt to save a dollar costs ten, and Bax believed that it is better to have a high cost mechanic sitting around 8 or 12 hours a day and being needed once a week than having several foresters running around trying to pick up transmissions, etc.

*Professional Supervision on the Planting Site*

Hutchison asked LeClaire how often supervisors at the professional level from the regional office as well as from district management inspect the spring planting site: are their visits frequent enough to give them an adequate idea of the problems encountered?

LeClaire replied that the district timber supervisor and the unit foresters are on site about once a week: regional staff might or might not appear on any given planting operation. More time spent with the plant foreman would improve the professional's understanding and appreciation of the problems, LeClaire thought.

*Training and Supervision of Planters*

Noting that both O. Carlson (describing hourly rated operations) and Campbell (on piecework operations) gave only passing reference in their papers to the training of crew bosses and planters, Robinson asked these authors to comment on the type of training given and the cost of supervision needed to obtain quality work with each system.

Campbell replied that he depended on a nucleus of experienced casuals and supervisors: gangs have been reduced in size over the years to increase the efficiency of supervision. He feared that the new personnel policy would force him to use large gangs again. He could not give actual figures for the cost of supervision, but thought that, while it may be somewhat higher than for hourly rated operations, there would be no major difference: it takes a good man on his toes to supervise even a 10-man crew, Campbell said, but the slightly higher cost of piecework supervision is offset by the greater productivity.

Crew bosses, Carlson said, are picked from experienced planters, female bosses for female crews. The turnover is small, and many women have been bosses for a number of years. Each year, regardless of whether or not they are experienced, crew bosses, all casual foremen, and anyone else who is going to be involved in planting arrangements, all attend a 2-day instructional meeting and field trip.

On the question of piecework versus time work, Carlson said that piecework had been tried only once since he had joined the Atikokan staff: the exception was with containerized stock and one small experienced crew. Productivity was very little higher than with time work planting. In normal (time work) operations, the supervision amounted to one crew boss per ten planters, and four crews to one or two foremen and a clerk, excluding permanent staff. If piecework were to be adopted in the Atikokan District, one crew boss per three planters would probably be needed because of the roughness of the topography.

*Personnel Policy Change*

Clarke wondered what case there was for "this new fantastic policy" of which Weiher was severely critical. Weiher reiterated that the new policy would have most serious effects both on the calibre of staff available and on the ability of the districts to get the planting job done.

*Outplant Survival Rates*

G. Brown raised the question of survival rates in new plantings. He noted that several authors had not given survival rates and that O. Carlson had reported losses of about 30% in 2 years. Additional losses could be expected in the next 3 years. Brown said that he "usually insisted" on a minimum survival rate of 80% after 5 years. What, Brown asked Carlson, had caused the high mortality?

Carlson replied that the losses had been caused by a combination of factors including poor stock, poor land, poor weather, etc. In his experience, however, the highest mortality occurs in the first year and he expected very little increase in mortality between years two and five.

*Communication*

Since much of the rationale for holding symposia derived from the need to communicate and exchange information, Fayle took the opportunity to draw attention to the OMNR publication series called "Forest Research...". This series is an annual summary of current research by the Forest Research Branch. For each field of research, a brief description of the work is given together with the names of the people involved. A request card is included to make it easy for anyone to obtain further information. Each year the publication is sent to everyone in the Ministry, and "Forest Research 76" is scheduled for distribution in 1976. Fayle asked OMNR participants to let him know if they do not receive a copy. A copy is addressed to each individual but mailing is in block to the Regions.



Replying to Swan, Fayle said that "Forest Research..." is available on request to anyone anywhere in the world, and it is mailed to forestry libraries internationally.

Glerum, referring to Erickson's attempt and reported failure to obtain information on the Mark III Ontario Planter, noted that Citro was present and wondered just what had happened. Scott elaborated on the history of the machine's development and explained that testing of the Mark III had begun only 2 weeks prior to the symposium so that information was not available at the time of Erickson's request. Citro confirmed that this had been conveyed to Erickson, adding that tests have to be continued to a certain minimum point before one can be reasonably sure that a machine is working properly.

Glerum summed up the case: Erickson *had* received information--that there was no information.

Chairman Markus said it was too early in the day for that sort of thing.

## TENDING

[28] Release Treatments in Artificially Established Plantations in Northern Ontario: A Review and Forecast.

J. Miller, Ontario Ministry of Natural Resources, North Bay, Ontario.

*Competition from woody and herbaceous vegetation often obstructs successful plantation establishment and performance. To realize successful plantations, one should consider tending as part of a silvicultural system and should plan for it at the time of plantation establishment. In planning for release projects the following factors should be considered: (i) a definition of the type of stand to be managed and the species components desired; (ii) an appreciation of site productivity, and the type of competition which will arise, in order to establish the type of control to use; (iii) an understanding of the degree of control needed; (iv) consideration of when competing vegetation is most susceptible to release treatments.*

*The 5th-year survival of nursery stock planted between 1966 and 1971 in northern Ontario has been less than 65%: black spruce* (Picea mariana *[Mill.] B.S.P.) (61%); white spruce* (P. glauca *[Moench] Voss) (60%); jack pine* (Pinus banksiana *Lamb.) (64%); red pine* (P. resinosa *Ait.) (47%); white pine* (P. strobus *L.) (58%).*

*Although it is difficult to assess precisely the impact of competing vegetation on plantation success, it is safe to say that competition has played a major role in stock mortality.*

*Release treatments have generally been confined to mechanical (hand) release and chemical sprays of 2,4-D (2,4-dichlorophenoxyacetic acid). To keep pace with the regeneration program, release projects which treated 6 000 ha in 1973 will be expanded to 24 100 ha in 1982, and primarily herbicide sprays will be used. Future tending efforts in plantations will concentrate on the release of white spruce and black spruce. To reduce the undesirable effects of competition, consideration should be given to the effect each silvicultural phase has on the competitive strength of weed species.*

*In the forest manager's efforts to improve plantation success, each phase of regeneration must be scrutinized for potential improvements. Failure to tend plantations will result in additional mortality, poor performance, and extended rotations.*

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*La concurrence de la végétation ligneuse et herbacée est souvent une entrave au succès de l'établissement et du rendement d'une plantation. Pour faire une réussite de ses plantations, on devrait songer à un système de soins culturaux et le planifier au moment de*

*l'établissement de la plantation. Les facteurs suivants sont à retenir lorsqu'on planifie les projets qu'on veut lancer: (i) définir le peuplement à amenager et la composition des espèces à planter; (ii) évaluer la productivité de la station et le genre de concurrence qui se manifestera, afin de déterminer la lutte à utiliser; (iii) déterminer rationnellement le degré de lutte; (iv) trouver le moment (temps) où la végétation concurrente est la plus vulnérable aux herbicides.*

*Après cinq ans, la survie des stocks de pépinières plantés entre 1966 et 1971 dans le nord de l'Ontario fut de moins de 65%: l'Epinette noire* (Picea mariana [*Mill.*] *B.S.P.*) *(61%); l'Epinette blanche* (Picea glauca [*Moench*] *Voss*) *(60%); le Pin gris* (Pinus banksiana *Lamb.*) *(64%); le Pin rouge* (P. resinosa *Ait.*) *(47%); le Pin blanc* (P. strobus *L.*) *(58%).*

*Malgré la difficulté d'évaluer avec précision les effets de la végétation concurrente sur le succès d'une plantation, on peut dire, sans risque d'erreur, que la concurrence a joué un grand rôle dans la mortalité des plants.*

*Les traitements contre la végétation concurrente se sont généralement limités à des arrosages au moyen de dispositifs manuels seulement et à des vaporisations de produits chimiques: 2,4-D (acide 2,4-dichlorophénoxyacétique). Afin de suivre le programme de régénération, les projets de lutte contre 6,000 ha en 1973, seront de l'ordre de 24,100 ha en 1982, et on utilisera surtout des vaporisations d'herbicides. Dans les plantations on traitera à l'herbicide surtout l'Epinette blanche et l'Epinette noire. Afin de réduire les effets nocifs de la concurrence, il faudrait songer à l'influence que chaque phase de traitement sylvicole peut avoir sur les herbes nuisibles.*

*Il faut scruter toute possibilité d'amélioration de chaque étape de régénération pour améliorer la plantation. Le manque de soins à donner aux plantations aura comme résultat une mortalité additionnelle, un rendement médiocre et des révolutions plus longues.*

## Supporting Oral Presentation

J. Miller's intent was to promote discussion on tending techniques because of the great importance of combining the various phases of plantation management into a unified system of successful plantation establishment. It is senseless, he said, to spend time and effort in producing high-quality stock and then have it die because of faulty planting or site preparation, or have it succumb to competition.

Miller hoped that the summary included in his paper (of tending treatments carried out during the past 5 years in various districts) would be useful to those about to undertake tending operations.

On the basis of OMNR figures, it would appear that for the boreal conifers in northern Ontario plantations, success is about 60% survival after 5 years, and height growth can be considered no more than fair. Competition is a major causal factor.

Commenting on the Ministry's output targets, Miller noted that about 22 000 ha were regenerated in 1973 and that forecasts suggest that 27 000 ha will be regenerated in 1982; bare-root stock production is already approaching the 1982 target. But with tending, 6 000 ha were treated in 1973, whereas in 1982 about 24 000 ha--a fourfold increase--will need to be tended. Furthermore, Miller suggested, tending proposals are insufficient.

We can expect the problem of competition to become even greater in the future. The days of planting large sandflats may be coming to an end, and planting will be directed increasingly to areas that are difficult to regenerate and to backlog areas.

Root competition begins to limit growth before aerial interference, and the competing vegetation has a definite advantage over the planted stock. Random visual inspection of plantations is inappropriate for assessing tending requirements.

By 1982, the production scheduled for northern nurseries is expected to be white pine 2%, red pine 6%, jack pine 18%, white spruce 33%, and black spruce 41%. On productive sites, particularly where white spruce is planted, competition will be a *repeated* problem. Several release treatments, perhaps at 2-year intervals, may be needed.

Miller stressed that tending should be scheduled at the time of planting and should be part of a total silvicultural package based on site conditions and related competition. "If you get anything out of my paper", he said "that is what I would like you to get."

Finally, he noted how difficult it had been to obtain concrete evidence as to the results achieved by tending treatments, and advised that assessments of release projects be started immediately.

Miller thanked those who had responded to his questionnaire.



[29] Early Tending of Plantations: Southwestern Ontario.

J. D. Nolan, Forest Management Supervisor, Ontario Ministry of Natural Resources, Aylmer, Ontario.

*The early tending of plantations (i.e., those tending operations necessary during the first 5 years of the life of the plantation) constitutes but a minor component of the total spectrum of plantation management in the Southwestern Region of the Ontario Ministry of Natural Resources.*

*Nevertheless, where there is a need for this work, its importance cannot be overestimated. The early tending operations discussed in this paper are those normally carried out by the Ministry in this Region on plantations up to 5 years old. The species are mainly coniferous and the treatment comprises: (i) hand cleaning to free planted seedlings of unwanted shrub competition, and clipping to control the spread of insect and disease infestations; (ii) grass control in 2- to 5-year-old plantations containing black walnut* (**Juglans nigra** *L.) by application of chemical spray; (iii) rodent control by judicious application of rodenticide; (iv) early side branch pruning to encourage proper stem and leader development of black walnut.*

*Although some of the plantations in this Region occur on Agreement Forests and Crown properties, they have been established largely on private lands managed under Woodlands Improvement Act Agreements with individual landowners. Mention is made of refill planting of fail areas and protection against destructive agents such as fire and domestic animals.*

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*Les soins culturaux hâtifs que l'on accorde aux plantations (i.e., les opérations de soins sylvicoles requises au cours des 5 premières années de vie d'une plantation), constituent une composante mineure dans l'éventail complet des opérations d'aménagement de plantations du Ministère des richesses naturelles de l'Ontario pour la région sud-ouest de la province. Néanmoins, lorsque de tels travaux s'imposent, leur importance ne saurait être surestimée. Les opérations de soins sylvicoles hâtifs discutées (traitées) par l'auteur sont celles auxquelles procède le Ministère dans cette région, pour des plantations ayant jusqu'à 5 ans d'existence. Les espèces se composent surtout de résineux et le traitement comprend les étapes suivantes: (i) désherbage manuel pour libérer les semis en place des broussailles concurrentes indésirables et élagage pour mater les infestations d'insectes et les maladies; (ii) répression des graminées dans les plantations âgées de 2 à 5 ans et qui renferment du Noyer noir* (**Juglans nigra** *L.) au moyen d'arrosages avec des produits chimiques; (iii) lutte contre les rongeurs par une judicieuse application de rodenticide; (iv) élagage hâtif des branches latérales pour promouvoir un bon développement des tiges et des pousses apicales du Noyer noir.*

*Même si quelques-unes des plantations de cette région sont situées dans des forêts relevant d'ententes (Agreement Forests) et des propriétés de la Couronne, elles furent établies, pour une grande part, sur des terrains privés régis par le Woodlands Improvement Act Agreements avec l'aide des propriétaires terriens individuels. Il y est fait mention de remplir par un plantage, les surfaces trouées et de la protection contre les agents destructeurs comme l'incendie et les animaux domestiques.*

## Supporting Oral Presentation

Nolan's topic covered the types of tending operation carried out by OMNR in the Southwestern Region in the period of approximately 5 years between the initial planting and the time that the plantation is considered established.

Plantings in the region are on old fields, the bulk of them on private lands managed under the Woodlands Improvement Act of 1966. These lands are marginal or submarginal for agriculture. Early tending operations are of four kinds: hand cleaning; chemical control of grass; rodent control; early pruning. They cover a small area compared with the other silvicultural operations carried out, such as planting, later tending and thinning, and crop tree pruning.

Illustrating his talk with slides, Nolan described the early tending operations.

Hand cleaning and clipping of competition are avoided as much as possible, but the situation often occurs where invasion or re-invasion by hawthorn becomes serious enough to require treatment. Then just those portions of the hawthorn (or wild apple or whatever) that are competing with the planted stock are removed, together with double leaders or infected shoots of the outplants, at a cost of $20-30/ha.

Grass control is needed on many sites that are ideally suited to forestation. Usually, simazine at the rate of 6.7-10 kg per treated ha depending on species is used as a spray. But with European larch and most of the hardwoods except black walnut simazine is not used, and hand scalping is usually resorted to. Measures taken at the time of planting are usually sufficient to control grass competition for 2 years. With high-value species, such as black walnut, simazine spraying against grass competition will often have to be done at about 3 or 4 years, sometimes 2, to free the trees before they begin to stagnate.

Rodents will seriously damage not only hardwood outplants but also conifers. Rodent populations increase cyclically to the point at which control measures are needed. Phosbait is applied along every fourth or fifth row in threatened plantations: where possible the poison is placed under heavy grass. There have been no problems with this method.

Early pruning of walnut is warranted up to about $25/ha. It is money well spent to prune the lowermost young branches of walnut, sometimes as young as 5 years of age, to promote proper stem form. The work is usually done in January or February, when the chances of fungal infection and bleeding are minimal.

Other protective measures that have to be taken more particularly in southern Ontario include fireguard maintenance and grazing prevention.

[30] Insects and Diseases Important in Plantation Establishment.

W. L. Sippell, Head, Forest Insect and Disease Survey Unit[3], Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario.

*Among the hundreds of insects and disease-causing organisms known (on the basis of 25 years of forest pest surveys) to affect planted pines and spruces in Ontario, any of five insects or insect groups and four diseases can seriously disrupt plantation establishment: white grubs,* **Phyllophaga** *spp.; spruce and jack pine budworms,* **Choristoneura fumiferana** *(Clem.) and* **Choristoneura pinus pinus** *Free.; redheaded pine sawfly,* **Neodiprion lecontei** *(Fitch); yellowheaded spruce sawfly,* **Pikonema alaskensis** *(Roh.); and pine root collar weevil,* **Hylobius radicis** *Buch.; Scleroderris canker of pine,* **Gremmeniella abietina** *(Lagerb.) Morelet; white pine blister rust,* **Cronartium ribicola** *J. C. Fischer; Armillaria root rot,* **Armillaria mellea** *(Vahl ex Fr.) Kummer; and Fomes root rot,* **Fomes annosus** *(Fr.) Karst. Another 13 insects and 10 diseases listed are categorized as having the potential to retard plantation establishment. The potential impact, geographical importance, and methods of detecting a developing problem are given for the nine disruptive pests. Control methodology is described where available and applicable and advice is offered on when Unit Foresters should seek further assistance on control action. The successful joint government action which has been taken in recent years to reduce levels of Scleroderris infection is outlined. Descriptions are given of the Forest Insect and Disease Survey Unit, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario, its responsibilities, and the service it provides to provincial Unit Foresters.*

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*Parmi les centaines d'insectes et d'organismes pathogènes connus (en se fondant sur 25 années de relevés des fléaux forestiers) qui affectent les plantations de Pins et d'Epinettes dan l'Ontario, n'importe lequel des cinq insectes ou groupes d'insectes suivants et quatre maladies peuvent sérieusement rompre l'établissement d'une plantation: les vers blancs,* **Phyllophaga** *spp.; les Tordeuses des bourgeons de l'Epinette et du Pin gris,* **Choristoneura fumiferana** *(Clem.) et* **Choristoneura pinus pinus** *Free.; le Diprion de LeConte,* **Neodiprion lecontei** *(Fitch); la Tenthrède à tête jaune de l'Epinette* **Pikonema alaskensis** *(Roh.); et le Charancon du collet du Pin* **Hylobius radicis** *Buch.; le Chancre scléroderrien du Pin,* **Gremmeniella abietina** *(Lagerb.) Morelet; la Rouille vésiculeuse du Pin blanc,* **Cronartium ribicola** *J. C. Fischer; le Pourridié-agaric,* **Armillaria mellea** *(Vahl ex Fr.) Kummer; et la maladie du Rond,* **Fomes annosus** *(Fr.) Karst. Encore 13 autre insectes et 10 maladies répertoriés forment une catégorie de fléaux pouvant retarder l'établissement des plantations. La possibilité de ravages, l'importance géographique et les méthodes de détection d'un problème croissant sont*

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[3] now Program Manager, Forest Entomology and Pathology.

*données pour neuf fléaux qui dérèglent la vie des arbres. L'auteur décrit une méthodologie de lutte lorsqu'elle est disponible et applicable et il conseille les forestiers de son groupe quant au moment où ils devraient demander une aide accrue lors de leur lutte. Il souligne l'action concertée adoptée par les gouvernements au cours des dernières années et les succès obtenus dans la réduction des niveaux d'infection scléroderrienne. Il décrit de Groupe des relevés et des insectes et maladies des forêts au Centre de recherche forestière des Grands lacs, à Sault Ste-Marie, Ontario, ses responsabilités et le service qu'il fournit aux forestiers du Groupe provincial.*

## Supporting Oral Presentation

In getting to the nub of the enormously complex question of forest entomology and forest pathology in relation to plantation establishment in Ontario, Sippell concentrated on those insects and diseases that will kill planted trees. This gave nine insects or diseases that have been important in the last 25 years and that can be assumed to continue to be important problems in the next 25 years.

Sippell showed slides to indicate the diagnostic stage at which these problems can be detected.

White grubs can be a very serious problem in old field plantings in southern Ontario.

The spruce budworm continues to move northward, particularly in northeastern Ontario, and is spreading on balsam fir in northwestern Ontario. It defoliates balsam fir and causes some mortality. There are problems in attempting to establish spruce plantations in an area at the height of a budworm outbreak.

The jack pine budworm which, excepting its red head, looks just like the spruce budworm, attacks jack pine primarily but also white pine and Scots pine. It defoliates, and causes some mortality.

The redheaded pine sawfly is a serious problem on red pine: the larvae, which feed in colonies, have a distinctly red head and black spots along their sides. Defoliation will kill red pine in 0.5 ha patches.

The yellowheaded spruce sawfly larva is waxy in appearance and should be watched for in mid-June in southern Ontario, late June in the north.

The root collar weevil is closely confined to specific areas in Ontario; the main problem area is Simcoe County, and beyond that there are just scattered infestations. It attacks the root collar and a large gob of gum, insects, needles, soil, etc., builds up there.

Scleroderris is absent from large parts of Ontario, e.g., the southwest, but can be a serious problem. It causes flagging on red pine and jack pine. It also produces a spiral canker, and the green stained wood under the bark is very characteristic. Once trees have reached a height of 1.5 m they are no longer susceptible.

Armillaria root rot builds up in stumps and can invade adjoining young pine.

White pine blister rust is still a real problem where both alternate hosts are present.

Fomes root rot is normally not a problem in plantation establishment, but if infected plantations should be cleared and replanted to conifers, there could be a serious problem.

"The only other thing I would say", concluded Sippell, "is that if there are unit foresters who have not read the last paragraph of my paper, I would like them to read that even if they do not read anything else."

## Discussion

Insects and disease occupied the greatest part of the discussion. Silvicultural use of herbicides generated less discussion than might have been expected; apparently the results being obtained are silviculturally satisfactory, and there has been no public outcry against chemical herbicides even when they are used on private lands in southern Ontario. The only major problem seems to be that of obtaining aircraft at the right time for spraying operations in the north.

*Tending in the Total Silvicultural Program*

Flowers initiated a discussion on what priority should be given to tending in the total silvicultural scheme of things.

J. Miller believed that tending is often the first activity to be cut when funds are curtailed. Planting is continued at such times, he suggested, because the stock has already been produced. Yet it is to be regretted that while tree planting continues, existing plantations suffer sometimes to the point of extinction. He felt that the priority accorded tending was sometimes lower than it should be.

There is not much of a problem in southwestern Ontario, Nolan said, because tending is normally such a small part of the silvicultural program.

Gilmore differed. He felt that high priority is given to tending in the Southwestern Region, adding that tree planting would be cut before tending was curtailed if funding were in local hands.

Nolan explained that he had confined his remarks to the early tending period, between planting and establishment as opposed to the total tending picture. This, he thought, was made clear in his paper and oral presentation.

The point at which action becomes desirable to combat insects or disease is a value judgment that management has to make, Sippell said.

Thompson commented that tending had high priority in the Central Region, but much of the tending is scheduled for the latter part of August, and this is a real problem because aircraft are often unavailable, or the weather is unsuitable if aircraft are available. About 1 600 ha annually are scheduled for herbicidal spraying in Kirkland Lake District out of a regional total of some 8 000 ha. Spraying has at times to be continued after the frost with possible but so far undetermined loss of effectiveness.

Markus wondered to what extent the aircraft problem was general. G. Brown said that the same situation occurs in the Western Region.

*Insects and Diseases*

Armitage asked about the current status of the spruce budworm infestation in Ontario.

The general situation, replied Sippell, is that populations have declined somewhat in the Algonquin Region and the main part of the outbreak in southern Ontario, but populations are still high and there is continuing mortality of balsam fir. Populations are also down somewhat in the Sudbury—Sault Ste. Marie area, but the wave of infestation has moved northward. Balsam fir had been severely browned within an area of 1.2 to 1.6 million ha. In northwestern Ontario there is a gradually increasing ground swell of populations, but, despite intensive sampling of egg masses, no clear indication yet as to the probable cause of events. Available information would be analyzed and discussed with OMNR at the October 5, 1976 meeting.

*Forest Insect and Disease Survey*

Sippell put a general question: "How can the Forest Insect and Disease Survey (FIDS) best help the unit forester?" He outlined the background: Surveys and research in entomology and pathology have traditionally fallen to the Canadian Forestry Service, and this work has been going on for many years. The stage has been reached where FIDS is trying to get into the hands of the unit forester the biological information that has been gathered. As a start, FIDS has set up in each district office of OMNR a display case showing the insects of greatest concern in that district. The same thing has been done for forestry schools in colleges and universities. Also, the attempt had been and is being made to put this biological information into handbooks designed to help the unit forester--*Insects of Eastern Pines* was the first, and will be followed by *Insects of Eastern Fir, Spruce, and Hemlock.* Also planned are handbooks on cedars and the rest of the conifers, southern Ontario hardwoods, and poplar and birch. Any ideas for making this biological information more readily available or more usefully deployed would be appreciated.

The excellent cooperation by FIDS was appreciated by Groves, Myland, and McCready. The latter wondered whether similar display cases are to be made available for diseases.

Sippell responded affirmatively. Two professionals in FIDS are working on this, and are starting to accumulate the colored photographs that will be needed. A handbook on diseases (on a tree species basis) is also proposed.

Wynia, too, reported getting good service from FIDS but thought it was ridiculous that the service was available for only half the growing season.

A dollar goes only so far, replied Sippell, and it does not go as far this year as it did last. FIDS priorities are under review, and at present the highest priority is given to mortality checks, e.g., in northeastern Ontario. Ground truth has to be obtained, and the rangers will be out for possibly another week or two in the fall of 1976.

Innes raised the question of packing items for mailing to the FIDS since the specimen, after treatment by the Canada Post Office Box Crusher and Desiccator, is apt to arrive at its destination as a pile of dust.

Sippell said that FIDS mailing tubes should be used for insects, putting in just enough foliage for the insect to munch on for 2 or 3 days. With foliage diseases, the best way is to fold the leaves flat into tinfoil, turn the foil over and seal it with a drug store seal, fold it over, and mail it in a tube. A slip bearing the sender's name and address should *always* be enclosed. Perhaps, said Sippell, a simplified set of packing instructions should be supplied with the mailing tubes.

Severe mortality that he had seen in white spruce plantations in Calder Township near Driftwood in the Cochrane District prompted G. Brown to ask whether it was spruce budworm or the spruce sawfly that was "wiping out" plantations. He noted that white spruce has been planted extensively in that area for about 10 years. He had always been concerned about white spruce in pure stands, fearing that they would be highly susceptible to insect attack.

MacNaughton commented that the budworm was only just starting to go through the Cochrane area, and he thought that part of the damage seen by Brown was caused by highway operations in the winter and by highway spraying at other times. There had also been instances of damage by white pine weevil.

G. Brown countered that the damage he had seen was on both sides of the road as far as the eye could see.

Defoliation in white spruce plantations similar to that referred to by G. Brown had been seen by Campbell all the way from Hearst to Cochrane. The problem has been identified, though not by entomologists, as the spruce sawfly: it has been doing extensive damage for 3 or 4 years, and it is generating great concern.

G. Brown suggested that FIDS rangers should look into the situation and he wanted to know how detrimental to white spruce plantations such attacks might be.

Sippell apologized that he could not say, not knowing the area. But he did not think that pure plantations of white spruce were susceptible to the spruce budworm: they would not lend themselves to budworm population buildup. Past experience had been that the budworm population builds up in mature white spruce, then spills over onto the balsam fir. Past experience suggests and all the textbooks state that the older the balsam fir, the more susceptible it is to the budworm. Yet there was an outbreak at Chapleau in 30- to 35-year-old balsam fir, and there was very little older balsam fir. The extensive pure plantation of white spruce, conjectured Sippell, might become a problem only if surrounded by enormously extensive areas of balsam fir. There had been very little mortality of white spruce anywhere within the area of budworm outbreak that began in Ontario in 1967. At one location, mortality in white spruce had reached 8-9%; the mortality is concentrated in balsam fir.

McCready asked Sippell whether he had implied that good spruce plantations would be possible if balsam fir were eliminated from them. Balsam fir undergrowth could be eliminated by, say, prescribed burning.

No, said Sippell. What he was saying was that a stand of white spruce is not as susceptible to spruce budworm as one of balsam fir.

The situation facing MacNaughton was that he had a lot of good spruce sites surrounded by a lot of budworm. Should spruce still be planted in those areas?

Sippell found that a difficult question to answer. Control of the spruce budworm in white spruce plantations at the Petawawa Forest Experiment Station had been attempted with little or no success; but the situation there was unique, with mass migration into the area, and heaps of moths 40 cm deep beneath fluorescent lights. However, if he were forced to generalize, he would say that white spruce plantations are normally not nearly as susceptible as are natural stands of balsam fir. He thought it unlikely that severe mortality, in terms of plantation establishment, would be experienced; and, as long as defoliation can be tolerated, Sippell did not consider the situation to be serious.

Sutton, however, mentioned that if the budworm struck within 2 or 3 years after spruce plantings, before the trees have properly established themselves, then mortality can be considerable. But the situation may change quickly. In the Chapleau area, for example, black spruce and white spruce outplants 40 cm high, in their fourth growing season, were yielding 40 to 50 full-grown larvae. The degree to which a young plant can tolerate such defoliation is rather limited, and, even if it survives, probably 5 years have been added to the establishment period. This year, however, the budworm pressure on these plants is much less. Sutton therefore thought that, if possible, the planting program should be modified to delay the planting of spruce in susceptible areas that are heavily infested. If not, there would probably be losses.

Pursuing the question of monoculture, Turmel asked whether Sippell was not afraid of insect or disease epidemics in large tracts of pure stands.

Sippell, however, was not unduly concerned. He had concluded that as forest management is intensified so will the problems of insects and disease be intensified, and there will be a greater need for prompt answers to the problems.

Responding to Innes' request for elaboration, Sippell explained that the problems are distributed heterogeneously, and this is why the sampling effort has to be so large. As forest management is intensified, e.g., with the hybrid poplar work, then entomologists and pathologists almost have to be on hand because by the time a problem has developed the results may be devastating.

Navratil supported Sippell's views. Monoculture has been practised in Europe for 150 years and although there have been problems, these have been solved by evolving technology and advances in pathological and entomological knowledge.

G. Brown returned to the subject of the spruce sawfly outbreak on white spruce. He noted that there was defoliation two-thirds of the way down, there were no new leaders, and just the lower branches were alive. If white spruce is planted extensively on the richer soils right across the province from North Bay to the Manitoba border, and if the sawfly comes along in the sixth or eight year or so and wipes out the plantations, then that, at $200 to $300/ha, would represent a big financial loss.

Sippell agreed that concern was justified *if* the situation is serious. But he advised against over-reaction to entomological situations.

FIDS experience with *Pikonema alaskensis* (Roh.), the supposed culprit, has been humiliating in that apparently serious defoliation in one year has typically been followed by complete recovery the following year. The spruce sawfly had not been a serious problem in the previous 25 years; but if mortality or severe damage does occur then a closer look is certainly called for.

Brown went on to suggest that there are dangers associated with trying to increase "to an abnormal level" the content of white spruce in the boreal forest. He was not worried about his 24 000 ha of pine plantations because they are on natural pine sites, but if white spruce is planted "like wheat", then Nature's balance may be upset.

*Fire and Control of Insects and Disease*

Heatman asked Sippell what role fire plays in controlling disease and insects in artificially regenerated stands: can prescribed burning lead to disease problems in some cases?

On the contrary, Sippell thought that fire is quite a safe tool. He mentioned, without specifying them, that there had been problems in Europe, but none had been experienced in Ontario. And the fact that Scleroderris cannot be found in any of the many susceptible plantations established after the big Mississagi burn of 1948 may indicate that fire has a sterilizing effect.

*Herbicides*

Atkins asked J. Miller whether 2,4-D is effective if applied to foliage after it has changed color in the fall. Miller had no experience of this but noted that the literature suggests that spraying is effective up to the first frost.

G. Brown and an unidentified speaker from the Englehart Management Unit reported that kill of dense aspen was almost total after early- to mid-September treatment with 2,4-D; later spraying did not kill completely but retarded the aspen enough to let the pine come through, and this, suggested Brown, might be better silviculturally than a total kill.

Brown added that spraying of pine should not be undertaken until the terminal bud feels sharp to the finger. He has found that pine will not then be damaged by up to about 1.7 kg a.i./ha and while conceding that Day's figure of 2.24 kg a.i./ha might be all right, he, Brown, has levelled off at 1.40 kg a.i./ha after the terminal bud has become sharp.

An unidentified speaker wanted to know to what extent OMNR is responding to the public's objection to the use of herbicides.

Nolan said that in southern Ontario there has been essentially no adverse reaction to the use of simazine for establishing plantations even on private land under the Woodlands Improvement Act. The fact that the herbicide promotes the growth of the planted trees is a strong selling point.

In the north, J. Miller had seen no indication that tending had been reduced because of any public concern.

Miller was asked by Frisque what his opinion was on the use of growth inhibitors instead of herbicides for controlling competition in plantations. Miller replied that he had had no experience with the subject and had found so little about it in the literature that he had not included it in his paper.

Bax volunteered that the product called Krenite® was developed as a growth inhibitor, but it worked too well, and killed. Bax had no results yet from work already in hand, but "a lot of results" were available from work done in the United States.

*Planting in Relation to Existing Competition*

Flowers asked Nolan how he got planters to plant away from existing competition, since most planters tend to plant according to spacing.

Nolan replied that close supervision kept the problem within bounds; it did not add much to the hand cleaning and clipping required.

*Survival Rates in Plantations after 10-20 Years*

Information on survival rates in plantations 10, 15, and 20 years after planting was sought by C. Miller.

Markus (?) said that most districts would have such records and would be glad to make the information available.

G. Brown added that his oldest plantation was at Butler Lake, heading out to Iroquois Falls: it is about 21 years old. The next oldest plantations (just north of Waterbeag Lake) are 19 or 20 years old and these are the oldest of the pine plantations. They were planted by the Lowther Wildland Planter at about 2 400 trees/ha; fifth-year survival was 96-98%.

Perrin remarked that some mature plantations in southern Ontario were now being harvested and are surely successful according to the objectives of management.

# PERFORMANCE ANALYSIS

## [31] Monitoring Nursery Shipping Stock.

A. Wynia, Nursery Superintendent, Thunder Bay Forest Station, Ontario Ministry of Natural Resources, Thunder Bay, Ontario.

*Systematic sampling of nursery stock to be shipped to various tree planting operations can improve the documentation of newly established forests. Although the present monitoring program may be statistically imperfect, it serves to make field staff more cognizant of stock characteristics and provides the nursery with a means of quality control.*

*Some stock characteristics require much more intensive sampling than others to obtain data of comparable reliability. Also, different populations may vary widely.*

*At the Thunder Bay Forest Station, stock quality monitoring now involves sampling for dry weight, top:root ratio, root area index, compliance with culling rules, physical damage, and moisture stress. After the stock has been planted, this information is supplied to field officers for inclusion with permanent records.*

*Examples of data routinely collected are presented and concepts are explained.*

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*L'échantillonnage systématique des stocks de pépinières destinés aux divers lieux à reboiser peut améliorer la documentation sur les nouvelles forêts. Même si le programme actuel de surveillance est peut-être imparfait statistiquement, il sert à renseigner le personnel sur le terrain sur les caractéristiques des stocks et il donne aux pépinières un moyen de contrôler la qualité.*

*Certaines caractéristiques des stocks exigent un échantillonnage beaucoup plus intensif que d'autres pour obtenir des données d'une fiabilité comparable. De plus, les différentes populations peuvent varier de beaucoup.*

*A la Station forestière de Thunder Bay, pour suivre de près la qualité des stocks, on échantillonne le poids anhydre, le rapport entre les pousses aériennes et les racines, l'indice de surface des racines, l'observance des règlements régissant la mise aux rebuts, les dommages physiques et les effets de l'humidité. Après le plantage des stocks, on fournit ces renseignements aux agents forestiers sur le terrain qui les inscriront dans les registres permanents.*

*L'auteur cite à titre d'exemple des données recueillies de façon routinière et il explique certains concepts connexes.*

## Supporting Oral Presentation

Wynia expressed the opinion that performance analysis is the first thing that we should be concerned about: he was disappointed that the subject had not been mentioned during any of the discussions on planning. Wynia went on to say that he had established in his own mind that a comprehensive description of the nursery stock being planted should be a basic input into the plantation records. At the Thunder Bay nursery, the morphological characteristics and a few physiological characteristics are now routinely recorded according to a system being developed by Wynia. The present system, Wynia realized, is minimal, and he said he was anxious to receive constructive suggestions on how it might be improved.

Instead of going over the pre-distributed paper, Wynia handed out and discussed the paper "Results of stock quality monitoring on the Thunder Bay Forest Station 1976"[4]. A Planting Stock Shipment Record form accompanies every shipment of stock from the nursery. This form has headings for species, lifting date, packing date, seed lot number, stock condition, age, site region, compartment lifted from, number and type of containers, and number of trees shipped. That last item was the only information that Wynia used to receive in the field when taking delivery of planting stock--if he was lucky and remembered to ask the driver for it. Now, in 1976, 180 of these shipment record forms have been sent out. However, Wynia had subsequently found that more than 80% of the forms were incomplete, and yet there had been no word of complaint about the incompleteness, something, he stressed, that the unit foresters should be concerned about.

In guiding his audience through a complete record form, which would be the sheet the receiving forester gets from the truck driver, Wynia again emphasized that this is the link between the trees in the shipment and those that have been monitored in the nursery. In the example presented, the sampling was done on April 27. Three bundles of 25 trees were sampled. Wynia appreciated that the sample size may be inadequate. Only 73% of the trees in the sample were judged to meet all the OMNR standards under which the trees had been graded. There was no mention of the major defect, viz., smashed tops resulting from packing trees in boxes too small for them. Plant moisture stress was measured at the time of packing, and the number of degree days that had elapsed since the beginning of the shipping season was noted.

Wynia exhibited a number of seedlings of known root area index: one root system of 29 $cm^2$ RAI was "not very big", one of 41 $cm^2$ RAI was in the medium range: the only way to assess RAI is with an unbiased instrument. Such readings can be done quite quickly now, e.g., about 1,000 trees/day can be run through the machine at the Thunder Bay nursery. Wynia pressed the point that only by becoming familiar with the meaning of RAI values, etc., and relating the characteristics of the stock used to the results obtained can the unit forester determine the specifications of stock that give the best results in any given site conditions.

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[4] Available on request from the Information Office, Great Lakes Forest Research Centre, Box 490, Sault Ste. Marie, Ontario. P6A 5M7.

[32] The Improvement of Regeneration Through the Integration of Nursery Stock Monitoring and Plantation Quality Assessment.

K. M. McClain, Ontario Ministry of Natural Resources, Thunder Bay, Ontario and H. W. Anderson, Ontario Ministry of Natural Resources, Maple, Ontario.

*Forest regeneration practices in Ontario rely heavily on the planting of bare-root stock, which is expensive to produce. Although intensive efforts are made to secure successful plantations through good silvicultural decision-making, many failures suggest that, over all, the total regeneration effort lacks efficiency. This may be due to inadvertent discontinuities in, or segmentation of, the reforestation process.*

*To improve regeneration efficiency the Ontario Ministry of Natural Resources is embarking on a directed and integrated program of monitoring stock quality, the establishment procedures used, and the productivity of the plantations produced thereby. Because the quality of nursery stock and methods of handling, etc., affect the chances for initial survival and good subsequent growth, basic data on plantation performance should lead to a free two-way exchange of integrated information enabling the identification of deficiencies within the reforestation process. For example, ratings given to plantation performance could be used to guide the manner of future nursery stock production. Poor plantation survival and growth, if found to be a direct result of poor stock quality, would therefore suggest amendments to cultural, handling, and storage practices in the nursery. Likewise, poor plantation performance* not *attributed to stock condition prior to shipping would suggest close scrutiny of other factors such as transportation, field storing, planting method, choice of site, weather, etc.*

*The success of this integrated program of monitoring to improve regeneration success depends largely on a mutual and honest cooperation of all concerned with the reforestation process.*

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*La restauration forestière en Ontario repose en grande partie sur le plantage de dispendieux stocks à racines nues. Même si de grands efforts sont faits pour assurer le succès des plantations via de sages prises de décisions par les producteurs sylvicoles, de nombreuses faillites démontrent que, somme toute, l'effort global au chapitre de la restauration manque d'efficacité. Ceci, peut-être, est causé par l'intermittence involontaire du reboisement ou la fragmentation du processus de restauration.*

*Afin d'améliorer l'efficacité de la restauration, le Ministère de richesses naturelles de l'Ontario se lance dans un programme dirigé et intégré à la surveillance de la qualité des stocks, de l'établissement*

*des méthodes employées et de la productivité des plantations ainsi produites. Parce que la qualité des plants de pépinières, les méthodes de manipulation, etc., réduisent les chances de survie et la bonne croissance ultérieure, des données de base sur le rendement des stations devraient conduire à un libre échange aller-retour de renseignements complets pouvant identifier les déficiences au sein du processus de restauration forestière. Par exemple, l'estimation qu'on accorde au rendement d'une plantation pourrait guider la manière de produire de futurs stocks de pépinière. Une survie et une croissance médiocres des plantations, si elles étaient le fruit direct d'une pauvre qualité des stocks, inciteraient à proposer des changements dans les pratiques sylvicoles, de manipulation et d'entreposage en pépinière. De même façon, un rendement inférieur dans une plantation* non *attribuée à l'état des plants avant leur expédition suggérerait un examen minutieux d'autres facteurs comme le transport, l'entreposage sur le terrain, les méthodes de plantage, le choix de la station, le climat, etc.*

*Le succès de ce programme intégré de surveillance étroite pour améliorer le succès de la régénération dépend pour beaucoup d'une coopération mutuelle et honnête entre toutes les personnes qu'intéresse le processus de restauration forestière.*

## Supporting Oral Presentation

Speaking for himself and coauthor Anderson, McClain began by explaining that their paper had been written to help bridge gaps in the regeneration program that have contributed to inefficiency and inconsistent results ranging from total failure to overwhelming success. McClain fully supported the rejection of negativism and called for its replacement by positive, constructive attitudes toward the regeneration program. What he and Anderson offered, said McClain, was the idea that the solution lies in a strong and continuing effort to integrate the data base from the current programs of nursery stock quality monitoring, as described by Wynia, with the plantation quality assessments. Such integration would foster a two-way exchange of information that would benefit the whole regeneration program. The data from nursery stock monitoring and plantation quality assessments would be used to determine the relative quality of planting stock raised under given cultural prescriptions.

McClain stressed that in the final analysis successful integration of the nursery and field assessment programs would depend largely on the willingness of the field and nursery foresters to work together. Integration and cooperation together are the key.

[33] Analysis of Young Stage of Plantation Establishment.

S. Kim, Forest and Field Service Supervisor, Ontario Ministry of Natural Resources, Maple, Ontario

*The objective of a newly established program of monitoring artificial regeneration performance in the Ministry's North Central and Northwestern regions is to develop quantitative measures of factors influencing plantation establishment, thereby enabling the forester to improve the probability of success of his prescription for plantation survival and performance. During the last three spring planting periods, District tree planting operations have been monitored on 37 sites. Sample plots of 0.04 ha (0.1 acre) were used to evaluate performance on the basis of site, species, quality of nursery stock, quality of handling, and quality of planting.*

*First-year mortality of 0 to 25% was attributed to poor planting, 0 to 12% to poor handling. Transplant survival was about 10% higher than seedling survival. Site preparation improved survival by about 10%.*

*It was concluded that vigorous application of current knowledge needs to be emphasized in regeneration programs, that the biological requirements for survival and growth of planting stock must be met in the nursery and that subsequent treatment must not cancel out the salutary effects of nursery treatment. This is essential for success in plantation establishment.*

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*Dans un programme de surveillance du rendement de la régénération artificielle établi récemment dans les régions centre-nord et centre-ouest sous la responsabilité du Ministère de richesses naturelles de l'Ontario, on s'emploie à mettre sur pied des mesures quantitatives qui touchent les facteurs pouvant influer sur l'établissement d'une plantation. Par ce moyen, le forestier pourra améliorer la probabilité de succès quant à la survie et au rendement de la plantation prescrits. Au cours des trois derniers printemps, les opérations de plantage du District ont été suivis de près en 37 stations. Pour évaluer le rendement, on a utilisé des placette-échantillons de 0.04 ha (0.1 acre) en se fondant sur la station, sur les essences d'arbres, sur la qualité des stocks de pépinières, de la manutention et du plantage.*

*Une mortalité de 0 à 25% la première année fut imputée à un plantage médiocre, alors que 0 à 12% furent attribués à une mauvaise manutention. La survie des plants repiqués fut de 10% supérieure à celle des semis. La préparation de la station améliora la survie d'environ 10%.*

*En conclusion, l'application rigoureuse des connaissances actuelles devra être accentuée dans les programmes de restauration forestière; et, les exigences biologiques pour la survie et la croissance du matériel de reproduction doivent être satisfaites en pépinière; aussi, les traitements ultérieurs ne doivent pas éclipser les effets salutaires des traitements reçus en pépinière. Tout cela est essentiel au succès de l'établissement des plantations.*

## Supporting Oral Presentation

Kim's message was conveyed largely through the medium of colored slides. He had examined the care and handling of planting stock during the last three spring planting seasons and had found a range of quality control from very poor to very good.

He emphasized three points: the mistakes now being made in tree planting are the same mistakes that were being made 20 years ago; vigorous application of current knowledge and common sense is needed in every phase of plantation establishment; the organization of the program has to be structured to provide for, support, and ensure a successful regeneration program.

In commenting on one slide, Kim observed that after being told that tree planting spacing was 6 ft x 6 ft, or roughly 1000/acre, examination of 0.1 acre plots revealed that spacings varied between 600/acre and 2 200/acre.[5] Also, he added, some naturally regenerated areas had been planted, an obvious waste.

Kim also remarked on the great variability in size of *graded* stock. He illustrated this very clearly, and it is a point of considerable significance if attempts are going to be made to relate nominal stock grades to field performance.

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[5] 1 ft = 30.48 cm
1 acre = 0.40 ha

[34] Growing the Second Forest in Ontario - Views from the Grass Roots and the Ivory Tower.

K. W. Hearnden, Chairman, School of Forestry, Lakehead University, Thunder Bay, Ontario.

*A recent survey of the experience and opinions of 45 Ontario Ministry of Natural Resources foresters and technicians and forestry students suggests that significant problems are being encountered in all phases of the bare-root tree planting program. Qualitative deficiencies are attributed chiefly to the stresses created by pressures for the attainment of production objectives.*

*Suggestions from the respondents for improvement of the program included abandonment of the piece-rate system, the use of larger transplant stock, the provision of adequate storage facilities in the field, and a reduction of the scale of the program by expanded application of natural regeneration techniques.*

*From an "ivory tower" viewpoint, the provincial high-cost artificial regeneration program should be redirected and concentrated on private, municipal and Crown lands in strategic zones within close range of wood-using plants. Beyond these zones, minimum-cost silvicultural methods should be implemented to secure natural regeneration on the fragmented complexes of sites characteristic of much of the boreal region.*

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*Une étude récente, fondée sur l'expérience et les opinions de 45 forestiers et techniciens du Ministère des richesses naturelles de l'Ontario et d'étudiants en foresterie montre que de sérieux problèmes sont envisagés dans toutes les étapes du programme de transplantations d'arbres à racines nues. On attribue les déficiences qualitatives principalement aux contraintes créées par les pressions imposées pour atteindre certains objectifs de production.*

*Les apôtres du programme d'amélioration ont suggéré entre autres choses l'abandon du système de taux à l'unité, l'emploi de plants plus gros, la fourniture d'installations d'entreposage appropriées sur le terrain, ainsi qu'une réduction de l'envergure du programme par l'application accrue de méthodes de régénération naturelle.*

*Celui qui "se tient en haut de la tour d'ivoire" propose que le programme provincial de régénération artificielle, fort onéreux, devrait être réorienté et concentré sur des terres privées, municipales ou de la Couronne, dans des zones stratégiques sises à proximité des usines de transformation du bois. Au-delà de ces zones, on devrait élaborer des méthodes sylvicoles à coût minimum afin d'assurer la régénération naturelle dans des zones ou bassins versants différents qui caractérisent une grande partie de la région boréale.*

## Supporting Oral Presentation

Hearnden noted that his paper was essentially in two parts. In the first part, he had recorded what seemed to be rather strong sentiments expressed by unit foresters, forestry technicians, and forestry students, on various aspects of the reforestation program. He did not intend to defend those remarks, although they could be debated during later discussion.

The second part provided an Ivory Tower viewpoint: well removed from many of the day to day problems confronting the field forester and technician, Hearnden could see a number of problems related to the regeneration program. First there were the problems arising from the separation of logging from silviculture. As long as timber harvesters can continue to operate in the manner they have been accustomed to for the past 50 years, cleaning off those parts of stands for which they have a ready market and leaving in some cases incredible volumes of residual wood, standing and fallen, we can expect severe difficulties in reforestation.

Hearnden thought that the organization of the forestry effort in Ontario is irrational, illogical and does not provide incentives for serious, properly directed, sustained yield management, of which regeneration is one part.

Also, there is a serious problem in the matter of professional and technical manpower. The numbers are hopelessly inadequate, Hearnden continued, especially when coupled with the consequences of reorganization of the former Department of Lands and Forests which led to a serious vacuum, a miniscule number of practitioners at the base of the pyramid. He believed that Armson in his recent report had indicated that there were a mere 88 unit foresters in Ontario. Difficulties with the reforestation program are going to continue unless realistic working circles are established under adequate professional and technical direction.

Hearnden suggested that rather than continue the present shotgun attack on the problems of forestry, perhaps it is time to concentrate efforts on productive areas close to the mills. Around the mills in Thunder Bay, for instance, Hearnden sees a vast area occupied by very inferior poplar, open fields, and junk balsam fir extending for miles from the mills. In spite of the serious problems that lie in the way of getting those lands back into useful production, the forestry profession cannot ignore what are in many cases the most productive sites for forestry purposes and yet blindly go on planting, up to 300 km from the mills, in scattered locations all over the vast areas that are cut over each year. We all need to be concerned about the preoccupation with *numbers*, hectares planted, trees produced, etc. This seems to be almost an end in itself, and too often, said Hearnden, he sensed a desperate feeling among the respondents of Part I, of needing to get the annual sorcerer's apprentice flow of planting stock from the nursery into the ground *somewhere*.

Finally, Hearnden stated that he would definitely not support any move to put more money into the regeneration program under present conditions. It would be a very big mistake to plow more public money into the existing organization. Attention must be turned to providing a basic framework within which sustained yield management, including reforestation, can be entertained.

[35] Labor: The Key to Ontario's Silvicultural Program.

D. E. Ketcheson and J. H. Smyth, Economists, Department of the Environment, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario.

*Availability of labor in the right place at the right time is the key to success in any silvicultural program. On the basis of Ontario's estimates of the total area to be treated annually in the province to the year 1982-1983, the demand for labor for regeneration alone is forecast to increase by 66% to 191 000 man-days in 1982-1983 from 115 000 in 1973-1974. Most of this demand is expected to be centred in northern Ontario. However, demographic studies show that population growth in northern Ontario over the next 30 years will be slow. Several districts in the region are currently showing marginal decreases in population. Examination of the age class distribution for northern Ontario shows that, in 1986, 31% of the population will be between the ages of 25 and 44, 24% between 5 and 19, 17% between 45 and 64 and 9% between 20 and 24. On the surface it appears that persons 15-24 years of age represent the potential supply of silvicultural workers; however, the combined age group classes of 5-19 and 20-24 are forecast to decline from 42% of the total population in 1971 to about 34% in 1986. Expansion and development of the primary resource industry in the region, coupled with other interacting factors, suggest strongly that sufficient labor may not be readily available for the level of silvicultural activity proposed.*

*La réussite de tout programme sylvicole repose sur la disponibilité de la main-d'oeuvre au bon moment et au bon endroit. Selon les évaluations de la superficie totale à traiter annuellement en Ontario d'ici 1982-1983, la demande de main-d'oeuvre au seul chapitre de la restauration forestière sera, prévoit-on, augmentée de 66% pour atteindre 191 000 jours-hommes en 1982-1983, de 115 000 qu'elle était en 1973-1974. On prévoit que la plus grande partie de la demande proviendra de l'Ontario septentrional. Toutefois, les études démographiques montrent que l'accroissement de la population dans le nord*

PERFORMANCE ANALYSIS

*de cette province sera lent au cours des 30 prochaines années. On constate déjà un déclin marginal de la population dans plusieurs districts de la région. Si on examine la distribution des catégories d'âges dans l'Ontario nord, on trouvera qu'en 1986, 31% des habitants seront âgés de 25 à 44 ans, 24% de 5 à 19 ans, 17% de 45 à 64 ans et 9% de 20 à 24 ans. Superficiellement, il semble que les personnes ayant entre 15 et 24 ans représentent la source potentielle des futurs travailleurs sylvicoles; cependant, les groupes d'âges entre 5-19 et 20-24 ans, combinés, déclineront, selon les prévisions, de 42% de la population totale de 1971, à 34% en 1986. L'expansion et le développement de l'industrie primaire dans la région, associés à d'autres facteurs à l'action réciproque, indiquent fortement que la main-d'oeuvre nécessaire pourrait bien ne pas être disponible facilement pour atteindre le niveau des activités sylvicoles qu'on s'était proposé d'atteindre.*

## Supporting Oral Presentation

The presentation supporting Ketcheson and Smyth's paper was given by the senior author. He pointed out that labor costs are the largest single item in the OMNR silvicultural budget, almost 70% of 1973-1974 expenditures. Of this amount, 82% was for casual labor. Thus labor, and especially casual labor, is extremely important to the silvicultural program. Even with refined techniques and development of mechanized silvicultural systems, labor will remain the most important element in the program.

On the basis of OMNR production targets, demand for casual labor for silviculture is expected to increase 66% by 1982-1983, an amount equivalent to about 800 man years. The demand is expected to be greatest in northern Ontario.

Turning to the supply of casual labor, Ketcheson noted that the overall determinant of supply in an area is the population base. The population of northern Ontario is expected to grow very slowly in the foreseeable future: the large urban centres will grow but the population of outlying areas is expected to decline.

With a given population, the labor available for silvicultural work depends on the portion of the work force that is available for seasonal employment, the persons able to do physical labor, and, perhaps most important, the persons willing to work in cutovers.

Silvicultural labor is less available now than in the past, Ketcheson suggested, because people's expectations have changed with respect to jobs. Social welfare programs tend to reinforce these changing expectations by relieving some of the problems of unemployment.

The conclusion to be drawn from all this is that silvicultural labor will probably not be available in the required amount from traditional sources.

The major implication seen by Ketcheson and Smyth is that the population base will have to be expanded. This means that labor must be imported into northern Ontario. It also means that the cost of labor will continue to increase rapidly. The highest priority should be given to efficient utilization of labor.

Increasing pressures will be put on the forest industry to carry out more silvicultural operations. This will further aggravate their labor supply problems.

Labor intensive silviculture will have to be concentrated in areas relatively close to the larger centres of population. Extensive management will be the rule in the remoter areas.

If adequate recruiting programs are not brought forward, the silvicultural program will *never* reach the stated targets.

[36] Performance Assessment and Policy in Plantation Establishment.

F. B. Armitage, Director, Production and Environmental Forestry Branch, Department of the Environment, Canadian Forestry Service, Ottawa, Ontario.

*Performance assessment is the measurement of success in achieving objectives. It is undertaken at the several levels of the management hierarchy with different degrees of focus and patterns of emphasis. Review of plans and strategies in relation to goals set is a prerequisite for more detailed assessment of technical results. Success at this level is worthless if not oriented to achievement of the overall objective.*

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*L'évaluation des résultats équivaut à la mesure du succès (atteindre les objectifs). On l'entreprend à plusieurs niveaux de la hiérarchie de la Direction, selon différents points de vue. Une révision et une meilleure vision des plans et stratégies relatifs aux buts visés sont nécessaires à l'évaluation plus détaillée des résultats sur le plan technique. Le succès à ce niveau sera sans valeur s'il ne s'oriente pas vers la réalisation de l'objectif global.*

## Supporting Oral Presentation

Armitage's first point was that everyone attending the symposium is involved in some way with performance assessment. In the short time allowed, he would simply make a few general statements and discuss a few general concepts.

Performance assessment in the simplest form is undertaken to measure the extent to which the objectives of the agency or program are being achieved. It is undertaken to ascertain whether the resources deployed, and for which we are responsible, are being put to effective use in terms of the objectives. It is a *tool* that helps us uncover weaknesses so that we can do something about them.

Performance assessment is undertaken at successive levels in the management hierarchy. It is applied therein to different parts of the program according to the function of the assessor, and focuses with varying degrees of sharpness on specific features or jobs within the program.

In such assessments, we focus first on objectives and on the strategies that have been selected to achieve the objectives. Next, we are concerned with the definition of the standards that are to be achieved in economic, physical, and biological terms if the program or job is going to be carried out successfully. Then we break down the operation into identifiable components that make possible the necessary analyses. The tools for this are assessment criteria and procedures, and very often, Armitage noted, we are involved in developing these ourselves.

But performance assessment is not simply an audit undertaken at the end of a program. It is also concerned with many of the intermediate phases. Performance assessment is an integral part of the management function. Properly done, it forces us to enunciate objectives clearly and encourages the exercise of good judgment in selecting strategies that are the most economically, biologically, and physically appropriate for attaining the objectives.

When tackling a job such as stand establishment, Armitage continued, we must, of course, set and achieve high standards. But we must make sure that we decide on the right courses of action. To take a simple example, a high degree of success in producing nursery stock and in outplanting it would be fruitless if planting were not economically or biologically the sensible course to take and natural or direct seeding were the appropriate course.

Performance analysis, concluded Armitage, is not simply a matter of, for example, counting the number of established seedlings per unit area, necessary as it is to do that from time to time. It is a much broader, more critical process of assessing results in economic, physical, and biological terms, in relation to the objectives of management. The sorts of question that we must ask ourselves are: What was the goal? Did we, or are we going to, achieve it? Where did we go wrong? Where could we have done better? Did we choose the most appropriate strategies? Did we go at the job in the best way?

## Discussion

*Regeneration Program Shortcomings*

This discussion period opened with an observation by Flowers that the comments by unit foresters, etc., reported in the first part of Hearnden's paper would seem to be a serious self-condemnation. Most factors, Flowers said, were under their own control, and most of them seemed to blame others for their own shortcomings.

Responding, Hearnden said that the sampling of opinions had not been randomized. A questionnaire was sent out to people known to him and to School of Forestry staff, and to other people who volunteered to respond. A strong negative skew to the attitudes expressed in the replies could not be ruled out, but he could not say whether some of the complaints were directed against situations that were under the control of the unit forester.

G. Brown said that he had been a little upset on reading about the questionnaire in Hearnden's paper because of the immaturity of the respondents. It had taken Brown about 5 years just to get to know his unit let alone to decide how he wanted to manage it. How could Hearnden make those assumptions about the grass roots when the respondents had so little experience?

Hearnden assured Brown that the respondents included some "rather veteran technicians and foresters".

On a related matter, Innes asked Hearnden what chance he saw of Ontario formulating an effective forest policy before the supply of wood runs out, in view of the absence of historical precedent of any country making a firm political commitment to a coherent forest management policy while there is still wood. Hearnden thought the chances were not very good. He added that to discuss the question at this symposium was a case of preaching to the converted.

*Educational Standards*

Prefacing his question with the observation that Hearnden's association with the education of foresters and technicians made Hearnden indirectly responsible for the grass roots part of plantation establishment, Shannon questioned the standards set by colleges: if technicians at the end of their instruction are unable to distinguish between black spruce and white spruce, are not standards too low? Should not emphasis be placed on quality rather than on quantity?

Hearnden replied that existing standards are high enough to fail at least 30% to 40% of first-year candidates at first attempt. The staff is unanimous about the need for maintaining high standards. The

School of Forestry has no rule such as he understood to exist in high schools whereby the pass rate must be 90%, so that screening and examining are rigorous. The staff is opposed to the pressures that exist in the post-secondary system to accept large numbers of candidates for the School's program. The pressures are generated as a result of the official Ontario government policy of rewarding the universities and expanding their budgets in direct relation to the number of students admitted. It happens, Hearnden continued, that the forestry program at Lakehead University is at present very popular among high school leavers: 90 first-year candidates were being admitted into each of the technology program and the degree program. This was a fraction of the applicants. The university administration would like to see numbers rise somewhat because every degree candidate is worth about $4 600 the first year, but the school manages to put up a fairly good argument for restricting numbers. Hearnden agreed with Shannon that it would be best to keep numbers down. Anyone unhappy with the pressures to increase numbers might pass a resolution down to the Ministry of Colleges and Universities and the Premier of Ontario.

*Provincial Hiring Practice*

Shannon also asked for an explanation of the reasoning behind the practice of laying off technicians from the provincial payroll and absorbing them into the federal payroll. Was there not enough work that could be done during the winter months to give these people full-time employment?

Hearnden commented that many graduates from the Lakehead University School of Forestry had complained bitterly about the OMNR practice of annual laying off because they do not like going on unemployment insurance every year for a number of years until they are absorbed into the permanent staff. The practice is demoralizing and it persuades many good people to seek other employment. The practice, Hearnden supposed, results simply from the freeze on the size of the civil servant labor force.

Wynia saw the situation as part of the seesaw battle in manipulating people. The unions represent only permanent employees and push for getting seasonal employees accepted on the permanent staff. The government has a policy of constraint. This pushing around of people is demoralizing for all concerned, Wynia said, but the practice of laying off seems to be the only administrative solution that can be found during this period of constraint. Wynia added that these were his personal opinions, not OMNR policy.

*Needless Planting*

Kim's point about some areas being needlessly planted when natural regeneration was already adequate was taken up by Ferdinand who wanted to know how often this occurred. Kim replied that his data showed that it had occurred on 4 out of 37 areas, i.e., about 10%. Satisfactory stocking was on the basis of desirable species only: poplars, large numbers of which appear on many sites, were not counted.

Ferdinand asked further whether the errors in pre-planting stocking assessment were due primarily to inadequate attention by field personnel or to the regeneration survey method.

The problem, Kim said, was multifaceted. Handling was the basic problem, with supervisors sometimes negligent, and the organizational structure sometimes inappropriate.

*Labor Supply*

Ketcheson and Smyth's paper drew considerable comment.

Innes set the ball rolling when he asked Ketcheson what degree of confidence could be placed on the forecast levels of available labor.

The background was sketched by Ketcheson. He had been thinking about labor supply for a long time, and when he looked to find out just how well documented the problem is and where and why it is occurring, he discovered that "it was a wide open field for generality". He put together a few statistics to see what sort of picture could be drawn. The kind of statistics that he and Smyth used in their paper were more illustrative than substantive, but Ketcheson hoped the topic was one that OMNR and other organizations concerned with forest management will look at seriously.

Innes wondered whether, given more time to study the problem, Ketcheson and Smyth could sharpen up the forecast and increase confidence in it. Ketcheson thought that improvements were certainly possible.

*Mechanization and Labor*

Vyse asked Ketcheson about the possibility of solving the labor problem by mechanization.

Ketcheson replied that mechanization might reduce the demand for labor in forestry between 10% and 15%, but that it wouldn't solve the labor problem. Mechanization, he thought, did not have that much to offer within the period in which the problem is likely to become critical. Mechanization may actually aggravate the problem: the suggestion has been made that if all the easy sites are planted by machine, hand planting becomes so unattractive that labor cannot be found to do it. This illustrates his view, Ketcheson said, that mechanization is not going to be a panacea.

Burger, however, argued that mechanization offers great possibilities in forestry just as it already does in agriculture and horticulture. A good look should be taken at the many sites on which mechanization could be used.

Ketcheson did not disagree with that, but he repeated his view that mechanization would not solve the problem of labor supply. In many ways the problem in the forest industry has been shifted from finding labor to finding highly trained labor.

The availability of data on the productivity of labor as compared with the productivity of capital in the logging industry was mentioned by Armson. He thought he recalled that whereas the productivity of labor had increased very significantly the productivity of capital had not.

On this question of effectiveness in the use of capital, Burger observed that everything is related to everything else. The interrelationship between logging and regeneration should be kept in mind, and the investment in the machine-oriented logging operations should be tied in with--and evaluated for possible application to--mechanization in reforestation.

Miller commented on the question of parallelism between mechanization for reforestation and mechanization for harvesting. He said that although good progress has been made in the latter, problems remain, especially in relation to multifunction machines. Also it has become very obvious that there has been quite a shift in the labor input towards maintaining and supplying the machines to keep them operating. It is abundantly evident that if workers do not have a proper attitude toward the machines they operate then the problems in maintaining and using them are multiplied tremendously to the point that many of the machines become almost uneconomical as a replacement for hand labor in some basic woods operations.

Ketcheson added a comment on the widespread belief that machines can solve all labor management problems. This is done under the guise of increased productivity and decreased cost, but in many instances increased technology means increased costs.

The extent of mechanization in silviculture is far greater than was apparent from the discussions, said Robinson, perhaps because of the type of symposium. Planting is only one aspect, and OMNR has a large program of seeding that is almost completely mechanized. Also being developed is a program in black spruce with strip cutting and scarification by machine for regeneration.

Ketcheson countered that such programs were not solving the labor problem. He agreed that if all regeneration had to be done by planting then the situation would be even worse. Also, with strip cutting, for instance, the problem is merely transferred from OMNR to the companies.

*Location of Planting Effort*

Noting that Hearnden had called for regeneration to be concentrated away from remote areas, and that OMNR has been able to get only 60% survival and poor to fair growth after high-cost planting, Robinson suggested that perhaps this record should be improved before moving planting operations closer to centres of population and public judgment.

Hearnden thought that it should be possible to achieve reasonable success with planting provided that problems deriving from the pressures for expansion are abated.

*Carrying Out Policy*

Gilmore, directing the question to Armitage, asked what would constitute suitable rewards and punishments to ensure that a given policy and the resultant guidelines were followed.

Armitage replied that if a person is employed in a system that is set up to carry out policy, some kind of contract is established. The person will expect a living at some level in return for some level of input. Armitage added that he would like to think professional attitudes will persist for some considerable time in the forestry profession. People will enter this field with at least a degree of idealism in their makeup and a motivation to contribute. Given that, a wide range of possibilities by way of rewards will be possible. Without that, the future would seem to be rather hopeless.

Kokocinski observed that in Poland and some other European countries, the wages of unit foresters are assessed on the basis of the success or failure of their regeneration programs. Now, possibly this system of basing reward on achievement would not work here but..., concluded Kokocinski.

Accountability was the topic picked up by Bax. From his experience as consultant and contractor, Bax faced accountability at a high level. If a contractor does not do a job properly, he will not remain a contractor. Robin Brown had referred to quality standards as developed in British Columbia: if those standards are reasonably attainable and no payment at all is made unless a quality standard of at least 75% is achieved, then Bax would guarantee that the job is going to be done properly. Otherwise that contractor will not remain in business. Bax did not know how that sort of reward and punishment could be introduced into organizations such as OMNR, but he stressed that accountability must not be neglected.

*Organization*

Hearnden's criticism of the gulf between harvesting and regeneration prompted Yeatman's question regarding the justification for a separation of objective, function, and administration between protection and management in the forestry branch.

The question received no direct answer, but Armson quoted Fernow's epigram: "Protection bears that same relation to silviculture as the fire department to the practice of architecture."

*Integration of Data*

McClain was asked by Navratil to elaborate on the mechanism he envisaged for the proposed data integration system. Who would be doing the actual work? Would it create more paper work for the field people? Also, does the Research Branch have the capacity to handle such a large program?

The question of integrating plantation assessment and nursery stock quality, replied McClain, is not new, but he believed that it is now time to attempt an initial program. He would expect to have two basic units, one in the nursery, one in the field. Ratings given to plantation performance would ultimately be used to guide the manner of nursery stock production. Poor plantation survival and growth, if found to be a direct result of poor stock quality, would suggest amendments to nursery cultural practices. Quality control work would be carried on very closely with nursery superintendents. The plantation quality control monitoring group would expand on the work of Kim and Clark.

If we can define what happens in the field, continued McClain, and if we can relate field performance to what has gone on in the nursery, then increasingly effective planting stock can be grown.

Research must provide good descriptive tools initially, McClain said, and the Research Branch has the ability to do so at this time.

Navratil objected that a province-wide program would be large, but McClain pointed out that the regeneration program is large and therefore the integration program would eventually have to be large. Sutton commented that there would be no need to try to begin a large program all at once. Much valuable information and insight could be obtained from selective monitoring from the nursery through to plantation establishment. Sutton hoped that the program would be built up from there as its usefulness became apparent.

*Monitoring and Documentation*

The discussion of integration led to questions about monitoring in general. Innes was concerned about collecting data for no purpose. Myland, too, thought that although monitoring is a good idea, much of it is a waste of time.

Wynia, however, spoke strongly in favor of monitoring and documenting significant characteristics of nursery stock and supplying that information to the unit foresters. Such information is vital to an appreciation of stock performance in the field. The unit foresters are going to have to decide what sorts of stock they need, and their requirements will have to be based on data from monitored stock. If we do not keep track of our stock, where it comes from, where the seed comes from, how it survives, where it is planted, etc., how then can reasons for plantation failure be found and the problems rectified? McClain and Sutton were in complete agreement with Wynia's argument.

Armitage spoke against keeping useless records. But as Wynia pointed out, a low percentage usefulness is no justification for dispensing with records altogether. This point was reinforced by Kokocinski who told of problems faced in the tree improvement program: basic information such as seed source is often lacking for plantations, established say 15 years ago, that have been proposed as seed production stands. Without seed source data, the plantation has to be rejected. There is no substitute for documentation.

*Double Leader Acceptability*

Taking advantage of the opportunity, Wynia conducted a spot check to determine to what extent double leaders in white spruce and black spruce are acceptable among unit foresters. He obtained the following result:

| | Medium | | Large | |
|---|---|---|---|---|
| | Yes | No | Yes | No |
| White spruce | 2 | 3 | 2 | 8 |
| Black spruce | 5 | 6 | | |

The medium white spruce and the black spruce stock could presumably be used in pulpwood plantings, large white spruce in sawlog plantings.

# APPENDIX

# APPENDIX

## REGISTERED ATTENDANCE
## AT THE PLANTATION ESTABLISHMENT SYMPOSIUM

B. Aho
Ontario Ministry of Natural Resources
Atikokan, Ontario POT 1C0

A. A. Alm
University of Minnesota
Cloquet Forestry Center
Cloquet, Minnesota 55720

B. Altman
Ontario Ministry of Natural Resources
Box 5080
Kenora, Ontario
P9N 3X7

D. Anderson
Ontario Ministry of Natural Resources
Box 323
Red Lake, Ontario
POV 2M0

F. B. Armitage
Environment Canada
Canadian Forestry Service
Ottawa, Ontario
K1A 0H3

K. A. Armson
Faculty of Forestry and Landscape Architecture
University of Toronto
203 College St.
Toronto, Ontario
M5S 1A1

H. A. Bax
KBM Forestry Consultants
115 N. Cumberland St.
Thunder Bay, Ontario
P7A 4M3

L. W. Bennett
The Ontario Paper Co. Ltd.
25 Cedar St. North
Timmins, Ontario
P4N 6H8

P. K. Bidwell
Ontario Ministry of Natural Resources
Box 670
Hearst, Ontario
POL 1N0

C. Boddy
Eddy Forest Products Ltd.
Espanola, Ontario
POP 1C0

G. Bragg
Ontario Ministry of Natural Resources
Box 730
Cochrane, Ontario

R. O. Brandes
Ontario Ministry of Natural Resources
Box 3000
Cochrane, Ontario
POL 1C0

P. Brook
Ontario Ministry of Natural Resources
Box 250
White River, Ontario
POH 3G0

G. Brown
Ontario Ministry of Natural Resources
Box 5160
Kenora, Ontario
P9N 3X7

R. Brown
Reforestation Division
B.C. Forest Service
Victoria, British Columbia
V8V 1X5

M. Buck
Ontario Ministry of Natural
Resources
Box 460
Chapleau, Ontario
POM 1KO

W. R. Bunting
Ontario Ministry of Natural
Resources
Box 119
Orono, Ontario
LOB 1MO

D. Burger
Forest Research Branch
Ontario Ministry of Natural
Resources
Maple, Ontario
LOJ 1EO

D. A. Cameron
Great Lakes Forest Research Centre
Box 490
Sault Ste. Marie, Ontario
P6A 5M7

A. J. Campbell
Ontario Ministry of Natural
Resources
Brockville, Ontario
K6V 5Y8

B. Campbell
Ontario Ministry of Natural
Resources
Box 670
Hearst, Ontario
POL 1NO

G. Campbell
Ontario Ministry of Natural
Resources
Box 190
Blind River, Ontario
POR 1BO

R. Campbell
Forest Management Branch
Ontario Ministry of Natural
Resources
Parliament Buildings
Toronto, Ontario M7A 1W3

L. W. Carlson
Canadian Forestry Service
Northern Forest Research Centre
5320 - 122nd Street
Edmonton, Alberta
T6H 3S5

O. R. Carlson
Ontario Ministry of Natural
Resources
Atikokan, Ontario
POT 1CO

J. H. Cayford
Great Lakes Forest Research
Centre
Box 490
Sault Ste. Marie, Ontario
P6A 5M7

J. Christian
Ontario Ministry of Natural
Resources
Box 1340
Espanola, Ontario
POP 1CO

A. Citro
Mechanical Research
Ontario Ministry of Natural
Resources
Maple, Ontario
LOJ 1EO

R. Clarke
108 Robinson Drive
Thunder Bay "P", Ontario

W. H. Collins
Algonquin College
315 Pembroke St. E.
Pembroke, Ontario
K8A 3K2

A. Corlett
Ontario Ministry of Natural
Resources
Box 239
Lanark, Ontario
KOG 1KO

D. Curran
Ontario Ministry of Natural
Resources
Box 730
Cochrane, Ontario POL 1CO

M. A. Dancause
Department of Lands and Forests
Quebec, Quebec

R. J. Day
Department of Forestry
Lakehead University
Thunder Bay, Ontario
P7B 5E1

A. J. Denys
Ontario Ministry of Natural
Resources
Metcalfe St.
Tweed, Ontario
KOK 3J0

D. Deugo
Ontario Ministry of Natural
Resources
Box 1138
Bracebridge, Ontario
POB 1CO

P. Devillers
Ontario Ministry of Natural
Resources
Box 730
Cochrane, Ontario POL 1CO

T. Dolhy
Ontario Ministry of Natural
Resources
Box 38
Temagami, Ontario
POH 2HO

R. H. Dunne
Ontario Ministry of Natural
Resources
Box 460
Chapleau, Ontario
POM 1KO

A. Erickson
Ontario Ministry of Natural
Resources
Swastika, Ontario
POK 1TO

H. G. Faulkner
Frost Campus
Sir Sandford Fleming College
Box 8000
Lindsay, Ontario
K9V 4S6

D. C. F. Fayle
Ontario Ministry of Natural
Resources
Maple, Ontario
LOJ 1EO

G. C. Felton
Ontario Ministry of Natural
Resources
4 Miller St.
Parry Sound, Ontario
P2A 1S8

S. I. Ferdinand
Timber Management Branch
Alberta Forest Service
Energy and Natural Resources
200 Natural Resources Bldg.
9833 - 109 St.
Edmonton, Alberta
T5K 2E1

B. Ferguson
Ontario Ministry of Natural
Resources
922 Scott St.
Fort Frances, Ontario
P9A 1J4

J. F. Flowers
Ontario Ministry of Natural
  Resources
Box 5000
Thunder Bay, Ontario
P7C 5G6

L. J. Forcier
Ontario Ministry of Natural
  Resources
Swastika Nursery
Swastika, Ontario P0K 1T0

G. Frisque
Laurentian Forest Research Centre
Box 3800
Ste-Foy, Quebec
G1V 4C7

R. C. A. Gilbert
Ontario Ministry of Natural
  Resources
Beaverdale Road
Cambridge, Ontario
N3C 2V3

J. Gilham
Ontario Ministry of Natural
  Resources
Chapleau, Ontario
P0M 1K0

W. C. Gilmore
Ontario Ministry of Natural
  Resources
1106 Dearness Drive
London, Ontario
N6E 1N9

A. Glatz
Ontario Ministry of Natural
  Resources
Box 640
Dryden, Ontario
P8N 2Z3

C. Glerum
Forest Research Branch
Ontario Ministry of Natural
  Resources
Maple, Ontario
L0J 1E0

C. R. Groves
Ontario Ministry of Natural
  Resources
Midhurst Forest Tree Nursery
Midhurst, Ontario
L0L 1X0

D. Gummer
Ontario Ministry of Natural
  Resources
Box 1160
Wawa, Ontario
P0S 1K0

R. A. Haig
Great Lakes Forest Research Centre
Box 490
Sault Ste. Marie, Ontario
P6A 5M7

R. Hakala
13295 Bristol
Pierrefonds, Quebec
H9A 1L2

S. Hambly
Research Division
B.C. Forest Service
Parliament Bldgs.
Vancouver, British Columbia

K. W. Hearnden
Department of Forestry
Lakehead University
Thunder Bay, Ontario
P7B 5E1

J. Heikurinen
Ontario Ministry of Natural
  Resources
174 Douglas St. W.
Sudbury, Ontario
P3E 1G1

A. Henderson
Ontario Ministry of Natural
  Resources
Box 3070
North Bay, Ontario
P1B 8K7

H. J. Henry
Ontario Ministry of Natural Resources
Box 9000
Huntsville, Ontario
P0A 1K0

J. D. Henson
Leslie M. Frost Natural Resources Centre
Ontario Ministry of Natural Resources
Dorset, Ontario
P0A 1E0

F. J. Hermer
Sir Sandford Fleming College
Frost Campus
Box 8000
Lindsay, Ontario
K9V 4S6

D. Holder
Forest Management Branch
Ontario Ministry of Natural Resources
Parliament Bldgs.
Queen's Park
Toronto, Ontario
M7A 1W3

R. Hutchison
Ontario Ministry of Natural Resources
Midhurst Research Centre
Midhurst, Ontario
L0L 1X0

M. R. Innes
Ontario Ministry of Natural Resources
Huronia District
Midhurst, Ontario
L0L 1K0

B. James
Ontario Ministry of Natural Resources
Chapleau, Ontario
P0M 1K0

F. Janser
Ontario Ministry of Natural Resources
Box 130
Sault Ste. Marie, Ontario
P6A 5L5

D. Jovic
Ontario Ministry of Natural Resources
Box 640
Geraldton, Ontario
P0T 1M0

J. Kekanovich
Ontario Ministry of Natural Resources
Box 3000
Cochrane, Ontario
P0L 1C0

D. E. Ketcheson
Great Lakes Forest Research Centre
Box 490
Sault Ste. Marie, Ontario
P6A 5M7

S. Kim
Ontario Ministry of Natural Resources
Dufferin St.
Maple, Ontario
L0J 1E0

R. Kirkbride
Ontario Ministry of Natural Resources
Box 970
Nipigon, Ontario
P0T 2J0

R. A. Klapprat
Ontario Ministry of Natural Resources
Box 323
Red Lake, Ontario
P0V 2M0

G. Kokocinski
Ontario Ministry of Natural Resources
Thunder Bay, Ontario P7G 5G6

E. A. Kraker
Ontario Ministry of Natural Resources
Niagara District
Box 1070
Fonthill, Ontario
LOS 1EO

K. Leclaire
Ontario Ministry of Natural Resources
34 Birch St.
Chapleau, Ontario
POM 1KO

R. A. Lockhart
Ontario Ministry of Natural Resources
322 Kent St. W.
Lindsay, Ontario
K9V 2Z9

S. Lucas
Ontario Ministry of Natural Resources
Ramsayville, Ontario
KOA 2YO

F. Lyon
Northern Forest Research Unit
Ontario Ministry of Natural Resources
Box 2960
Thunder Bay, Ontario
P7B 5G5

A. R. K. MacDonald
Ontario Region EMS
Environment Canada
Box 5050
Burlington, Ontario
L7R 4A5

L. B. MacHattie
Forest Fire Research Institute
Canadian Forestry Service
Ottawa, Ontario
K1A OW2

R. L. MacNaughton
Ontario Ministry of Natural Resources
Box 730
Cochrane, Ontario
POL 1CO

R. Magee
Ontario Ministry of Natural Resources
Swastika, Ontario
POK 1TO

E. Markus
Ontario Ministry of Natural Resources
Box 2050
Cochrane, Ontario
POL 1CO

J. R. Mask
Ontario Ministry of Natural Resources
Whitney, Ontario
KOJ 2MO

P. McAlister
Ontario Ministry of Natural Resources
Box 5000
Thunder Bay, Ontario P7C 5G6

K. M. McClain
Ontario Ministry of Natural Resources
Northern Forest Research Unit
Box 2960
Thunder Bay, Ontario
P7B 5G5

J. McCready
Ontario Ministry of Natural Resources
174 Douglas St. W.
Sudbury, Ontario
P3E 1G1

J. M. McMahon
Operations Engineer
Longlac Woodlands
Kimberly-Clark of Canada Ltd.
Longlac, Ontario
POT 2A0

R. G. McMinn
Pacific Forest Research Centre
506 West Burnside Road
Victoria, British Columbia
V8Z 1M5

B. Miller
Ontario Ministry of Natural Resources
Box 670
Hearst, Ontario
POL 1N0

C. S. Miller
Woodlands Division
Abitibi Paper Co. Ltd.
Iroquois Falls, Ontario

J. Miller
Ontario Ministry of Natural Resources
Box 3070
North Bay, Ontario
P1B 8K7

J. G. Minor
Ontario Ministry of Natural Resources
Swastika, Ontario
POK 1T0

J. Muli
Ontario Ministry of Natural Resources
Box 309
Sioux Lookout, Ontario
POV 2T0

T. Myland
Ontario Ministry of Natural Resources
Box 640
Dryden, Ontario
P8N 2Z3

S. Navratil
Department of Forestry
Lakehead University
Thunder Bay, Ontario
P7B 5E1

D. I. Nicolson
Ontario—Minnesota Pulp and Paper Co. Ltd.
145 Third St. W.
Fort Frances, Ontario
P9A 3N2

T. Nieman
Petawawa Forest Experiment Station
Department of the Environment
Canadian Forestry Service
Chalk River, Ontario
K0J 1J0

J. D. Nolan
Ontario Ministry of Natural Resources
Box 40
Aylmer West, Ontario
N5H 2S8

W. A. O'Donnell
Ontario Ministry of Natural Resources
896 Riverside Drive
Timmins, Ontario
P4N 3W2

D. Offord
Ontario Ministry of Natural Resources
Manitouwadge, Ontario
POT 2C0

G. C. Olford
Ontario Ministry of Natural Resources
Gogama, Ontario
POM 1W0

D. Oxley
J. D. Irving Ltd.
Woodlands Division
284 Union St.
St. John, New Brunswick
E2L 4M3

B. Payandeh
Great Lakes Forest Research Centre
Box 490
Sault Ste. Marie, Ontario
P6A 5M7

W. Perrin
Ontario Ministry of Natural Resources
Postal Bag 3040
Napanee, Ontario
KOK 2RO

J. Phillips
Ontario Ministry of Natural Resources
Box 730
Cochrane, Ontario
POL 1CO

S. Price
Forestry Branch
Department of Tourism and Renewable Resources
Room 300, Provincial Office Bldg.
49 - 12th St. E.
Prince Albert, Saskatchewan
S6V 1B5

F. A. Prince
1076 Broadway Heights
R. R. No. 2
Charlotte, Michigan 48813

K. Reese
Forest Management
Ontario Ministry of Natural Resources
Parliament Bldgs.
Queen's Park
Toronto, Ontario
M7A 1W3

J. Richardson
Newfoundland Forest Research Centre
Box 6028
St. John's, Newfoundland
A1C 5X8

L. F. Riley
Great Lakes Forest Research Centre
Box 490
Sault Ste. Marie, Ontario
P6A 5M7

F. C. Robinson
Forest Management Branch
Ontario Ministry of Natural Resources
Parliament Bldgs., Queen's Park
Toronto, Ontario
M7A 1W3

D. Salter
Forestry and Wood Products Group
Dryden Division
Dryden, Ontario
P8N 2Z7

J. B. Scarratt
Great Lakes Forest Research Centre
Box 490
Sault Ste. Marie, Ontario
P6A 5M7

J. D. Scott
Forest Management Branch
Ontario Ministry of Natural Resources
Parliament Bldgs., Queen's Park
Toronto, Ontario
M7A 1W3

W. K. Shine
Ontario Ministry of Natural Resources
922 Scott St.
Fort Frances, Ontario
P9A 1J4

W. L. Sippell
Great Lakes Forest Research
Centre
Box 490
Sault Ste. Marie, Ontario
P6A 5M7

B. Smith
Ontario Ministry of Natural
Resources
Box 5080
Kenora, Ontario
P9N 3X7

R. Smith
Chapleau Lumber Co. Ltd.
Chapleau, Ontario

S. M. Smith
Woodlands Enterprises Ltd.
(Prince Albert Pulpwood Ltd.)
Box 1720
Prince Albert, Saskatchewan
S6V 5T3

L. F. Snook
Woodlands Division
Abitibi Paper Company Ltd.
Iroquois Falls, Ontario

R. Staley
Ontario Ministry of Natural
Resources
10670 Yonge St.
Richmond Hill, Ontario
L4C 3C9

H. Stanley
Longlac Woodlands
Kimberly-Clark of Canada Ltd.
Longlac, Ontario
POT 2A0

L. Starr
Great Lakes Paper Co. Ltd.
Box 430
Thunder Bay, Ontario
P7C 4W3

W. M. Stiell
Canadian Forestry Service
Forest Management Institute
Ottawa, Ontario
K1A OH3

C. R. Sullivan
Great Lakes Forest Research Centre
Box 490
Sault Ste. Marie, Ontario
P6A 5M7

R. F. Sutton
Great Lakes Forest Research Centre
Box 490
Sault Ste. Marie, Ontario
P6A 5M7

H. S. D. Swan
Woodlands Division
C.P.P.A.
2300 Sun Life Bldg.
Montreal, Quebec
H3B 2X9

B. Thompson
Ontario Ministry of Natural
Resources
Swastika, Ontario
POK 1TO

C. Turmel
Eddy Forest Products Ltd.
Box 600
Hull, Quebec
J8X 3Y7

P. Vaillancourt
G. W. Crothers Ltd.
Box 1002
Timmins, Ontario
P4N 7H6

H. P. G. van Bers
Ontario Ministry of Natural
Resources
Box 5000
Thunder Bay, Ontario
P7C 5G6

G. D. van Raalte
Maritimes Forest Research Centre
Box 4000
Fredericton, New Brunswick
E3B 5G4

P. E. Vézina
Faculty of Forestry
Université Laval
Québec, P.Q.
G1K 7P4

R. K. Vincent
Silviculture
Procter and Gamble Cellulose Ltd.
Postal Bag 1020
Grande Prairie, Alberta
T8V 3A9

W. D. Vincent
Ontario Ministry of Natural Resources
Box 640
Dryden, Ontario
P8N 2Z3

A. Vyse
B.C. Forest Service
Williams Lake,
British Columbia

W. W. Wahl
Ontario Ministry of Natural Resources
Box 220
Pembroke, Ontario
K8A 6X4

J. Waldram
Ontario Ministry of Natural Resources
Box 309
Sioux Lookout, Ontario
POV 2TO

H. Weiher
Ontario Ministry of Natural Resources
Box 5000
Thunder Bay, Ontario
P7C 5G6

D. P. White
Department of Forestry
Michigan State University
East Lansing, Michigan 48824

K. Wiskin
Ontario Ministry of Natural Resources
896 Riverside Drive
Timmins, Ontario
P4N 3W2

R. Wray
Ontario Ministry of Natural Resources
Minden, Ontario
KOM 2KO

D. Wright
Ontario Ministry of Natural Resources
6 Government Road
Kapuskasing, Ontario
P5N 2W4

A. Wynia
Ontario Ministry of Natural Resources
Thunder Bay Forest Station
R. R. No. 1
Thunder Bay, Ontario
P7C 4T9

C. W. Yeatman
Petawawa Forest Experiment Station
Department of the Environment
Canadian Forestry Service
Chalk River, Ontario
KOJ 1JO

## ATTENDING BUT NOT REGISTERED

A. J. Herridge
Assistant Deputy Minister
Resources and Recreation
Ontario Ministry of Natural Resources
Parliament Buildings
Toronto, Ontario
P7C 5G6

## AUTHORS NOT ATTENDING

H. H. de Vries
Provincial Forest Station
Ontario Ministry of Natural Resources
R. R. No. 4
Kemptville, Ontario
KOG 1J0

R. E. Mullin
Ontario Ministry of Natural Resources
Midhurst Research Centre
Midhurst, Ontario
LOL 1X0

G. Pierpoint
Ontario Ministry of Natural Resources
Forest Research Branch
Maple, Ontario
LOJ 1E0