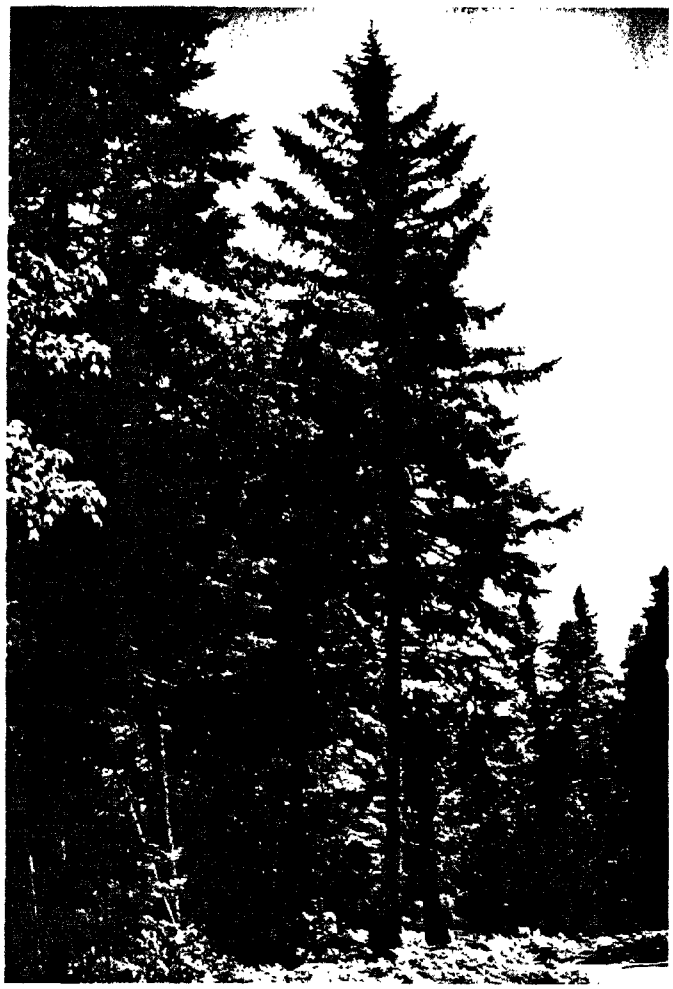
Proceedings of the SYMPOSIUM ON INTENSIVE CULTURE OF NORTHERN FOREST TYPES



USDA FOREST SERVICE GENERAL TECHNICAL REPORT NE-29
1977

FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
NORTHEASTERN FOREST EXPERIMENT STATION
6816 MARKET STREET, UPPER DARBY, PA. 19082

FOREWORD

THE NORTHERN FOREST TYPES constitute a vast natural resource for the United States and Canada. For instance, in the eastern United States there are more than 10 million acres of commercial forest land supporting spruce and fir types alone. The magnitude and variety of this resource is such that treating it in any detail at a 3-day meeting was impossible. Rather, the idea that germinated and developed into this symposium was to present a broad picture of the extent of our knowledge of intensive cultural techniques, the status and trends of our research in the northern forest types, and some actual experiences in managing this resource; and to explore those factors that affect our use of the intensive cultural techniques we have at hand.

There is no doubt that we face a new era in the management of northern forests. The production of wood products is no longer the primary objective of many owners, and increased pressure for the social values of our forests is being felt by all landowners. We must recognize these other forest values, which in turn dictates intensification of all aspects of forest management if we are to meet the future demands of a wood-hungry society.

The enthusiastic efforts of the symposium sponsors—the School of Forest Resources, University of Maine; the Maine Bureau of Forestry; the Maine Forest Products Council; and the U.S.D.A. Forest Service—and the individuals behind those efforts, should be commended. Special thanks are due to Great Northern Nekoosa, Inc., and Brooks B. Mills for their help in providing interesting field trips, and to the Casco Bank and Trust Co. for sponsoring the symposium brochure. Also, without the enthusiastic participation of the experts invited to present papers, and the moderators of each session, the Symposium could not have taken place.

—BARTON M. BLUM
Symposium Chairman

PUBLISHER'S NOTE

This report is published by the Northeastern Forest Experiment Station as a public service. The papers it contains are published as received from the authors. Any questions or comments about these papers should be directed to the authors.

Proceedings of the SYMPOSIUM ON INTENSIVE CULTURE OF NORTHERN FOREST TYPES

held 20-22 July 1976 at Nutting Hall, University of Maine, at Orono.

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- School of Forest Resources, University of Maine
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PRESENT METHODS AND TECHNOLOGY AVAILABLE FOR INTENSIVE MANAGEMENT AND EXTENT OF PRESENT USE

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Abstract

While there have been major technological developments in regional agriculture and forest harvesting and in intensive forest management in the Southern pine region and the Pacific Northwest, the application and development of intensive forest management has lagged in the Northeast.

Some of the characteristics of low, medium and high yield forestry are presented and recent developments in operational and managerial technology are reviewed.

It is concluded that we do have operational "hardware" for more intensive forest management, although mechanization could be further advanced. However, we are often lacking in the decision making "software", particularly at the 'whole forest' level, in order to account for the many factors which dictate which of the management options are appropriate. The northeastern forest, particularly the hardwoods, seem best suited to medium yield management for stand quality. The need for suitable financial incentives is stressed and attention is drawn to the important human and institutional problems that must be considered.

SINCE OTHER SPEAKERS are reviewing some of the techniques used in intensive forest management in some detail, the purpose of this paper is to briefly review each of the present techniques available for use and identify those which have developed rapidly in the last ten years,and note their relevance to conditions in the Northeast. The paper will have an understandably Candian bias. The N.E. region, I assume, covers those States belonging to the Northeastern Region of the U.S. Forest Service plus the Maritime Provinces.

We live in a technological era, and while we have all noted the dramatic changes in agriculture (Schebecker 1975) which have produced the so-called "green revolution", and we have also seen dramatic changes in the development of forest harvesting techniques, there have been relatively few dramatic developments in technology in the growing and management of forest crops in the Northeast. I will not dwell on the social, economic and geographic reasons for

lack of intensive forest management in the region; suffice to say that the application of technology to the region is compounded by such problems as terrain unsuitable for mechanized equipment, low quality and non-uniform stands composed of several species, many of which have low market values, and land ownership patterns and history of land use unfavourable to investment in forest management.

The major developments in technology for intensive forest management are being developed either in the Southern pine region or in the Pacific Northwest, or are direct applications of spinoffs from the developments in agriculture. The technology presently available will be considered under two headings: Operational and Managerial. (See Table 1).

OPERATIONAL TECHNOLOGY

The region is not characterized by major investments in plantation forestry. Historically forests have often been 'high graded' for quality species stands and logs. Initial efforts of improved management have usually called for judicious partial cuts for timber stand improvement, or shelterwood cuts or modified clear cutting, all with reliance on natural regeneration. However, it is in plantation forestry where there have been dramatic technological changes. Research in forest genetics and cooperative forest tree improvement programs in the Southern United States and elsewhere have led to the massive production of genetically improved tree seed (Zobel 1976). The economic benefits of such programs can only be realized through artificial regeneration. While there is little doubt that the techniques of forestry improvement, if applied to the Northeastern tree species, would produce economically attractive changes in stand volume, quality and vigour, the application of this technology has been quite limited due to the lack of reforestation programs (Carlisle and Teich 1971, Carlisle and Ottens 1976). There has been local interest in hybrid poplar production for short rotation management (Anderson and Zsuffa 1975) and in the use of certain exotics, particularly larches (Cook 1975). While research workers continue to investigate the genetic variability and heritability of the Northeast species and conduct provenance trials and trials of exotics (Fowler 1976), at the operational level practice is limited to the usual precautions regarding seed collection zones, seed collection procedures and the identification of phenotypically superior stands for seed production. Good guides are available for the collection and handling of tree seed and mechanization of collection is developing.

There have been periodic enthusiasms for direct seeding because of its apparent low cost and ease of application. Two symposia have been held (Abbott 1964, Cayford 1974). At the operational level the track record has been grim. There have been local successes and it is used for jack and lodgepole pine in the boreal forest, but even the technology developed for chemical seed coatings

to prevent losses due to rodents are now environmentally unacceptable. Successful operational direct seeding usually calls for adequate quantities of reasonably priced seed and some very careful prescriptions regarding seed bed preparation and timing of the seeding operation, especially in relation to snowfall; these areas need further work. The operational aspects of actually spreading the seed and monitoring results are fairly well established.

In forest nursery stock production there have been major technological changes. For conventional nursery stock, the operational aspects of control of nursery bed fertility and the mass production of quality stock by mechanized techniques have all become highly developed, largely based on work done outside the region (Moon, et al 1973). The refinements in this technology have been followed by the ultimate control of growing conditions and seedling quality in container stock production in greenhouses. Forest container stock production has been the subject of another recent symposium (Tinus, Stein and Balmer 1974) and is being enthusiastically and vigorously developed. Much of the pioneering work in this area was done in Scandinavia, where it is widely used, and in certain Canadian provinces.

It now appears possible to mass produce high quality, uniform tree seedlings grown in a variety of containers such as peat pellets, Nissula rolls, styrofoam blocks, plastic bullets and biodegradable containers on a very large scale at relatively low cost to large sizes and all in a few months instead of two to four years in conventional nurseries. Such container stock production is less robust and calls again for careful site preparation and is very suited for mechanized handling and planting systems. Special high production planting machines are being developed and bullets are being 'bombed' from planes.

Site preparation for either seedbed preparation, or for planting, has developed very rapidly outside the region. It is now possible, provided a tractor can traverse the ground, to treat very large acreages at relatively low costs, using front or rear mounted equipment on the tractor, suitable for direct seeding, or for natural seeding or as suitable sites for planting operations.

The application, however, again is limited in this region to a few locations. The 30,000 plus acres of spruce plantations in northern New Brunswick were established by the Irving organization using a Letourneau tree crusher for site preparation in one such example. However, the large block of privately owned land and the gently rolling, relatively stone free soils of the area represent a rather unusual combination of favourable conditions.

Control of vegetative competition through the use of auxin herbicides such as 2,4-D and 2,4,5-T and chemicals such as atrazine and simazine and cacodylic acid are also well established techno-

nologies, which can be effective and are in cases absolutely essential, for successful stand establishment. However, enthusiasm for their use has been considerably dampened by concerns about their environmental effects. The literature in this area is enormous, but on balance it does appear that, as in agriculture, the use of such chemicals to control vegetative competition is often the only feasible way of getting the job done and that the environmental risk is acceptable, especially for the auxin herbicides (Newton 1975, Newton and Norris 1975).

Pre-commercial thinning of excessively dense young stands has received a lot of attention recently (Porterfield and Schweitzer 1975). It is widely practised outside the region and is one of the most attractive areas for investment in forest management because it controls spacing, vegetative competition and species composition and produces stands of high mean diameters on shorter rotations. It is nearly all hand labour using either power saws or special brush saws. It has resisted, and probably will continue to resist, all attempts to mechanize it (Dunfield 1974). Even the use of tree killing chemicals, such as cacodylic acid, has fallen into disfavour. The high labour content, the relative ease of application and its almost year-round application made it an attractive investment for government agencies in areas of high unemployment.

Forest fertilization is an operational technology in the South, mainly using phosphorous, and in the Pacific Northwest and Scandinavia, using nitrogen. It has attracted a lot of research, it works in the right situations. It uses expensive fertilizers and it is of doubtful economy for low quality stands, or a low value species. Whether or not nitrogen fertilization of Northeastern tree crops can match the economic returns and priorities for fertilizer use in agriculture crops is questionable. Forest fertilization is also a favourite topic for symposia, one recent in this region (Northeastern Forest Soils Conference 1973). It does appear that fertilization is the frosting on the top of the total forest management cake and without the cake there is little economic justification for the frosting. The environmental hazards involved appear to be acceptable, based on present information.

I am reluctant to blow any cobwebs off the hoary old questions surrounding the application of commercial thinnings. All over the western world, and this region is no exception, high labour costs and shortages of manual labour for hard physical work, have greatly reduced the application of the beautiful and rational thinning regimes designed to recover mortality and improve stand quality. Present trends are to grow trees at wide spacing and on short rotations and thus avoid thining (Buckman and Newton 1972). The dramatic changes in the technology of logging has in some instances led to the development of special mechanized equipment for

thinning, especially in plantations. However, outside of plantations, such machines have little application in this region, mainly because of low stand quality and excessive stand densities. Of much more pragmatic significance for the region is whether or not it is feasible for certain types of stands to carry out partial removals of the stand, which can be designated either as thinnings or partial cuts or shelterwood cuts, using rubber-tired skidders and either short wood or tree length methods. It can be done and is being done, for example, on the holdings of the Seven Islands Land Company in Maine, but does require great care on the part of the cutter and the skidder operator. This technology and this practice is very appropriate to the region and controversy exists as to whether it is possible to mechanize the operation further to remove the undesirable and unpleasant labour aspects involved, without losing the flexibility, low cost and ease of applicability.

There is also concern about the mechanization of logging. Sophisticated new machinery for tree length and whole tree harvesting, with high operating costs, limited operational flexibility, requires high quality stands. Advance growth may be destroyed, forests may be high graded and environmental problems involving physical and chemical damage to the soil may develop. Whether or not this technology favours or hinders intensive forest management is dependent upon a commitment to intensive forest management and a clear set of management objectives. In many cases this technology has invaded the forest without allowance being made in management planning, in increased investments and in adjustments in cutting schedules, allowable cuts and the application of the appropriate management technology to ensure prompt restocking. Often the response has been when in doubt scarify! It is this latter area of decision-making which leads to what I consider to be the crux of the whole affair and that is

MANAGERIAL TECHNOLOGY

This has been an area of major technological change, because while historically we could handle much of the operational technology to carry out intensive management, we were not in a position to justify expenditures of money in order to make due allowance for uncertainty of yields and biological variability. The application of intensive forest management elsewhere in North America has been justifiable at the industrial level, mainly because it works biologically and it was possible to quantify the benefits. The shorter the rotation and the less biologically complex forest, the easier this job becomes. There is a new technology of forest resource decision making. A new textbook in this area which is now widely used in many North American forestry schools by Duerr et al (1975) is symptomatic of the change. Computers have made a great many changes in our lives. There is a theoretical and to a certain extent applied technology using stand

and tree growth simulation models which does permit the estimation of yields of forest stands by age, species, site class and density, with outputs in terms of tree size, volume, biomass, tree quality and age initiation of mortality (Fries 1974). Forest inventory procedures have been completely changed. Analyses of growing stock by stands, allocation of cuts, inputs from social and economic factors are now analyzable and to a reasonable degree quantifiable for whole forest systems (Navon 1971, Ware and Clutter 1971, Alston 1972, Hoyer 1975, McDonough and Park 1975, Lussier 1976). For large corporate forest holdings and for large public forests, analyses of this type now permit a rational examination of the benefits of intensive forest management. One of my favourite examples of this type of an approach in intensive forest management is that of the Swedish Cellulose Company which has stand development and silvicultural decision models, which indicate for various site classes and stand conditions those locations most appropriate for intensive management investments (Hagner and Fries 1972, Hagner 1974). The Weyerhauser corporation is very advanced in this technology, with its 'target forests' and $5,000,000 annual forest research expenditure (Mitchell and Roberge 1974).

While this technology will handle a lot of the figuring, there is still the on-the-ground problem of soil fertility and site variability. Intensive forest management calls for decision making which locates on the ground, sites most suitable for treatment and which indicates how such treatments will relate to other forest land uses, such as wildlife, recreation, watershed values, etc. The prescriptions cannot be oversimplified (Smith 1975). There have been troubles in this area, environmental troubles when forest management technologies are blindly applied, while ignoring these values. Again a system is called for. I feel we have made progress in this area. In Canada we have a biophysical land classification system which permits, through the use of appropriate inventory techniques by specialists in ranking and rating of land capability and the rational integration of land uses (Jurdant 1969). Such ecological approaches permit a rational framework into which decisions regarding intensive forest management can be incorporated. There are so called "folio" approaches to resolving some of these complex problems (Bullen 1975) and there are new inventory procedures designed to collect the appropriate information of all the resource values. Here in the U.S. my understanding of the situation is less clear. The philosophical and operational procedures are different. The decision making centres around soil mapping by the Soil Conservation Service and other agencies followed by woodland interpretations. There has been an emphasis on predictive equations to relate yield to measurable soil parameters.

Our improved understanding of growth and yield and the silvics of the species, together with our analytical capabilities in

forest economics, have given rise to a series of very useful bulletins and guides for intensive forest management. For example, the Ontario Silviculture Guides for Working Groups and the Spruce-Fir and Northern Hardwood Guides produced by the Northeast Forest Experiment Station indicate appropriate tending and harvesting procedures for different stand ages and stand conditions. Other reports indicate economic returns and methods of analyzing the results of various management practices. These bulletins are not decision making models for management but they do provide most useful information when management decisions are needed. It is now technically possible to develop a complete system for decision making in the application of intensive forest management.

APPLICATION OF TECHNOLOGY

Table 2 outlines the characteristics of low, medium and high yield forest management. While we apparently have the operational technology to conduct any of the three options, i.e.,'the hardware' to do the job; I feel that we lack the decision making 'software' to decide on which option, at which locations and at what level of intensity. Rather than follow the usual pattern of opting for low yield forestry with declining utilization standards, I feel there is a good case to be made for the middle option in the N.E. - an emphasis on stand quality rather than quantity - particularly for the hardwood species. The emphasis here is on directing the natural forces of competition and selection rather than establishing an maintaining an artificial forest crop.

Much of the work that has been done in developing high yield, intensive management systems and decision making procedures during the last few years has been done by large corporations or big government. This body of technology is essential if decisions on major investments in intensive forest management are to be made on some rational basis. Many of the areas are quite complex, require considerable capital investment and a high degree of expertise in their application. The benefits which accrue from such investments, particularly when rotations are long, are difficult to justify for smaller forest holdings. The Northeast region is characterized largely by smaller ownerships and much of this new technology for intensive forest management is thus very difficult to apply, but it has been done in other countries, as for example, Finland and Norway. Also, most of the technology is best suited to growing relatively intolerant trees in plantations. Much of it is ill-suited to tolerant trees, particularly hardwoods. Stand conversion is usually required.

It is interesting to note that in Eastern Canada much of the funding for intensive forest management, where it is practised, has come from government agencies which have been motivated by social reasons. There is a powerful argument for government subsidies, tax incentives, etc., for intensive forest management which

will give rise to improved local employment and better quality forests, which in turn will attract capital investment for forest industry. In some cases the pressure for this type of funding has come from the rural residents and not from large corporations or government planners. In my view we do have existing and workable technologists to practise intensive forest management now but their application is constrained by lack of management systems and lack of suitable financial incentives provided by government (Skok and Gregersen 1975, Weetman 1976). While we must continue to work on improving our technology and reviewing our progress in intensive management in symposia such as this one, we must not ignore the human and institutional problems and attitudes which must be changed if we are to put intensive forest management into practice.

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TABLE 1.

TECHNOLOGY FOR INTENSIVE FOREST MANAGEMENT IN NE

OPERATIONAL

- Seed Production Areas (1)
- Seed Orchards
- Seed Treatment
- Direct Seeding
- Seedbed Préparation (1) (4)
- Site Preparation (1) (3) (4)
- Conventional Nursery Stock Production (2) (3)
- Container Stock Production (1) (3) (4)
- Herbicide Control of Vegetative Competition (1) (3)
- Modified Cutting (2)
- Planting Mechanization (1) (3)
- Pre-Commercial Thinning or Spacing Control (1) (3)
- Timber Stand Improvement (1)
- Thinning (1) (3)
- Pruning (1)
- Fertilization (3) (4)
- Spraying and Cutting to Control Insects and Diseases (2) (4)

(1) Used in NE on Limited Scale
(2) Used in NE on Extensive Scale
(3) Technology Well Developed and Used in Other Regions.
(4) Important Recent Developments in Technology.

MANAGERIAL

- Ecological Surveys for Integration with Other Forest Uses and Choice of Sites, Species and Degree of Effort (1) (4)
- Improved Data Collection in Forest Inventory for Analyses of Stand Conditions and Growth Rates (1) (3) (4)
- Soil Survey and Site Index Studies for Fertility Estimates (1) (3)
- Managed Yield Tables Giving Volume Production by Species, Site, Density and Rate of Mortality or Thinning (1) (3) (4)
- Silvicultural Guides for Species Working Groups and Stand Conditions (2)
- Stand Simulation and Optimization Models Giving Production and Economic Returns from Different Management Practices and Strategies (1) (3) (4)
- Whole Forest Models Analysing Various Socio/Economic/Ecologic Inputs and Strategies (4)
- Production and Performance Models and Decision Making Tools for Choice of Operational Equipment and Methodology (2) (3)
- Studies of Effects of Changing Utilization Standards on Rotation Lengths and Usable Yield (2) (4)

TABLE 2.

CHARACTERISTICS OF INTENSIVE FOREST MANAGEMENT OPTIONS

Option	Energy & Dollar Inputs for Management	Expertise & Capital Required for Management	Application to NE	Provision of Stable Rural Employment	Technology Available?	Decision Making Tools Needed
1. High yield plantation forest - removal of original forest cover - site preparation - use of genetically improved stock - short rotations - emphasis on stand quantity & quality - mechanized operations	high	high	limited by trafficability	may be limited by expertise & mechanization required	for some species & sites	- site fertility equations - sophisticated forest inventory - managed yield tables - economic analysis of operations - a total system for management - monitoring and analysis of performance
2. Medium-yield forests - limited logging mechanization - modified cutting - seedbed preparation - natural regeneration or limited planting - precommercial thinning - longer rotations - emphasis on stand quality	medium	medium	suitable for many sites & species	good potential	for some species	- workable ecological classification - managed yield tables - inventory by stand condition - estimates of "additional" costs of operations - management system & field guides
3. Low-yield forests - lowest cost logging - often heavily mechanized - natural regeneration - stable or declining stand quality	low	low	widely applied now	limited	readily available	- inventory of commercial operable timber - a method to choose lowest cost logging operations - monitoring of stand quality & quantity

HOW APPLICABLE IS EVEN-AGED SILVICULTURE IN THE NORTHEAST?

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Abstract

The applicability of even-aged silviculture in the management of forest stands in the Northeast is examined through consideration of the forest stand, stand development, intermediate cuttings, and regeneration methods. It is concluded that even-aged silviculture is quite applicable in the management of forest stands in the Northeast.

Experience has taught me that rational discussions of silvicultural practices require mutual understanding of standard terminology. I have had on occasion the frustrating experience of continuing a somewhat heated discussion regarding a particular silvicultural practice with a colleague only to realize eventually that we were in complete agreement but were using different terminologies. To avoid such an occurrence here, I shall give particular attention when warranted to terminology in answering the question, "How applicable is even-aged silviculture, i.e. the growing of timber crops in even-aged stands, in the Northeast?" Furthermore I have organized my answer in what seems to me to be a logical approach by considering the forest stand, stand development, intermediate cuttings, and regeneration methods.

FOREST STAND

The forest stand is defined as being "a community of trees possessing sufficient uniformity as regards composition, constitution, age, spatial arrangement and/or condition to be distinguishable from adjacent communities so forming a silvicultural or management entity" (Society of American Foresters 1971). I should like to emphasize (1) that a forest is composed of forest stands, each occupying a specific area on the