NODA/NFP Tech. Rep. TR–1

Northern Ontario Development Agreement, Northern Forestry Program:

Compendium of Projects

Approved Under Forestry Canada's First Request for Proposals
under the
Applied Research,
Technology Development and Transfer
and
Decision Support Components

R.L. Macnaughton
Project Coordinator
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1993

Funding for this report has been provided through the Northern Ontario Development Agreement's Northern Forestry Program.

Canadian Cataloguing in Publication Data

Macnaughton, R.L.
Northern Ontario Development Agreement, Northern Forestry Program: Compendium of Projects (NODA/NFP technical report; TR–1)
Includes an abstract in French.
"Approved under Forestry Canada's First Request for Proposals under the Applied Research, Technology Development and Transfer and Decision Support Components"
ISBN 0–662–20821–8 DSS cat. no. Fo29–41/1993E

1. Forestry projects—Ontario.
2. Forestry policy—Ontario.
3. Forests and forestry—Economic aspects—Ontario.
I. Great Lakes Forestry Centre.
II. Title.
III. Series: NODA/NFP report; TR–1.

SD568.05M32 1993 634.9'07207131 C93–099624–0

Catalogue No. Fo 29–41/1–1993E
ISBN 0–662–20821–8
ISSN 1195–2334

Copies of this publication are available at no charge from:
Communications Services
Great Lakes Forestry Centre
Forestry Canada–Ontario Region
P.O. Box 490
Sault Ste. Marie, Ontario
P6A 5M7

Microfiches of this publication may be purchased from:
Micro Media Inc.
Place du Portage
165, Hotel-de-Ville
Hull, Quebec
J8X 3X2

Macnaughton, R.L. 1993. Northern Ontario Development Agreement, Northern Forestry Program: compendium of projects. For. Can., Ont. Region, Sault Ste. Marie, Ont. NODA/NFP Tech. Rep. TR–1 74 p.

ABSTRACT

This Compendium provides a descriptive summary of fifty-eight applied research; technology development and transfer, and decision-support projects that were funded by Forestry Canada–Ontario Region under the Northern Ontario Development Agreement, Northern Forestry Program. The projects cover a broad range of topics in the areas of integrated resource management, silvicultural practices, forest protection, environmental impacts and planning and forest resource management. These projects were selected from more than 230 research proposals submitted under Forestry Canada's first Request for Proposals (RFP-I) and are being carried out by Forestry Canada, universities, the forest industry, private forestry consultants and non-governmental organizations throughout Ontario. These priority areas of research contribute to Forestry Canada–Ontario Region's Strategic Plan and the Ontario Ministry of Natural Resources' Sustainable Forestry Initiative. Each project summary describes the objectives, methodology, expected results, and implications of the research. This Compendium will be of interest to forest managers, field foresters, the research community and the general public interested in forestry research and is an example of our commitment to transfer knowledge to field personnel. The Compendium will be updated with articles on additional projects approved under Forestry Canada's second Request for Proposals (RFP-II).

RÉSUMÉ

Ce Compendium présente un sommaire descriptif de 58 projets de recherche appliquée, de développement et de transfert technologique et de systèmes d'aide à la décision qui ont été financés par la Région de l'Ontario de Forêts Canada en vertu de l'Entente de développement du nord de l'Ontario, Programme forestier du Nord. Ces projets portent sur une vaste gamme de sujets liés à la gestion intégrée des ressources, aux pratiques sylvicoles, à la protection des forêts, aux incidences environnementales de même qu'à la planification et à l'aménagement des ressources forestières. Ces projets ont été choisis parmi plus de 230 propositions de recherche présentées à la suite de la première demande de propositions de Forêts Canada (RFP–I) et sont effectués par Forêts Canada, des universités, l'industrie forestière, des experts-conseils en foresterie du secteur privé et des organismes non gouvernementaux un peu partout en Ontario. Ces domaines prioritaires de recherche contribuent au Plan stratégique de la Région de l'Ontario de Forêts Canada et au programme de développement forestier durable du ministère des Richesses naturelles de l'Ontario. Chaque résumé de projet précise les objectifs, les méthodes, les résultats escomptés et les incidences de la recherche. Ce Compendium intéressera les aménagistes forestiers, les forestiers de terrain, la communauté de chercheurs et les membres du public s'intéressant à la recherche forestière. Il est un exemple de notre engagement envers le transfert de connaissance au personnel de terrain. Le Compendium sera mis à jour et comportera des articles sur d'autres projets approuvés en vertu de la deuxième demande de propositions de Forêts Canada (RFP–II).

ACKNOWLEDGMENTS

I would like to thank a number of people for their contribution to this Compendium.

First, thanks must go to the principal investigators who submitted high-quality proposals to the Northern Forestry Program. Second, I thank Jane Scott-Barsanti and Sandra Paul for their efforts in taking the volumes of information I provided and preparing most of the single-page articles for each project. Special appreciation and thanks to Theresa Glover for her work in packaging the articles and ensuring consistency in the appearance and wording. Sandy Burt and Geoff Hart provided the technical expertise required to publish this Compendium. Staff of the Development Sections provided support and advice throughout the production of this report, especially Brian Sykes and Diana Callaghan.

I hope the articles included here will provide you with a wealth of information on current research and open doors to increased linkages between research efforts and the field. If even one article leads to a contact that results in the improvement of forest management in Ontario, then this report will have made a valuable contribution.

R.L. Macnaughton, R.P.F.

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INTRODUCTION

The purpose of this Compendium is to provide a summary of the objectives and anticipated results of fifty-eight applied research, technology development and transfer, and decision-support projects approved during the first Request for Proposals (RFP-I) issued by Forestry Canada–Ontario Region under the Canada–Ontario Northern Ontario Development Agreement, Northern Forestry Program (NODA/NFP). These projects address several of the priority areas documented in Forestry Canada–Ontario Region's Strategic Plan and the Ontario Ministry of Natural Resources' Sustainable Forestry Initiative, and are funded by the Government of Canada. The following provides a background to the Northern Forestry Program.

Canada's forests play a vital role in the environmental, social, cultural and economic fabric of this vast nation. The federal and provincial governments have demonstrated the importance of appropriate management, regeneration and protection of Canada's forests by entering into several generations of resource development agreements over the past 40 years. The majority of the agreements were negotiated individually to meet the needs of the provinces.

There have been two distinct periods of federal–provincial agreements: 1951–1967, and 1978 to the present. During the 1951–1967 period, either through individual forestry agreements or through multi-sectoral agreements, almost $64 million in federal funds were spent in conjunction with provincial funding in support of forest inventories, reforestation, fire protection, access roads and stand improvement, all carried out by provincial forestry departments[1]. Although research programming was not directly provided for in these agreements, research activities were conducted either within the scope of these early agreements or through parallel programs as issues surrounding inventory design, reforestation, fire protection and stand improvement became important.

[1]Johnstone, K. 1991. Timber and trauma: 75 years with the Federal Forestry Service, 1899–1974. For. Can., Ottawa, Ont. 194 p.

The most recent period of sectoral sub-agreements started in 1978 and these were negotiated under umbrella regional development agreements. The General Development Agreement (GDA, 1974–1984) provided the framework for the Forest Management Subsidiary Agreement (FMSA, 1979–1984). The Canada–Ontario Economic and Regional Development Agreement (ERDA), signed in 1984 for a 10-year period, provided the framework for the negotiation and conclusion of the Canada–Ontario Forest Resource Development Agreement (COFRDA, 1984–1989) and the Canada–Ontario Subsidiary Agreement on Northern Ontario Development, or more familiarly, the Northern Ontario Development Agreement (NODA, 1991–1995).

The primary thrust of FMSA was construction of infrastructure such as roads, and improvement and expansion of nurseries; with COFRDA, the focus was on renewal of the forest. With earlier agreements concentrating on the establishment of infrastructure and silvicultural treatment levels sufficient to ensure a long-term wood supply and with the responsibility for silvicultural programs resting with the provinces and/or industry, the priorities for agreements have shifted towards research and development and technology transfer; the new focus is on improved silvicultural techniques and forest management planning, thereby improving the allocation of silvicultural funds and the cost-effectiveness of reforestation and stand tending practices. Both of the former agreements, however, contained a strong

component of research and development, and produced a variety of results intended to solve forestry related problems at both basic and applied levels.

In November 1991, the governments of Canada and Ontario signed NODA. This four-year, $95 million agreement covers the three major economic sectors in northern Ontario—forestry, mining and tourism. These sectors have developed the north and will continue to be the major development sectors in the future. The Northern Forestry Program provides $50.0 million and consists of four principal programs: Sustainable Forestry Development; Aboriginal Forestry; Communications, Awareness and Education; and Management and Evaluation. The largest program is Sustainable Forestry Development, under which Canada and Ontario have each allocated $16.0 million to undertake projects in five subprograms: Applied Research, Technology Development and Transfer, Decision Support, Socio-Economic Analysis, and Integrated Resource Management Demonstration Areas.

In order to meet the needs of field forestry and to fund research initiatives relevant to field forestry issues, Forestry Canada issued a call for proposals with the intent of utilizing the broad range of expertise available within Ontario's forest research and technology development and transfer communities. Approximately $8.0 million was set aside to fund projects that clearly addressed research priorities and that met client needs.

The priorities of the Applied Research subprogram include:

- studies that develop information related to integrated resource management and planning;
- studies designed to develop effective, environmentally considerate silvicultural techniques, protection practices and harvesting methods; and
- studies designed to improve the quality and extend the utilization of the forest resources.

The Technology Development and Transfer subprogram priorities include:

- activities that transfer information for the adoption of techniques or tools consistent with the area addressed under the Applied Research subprogram;
- activities that operationalize past and present research results and contribute to the objectives and criteria of the subprograms; and
- activities that specifically reduce the costs of forest management within the context of sustainable forestry development.

The Decision Support Component subprogram priorities include:

- the development of new systems based on existing data that improve the quality, timeliness and/or scope of decision-making in forest management operations planning or research; and
- activities that incorporate existing data to enhance existing decision-support tools for forest management and related fields (i.e., protection, planning, etc.).

Specific project results will be published and made available over the next four years. The Compendium will be updated with information on additional projects approved under Foresty Canada's second Request for Proposals (RFP-II).

USING THE COMPENDIUM

This Compendium outlines the projects funded by Forestry Canada–Ontario Region (FCOR) in response to FCOR's first request for proposals. Interested individuals may wish to contact the Principal Investigators of the projects to obtain more information and determine whether the research results or tools would be of use in their area.

To assist readers with the identification of projects of interest, the Compendium has been subdivided into five research priorities: Integrated Resource Management, Silvicultural Practices, Forest Protection, Environmental Impacts, and Planning and Forest Resource Management. Although it is recognized that many of the individual projects address more than one priority, they have been categorized based on primary focus. The projects within each priority have been sorted numerically by the three NODA/NFP subprograms:

- Applied Research – 40XX
- Technology Development and Transfer – 41XX
- Decision Support – 42XX.

The title listed for each project reflects that which was submitted in response to the initial request for proposals (RFP-I).

Two terms used throughout the articles require definition because they may have been used in an unfamiliar context. "Principal Investigator" means the contractor with responsibility for completion of the project and for its technical content. A "Scientific Authority" is designated by Forestry Canada—Ontario Region to ensure the scientific quality of the project's implementation and delivery. (Scientific Authorities are not assigned to projects undertaken by Forestry Canada, for which other review mechanisms are in place.) The Scientific Authority maintains ongoing contact with the Principal Investigator to ensure the quality of the project's objectives, experimental design, methodology, and deliverables that result from the project.

Three acronyms are used throughout the project descriptions, and are explained here for simplicity:

FCOR = Forestry Canada–Ontario Region
OMNR = Ontario Ministry of Natural Resources
NODA/NFP = Northern Ontario Development Agreement, Northern Forestry Program

R.L. Macnaughton, R.P.F.
Forestry Development
Forestry Canada–Ontario Region
May, 1993

INTEGRATED MANAGEMENT

Techniques for Sustaining Wildlife Populations in Managed Forest Land

Duration: 01 June, 1992 to 31 May, 1995 **Contract Value:** $203,100

Principal Investigator: D. Welsh
Canadian Wildlife Service–Ontario Region, Nepean

Scientific Authority: R.A. Lautenschlager
Ontario Forest Research Institute, OMNR, Sault Ste. Marie

OBJECTIVE:

To model the relationship between habitat type and wildlife productivity and thereby be able to predict the relative importance of different habitat types for sustaining wildlife populations.

DESCRIPTION:

A primary challenge in forest management is to develop a system to jointly manage timber supply and wildlife conservation. A number of diverse approaches for conserving wildlife habitat have been developed in recent years: indicator species, featured species, Habitat Supply Indicators, Habitat Supply Analyses and ecosystem supply, for example. However, it is ultimately necessary to know the actual population sustainability of the landscape and not just the availability of habitats. All approaches, of necessity, recognize habitats of differing quality, usually based on the abundance of the species. An additional fundamental issue that is rarely addressed is the need to relate per capita productivity and survivorship to species abundance. By measuring productivity in habitats of low, medium and high abundance this project will attempt to answer questions related to this issue.

The Canadian Wildlife Service has information relating the abundance of approximately 50 bird species to the site classifications of the Northwestern Ontario Forest Ecosystem Classification (FEC). These data can be used to predict the abundance in different habitats of a selected group of species representative of the major bird communities in northwestern Ontario. The productivity of these species will be measured at sites of different quality where species abundances are low, medium and high.

Throughout three breeding seasons, beginning May 1992, productivity at six sites will be measured. From this data, relative adult population size, adult survivorship, post-fledging productivity and recruitment into the adult population can be determined. This will give measures of reproductive potential for each habitat and species combination and will enable researchers to determine whether the populations are self-sustaining.

The productivity data will be incorporated into a mathematical modeling approach (Population Viability Analysis) to predict the probability of a population surviving when it is subject to different habitat management options. Landscape management can then be developed to maximize the probability of population survival. The projected use of this method is to assess the relative importance of patches of habitat to the regional population in a changing landscape.

EXPECTED RESULTS:

The results will allow the development of a computer simulation model and a manual for the development of productivity ratings for selected FEC groups and target species. The computer model will relate productivity to habitat described by FEC and forest resource inventory (FRI) measures.

IMPLICATIONS:

The computer model will relate productivity to a habitat described by FEC and FRI measures. The Population Viability Analysis will allow evaluation of alternative management approaches and assist managers in predicting how, where and when to harvest timber while still maintaining essential habitat. Likewise, the model will assist in identifying critical habitats for species and help predict the size of reserves necessary to maintain species particularly susceptible to habitat disturbances. Both the manual and model will be made available to the forest industry, Forestry Canada and OMNR.

COLLABORATORS:

Wildlife Policy Branch, Northeast Science and Technology, Northwest Region Science and Technology Unit, and Sustainable Development, OMNR; L. Venier, Canadian Wildlife Service; T. Norton, Centre for Resource and Environmental Studies, Australian National University; B.G. Mackey, FCOR.

Project No.: 4205

Remote Tourism and Timber Management in Boreal Forest Landscapes

Duration: 01 April, 1993 to 30 September, 1994 **Contract Value:** $41,280

Principal Investigator: P. Duinker
Lakehead University, Thunder Bay

Scientific Authority: S. Andersen
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To study how remote-tourism lakes and businesses can be protected from the undesirable effects of timber management while still enabling some level of timber harvest in the forest landscape.

2. To quantify the tradeoffs that result from different levels of protection of remote-tourism values from timber-management activities.

3 To develop and recommend a practical approach, with associated analytical procedures, for planning timber management in tourism landscapes in northern Ontario.

DESCRIPTION:

Remote lake-based tourism is a multi-million dollar industry in many areas of northern Ontario. In the past, the tourism lakes were isolated from roads and timber-management activities. Recently, however, forest managers have had to undertake timber harvests, and build the required access roads, closer and closer to remote-tourism lakes and businesses.

The OMNR has established guidelines for the protection of tourism values in timber management, but many tourism operators believe that the guidelines are insufficient to protect their businesses.

Both the remote-tourism and timber industries are vital to the economic survival of many communities in northern Ontario. Each case of conflict is unique and the many different factors involved would suggest that the key stakeholders should design forest management in each tourism landscape based on negotiations supported by a quantitative analysis of the tradeoffs that would result from a wide range of management scenarios.

This project is designed to help tourism and timber stakeholders find ways to co-inhabit boreal-forest landscapes amicably and successfully. Using digital elevation data, a Geographic Information System (GIS) can be used to determine what activities, such as timber harvest, can be seen from the surface of a lake. A GIS is also vital for analysis of the practicality of alternative timber harvests, road locations and cut block layouts. Because of the potential for rapid changes in the character of boreal-forest stands, especially in terms of timber volume, it is important in timber versus tourism tradeoff analyses to track forest dynamics into the long-term future.

EXPECTED RESULTS:

This project will develop and test an approach to conflict resolution for general application across northern Ontario.

IMPLICATIONS:

Quantitative analysis in support of negotiations has great potential to identify workable solutions to tradeoffs between different uses of the forest resource in which the users of both resources can "win". These resolutions will be central to continued economic prosperity in northern Ontario.

COLLABORATORS:

P. Higgelke and N. Bookey, Lakehead University; L. Colpitts, Nagagami Forest, OMNR; S. Dubé-Veilleux, Remote Tourism Industry Association, Wawa.

Developing Analytical Procedures for Establishing the Level of Protection for Forest Fire Management to Support Sustainable Forestry in Ontario

Duration: 14 August, 1992 to 30 June, 1994 **Contract Value:** $125,700

Principal Investigator: D.L. Martell
Faculty of Forestry, University of Toronto

Scientific Authority: F.M. Dunn
Aviation, Flood and Fire Management, OMNR, Sault Ste. Marie

OBJECTIVES:

1. To improve the degree of understanding of the relationship between forest and fire management within the forestry community.

2. To develop a widely understood and acceptable means of selecting the level of protection for fire and forest management programs.

3. To develop the means to integrate decisions on the required level of protection in forest management planning.

4. To develop analytical procedures that facilitate the allocation of resources between components of the fire management program, and that are compatible with forest management objectives and targets.

DESCRIPTION:

Although the occurrence and behavior of forest fires are largely random, their effects and damage are not totally unpredictable or beyond the control of resource managers. Forest fire management is truly risk management. The impact of fire in the forest is a function of management decisions on the allocation of resources to prepare for and respond to fires.

Presently, there are no comprehensive means of relating fire management needs to forest management objectives in Ontario. Forest management plans can identify priority protection areas, and fire plans can identify various degrees of hazard and risk. However, managers have difficulty in describing the expected or acceptable impact of fire in a specific forest, and in objectively determining the resources and fire management strategies required to ensure the acceptable level of fire management is provided efficiently.

This project will, in cooperation with staff of OMNR's Fire Management program and other resource managers, provide a comprehensive definition of the concept of "level of fire protection", and develop quantitative analytical tools to aid resource managers and planners in establishing level of protection needs and alternatives. A specific model will be created and decision-making processes designed that will be compatible with decision-making in regional fire management strategies, provide assistance for assigning targets in future land use plans, and be responsive to decision needs and directions developed in OMNR timber production policy and subsequent timber management plans.

EXPECTED RESULTS:

A model to support fire management decision-making and assist in making level of protection decisions will be developed, and a report that describes the operational planning process incorporating the tools and models developed under this project will be prepared.

IMPLICATIONS:

This project will result in a clear and concise definition of the concept of level of protection commonly understood by all partners in forest management. It will provide the means for fire management to participate in forest management planning meaningfully and effectively, and will complement OMNR's new directions for a planning system, currently under review in the province.

COLLABORATORS:

P.C. Ward, Aviation, Flood and Fire Management, OMNR.

NOTES

SILVICULTURAL PRACTICES

Competitiveness of Nutrient-loaded Seedlings on Vegetation-rich Boreal Mixedwood Sites

Duration: 29 May, 1992 to 31 March, 1995 **Contract Value:** $228,600

Principal Investigator: V. Timmer
Faculty of Forestry, University of Toronto

Scientific Authority: I.K. Morrison
FCOR, Sault Ste. Marie

OBJECTIVE:

To develop a new growing technique for container seedlings, called exponential nutrient loading, which will enhance competitive growth performance of planted trees on weed-prone sites.

DESCRIPTION:

Boreal mixedwood sites, which make up a large part of the forest area of northern Ontario, are characterized by intensive competition from natural vegetation after harvesting and planting. Herbicides have often been used to control the competing vegetation, but alternative non-herbicidal means of control are now being sought because of environmental concerns. Traditional approaches to vegetation management have focused primarily on controlling the non-crop competing vegetation by site preparation, partial cutting or complete eradication to favor the development of the planted crop.

This project will investigate a different approach to weed control based on enhancing the initial performance of planted trees to suppress growth of competitive vegetation. Improved seedling quality will be induced, in both the greenhouse and in the field, by a new method of nutritional preconditioning of planting stock that combines exponential fertilization with nutrient-loading techniques.

In the first year seedlings will be produced under simulated operational greenhouse conditions using both conventional fertilization and exponential nutrient loading techniques. Subsequently, the trees will be planted on sites adjusted to different vegetation densities to assess plant interactions and nutrient dynamics over a two-year response period.

EXPECTED RESULTS:

The results of growth analysis and the nutrient allocation patterns of the crops are expected to show that the exponentially loaded seedlings compete better for moisture, nutrients and light among competing vegetation than do the non-loaded seedlings because of improved preconditioning treatments applied in the nursery. An operational manual for producing exponentially nutrient-loaded seedlings will be prepared for commercial seedling producers.

IMPLICATIONS:

This study will provide a method for enhancing the competitive growth performance of new seedlings, while minimizing herbicide use.

COLLABORATORS:

A. Aidelbaum, North Gro Development Ltd.; G.E. Stanclik, Abitibi-Price Inc., Iroquois Falls.

Regeneration of Black Spruce Cutovers Using Mini-plugs

Duration: 15 June, 1992 to 15 June, 1995 **Contract Value:** $130,060

Principal Investigator: R. Booth
Domtar Inc., Red Rock

Scientific Authority: G. Hogan
FCOR, Sault Ste. Marie

OBJECTIVE:

To determine, by comparative field trials and ecophysiological studies, the suitability of mini-plugs for plantation establishment on a range of site types in northwestern Ontario.

DESCRIPTION:

Plantation establishment using conventional bareroot or container stock is among the most expensive regeneration methods being applied in northern Ontario. One low-cost alternative that has shown considerable promise is the outplanting of "mini-plug" stock. In 1988 Domtar Inc., in conjunction with OMNR's Northwest Region Science and Technology Unit, began studying the feasibility of using mini-plug stock to regenerate shallow-soiled sites in the Lake Nipigon Forest Management Agreement area. These mini-plugs consist of a 4-cm-long, 1-cm-diameter peat/polymer mix in which seedlings are grown for 10 to 12 weeks in the greenhouse to a target height of 4 cm. Their small size, low cost (about one third the production cost of conventional container stock), and favorable growth response after outplanting make mini-plugs an attractive alternative for reforesting many boreal sites.

Three stock types (mini-plug, vent block container and 3G+2 bareroot transplants) will be compared through field trials on a range of upland site conditions commonly found in northwestern Ontario. The ecophysiological component will investigate the physiological condition of the stock types at the time of outplanting and examine changes in physiological response over the growing season in relation to soil water availability and light levels.

EXPECTED RESULTS:

A series of reports on the feasibility of using mini-plugs will be prepared, along with management guidelines on the suitability of mini-plugs on various northwestern Ontario Forest Ecosystem Classification Soil and Vegetation Types. These will enable forest managers to determine the suitability of mini-plugs for use in their particular areas.

IMPLICATIONS:

Development of low-cost planting techniques for regenerating certain types of sites (i.e., sites without excessive competition) would greatly reduce silvicultural costs and permit a much larger portion of Ontario's black spruce cutovers to be satisfactorily regenerated.

COLLABORATORS:

R. Fleming, FCOR; Northwest Region Science and Technology Unit, Nipigon District, Northwest Region and Thunder Bay Forest Nursery, OMNR.

Efficacy of Release Treatments on Regeneration Strategies of Major Competing Species of Northwestern Ontario

Duration: 20 October, 1992 to 31 December, 1995 **Contract Value:** $165,000

Principal Investigator: A. Mallik
Department of Biology, Lakehead University, Thunder Bay

Scientific Authority: W. Bell
Ontario Forest Research Institute, OMNR, Sault Ste. Marie

OBJECTIVES:

1. To study the efficacy of three release treatments (the herbicide Vision®, the use of brush saws, and complete removal of competing vegetation) in relation to the regeneration strategies of the major competing (non-crop) species of northwestern Ontario.

2. To predict vegetational changes following release treatments based on the regeneration strategies of competing species.

DESCRIPTION:

Public concern regarding the use of herbicides for tending or releasing crop trees in regenerated cutovers has increased significantly in northwestern Ontario during the last few years. At present, little is known about how the major competing species respond to various release treatments. An understanding of pre- and post-treatment regeneration ability and the population dynamics of competing species would help to explain the vegetation processes observed in the field following release treatments, and has practical implications for vegetation control strategies.

This project will study three release treatments:

1. Brush saw use (ground);
2. Aerial application of Vision® (1.5 kg a.i/ha); and
3. Complete removal of competing vegetation with repeated backpack application of Vision® (aerial, then ground).

These will be compared against a control. This study will monitor the crop plant response, the percentage cover and average height of competitive vegetation, and the size of small mammal populations.

The regeneration strategies of five species (trembling aspen, beaked hazel, pin cherry, green alder and red raspberry) will be studied before and after treatment.

EXPECTED RESULTS:

A field guide will be produced, highlighting the major findings and their practical implications for competition control using the release treatments.

IMPLICATIONS:

Increased knowledge of the reproductive processes of the major competing species will enhance the manager's ability to predict the effects of release treatments used in forest management in the boreal forest.

COLLABORATORS:

W.D. Towill, Northwest Region Science and Technology Unit, OMNR; J. Keene, Boise Cascade, Fort Frances Division.

Low Cost, Antistress Antioxidants for Enhanced Growth and Stress Tolerance in Conifer Transplants

Duration: 01 August, 1992 to 31 March, 1995 **Contract Value:** $225,000

Principal Investigator: T.J. Blake
Faculty of Forestry, University of Toronto

Scientific Authority: I.K. Morrison
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To develop techniques suitable for nurseries and greenhouses to use in hardening seedlings to make them more competitive on harsh, northern boreal microsites.

2. To document the increased survival, vigor and competitiveness of Ambiol®-treated coniferous transplants.

3. To determine the nature of the stress posture induced by Ambiol®.

DESCRIPTION:

Environmentally tolerant seedlings are critical for successful reforestation. Young succulent coniferous seedlings are transplanted from an optimal environment in the greenhouse to harsh, boreal planting sites, where disease, frost, drought and other environmental stresses limit their success. Slow growth of coniferous transplants reduces their competitiveness, so release from weed competition becomes necessary. At issue here is how to ensure that environmentally tolerant seedlings will grow vigorously, enabling them to compete with weed competition. A related problem is that of overwintering damage in container stock. Techniques are required that minimize overwintering damage while promoting vigorous growth after planting.

Treatment with vitamins E and C (natural antioxidants) can be used to "fool" the plant into a stress-reactive posture, "arming" it against anticipated onslaughts. Vitamin therapy induces the formation of "defence proteins" that reduce defoliation by gypsy moth and other larvae. Antioxidants also scavenge free radicals, helping to protect plasma membranes from the damaging effects of stress. Synthetic analogs such as Ambiol® are cheaper to produce and they are able to stimulate growth rate and biological productivity.

This project will test the hypothesis that Ambiol®-treated seedlings grow faster under stress due to their ability to maintain carbohydrate-gain rates during the early stages of a drought and recover faster than untreated seedlings.

The growth and physiological response of seedlings to Ambiol® under controlled conditions will be studied, including: (1) growth enhancement (height, diameter and dry weight of roots and shoots); (2) alteration of plant water relations; and (3) effects of Ambiol® on the acquisition of frost, heat and drought tolerance. Biochemical changes in 1 and 2, and genetic variation in Ambiol® response will also be studied. The stress-enhancing capability of Ambiol® will be verified in the field.

EXPECTED RESULTS:

A manual, intended for use by the greenhouse or nursery operator, will be developed for seed pretreatment with Ambiol® to harden coniferous seedlings against biotic and abiotic stresses. This technology will also be transferred to the end users (greenhouse and nursery operators).

IMPLICATIONS:

This study will develop a technique to harden seedlings to improve their competitiveness. Faster-growing, more competitive seedlings will reach the "free-to-grow" stage earlier and there will therefore be less need for herbicide treatments.

COLLABORATORS:

F. Beall, FCOR; S. Colombo, Ontario Forest Research Institute, OMNR; New North Greenhouses; Uniroyal Chemical Co. Ltd.

Natural Regeneration of Softwood and Hardwood Tree Species After Full-tree Harvesting in Northwestern Ontario

Duration: 01 January, 1993 to 31 December, 1994 **Contract Value:** $159,347

Principal Investigator: E. Symons
Earthworks, Thunder Bay

Scientific Authority: J.B. Scarratt
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To ascertain whether full-tree harvesting results in different rates of ingress of natural regeneration, species composition, and stand structures for selected sites in northwestern Ontario.

2. To study Objective 1 within the framework of ecological site types and seedbed condition classes for hardwood and softwood tree species that occur in northwestern Ontario cutovers.

3. To review Objective 1 with respect to current OMNR requirements for timing of post-harvest regeneration surveys.

DESCRIPTION:

Data collected by the Survey of Artificially Regenerated Sites (SOARS) program in 1985–1986 showed that 10- to 14-year-old jack pine and black spruce plantations in northwestern Ontario averaged 5,800 stems per hectare. Initial planting densities averaged only 1,880 stems per hectare. The additional stems were the result of ingress of natural tree seedlings. These SOARS data clearly showed that cutovers in northwestern Ontario suffer (at least from a timber optimization point of view) from too many trees on the ground, not too few. These results demonstrated the need for a tool to help predict the rate and abundance of natural regeneration.

Promotion of natural regeneration will not only reduce the costs of forest regeneration, but knowledge of the site-specific responses of ingress of natural regeneration will allow flexibility in the timing of regeneration surveys and setting performance standards based on site-specific stand dynamics.

The OMNR's Northwest Region Science and Technology Unit has recently completed the field portion of a two-year project investigating the ingress of natural regeneration in 10- to 15-year-old plantations. The currrent project will carry out a similar investigation, but it will focus on plantations established after full-tree logging.

EXPECTED RESULTS:

This project will result in a report that describes the ingress of natural regeneration on selected site types of the Northwestern Ontario Forest Ecosystem Classification (FEC) after full-tree logging. Workshops will also be held to transfer the results of the project directly to clients in the field. An FEC Interpretation for ingress of natural regeneration by site type will also be developed.

IMPLICATIONS:

Information from this project on the ingress of natural regeneration will reduce the costs of regenerating forests across northwestern Ontario, and perhaps across much of the boreal forest, and will enable improved silvicultural decisions. Species composition and stand structure data gathered during this project can be used to refine decisions in the context of predicting the need for vegetation management after harvesting.

COLLABORATORS:

C. Bowling, Northwest Region Science and Technology Section–Terrestrial Unit, OMNR; W. Wiltshire and P. McAlister, Thunder Bay District, OMNR; R. White, Northwest Region, OMNR; W. Klages, Canadian Pacific Forest Products Ltd., Thunder Bay.

Project No.: 4022

Yellow Birch and Sugar Maple Thinning: Effects on Diameter and Height Increment, Crown Size and Stem Form

Duration: 15 June, 1992 to 31 March, 1994 **Contract Value:** $18,700

Principal Investigator: J.E. Wood
FCOR, Sault Ste. Marie

OBJECTIVE:

To determine the effects of different intensities of thinning on diameter and height increment, crown size, stem form and epicormic branching of yellow birch and sugar maple crop trees.

DESCRIPTION:

Strip clearcutting in the tolerant hardwood stands of OMNR's Blind River area resulted in excellent natural regeneration of yellow birch and sugar maple. However, many stands were severely overstocked and required thinning to obtain their maximum potential. These stands were thinned in 1986, after about 20 years of growth, as part of a research study designed to obtain information on the effects of various intensities of thinning on young hardwood stands in the tolerant hardwood forests of northern Ontario. In the autumn of 1991, the height, diameter, and crown size increments of the yellow birch crop trees were recorded as well as the number of epicormic branches. Similar measurements will be taken for the sugar maple crop trees. The 5-year growth data for both species will be compiled and analyzed to determine the effects of thinning at different intensities.

EXPECTED RESULTS:

This project will provide recommendations for the thinning of 20- to 30-year-old yellow birch and sugar maple stands.

IMPLICATIONS:

Foresters throughout the Great Lakes–St. Lawrence Forest Region will be able to use this information to determine how to increase the growth and improve the stem quality of tolerant hardwoods through thinning, thus maximizing the value of timber resources earlier in the rotation.

COLLABORATORS:

F.W. von Althen, Sault Ste. Marie; G. Mitchell, FCOR; G. Campbell, Blind River Area, OMNR.

Black Spruce Outplantings on Boreal Mixedwood Sites: Effect of Vegetation Management and Stock Size

Duration: 01 June, 1992 to 30 June, 1994

Contract Value: $21,850

Principal Investigator: J.E. Wood
FCOR, Sault Ste. Marie

OBJECTIVE:

To evaluate the effects of post-planting vegetation management and the effects of stock type and grade on black spruce establishment on upland boreal mixedwood sites.

DESCRIPTION:

The short-term beneficial effects of controlling weeds in black spruce plantations have been well documented, but it is not yet certain whether these beneficial effects will increase or decrease over the long term. In addition, the effects of stock type and grade on long-term plantation performance have not been adequately documented. In this project, researchers will carry out an eleventh-year remeasurement of four black spruce vegetation management and comparative planting experiments in northeastern Ontario.

EXPECTED RESULTS:

This project will provide information on the long-term effects of vegetation control on black spruce regeneration.

IMPLICATIONS:

The project will provide forest managers with the information needed to develop sound regeneration programs and to develop plantation performance standards on boreal mixedwood sites. It should be possible to determine the best planting season, the most resilient stock type and the best vegetation control treatment for producing hardy black spruce from seedlings. Chemical costs could be reduced and long-term growth and survival of seedlings could be enhanced.

COLLABORATORS:

G. Mitchell, FCOR.

Project No.: 4026

Low-cost Regeneration Methods for Black Spruce on Peatlands

Duration: 15 June, 1992 to 30 June, 1995 **Contract Value:** $54,000

Principal Investigator: A. Groot
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To compare 10-year development of black spruce advance growth following harvesting by three different methods.

2 To examine 10-year development of broadcast-seeded black spruce on peatlands.

DESCRIPTION:

Follow-up measurements and analysis on two experiments established between 1982 and 1984 will be conducted. One experiment examined in detail the survival and growth of black spruce advance growth following three types of harvesting: chainsaw felling with narrow-tire skidder forwarding in summer; feller-buncher felling with wide-tire skidder forwarding in summer; and feller-buncher felling with narrow-tire skidder forwarding in winter. Follow-up measurements taken between 1992 and 1994, 10 growing seasons later, will be compared with earlier measurements on the same sites. The other experiment examined how weeding rate and seedbed amount influenced seedling stocking and density. These trees will also be measured after 10 growing seasons and the data will be analyzed and compared with earlier measurements.

EXPECTED RESULTS:

The long-term effects of three harvesting methods on the survival and development of black spruce advance growth on peatlands, and the long-term development of broadcast-seeded black spruce on peatlands over the same time period, will be reported.

IMPLICATIONS:

Results from this project will assist forest managers and silviculturists in planning and implementing harvesting and regeneration treatments for black-spruce dominated peatlands, which are particularly difficult and expensive areas to replant. Managers should be able to determine which harvesting method will allow advance growth black spruce seedlings to regenerate the area. This project will also clarify whether the broadcast seeding of cutover peatland forest will result in reliable growth and development of black spruce forests. If these methods are adopted, more cutover peatlands could be regenerated at lower cost.

COLLABORATORS:

M. Adams, FCOR.

Black Spruce Stand Development in Naturally-regenerated Strip Cuts at Fifteen Years

Duration: 01 July, 1992 to 30 June, 1994 **Contract Value:** $90,100

Principal Investigator: J.K. Jeglum
FCOR, Sault Ste. Marie

OBJECTIVE:

To assess stand development after 15 years in naturally regenerated black spruce stripcuts on shallow soils in OMNR's Nipigon District.

DESCRIPTION:

The Nipigon Strip Cut Study, initiated in 1982, was designed to study stand and vegetation development following clearcutting (specifically strip clearcutting) in boreal black spruce in Canada. Fifth-year regeneration response was recorded in 1987, with stocking levels at that time reported as fully acceptable. It is not known, however, if these levels have remained the same, increased or decreased. This project will reassess three existing study areas for regeneration, vegetation and quality of seedbed at years 15 to 17 after harvest, providing a temporal sequence of structural and floristic (species) diversity changes. Researchers will look at whether vegetational competition will negatively affect the black spruce regeneration and whether the original forest cover type relates to the level of competition that is developing.

EXPECTED RESULTS:

Stocking and density development for black spruce and other species present on the study areas will be compared between the pre-harvest period and at post-harvest years 1, 3, 5, 15, 16, and 17. The temporal changes in vegetation cover and floristic richness will be summarized. Vegetational changes will be related to site type, original broad cover type, and to the density and composition of the developing stands. Stand structure and development in the permanent sample plots for various cover types and original forest cover conditions will be summarized. A demonstration area featuring the results of regeneration in stripcuts will be established.

IMPLICATIONS:

This project will provide reliable information on the probability of regeneration success after strip-clearcutting in black spruce. Foresters will be able to predict the proportion of strip clearcut areas that will need retreatment or fill planting. Foresters will also be able to manage initial conditions better to achieve optimum stand development and fiber production, and to predict the volume of wood that will be available. The findings from this study will be appropriate for application in upland and shallow-soil black spruce ecosystems and on similar black spruce boreal sites.

COLLABORATORS:

D. Ropke, FCOR; Q. Day and T. Zitnak, Nipigon District, OMNR; K. Belanger and R. Booth, Domtar Forest Products, Red Rock; M. McLaughlan, Northwest Region Science and Technology Unit, OMNR.

Seedbed and Microsite Effects on the Growth of Seeded Upland Black Spruce

Duration: 01 July, 1992 to 31 March, 1994 **Contract Value:** $35,500

Principal Investigator: R.L. Fleming
FCOR, Sault Ste. Marie

OBJECTIVE:

To enhance the establishment, growth and productivity of seed-regenerated stands of black spruce by identifying optimal seedbed and microsite conditions on different upland site types in northwestern Ontario.

DESCRIPTION:

Although specific seedbed requirements for black spruce establishment on coarse-textured soils have now been identified, there is still little information on the effects of different seedbed and microsite conditions on the subsequent growth and development of seeded stands. In 1982, as part of a larger series of black spruce scarification and seedbed microsite trials, two groups of experiments were specifically designed to investigate the effects of upland seedbed and microsite types on seedling establishment and growth. Five years following seeding, established seedlings were measured for height growth, annual height increment and diameter. To provide complete regeneration response information, this project will measure the same seedlings to determine growth response over the last five years. Growth response will be related to the seedling's particular seedbed and microsite conditions.

EXPECTED RESULTS:

Two reports will be produced, one that deals with the effects of seedbed, microsite and northwestern Ontario Forest Ecosystem Classification site type on 10-year growth response of seeded black spruce. Based on the seedbed and site information, a second report will establish scarification guidelines for direct seeding black spruce on coarse-textured soils in northern Ontario. A workshop will be held to present the results of the study to practicing field foresters.

IMPLICATIONS:

The successful development of direct seeding techniques for black spruce will permit cost-effective regeneration of many sites that currently receive little silvicultural treatment because of distance from mills, poor access, limited site productivity and budget constraints. Information from this study will be used by management foresters in the planning of silvicultural operations and the selection of site preparation equipment. Field foresters and forestry technicians will be better able to prescribe seedbed requirements and assess scarification performance.

COLLABORATORS:

Thunder Bay District, OMNR; Northwestern Ontario Region, OMNR; and Northwest Region Science and Technology Unit, OMNR.

Partial Cutting in Boreal Mixedwoods: Evaluation of Harvesting Operations, Site Disturbance and Damage to Residual Trees and Advance Growth

Duration: 01 April, 1993 to 31 March, 1996 **Contract Value:** $217,000

Principal Investigator: J.B. Scarratt
FCOR, Sault Ste. Marie

OBJECTIVES:

In an experimental comparison of partial cutting versus clearcutting in boreal mixedwoods, using different harvesting systems and methods:

1. To determine relative harvesting productivities and efficiencies;
2. To evaluate relative levels of soil disturbance during harvesting;
3. To quantify and evaluate wounding and damage to advance growth and residual trees;
4. To evaluate wound infection and healing processes, and to rate the hazard for stain and decay in residual trees; and
5. To quantify the post-harvest survival and development of advance growth, and the ingress of natural regeneration of the major tree species, in relation to site disturbance.

DESCRIPTION:

Boreal mixedwoods constitute an important element in Ontario's forest resource base. In today's society, it provides not only economic benefits but also many non-timber values, *viz.*: fish and wildlife habitat, aesthetics and recreation, and biological and landscape diversity. In the past, management of boreal mixedwoods has been simplistic in both its approach and its goals. Today, with ecosystem management and integrated resource management the operating words, the range of management options available to forest managers must be expanded to enable them to respond to the needs of different resource interests.

This project examines partial cutting as an alternative to clearcutting. Using different harvesting intensities and equipment, the experimental approach will compare partial cutting with clearcutting in terms of harvesting productivities and silvicultural impacts.

EXPECTED RESULTS:

Two major reports, one that describes the operational nature of the treatments, and another that covers the scientific aspects of the project, will be produced. In addition, a number of technical notes will be written to cover the operational aspects, short-term environmental impacts, nature and incidence of logging damage to advance growth and residual trees, recovery and development of surviving advance growth, pathological relationships and interpretations, ingress of natural regeneration and implications for stand perpetuation and development.

IMPLICATIONS:

This project will benefit sustainable forestry development in northern Ontario by helping to define the feasibility of alternative management strategies in boreal mixedwoods through an evaluation of the effectiveness, costs and impacts of partial cutting in an operational setting.

COLLABORATORS:

M.T. Dumas, I.K. Morrison and J.-D. Leblanc, FCOR; J.A. Addison, Forestry Canada, Forest Pest Management Institute; J.F. Gingras, Forest Engineering Research Institute of Canada, Pointe Claire, Quebec; Canadian Pacific Forest Products Ltd., Thunder Bay.

Project No.: 4039

Small Forest Openings to Promote the Establishment and Growth of White Spruce in Boreal Mixedwood Stands

Duration: 01 September, 1992 to 31 August, 1995 **Contract Value:** $148,000

Principal Investigator: A. Groot
FCOR, Sault Ste. Marie

OBJECTIVES:

To determine how small forest openings can be used to:

1. Improve the establishment of white spruce from seed;
2. Reduce planting check in white spruce;
3. Reduce frost damage to white spruce; and
4. Inhibit the development of broadleaved competition.

DESCRIPTION:

White spruce, once the unifying species in natural boreal mixedwood forests, is losing its dominant position to trembling aspen and balsam fir. It would be desirable to sustain the white spruce component of mixedwood forests for several reasons:

1. To reproduce the composition of natural forests;
2. To maintain species diversity; and
3. To provide a diversity of potential forest products.

Planting in large clearcuts has a number of problems, including planting check, frost tolerance of spruce, and rapid-growing broadleaved competition, especially on fertile sites.

This project will look at white spruce regeneration from the context of small openings in the canopy by studying the effects of the size and configuration of forest openings on white spruce establishment. The aim of the canopy treatments is to provide a range in forest influence, which is the effect of the surrounding forest on light, temperature, moisture and humidity conditions. The effects will be studied from several perspectives: establishment of white spruce from seed, alleviation of planting check, frost damage, development of trembling aspen, analysis of seedling and aspen responses, and environmental measurements.

EXPECTED RESULTS:

Practical information will be provided on several important aspects of white spruce regeneration in mixedwood stands. Information on plant responses to environmental variables and on the effects of forest opening configuration on environmental variables will be used to develop generalized guidelines for the establishment of white spruce on mixedwood sites.

IMPLICATIONS:

Knowledge of the effects of forest opening size and configuration on white spruce establishment from seed, on white spruce planting check, on the development of trembling aspen and on night-time temperatures will be of immediate and direct relevance to forest managers who wish to establish white spruce under conditions similar to those of the experimental stand and site.

COLLABORATORS:

R.L. Fleming, F. Beall, M. Adams, D. Mossa and D. Marles, FCOR; Superior Forest Management, Chapleau; OMNR.

Development and Transfer of Methods for Predicting the Abundance and Distribution of Advance Growth in Black Spruce Ecosystems in Northeastern Ontario

Duration: 01 September, 1992 to 31 July, 1995 **Contract Value:** $200,210

Principal Investigator: R.W. Arnup
Ecological Services for Planning Limited, Timmins

Scientific Authority: D. Archibald
Northern Forest Development Group, OMNR, Timmins

OBJECTIVES:

To transfer knowledge related to the management of coniferous advance growth in black spruce ecosystems to forest managers in northeastern Ontario. This includes the following components:

1. Stand and site conditions associated with the abundance of advance growth;
2. Tools and techniques for predicting the abundance and distribution of advance growth in black spruce ecosystems for inventory and planning purposes; and
3. Experience regarding utilization of the advance growth component in harvesting and regeneration prescriptions.

DESCRIPTION:

Extensive research on advance growth in black spruce ecosystems in Ontario and Quebec has been conducted over the last decade. This research has shown that preservation of advance growth by careful logging is a viable and environmentally sound regeneration prescription and that the abundance of black spruce advance growth can be related to specific stand and site conditions. However, methods for generating an inventory of advance growth conditions, or alternatively, a mechanism for stratifying existing forest inventories, are lacking.

For this project, existing databases relating to the distribution and abundance of advance growth will be obtained. These include the Clay Belt Forest Ecosystem Classification (FEC) database, the more recent Northeast Region FEC database, relevant data from the northwestern Ontario FEC program, and the Advance Growth Survey database collected by Art Groot of Forestry Canada in 1982. These databases will be used to determine and refine ecological relationships for advance growth (i.e., relationships to site types and stand/site features).

There is no advance growth data available for the non-Clay Belt part of Northeast Region. In the first year of the project, 30 forest stands will be selected in this area (southern districts) for detailed Advance Growth Survey plots.

As well, an airphoto interpretation model will be developed that describes stand features that can be used to identify the potential for abundant advance growth in a stand.

In the second year of the project, a more extensive, less detailed survey will be conducted to specifically address the question of variability in stocking to advance growth within forest stands, and to allow for testing of tools developed for predicting advance growth abundance from existing inventories and remote sensing. This latter survey will also be used to test and verify the ecological relationships developed in the first year and in Groot's original work.

EXPECTED RESULTS:

This project will result in the development of a manual to assist forest managers in predicting and mapping the abundance of advance regeneration prior to harvest planning. As well, workshops will be held to train forest planners and field staff in Northeast Region in the use of the predictive tools and aids to mapping advance growth.

IMPLICATIONS:

Ontario is currently faced with reduced production of planting stock, leading to a greater need for alternative regeneration methods. Preservation of advance growth takes advantage of existing stock in stands, and does not increase the burden on seed and tree production programs. The forest industry and OMNR in northeastern Ontario have been exploring the feasibility of regenerating black spruce ecosystems by protecting the advance growth component during harvesting operations. These agencies would benefit greatly from a synthesis of the existing data and experience related to advance growth prescriptions and from the development of better planning tools and inventory techniques.

COLLABORATORS:

Northeast Science and Technology, OMNR.

Field Manual for Direct Seeding Black Spruce and Jack Pine in Northern Ontario

Duration: 01 October, 1992 to 30 September, 1995 **Contract Value:** $58,000

Principal Investigator: M.J. Adams
FCOR, Sault Ste. Marie

OBJECTIVE:

To provide, in a convenient form, the information and predictive models that foresters and technicians need to make and implement direct-seeding prescriptions.

DESCRIPTION:

A joint advisory committee will define the terms of reference, determine the working criteria and construct the framework for a manual and corresponding personal computer-based model that will prescribe direct-seeding programs for black spruce and jack pine in northern Ontario. Predictive model software will be developed along with a manual that will incorporate and synthesize all published data on direct seeding of black spruce and jack pine. The draft manual and integrated software will be evaluated under field conditions and revised before the final printing.

EXPECTED RESULTS:

A field manual and computer software will be produced that will provide the information and predictive models that foresters and technicians need to make and implement direct-seeding prescriptions for black spruce and jack pine in northern Ontario. Training workshops will be held in the use of this technology.

IMPLICATIONS:

The field manual developed by this project will enable managers to carry out a statistically sound reconnaissance survey more readily, accurately identify all seedbed types present, and estimate their respective areas. The computer model, relying on input generated by the field survey, will predict the likelihood of regeneration success in accordance with the course of action taken. Foresters will be able to identify and select candidate sites for direct seeding of black spruce and jack pine and predict the resources required to treat these sites effectively.

COLLABORATORS:

A. Groot, R. Fleming, D. Mossa, G. Atkinson and F. Foreman, FCOR; J. Leach, Spruce Falls Inc., Kapuskasing; R. Seabrook, Canadian Pacific Forest Products Ltd., Thunder Bay; R. Deslauriers, Boise Cascade Canada Ltd., Fort Frances; A. Willcocks, Northeast Science and Technology, OMNR; V. Wearn, Ontario Forest Research Institute, OMNR; M. Ryans, Forest Engineering Research Institute of Canada, Pointe Claire, Quebec; L. Van Damme, Ontario Advanced Forestry Program, Lakehead University.

The Use of Alternative Harvesting and Silvicultural Systems in Boreal Mixedwoods—Review and Synthesis of Information

Duration: 01 November, 1992 to 31 December, 1993 **Contract Value:** $66,500

Principal Investigator: J.B. Scarratt
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To assemble and review literature in the public domain (both operational and research information) that deals with the application of alternative (i.e., non-clearcutting) harvesting and silvicultural systems in boreal mixedwoods, with emphasis upon the experience in Ontario.

2. To synthesize the information so gathered into a report that: (1) summarizes the Ontario experience with the application of alternative systems, as well as the short- and long-term results and impacts of the practices described in relation to resource management goals and concerns; and (2) identifies gaps in our knowledge that must be filled in order to implement alternative harvesting and silvicultural systems successfully in boreal mixedwoods in Ontario.

DESCRIPTION:

The need for new research initiatives in support of boreal mixedwood management in Ontario has been identified repeatedly over the past several years. Integrated resource management must become a reality because of the increasing demands that are now being placed upon boreal mixedwoods. It is important to develop methods for harvesting, regenerating and managing mixedwood stands that avoid the use of extensive clearcutting and intensive plantation silviculture to meet timber production objectives and environmental, wildlife, recreational and other non-timber objectives.

This project will review and synthesize information in the public domain that describes the harvesting and silvicultural systems, excluding clearcutting, that have been applied to the management of boreal mixedwoods in Ontario.

EXPECTED RESULTS:

A report that summarizes the present state of knowledge on the application, results and bioenvironmental impacts of alternative silvicultural systems in boreal mixedwoods, with emphasis on boreal Ontario, will be published. A comprehensive review of relevant literature on alternative silvicultural practices in boreal mixedwoods in Ontario will be prepared and made available on ProCite, a computerized bibliographic database.

IMPLICATIONS:

The synthesis and conclusions derived from this study will be of importance in the management of our boreal forest by emphasizing the application of alternative practices to boreal mixedwoods in Ontario as well as by identifying specific areas in which research can be directed.

Project No.: 4113

Publication of "Guide to the Application of Mechanical Site Preparation Equipment in Northwestern Ontario"

Duration: 01 July, 1992 to 31 March, 1993 **Contract Value:** $17,400

Principal Investigator: B.J. Sutherland
FCOR, Sault Ste. Marie

OBJECTIVE:

To complete publication of a guide on the application or use of mechanical site preparation equipment on sites in northwestern Ontario.

DESCRIPTION:

With the increased variety and sophistication of equipment used in silvicultural practice, the forest manager often has a problem deciding upon the most suitable tool to meet management objectives. This, together with species and site/soil complexities characteristic of the boreal forest region, challenges the manager's ability to select the most appropriate site preparation treatment. Further exacerbating this problem has been the lack of guidelines in Ontario, available only recently, for categorizing boreal forest sites into components useful for forest management.

The Forest Ecosystem Classification (FEC) system for northwestern Ontario provides a framework for describing the various forest stand conditions present in the natural forest and the various site/soil conditions upon which they occur. The next stage will produce a series of interpretations, using the FEC system, to assist with the various decision-making activities involved in forest management. This project is aimed at completing one such set of interpretations, namely an FEC-based guide to the use of site preparation equipment in northwestern Ontario.

Supported by a literature search and a review of other information, the guide will focus on the relationship between site/soil factors and the site preparation treatments that can be applied. Using an approach similar to that used in the FEC interpretations (i.e., two-way lookup tables and fact sheets), the guide will be field validated and published in an easy-to-read format complete with color photographs.

EXPECTED RESULTS:

A guide for forest managers and other field staff to assist with the selection and proper use of mechanical site preparation equipment for sites in northwestern Ontario will be published.

IMPLICATIONS:

The guide will assist the forest manager in making rational decisions on the choice of site preparation equipment and treatment.

COLLABORATORS:

F. Foreman, FCOR; W.D. Towill, Northwest Region Science and Technology, OMNR.

Black Spruce Silviculture: a Compendium of Notes

Duration: 01 July, 1992 to 31 March, 1994

Contract Value: $122,000

Principal Investigator: A. Cameron and G. Crook
FCOR, Sault Ste. Marie

Scientific Authority: C.R. Smith
FCOR, Sault Ste. Marie

OBJECTIVE:

To prepare and distribute to field practitioners user-oriented summaries of key, currently relevant research results from more than 25 years of black spruce silviculture research carried out by Forestry Canada.

DESCRIPTION:

Numerous research results have been published on black spruce silviculture. However, these reports were generally written for a scientific audience and were not geared to the field forester. These results will be reviewed and presented as a series of technical notes, in a clear, concise and factual manner readily understandable by field personnel.

EXPECTED RESULTS:

A compendium of technical notes in three-ring binders will be produced to summarize Forestry Canada's research on black spruce silviculture. Such a format will allow for the addition of later notes and updates to existing notes.

IMPLICATIONS:

As a result of this project, field personnel will gain easy access to a wide variety of technical information that will improve the knowledge base on black spruce silviculture and improve decision-making at the field level.

COLLABORATORS:

Thirty current and, in some cases, retired FCOR scientific, professional and technical staff will contribute.

Project No.: 4209

Cone Crop Monitoring Systems and Decision Support Systems for Jack Pine and Black Spruce Seed Orchards

Duration: 01 July, 1992 to 31 March, 1995 **Contract Value:** $170,000

Principal Investigator: P. de Groot
Forestry Canada, Forest Pest Management Institute, Sault Ste. Marie

OBJECTIVE:

To develop cone-crop monitoring and decision-support systems for jack pine and black spruce orchards, so that seed orchard managers can determine the causes of cone losses, predict seed yields, and decide on the most appropriate cone-crop management option.

DESCRIPTION:

Tree improvement is vital to maintain the sustainable development of Ontario's forests. Seed orchards will be the backbone of the province's tree improvement program. Jack pine and black spruce seed orchards comprise more than 90% of the total area in seed orchard production in Ontario. Most of the seed orchards in Ontario have been established in the last decade, and several are now coming into production. The most significant and controllable mortality factors in jack pine and black spruce cones and seed are cone and seed insects. A system to monitor and predict cone survival over time and to decide on the most appropriate management action will be essential to the management of a seed orchard.

A manual prototype Cone Crop Monitoring System (CCMS) was developed in 1990, and has been very favorably received by seed orchard managers. This project will address all aspects of a CCMS and develop a decision-making process in order to ensure that efficient, effective, and appropriate decisions are made in managing cone crops. Successful management of jack pine and black spruce seed orchards will enable Ontario to meets its stated goal of sustainable resource management.

Specific products to enable seed orchard managers to manage their orchard more efficiently will be delivered by combining new applied research and product development with existing data, knowledge and technology. Software will be MS-DOS-based and executable on compatible personal computers.

EXPECTED RESULTS:

Computer-based CCMS software in an MS-DOS environment to monitor and predict cone crops in seed orchards will be produced. Courses and manuals will be developed to ensure transfer of this technology to the seed orchard managers.

IMPLICATIONS:

The monitoring and support system developed in this study will provide tools for improving the predictability of jack pine and black spruce cone production from seed orchards.

COLLABORATORS:

R. Fleming and J. Turgeon, Forestry Canada, Forest Pest Management Institute; F. Schnekenburger and D. Joyce, Ontario Forest Research Institute, OMNR; Regional Tree Improvement Specialists throughout Ontario.

Seed Zone Delineation for Jack Pine in the Ontario Northwest Region by Short-term Testing and Geographic Information Systems

Duration: 01 July, 1993 to 15 June, 1995 **Contract Value:** $318,547

Principal Investigator: W.H. Parker
School of Forestry, Lakehead University

Scientific Authority: D. Joyce
Ontario Forest Research Institute, OMNR, Sault Ste. Marie

OBJECTIVES:

1. To improve knowledge of the adaptive variation of jack pine in the Northwest Region of Ontario.
2. To refine the existing pattern of seed zones for the region.
3. To develop a rapid, operational method of site-specific seed source selection based upon Geographic Information System (GIS) techniques.

DESCRIPTION:

Seed zone boundaries have been established in northern Ontario to avoid the use of maladapted seed in forest renewal efforts. At present, seed collected from anywhere within a zone is considered suitable to reforest all sites within that zone, but undesirable to reforest areas in adjacent or more distant zones. Although it has been shown that boreal conifers show range-wide clinal variation, the established seed zones in northern Ontario are not based on demonstrated patterns of adaptive variation. Instead, it is assumed that these established seed zones should reflect adaptive variation since they correspond to changes in climate and in some cases vegetation.

For this project, jack pine seedlings from approximately 130 sites will be used for frost hardiness trials, phenological observations and height growth and survival observations in both greenhouse and replicated field trials. These trials will be conducted over a three-year period to establish a database that summarizes adaptive variation in jack pine for Northwest Region.

The project will also develop an operational method for identifing dynamic focal-point seed zones. In this method, an individual site to be reforested becomes the focal point, and a seed zone is specially defined for each site, as required, using a GIS.

EXPECTED RESULTS:

This project will result in an Arc/Info database that summarizes adaptive variation in jack pine for the Northwest Region of Ontario. Information from the project will provide the guidelines for improved seed transfers in the region.

IMPLICATIONS:

Existing boundaries of established zones may be either too conservative or too liberal. If too conservative, overly intensive seed collection efforts waste funds that could be applied elsewhere; if too liberal, the use of maladapted seed results in reduced growth rates or unacceptable survival levels. Improved guidelines for seed transfers within the region will minimize the risk of using maladapted seed.

COLLABORATORS:

P. Charrette, School of Forestry, Lakehead University; R. White, Northwest Region, OMNR; R. Reynolds, Canadian Pacific Forest Products, Dryden; D. Joyce, Genetic Resources Management Unit, Ontario Forest Research Institute, OMNR; Lake of the Woods English River Seed Management Cooperative.

NOTES

FOREST PROTECTION

The Development of Bialaphos and Glufosinate-ammonium as Silvicultural Herbicides

Duration: 01 January, 1993 to 31 December, 1995 **Contract Value:** $363,680

Principal Investigator: G.R. Stephenson
University of Guelph

Scientific Authority: R. Wagner
Ontario Forest Research Institute, OMNR, Sault Ste. Marie

OBJECTIVES:

1. To compare the tolerance (i.e., survival and growth) of important boreal coniferous species (i.e., jack pine, black spruce and white spruce) and important weed species (i.e., bluejoint, aspen and raspberry) to the natural phytotoxin bialaphos and its chemically synthesized analogue glufosinate-ammonium, and to determine if there are effective rates and application methods that control these weedy species but do not harm the conifers under controlled environmental conditions and in the field.

2. To determine the effect of morphological factors (i.e., cuticle thickness), physiological factors (i.e., uptake and translocation) and biochemical factors (i.e., metabolism) on the phytotoxicity of bialaphos and glufosinate-ammonium.

3. To determine the fate and persistence of bialaphos and glufosinate-ammonium in a forest soil and in aquatic systems (lentic as well as lotic environments) and to determine the mobility of these two herbicides in the soil.

DESCRIPTION:

Although synthetic herbicides offer substantial benefits to the forest manager, public resistance to their use is increasing. Naturally produced phytotoxins could be more acceptable to the public than synthetic herbicides while at the same time providing forest managers with a cost-effective and efficient silvicultural tool. One such product, bialaphos, is currently being used as a herbicide in Japan. Bialaphos is a natural weed-control agent that is the fermentation product derived from *Streptomyces viridochromogenes* and is produced by Meiji Seika Kaisha, Japan. The active phytotoxic ingredient in bialaphos is phosphinothricin. Hoechst, AG (Frankfurt, Germany) is producing a synthetic phosphinothricin whose common name is glufosinate-ammonium. Preliminary data show that glufosinate-ammonium is an effective plant desiccant and may fill the current need in northern Ontario for a desiccant prior to the use of prescribed fire. Because both of these potentially useful silvicultural herbicides have the same active ingredient, an applied research program that focuses on the coordinated development of bialaphos and glufosinate-ammonium for forestry has been proposed. The work will focus on meeting the data requirements for herbicide registration submissions. This involves three separate areas of investigation: (1) efficacy and crop tolerance research; (2) physiological studies; and (3) environmental fate and impact studies.

EXPECTED RESULTS:

Research under this proposal will provide fundamental knowledge on differences in the translocation, mode of action and behavior of glufosinate-ammonium and bialaphos in plants. Subsequent field studies will provide a comprehensive database on the environmental fate, persistence and efficacy of both compounds in aquatic and terrestrial compartments typical of potential forest use in northern Ontario. Rate–response studies conducted in the efficacy component will provide knowledge that will allow optimal rates for control of competing vegetation while minimizing the chemical burden on the environment. Data and knowledge generated via this proposal are required for registration of the herbicide.

IMPLICATIONS:

Ultimately, the data from this project will aid in the delivery of a biorational herbicide with greater public acceptance to the forest manager and a suitable desiccant that can be used in prescribed fire programs in Ontario.

COLLABORATORS:

J. Wood, FCOR; D. Thompson and R. Campbell, Forestry Canada, Forest Pest Management Institute.

Project No.: 4010

Alternative Biological and Biorational Control of *Botrytis* Grey Mold in Containerized Conifer Stock

Duration: 01 January, 1993 to 31 March, 1995 **Contract Value:** $126,000

Principal Investigator: J. Sutton
University of Guelph

Scientific Authority: A. Hopkin
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To evaluate biological control organisms and biorational compounds as alternatives to fungicides for controlling *Botrytis* grey mold in containerized conifers.

2. To develop integrated pest management strategies for effective control of grey mold in containerized conifers.

DESCRIPTION:

Botrytis grey mold is considered the number one disease problem that affects the production of containerized coniferous (black spruce, white spruce) stock, and is prevalent in northern Ontario. The causal pathogen, *Botrytis cinerea*, develops as a greyish mold on the foliage and often kills the leader, branches and stem. Weakened seedlings often die after outplanting. Measures to lower humidity and increase lighting in greenhouses, careful fertilizer use, and good sanitation help to suppress the disease, but fungicide programs continue to be the mainstay of control efforts.

Reduced dependency on fungicides might be possible through the use of biocontrol agents for grey mold control. Control might also be possible with the use of a soluble silicate, which has been shown to decrease the susceptibility of some horticultural plants to foliar pathogens, or with sodium bicarbonate, which suppresses various foliar diseases.

During this project, several biocontrol organisms (mycelial fungi, yeasts, and bacteria) that effectively suppressed *Botrytis cinerea* in preliminary screening tests on spruce seedlings will be evaluated in terms of their suppression of grey mold in populations of containerized spruce seedlings in the greenhouse. The progress of the disease will also be monitored on seedlings subjected to various concentrations of sodium silicate and sodium bicarbonate.

This study will examine coniferous seeds, host residues in the greenhouse environment, and air introduced into the greenhouses to identify possible sources of initial inoculum in grey mold epidemics.

Strategies for applying biocontrol agents will be developed in relation to the sources and incidence of initial inoculum, receptivity of the coniferous seedlings to *Botrytis*, microclimatic conditions, and time. The effectiveness of integrated management programs that utilize biocontrol agents and fungicides will also be examined.

EXPECTED RESULTS:

This project will result in the development of effective biological control of *Botrytis* grey mold as an alternative to chemical fungicides in containerized conifers, and the evaluation of a soluble silicate and sodium bicarbonate against *Botrytis* grey mold and as alternatives to chemical fungicides. A report will be prepared on *Botrytis* grey mold, including new information on its epidemiology and management, and available control recommendations.

IMPLICATIONS:

The development of integrated pest management strategies and alternatives to fungicides would result in enhanced production of black spruce and white spruce stock while addressing environmental concerns.

COLLABORATORS:

P. Zhang, University of Guelph.

Silvicultural Prescriptions for Management of White Pine Weevil in Jack Pine

Duration: 01 June, 1992 to 31 March, 1995 **Contract Value:** $156,192

Principal Investigator: S.M. Smith
Faculty of Forestry, University of Toronto

Scientific Authority: G.M. Howse
FCOR, Sault Ste. Marie

OBJECTIVE:

To quantify the effects of stand manipulations on the survival of and damage by the white pine weevil in young jack pine plantations and to provide predictive information that will enable forest managers to reduce weevil populations through silvicultural prescriptions.

DESCRIPTION:

The white pine weevil (*Pissodes strobi*) has been recognized as a serious pest of white pine and Sitka spruce for more than 60 years and is now a serious concern in northern Ontario on jack pine. Jack pine represents a major part of the province's reforestation effort and the white pine weevil will have a serious effect in plantations and newly established tree improvement areas.

Insect pest populations can be controlled through a number of management options, although traditionally these have been studied in isolation and have focused on pesticides. Although effective under given conditions, these approaches have become increasingly restricted in forestry, leaving the forest manager with few available control options. Silvicultural manipulation of forest stands has been often cited as a long-term option for controlling forest insects and is undoubtedly the easiest control for the manager to implement. Such techniques are rarely used, however, because little is known about the impact of stand manipulations on the biology and ecology of the pest.

Infestation of jack pine by the white pine weevil presents an opportunity to study the effects of stand manipulation on pest populations. The plantations are discrete, even-aged and generally accessible. In tree improvement areas, considerable control over site conditions can be achieved. This project will examine innovative pest control practices in these stands that will lead to long-term management of the weevil. Research on stand manipulation to increase mortality of weevils will demonstrate several techniques for reducing weevil damage on jack pine by reducing litter under trees, augmenting shrew and mice populations and increasing herbaceous cover.

In addition, a method for forecasting the impact of the white pine weevil in young jack pine stands will be developed to enable forest managers to predict the extent and severity of damage by varying weevil densities during early development of the stand.

EXPECTED RESULTS:

The method for impact forecasting will be summarized in a technical report for distribution to forest managers and as a result of collaboration with Forestry Canada's Forest Insect and Disease Survey, the results will be directly available to field personnel for incorporation into the current sampling program.

The project will also provide several techniques for reducing white pine weevil damage on jack pine and through stand manipulation.

IMPLICATIONS:

The ability to reduce weevil infestations through silvicultural prescriptions will enable forest managers to protect high initial investments in jack pine regeneration and ensure the continuation of healthy provenance trials in nurseries and tree-improvement sites. It will provide an environmentally acceptable and long-term solution to the management of this pest that is truly integrated with forest management practices. The proposed sampling plan will allow foresters to assess and predict weevil infestations directly.

Recommendations from this study will apply to other species regenerated for commercial production throughout Canada (e.g., Sitka spruce and lodgepole pine in British Columbia; white spruce and Norway spruce in Manitoba, Quebec and the Maritimes). Slightly modified, the predictive sampling plan could also be used for management of the weevil in other tree species.

COLLABORATORS:

V. Nealis and J. Meating, FCOR; S. Hannon, University of Alberta; T. Scarr, Forest Resources Branch, OMNR.

Project No.: 4024

Guidelines for Rating Root Rot Hazard Based on Ecological Site Character and Inoculum Level

Duration: 01 September, 1992 to 30 June, 1995 **Contract Value:** $185,200

Principal Investigator: H.L. Gross
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To investigate the relationship of root rot infection hazard in relation to site character as rated by the Forest Ecosystem Classification (FEC) system.
2. To produce an interpretive manual with guidelines for rating root rot infection hazard on sites being regenerated to spruce.
3. To assess the impact, distribution and intensity of infection of root rots in Ontario's Northwest Region.

DESCRIPTION:

Mortality of young trees caused by root rot is of concern to foresters managing regeneration programs. Damage by some root rots (particularly *Armillaria*) is known to increase in severity when trees are stressed. Certain site characters such as soil texture and moisture regime relate to stress susceptibility. This project will expand on the site analysis techniques developed under the FEC to investigate root rot hazard. It is anticipated that groupings of sites in relation to root rot hazard will reflect FEC groupings.

EXPECTED RESULTS:

An interpretive manual will be produced with guidelines for rating root rot infection hazard on sites being regenerated to spruce. These guidelines will include a site-specific set of root rot control recommendations. A workshop will be held to present the results of the study.

IMPLICATIONS:

This study will provide managers with site selection criteria to identify sites on which root rot damage can be expected to be substantial. Managers will be able to initiate corrective actions on these sites to minimize damage and thereby improve the overall performance of the regeneration program. Information generated by this project will enable foresters to estimate the eventual yield on regenerated sites with greater certainty.

COLLABORATORS:

J.K. Jeglum, R.A. Sims and M. Dumas, FCOR; R.D. Whitney, consultant.

Development of Aerial Survey Methodology for the Evaluation of Balsam Fir and White Spruce in Stands Affected by the Eastern Spruce Budworm

Duration: 01 June, 1992 to 31 March, 1993 **Contract Value:** $27,000

Principal Investigator: J.H. Meating
FCOR, Sault Ste. Marie

OBJECTIVE:

To develop an aerial survey methodology for the evaluation of host condition in stands affected by the eastern spruce budworm.

DESCRIPTION:

The eastern spruce budworm is the most destructive forest insect pest in northern Ontario. Ground surveys and aerial sketch-mapping surveys have economic and logistical limitations. Stand-specific details acquired by aerial mapping are also limited. This study will evaluate videography as an additional tool for assessing stand conditions during spruce budworm outbreaks in northern Ontario. Researchers will fly along several predetermined flight lines in the Northwest Region of Ontario, where a variety of conditions will be encountered. Using experimental videography equipment, surveys will be conducted from the plane to evaluate stand conditions. Data will be collected from the ground following the same flight lines. Videography tapes will be interpreted and compared with ground survey data for such features as total tree defoliation, presence of dead tops and tree mortality rates.

EXPECTED RESULTS:

This project will report on the potential use of aerial videography as a survey tool for assessing stands affected by the spruce budworm.

IMPLICATIONS:

Videography could provide a cost-effective and convenient means of visually recording and identifying a variety of phenomena that threaten forests, including insect outbreaks, diseases, fires, and environmental damage. This information will assist managers in assessing and recommending solutions to control these problems. In addition, decisions such as silvicultural treatments, harvest schedules, salvage operations and protection programs that are influenced by current stand conditions will be made faster and better, at lower cost.

COLLABORATORS:

G.M. Howse, FCOR; T. Scarr and J. Churcher, Forest Resources Branch, OMNR.

Project No.: 4028

Evaluation of Site Preparation Methods on the Development and Progression of Root Decay Fungi with Emphasis on *Armillaria*

Duration: 01 January, 1993 to 31 December, 1995 **Contract Value:** $86,500

Principal Investigator: M.T. Dumas
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To determine the species of *Armillaria* and relative levels of inoculum present on sites that were treated with various scarifying techniques and then seeded.

2. To compare and correlate the infection rate by *Armillaria* with seedling mortality and the method used to prepare the site.

DESCRIPTION:

Current site preparation techniques undoubtedly make the seedbed environment more conducive for the establishment of seedlings. These techniques, however, have long-term impacts on the establishment and sustainability of the stand. One factor that can have a profound influence on the regeneration of a stand and the quality of material it will produce is *Armillaria* root decay. Various conditions, such as stand age, history, composition, site, susceptibility of the host and virulence of the pathogen influence the establishment and progression of root decay in stands. Little is known about the impact of site preparation on the subsequent development and spread of *Armillaria* and other decay fungi in regenerating stands.

Through a comprehensive understanding of the influence different site preparation methods have on the infection rate and spread of *Armillaria*, appropriate silvicultural options can be developed. This would lower the incidence of this pathogen, increase seedling establishment and survival, and improve the long-term productivity of the regenerated stand.

Using scarified sites on plots that were seeded with black spruce and jack pine in the Black Sturgeon and Wawa–Chapleau areas, this project will establish 10- by 10-m plots, and the whole root system of the plants in each plot will be examined for root decay. The decay fungi will be cultured from the samples and identified.

The trap-log method will be used to determine the level of *Armillaria* in each plot. Each plot will be sampled in the fall of each year of the project to obtain sporophores of *Armillaria* for identification and to determine the disease's rate of spread. The results will be analyzed using appropriate statistical methods. Areas not scarified but seeded will be used as controls. The experimental plots will be sampled in consecutive years.

EXPECTED RESULTS:

Insight into the effects of scarification on the development and spread of pathogenic fungi, especially *Armillaria*, will be of benefit to the forester in the implementation of techniques to minimize or alleviate the establishment of decay fungi at an early stand age, when it is most susceptible to these pathogens.

The results obtained from this study will be transferred to field foresters through scientific and technical reports, presentations at meetings and symposia, and workshops and demonstrations. A technical note will be prepared to outline the most appropriate site preparation techniques to minimize root decay damage. The various techniques will be demonstrated to familiarize foresters and silviculturists with alternative scarification options to minimize the effects of decay fungi in regenerating stands.

IMPLICATIONS:

This study will produce information that will enhance forest regeneration techniques through the development of biological methods to control root decay fungi.

COLLABORATORS:

N.W. Boyonoski and a post-graduate student, FCOR; T. Meyer, Ontario Forest Research Institute, OMNR.

Monitoring Changes in Forest Fire Hazard using Satellite Remote Sensing Data

Duration: 01 July, 1992 to 30 June, 1994

Contract Value: $78,000

Principal Investigator: T.J. Lynham
FCOR, Sault Ste. Marie

OBJECTIVE:

To investigate the feasibility of developing operational applications of the Normalized Difference Vegetation Index (NDVI) for monitoring changes in forest fire hazard in the forests of northern Ontario.

DESCRIPTION:

Changes in forest health, such as those caused by insects, diseases or anthropogenic influences, can make forests more susceptible to forest fire. These changes in forest health often reflect a change in the overall amount of chlorophyll present in plants. Chlorophyll reflects in the near-infrared portion of the electromagnetic spectrum and this portion may be monitored by sensors on earth-orbiting satellites. Since the launch of the LANDSAT satellite program in 1972, techniques have been developed for monitoring vegetation greenness. It is now possible to observe the spring green-up process by using sensors to monitor chlorophyll reflection in the near-infrared portion of the electromagnetic spectrum. By monitoring the greenness of the vegetation, it may be possible to provide fire management agencies with timely information on the changes in forest fire hazard, and thereby enable them to take precautionary action such as pre-positioning fire fighting resources close to an area of concern. The LANDSAT Multispectral Scanner (MSS) and the National Oceanic and Atmospheric Administration's Advanced Very High Resolution Radiometer (AVHRR) are primary sources of remote-sensing data for forestry.

This project will investigate NDVI values calculated from AVHRR data for northern Ontario to determine if the data can be used to assess vegetation greenness, and to examine the temporal state of vegetation greenness surrounding two areas (Sudbury and Wawa). Anthropogenic sources of pollution have had a significant influence on the health of the forest in each of these areas, which in turn affects the incidence of fire occurrence as a result of changes in fire hazard.

One stage of the project will focus on using NDVI values to track green-up in the early spring. Satellite data will be correlated with known ground observations to be collected by OMNR field staff. The second stage of the analysis will concentrate on the use of LANDSAT data to compare early 1970s imagery for the Sudbury and Wawa areas with imagery from more recent dates (1980 and 1990); it is suspected that the area is less fire-prone now than it was from 1960 to 1975.

EXPECTED RESULTS:

An operational system for monitoring vegetation greenness over the northern forests of Ontario will be produced by acquiring AVHRR data and processing it for NDVI analysis.

IMPLICATIONS:

This project will provide a tool for provincial fire management agencies to monitor changes in vegetation greenness for specific forest areas and will result in a method for immediately determining areas of potential forest fire hazard.

COLLABORATORS:

B.J. Stocks, FCOR; P.C. Ward, Aviation, Flood and Fire Management, OMNR; J. Cihlar, Canada Centre for Remote Sensing; H. Pokrant, Manitoba Centre for Remote Sensing.

Project No.: 4033

Management Guidelines for Jack Pine Budworm

Duration: 01 July, 1992 to 31 March, 1997 **Contract Value:** $160,000

Principal Investigator: G.M. Howse
FCOR, Sault Ste. Marie

OBJECTIVE:

To develop jack pine budworm impact estimators that will provide accurate predictions of growth loss, top kill, tree mortality, decay and defect in order to develop guidelines for the management of jack pine budworm in northern Ontario.

DESCRIPTION:

More and better information is needed to relate population levels of the jack pine budworm and subsequent damage (impact) caused by the insect in terms of individual tree or stand characteristics such as age, height, stand composition, stocking, site and environmental factors such as drought. This project will collect basic jack pine budworm impact data throughout the next three years of an expected outbreak. Plots will be established based on site class, age and stocking. Trees in the plots will be evaluated each year as to their condition, (e.g., dead, alive, bare top, and amount of defoliation). At the completion of the outbreak, an analysis of radial growth by the trees will be performed.

EXPECTED RESULTS:

Two reports will be produced. The first will describe the progression of the jack pine budworm infestation and its impact on forest characteristics and will present the growth rate and the occurrence of decay and defect of defoliated trees at the stand level. The second report will present a set of management guidelines for the jack pine budworm.

IMPLICATIONS:

Information provided by this project will improve the targeting of protection efforts and reduce spraying costs. Foresters will be able to determine protection requirements and whether outbreaks can be prevented or damage minimized by silvicultural means. Jack pine budworm management guidelines will support decisions on protection, harvesting, salvage and regeneration.

COLLABORATORS:

J.H. Meating, D.B. Roden, A.A. Hopkin, H.L. Gross, C.J. Sanders and V.G. Nealis, FCOR; T. Scarr and H. Liljalehto, Forest Resources Branch, OMNR; J. Waddell, E.B. Eddy Forest Products Ltd., Espanola; L. Suomo, Canadian Pacific Forest Products Ltd., Dryden; D. Munro, Boise Cascade Canada Ltd., Kenora.

Advanced Forest Pest Management Training Program

Duration: 01 January, 1993 to 31 March, 1995 **Contract Value:** $70,500

Principal Investigator: C. Howard
Forestry Canada, Forest Pest Management Institute, Sault Ste. Marie

OBJECTIVE:

To develop two advanced courses in forest pest management and deliver them as part of the Advanced Pest Management Training Program through the Sault College of Applied Arts and Technology.

DESCRIPTION:

If Ontario is to realize the goal of having its forests managed in a more holistic manner, then it is essential that opportunities be created to allow forest managers and other interested parties to get expert training that presents multidisciplinary information in an integrated and practical manner. This is especially true in the field of forest pest management, which has historically been the domain of a handful of "experts" in each province. It has rarely been fully integrated into the whole scope of timber management, let alone the larger arena of "forest management".

This project will develop a series of training projects, presented at a national standard level, that will broaden the horizon of traditional pest management operations and establish a practical manner of assessing and managing forest pest management problems in an integrated fashion with forest management.

EXPECTED RESULTS:

Two advanced pest management courses will be developed. Each will be seven to 10 days in length. The courses are:

1. The Advanced Forest Insect Management Course
2. The Integrated Forest Pest Management Course

Under this project, the inaugural Integrated Forest Pest Management Course will be presented.

These courses, along with the already-developed Advanced Forest Herbicides Course and a proposed Integrated Pest Management for Forest Nurseries Course, will form the Forest Pest Management Program. A planning guide will be prepared from information presented in these courses when all are complete.

IMPLICATIONS:

Integrated forest pest management is a key component of meeting the holistic agenda of sustainable forestry. This program will provide a mechanism for the forest management community to have direct exposure to pest management methodology that is environmentally sound, economically viable and socially acceptable. In short, the program will bring the conceptual attractiveness of integrated forest pest management into the practical world of the forest manager.

COLLABORATORS:

Sault College of Applied Arts and Sciences; Vegetation Management Alternatives Program, OMNR; E. Harvey, Forestry Canada, Forest Pest Management Institute.

Root Rot Fungi and their Relationships with Above-ground Decay in Three Conifers in Ontario

Duration: 04 December, 1992 to 31 December, 1993 **Contract Value:** $22,850

Principal Investigator: R.D. Whitney
Forest Pathology Consultant, Sault Ste. Marie

Scientific Authority: H.L. Gross
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To publish the identity and the age and site relationships of root-rotting fungi in three coniferous species in northern Ontario.

2. To determine relationships between the main root-rotting fungi and their aboveground decay in these three conifers.

DESCRIPTION:

In northern Ontario, root rot damage in the form of dead and windfallen trees and butt cull averages 23% of gross merchantable volume in black spruce, 16% in white spruce and 33% in balsam fir. Some 25 fungi cause root rots, with four or five accounting for 80 to 85% of the damage in these three conifers. Diagnosis of root rot intensity in living trees would be much enhanced if it could be determined from aboveground symptoms. The various root rot fungi have different characteristic patterns in this regard. Testing for a relationship between belowground root rot and the decay columns that result when the rot extends above the ground could well facilitate this diagnosis.

Measurements of both root rot intensity and decay columns at stump height (30 cm) and higher have been obtained for about 1,200 black spruce, 1,300 balsam fir and 500 white spruce in trees from 30 to 120 years old on a range of sites (165 stands) in northern Ontario. Under this project, data analysis will be completed.

EXPECTED RESULTS:

This project will result in two reports. The first will look at the approximately 25 fungi that cause root rot and their relationship with tree age, broad site class and stand composition. The second report will look at the relationships between root rot and decay columns (areas) at 30 cm up the stem for each of the three major fungi, and for all fungi in each tree species by broad age class.

In addition, a workshop will be held to provide a practical demonstration of the types of root rot to forest managers.

IMPLICATIONS:

Clarification of the influence of root rot damage on net merchantable volumes of wood, stocking and stand alteration at various ages across a range of sites, and improvement of the methodology for root rot determination, could facilitate forest management decisions by improving knowledge of net merchantable timber volumes over time; helping to determine cutting cycles (rotations) on various sites; altering planting schedules (species selection) on the more susceptible sites; providing information on longer rotations (large timber) on less susceptible sites; and making root rot evaluations more readily obtainable by forest managers and surveyors.

COLLABORATORS:

T.J. Ennis, FCOR; T. Meyer, Ontario Forest Research Institute, OMNR; various OMNR district offices.

Application of Portable GPS/Desktop-GIS for Fire Management Support

Duration: 01 July, 1992 to 30 June, 1993

Contract Value: $70,342

Principal Investigator: D. Tortosa
ELIRIS Inc., Sault Ste. Marie

Scientific Authority: B.J. Stocks
FCOR, Sault Ste. Marie

OBJECTIVE:

To demonstrate the feasibility of implementing a user-friendly, portable, low-cost technology using a Global Positioning Satellite (GPS) system and a notebook computer-based Geographic Information System (desktop GIS) for the rapid updating, inventory and analysis of forest fires.

DESCRIPTION:

The OMNR currently uses manual techniques to identify the location and trace the progress of forest fires. Monitoring the progress of forest fires is primarily qualitative and relies on correct, identifiable locations on the ground (e.g., lakes and streams) for accuracy. Additional quantitative information on the area and perimeter covered by the fire, and by inference, its rate of advance, is not readily available to the Fire Management Unit.

A trial test completed by OMNR in Timmins in 1991, using airborne GPS and GIS (ARC/INFO) indicated that helicopter-supported GPS provides a rapid (near real-time) and accurate representation of the fire that is only surpassed by supplementary airphotos. However, the GIS technology used for the pilot project is not easily transported into the field, requires GIS specialists and support staff, and has a high cost.

This project will demonstrate the feasibility of a user-friendly, portable, low-cost technology using a GPS system and a notebook computer-based GIS for the rapid updating and inventory of forest fire data.

The GPS/desktop GIS will be tested in parallel with current manual methods during an active fire situation. Mobilization/demobilization time and efficiency for the portable system will be assessed and GPS data will be assessed in terms of real-time analysis of factors such as the area and circumference of the fire, its rate of advance, and a determination of values at risk.

EXPECTED RESULTS:

The project will demonstrate the feasibility of using a portable GPS/desktop GIS as an operational field tool with a near real-time capability, which can serve as an aid to support the Fire Management Unit.

IMPLICATIONS:

The ability to incorporate GPS information quickly and directly into a desktop GIS in order to produce maps and statistics, on a near real-time basis, will enable fire managers to set priorities quickly for dispatching fire-fighting resources and will enhance decision support in determining the dispatch of resources. The GPS/desktop GIS would also be useful in locating the accurate position of resource values ahead of a fire which could be easily relocated by air or on the ground. Small lightning fires that could not be attended immediately, could be relocated accurately with GPS even though the fire might not be visible.

COLLABORATORS:

T. Lynham and J. Mason, FCOR; G. Gordon and P. McBay, Aviation, Flood and Fire Management, OMNR.

Predictive Tools for Management of the Jack Pine Budworm

Duration: 01 September, 1992 to 31 August, 1995 **Contract Value:** $156,500

Principal Investigator: V.G. Nealis
FCOR, Sault Ste. Marie

OBJECTIVE:

To provide forest pest managers with a decision-making protocol based on sampling methods and predictive equations that relate information on population levels of various stages of the jack pine budworm to levels of defoliation in a stand.

DESCRIPTION:

Knowledge of the current status of forest pest populations and predictions of when and where damaging infestations are likely to occur is a basic requirement for management programs. During the course of this project, quantitative information will be collected to develop cost-effective and sufficient sampling methods to estimate population levels of various life stages of the jack pine budworm and to relate these levels to defoliation caused by the jack pine budworm.

EXPECTED RESULTS:

The methods for monitoring jack pine budworm infestations and making decisions on their management will be reported. Results will also be reported at annual pest review meetings, pest control forums, and annual meetings of professional societies.

IMPLICATIONS:

This project will provide a method of estimating the risk of damaging infestations at the stand level and will enhance our ability to determine meaningful levels of protection. Since outbreaks of the jack pine budworm are associated with mature jack pine stands, damage affects those stands in which there has already been the most investment and for which the impacts in terms of timber supply management are most acutely felt. As control programs have a considerable financial, environmental and political cost, they must be undertaken only where unacceptable damage is forecast. This project will develop risk and forecast models to plan and justify both spray and no-spray decisions by forest managers.

COLLABORATORS:

G.M. Howse and C.J. Sanders, FCOR; T. Scarr, Forest Resources Branch, OMNR; S.M. Smith, University of Toronto.

Development of an Eastern Spruce Budworm Hazard Rating System for the Forests of Northern Ontario

Duration: 01 July, 1992 to 31 March, 1995 **Contract Value:** $264,000

Principal Investigator: J.H. Meating
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To develop a hazard rating system to assist forest managers in assessing the susceptibility and vulnerability of forests in northern Ontario to spruce budworm attack by developing a spruce budworm susceptibility map.
2. To develop a spruce budworm vulnerability map and predictive vulnerability models for the major budworm hosts.
3. To develop a process for the production of an annual spruce budworm hazard report.

DESCRIPTION:

The eastern spruce budworm is the most destructive insect pest in the forests of northern Ontario. Average annual losses (1977–1981) attributable to the budworm through tree mortality and growth loss were estimated at 13,252,000 cubic metres.

Studies have demonstrated that stands differ in their vulnerability to the budworm and, therefore, require different management prescriptions during budworm outbreaks. Effective management requires a predictive capability to forecast stand development and damage. If sustainable forestry is to be achieved in northern Ontario, then it is essential that we begin to integrate the effects of spruce budworm outbreaks into forest planning and management. This project will provide the forest manager with a decision-support tool that will begin to integrate the impacts of this major pest into forest management.

A network of budworm impact plots will be established to develop techniques for assessing impact and to provide improved impact estimators over a wide range of stand conditions. Site factors such as stand composition, stand age, site class and climate may be critical variables in model development.

An effective hazard rating system will be quantitative and will utilize parameters normally assessed and available from forest inventory data. It should predict host mortality and growth loss within reasonable confidence limits and should integrate the effects of protection programs. The economic benefits of a hazard rating system will be realized in the effective management of susceptible stands between and during outbreaks. It will enable the forest manager to monitor pest populations more precisely, adjust harvest schedules, carry out silvicultural operations, delimit control operations, and select species for reforestation.

EXPECTED RESULTS:

In collaboration with OMNR, and using Geographic Information Systems (GIS) technology and provincial inventory data, a forest susceptibility map for northern Ontario will be produced at a management unit or provincial basemap level of resolution. A "first generation" budworm vulnerability map will also be produced at the same levels of resolution using the provincial inventory and GIS technology.

An effective and timely spruce budworm hazard report will provide the forest manager with an annual update on the current and predicted vulnerability of spruce and fir stands to the spruce budworm.

IMPLICATIONS:

The hazard rating system will provide the forest manager with a decision-support tool that will begin to integrate the impacts of major forest pests into forest management planning.

COLLABORATORS:

R.M. Rauter, Ontario Forest Industries Association; G.M. Howse and D.B. Roden, FCOR; T. Scarr, Forest Resources Branch, OMNR; J. Kapron, Information Systems Development, OMNR.

NOTES

ENVIRONMENTAL IMPACTS

Assessing the Short Term Effects of Timber Harvest within Riparian Zones on the Wildlife of Wetlands

Duration: 15 September, 1992 to 15 September, 1995 **Contract Value:** $266,140

Principal Investigator: M. Laronde
Teme-Augama Anishnabai, Bear Island

Scientific Authority: K. Abraham
Centre for Northern Forest Ecosystem Research, Thunder Bay

OBJECTIVES:

1. To document the short-term effects of commercial timber harvest in wetland riparian zones on the composition of the wildlife community in wetlands and associated riparian habitats

2. If effects are detected, to evaluate the mitigating value of 30-m shoreline reserves.

DESCRIPTION:

In December of 1991, the Teme-Augama Anishnabai called for a minimum 30-m no-cut riparian reserve to be established adjacent to all wetlands within harvest areas of their traditional homeland, n'Daki Menan. It is recognized that this may not be the most appropriate width in all situations but that by providing at least 30 metres of protection to wetlands, it is thought that habitat will be maintained for dependent wildlife. The study will be conducted in those portions of the Temagami and North Bay OMNR administrative districts of n'Daki Menan, as well as on wetlands which lie outside n'Daki Menan.

The composition of the wildlife community in wetlands and riparian habitats will be monitored (one year prior to harvest and for two years after harvest) in 30 to 45 wetlands that will be allocated to one of three treatments:

1. Commercial timber harvest with no shoreline reserve;
2. Commercial timber harvest with 30-m shoreline reserve; and
3. No commercial timber harvest within 500 m of the wetland (control group).

From collected data, the short-term effects of timber harvest on wildlife community species composition and diversity will be assessed, along with the effectiveness of a 30-m shoreline reserve in mitigating those effects.

EXPECTED RESULTS:

This study will assess the short-term effects of timber harvest on wildlife community species composition and diversity in wetlands and associated riparian habitats. If there are short-term effects, this study will assess whether a 30-m shoreline reserve is adequate in mitigating those effects. Study results will be available in a report for interested parties upon completion of the project, and project findings will be presented to all local and regional resource managers.

IMPLICATIONS:

Knowledge gained from this project will better define the mitigating effects of reserves adjacent to wetlands. The results will provide valuable input for refining provincial guidelines for habitat protection.

COLLABORATORS:

B. Naylor, Central Region Science and Technology Unit, OMNR; W. Selinger and D. Stetson, Temagami District, OMNR; F. Knaapen, North Bay District, OMNR; J. Cutter, Mid North Forest Industry Alliance, Monetville; R. Groves, Temagami Trapper's Council; T. Whitfield, T.W.'s Ecological, North Bay; D. Callaghan, FCOR.

Evaluating Changes to Physical Microsite Properties Effected by High-speed Mixing Site Preparation Methods

Duration: 01 March, 1993 to 31 July, 1994 **Contract Value:** $25,508

Principal Investigator: M. Ryans
Forest Engineering Research Institute of Canada, Pointe Claire, Quebec

Scientific Authority: B. Sutherland
FCOR, Sault Ste. Marie

OBJECTIVE:

To evaluate the effects of various settings of the Forest Engineering Research Institute of Canada (FERIC) rototiller upon the soil environment on a site in Northern Ontario.

DESCRIPTION:

Seedling establishment is enhanced by site preparation practices that improve the soil temperature and soil moisture environments, and that remove competing vegetation. Soil mixing is a relatively new method of forest site preparation that has been shown to produce such beneficial effects. In 1991, FERIC developed a unique high-speed rototilling implement that can be mounted on a wheeled skidder. In 1992, the implement was field tested under a range of soil, vegetation and slash conditions in Saskatchewan. The unit has been prepared during the past winter for a series of operational and research-scale trials.

Forestry Canada will use this implement in a large-scale biological evaluation of various site preparation techniques (see Project 4025, discussed on the next page). The FERIC project will conduct detailed assessments of the effects of various tilling depths and intensities upon soil properties. The work will be carried out on blocks adjacent to the experiment being established by Forestry Canada, and the results will be correlated with the results of the biological study.

EXPECTED RESULTS:

This project will result on a technical report on the results, costs and applicability of rototilling in northern Ontario and a professional-quality video of the entire trial.

IMPLICATIONS:

This project will be an important addition to the database of knowledge pertaining to the effects of rototilling on different sites, which will ultimately permit more site-specific rototilling prescriptions. As well, this project, in conjunction with the Forestry Canada project, will provide a unique linkage between the engineering and biological aspects of forest soil mixing.

COLLABORATORS:

This project is one component of an investigation of alternative methods of site preparation in the boreal mixedwood forests of Ontario and is closely linked to Project 4025, discussed on the next page.

Assessment of Current and Alternative Site Preparation Methods: Environmental Impacts on Forest Soil and Implications for Vegetation Control and Biodiversity

Duration: 01 April, 1993 to 31 March, 1995 **Contract Value:** $115,900

Principal Investigator: B. Sutherland
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To evaluate selected boreal mixedwood site preparation techniques in terms of vegetation/tree response, and the impacts on organic matter decomposition and element mobilization, biodiversity of soil microflora and fauna, and spread of root decay fungi.

2. To elucidate the efficacy and environmental implications of soil mixing as an alternative to current boreal mixedwood site preparation techniques in terms of vegetation response, conservation of organic matter/elements, maintenance of soil microfloral and microfaunal biodiversity, and the control of root decay fungi, primarily *Armillaria ostoyae*.

DESCRIPTION:

This project will use an interdisciplinary approach to investigate the response of the soil system after harvesting to different site preparation techniques. Areas of specific interest include the reaction of vegetative competition to the type of site preparation, the changes in soil characteristics, soil microbiological relationships, and the population dynamics and diversity of microbial populations. Four approximately 1.0-ha treatment blocks will be established, with sub-blocks of 10 by 10 m size, to accommodate the following treatments:

1. Strip and area mixing using the Forest Engineering Research Institute of Canada rotary mixing machine;
2. Strip and area screefing using conventional techniques;
3. Standard herbicide treatment; and
4. Untreated control.

This project is linked with Project 4013, discussed on the previous page.

EXPECTED RESULTS:

The results of this project will provide forest managers with an evaluation of the suitability and environmental impacts of different site preparation techniques in boreal mixedwoods.

IMPLICATIONS:

This project will benefit sustainable forestry development in northern Ontario through the refinement of site preparation practices. Study results will assist in the ranking of a variety of site preparation treatments in terms of their influence on soil nutrient availability and export from the site, the diversity and distribution of the soil fauna and microflora, and the inoculum potential of pathogenic *Armillaria* fungi. These processes have implications for the long-term nutrient status and general health of forest stands.

COLLABORATORS:

M. Ryans, Forest Engineering Research Institute of Canada, Pointe Claire, Quebec; J.A. Addison, Forestry Canada, Forest Pest Management Institute; I.K. Morrison and M.T. Dumas, FCOR; Canadian Pacific Forest Products Ltd., Thunder Bay.

Project No.: 4037

Impact of Harvesting and Site Preparation on Forest Productivity, Soil Nutrient Reserves and Nutrient Leaching from Jack Pine Cutovers

Duration: 01 July, 1992 to 30 June, 1995 **Contract Value:** $132,000

Principal Investigator: N.W. Foster
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To evaluate nutrient cycling models for simulating the responses of jack pine forests to harvesting.

2. To develop recommendations on pine sites at risk of a loss of forest productivity as a result of intensive harvesting and site preparation.

3. To identify harvesting and site preparation techniques that favor the early growth of pine regeneration and those that have detrimental effects.

DESCRIPTION:

A critical concern expressed during the Class Environmental Assessments for Timber Management on Crown Lands in Ontario, and in other environmental forums, is the impact of clearcutting using full-tree harvesting on the long-term site productivity and the sustainability of forest ecosystems. Site preparation by blading, which concentrates the remaining forest floor and slash into windrows and leaves wide strips of exposed mineral soil, has the potential for even greater site degradation. Traditional lines of study suggest that the productive potential of infertile sites could be degraded by losses of nutrients and organic matter.

The interactions among nutrient cycling processes that control the movement of elements between soil and vegetation determine the forest's nutrient status, health, and productivity. This project will produce models of nutrient cycles that can be used to examine the long-term sustainability of forest production on infertile jack pine sites.

The response of nutrient cycles in jack pine ecosystems to forest management practices will be determined. Impacts related to differences in carbon and nitrogen reserves between sites and differences in removals of carbon and nitrogen through harvesting and site preparation treatments will be assessed. The nutrient content of the trees, understory vegetation, woody litter, forest floor and mineral soil will be determined for each site prior to harvest. The nutrient removal from the sites by each management practice will then be calculated.

EXPECTED RESULTS:

Outputs include a short-term simulation of nutrient losses from the soil by leaching and forward projections, through one or more rotations, of vegetation growth and depletion/recovery of nutrient pools in the vegetation and soil. Results and recommendations will be presented in reports and technical notes that summarize the project and model simulations.

IMPLICATIONS:

A generalized model or models of nutrient cycling in jack pine ecosystems will be produced that will enhance the ability of Forestry Canada and OMNR to evaluate the long-term impacts on other forest ecosystems. The model will aid in evaluating current management practices in jack pine in Ontario and in recommending those that are most environmentally acceptable.

Increased forest productivity will result from adopting the recommendations and findings of this project.

COLLABORATORS:

J.K. Jeglum, D. Ropke and I.K. Morrison, FCOR; A.G. Gordon, D. Morris, P. Uhlig and N. Balakrishnan, Ontario Forest Research Institute, OMNR; P. Arp, University of New Brunswick; D. Pyke, Chapleau District, OMNR; B. Fox, Blind River Area, OMNR.

Wetland Ecosystem Classification in Ontario, and Impacts of Forestry on Wetlands

Duration: 01 July, 1992 to 31 May, 1995

Contract Value: $101,500

Principal Investigator: J.K. Jeglum
FCOR, Sault Ste. Marie

OBJECTIVE:

To provide a manual on the classification of the wetland types in Ontario based upon an updating of the Ontario Wetland Classification; to analyze and report on the unanalyzed data sets on wetlands for Ontario; and to summarize the impacts of forestry practices and provide preliminary guides to minimize these impacts.

DESCRIPTION:

The OMNR has expanded its program of wetland evaluation from southern into northern Ontario in recent years, and is increasingly concerned with wetlands inventory, wildlife habitat, and the environmental impacts of forestry activities in or near wetlands.

This project addresses the following problems:

1. To clarify the status of wetland classification in Ontario by writing a manual on wetland classification, which will provide the various criteria and purposes for classification, and keys and descriptive aids for recognition of the current Ontario Wetland Classification.
2. To assemble all existing wetland data sets. To analyze those data sets that require analysis using current multivariate ecological methods. This would be used to further clarify wetland variation and to refine the Ontario Wetland Classification for the manual.
3. To assess the impacts of forestry practices on wetlands and prepare preliminary guidelines for minimizing impacts.

EXPECTED RESULTS:

An updated version of the Ontario Wetland Classification will be published, which will summarize the approaches to classification and identify wetland types and areas in the province where data is lacking. Separate NODA/NFP reports will analyze and classify several wetland data sets. A joint NODA, North American Wetlands Conservation Council (NAWCC) and Canadian Pulp and Paper Association (CPPA) report on the impacts of forestry practices in wetlands will be produced.

IMPLICATIONS:

The increased knowledge and classification of wetlands will result in improved forestry practices for the Ontario wetland types.

COLLABORATORS:

R.A. Sims, FCOR; J. Riley, Southern Region, OMNR; C. Rubec, NAWCC, Ottawa; CPPA, Montreal; E.D. Wells, Forestry Canada–Newfoundland and Labrador Region; P. Uhlig, Ontario Forestry Research Institute, OMNR; R. Remple and K. Abraham, Centre for Northern Forest Ecosystem Research, OMNR; B. Chambers and F. Pinto, Central Region Science and Technology Unit, OMNR; R. Watt, Northeast Science and Technology, OMNR; G. Racey and A. Harris, Northwest Region Science and Technology Unit, OMNR.

NOTES

PLANNING AND FOREST RESOURCE MANAGEMENT

Satellite and Airborne Remote Sensing for Forest Ecosystem Classification in Northwestern Ontario

Duration: 01 April, 1993 to 31 June, 1995 **Contract Value:** $96,850

Principal Investigator: P.J. Howarth
Earth-Observations Laboratory, Institute for Space and Terrestrial Science, Waterloo

Scientific Authority: R.A. Sims
FCOR, Sault Ste. Marie

OBJECTIVE:

To develop a procedure for using airborne and satellite remote-sensing data for discriminating among the mature forest classes defined by the Forest Ecosystem Classification (FEC) for northwestern Ontario.

DESCRIPTION:

Detailed information on forest ecosystems is required for forest resource managers to make informed decisions that will affect the economic, social and environmental prosperity provided by Ontario's forests. This information is now being obtained through application of the FEC, currently in use in northern Ontario. At present, these data are obtained through extensive field data collection and airphoto analyses.

The availability of high-resolution airborne and satellite multispectral and imaging spectrometer data has greatly increased the information content of remote-sensing data. However, detailed information on forest parameters has been difficult to extract from these data using existing image-analysis techniques and/or traditional classification schemes due to a poor understanding of how forest canopy spectra are sampled and/or integrated at a range of scales and spatial and spectral resolutions. As well, there has been little effort to incorporate potential information available on the phenological cycle in landscape reflectance.

This project will examine the relationship between forest ecosystem parameters and remote-sensing data at six spatial resolutions (1.25, 2.5, 5.0, 10.0, 20.0 and 30.0 m). Image-analysis techniques will be tested for discriminating ecological parameters, particularly the FEC classes. These classes will range from the detailed vegetation classes ("V-types") of the FEC to more generalized classes referred to as "Treatment Units".

Additional data to be incorporated into the analysis procedures includes a digital elevation model, from which slope, aspect and elevation maps can be derived. It is anticipated that these data will enhance the separation of forest ecosystems due to the influence of slope, aspect and elevation on forest and soil development.

Once the techniques are developed for mapping FEC and/or related ecological classes from remote-sensing data, cost estimates will be reported for development of an operational mapping program.

EXPECTED RESULTS:

This project will develop technologies that will allow for the interpretation of forest ecosystem data, based on the FEC, from remote-sensing data, and develop technologies that will allow for the extrapolation of forest ecosystem information to large areas from remote-sensing data. The methodologies and procedures that will result from the project will be transferred to forest managers through several workshops.

IMPLICATIONS:

It is expected that the findings of this project will improve current capabilities for the collection and extraction of forest ecosystem information from remote-sensing and digital terrain data for improved forest management. The methodologies developed will provide a cost-effective means for mapping forest ecosystem classes for large areas of northwestern Ontario.

COLLABORATORS:

P.M. Treitz and J.R. Miller, Institute for Space and Terrestrial Science, Waterloo; G.M. Wickware, Geomatics International Inc., Burlington; R. Stanton-Gray, Canada Centre for Remote Sensing, Ottawa; A. Jano, Provincial Remote Sensing Office, OMNR.

Project No.: 4007

Preparation of a Case Study Report on the Photo Interpretation of NWOFEC Soil Types and Vegetation Types in the Roslyn Lake Pilot Mapping Study Area

Duration: 01 September, 1992 to 04 June, 1993 **Contract Value:** $28,220

Principal Investigator: A. Walsh
For-Site Consulting, Sault Ste. Marie

Scientific Authority: R.A. Sims
FCOR, Sault Ste. Marie

OBJECTIVE:

To produce a technical report that will provide resource managers in northwestern Ontario with tools to aid them in identifying and delineating northwestern Ontario Forest Ecosystem Classification (FEC) Soil and Vegetation Types on medium-scale black and white aerial photographs.

DESCRIPTION:

An ecosystem approach to resource management is becoming increasingly important and more widely used. Now is the time to provide resource managers with the tools that will enhance their ability to incorporate ecosystem concepts in their planning and management strategies. The northwestern Ontario FEC is such a tool. It defines Soil Types and Vegetation Types as the framework for describing forested ecosystems in northwestern Ontario, but any stand that is to be classified using the FEC system must be intensively sampled in the field.

The practical value of this classification system could be greatly enhanced if the resource manager could identify and delineate the spatial extent of Soil and Vegetation Types through interpretation of aerial photos.

In 1987–1988, a pilot mapping project was initiated to study the feasibility of photo interpretation and mapping of FEC Soil and Vegetation Types. As part of that initiative, data was collected on a 100-km² area near Roslyn Lake, northeast of Nipigon. The data were used to develop draft keys to the photo interpretation of FEC Soil and Vegetation Types. However, the draft keys incorporated preliminary versions of the FEC Types and were not updated once the classification was finalized in 1989. This project will revise and update these draft photo interpretation keys and prepare a revised guide, thereby providing resource managers in northwestern Ontario with an up-to-date case study of the photo interpretation of FEC Types.

EXPECTED RESULTS:

The guide that will result from this project will illustrate the development of area-specific photo interpretation keys so that managers and airphoto interpreters in other parts of northwestern Ontario can develop photo interpretation keys that are specific to their own particular management areas. Being able to identify FEC Soil and Vegetation Types on airphotos will facilitate mapping of distinct FEC units, thereby encouraging ecologically oriented resource management decisions.

IMPLICATIONS:

The photo interpretation keys that will be provided as a result of this proposed work will be a practical tool for resource managers in northwestern Ontario who need to identify and map large-scale forest ecosystem units.

COLLABORATORS:

W.D. Towill, Northwest Region Science and Technology Unit, OMNR; R.C. Booth, Domtar Forest Products, Red Rock.

White and Red Pine Volume Growth under Uniform Shelterwood Management in Algonquin Park

Duration: 01 April, 1993 to 31 July, 1994 **Contract Value:** $101,000

Principal Investigator: R.D. Pick
Algonquin Forestry Authority, Pembroke

Scientific Authority: R. Miller
Ontario Forest Research Institute, OMNR, Sault Ste. Marie

OBJECTIVE:

To determine the volume growth of white pine and red pine stands that have been managed for 17 years under the uniform shelterwood silvicultural system.

DESCRIPTION:

Timber management in Ontario is based on area control and volume is looked at for only the upcoming five-year term. In order to have sustainable timber management, the total volume of a species on a land base should be determined and the net volume of a species harvested over a five-year term should not exceed the net growth over this time frame.

This project will collect data from nearly 400 plots, and the results will be analyzed to determine the net volume growth of white pine and red pine managed under the uniform shelterwood silvicultural system.

EXPECTED RESULTS:

The project will result in a report that will present the total net white pine and red pine volumes for Algonquin Park and the average net volume growth per year for these species.

IMPLICATIONS:

Information on pine growth rates within Algonquin Park based on site and stocking would permit modeling of the long-term timber supply and provide volume information to mills that depend on pine from Algonquin Park. As well, the growth data could be applied to areas adjacent to Algonquin Park to enable similar long-term decision-making.

COLLABORATORS:

F. Pinto, Central Region Science and Technology Unit, OMNR; W.F. Hubbert and C.M. Corbett, Algonquin Forestry Authority, Huntsville.

Project No.: 4020

Development of Methods for Forest Ecosystem Classification (FEC) Mapping for Northeastern Ontario

Duration: 01 December, 1992 to 31 March, 1995 **Contract Value:** $209,350

Principal Investigator: R. Arnup
Ecological Services for Planning Ltd., Timmins

Scientific Authority: R. Sims
FCOR, Sault Ste. Marie

OBJECTIVE:

To evaluate the relative accuracy, speed and cost of three separate approaches to using existing air photography, forest resource inventory (FRI), botanic, edaphic topographic and other ecological data to create Forest Ecosyustem Classification (FEC) Site Type polygon maps for two ecologically representative study areas in northeastern Ontario at a 1:20,000 scale.

DESCRIPTION:

Increasing public scrutiny of forest management policy and practice is resulting in demands for the "ecosystem approach" at all planning scales in public and private sector forestry. FEC systems provide knowledge suitable for a wide range of forestry interpretations, including trafficability, road locations, harvest planning, advance growth abundance, suitability for seeding, growth and yield potential, vegetation management, wildlife habitat suitability and environmental impact. However, FEC has mainly been used as a site-level tool and has not been applied to a spatially referenced inventory on a large scale. This inventory is needed for input into forest level models and would greatly benefit future forest planning.

There is an urgent need for maps, a spatially referenced inventory of forest ecosystem site types that can be generated efficiently, inexpensively and with known reliabilities.

This project will evaluate three methods of deriving FEC maps in two study areas for accuracy, speed and cost, to provide clients with a sound, tested basis for investment in an operational mapping technique. An FEC inventory will be generated by:

1. Airphoto interpretation of standard panchromatic imagery (FRI photography) in combination with intensive ground-truthing;
2. Airphoto interpretation of FRI photography combined with supplementary large-scale color photography and/or large-scale photography (LSP) and extensive ground-truthing; and
3. Predictive algorithms that use tabular forest and soil inventory data to generate the inventory based on existing maps (e.g., FRI and Prime Land Soil II Maps).

EXPECTED RESULTS:

This project will result in the development and or confirmation of a practical, accurate, cost-effective method (or combination of methods) of mapping FEC Site Types at 1:20,000 scale across Northeast Region. A final report will be prepared on the relative accuracy, speed of production and likely costs of each derivation method. A user's guide will also be prepared for use in training field staff and will include practical tools for use in photo interpretation of FEC types, inventory and mapping.

IMPLICATIONS:

Evaluating different approaches to FEC mapping will reduce the potential for scarce resources to be wasted when users adopt a suboptimal approach to FEC mapping of large areas. This project will evaluate the three approaches to FEC mapping to determine whether costs can be reduced while preserving or improving accuracy levels and production speed.

COLLABORATORS:

K. Virgo, Spruce Falls Inc., Kapuskasing; R. Tomchick, QUNO Corporation, Thorold; T. McCarthy, Northern Forest Development Group, OMNR.

Enhancing Ontario's Forest Resources Inventory with Stand Structure and Forest Ecosystem Vegetation Types using Large Scale Aerial Photography

Duration: 01 March, 1993 to 31 August, 1994 **Contract Value:** $225,500

Principal Investigator: U. Nielsen
Dendron Resource Surveys Inc., Ottawa

Scientific Authority: N. Maurer
Northeast Science and Technology, OMNR, Timmins

OBJECTIVE:

To develop an efficient methodology using large-scale aerial sampling photography (LSP) to enhance the existing Forest Resource Inventory (FRI) by describing stand structure within forest classes.

DESCRIPTION:

For more than 30 years, the FRI has provided information and input for the decision-support tools used in timber management planning. However, FRI has two major shortcomings that limit a resource manager's ability to develop appropriate strategies for timber and non-timber objectives: (1) it does not describe the diameter and height distribution (stand structure) of trees in a forest class; and (2) it does not identify the age or site class of non-working group species.

This project will use the Timmins Forest in northeastern Ontario as a study site to demonstrate the use of LSP to address the shortcomings of the FRI. LSP will be utilized to acquire 1:1,200 scale, stereo photographs to obtain 0.02-ha sample plots in which the derived diameter (through regression) and height frequency distributions of the trees will be compiled. Using Honer's (or local) volume tables, volumes will be determined by species and diameter class for each sample plot. The photos will be aggregated to describe the average conditions of forest classes. This plot data will then be aggregated to describe the average stand and site conditions for forest classes.

Diameter regression estimators will be determined for commercial species (black spruce, white spruce, jack pine, white pine, balsam fir, trembling aspen/balsam poplar and white birch), and will be used to predict DBH using tree height and crown area measured using LSP. Other variables will be investigated to determine whether their contribution will increase the accuracy and precision of DBH estimation. As well, look-up tables for non-working group species specific to the Timmins Forest will be developed.

The sample plot data will be aggregated to provide descriptive statistics for each forest class on a per-hectare basis, including diameter and height distributions for each species, net merchantable volume by species and diameter class, stems per hectare by species, percent canopy closure by species and height class, basal area by species, a revised average species composition, and the distribution of dead and fallen logs. These observations will be used to estimate the yield, by species, for areas that have been harvested in the past three years, and will be compared to actual scaling data. The accuracy and cost of obtaining the required data using LSP technology will be compared with those of conventional methods.

EXPECTED RESULTS:

This project will result in a report that will describe the results and management implications of all project activities, along with technical notes addressing the diameter regression estimators and their applications, look-up tables for non-working group species, a comparison of LSP and conventional methods, the application of LSP technology in wood supply modeling (a case study) and the use of LSP in habitat evaluations. A workshop will also be held to present the results of the project.

IMPLICATIONS:

This project will demonstrate the capability of LSP to enhance the information available from the FRI. The methodology developed will be tested for meeting the objectives of the QUNO Paper Co. Ltd., and detailed documentation will provide the opportunity for others to apply the same or similar approaches with predicted quality of results and costs. This will enable resource managers to make the best use of limited resources.

COLLABORATORS:

R. Miller, Ontario Forest Research Institute, OMNR; F. Addante, Forest Management Information System, OMNR; N. Iles, Resource Planning and Assessment, OMNR; L. Bennett, QUNO Corporation, Timmins; R. Watt and J. Duncan, Northeast Science and Technology, OMNR.

Project No.: 4032

Development of Interim Guidelines to Maintain Long Term Productivity in Boreal Ecosystems of Ontario

Duration: 01 October, 1992 to 30 September, 1994 **Contract Value:** $51,000

Principal Investigators: J.K. Jeglum
FCOR, Sault Ste. Marie

D.M. Morris
Ontario Forest Research Institute, OMNR, Sault Ste. Marie

OBJECTIVE:

Based on the current state of knowledge (e.g., scientific literature and expert opinion), to identify potentially nutrient-poor sites in the boreal forest region of Ontario and to develop "good practice" recommendations for harvesting operations as an interim measure while awaiting results from current research initiatives by the Ontario Forest Research Institute (black spruce) and FCOR (jack pine).

DESCRIPTION:

The resilience of a stand, its ability to return to its original equilibrium after disturbance, can have a bearing on site productivity and low resilience can lead to a lengthening of the rotation age of a forest. The determination of resilience for a given site is extremely complex, and varies with species, site quality factors, age, stand density, silvicultural treatments (e.g., harvesting, site preparation, planting and tending prescriptions), residual nutrient reserves, rates and amounts of inputs, and their multi-order interactions.

A great deal of quantitative information on the structure and function of various ecosystems has been published over the past two decades. Information on the impacts of disturbance and, more specifically, the impacts of silvicultural systems on ecosystem stability and sustainability is also present. What is lacking in Ontario is the development of environmental guidelines, based on the current state of knowledge, that are designed to identify and maintain the long-term productivity of potentially nutrient-poor sites.

This project will accomplish the following:

1. A site framework for both jack pine and black spruce based on the same physiographic features will be developed and linked with the Forest Ecosystem Classification systems.
2. The framework will be overlain with site quality classes and their associated site indices.
3. The site requirements of each species will be identified, utilizing current literature and expert opinion.
4. The regional significance of potentially nutrient-poor sites identified by this process can be assessed.
5. Based on existing knowledge, an interim set of "good practice" recommendations will be prepared and applied while long-term research is being completed.

EXPECTED RESULTS:

An annotated bibliography entered into a Procite database and a printed report will be produced. A report on nutrient-poor sites and recommendations for managing them will also be developed. An interim set of guidelines to good practices will be prepared. OMNR's Science and Technology Units will be used to transfer the results to field staff.

IMPLICATIONS:

This type of guidance would provide forest managers with the most up-to-date information on site vulnerability in terms of nutrient depletion. This information can be utilized in the timber management planning process to assist in the selection of the most appropriate silvicultural system for the array of sites addressed in the plan.

COLLABORATORS:

N.W. Foster and I.K. Morrison, FCOR; A.G. Gordon, N. Balakrishnan and P. Uhlig, Ontario Forest Research Institute, OMNR; D.W. Carmean, Lakehead University.

Impact Assessment of *Scleroderris* Canker in Ontario

Duration: 01 August, 1992 to 31 March, 1995 **Contract Value:** $68,020

Principal Investigator: A. Hopkin
FCOR, Sault Ste. Marie

OBJECTIVES:

1. To develop a framework in which to study the impacts of forest pests.

2. To provide a definitive statement on the losses, economic and otherwise, caused by the *Scleroderris* disease in red pine plantations.

DESCRIPTION:

The development of a general economic framework in which to evaluate insect and disease problems and to identify the feasibility of protection is needed. The *Scleroderris* canker of pines is an important pest in Ontario and would provide an excellent case study for which to develop such a framework. In this project, key elements that contribute to the disease's impact will be identified in consultation with economists and silviculturists. Based on biophysical and economics data, these elements will be incorporated into a framework for impact evaluation. To illustrate the decision-support tool, a cost/benefit analysis of the influence of *Scleroderris* canker and of the response program will be performed using the general impact framework.

EXPECTED RESULTS:

A report that will describe a generic economic framework for the evaluation of forest pest impacts will be published. A technical note on the disease as it occurs in Ontario will be published and other reports will be produced to detail the present distribution, importance and impact of the *Scleroderris* canker disease in Ontario and to describe control strategies and a cost/benefit analysis of control options. A workshop will be held to present the results of the study to forest managers.

IMPLICATIONS:

The information from this study will help managers to make effective decisions concerning future plantings and stand management practices where the *Scleroderris* canker disease is a factor. Managers will be able to weigh growth loss against the costs of surveillance, detection, sanitation and eradication, keeping in mind the potential benefits of such action. The economic impact framework can be modified for use with other disease pests.

COLLABORATORS:

H. Gross and D. McKenney, FCOR; G. Fox, University of Guelph; T. Meyer, Ontario Forest Research Institute, OMNR; G. Felton, Parry Sound District, OMNR.

Project No.: 4035

The Refinement of Prescribed Burning Procedures for Northern Ontario

Duration: 01 July, 1992 to 31 March, 1995 **Contract Value:** $65,000

Principal Investigator: D.J. McRae
FCOR, Sault Ste. Marie

OBJECTIVE:

To increase the effectiveness of the prescribed burning program in terms of a sustainable forestry program for northern Ontario.

DESCRIPTION:

The use of prescribed fire is becoming more attractive as a cost-effective site preparation technique for forest renewal. Changing times in forest management require that the knowledge of prescribed burning on smaller clearcuts and protection of more areas of concern must be refined and updated to conduct burns safely and with little environmental consequence. In this project, researchers will quantify the energy release of prescribed fires by aerially scanning prescribed burns with an infrared camera. The other major activity of the study will be fire wind-flow modeling through analyses of wind speed and direction data collected during prescribed burns.

EXPECTED RESULTS:

Reports will be published on the determination of energy release and on fire wind modeling. A video will be produced on the simulation of wind fields. Technical notes on energy release and fire behavior, fire modeling, and operational prescribed burning ignition conditions will also be generated. Presentations of the results of the study will be made in conjunction with OMNR's regional fire meetings.

IMPLICATIONS:

Prescribed fire is an economical site preparation tool when compared with some alternative methods. In stand conversion projects, fire is the only economical means of removing heavy forest residue and preparing the seedbed. This study will give forest managers more control over the prescribed burning process by enabling forest managers to predict the behavior and impact of their burns during the planning phase and to match prescribed burning prescriptions to site and environmental conditions.

COLLABORATORS:

B.J. Stocks, FCOR; P.C. Ward and P.A. McBay, Aviation, Flood and Fire Management, OMNR; F. Weirich, University of Iowa.

Impacts of Spruce Budworm and Budworm Spraying on Succession in Boreal Mixedwood Forest

Duration: 01 April, 1993 to 31 March, 1996

Contract Value: $86,300

Principal Investigator: C.J. Sanders
FCOR, Sault Ste. Marie

OBJECTIVE:

To determine the interaction of damage caused by the budworm and spraying with pesticides on stand succession in the boreal mixedwood environment.

DESCRIPTION:

Much of the northern Ontario boreal mixedwood forest consists of conifers, with balsam fir being one of the predominant coniferous species. Balsam fir is more susceptible to spruce budworm attack than spruce and, where it is present as the major component of a coniferous stand, the mature stand can be rendered unmerchantable after a budworm attack. The logical step is to spray these stands with pesticides prior to harvesting to maintain the coniferous component. Recent thinking suggests that this will perpetuate the balsam fir component of the stand.

This project will test the hypothesis that spraying for spruce budworm in stands with a heavy balsam fir component in the overstory favors the growth of balsam fir regeneration and suppresses the spruce component through competition. In contrast, the understory fir component is killed off by the budworm if no spraying is conducted, leading to a higher spruce component in the regenerating stand.

EXPECTED RESULTS:

The results of this study will provide guidelines for decision-making on the impact of spraying on regeneration and stand succession. The project's results will also predict the future composition of stands in the study area after a budworm outbreak. The plots established could serve as the nucleus for future long-term studies or as demonstration areas.

IMPLICATIONS:

Boreal mixedwoods occupy some of the most productive and accessible areas of the boreal forest. A successful proof of the study's hypothesis would lead to silvicultural prescriptions for the maturing forest that could lead to a greater component of spruce in the regenerating forest after harvesting.

COLLABORATORS:

A.G. Gordon, Ontario Forest Research Institute, OMNR; J.B. Scarratt, FCOR; Canadian Pacific Forest Products Ltd., Thunder Bay; Y. Prevost, Lakehead University.

Project No.: 4104

Technology Transfer: Forestry Canada's HSG Wood Supply Model

Duration: 01 September, 1992 to 31 July, 1993 **Contract Value:** $124,900

Principal Investigator: A. Welch
Dendron Resource Surveys Ltd., Ottawa

Scientific Authority: S. Anderson
FCOR, Sault Ste. Marie

OBJECTIVE:

To transfer the Harvest Scheduler Generator (HSG) software, developed at the Petawawa National Forestry Institute (PNFI), from the research laboratory to operational forest resource managers and other interested parties in northern Ontario.

DESCRIPTION:

Sustainable forestry development requires solutions that optimize resource allocations on the basis of multiple economic, environmental and social values within complex spatial and temporal relationships. Such optimization requires:

1. The flexibility to accommodate changes to existing parameters and the incorporation of additional parameters;
2. The ability to compile and analyze large amounts of data; and
3. A high spatial resolution of the forest base.

The HSG software, a powerful wood supply model developed by the Forest Management Modeling project at PNFI, meets these requirements. Although considerable interest has been generated and a number of copies of the basic software have been provided to the public and private sectors in northern Ontario and elsewhere, operational utilization of the software has not yet been achieved.

This project will move this technology into the field through the development of a user-friendly, robust version of the HSG software and related support material, and through the design and development of training materials. Workshops will also be held to test the materials and techniques.

EXPECTED RESULTS:

This project will result in a user-friendly version of the HSG software, including training materials. The training materials will be tested during two one-week workshops aimed at the OMNR, at medium and large industrial interests and at universities and colleges with courses related to resource management. Not only will these workshops test the training materials, but they will also transfer the HSG technology.

IMPLICATIONS:

As an operational tool, HSG will allow resource managers and others to study the potential implications of management actions on the resource base. It will also accommodate the incorporation of research findings in such areas as growth and yield, habitat assessment and economic analyses.

COLLABORATORS:

V. Janusauskas, Dendron Resource Surveys Ltd.; T. Grimes and J. Bouchard, IDSYS; P. Duinker, Lakehead University; J. Williams, MW Resource Analysts; T. Moore, PNFI; Northeast Region, OMNR.

Transfer of Volumetric Wood Supply Analysis Technology

Duration: 14 September, 1992 to 08 October, 1993 **Contract Value:** $76,500

Principal Investigator: K. Lindquist
Forest Computer Consulting, Chapleau

Scientific Authority: B. Callaghan
OMNR, Sault Ste. Marie

OBJECTIVE:

To improve upon the transfer of volumetric wood-supply analysis technology to forest managers in northeastern Ontario who are directly involved in preparing timber management plans on Crown Land.

DESCRIPTION:

The Northeast Region of OMNR contains 28 forest management units, for which a timber management plan is prepared every five years. A critical component of these plans is volumetric wood-supply analysis, yet the technology to undertake this analysis readily has been poorly transferred to the field.

The major limiting factor in the transfer of this technology has been the lack of a documented methodology to aggregate forest resource inventory (FRI) data to create input files for wood-supply analysis. Previous training has focused on using the wood-supply model itself (usually FORMAN or CROPLAN), but has largely ignored the critical first step of properly understanding and aggregating the FRI to create input files for these models. Furthermore, although an undocumented FRI aggregation program (NORMAN) exists for the VAX/VMS operating system used by OMNR, there is no program for the MS-DOS operating system commonly used by the forest industry. This project will produce a well-documented FRI aggregation program for both the VAX/VMS and the MS-DOS operating systems. Training and support will also be provided for forest managers who use these analysis tools.

EXPECTED RESULTS:

An MS-DOS program for aggregating FRI files to produce input for wood-supply models will be written and documented in both a user's manual and a technical manual, and will be introduced to field forest managers in a series of mini-workshops across the region.

IMPLICATIONS:

This study will result in the successful transfer of existing FRI database manipulation technology to field managers who are directly involved in preparing wood-supply analyses for timber management plans. A further result will be a better understanding of the forest management practices and expenditures required to sustain the benefits from northern Ontario's forests.

COLLABORATORS:

R. Galloway, W. Thornton, M. Fleming and D. Hayhurst, Northeast Region, OMNR; N. Iles, Resource Planning and Assessment, OMNR.

Project No.: 4110

Publication of Two NODA Technical Reports Dealing With: 1. Boreal Forest Humus Forms in NW Ontario; and 2. *Sphagnum* spp. Habitats in Relation to NW Ontario FEC Types

Duration: 01 July, 1992 to 31 May, 1993

Contract Value: $12,100

Principal Investigator: R.A. Sims
FCOR, Sault Ste. Marie

OBJECTIVE:

To publish two reports, one on the classification of boreal forest humus forms, and the other on the ecological site requirements of forest-dwelling *Sphagnum* species in northwestern Ontario.

DESCRIPTION:

Both humus forms and *Sphagnum* habitats are important site indicators that the forest manager can use for management planning purposes. Already, data for these two indicators has been gathered in more than five years of field work and analyzed in conjunction with the development of the northwest Ontario Forest Ecosystem Classification (FEC). This project will allow for the final writing and publishing of two reports, one on boreal humus forms in northwestern Ontario, and the other on *Sphagnum* spp. habitats in relation to the FEC in northwestern Ontario.

EXPECTED RESULTS:

Two reports will be written, published and distributed to field staff.

IMPLICATIONS:

These two reports will complement the Northwestern Ontario Forest Ecosystem Classification system and will provide scientific and technical information that is of value in the context of current forest management activities in northwestern Ontario.

COLLABORATORS:

K.A. Baldwin, FCOR; W.D. Towill, Northwest Region Science and Technology Unit, OMNR.

Development of an Enhanced OLI-based Prime Land Inventory System for Northwestern Ontario

Duration: 01 July, 1992 to 31 July, 1993 **Contract Value:** $135,750

Principal Investigator: G.M. Wickware
Geomatics International Inc., Burlington

Scientific Authority: R.A. Sims
FCOR, Sault Ste. Marie

OBJECTIVES:

To integrate, using Geographic Information System (GIS) technology (ARC/INFO), 1:100,000 scale Northern Ontario Engineering Geological Terrain Study (NOEGTS) information and Système Probatoire d'Observation de la Terre (SPOT) satellite data with a recently completed 1:250,000 Ontario Land Inventory (OLI) prime land database, to:

1. Evaluate the degree to which the spatial heterogeneity can be reduced using the proposed methodology; and
2. Evaluate the degree to which prime land prediction for individual commercially important species can be improved.

DESCRIPTION:

The OMNR's Northwest Region Science and Technology Unit completed a project in 1990–1991 to identify and map prime land areas across northwestern Ontario using an integrated GIS mapping and prime land modeling approach. Attributes of the OLI such as soil moisture, texture, drainage and parent material, along with independently derived species/site-productivity information derived from regional growth and yield initiatives and the OLI graphics database, were integrated into a prime land classification productivity model. As a result, 23 OLI map sheets at 1:250,000 and associated map polygons have been interpreted, classified and mapped in terms of species productivity. Although this information base has proven useful for initial stratification of the landscape, the spatial resolution is low and the polygon size is large because of the relatively small scale of the maps (the average polygon size across three maps sheets is approximately 7,000 ha). Within these large polygon areas, a wide range of soil and topographic conditions occur. Therefore, in order for the approach to be operationally useful, there is a need to refine these polygons into more homogeneous soil units.

This project will study the integration of existing larger scale 1:100,000 NOEGTS (surficial deposits) maps, 1:50,000 Agriculture Canada (soil survey) information and SPOT satellite data with the existing OLI-based prime land productivity maps. The integration of this information would reduce polygon size and heterogeneity.

EXPECTED RESULTS:

The study will show that increased spatial homogeneity and prime land predictability results in a more accurate assessment of forest soil/site conditions, the area of prime land and the locations of prime land.

IMPLICATIONS:

This study will lead to improved strategic and sustainable forest land planning at the district and regional planning levels. For example, the approach would enable the forest industry to dramatically increase, at a reasonable cost, the development of operationally useful soil/site productivity thematic maps that include the identification of the most productive forest sites.

COLLABORATORS:

W.D. Towill, Northwest Region Science and Technology Unit, OMNR; Canadian Pacific Forest Products, Thunder Bay; R. White, Northwestern Region, OMNR; J. Osborn and J. Kapron, Information Systems Development, OMNR.

Project No.: 4203

Sustainable Development Indicators for the Forest Resources of Ontario

Duration: 01 September, 1992 to 31 May, 1993 **Contract Value:** $25,080

Principal Investigator: P.N. Duinker
Forest Management and Policy, School of Forestry, Lakehead University, Thunder Bay

Scientific Authority: S. Andersen
FCOR, Sault Ste. Marie

OBJECTIVE:

To develop and test a preliminary set of biophysical indicators of sustainable development for the forests of Ontario.

DESCRIPTION:

The goal of sustainable development will remain an empty one unless there are means of measuring progress. Until recently, only indicators of resource management pertinent to wood supply and the economic benefits of timber have been seriously considered by managers of forest resources. However, forest managers require a broad base of environmental information from which to make sound integrated resource management decisions. Indicators can provide a significant source of this information on the forest resource in the form of quantitative data relevant to sustainable forestry characteristics.

Through a literature review and a solicitation of input from stakeholders and interest groups, a preliminary suite of indicators that encompass a wide range of biophysical and environmental aspects of sustainable development will be developed. The indicators will be applicable at the forest management unit, bioregional and provincial levels, and the indicator development process will be cognizant of the past, present and future.

A workshop will be held to discuss the technical aspects of the implementation of the proposed indicators in the planning process, and will result in a final suite of indicators that are measurable with current data availability and that could be implemented in a practical way at present. Operational testing of the suite will then be undertaken for the Spruce River Forest Management Unit in northwestern Ontario, in cooperation with Abitibi-Price Inc.

EXPECTED RESULTS:

The project will result in a comprehensive set of indicators of sustainable development for the forest resources of Ontario. This will include the identification of a technically feasible suite of indicators, measurable in the foreseeable future, and a practical suite of indicators that is measurable with current data availability. Recommendations will also be made on how to apply, measure, forecast and interpret the indicators.

IMPLICATIONS:

The development of a specific set of indicators of sustainable forestry development will result in improved consideration of non-timber values, and will also improve the ability to monitor forest ecosystems and the forest's ability to satisfy forest-related public values.

COLLABORATORS:

M. Squires, Abitibi-Price Inc., Thunder Bay; P. McAllister, Thunder Bay District, OMNR; F. Kennedy, Forest Policy Branch, OMNR; R. Payne and J. Kayll, Lakehead University.

Visibility Analysis: A Decision Support Technique for Forest Resource Management Planning

Duration: 01 September, 1992 to 31 March, 1994 **Contract Value:** $34,725

Principal Investigator: A. Welch
Dendron Resource Surveys Ltd., Ottawa

Scientific Authority: H. Jääskeläinen
FCOR, Sault Ste. Marie

OBJECTIVE:

To enhance a decision-support system that will assist in identifying and quantifying areas of potential conflict between multiple values (including fiber and recreation) and provide support to the development of integrated resource-management solutions.

DESCRIPTION:

Northern Ontario waterways and the land bordering them are the source of numerous values for various groups, including recreational users, aboriginal groups, and industrial interests. Integrated resource management in these areas requires planning efforts that will take all values into account, where possible, in an unbiased, scientific manner.

Dendron Resource Surveys Ltd. has developed a decision-support tool (visibility analysis) that addresses this issue. This technique combines a Geographic Information System and field photogrammetry technologies within a procedure designed to address the operational requirements of resource managers. It identifies potential areas of conflict between visual and other values and assists in the development of alternatives for integrated resource management planning efforts.

This project will undertake visibility analysis in a study area in the northwestern corner of Thistle Township, which is within OMNR'S North Bay District. This area contains values for recreational and industrial (logging) interests, and is within the land claim of the Teme-Augama Anishnabai. Stakeholders from each of the three interest groups have agreed to participate in the project.

EXPECTED RESULTS:

An information session will be held to present the entire project to stakeholders and resource managers from other locations in northern Ontario. A final report will also be prepared to present the methodology and results, including user requirements, computer analysis and field verification.

This study will identify and quantify areas of potential conflict between multiple values and will provide support to enhance the development of integrated resource management solutions.

IMPLICATIONS:

Integrated resource management is a requirement for sustainable forestry development. The process being studied under this project will assist planning efforts in northern Ontario. Potential benefits include:

1. Increased cooperation between interest groups with potentially conflicting values,
2. The protection of recreational, wetland and heritage values,
3. The maximization of fiber values under constraints imposed by other values, and
4. The development of a concept that is readily adaptable to other parts of Canada.

Other forest resource values (e.g., wildlife, water) could be incorporated in future efforts.

COLLABORATORS:

F. Knappen, North Bay District, OMNR; F. Pinto, Central Region Science and Technology Development Unit, OMNR; M. Goulard, Goulard Lumber; M. Laronde, Teme-Augama Anishnabai, Temagami; G. Mitchell, Island Lake Camp.

Project No.: 4208

Bio-environmental Indices: a New Approach to Trade-off Analysis in Forest Planning

Duration: 01 May, 1992 to 31 March, 1995 **Contract Value:** $450,000

Principal Investigators: D.W. McKenney and B. Mackey
FCOR, Sault Ste. Marie

OBJECTIVE:

The objective of this project is to provide spatially reliable estimates of selected wood and non-wood values for the forests of Ontario. These data will be used as input to Geographic Information System-based decision-support tools that will assist in trade-off analyses.

DESCRIPTION:

Industry and government are increasingly faced with difficult resource management decisions. Other issues must now be considered alongside wood production, including the conservation of biodiversity and sustainable development. Resolving conflicts requires determining the most appropriate use for a forest or stand. Often a landscape will have the potential to support a variety of land-use activities. Allocating the forest to one use may preclude or degrade its suitability for another. To best serve the public welfare, decision-makers will require adequate information about the ecological and economic consequences of their decisions.

This project will develop an operational framework for evaluating non-wood values. Of particular interest are values that relate to the conservation of biodiversity. The non-wood values defined by a set of bio-environmental indices that will account for ecological values that contribute to the conservation of biodiversity are: (1) representativeness of forest ecosystems; (2) habitat suitability and population viability of selected fauna; (3) taxonomic diversity of landscapes and intra-species diversity; and (4) naturalness and remoteness.

Timber growth and yield for each of the major tree species will also be derived as indices that reflect spatial variation in site productivity.

EXPECTED RESULTS:

The products produced over the four major phases of the project will have enduring value for natural resource management and planning in the province. These include:

1. Spatial Climate Model of Ontario;
2. Digital Elevation Model (DEM)-based Catchment Study (Rinker Lake area);
3. DEM for Ontario;
4. Ontario Landscape Classification (based on a minimum of climate and terrain analysis);
5. Spatial Prediction Model (TREEWHERE) (PC-based DSS);
6. Biological Modeling for Spatial Analysis (BIOMOD)—a cookbook of procedures and computer programs;
7. Forestry and Ecological Trade-off Analysis (FETA)—Selected procedures/analyses of trade-offs between alternative land allocations (bio-environmental); and
8. A NODA/NFP Final Report.

IMPLICATIONS:

This study will provide important information that can be used for enhanced forest management and planning.

COLLABORATORS:

N. Sczyrek, K. Campbell, T. Perry, R. Sarker, R.A. Sims, J.K. Jeglum, T. Hopkin and J. Roland, FCOR; J. Osborn, Information Systems Development, OMNR; D. Joyce, P. Uhlig, A. Perara and R. Greenwood, Ontario Forest Research Institute, OMNR; P. Ward, Aviation, Flood and Fire Management, OMNR; R. Watt and T. McCarthy, Northeast Science and Technology, OMNR; F. Pinto, Central Region Science Development Unit, OMNR; G. Racey, Northwest Region Science and Technology Unit, OMNR; B. Graham, Aylmer District, OMNR; H. Nix, I. Moore, M. Hutchinson, M. Common, T. Norton and J. McMahon, Australian National University, Centre for Resource and Environmental Studies.

GIS Methodologies to Develop Spatially-based Boreal Ecosystem Models in the Rinker Lake Research Area, NW Ontario

Duration: 01 June, 1992 to 31 March, 1995

Contract Value: $101,877

Principal Investigator: R.A. Sims
FCOR, Sault Ste. Marie

OBJECTIVE:

To develop a prototype, spatially based integrated ecosystem model with the assistance of a Geographic Information System (GIS) for a representative boreal forest area in northwestern Ontario.

DESCRIPTION:

Using an analytical GIS approach, this project will integrate a variety of parameters (e.g., forest stand, vegetation, soil, site, surface elevation, climate) to construct and test ecosystem models. The results will provide a methodology and a case study application that will be of direct interest to forest and resource managers and planners. The work will provide resource inventories and spatial databases that will also be used by other related research activities.

The work constitutes one of a set of NODA/NFP projects linked to FCOR's "Boreal Mixedwood Research Program". Several other projects are ongoing in the Rinker Lake area that will take advantage of the results of this project. These include data on bird habitat utilization (NODA/NFP Project 4005) and remote-sensing methodologies for a Forest Ecosystem Classification (FEC) Vegetation and Soil Type interpretation within the Rinker Lake Research area (NODA/NFP Project 4002). Several other related research activities are also being proposed for the Rinker Lake Research Area.

EXPECTED RESULTS:

This project will provide an opportunity to develop and test new Digital Elevation Model (DEM)-based methodologies for forest ecosystem study at approximately 1:20,000 scale. The approach may serve to demonstrate potential new uses for digitized Ontario Base Map data. The project will also permit an objective, case study evaluation of northwestern Ontario FEC mapping used in conjunction with other spatial datasets in order to develop decision-support systems (e.g., forest bird habitat supply models, climate contour models, hydrological flow models, integrative ecosystem models).

IMPLICATIONS:

The results of the project will provide a demonstrated application of personal computer-based GIS for forest management in northwestern Ontario. The results should provide industrial GIS users with some new techniques and methodologies for area-based studies in forestry.

COLLABORATORS:

B. Mackey, K. Baldwin and K. Lawrence, FCOR; Northwest Region Science and Technology Unit, OMNR.

Project No.: 4213

Calibration of "ONTWIGS" Forest Projection System for the Mixedwood Types of North Central Ontario

Duration: 01 January, 1993 to 30 September, 1995 **Contract Value:** $50,000

Principal Investigator: B. Payandeh
FCOR, Sault Ste. Marie

OBJECTIVE:

To fully calibrate the forest growth and yield projection system "ONTWIGS" for the boreal mixedwoods in north-central Ontario and to demonstrate the model to its prospective clients.

DESCRIPTION:

With more than three million hectares of Ontario's productive forest lands classified as mixedwoods, and greater demands for wood, recreational, environmental and wildlife uses being placed on these mixedwoods, better information on stand productivity under various management regimes and treatment intensities is required. To date, little growth and yield information is available from research studies for management of such a complex forest resource, considering alternative uses, site conditions, etc.

Several computer models have been developed in the United States that are suitable for growth and yield projections for uneven-aged mixed-species forest stands. One model, Stand and Tree Evaluation and Modelling System (STEMS), has been adapted for the micro-computer environment (TWIGS). The Lake States version (LSTWIGS) was developed for the states of Michigan, Wisconsin and Minnesota, and because of similarities in growth conditions between Ontario and the Lake States, LSTWIGS can be modified for application in Ontario.

"ONTWIGS" has been created from the LSTWIGS model by converting the program to use metric units and substituting Ontario species codes. This project will focus on the following three aspects of the modification:

1. Model validation (to determine how closely ONTWIGS, as is, predicts Ontario conditions);
2. Model calibration (to modify the model's coefficients so as to bring its predictions as close as possible to Ontario's growth conditions); and
3. Development of new submodels based on local data to represent Ontario's tree growth conditions based on new functional relationships, if necessary.

EXPECTED RESULTS:

The ONTWIGS growth and yield model should be fully adapted from LSTWIGS and calibrated for local conditions. It will be demonstrated to collaborators and other interested clients in workshops and conferences as well as in a report that describes the work performed.

IMPLICATIONS:

This system for providing a preliminary stand growth and yield projection system for the mixedwoods of Ontario will benefit sustainable forestry development in northern Ontario. The manager will be able to analyze alternative management activities in a way not now available in Ontario.

COLLABORATORS:

Y. Wang and P. Papadopol, FCOR; W.D. Towill, Northwest Region Science and Technology Unit, OMNR; D. Finan, James River/Marathon Co., Marathon; R. Fry, Buchanan Forest Products Ltd., Thunder Bay; G. Murchison and K. Brown, Lakehead University.