COOPERATIVE FORESTRY RESEARCH UNIT

1999 ANNUAL REPORT

COLLEGE OF NATURAL SCIENCES, FORESTRY, AND AGRICULTURE
MAINE AGRICULTURAL AND FOREST EXPERIMENT STATION
MISCELLANEOUS REPORT 417

THE UNIVERSITY OF MAINE

CFRU Information Report 44

1999 ANNUAL REPORT AND RESEARCH SUMMARY OF THE COOPERATIVE FORESTRY RESEARCH UNIT

COLLEGE OF NATURAL SCIENCES, FORESTRY, AND AGRICULTURE
MAINE AGRICULTURAL AND FOREST EXPERIMENT STATION
UNIVERSITY OF MAINE
ORONO, MAINE 04469

Miscellaneous Report 417

December 1999

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Highlights 1998-1999

Organizational

- A major restructuring of the unit was initiated to increase operating funds for research, provide greater flexibility, enhance leveraging opportunities, and encourage more interdisciplinary research
- A draft prospectus was developed detailing the new organizational design, mission statement, guiding principles, and general research objectives
- A survey of cooperator research priorities was completed
- Major staff changes occurred as a result of the restructuring:
- Bob Wagner was appointed as CFRU Director
- Mike Greenwood and Dan Harrison were appointed as CFRU Cooperating Scientists
- Chip Griffin was hired as CFRU Communications and Financial Coordinator

Research

- Seasonal patterns of injury to young red spruce and balsam fir from of glyphosate, imazapyr, and triclopyr herbicide applications were documented
- Use by American marten of selection harvested and mature stands differed during the winter and marten prey availability varied with stand condition
- The effect of timber harvesting and trapping on the viability of American marten populations was determined
- Influence of precommercial thinning on root damage to residual spruce and balsam fir is being quantified
- Continued work at Weymouth Point indicates that precommercial thinning did not increase nitrogen mineralization
- Permanent sample plots were installed at Austin Pond to quantify the effect of herbicide treatment and pre-commercial thinning on the 22-year development of spruce-fir stands
- A draft site classification guide for hardwood stands was completed
- Substantial progress was made on three studies examining the wood properties of red spruce
- Third-year measurement of a study examining the response of precommercially thinned spruce-fir stands to nitrogen fertilization near crown closure was completed
- A 20-year provenance study of white spruce from Maine and Canada provide valuable genetic material for Maine tree improvement and planting programs
- The possible long-term effect of diameter-limit cutting on red spruce and site productivity was examined
- Remeasurement of commercial thinning plots and new plots on sites to be commercially thinned on cooperator lands provided valuable data for new research on commercial thinning
- A new project was approved that uses the 1998 wood supply model of the Maine Forest Service to help identify silvicultural research priorities for the CFRU

Major Cooperating Organizations

Baskahegan Corporation
Great Northern Paper
Champion International Corporation
Fraser Paper, Ltd.
Hancock Timber Resource Group
J. M. Huber Corporation
International Paper Company
Irving Woodlands, Ltd.
Maine Bureau of Parks and Lands
Mead Corporation
Plum Creek Timberlands, Inc
Prentiss & Carlisle
Seven Islands Land Company
The Nature Conservancy
Ste. Aurelie Timberlands Co., Ltd

Other CFRU Cooperators

Bethel Furniture Stock, Inc.
H. O. Bouchard, Inc.
Field Timberlands
Finestkind Tree Farms
H. C. Haynes, Inc.
James W. Sewall Company
Landvest
F. A. Madden, Inc.
Peavey Manufacturing Company
Penley Corporation
Pride Manufacturing Co.
Robbins Lumber Company
Saunders Brothers
Timberlands Enterprises / Pinebelt, Inc.
Western Maine Nurseries
Maine Christmas Tree Association

CFRU Staff

Director:
Robert G. Wagner
Associate Professor of Forest Ecosystem Science

Cooperating Scientists:
Michael S. Greenwood
Professor of Forest Ecosystem Science

Daniel J. Harrison
Associate Professor of Wildlife Ecology

Project Scientists:
William D. Ostrofsky
Associate Professor of Forest Management

Professional Staff:
H. E. "Chip" Griffin
Communications and Financial Coordinator

Project Scientists:
Robert S. Seymour
Professor of Forest Ecosystem Science

Robert K. Shepard
Professor of Forest Management

Katherine K. Carter
Associate Professor of Forest Ecosystem Science

James W. McLaughlin
Assistant Research Professor, CFRU

Advisory Committee Chair's Report

When I assumed the role of Chair of the Advisory Committee two years ago, CFRU was a completely different organization than it is today. At the beginning of 1998, CFRU had reached a critical juncture where decisions about its future and very existence had to be examined.

Although staffed with dedicated, accomplished and loyal scientists and technicians, CFRU was finding it increasingly difficult to meet the needs of its contributing customer base. There were several reasons for this that are outlined in further detail elsewhere in this report, but the combination of flat funding and ever increasing personnel costs was strangling the Unit. In addition, excess funds in the reserve account were being depleted, meaning that unless dues were raised, budgets would have to decline even further.

This untenable situation needed immediate attention, and that is what the combined efforts of the executive and advisory committees, the CFRU staff, **Bob Wagner**, **Mike Greenwood** and **Dan Harrison** have brought to fruition this year.

Instead of a team of full time scientists, CFRU now works with a "virtual faculty" of scientists from the University of Maine and elsewhere. These scientists will propose projects to answer questions posed by the research priorities from the advisory committee. The Unit has a director, **Bob Wagner**, who oversees the research being performed, and a team of Cooperating Scientists who have a close connection to the Unit due to the alignment of their disciplines and CFRU's research priorities.

This new structure promises to offer the cooperators greater flexibility and the ability to conduct research over a broader range of topics than before. In addition, we can use our limited funds more efficiently by limiting the number of CFRU funded positions.

I was gratified to see a large number of excellent proposals put before the advisory committee this fall. There are clear signs of a new vitality and energy both within CFRU and the advisory committee. This influx of new ideas and research should keep CFRU productive and valuable to the cooperating landowners for many years to come.

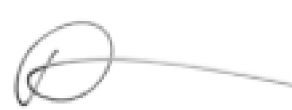
I wish to deeply thank my fellow members of the restructuring team: **John Cashwell**, **Dave Field**, **Peter Caron**, **Tony Filauro**, **Mike Greenwood**, **Carl Haag**, **Dan Harrison**, **Brian Higgs** and **Bob Wagner**. We had a very difficult task that absorbed much of our limited time. I am proud of the work we have done and its results.

The Advisory Committee was also closely involved with the process, and their time and commitment helped make sure that the final product of the restructuring team was acceptable to the cooperators. Many thanks to each member of the committee.

The Dean, **Bruce Wiersma**, was engaged with the process from beginning to end, offering us support and helping us through several rough patches. Thank you, Bruce.

Finally, special thanks go to **Bob Wagner**. He arrived as the silviculturist for CFRU in late 1998, and promptly found himself in the process of redesigning the very organization he had planned to work for. His drive, enthusiasm and good ideas were key to the success of the process.

I have enjoyed my tenure as Chair of the Advisory Committee, and I am proud of what we've accomplished in the past two years. I expect to see CFRU as a viable, productive organization for many years to come.



Peter Triandafillou, Chair
CFRU Advisory Committee

Dean's Report

We are finishing our first year under the new structure for the CFRU. Under the able leadership of **Bob Wagner**, with the help of 2 faculty advisors and Communications and Financial Coordinator **Chip Griffin**, research is being redirected and reinvigorated. The new structure also gives us greater flexibility of response to a broader array of research questions.

The support of the members of CFRU has, as always, been steadfast and impressive. Without that support the CFRU could not function. We deeply appreciate all the time and effort that the members have expended to make the new structure of CFRU a successful reality.

The new structure has also allowed us to better integrate the research mission of the CFRU with the base funded (McIntire-Stennis) research forestry programs. We have circulated (and will continue to) pre-proposals for new McIntire-Stennis forest resources research projects to members of the CFRU. We encourage you to communicate directly with these faculty to help make your needs and ideas known. We have also seen a significant increase in our funding and for the last two years we have been able to put out a general call within the **Maine Agricultural and Forest Experiment Station**. The responses and the call itself have been shared with members of the CFRU.

Great challenges remain for the CFRU. Major shifts in land ownership patterns and reluctance of new owners to commit to long-term research on forest resources issues will strain the funding base of the CFRU. I will work with **Bob Wagner** and other CFRU leaders to help minimize or eliminate this funding problem. Also, we need to revitalize the general forest resources advisory committee. I see the CFRU as having a significant role to play in the new FRAC. **Michael Greenwood** has the responsibility to develop this new FRAC and I trust you all will work closely with Mike to help carry this out.

The opportunities and responsibilities for executing forestry research in Maine in the future are both exciting and daunting. But I am optimistic that the new structure, committed members, excellent faculty, and an imaginative and creative leader will rise to meet these opportunities.

G. Bruce Wiersma, Dean
College of Natural Sciences, Forestry and Agriculture

Director's Report

This year has been a challenging one for the CFRU. Some very difficult decisions had to be made by our restructuring committee to create a new organizational design for the unit. Details of these efforts are described in this report. I thank members of the restructuring committee for their hard work and also appreciate the patience of all cooperators during this period. This hard work and patience reflect the strong commitment that member organizations have to the CFRU. I am confident that the new organizational structure will provide greater flexibility, enhance cross-organization lever-aging opportunities, and encourage more interdisciplinary research. This new CFRU will help cooperators meet Maine's forest research challenges in the new century.

I also want to thank all CFRU staff for the high degree of professionalism during the restructuring. I am pleased to report that nearly all of the former staff successfully moved onto new career opportunities or returned to school to pursue an advanced degree. Your commitment to the CFRU over the years is recognized and appreciated by all.

In addition to the challenges presented by the restructuring, the CFRU also weathered a substantial upheaval with an unprecedented turnover of forestland. Approximately 3.5 million acres of cooperator lands went up for sale this year. Of these acres, we were able to maintain about 2.5 million acres in the CFRU. The loss of the 1 million acres, however, represents a significant loss to the CFRU dues base and exemplifies why the CFRU needed to restructure. Efforts have been underway to pursue the lost 1 million acres, but have proven difficult in the short-term given the nature of the organizations that purchased these lands.

With respect to the 2.5 million acres we kept in the CFRU, we wish to thank **Irving Woodlands** for agreeing to maintain their newly purchased 1 million acres from Great Northern Paper - Bowater in the CFRU. We also thank **Great Northern Paper** for their tremendous support over the years as the largest contributor to CFRU and for maintaining their membership despite these land changes. Thanks also go to **Plum Creek Timber** for joining the CFRU with the nearly 1 million acres they purchased from SAPPI. We also thank **SAPPI** for their years of support to CFRU. We also welcome **The Nature Conservancy** as a new member of CFRU based on their newly purchased acres. The sale of Maine lands by **Georgia Pacific** means that we lost them as a cooperator this year, but thank them for their years of membership in CFRU.

As part of the restructuring, we were able to fill several positions in the new organization. In July, **Mike Greenwood** and **Dan Harrison** became Cooperating Scientists. Mike and Dan have been involved as project scientists with CFRU for a number of years and were very helpful during the restructuring of CFRU. Thank you for your help and we look forward to your helping implement the new organization. As soon as the five-year objectives for the CFRU are complete, we will be pursuing new Cooperating Scientists to help lead the CFRU in these areas of research.

We also were fortunate to hire **Chip Griffin** this year. Chip comes to the CFRU very well qualified and we look forward to his designing and implementing a communications plan as well as managing the business affairs for the new CFRU. Efforts early in the new year will focus on filling the new Field and Data Coordinator position.

Despite the upheaval caused by the restructuring, staff changes, and land sales, I am pleased to report that we were able to maintain a productive year. The research accomplish-ments of the CFRU are presented in the following report.

R. Wagner

Robert G. Wagner
CFRU Director

Introduction

Formed in 1975, the CFRU is one of the oldest industry / university forest research cooperatives in the US. The unit was restructured in 1999 to provide cooperators with a more flexible and efficient organizational design. Funding comes from private industrial, private non-industrial, and public forest landowners, plus other private contributors. Currently, the CFRU is composed of over 30 members from across the state of Maine.

Over the first quarter century, CFRU researchers and cooperators have seen dynamic changes. The CFRU has served the forest managers and landowners of Maine during this period with research projects that meet the most pressing problems to cooperators. Research in the fields of site classification, growth & yield, vegetation management, nutrient cycling, wildlife, tree improvement & genetics, beech bark disease, and spruce budworm are particularly noteworthy. These projects have resulted in the publication of over 475 research articles and other publications. Several long-term research sites (e.g., Weymouth Point and Austin Pond) have been established and continue to be maintained.

Regular quarterly meetings, workshops, and conferences are conducted and sponsored by the CFRU. Technical advice and recommendations to cooperators continues to be a benefit of membership and has been a hallmark of the organization since its earliest days. Research results are presented to cooperators via presentations, field tours, conferences, research reports, annual reports, website, and articles in scientific journals. This annual report documents progress made by the CFRU during the fiscal year 1998-1999.

Organizational Accomplishments

Restructuring

Robert G. Wagner, CFRU Director

Introduction

This past year has been a turbulent one for the CFRU. Pressure that had been accumulating for a number of years initiated a series of changes that culminated this year, forcing a substantial amount of disruption. Since its inception in 1975, the CFRU had been maintained within the University of Maine as a three-scientist research team. In addition, three full-time technicians and an administrative assistant composed the balance of the 7-person unit. This organizational structure served the CFRU member organizations well over this period.

In recent years, however, flat funding of the CFRU dues base combined with increasing personnel and other research costs resulted in a substantial increase in the proportion of the total budget committed to staff salaries, benefits, and overhead. As a result, available operating funds to conduct research projects had declined to a critically low level and were deemed incapable of supporting a viable research effort for much longer. Either a substantial infusion of new financial resources or a restructuring of the way the CFRU delivered its research program was required. The CFRU Advisory Committee determined that the most feasible option was to seek a new organizational structure for delivering the research program.

Restructuring Team

To address the difficult task of developing a new organizational structure for the CFRU, the CFRU Advisory Committee appointed a Restructuring Team. The team consisted of Peter Triandafillou (Huber Resources) (Chair), Peter Caron (CFRU), John Cashwell (Seven Islands Land Co.), Dave Field (University of Maine), Tony Filauro (Great Northern Paper Co.), Mike Greenwood (University of Maine), Carl Haag (Plum Creek), Dan Harrison (University of Maine), Brian Higgs (Baskahegan Co.), and Bob Wagner (University of Maine). We thank this Team for their hard work over the past year to bring about the difficult but necessary organizational changes that are described below. These efforts have brought the CFRU through perhaps its most difficult period to date. The new organizational design developed by this team promises to help CFRU members meet the forest research challenges of the new century.

Staff Changes

Staff Departures

Instability within the CFRU, as well as the nature of the new organizational design, prompted major staff changes this year. **Bill Ostrofsky**, who served as CFRU Leader for the past 8 years, became Director of the Office of Professional Development for the College of Natural Sciences, Forestry, and Agriculture at University of Maine. **Jim McLaughlin**, leader of the soil / site research program, moved to Texas as a Senior Environmental Planner with the Houston-Galveston Area Council. **Rick Dionne**, research technician for the silviculture research program, took a permanent position with the US Forest Service in Bradley, Maine. **Stephanie Arnold**, research technician for the soil-site program, returned to graduate school at University of Maine to pursue a Ph.D. in the Department of Forest Management. **Peter Caron**, research technician for the genetics program, is pursuing a career as a computer consultant. **Margaret Colman**, administrative assistant for the unit, is now an administrative assistant for the Sawyer Research Center on the University of Maine campus. The CFRU membership thanks all of these former CFRU staff members for their years of commitment and excellent service to the unit.

Interim Staff

During the major staff changes that occurred this year, several members of the University of Maine staff stepped in to take on critical interim roles for the CFRU. **Mike Greenwood** (Dept. of Forest Ecosystem Science) served as interim CFRU Director after the departure of Dr. Ostrofsky. We thank Mike for successfully leading the CFRU through this extremely turbulent period. **Gail Belanger** (Dept. of Forest Ecosystem Science) served as the CFRU administrative assistant after the departure of Margaret Colman. **Jan Gifford** (NSFA Administration) continued to manage all financial matters for the unit. We thank Gail and Jan for their outstanding work in keeping the administrative affairs of the unit in order during this transition period.

New Staff

Implementation of the new organizational design (described below) required that the unit appoint or hire several new staff members. **Bob Wagner** (Dept. of Forest Ecosystem Science) was appointed as CFRU Director effective May 1, 1999. Bob has been leading the CFRU silviculture research effort since April 1998 and has experience running forest research cooperatives in Oregon and Canada.

Mike Greenwood and **Dan Harrison** (Dept. of Wildlife Ecology) were appointed as a CFRU Cooperating Scientists in July 1999. Dan and Mike will provide leadership for the wildlife ecology and genetics/tree improvement efforts, respectively, for the CFRU under the new design. Both Mike and Dan have been long-time project scientists working with the CFRU and were important participants in helping reorganize the cooperative this year.

The first of two new professional support positions for the CFRU was filled at the end of this fiscal year. The Communications and Financial Coordinator position is responsible for all technology transfer activities, communications, and financial affairs for the CFRU. A wide search this year yielded a number of fine candidates. We were very fortunate to hire **Chip Griffin** to fill this first of two new CFRU staff positions. Chip comes to the unit extremely well qualified. He received a MBA from University of Maine in 1999 and has work experience with university, research, and business administration. We look forward to Chip helping us build the new CFRU organization.

The second and last staff position to be filled is that of Field & Data Coordinator. This position will be responsible for installing and maintaining CFRU research sites, coordinating field crews and logistics, managing the CFRU databank, conducting statistical analyses, and supporting technology transfer activities for the unit. A search will commence in winter 1999 and the position filled by the spring of 2000.

New Organizational Design

The CFRU Restructuring Team decided to tackle redesigning the CFRU in two phases. The first phase dealt with redesigning the organizational structure of the unit and the second phase defining the mission, guiding principles, and objectives of the research program. Because the need for restructuring emanated from the costs associated with the original organizational design, this was the first task addressed.

Organizational Structure

The Restructuring Team first defined the attributes that the new organizational structure should possess to be successful. It was decided that the new design should:

- enhance cooperation and teamwork among researchers;
- enhance interactions between researchers and cooperators;
- enhance productivity, creativity, and synergy of research teams;
- increase efficiency and accountability of researchers;
- attract the best researchers;
- encourage interdisciplinary research;
- optimize flexibility with changing research needs;
- maximize operating funds available for research; and
- encourage shared funding and integration of research projects within the Maine Agricultural & Forest Experiment Station and with other academic departments at University of Maine, as well as other researchers, organizations, and funding agencies.

A design was sought that could balance the advantages of the traditional research unit, where interactions between cooperators and staff scientists are very high, with that of a competitive research fund, where flexibility and financial leveraging opportunities are maximized. The Restructuring Team decided that a design similar to that achieved by "virtual" organizations could provide the best balance between the research unit and research fund models.

The new design reduced the number of full-time support staff to two: one to coordinate the communications and financial affairs of the unit and the other to coordinate all field, databank, and statistical activities. This change reduced the number of full-time staff from 7 to 2, substantially reducing core staffing needs and expenses. The Director's position is appointed from among current University of Maine faculty. Borrowing from a concept used by the CFRU for years, Cooperating Scientists form the scientific "staff" and are drawn from current University of Maine faculty or from other institutions based on research needs of the unit. Stipends and other forms of compensation are available for the Director and Cooperating Scientists as part of the CFRU administration.

Apart from an annual administration budget, all CFRU funding is allocated to scientists based on a competitive evaluation of their research proposals. This new design allows both funding and scientific talent to rapidly adapt to the changing information demands by the cooperators. The design also encourages and facilitates shared funding with other institutions as projects of common interest arise.

The Restructuring Team developed a CFRU Prospectus (described below) that details the roles, responsibilities, and relationships of all components in this new organizational design. Figure 1 shows a generalized scheme for the organizational structure of the new CFRU.

Mission, Objectives, & Guiding Principles

The second task of the Restructuring Team was to define the mission, guiding principles, general objectives, and five-year objectives under which the new organizational structure would operate. The following describes the outcome and status of each.

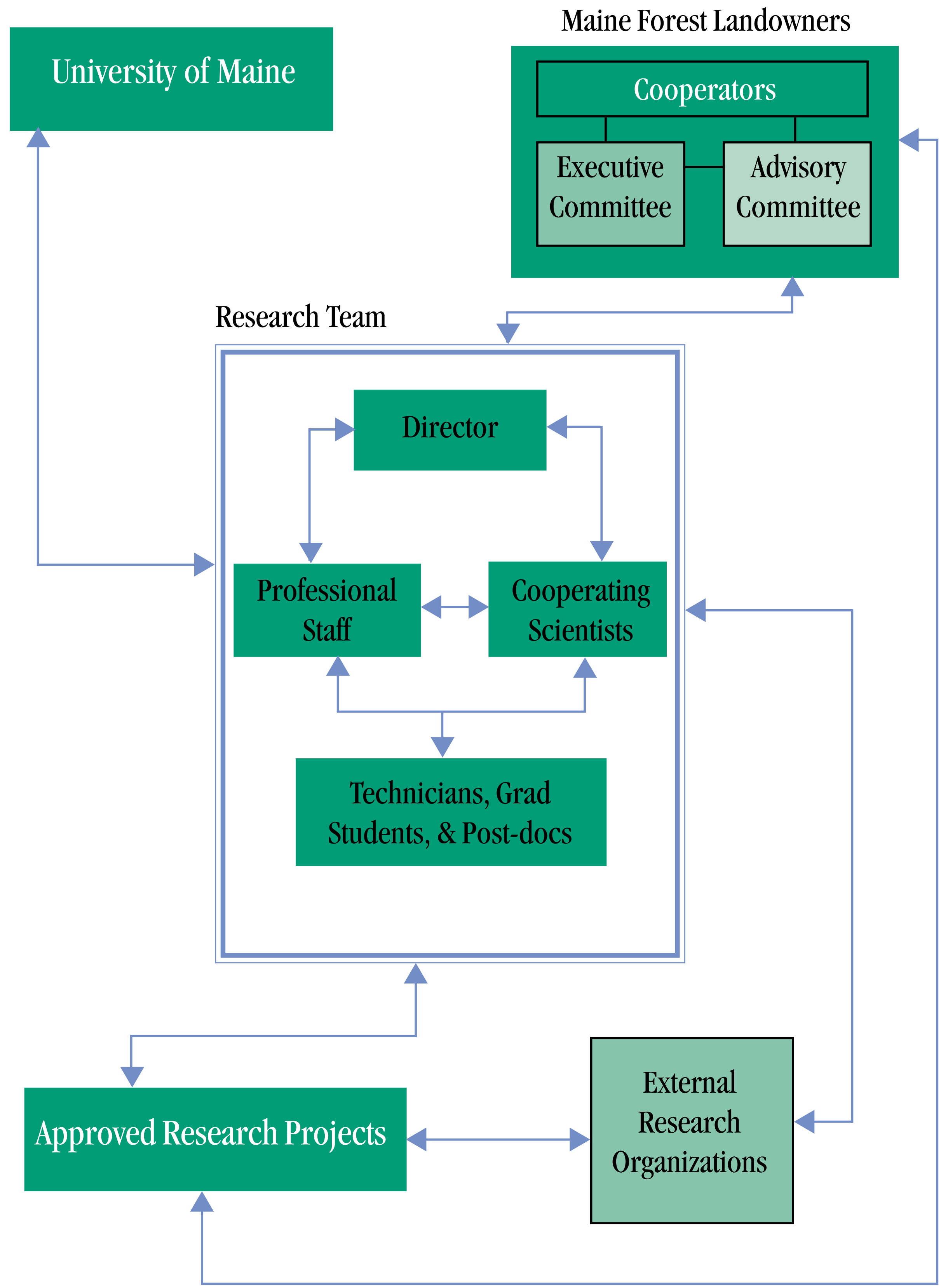


Figure 1. ***New Organizational Design of CFRU***

Mission

The overarching mission of the CFRU is to:

conduct applied scientific research that contributes to the sustainable management of Maine's forests for desired products, services, and conditions

General Objectives

This mission will be achieved by accomplishing the following general research objectives:

- increase the growth and yield of forest stands, and improve methods of growth and yield prediction;
- improve the efficacy and cost efficiency of silvicultural operations;
- enhance the long-term supply and quality of wood in Maine's forests;
- maintain and enhance the health of managed forest ecosystems; and
- maintain and enhance the socioeconomic base of forest-dependent communities.

Guiding Principles

Research conducted by the CFRU will adhere to the following guiding principles:

- Research will be conducted that focuses primarily on developing applied information that can be used by CFRU Cooperators to improve forestland management. However, since increasing our fundamental understanding of forest ecosystems can often make the most significant strides towards improved management, basic research efforts that are closely aligned with applied research objectives will be encouraged.
- Experimental design, methods, and procedures used in CFRU research will achieve the highest standards. All research proposals will be subjected to external scientific review before they are funded.
- Since field research involves a substantial investment, every effort will be made to encourage projects led by research teams that include interdisciplinary questions and collaboration.
- All research projects will seek to optimize opportunities for leveraging through shared collaborations, in-kind contributions, and funding with other organizations that have similar goals and/or the required expertise.
- Research results from CFRU projects will be rapidly communicated to Cooperators using the most effective means of communication (including oral presentations and the CFRU research report series). Completed research will be promptly submitted for publication in peer-reviewed scientific journals.
- Since success of the CFRU relies heavily on the collaboration between Cooperating Scientists and Cooperators, vigorous cooperation is expected from each Cooperator, including direct participation and in-kind contributions for Approved Research Projects.

Five-Year Objectives (2000-2005) and Research Priorities Survey Results

It also was recognized by the Restructuring Committee that a more specific set of research objectives (beyond the general objectives stated above) was needed to provide: 1) more focus for requesting and evaluating research proposals submitted to the CFRU, and 2) a basis for evaluating directional progress made by the CFRU from its research activities.

At the April 27, 1999 Advisory Committee meeting, Bob Wagner was given the task of surveying the CFRU members for a detailed assessment of their research priorities. The Survey was mailed out in June, returned in August, and analyzed in September. The survey was designed to measure and rate how important 68 researchable forestry issues would be for achieving management objectives of the cooperators during the next decade. Ninety-eight percent of the CFRU dues base responded. These results are being used to define the 5-year objectives for the new CFRU Prospectus (described below) that will be completed in early spring of 2000.

The top 20 research priorities from this survey are presented in Figure 2. The top dozen or more priorities can be summarized in the following list:

- Commercial thinning strategies, especially growth and yield responses, timing of entry, spacing standards, prioritizing stands, and other decision-making criteria
- Riparian zone management, especially buffer strip requirements and effects of harvesting practices on water quality
- Growth and yield models for conifer and hardwood species, and for mixed wood stands
- Effects of forestry practices on biodiversity, wildlife, and landscapes
- Understanding public attitudes and perceptions about forestry practices / better ways to communicate and resolve conflict with the public over forestry issues

Cooperators also were asked in the survey how they would prefer to receive research information produced by the CFRU. Results in Figure 3 indicate that short research notes (<5 pages), field guides, field tours, on-site demonstrations, and small workshops were the preferred methods of technology transfer. Communications efforts in the coming years will strive to package information using these methods most preferred methods.

CFRU Prospectus

Details of the above organizational design, including the mission, objectives, guiding principles, roles, responsibilities, Advisory Committee bylaws, policies, procedures, guidelines, and other matters necessary for governance of the CFRU are being compiled into a CFRU Prospectus.

This Prospectus is to be maintained by the CFRU Advisory Committee. At the January 27, 1999 meeting, the Advisory Committee accepted a first draft of the Prospectus that has been used as the guiding document under which the new organization is being put into place.

The new five-year objectives, revised bylaws, guidelines, and other procedures necessary for administering the CFRU are in the process of being updated and made consistent with the new organizational design. The final draft of the new Prospectus will be completed and presented to the Advisory Committee for acceptance in early 2000.

For more information about the restructuring of the CFRU, please contact **Bob Wagner** at **207-581-2903** or **bob_wagner@umenfa.maine.edu.**

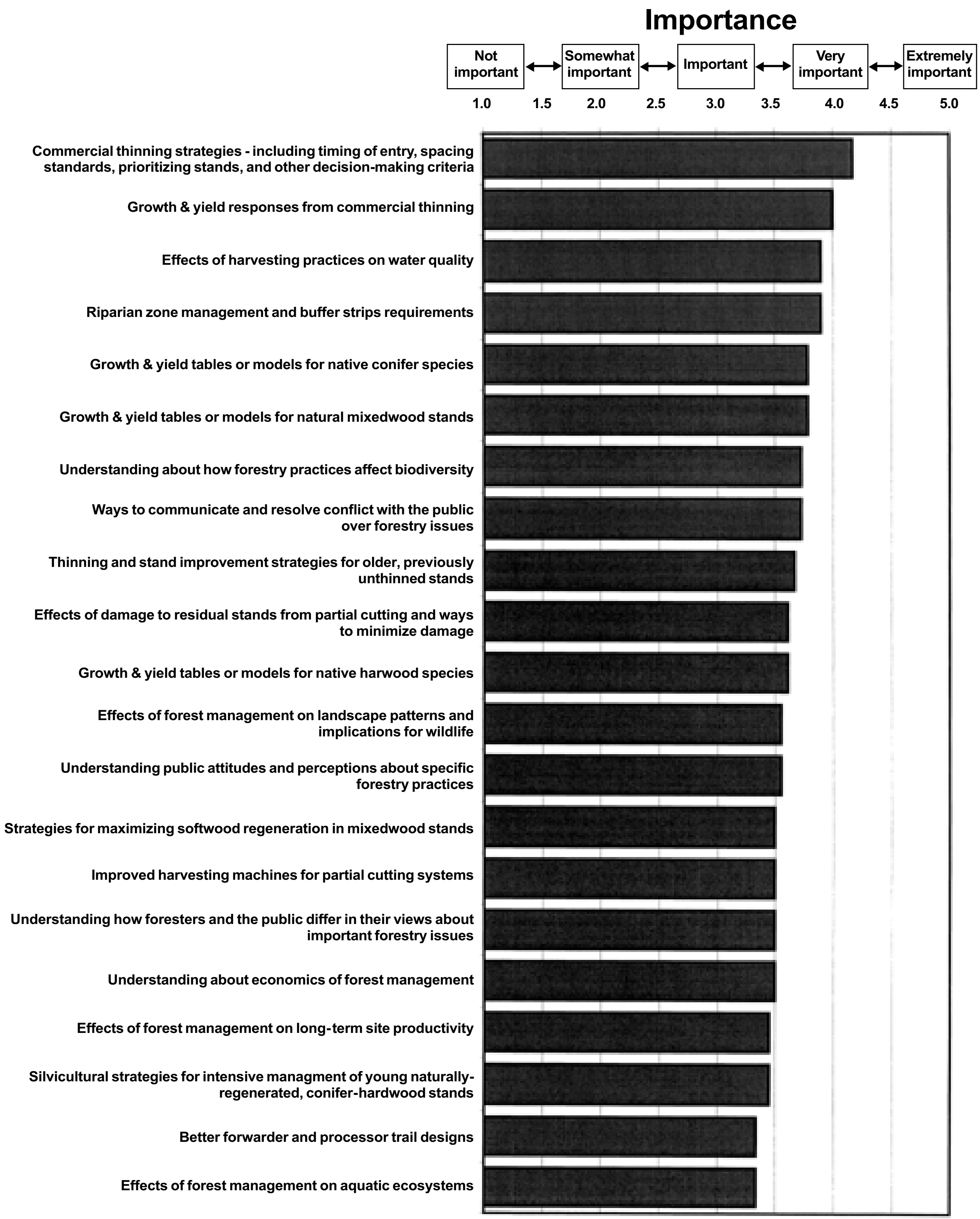


Figure 2. ***The top 20 research priorities***

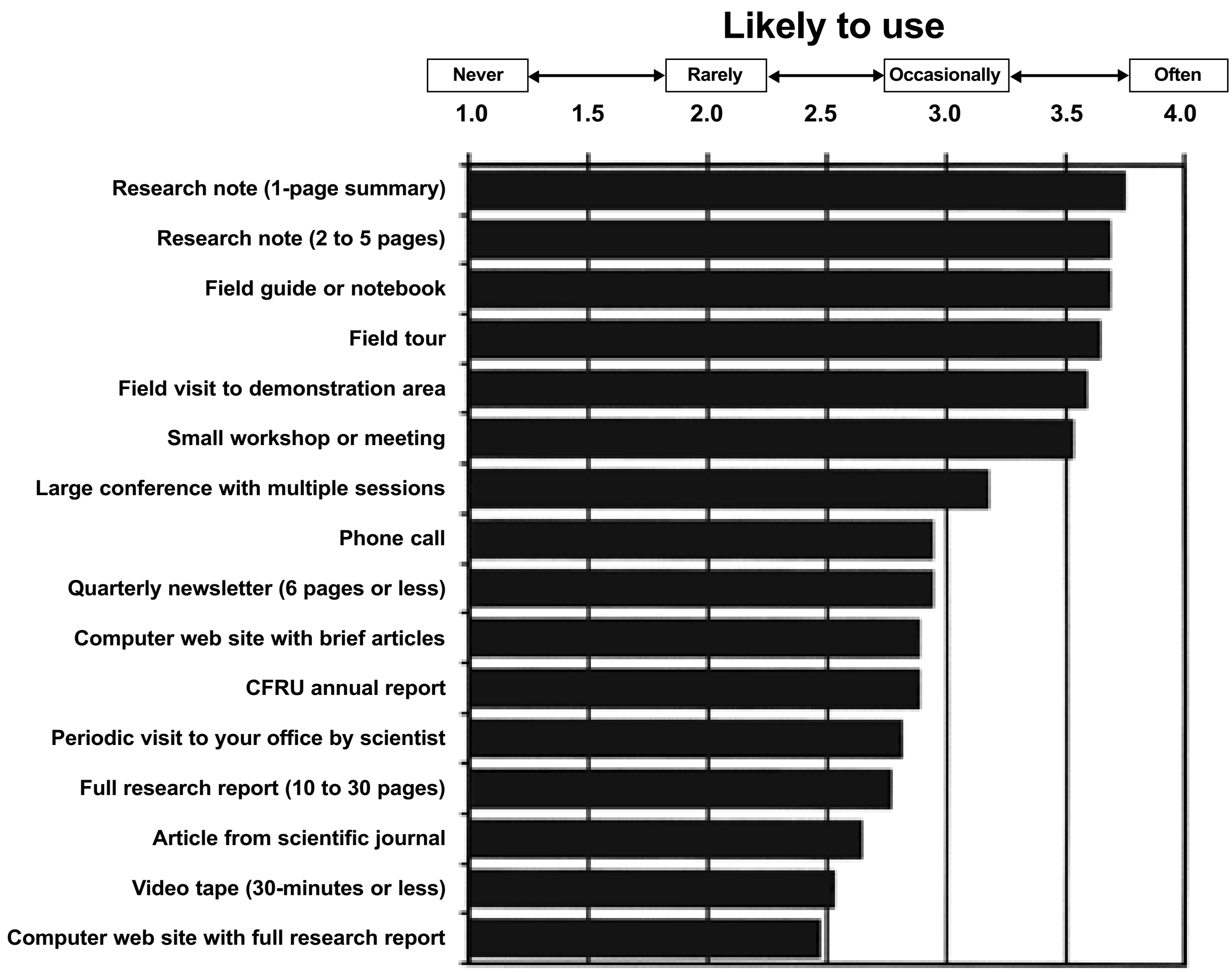


Figure 3. ***Preferred methods of receiving research results***

CFRU Advisory Committee

The CFRU Advisory Committee, which governs all the affairs of the CFRU, had a busy year. In addition to addressing an array of complex re-organizational issues (see pgs. 1-6 of this report) the Advisory Committee helped ensure that ongoing research efforts continued and that new research ideas were developed (see pgs. 43-44 of this report). We thank the officers **Peter Triandafillou (Huber Corp.)** — Chairperson, **Brian Higgs (Baskahegan Co.)** — Vice Chairperson, **Anthony Filauro (Great Northern Paper Co.)** — Financial Officer, and **Carl Haag (Plum Creek)** — Member-At-Large for their hard work and dedication to the CFRU during the past two years.

The Advisory Committee met quarterly (October 1-2,1998; January 27, 1999; April 27, 1999; and July 20, 1999). The highlight of the year was the annual CFRU field tour in October 1998, which was hosted by **J.D. Irving** in St. Leonard, New Brunswick. On the second day of the meeting, the committee toured J.D. Irving's **Black Brook District**. This 465,000-acre district is among the most intensively managed forests in the Northeast and was recently certified by the Forest Stewardship Council. The tour included detailed discussions about J.D. Irving's management of the district, including shelterwood and selection harvesting systems for hardwood stands, commercial thinning, the Unique Areas Program, vegetation management approaches, tree improvement program, and concluded with a visit to the site of JDI's first tree planting. The CFRU thanks J.D. Irving for hosting this very stimulating tour.

At the April 1999 meeting, nominations and elections for new officers were held. **Peter Etheridge (J.D. Irving)** was nominated and elected as the new Vice Chairperson. **Carl Haag** will continue for another term as Member-At-Large. **Brian Higgs** will become Chairperson and **Peter Triandafillou** becomes Financial Officer. The two-year term of this new Executive Committee begins January 1, 2000. We thank **Anthony Filauro** for his a tremendous dedication and service to the CFRU Executive Committee over the past 6 years.

CFRU Advisory Committee Members

Peter Triandafillou, Huber Cooperation (Chair)
Brian Higgs, Baskahegan Company (Vice Chair)
Anthony Filauro, Great Northern Paper (Financial Officer)
Carl Haag, Plum Creek Timber Co., LLC
Si Balch, Mead Corporation
John Brissette, USFS Northeast Forestry Experiment Station
John Cashwell, Seven Islands Land Company
Peter Etheridge, J. D. Irving, Limited
Chuck Gadzik, Irving Woodlands LLC
Wayne R. Marion, Hancock Timber Resource Group
Craig MacLean, International Paper Company
Thomas A. Morrison, Maine Bureau of Parks and Lands
Jacques Morin, Ste. Aurelie Timberlands Co., Ltd
Nancy Sferra, The Nature Conservancy
Joel Swanton, Champion International Corporation
Kevin Topolniski, Fraser, Papers Inc.
G. Bruce Wiersma, Dean, College of Natural Sciences, Forestry and Agriculture

Ongoing Research Projects

Seasonal Tolerance of Red Spruce and Balsam Fir to Glyphosate, Imazapyr, And Triclopyr Applications

Robert G. Wagner
University of Maine

Inconsistent results with Accord (glyphosate) herbicide applications in Maine forests, including reports of greater conifer injury and less effective vegetation control from release treatments, prompted this CFRU investigation. In June 1998, **Bob Wagner (CFRU),** in cooperation with **Steve Colombo (Ontario Forest Research Institute)**, installed an experiment on **International Paper Corp.** lands to examine seasonal patterns of herbicide tolerance for red spruce and balsam fir. **Rick Dionne (CFRU)** provided lead technical support for the project.

The objectives of this study were to 1) document the seasonal pattern of injury to young red spruce and balsam fir following typical applications of glyphosate (Accord®, Vision®), imazapyr (Arsenal Applicators Concentrate®), and triclopyr (Garlon 4®); and 2) examine the relationship between degree of conifer injury produced by these herbicides during the growing season and a variety of phenological indicators. A randomized complete block, split-plot, design with 3 replications (blocks) was installed on a regenerating clearcut site, which contains high densities of red spruce and balsam fir, near Medway, ME.

A total of 150 treatment plots (7 timings x 7 herbicide treatments x 3 blocks plus 3 untreated subplots) were established, treated, and measured during 1998. Ten healthy trees of each species were tagged in each plot before treatment, making a total sample of 1500 spruce and 1500 fir. The treatments include:

- Accord® (2 qts) in 5 gals water / A;
- Accord® (2 qts) + Entry II® surfactant (20 fl oz) in 5 gals water / A;
- Accord® (2 qts) + Entry II® surfactant (20 fl oz) + Arsenal Applicators Concentrate® (2 oz) in 5 gals water / A;
- Arsenal Applicators Concentrate® (2 oz) in 5 gals water / A;
- Arsenal Applicators Concentrate® (4 oz) in 5 gals water / A;
- Vision® (2 qts) in 5 gals water / A;
- Garlon 4® (2 qts) in 5 gals water / A;
- No treatment

Each herbicide treatment was applied at periodic intervals to capture seasonal patterns of herbicide tolerance for each tree species. The treatments were applied June 1, June 22, July 13, August 3, August 24, September 21, and October 6 of 1998. First-year injury to the spruce and fir, quantified as a damage index based on foliage injury to the leader, 1st-order lateral branches, and 2nd- and 3rd-order lateral branches, was recorded at the end of October 1998.

Dramatic differences in foliage injury among the treatments were observed (Fig.1). Results from measurements of first-year injury indicate the following:

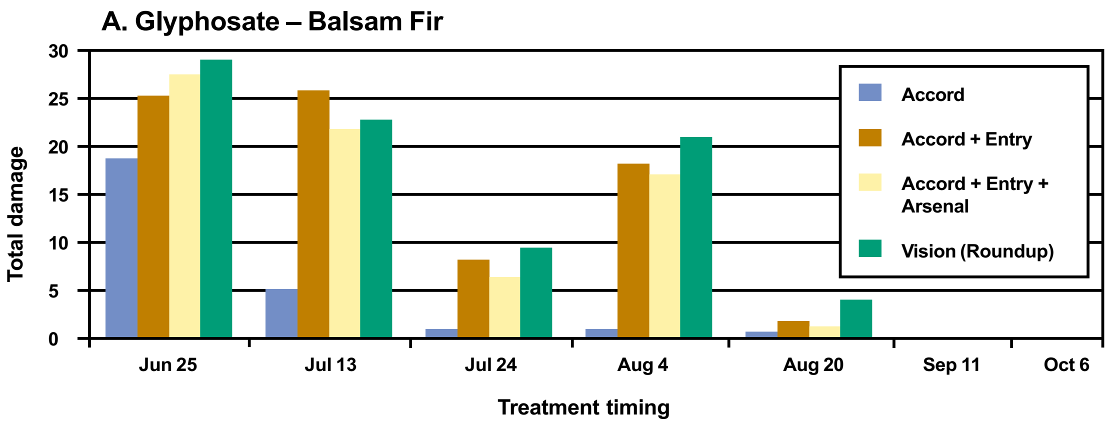
Figure 4. ***Leader and foliage damage to red spruce (left) and balsam fir (right) in the first year after receiving an early-season (July) glyphosate herbicide application.***

- There was no difference in the degree of fir or spruce injury produced by Accord/Entry II and Vision (old Roundup) glyphosate products. Concerns that there are differences between Accord/Entry II and Roundup (Vision) products were not supported by this study (Fig. 5).
- Glyphosate injury decreased with time of season for both species until early August (Fig. 5). Any applications before August produced unacceptably high levels of foliage injury to both conifer species. Spruce injury declined substantially by the end of July, while fir injury occurred through mid-August — suggesting a slightly longer "window" (1 to 2 weeks) of glyphosate application for spruce than fir.
- As expected, the addition of Entry II surfactant significantly increased Accord (glyphosate) injury in both fir and spruce (Fig. 5).
- Triclopyr (Garlon 4) injury also decreased with time of season until early August, producing levels of injury that were the same as glyphosate (Accord) without the Entry II surfactant (Fig. 6). Red spruce also was less susceptible to injury by triclopyr than balsam fir.
- Imazapyr (Arsenal) produced no visible foliar injury to either spruce or fir. However, by dissecting buds at the end of the growing season we found substantial differences in the number of needle primordia on treated relative to untreated trees when imazapyr was applied before early August (Fig. 7).
- The pattern of bud primordia injury was similar to the pattern of foliage injury produced by both glyphosate and triclopyr. The 4 oz / A rate of imazapyr caused more injury than the 2 oz / A rate. No difference in degree of bud injury by imazapyr was found between spruce and fir.

The phenological stages of the fir and spruce (measured as bark color, number of bud primordia, leader extension, and cuticular transpiration) were recorded throughout the season and reported in the 1998 CFRU Annual Report (pg. 3). In the coming months, these phenological measurements will be used to examine possible correlations between degree of conifer injury from each herbicide treatment and phenological stage.

In late fall 1999, we will measure height increment of all imazapyr treated plots to examine the relationship between first-year leader increment and degree of bud primordia injury in the previous year.

Full results from this work will be presented in future CFRU Research Notes. For more information about this study, contact **Bob Wagner** at **207-581-2903** or **bob_wagner@umenfa.maine.edu**.



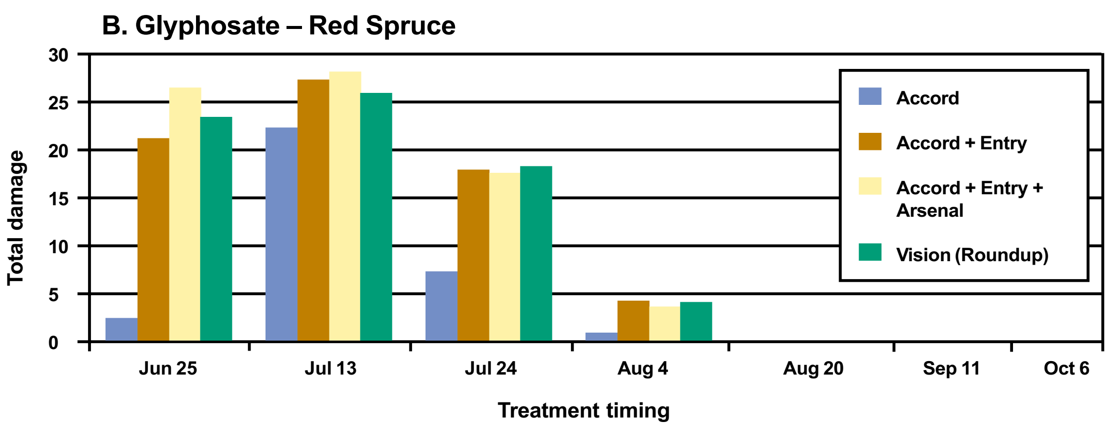


Figure 5. ***Leader and foliage damage index for balsam fir (A) and red spruce (B) in the first year after receiving four different glyphosate herbicide treatments at seven times during the growing season. Maximum damage score = 30, no damage = 0.***

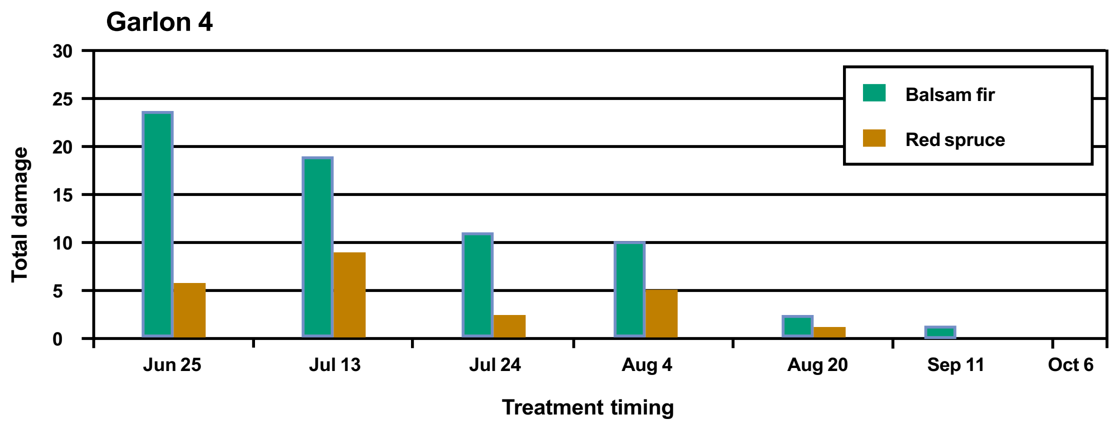
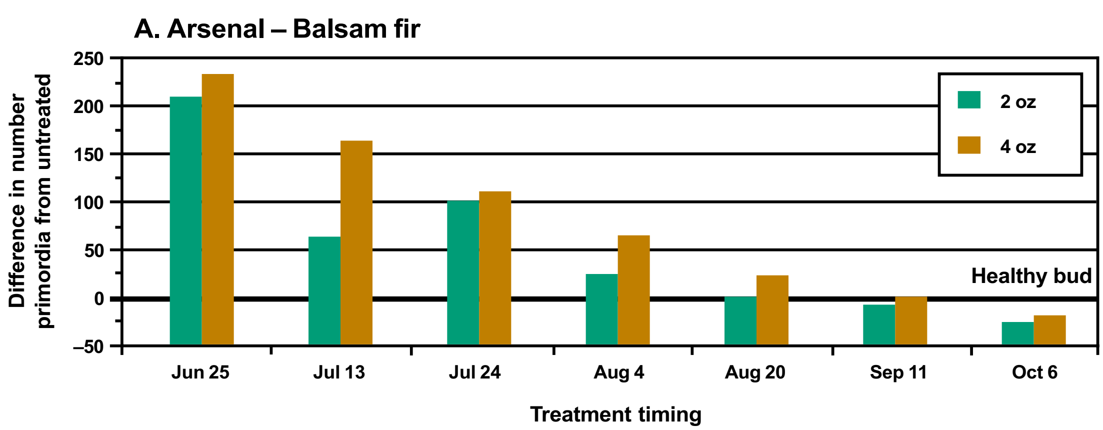


Figure 6. ***Leader and foliage damage index for balsam fir and red spruce in the first year after receiving a triclopyr (Garlo 4) herbicide treatment at seven times during the growing season. Maximum damage score = 30, no damage = 0.***



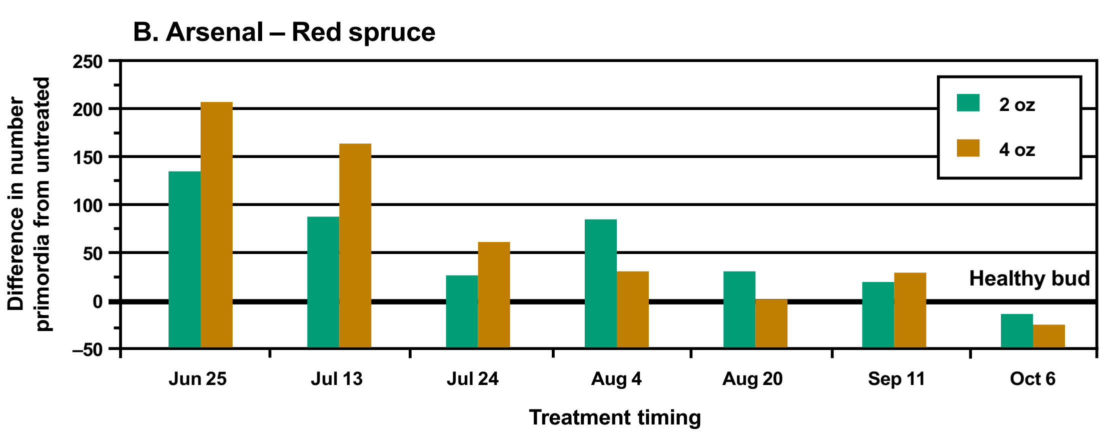


Figure 7. ***Difference in number of needle primordia from buds on untreated balsam fir (A) and red spruce (B) seedlings and buds from trees receiving two imazapyr (Arsenal) herbicide treatments (2 and 4 oz ai./A) at seven times during the growing season. Line indicates where there was no difference between treated and untreated buds.***

Effects of Timber Harvesting and Trapping on Population Characteristics, Habitat Selection, and Area Occupancy by American Martens in Northern Maine: The Baxter Park Study Site

David C. Payer and Daniel J. Harrison
University of Maine

Recent research with implications for management of the American marten (Fig. 8) in the U.S. and Canada has focused on habitat alteration associated with timber harvesting. Although habitat loss through timber harvest has contributed to declines of some marten populations, the relative contribution of increased marten harvest following the construction of forest roads has not been fully elucidated. This is a significant oversight in light of the species' vulnerability to overharvest associated with ease of capture, low reproductive rates, and relatively high pelt value. In fact, overtrapping has been implicated in large-scale declines of marten populations during the early 1900's, and has also contributed to declines in some modern populations.

The effects of timber harvesting and trapping on marten population viability must be isolated to effectively maintain marten populations while providing reasonable opportunities for sustained use of forest products (i.e., timber and fur). This study has isolated these effects by concurrently studying marten habitat associations in three contiguous sites in north-central Maine at three spatial scales, i.e., position of the home range on the landscape (landscape-level selection), selection for overstory characteristics within the home range (stand-level selection), and use of microhabitat features within selected occupied areas. Population characteristics of marten among these sites were also compared in the study. The three study sites differ in regards to habitat alteration and trapping pressure as follows:

- timber harvest and trapping;
- timber harvest and no trapping; and
- no timber harvest or trapping.

Three specific objectives of the CFRU funded portion of our project are to:

- document and compare seasonal habitat selection by marten in an untrapped forest preserve, an untrapped industrial forest, and a trapped industrial forest;
- document and compare population characteristics (i.e. home range size, inter- and intra-sexual home range overlap, density, age and sex structure, survival, and percent females lactating) of martens in an untrapped forest preserve, an untrapped industrial forest and a trapped industrial forest; and
- quantify and separate the influences of trapping and timber harvesting on marten populations by assimilating results from objectives #1 and #2.

Fieldwork was initiated in May 1994 and ran continuously through October 1998. Project personnel captured 189 nonjuvenile (>1 year of age) marten and obtained sufficient data from radio collared animals to evaluate home range characteristics and habitat selection across the 3 forest treatments during 175 marten-years (105 M, 70F). Radio telemetry of collared animals resulted in 11,694 locations; 41% of locations were obtained from ground and 59% from fixed-wing aircraft. Survival and mortality information was based on 153 marten, 40,911 days of observation, 20 natural-caused mortalities, and 20 mortalities from fur trapping.

Reproductive performance was monitored for 48 adult (> 2 year old) marten monitored across the 3 forest treatments. Density of resident nonjuvenile marten in the re-

Figure 8. ***American Marten***

serve averaged 4.3x the density observed in the industrial forest landscape with fur trapping and 2.8x the densities observed in the industrial forest landscape without fur trapping. Thus, both direct mortality from humans and indirect reductions in habitat availability related to forest harvesting reduced populations below the densities observed in the reserve (Fig. 9).

A report detailing differences in patterns of landscape- and stand-scale habitat selection, survival, density, home range area, and age structure across the 3 sites has been completed and will be distributed at the Spring 2000 meeting of the CFRU Advisory Committee. Additional copies can be obtained by contacting the CFRU office.

The CFRU funding for this project has been completed and financed the portion of the project conducted within the Baxter Park site. This site is within a forest reserve without recent (> 35 years) trapping or timber harvesting, and serves as the baseline for evaluating the relative effects of trapping and timber harvesting (T4 R11 WELS), and timber harvesting without trapping (T5 R11 WELS) on marten population characteristics and habitat selection. Additional funding to support the field operation in Baxter Park was provided by the **Maine Forest Service (MFS)** and the **Maine Department of Inland Fisheries and Wildlife (MDIFW)**. Companion studies in the adjacent industrial landscape (T4 R11 WELS, T5 R11 WELS) were funded by MDIFW, the **Maine Agricultural and Forest Experiment Station (MAFES)**, and the **Department of Wildlife Ecology (DWE), University of Maine**.

An associated project was funded by the **National Council of the Paper Industry for Air and Stream Improvement (NCASI)**, with the objectives of evaluating thresholds in forest structure associated with different intensities of marten use within forest stands; to evaluate structural differences between stands subjected to

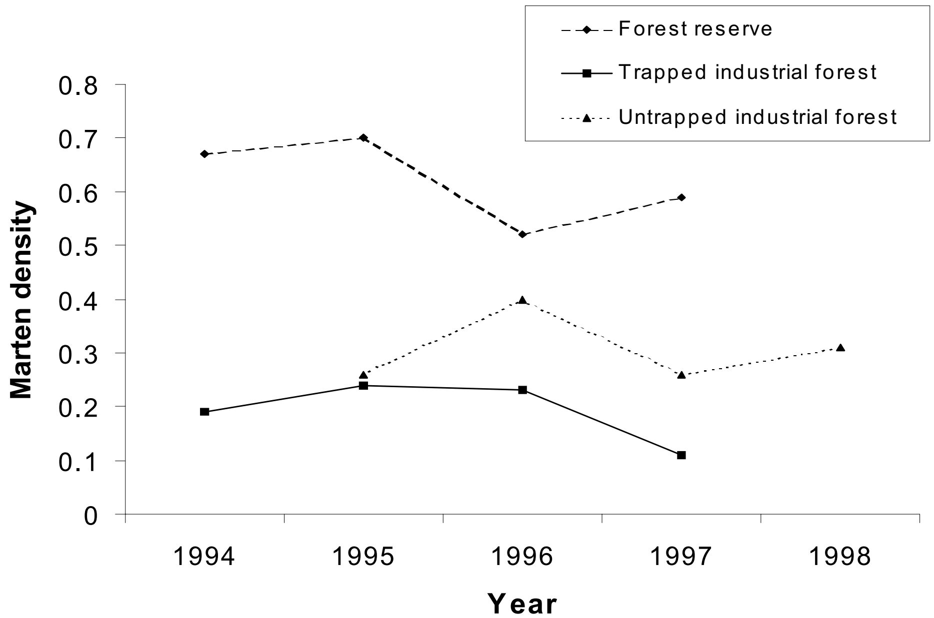


Figure 9. ***Estimated density (no./km^2) of resident, nonjuvenile ($\geq$ 1 yr) marten in a forest reserve, a trapped industrial forest, and an untrapped industrial forest in northcentral Maine, 1 May – 31 October, 1994 – 1998.***

natural disturbance (i.e., budworm-defoliated stands), which receive high use by marten, and clearcuts, which receive low use by marten; and to develop within-stand guidelines for managing harvested areas to maintain use by marten. This project was also completed during the past year. Results were distributed as a CFRU newsletter, during a presentation to the CFRU Advisory Committee, and as NCASI Technical Bulletin #787. Additional copies of the NCASI report can also be obtained by contacting the CFRU office.

The CFRU Advisory Committee voted at the July 1999 meeting to extend funding to support a project to develop statewide habitat projections for marten and to evaluate habitat supply in relation to population objectives that are being established by the **Maine Department of Inland Fisheries and Wildlife**. This project will involve a post-doctoral researcher and is jointly supported by **Maine Department of Inland Fisheries** and **Wildlife, Maine Chapter of the Nature Conservancy**, the **Maine Outdoor Heritage Fund**, and the **College of Natural Sciences, Forestry, and Agriculture at the University of Maine**. Work on that project will commence during spring 2000. For more information please contact **Dan Harrison** at **207-581-2867** or email him at: **harrison@umenfa.maine.edu.**

Influence of Selection Harvesting on American Marten and Their Primary Prey in Northcentral Maine

Angela K. Fuller and Daniel J. Harrison
University of Maine

Selection harvesting is being used increasingly in Maine, yet few studies have examined stand- or landscape-scale effects on forest-dependent mammals such as American marten. Partial overstory removal comprised >90% of the total acreage harvested in Maine during 1997; however, little was known about responses of marten and their prey (e.g., small mammals and snowshoe hares) to selection harvesting. The 3-year study addresses the following objectives:

- to document relative abundance of small mammals and snowshoe hare across 5 overstory types (selection harvests, regenerating clearcuts, and mature deciduous, coniferous, and mixed coniferous-deciduous stands);
- to evaluate patterns of stand-scale habitat selection by marten whose home ranges were composed of > 10% selectively harvested stands;
- to relate stand-scale habitat choices by marten with the relative densities of their primary prey; and
- to quantify and compare overstory, understory, and coarse woody debris characteristics between selectively harvested and mature forest stands.

Marten were trapped and radio collared during 1997 and 1998 in T4 R11 and T5 R11, northcentral Maine. Captured marten were weighed, measured, sexed, ear-tagged, radio-collared, and females were examined for lactation. Marten were monitored from ground and fixed-wing aircraft approximately 2 – 5 times weekly. Habitat characteristics including basal area, canopy closure, and harvesting trails were measured in the 3 largest selection harvest stands (125 – 344 ha) during summer of 1998, and stand structure was reconstructed prior to harvest (Table 1). To evaluate stand-scale habitat selection by marten, we used a multiresponse permutation procedure in a complete randomized block design.

Figure 10. ***Angela Fuller holding tranquilized marten***

Permutation tests for matched pairs were used to evaluate the effect of season on habitat selection by using marten that were monitored during consecutive seasons. Small mammals were surveyed by distributing 20 trap grids (70 x 70 m) among selection harvest (n = 7), mature mixed (n = 7), mature deciduous (n = 2), mature coniferous

Table 1. Characteristics of selection harvest stands compared to mature mixed coniferous-deciduous stands in townships T4 R11 and T5 R11 WELS, northcentral Maine.

	Selection Harvest Stands	Mature Mixed Stands
Tree Basal Area[a] (m^2/ha)	13	18 – 27
Stump Basal Area (m^2/ha)	14 – 18	
Basal Area Pre[b] (m^2/ha)	27 – 31	
Basal Area Removal (%)	52 – 59	
Snag Basal Area (m^2/ha)	1 – 3	
Tree + Snag Basal Area (m^2/ha)	14 – 16	
Harvesting Trails[c] (%)	3 – 38	
Summer Canopy Closure (%)	62 – 71	85 – 92
Winter Canopy Closure (%)	22 – 29	35 – 41
Coniferous Stems / ha (< 1.5 m)	469	1,875
Coniferous Trees / ha	250	732

[a] Basal area of live residual trees.
[b] Basal area of stand prior to harvest = tree basal area + stump basal area.
[c] Percent of straight line transects that intersected harvesting trails.

(n = 2), and regenerating clearcut (n = 2) stands. Each grid contained 64 traps and was sampled for 6 days per year in July of 1997 and 1998. Microsite characteristics were measured at 16 randomly selected trap stations within each small mammal trap grid.

Figure 11. ***Radio collared marten were monitored from the ground and from fixed-wing aircraft***

Snowshoe hare were surveyed using pellet counts, which provide an index of over-winter abundance. Pellets were counted within 5 m x 30 cm transects on the innermost 12 trap stations on each small mammal trap grid. Transects were cleared of all pellets during the fall of 1997 and pellets deposited during winter were counted prior to emergence of deciduous leaves during 1998. Stand-scale relationships of snowshoe hare were evaluated by developing

Figure 12. ***Selection harvest stand in winter***

a regression model that evaluated which variables best predicted estimated densities of hares across the 5 stand types.

We trapped and radio collared 19 marten (10 M, 9 F), of which 16 marten (9 M, 7 F) had home ranges during summer composed of > 10% selection harvest stands. Radiolocations during summer 1997 – winter 1999 totaled 1,852, including 55% obtained from ground and 45% from aircraft. 1,256 small mammals were captured representing 602 individuals (63% red-backed voles, 24% deer mice, and 13% shrews) during 1997 and 778 captures representing 426 individuals (51% red-backed voles, 30% shrews, 15% deer mice, and 4% jumping mice) during 1998.

At the stand scale, marten selected mature (> 9 m tree height) forest types and selection harvests (13 m^2/ha residual basal area, 52 – 59% basal area removal), and against young forests (3.1 – 6.0 m tree height) during summer (1 May – 31 October). There was no difference in stand-scale selection between mature forest and selection harvest stands during summer; however, marten exhibited stand-scale selection for mature forest types during winter (1 November – 30 April).

Home-range areas of marten increased during winter to include greater proportions of mature forest and less selection harvest. Home ranges of males and females during winter were substantially larger for marten whose home ranges included selection harvests than for those that did not (Figure 13). Increased home-range area during winter suggests that selection harvest stands are of reduced habitat quality during winter relative to summer.

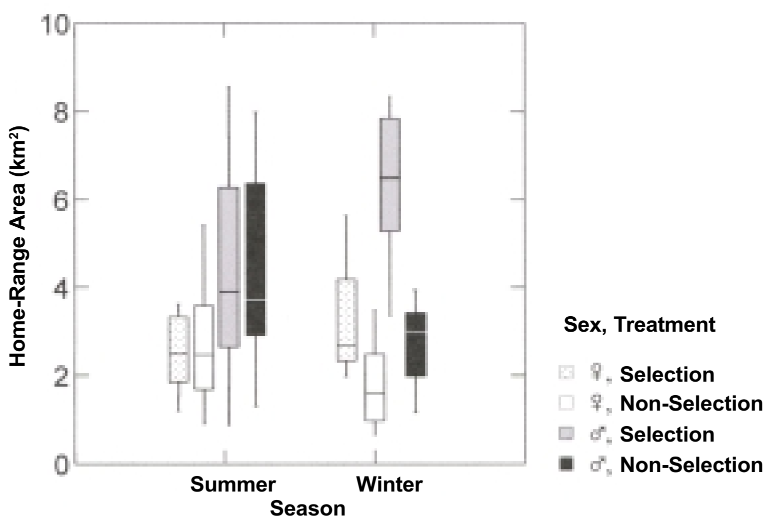


Figure 13. ***Box plots comparing median home-range area (km²) for marten with > 10% of home range composed of selection harvest stands (Selection, summer: n ♀ = 11, n ♂ = 20; winter: n ♀ = 4, n ♂ = 9) and marten with no selection harvest within home ranges (Non-Selection, Payer 1999, summer: n ♀ = 45, n ♂ = 36; winter: n ♀ = 12, n ♂ = 12) during summer (1 May – 31 October) and winter (1 November – 30 April) in townships T4 R11 and T5 R11, northcentral Maine, 1996 – 1999. Vertical line marks the median, boxes indicate the first and third quantiles, and whiskers indicate which values fall within 1.5 interquartile ranges of the first and third quantiles.***

Reduced use of selection harvests during winter may result from overhead canopy closure < 30% (Table 1), which may increase risks of avian and mammalian predation. Additionally, snowshoe hare are important prey for marten during winter, and selection harvests had the lowest hare density of all overstory types (Table 2). Hare densities were greatest in regenerating clearcut (harvested 15 – 16 years previously) stands (1.6 / ha), and least in selection harvest stands (0.01 / ha) (Table 2). Hare density was negatively associated with canopy closure and density of coniferous trees, and positively associated with conifer stem (< 1.5 m) density.

Selection harvests with basal areas of 13 m^2/ha support densities of small mammals that are comparable to mature mixed stands; selection stands contain sufficient densities of voles and mice to receive use by marten during the summer (Table 2). Densities of red-backed voles were greatest in mixed and selection harvest stands, and least in regenerating stands that had been clearcut 15 – 16 years previously. Deer mice were most abundant in selection harvest and deciduous stands, while combined numbers of deer mice, red-backed voles, and shrews were greatest in selection harvest stands.

We suggest that selection harvests be positioned within a mature forest mosaic to provide for seasonal shifts in home ranges of marten, and that selection harvests retain basal areas > 18 m^2/ha to maintain canopy closure > 30% during winter. Snowshoe hare densities in selection harvests should be maintained to approach densities in mixed stands by promoting advance coniferous regeneration.

Fieldwork was completed on 31 May 1999 and funding for the project ended 30 September 1999. A final report will be completed by December 1999 and distributed to cooperators in March 2000.

Funding for this project has been provided by the **CFRU**, the **Maine Department of Inland Fisheries and Wildlife**, **Federal Aid in Wildlife Restoration Project No. W-82-R-11-368**, the **Maine Agricultural and Forest Experiment Station**, and the **Department of Wildlife Ecology at the University of Maine**. **Bowater, Inc.** provided aerial photographs, overstory coverages, and access to their lands. Project personnel during 1997 – 1999 included Angela Fuller (M. S. student), Scott Becker, Gene Orth, Luke Thompson, and Andrew Weik (technicians), Jesse Berube, Thomas Gorman, Meredith Loud, Jennifer Martin, Tony McCue, Nicholas Wildman, and Guthrie Zimmerman (student technicians). For more information please contact **Dan Harrison** at **207-581-2867** or email: **harrison@umenfa.maine.edu.**

Table 2. Rank order of abundance of red-backed voles and deer mice versus rank order of marten habitat selection during summer, and rank order of snowshoe hare density versus marten habitat selection during winter in T4 R11 and T5 R11 WELS, northcentral Maine.

	Summer		***Winter***	
	Mice & Voles	Marten	Snowshoe Hare	Marten
Selection	1.5	1.5	3.0	2.0
Mature[a]	1.5	1.5	2.0	1.0
Regenerating	3.0	3.0	1.0	3.0

[a] Mature = mixed, deciduous, and coniferous stands.

Condition and Development of Root Systems of Balsam Fir and Red Spruce in Pre-Commercially Thinned and Unthinned Stands

Suzhong Tian and William D. Ostrofsky
University of Maine

The aboveground responses of pre-commercially thinned (PCT) softwood stands of red spruce and balsam fir have been well studied in comparison to the belowground responses. As PCT and unthinned stands mature and become large enough for the first commercial thinning, silvicultural prescriptions must take into consideration several stand factors if productivity is to be maximized. Stand stability or wind firmness, pathological considerations such as the prevalence and significance of pre-existing root diseases, and potential consequences of residual stand damage during the first commercial thinning are important determinants of overall stand productivity.

The objectives of the project were as follows:

- Compare differences in root structure and root development between pre-commercially thinned and unthinned stands of spruce and fir currently at or near commercial size;
- Compare the anchorage strength of trees in PCT and unthinned stands to determine relative wind firmness; and
- Determine general incidence and effects of root and butt decays on future risk from residual stand damage, and on risk to wind firmness.

A total of eight 10 x 10 m plots were established in the Penobscot Experimental Forest (PEF) to intensively study root characteristics of balsam fir and red spruce. Two plots were established in each of a thinned and an unthinned stand during the summer of 1998. An additional two replicates were established in an additional, similarly treated stand during the summer of 1999. All trees in the plots were mapped. The five largest spruce and the five largest fir in each plot were carefully excavated for detailed examination. Thus, the entire root systems from a total of 80 trees (40 red spruce and 40 balsam fir) were excavated.

Three 1 x 1 m subplots were also established in each of the larger plots to estimate total root biomass of the stand. Root systems of the crop trees were mapped down to a root size of one cm in diameter. The root systems of the crop trees were then removed for detailed

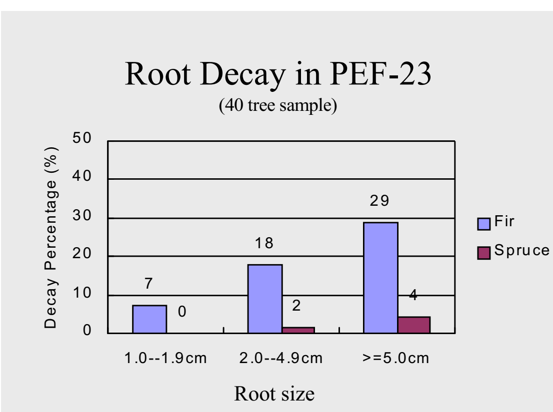


Figure 13. ***Root decay in PEF-23***

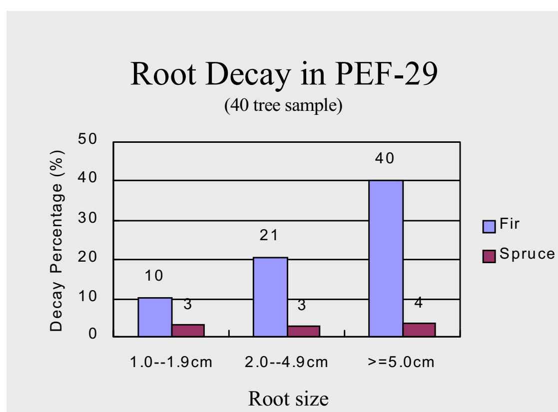


Figure 14. ***Root decay in PEF-29***

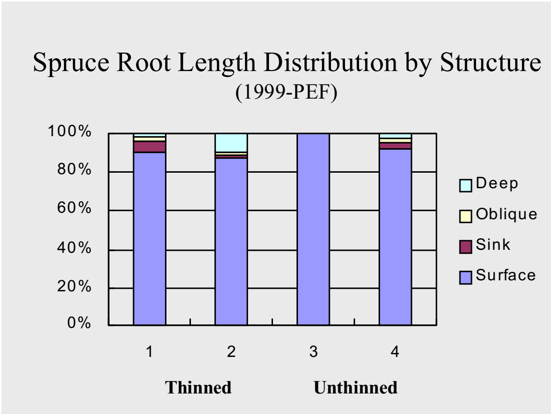


Figure 15. ***Spruce root length distribution by structure***

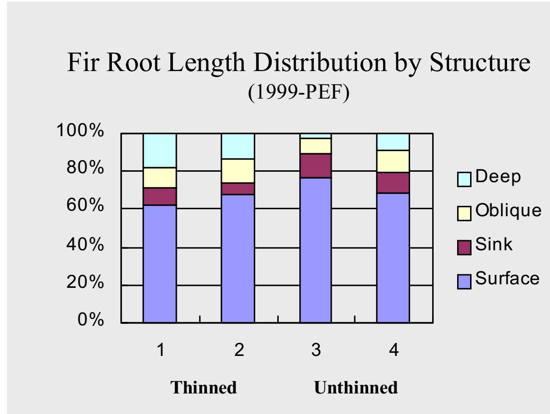


Figure 16. ***Fir root length distribution by structure***

analysis. Sample trees were weighed in the field for aboveground biomass. The excavated and cleaned root systems were weighed for total biomass using a series of root diameter classes. Decayed roots and stump sections were measured for decay volume and sampled for identification of pathogens.

Also in 1999, an unthinned stand in T5R18 WELS (Big Bog), and a stand pre-commercially thinned approximately 15 years ago in T8R5 WELS (Patton) were chosen for measurement of anchorage strength of tree root systems. In each stand 15 red spruce and 15 balsam fir were selected as study trees. Study trees were winched to the ground by hand, with force measurements indicated from a dynamometer for every 2^0 of fall. To determine maximum strength, force was measured from the standing tree (90^0) until the tree was uprooted (approximately 60^0). Crown dimensions, root and stem characteristics, and decay incidence was also recorded for these 60 trees.

Data on root weights and lengths were similar to those from 1998. Analysis of root data from plots measured in 1999 also show significant differences in rooting structure between fir and spruce. Only slight differences in structure attributed to the thinning treatment itself are apparent. Additional data indicate a high level of root decay in fir in the PEF plots, with decay incidence similar in both the thinned and unthinned stands.

Analysis of anchorage strength data is ongoing. The third and final field season of this project will concentrate on evaluation of thinned sites for incidence of root decay. The final analysis will include an integration of thinning treatment, species, root decay, anchorage strength, and crown characteristics on tree and stand stability.

For more information about this study, contact **Suzhong Tian at 207-581-3795** or **email: suzhong_tian @umenfa.maine.edu** and **Bill Ostrofsky** at **207-581-2877** or email: **ostrofsk@umenfa.maine.edu**.

Recent Highlights from the Weymouth Point Paired Watershed Study

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University of Maine

The role of soil functional processes as regulators of ecosystem net primary productivity and as keystones of soil quality is broadly recognized. Protection of these processes has gained international recognition for its importance in attaining sustainable forest management (Powers et al., 1998). In 1995, the Maine Council on Sustainable Forest Management was charged with the task of defining benchmarks for soil productivity of the state (MCSFM, 1995). Benchmark 2 of the council's criterion for soil productivity is to: "maintain an appropriate organic layer in harvest areas to optimize nutrient cycling and soil structure." For the spruce-fir forests of Maine, researchers have limited data on benchmarks for soil productivity. The equally important focus of this report is the impacts of multiple silvicultural practices on forest ecosystem soil element cycling and forest productivity.

Weymouth Point Paired Watershed Study's (WPW) value in defining and developing sustainable forestry in the State of Maine is two fold. First, preservation of the WPW control stand has afforded the opportunity to quantify long-term changes in ecosystem element capital and cycling. Second, intensive long term monitoring has been a powerful tool for quantifying temporal effects and distinguishing short and long term effects of silviculture on soil processes. In 1997, this study was initiated to quantify long-term effects of 1) whole tree harvest (WTH) and 2) precommercial thinning (PCT) on soil C, N, and P cycling and storage.

Measurements of C and N mineralization from late May to mid November 1998 has been very compelling. CO_2-C flux (mineralization) was greater in the WTH and PCT relative to the control (Fig. 15). However, PCT did not further influence C flux relative to the WTH. Increases of C flux immediately after harvest (Londo et al., 1999) and 4 to 6 years after harvest (Fernandez et al., 1999) have highlighted the importance of soil temperature controls on this process. The sustained increase of C flux found at Weymouth Point in 1998 is more puzzling. Although soil temperature is elevated in the WTH and PCT relative to the control, this increase in soil temperature is insufficient to explain the observed increase in C flux.

In light of these results, future research efforts by the CFRU at Weymouth point would be wise to focus on the following critically important question. Are the WTH soils acting as a source or sink of C? Soil C content is critical for maintaining soil productivity. Additionally, the retention of C in northern forests and northern forest soils is continually becoming more of a central topic of international mandates for sustainable forestry. To address these questions for the State of Maine, the CRFU may once again find the WPW of great value.

Studies quantifying the impacts of WTH on soil processes over time scales greater than 15 years are rare. Arguably, the measurements of N mineralization in 1998 may be the most useful and valuable results from this study. N mineralization was higher in the control stand than in the WTH and PCT (Fig. 15), a pattern opposite of that found with C mineralization. As with the previous case, PCT did not further impact N mineralization.

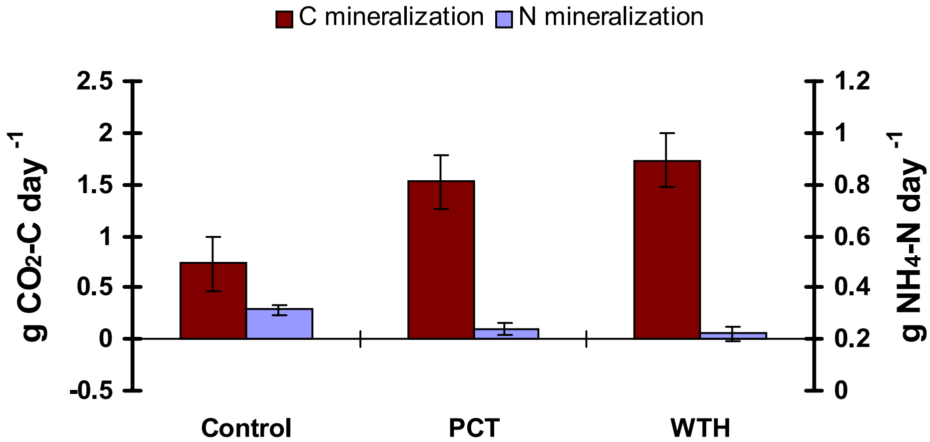

Figure 15. ***A contrast of average daily C and N mineralization at Weymouth Point from May to November 1998. Precommercial thinning (PCT) was applied on a 17-year-old red spruce-balsam fir stand naturally regenerated after whole tree harvest (WTH). In both the PCT and WTH treatments, C and N mineralization were different from the control stand. However, PCT treatment did not further influence either of these soil processes suggesting that both the WTH stand has not recovered to preharvest levels and that PCT was not an effective tool for increasing ecosystem N supply. Error bars represent one standard error of the mean.***

Previous work supported by the CFRU has shown that PCT is an effective tool for increasing tree N (Briggs et al., 1999) and tree growth (Briggs et al., 1994). However, this study suggests that PCT does not appear to be an effective tool for increasing ecosystem N supply because the PCT treatment did not further increase N mineralization. At sites like the Weymouth Point WTH with low N mineralization, increased tree N from PCT will most likely be temporal. Considering the cost of applying PCT, this practice will be more effective on higher quality sites where N supply is less limiting.

The continuation of precommercial thinning research at Weymouth Point has begun to bare fruit. Data gathered and compiled for a MS thesis has resulted in three presentations in the last year based completely on Weymouth Point data. Defense of his thesis, "Silvicultural Effects on Soil Functional processes in a 17 year old Whole Tree Harvested Low-Elevation Spruce-Fir Forest in Maine" is planned in the spring of 2000. For more information about this study, contact **Rich Cobb** at **978-724-3302 x248** or **rcobb @fas.harvard.edu**.

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Long-Term Effects of Herbicide and PCT Treatments on Young Spruce-Fir Stands: The Austin Pond Study

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Austin Pond is the CFRU's oldest research site. Established by **Max McCormack** in 1977 to examine the effects of vegetation management in regenerating spruce-fir stands, it is among the longest running studies of its kind in North America. Over the past decade, Austin Pond has yielded several publications that document the effects of herbicide treatments and pre-commercial thinning on stand growth, vegetation dynamics, and wildlife habitat (Newton et al. 1989, 1992a, 1992b; McCormack and Lemin 1998). The Austin Pond study is located on **Plum Creek** lands and presents one of the best experimental opportunities to quantify long-term stand dynamics under silvicultural prescriptions of varying intensity in the northeast. Since much of Maine's young spruce-fir forest is in a condition similar to that found at Austin Pond, the study is also highly relevant to today's forest conditions.

The original 1977 study included 12 aerially applied herbicide treatments plus an untreated check and a control. Six herbicides (2,4-D; 2,4-DP; 2,4,5-T; MSMA; glyphosate; and triclopyr) were applied in various combinations by helicopter to 2.4-acre (3 x 8 chain) plots that were each replicated twice. In 1986, all of the original 28 plots were divided in half and then one of the halves was pre-commercially thinned (PCT) to about 700 TPA. The experiment currently provides examples of good, moderate, and no vegetation control followed by PCT or no PCT in young, naturally regenerated, spruce-fir stands on a site of moderate productivity (McCormack and Lemin 1998).

Unfortunately, no long-term plan or permanent sample plots were ever established for Austin Pond. Studies published to date have been based on temporary entries to gather data for the intended purpose. In addition, no long-range plans for maintenance or future silvicultural prescriptions have been established for the study. Therefore, the objective of this new study, led by **Bob Wagner** and in collaboration with **Max McCormack, Mike Newton (Oregon State University)**, and **Carl Haag (Plum Creek)** is to establish a permanent inventory plot system in the original study plots and develop a plan for continued treatments that can quantify stand development under a wide range of silvicultural prescriptions.

Using this new inventory system, the specific objectives for this study are to:

- quantify species composition and wood volumes of forest stands 22 years after herbicide treatment and 13 years after PCT;
- model future stand development under the treatment regimes and assess potential long-term economic returns from herbicide application and PCT;
- quantify differences and similarities among the study plots, and using this information refine the experimental design so that new treatments (e.g., commercial thinning, vegetation management, fertilization, or pruning) can be added to the current silvicultural prescriptions; and
- implement the new treatments (developed in #3 above) and initiate a long-term sampling schedule for the study.

The CFRU Advisory Committee approved this new project at the January 1999 meeting and work began this year. The following was accomplished during the 1999 field season:

- All plot corners from the original 1977 study were relocated, marked, and the GPS coordinates determined. New corner markers, where PCT treatments had been applied in 1986, also were located and marked. The GPS coordinates were provided to **Plum Creek** for addition to their GIS database to facilitate protection of the site from logging and road building.

- A set of four 1/20-acre circular plots was installed inside each half (198 x 264 ft. or 1.2 acres) of the original 28 herbicide treatment plots. The total number of permanent sample plots established was 224 (28 main plots x 2 split plots x 4 sample plots / split plot). Re-bar with PVC post centers were installed at each sample plot center for future measurements.
- At each sample plot we measured species and DBH of all trees in the plot. All trees >3.5 inches DBH had their azimuth and distance from plot center, DBH, and species recorded. All trees less than 3.5 inches DBH were classed into <0.5, 1, 2, and 3-inch DBH classes by species. The species and DBH of all standing dead trees were recorded. The total height and height to live crown of a subset of trees of the major species across all DBH classes also were measured to develop height/DBH relationships by treatment plot.

Plans for the coming year include:

- entering all data collected during the 1999 field season (Fall 1999);
- finding a graduate student who will lead this project over the next two years (June 2000);
- conducting a preliminary statistical analysis of the original herbicide and subsequent PCT treatments on species composition, basal area, heights, diameter, stem density, diameter distributions, and standing wood volumes (Winter - Fall 2000); and
- establishing sample plots at all permanent plot locations to examine treatment differences in understory shrub and herbaceous species composition among treatments (summer 2000).

Work in subsequent years will include analysis of the understory vegetation data, projecting future stand development under the different treatments using available growth models, conducting an economic analysis of the stand projections, quantifying differences and similarities among the original study plots, and recommending a new sequence of treatments for the Austin Pond Study. This analysis will be part a graduate thesis and reported at CFRU meetings, field tours, and a variety of publications over the next several years.

For more information about this study, contact **Bob Wagner** at **207-581-2903** or email: **bob_wagner @umenfa.maine.edu**.

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Hardwood Site Classification Field Guide for Maine

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This ongoing project has been described in detail in previous CFRU Annual Reports (1997, pgs. 11-21 and 1996, pgs. 17-25). The objective of the project was to develop a site classification system for hardwood forests in the state of Maine, building on the spruce-fir classification system produced by **Russ Briggs** (1994, CFRU Tech. Note 6).

This year was spent compiling the first draft of the guide. The guide integrates soil charac-teristics, overstory vegetation, regeneration, and understory herbaceous vegetation to classify hardwood stands into groups. Data from 600 plots across Maine were used to identify 5 major vegetation groupings:

- Picea/Acer/Clintonia group
- Acer/Fagus/Viburnum group
- Acer/Fagus/Picea/Maianthemum group
- Acer/Fagus/Picea/Trientalis group
- Acer/Arisaema group

Site productivity classes of Briggs and successional pathways were determined for each vegetation grouping. Photographs of the key indicator plant species are provided to assist in the identification of each group. Potential competing plant species for each vegetation group also are described. Silvicultural prescriptions are suggested for each of the groups.

The guide is currently being externally reviewed and will be available as a CFRU Research Report in early 2000. For more information about this study, contact **Bob Wagner** at **207-581-2903** or **bob_wagner@umenfa.maine.edu**.

Wood Quality Research

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Factors controlling wood properties and the effects of shortened rotations on wood properties are important considerations as forests are managed more intensively. The purpose of this research is to investigate a variety of wood properties and the factors that affect them and to provide information on the possible effects of intensive management on wood properties.

During 1998-99, work was carried out on three studies, two of which were largely completed.

- *Red Spruce Wood Property Study* - The objective of this study is to determine the contributions of drainage class, stand, tree, age, and ring width to wood property variation in red spruce.
- *Red Spruce Pulping Study* - The objective of this study is to determine pulp yield, kappa number, and fiber length of red spruce wood of different ages. Funding for this and the first study was primarily from the USDA.
- *Effects of PCT on Wood Properties of Red Spruce and Balsam Fir* - The objective of this study is to assess the effects of PCT on wood properties of red spruce and balsam fir.

In the Red Spruce Wood Property Study, six dominant or codominant trees were sampled from eight stands each on moderately well drained, somewhat poorly drained, and poorly drained soils (24 stands total). Test specimens were cut at breast height and centered on growth rings 5, 20, 35, and 50 from the pith. This study began in 1994. Testing of specimens was completed in 1999, but some analyses still must be done. **Richard Dionne** and **Stephanie Arnold**, former CFRU Research Assistants, provided considerable help with this study.

Pulp yields were determined for wood of ages 5, 20, 35, and 50 yr in the Red Spruce Pulping Study. Wood from each of seven stands was pulped separately by stand. Chips from six trees per stand were made into four composite samples, one sample per age, and pulped in a digester that had been divided into quarters. The study also provided information on kappa number and fiber length.

The Effects of PCT on Wood Properties Study is in progress; trees of both red spruce and balsam fir are being sampled (seven trees from thinned areas and seven trees from nonthinned areas in each stand). Microbending specimens, which are small test specimens containing one or more growth rings and cut from the pith to the bark along two opposite radii, are being used to establish the relationships of specific gravity, modulus of rupture, and modulus of elasticity to age and ring width in both released trees and control trees. Trees have been obtained from three stands (two balsam fir, one red spruce) and more stands will be sampled. The U.S. Forest Service is participating in a portion of this study.

Results from the Red Spruce Wood Property Study indicate that wood properties did not differ significantly among drainage classes (moderately well-drained, somewhat poorly drained, and poorly drained) or among stands. The primary variables controlling wood property variation were individual-tree differences and wood age (rings from the pith). The relationship of wood properties to age for the four ages sampled is presented in Table 2.

Table 2 clearly shows that all three properties continued to increase through age 50, but that all differ in their relationship to age. The long improvement in wood properties with age suggests that a cultural practice such as

Table 2. Wood properties of red spruce wood of four ages (rings from the pith). Test specimens were taken at breast height from dominant and co dominant trees.

	WOOD PROPERTY		
Wood Age (yr)	Specific Gravity[a]	MOR (psi)	MOE (psi)
5	0.378	5,070	827,635
20	0.358	5,624	1,060,089
35	0.374	6,168	1,146,678
50	0.392	6,685	1,205,205

[a] All means for each property are based on 288 observations.

precommercial thinning, carried out very early in the life of a stand, may have a substantial effect on wood properties of the residual stand.

Increased growth rates when the trees are young mean that trees will reach a merchantable size at a younger age than the trees presently being harvested and because of this will generally have poorer properties.

Results from the Red Spruce Pulping Study indicate that pulp yields fluctuated with specific gravity and that wood with low specific gravity will yield smaller weights of pulp per unit volume than will high specific gravity wood. Fiber length nearly doubled between age 5 and age 20 suggesting that precommercial thinning will lead to an overall reduction in mean fiber length of the trees when they are harvested.

Work on the PCT study will continue and will be expanded to include overall tree characteristics as well as wood property characteristics. Work on wood property-age relationships at positions in the bole above breast height is contemplated. For more information please contact **Bob Shepard** at **207-581-2859** or email: **robert _shepard @umenfa.maine.edu.**

Effects of Fertilization on Pre-Commercially Thinned Stands that are Near Crown Closure

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[2] Champion International Corp.
[3] University of Maine

Recent work at the Weymouth Point Watershed Study showed that pre-commercial thinning (PCT) significantly increased height and diameter growth of spruce-fir stands. Fertilization (200 kg N/ ha) increased growth four years later (see Briggs, Lemin, and Hornbeck 1999, CFRU Research Bulletin 12). One model of fertilizer response suggests, however, that a growth response to fertilization may best be achieved when the stand is near crown closure. This is the question that **Russ Briggs (formerly of CFRU)** and **Rob Krantz (Champion International Corp.)** wanted to address with this project. The specific objectives are:

- to determine the impacts and conventional aerial fertilization with N at 200 kg N/ ha on PCT stands that have closed canopy;
- to compare results of conventional fertilizer with a slow release source of N (sulfur coated urea); and
- to determine crop tree response to several rates (0, 100, 200, and 400 kg N/ha) of slow-release fertilizer.

Five sites on **Champion International** lands that had been pre-commercially thinned in the mid-1980s were selected in the spring of 1997. CFRU crews divided each of the five sites into two treatment plots, making a total of 20 treatment plots (5 blocks x 2 treatments). Three 0.04 ha sample plots were randomly located inside each treatment plot to sample crop tree growth. In addition, three 0.04 ha slow-release treatment plots (100, 200, and 400 kg N/ha) were nested inside each of the five untreated control plots, making 15 slow-release treatment plots in total.

Foliage samples were collected for analysis before treatment in June 1997. Tree height and DBH were measured on at least 10 permanently marked trees in each sample plot during the summer of 1997. All aerial fertilizer treatments were applied on June 30, 1997, and the slow-release plots treated in August and September of 1997.

During the summer of 1999, **Bob Wagner (CFRU)**, **Rick Dionne (USFS)**, and the CFRU field crew relocated all of the original sample plots. The height and DBH of all sample trees were re-measured during September 1999.

Plans for the coming year include entering the data and analyzing the 2-year growth response of all treatments. Plans also call for the collection and chemical analysis of foliage samples. Results from this study will be reported in CFRU Research Notes and Annual Reports.

For more information about this study, contact **Russ Briggs** at **315-470-6989** or **rdbriggs @mailbox. syr.edu** or **Bob Wagner** at **207-581-2903** or email: **bob_wagner@umenfa. maine.edu**.

Ottawa River Valley White Spruce: 20-Year Results in Maine

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White spruce has been used for plantation establishment in Maine since the early 20th century (Ashman 1962). Early rangewide provenance tests of white spruce conducted by Nienstaedt (1969) indicated that the species has a large amount of genetic variation in growth rate, with provenances from near Beachburg, Ontario, in the Ottawa River Valley showing superior early height growth at many planting sites throughout North America. At Bradley, Maine, a plantation of Nienstaedt's provenance tests revealed that the Beachburg provenance was 28% taller that the plantation mean and 12% taller than the local (Bradley, Maine) seed source at year 15 (Wilkinson 1977).

In order to further investigate the performance of Ottawa River Valley white spruce compared to native Maine white spruce, half-sib seedlots from 112 parent trees in 28 natural stands of white spruce in southeastern Ontario and southwestern Quebec were obtained from the Petawawa (Ontario) Forest Experiment Station. Seedlots were collected from 6 white spruce identified as "superior" in natural Maine stands. All seeds were sown at the **Great Northern Paper Company's** greenhouse in January 1978. After 2 years' growth in the nursery, a total of 3,310 seedlings were outplanted by the University of Maine into randomized, replicated trials at 3 locations: Woodland, Orneville, and Ragmuff (T6R14). Tebbetts (1981) gives details of the seed source origins and seedling growth through year 2. This report summarizes the growth of these trees at year 20 (Woodland and Orneville) or year 21(Ragmuff) from seed.

All 3 planting sites are on deep, moderately to well-drained soils, which were considered to be favorable for white spruce. Overall, survival at the 3 sites averaged 86%. Table 3 lists the relative mean heights for trees from the 6 Maine seedlots and 28 Canadian seed sources, as well as the range of half-sib means within each Canadian stand. Overall, the Maine seed sources tended to be below average in height. Height of the Canadian stands, and of half-sib seedlots within stands, was quite variable. However, 9 of the Canadian stands had above-average height at all 3 planting sites. Two of these stands (PFES 8026 and 8028) from near Beachburg, Ontario, were at least 5% above average at all sites, and in addition almost all of the individual half-sib families within these stands were above average in height, some as much as 27%. These Beachburg area seedlots have maintained growth superiority over offspring of phenotypically selected Maine white spruce for two decades, and appear to be a valuable source of genetic resources for use in Maine tree improvement and planting programs. For more information, please contact **Katherine Carter** at **207-581-2855** or email: **carter@umenfa.maine.edu.**

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Table 3. Relative mean heights[a] for each of 6 Maine (USFS) white spruce seed sources and 28 Ottawa River Valley (PFES) seed sources (with range of family means), at three provenance test locations in Maine.

Seed Source #	*Ragmuff*	*Orneville*	*Woodland*
USFS 141	98	97	112
USFS 145	103	84	91
USFS 153	82	91	81
USFS 156	67	103	87
USFS 39	93	110	88
USFSmne	91	—	106
Maine seed source mean	93	99	95
PFES 8003	91 (82-102)	98 (91-102)	93 (88-98)
PFES 8004	99 (88-118)	94 (86-101)	88 (71-99)
PFES 8009	94 (87-103)	102 (97-106)	98 (94-105)
PFES 8010	97 (83-115)	98 (86-108)	96 (79-102)
PFES 8011	97 (98-106)	102 (84-112)	102 (94-116)
PFES 8012	101 (91-121)	101 (95-114)	108 (101-121)
PFES 8016	102 (92-118)	102 (94-110)	84 (76-90)
PFES 8019	101 (97-105)	104 (97-107)	101 (97-103)
PFES 8020	93 (83-111)	97 (93-103)	96 (86-104)
PFES 8024	96 (81-108)	101 (89-109)	97 (77-121)
PFES 8025	101 (95-112)	103 (93-113)	104 (89-122)
PFES 8026	106 (103-111)	111 (110-112)	107 (89-127)
PFES 8027	101 (98-103)	91 (85-97)	101 (93-107)
PFES 8028	105 (96-113)	108 (102-117)	108 (103-113)
PFES 8029	103 (95-117)	97 (85-107)	108 (99-116)
PFES 8030	89 (73-102)	—	88 (78-96)
PFES 8032	94 (90-104)	95 (92-101)	104 (85-116)
PFES 8033	101 (93-107)	89 (78-97)	98 (91-105)
PFES 8153	105 (102-113)	98 (94-101)	97 (93-101)
PFES 8154	103 (92-116)	101 (92-104)	104 (96-119)
PFES 8155	105 (98-125)	93 (79-113)	105 (96-112)
PFES 8161	101 (95-115)	102 (94-118)	102 (82-111)
PFES 8210	84 (67-99)	98 (88-110)	101 (87-114)
PFES 8211	94 (87-108)	101 (90-108)	102 (92-109)
PFES 8273	105 (99-109)	—	105 (92-117)
PFES 8274	98 (91-112)	105 (94-111)	91 (87-97)
PFES 8319	106 (103-110)	98 (86-109)	97 (69-104)
PFES 8323	101 (100-108)	101 (88-113)	105 (96-112)
Plantation mean height (m)	6.37	7.11	5.25

[a]Relative mean height = (seedlot mean height/plantation mean height)x100

The Legacy of Diameter Limit Cutting: A Case Study for Red Spruce

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A recent topic of concern has been an apparent downward trend in statewide conifer net annual growth, which if true could exacerbate the projected shortfall between net annual growth and projected harvest volume as reported by Gadzik et al. 1998. This possible decline may be related to the observation that growth per unit of growing stock has been declining for Maine's softwoods over the last 3 inventory periods (see table 4, based on Griffith and Alerich 1995).

Table 4. Growth per cubic foot of growing stock.

	Inventory Rates		
Softwoods	***1959-1971***	***1972-1982***	***1982-1995***
Growth per unit of growing stock	0.038	0.019	0.016
Hardwoods			
Growth per unit of growing stock	0.024	0.025	0.024

Why has softwood growing stock become seemingly less productive over the years? There are a number of possible reasons for this decline, including changes in age class distribution within the growing stock, climate change, or a decline in frequency of genes that control good growth characteristics. Given the long history of selective harvesting of red spruce in Maine, we have tried to determine to what extent red spruce has been subject to diameter limit harvest over the last inventory period, and whether or not the residual trees left after a diameter limit harvest represent slower growing trees than those that were removed.

The objectives of this study are to determine: 1) how much diameter limit cutting was done and where, 2) whether or not the relatively small residual trees were slower growing than those removed, and 3) estimate the effects of diameter limit cutting on the future growth of red spruce.

Using the data base from the latest inventory of Maine's forests, we determined 1) the total number plots containing red spruce which were harvested, 2) the basal area remaining after harvest, 3) the ownership on which the harvests occurred, and 4) the size of the trees before and after harvest. We also compared the growth characteristics over time by residual trees in diameter limit and selection cut treatments at the Penobscot Experimental Forest using data we collected as well as some from Kenefic and Seymour (1997). Trees were selected within 5m of transects in the compartments receiving these treatments.

From 1982 to 1995, about 700,000 acres of forest land with red spruce were partially cut (up to 90% of red spruce removed), compared with about 1.4 million acres which were essentially clearcut (more than 90% of spruce removed). Red spruce was much sought after during this period, and when it was present, most of it was removed (see Fig. 16). Most of the harvesting occurred on industrial land, with about 440,000 acres receiving partial cut and about 900,000 acres clearcut. The motivation towards this heavy harvest of red spruce is unknown, but may reflect the value of the species, as well as the perception that merchantable red spruce is susceptible to spruce budworm. In most of the partial cuts (90 out of 110), the residual trees were smaller than the trees removed (see Fig. 17).

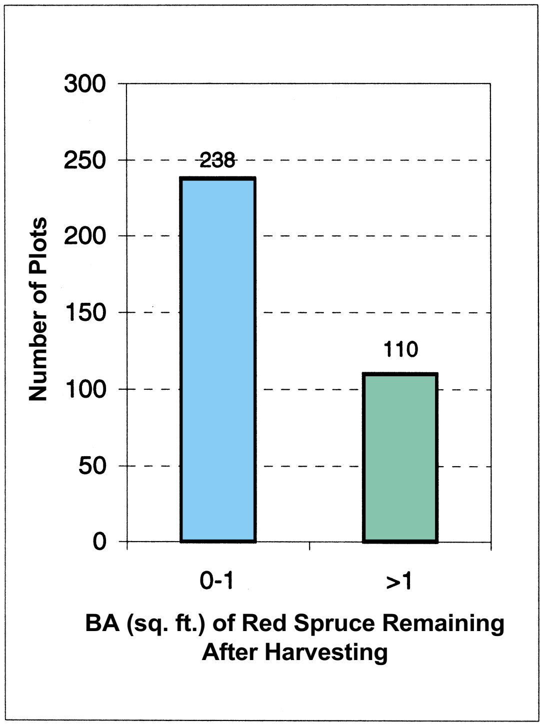

Figure 16. ***The amount of red spruce remaining after harvest. A total of 980 plots contained red spruce, and a total of 348 were harvested; in 238 of these plots less than 1 square foot of basal area was left, compared with 110 plots with more than 1 square foot. Total plots with Red Spruce = 980. Total plots with Red Spruce Removals = 348***

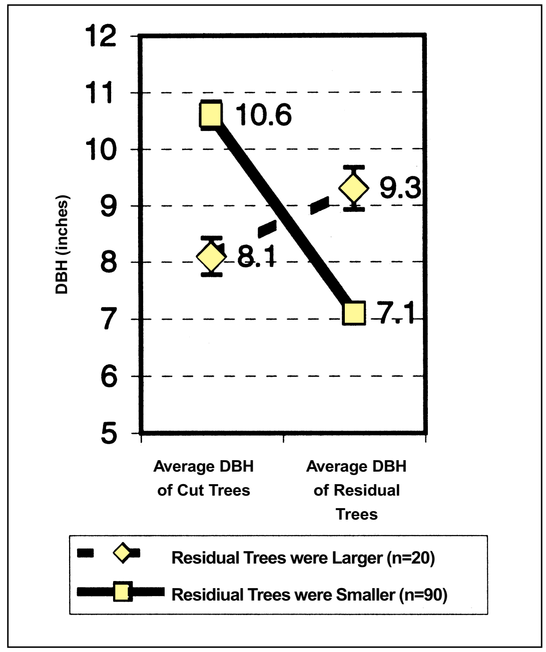

Figure 17. ***Diameter of harvested and residual red spruce in 110 plots where more than 1 square foot of basal area was left. Total Plots with Harvesting=348***

The growth characteristics of red spruce residual trees remaining after diameter limit cuts and selection cut treatments begun in 1953 at the Penobscot Experimental Forest are shown in Fig. 18. The residual trees in the diameter limit cut were approximately the same age as those in the selective cut, but were relatively slow-growing, especially in the first 60 years of their development.

Based on results from this work, we conclude that red spruce was harvested heavily from 1982 to 1995 over a total of about 2 million acres. About two-thirds of the acres harvested were clearcuts, while the remainder received some form of selection harvest. About 573,000 acres, or about 82% of the land that was partially cut appeared to have been subject to some sort of diameter limit harvest. The great majority of diameter limit harvests, about 440,000 acres, occurred on industrial land, indicating that this practice was still being practiced extensively during the most recent inventory period. Diameter limit harvest has been traditional for well over a century in Maine, and has continued through the 1995 inventory period.

What are the long-term implications of diameter limit cutting to the growth characteristics of red spruce? The comparison of growth over time for residual trees in diameter limit and improvement cuts at the PEF indicates, as expected, that the residual trees in the former were smaller. Smaller trees in the diameter limit cut could either be younger or slower growing than those in the selection cuts. The residual trees in both treatments were about the same age, and the time course of cumulative radial growth clearly shows that trees in the diameter

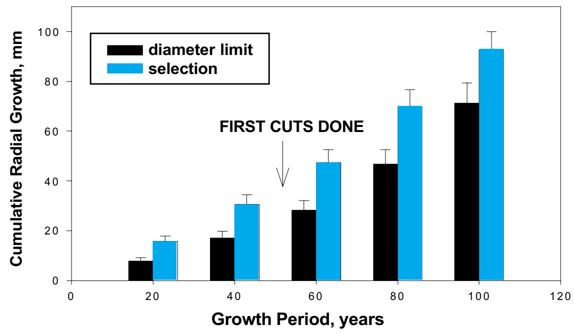

Figure 18. ***A large number of residual red spruce in both cutting regimes were over 100 years old; 115 and 85 trees were sampled in the diameter limit and selection cuts respectively. Diameter growth over 20-year periods is shown in the figure. Trees of similar age in the diameter limit cut grew significantly less (p<0.001) than trees in the selection cut.***

limit cut grew significantly slower during the first 60 years of their life span. Residual tree growth increased in both treatments after harvest began in the early 1950's. Kennefic and Seymour present data showing that red spruce over 100 years old in the selection treatment vary from about 7 to 50cm in diameter at breast height, so it is not surprising that diameter limit cutting does not leave mostly younger trees.

If these results are representative of what has happened after diameter limit harvest throughout the spruce-fir forest, then we can conclude that **1) the small, slower-growing residual trees may respond relatively poorly to release, and 2) these trees will seed in the next generation of seedlings.** Some of the slowing growing trees will represent individuals with genes for slow growth. Therefore, the cumulative effect of decades of diameter limit harvesting may have detectably decreased the productivity of Maine's softwood forests in the short run because of slow-growing residual trees, and in the long run because these trees will produce progeny with genes for relatively slow growth. For more information on this study contact **Mike Greenwood** at **207-581-2838** or email: **greenwd@umenfa.maine.edu.**

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New Projects

Commercial Thinning Response Studies

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University of Maine

In response to widespread cooperator interest in refining commercial thinning strategies in conifer stands, we began an effort to install and remeasure permanent plots in several locations. The objectives were to:

- document long-term thinning response of a mature, mixed white pine-red spruce stand in Twp 41 that was thinned in 1983;
- quantify pre-harvest stand conditions and actual thinning prescriptions in previously untreated, mature red spruce stands (Kossuth Twp) and immature balsam fir stands with a history of early spacing (Days Academy);
- test the utility of a new density management diagram (Wilson et al. 1999) for estimating stocking and predicting stand growth.

This effort was, in most respects, a pilot study designed to develop experience with commercial thinning operations, in preparation for designing a Maine-wide study of commercial thinning in conjunction with many CFRU cooperators. Field work and data processing were carried out by **Chad Keyser,** Graduate Research Assistant, with the help of **Sean Garber**, senior forestry student and summer employee.

Five stands on **Baskahegan Co.** and **Plum Creek Timber Co.** land were evaluated during the summer of 1999 for inclusion in the final thinning study. Two stands around Alder Brook and Pleasant Brook West were chosen in Kossuth Township on **Baskahegan Co.** land. The Alder Brook stand (AB) was thinned in 1990 using a Valmet processor, while the Pleasant Brook West (PBW) stand was thinned following plot establishment in the fall of 1999.

Six and twelve variable radius (10 BAF) plots were established in the Alder Brook and Pleasant Brook West stands, respectively. Both stands are composed of red spruce and eastern white pine; trees average about 70 years old, with some older individuals.

In addition, three stands (CCC, CCS, DA) were located in the Days Academy region north of Moosehead Lake on **Plum Creek Timber Co.** When data were collected, none had been thinned, but all had been identified by company staff as potential candidates for early commercial thinning based on their establishment date (1970s) and precommercial thinning history (early 1980s). The **Plum Creek** stands are heavily dominated by balsam fir with occasional red spruces and minor species. Five, ten and nine variable-radius plots were established in the CCC, CCS, and DA stands, respectively.

The same plot establishment procedures were used for all five stands. All trees were numbered and dbh and crown ratio were recorded. A sample of tree heights per species was taken at each plot based on the range of diameters present. Tree height was predicted using the height sample from each ownership for each species based on the following equation: $PHT = b_o + b_1 * \log(dbh)$. Individual tree volumes were calculated from Honer's volume equations (1967). Average tree volume and trees per acre were computed for each plot. Plots were then plotted on the newly published northeastern spruce-fir density management diagram (Wilson et al. 1999; Fig. 19). The DMD illustrates each plot's stocking relative to four reference lines:

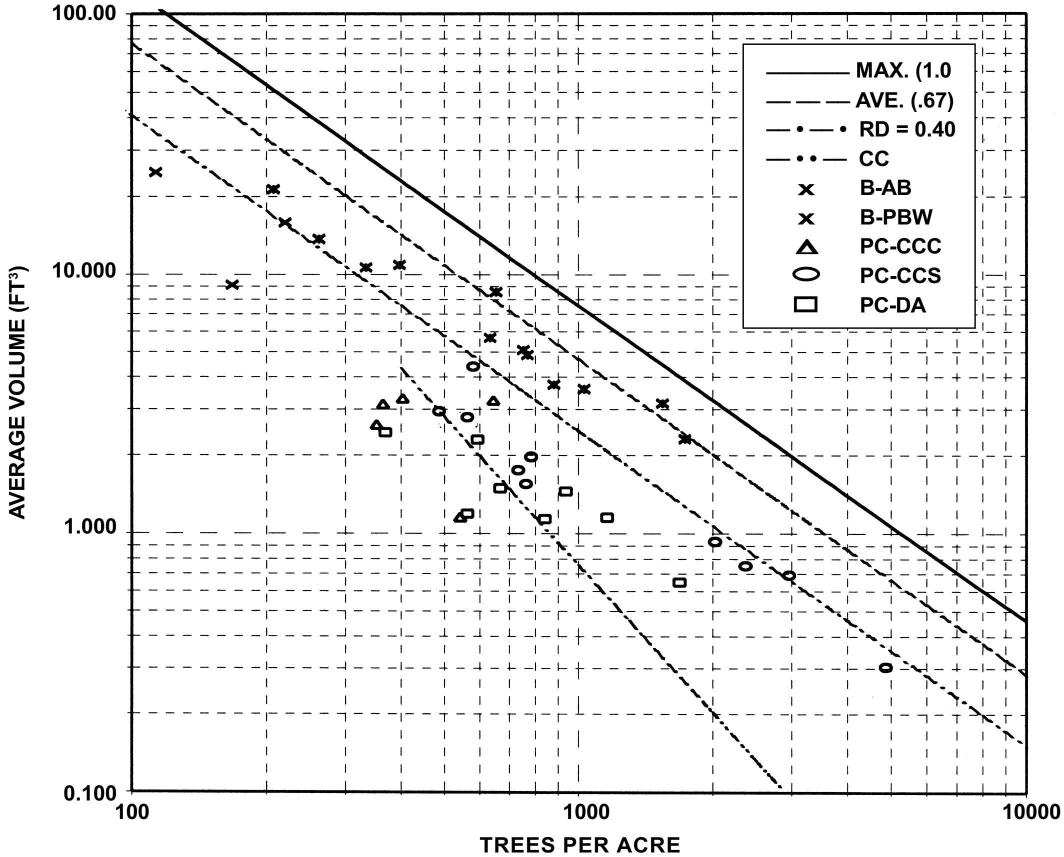

Figure 19. ***Density Management Diagram for red spruce and balsam fir forests in the Northeast. Plot data for various stands on Baskahegan Co. (B-) and Plum Creek Timber Co. (PC-) lands.***

- Relative Density (RD) = 1.0, the upper biological limit on stocking, and the reference standard used to compute RD for any stand;
- RD = .0.67, the line used to predict self-thinning behavior for the average fully stocked stand (i.e., once a stand reaches this line, it will then grow along it as mortality occurs);
- RD = 0.40, a typical value used to determine *residual* stocking levels for thinning operations designed to achieve maximum volume production (based on experience from other species for which DMD's have become widely used); and
- The Crown Closure (CC) line, which defines the RDs (not constant) at which crown closure first occurs at various densities.

The Gassabias Stream Thinning Area in Township 41 was established in 1983 and maintained through 1989 as part of the **Champion's** Thinning Growth Response Monitoring System. Twelve clusters of five variable-radius 10-BAF plots each were established in a thinned, two-aged spruce-fir-pine stand. In addition, one cluster of five variable radius plots was established in an unthinned area nearby as a control. The majority of the stand was made up of 60 year-old white pine, red pine, red spruce, and balsam fir with scattered remnants of 100 to 120 year old white pine. The stand was thinned manually to a residual basal area of 76 ft^2 per acre and a density of 245 trees per acre (Table 5), using a crop tree approach where spruces and pines were left on about a 13-foot spacing. The residual stand was 59% white pine, 28% red spruce, and 11% red pine by basal area. Most of the fir was removed during the thinning operation. All plots were established by **St. Regis Corporation** in 1983, with re-measurements in 1988 (by **Champion**) and 1999 (by CFRU). Dbh, height, and crown measurements were taken during each measurement period. Ongrowth (trees newly "in" to the prism) was also tallied and measured in 1988 and 1999 to update the sample for the future measurement period.

Individual-tree volumes (total stemwood, all sizes of trees) were calculated from Honer's volume equations (1967) for each measurement period. Average tree volume and trees per acre were computed for each plot. Plot trajectories were then projected on a northeastern spruce-fir density management diagram (Wilson et al. 1999) from 1983 to 1999 with a correction for ongrowth in 1988 (Figure 20). Gross (survivor) PAI vs. initial relative density were plotted for measurement periods, 1983 to 1988 and 1988 to 1999 (Fig. 21).

Table 5. Residual stand characteristics immediately after thinning in 1983, in a 60-year-old pine-spruce stand in T41. Plots installed by St. Regis Corporation and remeasured in 1988 by Champion International Corporation and in 1999 under the project reported here. Unthinned control plots not included.

Stand Parameter	Balsam fir	Hemlock	Red pine	Red spruce	Paper birch	White pine	Total (Average)
Trees/acre	2.1	0.1	15.8	111.8	0.5	114.6	244.9
Basal area/acre (ft²)	0.5	0.2	8.3	21.3	0.3	45.0	75.7
Total stemwood volume per acre (cubic feet)	11	4	236	496	9	1,203	1,959
Quadratic mean Dbh (inches)	6.6	15.9	9.8	5.9	11.0	8.5	7.5
Total stemwood volume per tree (cubic feet)	5.1	36.9	14.9	4.4	17.3	10.5	8.0

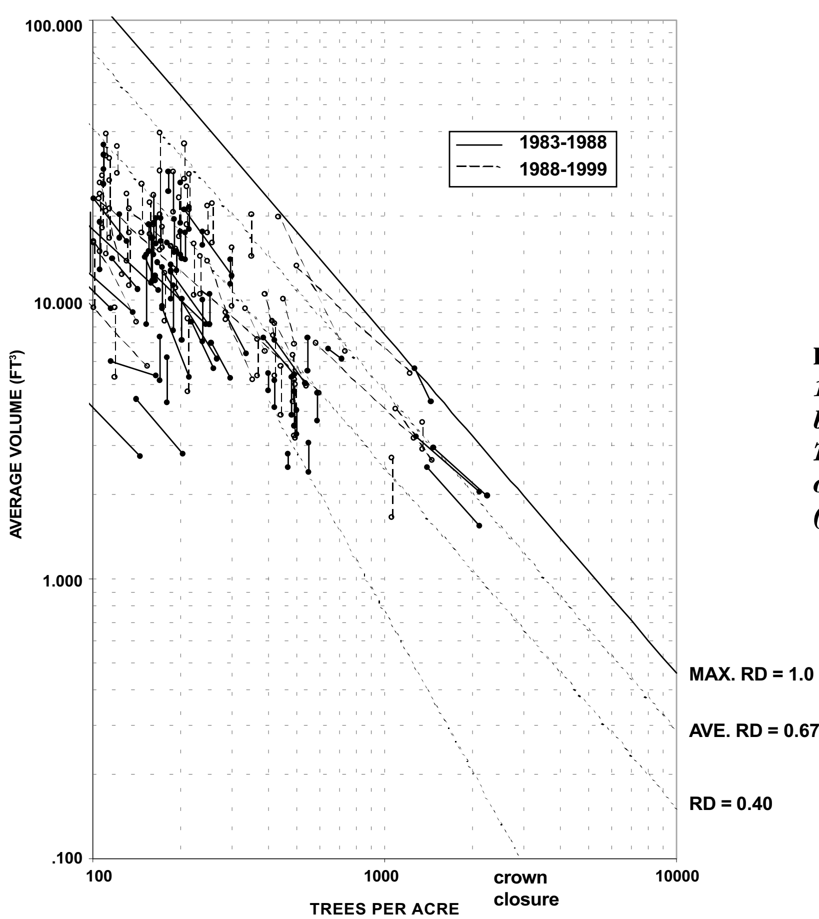

Figure 20. ***Stand trajectories from 1983-1988 and from 1988-1999 for both thinned and control plots in the Twp. 41 commercial thinning study on lands of Champion International. (See Table 5 for stand conditions.)***

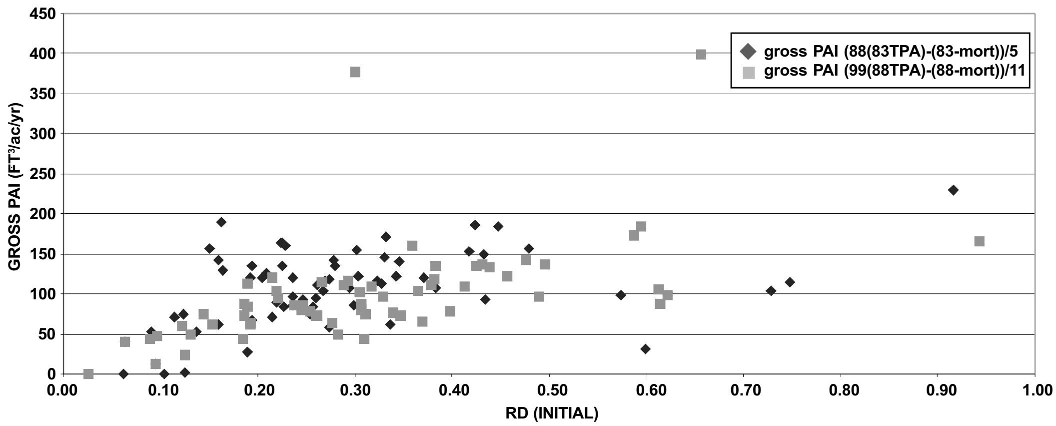

Figure 21. ***Gross (survivor) periodic annual increment vs. initial relative density (RD) for the Champion thinned plots***

The unthinned stand (PWB) on **Baskahegan** lands has a basal area of 168 ft^2 per acre and a density of 766 trees per acre, 77% of which is red spruce. RD averages 0.55, with individual points ranging from 0.42 to 0.75 (Fig. 19). The stand is clearly in need of treatment, as all points are well above the 0.40 RD thresholds. Note that actual density within the stand ranges widely from 207 to 1732 trees per acre, whereas relative density varies much less. This result emphasizes the value of RD and the DMD in standardizing stocking estimates and quantifying thinning prescriptions in comparison to simpler, absolute density measures.

The thinned stand on **Baskahegan** Lands (AB), harvested about 1990, has grown back to a basal area of 90 ft^2 per acre; RD is currently 0.29 and is thus still somewhat under stocked compared to the 0.40 standard for optimum growth. However, the company sees these partial-cutting treatments in mature spruce stands more as shelterwood establishment cuttings than true thinnings, in which case, such RD's seem quite appropriate.

The unthinned stand (PWB) will be remeasured prior to the next field season to assess the company's thinning prescription and provide a basis for future growth monitoring.

The unthinned stands on **Plum Creek** lands have much lower RD's than the older unthinned Baskahegan stand, ranging from 0.19 to 0.30. Basal areas of fir and spruce range from 73 (stand DA) to 109 (CCS) ft^2 per acre; density ranges from 370 to 1248 trees per acre, including 500 one-inch trees in stand CCS that represent ingrowth after the earlier spacing (Fig. 22). Most have just reached crown closure, as indicated by their nearly 100% live-crown ratios and their positions on the DMD (Fig. 19). Furthermore, average diameters are from 4-6 inches; larger (7-8 inch dbh) firs are present, but these are all vigorously growing dominants.

It would appear that these stands are at least 10-15 years away from the optimum time for a first commercial thinning entry, as they are still immature and understocked relative to the 0.40 guideline. Thinning them now, or soon, would leave them seriously understocked, and would obviously sacrifice much growth potential. It is noteworthy that the (low) relative densities of these plots agree with conventional criteria (low basal areas, high live crown ratios) here in supporting a decision to defer thinning.

The **Champion** remeasured plots offer a rare opportunity to document long-term growth of mature stands that were silviculturally thinned before this practice was economically feasible, as it is now. Average relative density after thinning was fairly low (0.25 in 1983). The basal area (all species) increased from 76 ft^2 per acre after thinning (Table 5) to 87 ft^2 per acre in 1988 and 115 ft^2 per acre in the 1999 remeasurement. The white pines grew particularly well throughout the period; red spruce suffered some post-thinning mortality during the first period (likely from spruce budworm defoliation), but rebounded somewhat during the 1989-99 period.

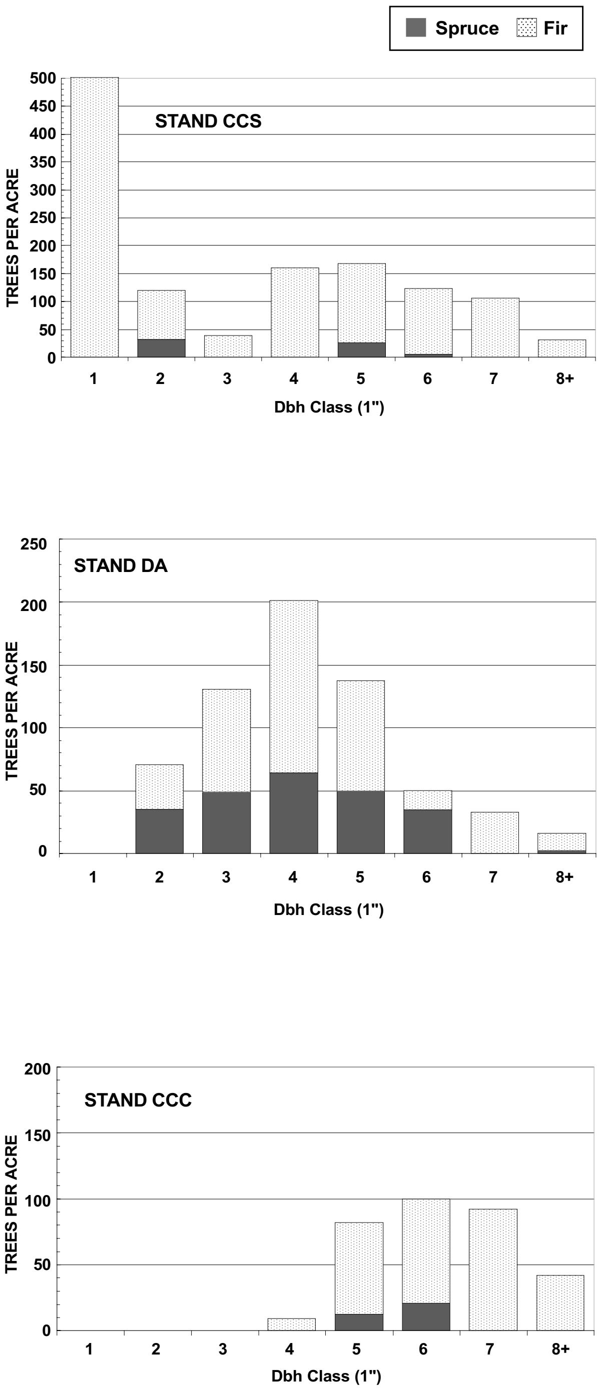

Figure 22. ***Diameter distributions of the young stands measured on Plum Creek lands, Days Academy.***

The gross periodic increment (total stemwood) over the first period averaged 106 ft^3 per acre per year (1.2 cords per acre), and decreased slightly to 94 ft^3 per acre per year (1.1 cords per acre) during the second period. The control plots averaged 116 ft^3 (1.4 cords) and 171 ft^3 (2.0 cords) during the same periods. This suggests if thinnings had been somewhat lighter, removing only those trees that died during the remeasurement periods, average growth rates could have been substantially higher, comparable to those predicted for high-site plantations. These are impressive and unexpectedly high growth rates for natural stands by most conventional standards, especially considering the site quality of this study site is not high.

The self-thinning behavior of these plots is, in general, accurately predicted by the DMD (Fig. 20). Most the plots in the 100-600 trees per acre range with RD's below 0.4 grew upwards with little mortality. RD's of the unthinned control plots averaged 0.71 in 1983 and 0.69 in 1988, virtually identical to the average of 0.67 predicted by the DMD. The self-thinning behavior of each control plot appears to follow a trajectory parallel to the upper lines on the DMD (Fig. 20), further supporting the validity of this tool.

Of great interest is whether RD is a better predictor of stand growth than simple density parameters such as basal area or trees per acre. To examine this classical "growth-growing stock" relationship, gross periodic annual increment for each remeasurement period was plotted over the RD at the beginning of the period for each point (Fig. 21). Clearly a strong positive relationship exists between relative density and gross growth. Although we did not attempt to fit a least-squares regression to the data, the pattern most closely approximates Hypothesis A (see Seymour 1999), which predicts continuously increasing gross growth (though at a declining rate) until reaching the maximum possible RD. The relationship between RD and net periodic increment (not shown) is much flatter above RD's of about 0.5, due to mortality of merchantable trees from self-thinning.

These invaluable data from **Champion** are the first time we have used a remeasured data set to evaluate the diagram. Although the stand composition is more dominated by pine than spruce-fir, the results are quite encouraging. The strong relationship between RD and growth suggests its potential as a key independent variable for establishing and standardizing thinning treatments in the study of commercial thinning growth response now in the design stages. For more information about this study, contact **Bob Seymour** at **207-581-2860** or **seymour@umenfa.maine.edu.**

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Using Wood Supply Analysis of Maine's Forest to Identify the Most Productive Areas of Silviculture Research for the CFRU

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[2]Fraser Papers, Inc.

Cooperators have identified silviculture research as a top priority for the CFRU. Identifying which areas of silvicultural research will provide the greatest benefit to cooperators and contribute most to improving the management of Maine's forests, however, is a difficult task. There also is no structured approach for evaluating the relative or absolute value of various areas of silviculture research for the CFRU. Since silvicultural research is a long-term and expensive undertaking, systematically evaluating which areas of silviculture are likely to have the greatest long-term value is a prerequisite.

The release of the *"Timber Supply Outlook for Maine: 1995-2045"* report by **Maine Forest Service** (MFS) in 1998 brought much attention to the issue of Maine's wood supply. The Aggregated Timberland Assessment System (ATLAS) computer model used in this analysis of **USDA Forest Service** inventory data from Maine provided the basis for the report. Part of this analysis included an evaluation of the wood supply implications for increased use of silvicultural practices such as thinning, plantations, and vegetation management. This analysis by the MFS provided the impetus for this project.

Could we use sensitivity analysis of silvicultural inputs for this wood supply model to determine the absolute and relative importance of various silvicultural practices on Maine's forest, and from this assess the value of various silvicultural research priorities? This is the question posed by **Bob Wagner (CFRU), Bob Seymour (CFRU),** and **Gordon Whitmore (Fraser Papers, Inc.)**, who are leading this new project. Joint funding support for this project was obtained this year from **CFRU**, **Maine Forest Service**, and **University of Maine NSFA R&D** funds. **Ernest Bowling (J.W. Sewall Co.)** will be conducting the modeling effort as a new member of the research team.

Specific objectives for this project include:

- translating the current ATLAS model to a WOODSTOCK platform to facilitate the analysis;
- quantifying the importance and sensitivity of various silvicultural treatments (including pre-commercial and com-mercial thinning, plantation establish-ment, gap planting, vegetation management, fertilization, tree improvement, even-aged vs. uneven-aged management) and other factors (hardwood/softwood supply inter-actions, wood utilization standards) to Maine's future wood supply and annual harvest;
- ranking the potential value of various silviculture practices on Maine's wood supply and annual harvest;
- comparing results from the state of Maine database with one or more industrial forest landowners;
- identifying information gaps for the most important model variables and prioritizing them based on sensitivity analysis of various silviculture activities;
- developing a framework for assessing and / or prioritizing potential research and development directions based on the above analysis, and recommending the most productive areas of silvicultural research for the state of Maine; and
- identifying a modeling approach that can be used in cooperation with the marten habitat supply models currently under development by **Dan Harrison (CFRU)**.

Work on this project is scheduled to begin in late fall 1999. For more information about this study, contact **Bob Wagner** at **207-581-2903** or **bob_wagner@umenfa.maine.edu**.

New Research Proposals Under Development

In addition to efforts spent re-structuring the CFRU over the past year, CFRU staff members have worked to develop new research ideas, assemble new research teams, and develop new research proposals. These efforts have focused on addressing high priority issues identified by the CFRU research priorities survey (see pgs. 5-6 of this report), as well as other issues identified as important by cooperators. As a result, a group of pre-proposals were initiated to address these important issues and will be presented to the Advisory Committee for funding consideration under the new organizational design in the coming year (see pgs. 3-4 of this report). The following provides a brief overview of these activities:

Commercial Thinning Research

Identified as a top CFRU research priority this year, **Carl Haag (Plum Creek), Bob Wagner (CFRU),** and **Bob Seymour (CFRU)** organized several small meetings to discuss specific research directions for this effort. In May 1999, a field tour with 20 cooperators and others visited **Plum Creek** commercial thinning sites for a discussion about research needs. Another meeting with 10 researchers and several CFRU cooperators was held in June 1999 to further develop ideas discussed at the May meeting.

Using the above discussions, Bob Wagner and Bob Seymour developed pre-proposal for a Maine Commercial Thinning Network that will be presented to the Advisory Committee, and if approved, developed for implementation in FY99-00. The proposed network would develop a series of experimental plots, growth & yield models, and other activities that will provide cooperators with needed data and recommendations about commercial thinning in Maine's forests.

As part of this effort, plans for a conference about thinning in the Maine forest were developed by **Bob Wagner, Andy Egan, Bill Ostrofsky,** and **Bob Seymour**. The purpose of this conference is to assemble state-of-the-art information about thinning that is applicable to Maine, and to further refine possible CFRU research directions and proposals. Plans call for this conference to be held November 15-16, 1999 in Augusta, Maine.

Effectiveness of Forest Stream Buffers on Water Quality

Based on cooperator concerns about a lack of information on the effects of harvesting on water quality in Maine, efforts this year focused on developing a research team that could address the issue for the CFRU. Meetings were held in June with **Si Balch (Mead Corp.), Carl Haag (Plum Creek), Jim Shepard [National Council for Air and Stream Improvement, Inc. (NCASI)],** and **Bob Wagner (CFRU)** to discuss specific research needs. A meeting also was organized with representatives of the **Maine Forest Service** to identify potential linkages.

Cyndy Loftin (USGS/University of Maine) and **John Hagan (Manomet Conservation Sciences)** were approached to develop research pre-proposals for the CFRU Advisory Committee. Proposals requested from these researchers include an examination of buffer strip width and other forest management activities on riparian zones in Maine. These studies seek to develop experimental installations on cooperator lands, as well as summarize the existing literature on potential effects of harvest practices under specified landscape-level constraints. Potential collaborations for a shared funding on this research also were developed with NCASI.

Amphibian Toxicology Related to Herbicide Tanks Mixes

Recent concerns about forest herbicide use and amphibians in New Hampshire, especially potential toxicological concerns related to herbicide tank mixes, prompted **Mead Corp.** and **Champion International Corp.** to pursue possible research in this area by CFRU. **Bob Wagner (CFRU)** worked with **Dean Thompson (Canadian Forest Service),** a regional expert in forest herbicides and the environment, to develop a research team and study proposal to address the issue. The resulting proposal developed by Thompson was presented to the Advisory Committee at the April 1999 meeting. The project includes a joint collaboration of researchers from the **Canadian Forest Service**, **Dartmouth College**, **University of New Hampshire**, **University of Guelph**, and **University of Maine**. The three-phase study proposes using both laboratory and field studies to examine potential synergistic effects of commonly used herbicides in tank mixtures on amphibians in northeastern forests. Shared funding for this project also is being sought from **NCASI** and will be presented to the Advisory Committee for possible funding early next year.

Effect of Pre-Commercial Thinning on Snowshoe Hare

Addressing recent concerns about the Canada lynx and pre-commercial thinning in Maine's forest, **Dan Harrison (CFRU)** developed a pre-proposal to conduct a retrospective study that will examine the relation between stand density and predators food sources, especially snowshoe hare, which is a important prey of the Canada lynx.

Dan is also seeking shared funding for this work from **US Fish and Wildlife Service**, **NCASI**, and **US Geological Survey**. The Advisory Committee accepted a pre-proposal for this study at the July 1999 meeting and a full proposal is being developed for funding consideration in FY99-00.

Hardwood Silviculture Research Advisory Committee

Increased activity by CFRU in hardwood silviculture has been in interest of several cooperators, especially **Baskahegan Co.**, **Huber Resources**, **Irving Woodlands**, and **Seven Islands Land Company.** Substantial interest in hardwood management was confirmed by the attendance of over 200 people at a June 1999 Hardwood Conference organized by **Max McCormack** (formerly of CFRU) in Bethel, Maine. A September 1999 hardwood tour led by Max McCormack and **Ralph Nyland (SUNY)** also identified several critical research needs in hardwood silviculture, especially 1) understory management of beech to enhance higher value hardwoods, and 2) mast production of diseased beech and potential wildlife implications.

Discussions about forming a Hardwood Silviculture Research Advisory Committee, composed of several experts on hardwood silviculture in the region, to guide CFRU research in this area was discussed. A pre-proposal is under development to pursue development such an advisory committee.

Patch Retention as a Tool for Maintaining Biodiversity in a Northeastern Industrial Forest

Concerns about biodiversity in Maine's forests and participation by **Plum Creek** and **Irving Woodlands** in the Manomet Shifting Mosaic Project, prompted development of a pre-proposal by **John Hagan** and **Andy Whitman (Manomet Conservation Sciences).** The proposed study seeks to test the capability of patch retention on harvested sites to support several biodiversity components, including herbaceous plants, lichens, mosses, salamanders, and ground beetles.

In addition to CFRU, shared funding is being sought from the **National Fish and Wildlife Foundation, John Merck Fund,** and **Hardwood Forest Foundation**. A pre-proposal is being developed for presentation to the Advisory Committee in October 1999.

Technology Transfer and Communications

CFRU personnel provided the following publications and technology transfer activities during 1998-1999:

Publications

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Harrison, D.J. Session summary: stand- and landscape-scale responses of wildlife to forest practices. *North American Forest Ecology Workshop*, University of Maine, Orono. June 30. 1999

Harrison, D.J. A summary from 10 years of marten research with a look to the future. Invited seminar presented to *Resource Assessment Staff, Maine Department of Inland Fisheries and Wildlife.* November 19. 1999

Harrison, D.J. Habitat associations of marten in Maine: responses to forestry and trapping. Invited presentation at *Pine Marten Symposium*, Corner Brook, Newfoundland. January 27. 1999

Harrison, D.J. Responses of wide ranging carnivores to forest characteristics at multiple spatial scales. *North American Forest Ecology Workshop*, University of Maine, Orono. June 28. 1999

Harrison, D.J. Using carnivores as a model for landscape-scale forest planning. Invited paper at *Maine Forest Biodiversity Conference*, Orono, Maine. November 19. 1999

Ostrofsky, W.D. 1999. Root characteristics of red spruce and balsam fir related to pre- commercial thinning. Presentation to the Cooperative Fores-try Research Unit Advisory Committee. April 27, Orono, Maine.

Tian, S., and W.D. Ostrofsky. 1999. Root char-acteristics of red spruce and balsam fir in a pre-commercially thinned and an unthinned stand in Maine. Poster presentation. Winter Meeting, of the New England Society of American Foresters, March 22 - 24, Burlington, Vermont.

Conferences/Meetings

Weymouth Point and Austin Pond studies featured at the Second North American Forest Ecology Workshop

The Second North American Forest Ecology Workshop, which included some 230 participants, was held on the University of Maine campus in Orono from June 27-30, 1999. On June 29 of the meeting, participants attended a selection of field tours. Two of the eight tours featured long-term CFRU research sites: Weymouth Point and Austin Pond. **Bob Wagner** and **Carl Haag** led a tour of the Austin Pond study on **Plum Creek** lands, describing the past and future of this study.

One tour focused entirely on the nearly 20 years of research results from the Weymouth Point watershed study. Led by **Max McCormack (formerly of CFRU), Russ Briggs (SUNY), and Tattersall Smith (Texas A&M)**, these former CFRU scientists presented results from this highly valued study. As a result of this tour, an informal Weymouth Point committee was formed to discuss the future of this paired-watershed study. In addition, **Jim Hornbeck (USFS), Ivan Fernandez (University of Maine),** and **Anthony Filauro (Great Northern Paper co.)** joined these discussions about the future of the study. Plans for the coming year include developing a long-term plan for maintaining and re-measuring the site. The new **CFRU Field & Data Coordinator** position (see pg. 2 of this report), guided by this committee, will have responsibility for developing a long-term plan for the site.

CFRU Participation in the Northeast Weed Science Society

At the January 5-6, 1999 annual meeting of the Northeast Weed Science Society in Boston, **Max McCormack** and **Bob Wagner (CFRU)** organized a special half-day session dedicated to forest vegetation management. Bob was elected Chair of the Industry, Forestry, and Conservation Section at the conference and will develop another forestry-focused session for the Boston NEWSS meeting, scheduled to be in Boston again during January 2001.

APPENDIX I

Financials

MODIFIED BALANCE SHEET 1998-1999

PERIOD 10/01/1998-09/30/1999

ASSETS: 10/01/98-09/30/99

BALANCE ON HAND	$111,964.85
INVESTMENTS	$32,992.74
CONTRIBUTIONS FY99	$387,662.00
Vehicle Sale less advertising	$2,757.76
Refunds (Forestry Suppliers/Wilderness Lodge)	$1,003.51
Unspent FY98 Budget Returned to Control	$27,057.98
Less Increase Budget to Harrison	($8,250.00)
Reduced Budget FY99 Ash/Hardwood (Ostrofsky)	$55,783.00
FY 2000	($260,034.00)
Unspent FY99 Budget Returned to Control	$40,329.99
UNALLOCATED BALANCE ON HAND 09/30/99	**$391,267.83**

FY99 BUDGET	**$405,466.00**

EXPENSES: 10/01/98-09/30/99

5-6-42820	ADMINISTRATION	$48,088.65
5-6-42821	SILVICULTURE-Wagner	$92,713.59
5-6-42822	SOIL-SITE-McLaughlin	$92,724.21
5-6-42823	WEYMOUTH POINT-McLaughlin	$13,115.82
5-6-42824	HARDWOOD/ASH-Ostrofsky	$46,509.71
5-6-42825	PINE MARTEN-Harrison	$27,772.48
5-6-42826	SPECIAL PROJECTS (Carter, Greenwood, Shepard)	$44,211.55

TOTAL EXPENSES	**$365,136.01**
UNSPENT FY99 BUDGET	**$ 40,329.99**

APPENDIX II

LIST OF CONTACTS

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APPENDIX III

LIST OF SCIENTIFIC NAMES

	SCIENTIFIC NAME	COMMON NAME
PLANTS		
	Abies balsamea	Balsam fir
	Abies spp.	Fir
	Fagus grandifolia Ehrh.	American beech
	Picea glauca	White Spruce
	Picea rubens Sarg.	Red spruce
	Picea supp.	Spruce
	Pinus resinosa	Red Pine
	Pinus strobes	White pine
	Tsuga Canadensis	Hemlock
	Betula papyrifera	Paper birch
ANIMALS		
	Blarina (brevicauda) Say	(Shorttail) shrew
	Clethrionomys gapperi Vigors	Red-backed vole
	Lepus americanus Erxleben	Snowshoe hare
	Martes americana Turton	American marten
	Napaeozapus insignus	Jumping mouse
	Peromyscus maniculatus Wagner	Deer mouse
	Sorex (cinereus) Keer	(Masked) shrew
	Felis canadensis	Canada lynx
INSECTS		
	Choristoneura fumiferana Clemens	Spruce budworm