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FOREST RESOURCES RESEARCH  
ADVISORY COMMITTEE  
1977 ANNUAL REPORT

The year 1977—the fourth year of the Forest Resources Advisory Committee—was one of accelerated progress towards of coordinating and intensifying forest research efforts at of Forest Resources. Research the goals the School

The research program of the Cooperative Forestry Research Unit solidified to the point where research problem analyses for economics, silviculture and entomology were presented to the FRRAC sub-committee and approved by them. Individual proposals for research within these problem statements have also been accepted, and a full and ambitious field season was undertaken. Progress on the various research projects is outlined later in this report.

FRRAC is exercising its responsibility to influence research priorities in the CFRU through the research advisory sub-committee, which approves all individual research projects proposed by the cooperative research unit scientists. The full FRRAC committee also reviews research activities and priorities for the entire School of Forest Resources and offers advice on the research program of the school.

The committee has expressed concern that contributions toward the Cooperative Forest Research Unit are still below the goals originally set, and that these funds are needed for the additional silviculturist originally planned for. With this in mind, a committee of four was formed to investigate equitable ways of seeking contributions from forest industries that are non-landowners and have not been solicited to date. New cooperators of the Forest Research Unit added during 1977 were: Kennebec Equipment Co., J. J. Tree Farm, Western Maine Forest Nursery, and Mr. Abbott Ladd.

Four committee members of FRRAC were reappointed to 3 year terms by the committee this year. They are: Fred Holt, Richard Anderson, Keith Miller, and Bud Wei land.

There were personnel changes at the School of Forest Resources during the year. Ed Giddings, Art Randall and Howard Mendall retired from the faculty and Norman Kutscha accepted a position in Takoma, Washington. Three new staff members were added: Ben Hoffman (forest management); Charles Williams (2-year program); and John Litvay (wood technology).

Dr. Knight has been named ASCUFRO (Association of State College and University Forest Research Organizations) representative to the Joint Policy and Program Council of the Joint Canada-U.S. (Canusa) spruce budworm program. This joint program is designed to coordinate research and development activities between the two countries dealing with the spruce budworm problem both in the east and west. The U.S. program will be administered by the U.S. Forest Service. Research projects of the CFRU that deal with the budworm may be eligible for competitive funding under the program.

Dr. Knight has also been involved with research planning at the national level, again representing ASCUFRO in the National Program of Research for Forests and Associated Rangelands which is addressing national research needs and problems. He is presently Vice-President of ASCUFRO.

Morris R. Wing, *Chairman* John G.  
Sinclair, *Vice Chairman* Barton M.  
Blum, *Secretary*

# COOPERATIVE FORESTRY RESEARCH UNIT

## ANNUAL REPORT - 1977

Nineteen seventy-seven marks the first full year of operation of the Cooperative Forestry Research Unit. We entered the year with a sound financial position and with the staff ready to get down to business.

Early in the year the three scientists (Drs. David Field, Mark Houseweart and Maxwell McCormack) presented excellent problem analyses of their respective areas of research. These analyses formed the basis for the specific research proposals that were made later in the year. In addition to launching the research effort, the administrative procedures for the unit were smoothed out through the course of the year.

Specific research proposals were prepared last spring and presented for approval at subcommittee meetings on June 28th and October 31st. Projects approved included:

*Aerial Application of Herbicides*  
*Raspberry Suppression Study*  
*Production of Spruce/Fir Planting Stock*  
*Thinning Spruce and Fir Stands*  
*Potentials for a Maine Hardwood Charcoal Industry*  
*Trap Nesting Wasps - Spruce Budworm*  
*Release of Triahogramma - Spruce Budworm*  
*Life Tables of the White Pine Weevil*  
*Sharing the Cost of Spruce Budworm Suppression in Maine*

Field work began on all of these projects this summer and based on the latest progress reports, I am confident in saying our first year has been a successful one.

In addition to the research being carried out by the CFRU staff, several projects supported by CFRU funds are being carried out by School of Forest Resources staff members. Your subcommittee has heard progress reports on this work. Summaries on all of these projects are included within this report.

The Cooperative Unit added one permanent professional person to the staff to work with Dr. McCormack. Mr. Ellis Sprague joined the program as a technologist on March 21, 1977.

The financial picture at year end is solid with a balance of \$200,000 on hand.

In summary, I am very pleased with the progress that has been made this year in getting the important work of the Unit underway. I also feel that the Unit has been a valuable addition to the School of Forest Resources and the impact has already been felt. It is pleasing to note that the Unit was singled out in a report to the University by an accreditation team from the United States Department of Agriculture.

**They said and I quote:** *"The new Cooperative Forestry Research Unit must receive strong commendation as evidence of the interest and support of industry and its faith in the ability of the school to provide research relevant to important problems. To our knowledge this is the only organized effort to cooperatively sponsor such a research program."*

I look forward to the new year with anticipation and am confident that the Unit will continue its record of accomplishment.

Robert F. Bartlett  
Chairman

## PROGRESS REPORTS ON COOPERATIVE FORESTRY

### RESEARCH UNIT SPONSORED PROJECTS

As mentioned earlier in Chairman Bartlett's report, several projects have been approved and initiated in the past year. Following is a progress summary giving the accomplishments of each over this time. These reports include also a summary on those projects partially funded by CFRU, but not carried out by CFRU scientists.

### REPORTS ON PROJECTS BY CFRU SCIENTISTS

#### SILVICULTURE - f&\*• Maxwell L. MaCormaak

#### HERBICIDAL SUPPRESSION OF RASPBERRY (*Rubus* spp.) TO BENEFIT SPRUCE-FIR (*Picea rubens* Sarg., *Picea glauca* (Moench.) Voss, and *Abies balsamea* (L.) Mill.) REGENERATION

This study was initiated in 1975 to evaluate herbicide treatments as a practical means to reduce raspberry competition with spruce-fir regeneration in strip cuttings. Objectives include quantification of responses to treatment by undesirable and desirable vegetation, and to determine treatments which should receive more intensive study in the future.

A technique was developed to simulate aerial application without disturbing the treated vegetation by using a backpack mistblower from the top of an eight-foot portable tower. Circular plots, four meters radius, were established on lines running parallel to the axis of the strip cuttings. Plots were established in newly developing *Rubus* (1 to 3 years) and in heavy, developed stands of *Rubus* (4+ years). The heavy stands commonly contained 85 to 120 live *Rubus* stems per square meter of heights sometimes exceeding two meters. Dry matter content of the *Rubus* material ranged up to 873 grams per square meter prior to treatment.

The field plots were concentrated in clearcut strips in T5R12 WELS. During the 1975 field season, 92 plots were established in four cuttings; 10 on the Wolcott Research Forest in northern Vermont. In 1976, 54 additional plots were treated in five strip cuttings. During 1977 the field effort concentrated on treatments of promise or greatest interest based on results to date and involved establishment of 50 additional plots as summarized in the following table.

SUMMARY OF 1977 *Rubus* SUPPRESSION PLOTS

Herbicide	Number of Plots		Rates Applied I/
	May	August	
Roundup	4	16 y	4, 1, 1%, 2 qts.
Krenite	-	4	6, 10 lbs.
Garlon	-	8	h, 1, 1 <sup>1</sup> ^, 2 lbs.
2,4,5-T	4	12 I/	1, 2, 3 lbs.
2,4,5-TP	2	-	2 lbs.

I/ Amounts per acre of ground treated. Applied in water; total volume delivered was 10 gals, per acre.

si Some applications of Roundup included additions of ammonium sulfate at the rate of one pound per quart of Roundup.

-' Some applications of 2,4,5-T included additions of sugar at the rate of 1.5 gm. per 25 ml. of 2,4,5-T applied, or additions of MSMA at the rate of 1/10 gal. per acre treated.

All 1975 and 1976 plots were evaluated and rated for effectiveness of *Rubus* suppression during the summer of 1977. Samples of *Rubus* vegetation were collected to evaluate possible reduction in dry matter resulting from treatment. A detailed report of progress has been drafted. Future work will include continued evaluation of the 186 plots in Maine and possible aerial application of the most promising treatments in August of 1978.

AERIAL APPLICATION OF HERBICIDES TO SUPPRESS  
UNDESIRABLE VEGETATION IN MAINE FORESTS

During the summer of 1977 a major effort was expended to establish the helicopter-applied treatments on four study areas as outlined in the study proposal. Approximately 300 acres (121 ha.) were treated for study across the four sites. The carrier for all applications was water with the total volume of spray delivered ranging from four to 10 gallons per acre treated. The rate of herbicide applied was a variable; for any single chemical it did not exceed four pounds of active ingredient per acre. The herbicides applied and the number of treatment areas, exclusive of control blocks, on each study site are summarized in the following table.

SUMMARY OF HERBICIDES APPLIED AND TREATMENT AREAS ON EACH OF THE FOUR 1977 STUDY SITES (+ = application(s) of herbicide on the site)

Herbicide Treatment	Study Site			
	Ga-Pac.Site TIR 2 Appld. 23 Jun 77	St. R. First Machias Lake Site Appld. 28 Jun 77	Scott Bald Mtn. Twp. Site Appld. 4 Aug 77	St. R. Alli- gator Lake Rd. Site Appld. 20 Aug 77
2,4,5-T	+	+	+	+
2,4-D + 2,4,5-T	+	+	+	+
2,4-D + 2,4,5-T + MSMA	+	+	+	
2,4-D + 2,4-DP + MSMA	+	+	+	+
Roundup (Glyphosate)			+	+
Garlon 3A (Tryclopvr)			+	+
Garlon 3A + 2,4-D			+	+
Tordon 101			+	+

Number of treatment areas	24	15	24	14
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Four permanent sample plots, 100 sq. meters in size, were established in each treatment area. Ground cover was evaluated and sample trees were marked and measured. Coniferous species under observation include balsam fir, white spruce, red spruce, eastern white pine, and eastern hemlock. Broadleaved species under observation include aspen, pin cherry, birches, willows, maples, elderberry, and beech.

All areas were visited in late summer for general observations after treatment. Measurements and observations will be continued through at least two growing seasons in order to evaluate effectiveness of the treatments. It is significant to note that the applications of Roundup and Garlon are the first such forestry applications in this region of the United States. A detailed report of progress is being drafted.

## THINNING SPRUCE AND SPRUCE-FIR STANDS IN MAINE

During the last of the 1977 field season, both phases of this study were initiated. The short-term phase, involving evaluation of individual trees which are residuals following past cuttings, started with measurements of study trees on five sites: Scott Brook, Telos Lake (2 sites), Carey Pond, and T2R12. Characteristics of the nineteen trees sampled are summarized in the following tables.

SUMMARY OF CHARACTERISTICS OF TREES SELECTED  
FROM FIVE SITES FOR STEM ANALYSES

Age Class (yrs.)	White Spruce	Red Spruce	Balsam Fir	Total	Diam. Class	White Spruce	Red Spruce	Balsam Fir	Total
50- 59	1	1	3	5	14		3	1	4
60- 69	1			1	16		3	1	4
70- 79		1	2	3	18		1	1	2
80- 89			1	1	20			3	3
90- 99		1	1	2	22	1	1	1	3
100-109		2		2	24		1	1	2
110-119		2		2	26				
120-129		1	1	1	28	1			1
130-139				1	Total	2	9	8	19
140-149		1		1					
Total	2	9	8	19					

Measurements from these trees are providing data, by species and age on delay of response to release, as well as diameter and height growth patterns before and after release. Branch measurements should provide information on crown diameter changes. Additional sample trees will be measured during the 1978 field season with the objective of completing this phase by the end of the year.

Data from the short-term phase will assist in choosing and treating the overstocked stands to be studied in the long-term phase. Individual trees are also being studied in this phase in order to gain data on tree responses to release treatments. These data should assist in characterizing future crop trees for selection in the administration of thinnings and the growth responses which could be expected. Data could then be expanded to characterize stand responses. This approach resembles the actual application of a thinning and, provided good results are obtained, will yield a data base for stand synthesis and modeling to gain a maximum yield of guideline information from the field measurements.

The one study site selected which was reported in the original proposal has been thinned. This area is a 13 to 20 years-old spruce-fir stand which followed a cutting in the winter of 1956-57. Excellent growth has occurred up to the present, but growth rings indicate the beginning of a reduction in growth rate. The stand is characterized, including the decrease in stand density from thinning, in the following table.

INDIVIDUAL TREE THINNING AREA  
SCOTT BROOK, T5R15 WELS  
DENSITY AND STEM CHARACTERISTICS

Study Block No.	Stem Density				Spruce		Fir	
	per Hectare		per Acre		Avg. db.h. (cm.)	Avg. Tot.Ht. (m.)	Avg. db.h. (cm.)	Avg. Tot.Ht. (m.)
	Original	Residual	Original	Residual				
I	28,750	1,500	11,640	607	10.6	5.9	8.4	6.6
II	34,666	2,666	14,035	1,079	8.1	5.7	7.9	6.6
III	28,000	28,000	11,336	11,336	5.4	4.9	5.2	4.9
IV	45,666	2,000	18,488	810	6.4	4.9	—	—
V	41,000	4,333	16,599	1,754	6.6	4.4	7.1	5.9

During the 1978 field season, two or three additional study sites will be located and treated; individual study trees will be marked and measured.

PRODUCTION OF SPRUCE AND FIR PLANTING STOCK  
TO SUPPLY FUTURE EXPERIMENTAL MATERIAL

During late 1977, two 4 x 12-foot beds were developed, fumigated, and seeded on the former state nursery site at the Orono Campus, University of Maine. Seedlings will be maintained through two growing seasons and then transplanted or used as experimental material. Seed was from balsam fir selections and controlled pollinations carried out in northern Vermont during 1974 and 1976. Red and black spruce seed provided by CFRU cooperators was also seeded. Additional bed space will be prepared as seed, appropriate to the research objectives of the CFRU, becomes available.

FOREST PROTECTION - Dr. Mark W. Houseweart

## WHITE PINE WEEVIL

Wayne N. Dixon, Graduate Research Assistant, conducted life table experiments and studied the fall feeding behavior of the white pine weevil. In this first field season Wayne has made significant progress in working out the sampling procedures and has accomplished some of the proposed original objectives.

Life Tables

Over 500 trees were sampled from April 13 to August 8 to determine natural mortality agents that operate on Maine's white pine weevil populations. It was determined that the destructive sequential sampling technique was not necessary due to the ability to reconstruct spring feeding and ovipositional activities even into the pupal sample. The developmental cycle in Maine was determined in which 1977 weevil life stages were predominant on the following dates: Spring adults - 13 May; Egg - 27 May; 1st and 2nd instar Larvae - 12 June; 3rd and 4th instar Larvae - 10 July; Pupae - 8 August; and Brood adults - early August to early November. Fifty exposed and 20 caged leaders were removed at these same life stages and were dissected to determine percent mortality and causal agents. Wayne found that immature weevil mortality was minimal until the 4th instar and pupal stages. Over 64% of the pupal stage population was decimated primarily due to parasites, predators, and birds. Overall, the average natural mortality per weevil infested leader was 90%, in that of 155 eggs only 16 adults emerged from a leader.

Fall Feeding

The location and importance of fall feeding by the white pine weevil was investigated this past fall. Several patterns were determined in the fall feeding behavior of adult white pine weevils:

1. Adult weevils were predominantly found in the top level and southern quadrant of brood trees in early October.
2. Feeding sites were found in greatest numbers on current-year (1977) growth in the top level and mainly on east and south exposed lateral branches.
3. Fall feeding on lateral branches occurred primarily on the stem of the current year growth.
4. Fall feeding is essential otherwise death due to starvation will result.

In the past, most weevil control efforts have been directed either towards spring adults or immature weevils within leaders. Disadvantages are the limited target area and the relatively short period of time when adults are vulnerable for spring insecticidal applications, while removing weevil-infested leaders in mid-summer destroys beneficial organisms and requires considerable manpower.

Our results show that on 7 October 1977 adult weevils were present and feeding primarily on brood trees and that over 70% were in the top level of these trees. Advantages of directing suppression tactics against adult weevils in the fall lies in their extended period of vulnerability plus their concentration in the upper tree crown. Furthermore, most natural enemies should have minimal insecticidal exposure due to their location in dead leaders. Thus, we feel that a high potential exists for suppressing weevil populations via fall insecticide applications. Selective ground applications may be appropriate for small plantations with a low weevil infestation since brood trees have significantly more weevils than non-attacked trees and are easily identified by their defoliated, terminal growth. Aerial applications of an insecticide may be more economical in larger plantations with greater and more uniform weevil infestation. The efficacy of fall aerial applications may be greater than spring applications because horizontal lateral branches are more accessible for spray deposit than vertical, terminal leaders in the spring. More detailed information on this study will appear in CFRU Progress Report #5 which is being printed at this time.

#### SPRUCE BUDWORM GROWTH IMPACT STUDY

James Rea, CFRU Assistant Research Technologist, has made significant progress this year on the growth impact study. Jim has developed new computer tally forms which should alleviate some of the errors found in the tall eying procedure and computer editing program. Also, Jim has initiated new computer output maps depicting yearly results rather than the table presentations of previous years.

The study was initiated with a training session held at the School of Forest Resources in June 1977. Field crews from the twelve cooperators began sampling plots in July and data collection was completed by the first of September. With the help of a two man crew supplied by the U.S. Forest Service it was possible to visit nearly each cooperator-crew as they started work to check their technique and skill at estimating budworm damage. In addition, the U.S.F.S. crew established 6 control plots in Baxter State Park.

Data transferal, editing, and processing was started in September and completed by mid-November. The most reliable results were the mortality volume estimates categorized by cause of death and species. Over the six counties the average estimate of mortality volume was 50 cu.ft./acre/year.

Approximately 8% of this mortality was attributed directly to the spruce budworm. Blowdown was the largest single cause of mortality accounting for 34% of the total estimate. These figures should not be interpreted as minimizing spruce budworm contributions to tree mortality. It is difficult to determine the exact cause of a tree's death except in the case of blowdown or removal in a harvesting operation. However, both of these categories may be budworm related. The two categories, Unknown and Other, which together make up 29% of the mortality probably also include direct or indirect budworm-caused mortality.

Growing stock volume estimates from the growth impact study were compared for the years 1975 to 1977 and no significant change in volume was apparent since the start of the study. This indication of zero net growth is attributable in part to the imprecision of repeated yearly DBH measurements. However, growth information will become more reliable toward the end of the 5 years when stem analyses are included. More detailed information will be published soon as a CFRU Progress Report.

#### SPRUCE BUDWORM RESEARCH

Various lines of research on the spruce budworm were initiated in 1977 in cooperation with Dr. Daniel T. Jennings, Research Entomologist, USFS. Studies on natural enemies of the budworm included: Trap nesting wasps, Trichogramma minutum, Kairomones, Pitfall traps, and Pheromones.

##### Trap Nesting Wasps

*Ancistocerus antilope*. (Hymenoptera: Eumenidae) was found to be present in spruce-fir stands of central Maine. Adult, female wasps provision their young, which are reared in natural cavities, with stung and paralyzed spruce budworm larvae. Pine blocks with predrilled holes were used as nesting traps both in dense stands and strip cuttings. Collection results showed that wasps used only the strip cut areas for nesting sites, and no budworm larvae were found in traps located in dense stands. This study points out the importance that some silvicultural manipulations may have on natural enemy populations.

##### Trichogramma minutum

Twenty-four release sites were utilized in studies of increasing spruce budworm egg parasitism by this parasitoid species. Release densities ranged from 31,000 to 2 million. Parasitism in the control plots ranged from 0.19 to 24% while in the release sites parasitism was from 1.73 to 32%. Results were variable and analysis is not yet complete, however, 1 plot (31,000 release) did increase parasitism by 15.5%. More work needs to be done to assess the true potential.

### Kairomones

When the spruce budworm female lays her eggs, a few scales from the wings are also deposited on or near the egg mass. *X-nn'.nutum*, a native egg parasite, uses the odors emanating from these moth scales to locate an egg mass for oviposition. A preliminary study was done in cooperation with Dr. Lewis, ARS, of Tifton, Georgia to determine the increase in parasitism if these chemicals are sprayed on foliage on which the spruce budworm has laid her eggs. Kairomone application was found to increase spruce budworm egg parasitism by *T. minutum*. Research will be continued to refine the chemicals and further define the concentration to apply.

### Pitfall traps

Traps to collect ground dwelling predators were placed in strip cut and dense stands to determine species of ground beetles and other predators present in the spruce budworm area. Collections are still being sorted and both species determinations and data analysis will be time consuming.

### Pheromones

The use of pheromone traps for survey and detection of spruce budworm populations has high potential for operational procedures. Thus, three specific studies were initiated: 1. Trap saturation, 2. Trap density, and 3. Pheromone blend.

1. Trap saturation - The point at which traps become saturated (i.e. filled with male moths and can catch no more) must be determined to monitor traps adequately. New, aged, control, and new-changed traps were used over the peak of moth flights. Results show that traps were saturated once approximately 50 moths were caught in the sticky collection trays.
2. Trap density - Also important is the placement of traps in relation to each other. This study was to determine the interference one trap may have on another. Traps were placed 5, 10, and 20 meters from the center trap and the control located 50-100 meters away. Final analysis is not yet complete but preliminary observations show that differences do exist.
3. Pheromone blend - The chemical composition of the budworm pheromone was investigated in cooperation with Dr. Chris Sanders of Canadian Forestry Service in Sault Ste. Marie, Ontario. Natural budworm pheromone exists as a blend of two components or isomers: cis and trans. Various percentage blends of the isomers were tested and it was found that blends with over 90% trans were most effective in attracting male moths to the traps.

Other studies on the spruce budworm which were preliminary in nature and have not been fully analyzed to warrant reporting on in this annual report are:

1. Collections of late instar larvae via various colored sticky boards.
2. Physical dislodgement of larvae via various means as survey tools.
3. Identification and importance of mites attacking adult moths.
4. Spiders preying on both egg masses and adult moths.

UTILIZATION - *Dr. David B. Field*

Most of this part of the Unit's work during early 1977 was devoted to preparing a "Problem Analysis", which outlined the scope of research appropriate to marketing, utilization, and forest economics concerns of the Cooperative's sponsors. The Advisory Committee's response to that analysis in early February indicated a particular interest in the economics of intensive management, a synthesis of existing information on new developments in roundwood harvesting and milling technologies relevant to the Maine context, and work involving forest policy, particularly the development of information on the economic benefits enjoyed by the people of Maine as a result of private forest land ownership and management.

Much of the year was devoted to background research in these areas of interest. Extensive reviews of past work were necessary to guide the preparation of specific proposals for new studies. The following proposals were prepared during the fall and presented to the Advisory Committee on October 31:

- Project 1: Potentials for a Maine Hardwood Charcoal Industry
- Project 2: Maine's Potentials for Wood Furniture Manufacture
- Project 3: Simulation of Regional Timber Markets
- Project 4: Models for Forestry Investment Analysis
- Project 5: Economics of Spruce-Fir Management
- Project 6: Problem Analysis of Economic Losses from Degradation  
of Spruce Budworm-Damaged Timber
- Project 7: **Public Benefits from Private Forest Land Ownership and Management in Maine**

Projects 1 and 6 have been approved and are discussed further below. Consideration of the remaining proposals (some incomplete in October) was deferred to early 1978.

### Charcoal Feasibility Study

The primary objective of this research, which is focused on existing and potential demands for charcoal for domestic space heating and industrial metallurgy, is to develop market outlets for a significant volume of Maine's excess hardwood timber resource. The ideal outcome would be outlets for enough of that resource to restore the quality of existing substandard timber stands and to absorb the inevitable volumes of low-grade material that will be produced indefinitely even under intensive sawtimber management. The means to this end will be to judge the economic feasibility of establishing one or more processing facilities based, initially, on charcoal production. If that judgement is favorable, the next step would be to develop specific information to attract capital investment in such facilities. Early stages of this project are the object of a Master's thesis that should be completed in June, 1978.

### Spruce Budworm Research

During 1977, Thomas H. Lee, a senior student in the School of Forest Resources, prepared (under Dr. Field's supervision) a review of the literature on the degrade and decay of spruce-fir timber damaged by spruce budworm feeding. The report is intended to present a summary of public knowledge on both direct and consequential budworm-instigated damage to balsam fir and, to a lesser extent, eastern spruces. Available information, especially on degrade, appears to be inadequate to the task of assessing alternative approaches to budworm control and damaged-timber utilization.

This report has been reviewed by several highly -qualified specialists and by the Maine Agricultural Experiment Station and is being prepared for publication as Cooperative Forestry Research Unit Information Report No. 2 (Lee and Field, 1978).

Mr. Lee also spent a considerable amount of time under this contract working the U.S. Forest Service's TRAS (Timber Resources Assessment System) computer model into the University computer system and conducting tests of that model. The object of this effort was to prepare this program for use in judging the sensitivity of Maine's spruce-fir growth rates and inventory levels to a range of possible budworm impact levels. The tests indicate apparent distortions, in either the data base provided by the Forest Service or in the model itself, which appear as highly improbable inventory volume expansions over long periods of forecast time.

The Spruce Budworm Suppression Act (12 MRSA C.213, sub.-c II-A) of 1976 requires that budworm suppression costs not met by Federal cooperative aid funds be shared by the State and those private landowners with property located in the Spruce-Fir Protection District, according to their respective benefits from the program. CFRU sponsors felt that it would be desirable to direct some of the work planned for Project 7 towards the immediate needs of providing information for a public hearing on this cost-sharing decision. In response to this, I prepared a report (Field, 1977c) which presents an argument for the division of suppression costs between public and private interests according to the monetary returns each realizes from the revenues generated from the spruce-fir timber resource.

PROGRESS ON PROJECTS PARTIALLY SUPPORTED BY FUNDS  
FROM THE COOPERATIVE UNIT

TREE IMPROVEMENT - *Dr. David Canavera*

Tree improvement activities supported in whole or partially by funds from the Cooperative Forestry Research Unit in 1977 summarized by level of genetics work performed were as follows:

Provenance Collections and Species' Trials

New plantings established this year were the following:

1. Jack pine (*Pinus banksiana*), 28 sources on St. Regis land.
2. White birch (*Betula papyrifera*), 68 sources on St. Anne-Nackawic Pulp & Paper Company land.
3. Japanese larch (*Larix leptolepis*), 16 sources on International Paper Company land.
4. Two larch species plantings including several provenances each of Japanese larch, European larch (*Larix decidua*) and Siberian larch (*Larix siberica*), 38 total sources on Diamond International Corporation and Great Northern Nekoosa lands.
5. Several birch species including: *Betula alleghaniensis*, *B. ermanii*, *B. dahurica*, *B. maximowicziana*, *B. papyrifera*, *B. platyphylla*, *B. populifolia*, *B. pubescens*, and *B. verrucosa* on Diamond International Corporation land.

A Norway spruce (*Picea abies*) provenance study of 58 sources was sown in the greenhouse in Japanese paperpots and then transplanted to the State Forest Nursery at Greenbush. These seedlings will be field planted in the spring of 1979.

Provenance collections of Douglas -fir (*Pseudotsuga menziesii*) 112 sources and Scotch pine (*Pinus sylvestris*) 64 sources were sown in the greenhouse in January 1978. They will be field planted in either 1979 or 1980 depending upon growth and development.

Initial base-line field measurements were made on the two black spruce (*Picea mariana*) and one white ash (*Fraxinus americana*) provenance plantings established in 1976.

### Individual-Tree Selections

New plantings established this year are the following:

1. White spruce (*Picea glauca*) superior nursery selections that were made from four nurseries in the Northeast, Lake States and southeastern Canada on Georgia Pacific Corporation land. This area will be used as a seed production area.
2. Two white birch progeny tests from selected trees of 94 sources on St. Anne-Nackawic Pulp & Paper Company land and 66 sources on Diamond International Corporation land.

A graduate student, Kevin Kenlan, has initiated a plus tree selection program in black spruce. Kevin will continue his work this summer and hopefully open-pollinated seeds will be collected in the fall of 1978. This will depend upon the 1978 cone crop.

Kathy Hale completed her thesis on the "Genetic Improvement of Northeastern Spruce Species". Most of her work was devoted to evaluation of the white spruce progeny test plantations established by the Spruce-Fir Committee.

Seeds of individual white spruce trees separated by stand from southeastern Ontario were sown in the School's greenhouse and Great Northern Nekoosa greenhouse in January 1978. These seedlings will be field planted as seedling seed orchards in 1979 or 1980. Previous research data have shown that 15 to 20 percent height-growth gains can be expected by using seed from these sources.

Initial base-line field measurements were made on plantings made in 1976. These included white spruce nursery selections and balsam fir (*Abies balsamea*) progeny tests.

### Hybrid Trees

Two plantings of Austrian x Japanese red pine (*Pinus nigra* x *densiflora*) hybrids were established on Scott Paper Company and Great Northern Nekoosa lands.

### Plantation Growth and Yield

A graduate student, Jim DiGennaro, has started field measurements to develop yield tables for red pine (*Pinus resinosa*) and white spruce plantations. The yield equations will be derived from 80-100 sample plots taken in old plantations from throughout the state. Jim will continue his work this summer.

FOREST FERTILIZATION - Dr. Robert K. Shepard

The first phase of the cooperative spruce-fir fertilization is nearing completion. Analyses of the Princeton and Telos Lake are finished; the effect of fertilization on growth and specific of the Rangeley stand is presently being determined. Results by categories are presented below.

project  
stands  
gravity  
specific

Diameter Growth

One-hundred-fifty pounds of nitrogen (N) per acre increased diameter growth at breast height by approximately 40 percent at Princeton. Nitrogen plus phosphorus (P) and nitrogen plus phosphorus plus potassium (K) also produced good responses, but not as good as the response to N alone. Intermediate and suppressed trees did not respond to fertilization; response was limited to the dominant and codominant overstory trees.

At Telos Lake none of the treatments produced an increase in diameter growth at breast height. Growth was less after fertilization than before for all treatments. The smallest decline in growth was associated with the NPK treatment.

Volume Growth

The N and NPK treatments produced the largest increases in volume growth at Princeton, approximately 0.4 cords per acre per year (40 percent) more than the unfertilized controls. Again, nothing was gained by the addition of other elements in combination with N.

Volume growth rates at Telos Lake were less after fertilization than before.

Specific Gravity

Specific gravity of post fertilization wood was generally higher than that of prefertilization wood at breast height but lower at the base of the crown. At breast height, specific gravity of the N trees increased by .023, whereas it increased by .021 for the controls. However, it appears that the NPK treatment, although causing a substantial increase in growth, may have caused a decrease in specific gravity.

At Telos Lake specific gravity at breast height increased after fertilization for all treatments, and the decrease in specific gravity at the base of the crown was not as pronounced as at Princeton.

Tree Form

The additional wood produced by fertilization was distributed quite uniformly over the entire stem, although somewhat more occurred in the

lower stem than in the upper stem. There was no change in form class. At time of fertilization, form class of the N trees at Princeton, based on the ratio of dib at 16.5 feet to dibh, was .86; 7 years after fertilization it was .87. Form class of the control trees at the time of fertilization was .87; 7 years later it was still 0.87.

#### Foliar Analyses

Analyses of nutrient concentrations in the foliage revealed only small differences between the stands prior to fertilization, although concentrations in the foliage of the Telos Lake stand were slightly higher than concentrations in the foliage of the Princeton stand. However, nutrient concentrations in the foliage of the Princeton stand increased much more after fertilization than did nutrient concentrations in the foliage of the Telos Lake stand. This may indicate that the Princeton stand was more vigorous, more able to take up the applied nutrients, and better able to use them.

#### Further Analyses

Analyses identical to those described above must still be completed for the Rangeley stand. In addition, wood samples will be examined microscopically to determine whether certain of the fertilizer treatments caused a change in wood characteristics. A pulping study to determine yield of pre- and post fertilization wood from the N trees and from the control trees is also planned.

All second phase areas were fertilized during the early summer of 1977. Soil samples were taken during October, and a sufficient number of foliage samples to ascertain the extent of nutrient uptake were also taken. Ultimately, trees from the second phase stands will be subjected to many of the analyses described above.

#### COMPLETE TREE INSTITUTE - Dr. Harold E. Young

This report is being prepared half way through the nineteenth consecutive year of research within the Complete Tree Concept which has evolved into the Complete Forest Concept. Each year some phases such as weight tables are continued along established procedures, some separate studies such as the thinnings projects are consolidated and some new aspects of the concept such as the use of wood ash are initiated. A brief summary follows:

#### Weight Tables

All existing data on the biomass of individual trees and shrubs is being consolidated by species to prepare a set of weight tables that will be the best available for Maine. Considerable progress was made during the spring and summer as a rainy day project which should be completed in the spring of 1978.

### Thinnings Biomass Studies

During the 1977 field season 39 softwood plots (1/100 acre) were cut and weighed bringing the total of such plots for hardwood and softwood immature stands to 204. The data have been analyzed and the first rough draft of a bulletin prepared. This should be completed and submitted for publication in 1978.

### Forest Biomass Inventory

With the collaboration of T. C. Tryon and C. Swenson the methods employed in the first two combined volume-biomass inventories were considerably improved for a 1,800,000 acre combined volume-biomass inventory. These improvements were the basis for a paper prepared for a national workshop in Tucson, Arizona.

### Pulping, Biomass and Nutrient Studies of Woody Shrubs and Shrub Size Tree Species

This is a downward extension of earlier studies with the woody shrub and tree species limited to the 0.5' 1.5"Dbh range. Pulping studies were completed on nine hardwood species and biomass and nutrient data were obtained for two softwood species and 15 hardwood shrub and tree species. All the data were analyzed and the draft of a manuscript prepared. This should be submitted for publication in the spring of 1978.

### Field Test of Hydraulic Vibrator Stump-Root Harvester

L. B. Foster designed the hydraulic vibrator and successfully married it to a Northwest Engineering Co. 35DH Timbermaster. Diamond International clearcut two 2.5 acre tracts where the equipment was tested in the summer of 1977. The field trials were successful and indicated specific improvements for the next prototype. 1500 Norway Spruce seedlings (3-0) were planted in the test area in both disturbed and undisturbed portions. Dr. M. Czapowski of the USFS is testing the soils and some fertilizer testing is planned for 1978.

### Wood Ash as Fertilizer

In collaboration with engineers of Georgia-Pacific Company and Dr. John Riley of the Agricultural Engineering Department of the University of Maine a pilot study is being made of the possibility of using wood ash as a forest fertilizer. Dr. Riley has made pellets from ash and this material will be tested as a fertilizer.

### Annual Softwood Needle Production

Earlier studies have shown that hardwood stands, fully stocked, produce about 1.0 ton oven dried of leaves each year and that immature fully stocked softwood stands have about 6.6 oven dry tons of needles spanning fourteen years. This raises the question of the annual production of oven dried needles per acre. In the 1977 field season data on 11 Red Spruce trees ranging from 1.0-10.0"Dbh were felled and sampled. In the fall of 1977 all of the calculations were made to obtain estimates of the current, one year old, two year old, three year old and all older needles on the tree. These will be analyzed in the spring of 1978 to determine any changes in sampling procedure so that more data can be obtained on other softwood species.

## PUBLICATIONS RESULTING FROM RESEARCH

## SUPPORTED BY THE CFRU IN 1977

- Apgar, W. P., H. E. Dickey and H. E. Young. 1977. Estimated Digestibility of Conifer Muka Fed to Sheep. Res. in the Life Sciences 24:2 6pp.
- Canavera, D. S. 1978. Effects of Various Growing Media on Container-Grown Yellow Birch. Tree Planter's Notes. (Acpt. for pub.).
- Canavera, D. S. 1978. Pelletized Birch Seed - An Aid to Nurserymen. Univ. of Maine Coop. For. Res. Unit Infor. Rept. (Acpt. for pub.).
- Dixon, Wayne N. and Mark W. Houseweart. Location and Importance of Fall Feeding by the White Pine Weevil, *Pissodes strobi* (Peck). CFRU Research Note (In Press).
- Field, D. B. 1977a. Effects of Taxation on the Planning and Implementation of Intensive Timber Management. In: Proc. Symp. on Intensive Culture of Northern Forest Types, U.S. For. Serv. Gen. Tech. Rep. NE-29. P. 311-332.
- Field, D. B. 1977b. Linear Programming: Out of the Classroom and Into the Woods. J. For. 75:330-334.
- Field, D. B. 1977c. Sharing the Costs of Spruce Budworm Suppression in Maine. Draft Report, Cooperative Forestry Research Unit, Univ. of Maine at Orono. 15p. mimeo.
- Field, D. B. 1977d. The Small Woodland System—Public Needs vs Private Goals. Paper presented at Winter Meeting, New England Section, Society of American Foresters, Bedford, N.H., March 16-18. 12p. mimeo.
- Gerry, R. W. and H. E. Young. 1977. A Preliminary Study of the Value of Conifer Muka in a Broiler Ration. Res. in the Life Sciences 24:1. 6pp.
- Hale, K. N. and D. S. Canavera. 1978. Preliminary Results of a White Spruce (*Picea glauca* (Moench) Voss) Half-Sib Progeny Test in Maine. Proc. Twenty-Fifth Northeastern For. Tree Imp. Conf. (Acpt. for pub.).
- Hale, K. N. 1977. The Genetic Improvement of Northeastern Spruce Species. M.S. Thesis, Univ. of Maine, Orono. 105p.
- Houseweart, Mark W. and Wayne N. Dixon. 1977. Update on the Saddled Prominent. CFRU Information Rept. #1. 15pp.
- Houseweart, Mark W., D. E. Rau, and H. M. Kultnan. 1977. Temperature Schedules for Overwintering Yellowheaded Spruce Sawfly Cocoons in the Laboratory. Minnesota Forestry Research Note 259. 4pp.

- Houseweart, Mark W., D. Gordon Mott, and Ancyl S. Thurston. 1978. Proceedings of the First Eastern Spruce Budworm Research Work Conference. 77pp.
- Houseweart, Mark W., Daniel T. Jennings, and Wayne N. Dixon. How to Examine Branches for Spruce Budworm Egg Masses. CFRU Tech. Note. (In Press).
- Jennings, Daniel T. and Mark W. Houseweart. Sexing Spruce Budworm Pupae. USFS Research Note. (In Press).
- Jennings, Daniel T. and Mark W. Houseweart. Spider Preys on Spruce Budworm Egg Mass. Entomol. News. (In Press).
- Lee, T. H., and D. B. Field. 1978. Degrade and Decay of Spruce -Fir Timber Following Spruce Budworm Attack - A Review. Coop. For. Res. Unit Inf. Rep. 2, School of For. Resour., Univ. of Maine at Orono. (Forthcoming).
- Linit, Marc J. and Fred B. Knight. 1977. Establishment of Hybrid Poplar Cuttings and White Pine Seedlings on Abandoned Agricultural Sites. Research in the Life Sciences 24(4):1-15.
- Lowe, W. J., H. W. Hocker, Jr. and M. L. McCormack, Jr. 1977. Variation in Balsam Fir Provenances Planted in New England. Canadian Journal of Forest Research 7(1):63-67.
- McCormack, Maxwell L., Jr. 1977. Christmas Tree Plantation Establishment. American Christmas Tree Journal XXI (1):7-11.
- McCormack, Maxwell L., Jr. 1977. Status of Herbicide Technology for Control of Tree Species and to Reduce Shrub and Grass Competition. Proc. Symposium on Intensive Culture of Northern Forest Types, USFS General Tech. Rpt. NE-29. pp. 269-277.
- McCormack, M. L., Jr. and Wolfgang Mieder. 1977. Die Weihnachtsbaum-Industrie in den Vereinigten Staaten. Allgemeine Forst Zeitschrift 32(46):1151-1152.
- McCormack, M. L., Jr., F. B. Knight and R. A. Rogers. 1978. Glyphosate as a Management Tool for Increasing Forest Productivity. Proc. Northeastern Weed Science Society 32:285-286.
- McCormack, M. L., Jr. 1977. Plantation Establishment. Tree Improvement Workshop for Field Foresters, Orono, Maine.
- Rea, James C. and Mark W. Houseweart. Spruce Budworm Growth Impact Study. CFRU Progress Report. (In Press).
- Safford, L. O., H. E. Young and T. W. Knight. 1977. Effect of Soil and Urea Fertilizer on Foliar Nutrients and Basal Area Growth of Red Spruce. Life Science and Agri. Bui. (In Press).

- Shepard, R. K. 1977. Sixth Annual Report on the Spruce-Fir Fertilization Project. CFRU Prog. Rep. No. 1, Univ. of Maine, Orono. 7pp.
- Shepard, R. K. 1977. Diameter Growth and Specific Gravity of Red Spruce at Two Locations in Maine Before and After Fertilization. CFRU Prog. Rep. No. 2, Univ. of Maine, Orono. 10pp.
- Young, H. E. 1977. Two Harvesting Developments in the USA in Proceedings of Working Meeting in Premises and Potential of Short Rotation Forestry. Stockholm, Sweden.
- Young, H. E. 1977. Comments for Panel on Graduate and Undergraduate Education Quantitative Ecology: Its Application to Forest Resources. Univ. of New Hampshire, pp. 98-99.
- Young, H. E. 1977. Biological Implication in Sustaining Optimum Productivity in Terms of Nutrient Cycling. In Quantitative Ecology: Its Application to Forest Resources, Univ. of New Hampshire, pp. 85-87.
- Young, H. E. 1977. Forest Biomass Inventory: The Basis for Complete Tree Utilization. TAPPI Biology/Wood Chemistry Conference, Madison, Wise., p.119-123 and Proceedings Second Pacific Chem. Engr. Conference (Pachec '77) p. 611-615.
- Young, H. E. 1977. Hardwoods Within the Complete Forest Concept. Forestry Chronicle. 53:204-207.

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# FRRAC SUBCOMMITTEE ON THE COOPERATIVE FORESTRY RESEARCH UNIT

## MEMBERSHIP AS OF DECEMBER 31, 1977

The members of the subcommittee appointed to set priorities and review proposals for the Cooperative Forestry Research Unit are as follows:

Mr. Robert F. Bartlett, Woodlands Manager, Great Northern Paper Co.  
 Dr. Barton Blum, Project Leader, U.S. Forest Service  
 Mr. Harold M. Klaiber, Chief Forester, Scott Paper Co.  
 Dr. Fred B. Knight, Director, School of Forest Resources  
 Mr. James L. Robbins, Robbins Lumber Co.  
 Mr. John G. Sinclair, President, Seven Islands Land Co.  
 Mr. Morris Wing, Regional Manager, International Paper Co.  
 Mr. George W. Weiland, Vice President, Dead River Co.

## COOPERATORS OF THE FORESTRY RESEARCH UNIT ON DECEMBER 31, 1977

Baskahegan Co.	Ray McDonald
J. H. Beardsley	Dwight E. Newman
Earl Bessey	Henry Plummer
Charles Blood	Prentiss & Carlisle Co.
Boise-Cascade	A. Redmond
P. H. Chadbourne	Robbins Lumber Co.
Ralph Clifford	St. Regis Paper Co.
Dead River Co.	Saunders Brothers
Dunn Timberlands	Scott Paper Co.
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Great Northern Paper Co.	James W. Sewall Co.
Hal I, Inc.	Smith Timberlands
Louis Hinton	Sprowl Brothers, Inc.
Huber Corp.	Clayton Totman
International Paper Co.	<b>J. J. Tree Farm</b>
Irving Pulp & Paper Co.	<b>Ted Tryon</b>
Kennebec Equipment Co.	Western Maine Forest Nursery
Abbott Ladd	Leon Williams
Perry Lamb	

## OTHER ORGANIZATIONS PROVIDING SUPPORT FOR CFRU PROJECTS REPORTED

Maine Forest Service	I.T.T
USFS, Northeastern For. Expt. Sta.	Weyerhaeuser
USFS, State & Private Forestry	Pejepscot
Diamond International	Monsanto
St. Anne-Nackawic	Me Intire Stennis
	Formula Funds

## SCHOOL OF FOREST RESOURCES

## STUDENT PROFILE

Year	Four-Year Undergraduates			Two-Year		Others	Totals
	Freshmen	Soph. Forestry	Jr. Sr. Wildlife	Forestry	Graduate		
1964	71	108	42	0	9	5	235
1969	104	95	92	63	25	2	381
1974	134	225	151	95	44	68	717
1975	147	247	196	111	53	114	868
1976	140	289	186	87	52	121	875
1977	187	265	123	89	60	117	841

## FACULTY AND STAFF OF THE SCHOOL

(DECEMBER 31, 1977)

Fred B. Knight, Director and Dwight B. Demeritt Professor of Forest Resources; Associate Director of Maine Life Sciences & Agriculture Experiment Station  
 Malcolm W. Coulter, Associate Director for Wildlife and Professor of Wildlife Resources Marshall D. Ashley, Associate Director for Administration, Director of Summer Camp Programs and Associate Professor of Forest Resources Thomas J. Corcoran, Professor of Forest Resources Ralph H. Griffin, Professor of Forest Resources Maxwell L. McCormack Jr., Research Professor of Forest Resources James E. Shottafer, Professor of Wood Technology and Head, Forest Products Laboratory Harold E. Young, Professor of Forest Resources and Head, Complete Tree Institute  
 David B. Field, Associate Research Professor of Forest Resources Richard A. Hale, Associate Professor of Wood Technology Benjamin F. Hoffman, Associate Professor of Forest Resources Floyd L. Newby, Associate Professor of Forest Resources Ray B. Owen, Jr., Associate Professor of Wildlife Resources Voit B. Richens, Cooperating Associate Professor of Wildlife Resources, and Acting Leader, Cooperative Wildlife Research Unit Wallace C. Robbins, Associate Professor of Forest Technology and Head, Two-Year Forest Management Technology Program Craig E. Shuler, Associate Professor of Wood Technology

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 Timothy G. O'Keefe, Extension Forestry Specialist and Assistant Extension  
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 Laurie Ann Fenwood, Assistant Wildlife Technologist  
 James C. Rea, Assistant Forest Technologist  
 Ellis Sprague, Assistant Forest Technologist

Cooperating Faculty with Joint Appointments

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 Richard J. Campana, Professor of Forest Pathology (Botany & Plant Pathology Dept.)  
 John B. Dimond, Professor of Forest Entomology (Department of Entomology) Harold C.  
 Gibbs, Professor of Wildlife Resources (Department of Animal and  
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 Hewlette S. Crawford, Research Wildlife Biologist, U.S. Forest Service  
 Robert M. Frank, Research Forester, U.S. Forest Service  
 Lloyd C. Irland, Forest Insect Manager, Maine Forest Service  
 Jerry R. Longcore, Biologist, U.S. Fish & Wildlife Service  
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 Ralph S. Palmer, Retired from New York State Museum & Science Service; Current  
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 Paper Company

Professors Emeritus

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 Lewis P. Bissell, Extension Forestry Specialist Emeritus  
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 Howard L. Mendall, Professor Emeritus & Leader of Cooperative Wildlife Research Unit  
 Albert D. Nutting, Director Emeritus  
 Henry A. Plummer, Associate Professor Emeritus of Forestry  
 Arthur G. Randall, Associate Professor Emeritus of Forest Technology