

1983 ANNUAL
REPORT
OF THE COOPERATIVE FORESTRY
RESEARCH UNIT

Mark W. Houseweart and Robert S. Seymour (Editors)

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CHAIRMAN'S REPORT

The year of 1983 has been a busy one for the Cooperative Forestry Research Unit (CFRU), particularly as a result of the changes at the University which saw the School of Forest Resources become the College of Forest Resources. With this change, came new CF RU leadership. Dr. Greg Brown was appointed Dean of the College of Forest Resources on August 1, 1983, and became the Director of the CFRU scientists, staff, and programs. The Advisory Committee, on behalf of the CFRU membership, extends their deep appreciation to Dr. Fred Knight for his leadership of the CFRU as Director of the School of Forest Resources. Dr. Knight not only played a central role in establishing the CFRU, but also in guiding the CFRU through its first seven years.

Jim Robbins, a member of the CFRU Advisory Committee since 1976, resigned this year. During Jim's tenure he served as secretary to the committee and was a valuable advocate for the white pine industry. CFRU thanks Jim for his contribution and welcomes Bob Chadbourne, Jim's replacement on the Advisory Committee.

The Advisory Committee took a significant step in defining its role by adopting official by-laws at its January 1983 meeting. In addition, the Advisory Committee approved a set of policies and procedures to guide the operation of the CFRU staff. Both documents formalize policies and procedures that had been approved over the years by the Advisory Committee.

Our research program continued to make important progress as the new Hardwood Research Project got underway with the approval of Bill Ostrofsky's problem analysis. A specific research project dealing with hardwood shelterwood cutting was approved in conjunction with Bill's problem analysis. Other projects approved include: two programs dealing with precommercial thinning, a stocking assessment study using aerial photography, and a forest protection project on seed and cone insects.

A highlight of the year for the Advisory Committee was the summer meeting held in Greenville. After a brief business meeting, the committee took a field trip to the precommercial thinning work being conducted by Bob Seymour and helicopter herbicide treatments installed by Max McCormack. Our thanks to Bob, Max, and to Scott Paper Company for an interesting day.

The year of 1984 promises to be challenging as we continue to deal with the organizational changes brought about by the new College status. This year the committee will also be planning renewal of funding for CFRU for the third 5-year period. The committee hopes to be ready by January 1985 to begin solicitation for continued support.

E. Bart Harvey, Chairman
CFRU Advisory Committee

DEAN'S REPORT

The Cooperative Forestry Research Unit (CFRU) has had another successful year in 1983. This is my first opportunity as Dean of the College of Forest Resources to prepare a letter for the CFRU Annual Report* and based on the excellent reputation of the CFRU* I am proud to have this opportunity.

During 1983, many research accomplishments were made by the CFRU staff. You will read about these accomplishments in this Report, but I would like to highlight the following contributions:

- 1) Effects of different site preparation practices on conifer seedling debarking damage caused by the weevil, *Hylobius congener*, were identified.
- 2) Technology was advanced and costs were reduced for precommercial thinning in young spruce-fir stands using mechanical and chemical methods.
- 3) Shelterwood harvesting in northern hardwoods and acid deposition effects on bark fungi of hardwood regeneration were investigated.

During 1983, Ron Lovaglio and Bob Chadbourne were appointed to the Advisory Committee, and I would like to welcome them. I also would like to recognize those leaving the Advisory Committee during 1983, Charles Webb and James Robbins, and thank them for their dedicated service. Likewise, I would like to recognize Charles G adzik who left the CFRU staff during 1983, and thank him for his contributions to the CFRU during recent years.

Since my arrival at the College of Forest Resources on August 1, 1983, we have continued to hold regular CFRU staff meetings. Also, Advisory Com mittee meetings have been held on schedule during 1983, and I have had several opportunities to meet with the CFRU Executive Subcommittee.

During 1983, Roger Taylor retired as Superintendent of the University Forests after many years in this role, and the College is indebted to Roger for those years of service. Chuck Simpson subsequently joined the College of Forest Resources as our new Superintendent of University Forests. David (Chip) Leslie joined our College's Wildlife Division as an Assistant Professor on August 1, 1983, and effective September 1, 1983, David Field became Chairman of our College's Forestry Division. I would like to thank Floyd Newby for having served as acting Chairman during the past year. Finally, Fred Knight presently is serving as o ur College's first Associate Dean, and we are indebted to him for his years of service as the previous School's Director and College's Interim Dean.

A busy year is in store for the CFRU staff and Advisory Committee during 1984. It is the year in which we begin promotion and negotiations for continuation of the CFRU for July 1985 through June 1990. The CFRU Executive Subcommittee already has met to outline several tasks which will be undertaken during 1984. These will includ e publication of promotional materials, tours, seminars, and personal visitations. Several events in recent years must be considered during renewal of the CFRU program for the next five -year period. These include changes in land ownership patterns within Maine, and the

inclusion of a hardwood silviculture research program in CFRU.

I would like to thank Bart Harvey for having provided leadership as Chairman of the CFRU Advisory Committee during 1983. You are aware of the outstanding job he has done, and we look forward to the CFRU's continued relationship with Bart. I further would like to thank all of the staff and members of the Advisory Committee for their service to the CFRU during 1983. Without the attention and efforts of each of these individuals, the CFRU could not have achieved its present successful status and high standing reputation. In turn, I would like to thank all the CFRU cooperators for having made the entire CFRU program possible.

Finally, I would like to pay particular tribute to two individuals who provided outstanding service to the CFRU between 1976 and 1983. Amy Morin served as secretary to the CFRU during this period, and contributed greatly toward its development and growth. Lynne Lavoie joined the CFRU in 1983 as secretary, and already has begun to build on the excellent services provided by Amy. I further would like to express the gratitude of everyone serving with or associated with the CFRU to Fred Knight for having provided outstanding leadership as Director for CFRU during this period. I hope to be able to continue the level of leadership established by Fred.

Greg N. Brown, Dean College
of Forest Resources

SILVICULTURE

Dr. Maxwell L. McCormack, Jr.

Intensive Forest Harvesting

Post-harvesting evaluations of the paired watershed study on Weymouth Point, T4R12 WELS, have continued. During 1983> the fourth year of soil solution and stream water sampling was completed.

The Ph.D. dissertation of C. Tattersall Smith, Jr., "Nutrient Removals and Soil Leaching from a Whole-Tree Harvest of a Red Spruce (*Picea rubens* Sarg.)-Balsam Fir (*Abies balsamea* (L.) Mill.) Stand in North-Central Maine," has been completed. This is a detailed account of the initial analytical work on the study. Included are descriptions and discussion of tree biomass and nutrient contents, the forest floor and mineral soil, soil solution conditions before and after harvest, the harvesting procedures, and the harvest residue management treatments. The manuscript will serve as a basis for future technical publications reporting specific results from the Weymouth Point watersheds.

CFRU Progress Report 26 entitled "Intensive Harvesting, Residue Management Alternatives and Nutrient Cycling in the Spruce -Fir Type: The Weymouth Point Study" has been published. It describes the establishment of the Weymouth Point study and summarizes the work done through the winter of 1981-82. It includes information on soil conditions and initial data on the soil solution chemistry for nitrate and calcium relative to drainage class. A listing and review of regression equations for estimating biomass of balsam fir and red spruce are also presented.

During August 1983, C.W. Martin of the U.S. Forest Service and C.T. Smith, Jr. of the Univ. of New Hampshire initiated a survey of the regrowth vegetation on the harvested watershed. This is part of the continuing effort to document conditions and changes associated with forest stand-soil characteristics and interactions related to harvesting systems. Sampling of soil solution and stream water also will be continued.

Precommercial Thinning

During July 1982, field trials were conducted to evaluate a helicopter system for use in treating a common forest management problem in the northeastern forests of balsam fir, red spruce, black spruce [*P. mariana* (Mill.) B.S.P.], and white spruce [*P. glauca* (Moench) Voss]. It is typical for natural regeneration to develop with 10,000 to 40,000 stems per acre. The objective of this technique was to adjust the density of stocking (ADS) by reducing the woody vegetation in regularly spaced bands. The establishment of this study and a complete list of treatments appear in our 1982 Annual Report.

Five blocks on three cutover spruce-fir forest sites in northern Maine were treated. In addition to the conifers, observed hardwood species were quaking aspen (*Populus tremuloides* Michx.), pin cherry (*Prunus pensylvanica* L.f.), paper birch (*Betula papyrifera* Marsh.), gray birch (*B. populifolia* Marsh.), and red maple (*Acer rubrum* L.). Common red raspberry (*Rubus idaeus* L. var. strigosus (Michx.) Maxim.) was also an important component. Post-

harvesting development of vegetation varied among the sites* providing opportunities to evaluate results on trees ranging from 3 to 25 ft (1-8 m) in height. In some cases, taller residual trees interfered with helicopter navigation and the spray patterns.

In July 1983, one year after treatment, all swaths were evaluated. Two pairs of observers each appraised two bands, and their evaluations were combined to form composite ratings for each entire swath. Effectiveness was assessed on a scale from 0 to 10, where 0 to 4 represents inadequate silviculture! advantage, 5 is the threshold of benefit, and 6 to 10 reflects increasing silvicultural effectiveness up to complete control. The composite ratings are based on 24 different values for each treatment.

Treatments involving bromacil (Hyvar XL) or glyphosate (Roundup*) were not silviculturally effective in this study. Treatments using dicamba (Banver^), picloram (Tordon^), or 2,4-D, applied singly or in combination, all provided satisfactory control of hardwood species in the bands (Table 1).

Table 1. One-year silvicultural effectiveness³ on hardwood brush species following aerial strip treatments to reduce density of stocking in young spruce-fir stands.

Herbicide	Rate ₁ lb/a ^b	Aspen	Pin Cherry	Paper Birch	Gray Birch	Rasp- berry	Red Maple ^c
dicamba	6	8	9	8	—	6	8
dicamba + 2,4-D	2+3.8	7	9	9	9	7	8
dicamba + 2,4-D	3+5.7	8	9	9	9	8	7
dicamba + picloram	3+1	9	9	9	8	7	7
dicamba + 2,4-D + picloram	4+4+1	8	9	9	9	—	8
picloram + 2,4-D	1+4	8	9	9	9	—	8
picloram + 2,4-D	1.5+6	9	9	9	9	8	8

Composite ratings across five study sites; 0 = no control, 10 = complete control (McCormack et al. 1982). All rates are active ingredient per acre. Limited number of observations.

The best control of conifers involved treatments with dicamba and picloram (Table 2). The addition of 2,4-D consistently provided improved efficacy. The reduction of conifer stems was closely related to their freedom from overtopping vegetation which intercepted spray coverage. Success of these treatments does not appear possible where broadleaf canopies overtop target conifers.

The size of the target conifers also appears to be an important factor. The smaller the trees, the more susceptible they are to the treatments. Species differences are also reflected in the effectiveness ratings. Red spruce is easiest to control, followed by balsam fir. Black spruce was the conifer most tolerant to the treatments. The tolerance exhibited by black spruce is not necessarily a problem. In some management situations an increase in the black spruce component could be desirable because, of the spruces, this species is relatively invulnerable to a prevalent insect pest, the spruce budworm [Choristoneura fumiferana (Clemens)].

Table 2. One-year silvicultural effectiveness³ on conifer species following aerial strip treatments to reduce stocking in young spruce-fir stands. density of

Herbicide	Rate. lb/a ^b	Red Spruce	Black Spruce	Balsam Fir
dicamba	6	5.5	1.0	5.0
dicamba + 2,4-D	2+3.8	9.0	1.0	5.0
dicamba + 2,4-D	3+5.7	8.5	0.0	3.0
dicamba + picloram	3.1	6.0	2.0	4.0
dicamba + 2,4-D + picloram	4+4+1	8.0	3.0	7.5
picloram + 2,4-D	1+4	7.0	3.0	5.0
picloram + 2,4-D	1.5+6	6.0	3.0	5.5

Composite ratings across five sites; 0 = no control, 10 = complete control (McCormack et al. 1982)

All rates are active ingredient per acre.

First-year results indicate several factors to be considered in future work with this technique: 1) It would be advantageous to select stands for treatment which do not have overstory trees, and 2) Select stands which have been treated previously to defoliate residual hardwoods. At least three modifications would likely improve control of the target conifers. First, earlier application of treatments (i.e. mid to late June, rather than July) would increase softwood susceptibility. Small -plot field trials with similar treatments during May -June 1983 confirmed this view. Second, an increase in the total volume applied per treated area would improve coverage in situations of high-biomass targets. Perhaps a volume of 25 gal/a would be more appropriate than the 20 gal/a used. Third, applying the ADS treatments during the early stages of stand development would assure better control of the overstocked softwood regeneration.

The results from this study of the ADS technique indicate its promise as a means for addressing a serious forest management problem. Experience in executing these tests verifies that the technique can be applied efficiently, under operational conditions, and to large acreages. Operational tests incorporating the suggestions for improving results will help to determine the utility of this silvicultural technique in the northeastern spruce-fir forests.

Thinning Spruce and Spruce-fir Stands

During 1983, the four major sites of the long -term thinning study were remeasured to evaluate responses over the five -year period since treatment. All the individual study trees were relocated and remarked as necessary. Thirteen to 21 attributes of each tree were remeasured. This project was the first field test of the Model 516 Polycorder*, a portable, programmable manual/electronic data collection system. The Polycorder functioned well. Its

major attributes Included: 1) rapid, accurate data recording; 2) programmed prompting of field procedures for orderly data measurement; 3) convenient review and editing; 4) ease of use in adverse weather such as heavy rain; and 5) automatic transfer of field data to the computer for analysis.

Two sites, Rowel 1 Brook (T 1R13 WELS) and Lakeville Plantation, have suffered heavy defoliation from the spruce budworm. Several balsam fir trees are completely defoliated and considered dead. Many red spruce trees are close to death and have foliated live -crown ratios as low as 10 percent. It appears that these conditions will seriously reduce the possibility of positive responses to the thinning treatments.

As a result of the defoliation, ground vegetation of raspberry, red maple, striped maple, and paper birch has occupied the forest floor on the two sites. On some of the areas spruce and fir regeneration had become established but is being overtopped. In an effort to maintain the sites for the thinning study, as well as to secure the conifer regeneration, it was decided to control the broadleaved brush with a backpack mist blower application of herbicide. Glyphosate was applied to the Rowel! Brook site in August; t he control blocks and one portion of the thinned area were left unsprayed. It is planned to spray the Lakeville Plantation site in 1984. Tree crowns on the Scott Brook site are in good condition after apparent recovery from an earlier budworm infestation. The Clayton Lake site is predominantly black spruce and continues to be in a relatively healthy condition with good, full crowns. To date, loss of study trees from windthrow has not been a serious problem on any of the sites.

The 1983 data are being compar ed to the original measurements to determine the possible value of an interim report of five -year responses. A comparison of height and dbh across all species measured on the Scott Brook and Clayton Lake sites is shown in Table 3.

Table 3. Average 5 -year height and diameter increment for spruce and fir study trees on two selected sites⁵.

Study Sites	Average 5-Year Increment			
	Height		Dbh	
	Thinned	Control	Thinned	Control
Scott Brook (T5R15 WELS) Thinned n=76; Control n=10	5,84	2,10	1,09	0,63
Clayton Lake (T11R16 WELS) Thinned n=122; Control n=9	3,91	2,67	0,47	0,34

¹ These two locations exhibited little evidence of spruce budworm defoliation in comparison to the Rowell Brook and Lakeville Plantation sites.

Data have been collected on an individual tree basis so that specific growth response models can be developed. It is intended to maintain this study for at least another five-year period.

Management of Undesirable Vegetation with Herbicides

Small-Plot Tests

A series of small -plot field tests for preliminary evaluation of new herbicides was initiated. Four -meter-radius plots (0.0124 a) have been established on three sites representing different conditions which are typical of vegetation regrowth on spruce -fir cut -overs. Table 4 summarizes the materials applied in the 1983 treatments.

Table 4. Summary of new herbicide test-plot treatments established during 1983^a.

Material	Manufacturer	Range of Rates	Total Number of Plots
AC252,925	American Cyanamid Co.	0.50 to 1.00 lb ^b	33
AC263,499	American Cyanamid Co.	0.50 to 1.00 Ib	6
UC77179	Union Carbide Agric. Prod. Co.	0.50 to 1.50 Ib	33
OUST	E.I. duPont de Nemours & Co., Inc.	1.50 to 12.0 oz	14
DPX T6376	E.I. duPont de Nemours & Co., Inc.	0.25 to 1.0 oz	3

¹ Dates of application across the three sites were 25 May through . 25 August.

⁵ All rates are active ingredient per acre.

These chemicals exhibit potential for a wide variety of forestry uses in Maine. Wide-spectrum control of vegetation shows promise for site preparation. Selectivity indicates possibilities for reducing competition around coniferous species or, perhaps, selecting from within groups of conifers to reduce the fir component in developing spruce -fir regeneration. During 1984, the established plots will be evaluated and additional treatments will be applied.

Austin Pond Study

The Austin Pond study site (Bald Mtn. Twp.), aerielly treated with a variety of herbicide treatments in August 1977, was re -evaluated. Initially, it was not intended to carry this study beyond three years. However, continued interest in the vegetation development on the area resulted in a decision to sample conditions in most of the 26 study blocks.

The original blocks (3 x 8 ch = 2.4 a) were relocated and ten plots (0.2 x 0.2 ch) were systematically located within a rectangular zone covering the central 20 percent of a single treatment area. All stems, breast height and above, were tallied to indicate species composition. Total heights and diameters of dominant and codominant trees were measured to assess relative growth rates and development. The data are being reviewed for inclusion in a report on the Austin Pond site. Selected data from glyphosate and triclopyr treatments are shown in Table 5.

Table 5. Average values of stocking and total height, by species, for selected treatments six years after herbicide application at the Austin Pond site.

Plot	Treatment	Rep	Species					Total			
			As	Fr	Lu	Sp	Other	Stems/a	Ht	D	FI
5	Control	---	900 (13.8)	525 (8.1)	2325 (35.6)	675 (10.3)	1175 (18.0)	5.0	6.2	2.0	2.1
19	Control	---	5300 (53.9)	225 (2.3)	175 (1.8)	200 (2.0)	2550 (26.0)	5.8	6.3	2.8	3.3
7	Glyphosate	2	0 (0)	75 (1.6)	0 (0)	300 (6.3)	4350 (91.1)	---	2.2	1.9	2.6
3	Glyphosate	4	100 (1.7)	125 (2.1)	0 (0)	475 (7.9)	5225 (86.7)	2.8	2.3	1.9	2.9
17	Glyphosate	4	750 (12.8)	25 (0.4)	0 (0)	300 (5.1)	4750 (80.8)	2.5	2.1	2.4	3.2
21	Triclopyr	2	25 (0.2)	675 (4.6)	475 (3.2)	3075 (20.8)	10300 (69.7)	2.1	3.4	2.2	3.0
24	Triclopyr	2	25 (0.3)	0 (0)	450 (6.0)	725 (9.7)	5075 (67.7)	1.4	-----	2.1	2.6
1	Triclopyr	4	250 (3.6)	275 (4.0)	0 (0)	650 (9.4)	5425 (78.9)	2.6	3.1	2.2	2.6
16	Triclopyr	4	100 (2.7)	400 (10.9)	25 (0.7)	175 (4.8)	2950 (80.3)	1.6	3.8	1.6	2.9

Triclopyr and glyphosate continue to exhibit strong residual benefits in comparison with untreated controls. Phenoxy herbicide treatments of 2,4,5-T, or combinations of 2,4-D + 2,4,5-T, show some benefit which has faded in recent years. A conifer component was maintained but it is again overtopped by competing hardwoods. Plot measurements do not reflect totally the conditions which are apparent by visual examination. After six years, several treatment-related patterns of vegetation development are evident:

1. The most effective treatments have maintained a species composition to allow development of a productive conifer stand.
2. Among the coniferous species present, fir tends to have the strongest positive response to treatments.
3. Undesirable hardwoods have attained a strong position of dominance in the untreated blocks.
4. A well-distributed, but not dominant, hardwood component has been maintained across the most effective treatments.

Reference Cited

McCormack, M.L., E.B. Sprague, T.B. Saviello, and R.J. Hendler. 1982. Timing triclopyr and glyphosate treatments on forest brush. Proc. NEWSS 36:209-214.

FOREST PROTECTION

Dr. Mark W. Houseweart

Regeneration Weevil Study

This was the second year of study by Celeste Welty, M.S. graduate student, on her thesis project concerning a seedling debarking weevil, *Hylobius congener* Dalla-Torre. The adult weevil (Figure 1A) feeds on the bark at the base of seedling stems (Figure 1B) and causes seedling death by girdling (Figure 1C).

Field experiments on the influence of various site characteristics on seedling debarking damage were continued in 1983. Experiments on duff and slash were repeated, and one on site preparation was initiated. Consistent with 1982 results, fewer seedlings were debarked when duff was scraped back from the seedling bases than when duff was left intact. Neither the amount nor the freshness of slash had a significant effect on the percentage of seedlings debarked. Fewer seedlings were debarked on sites that were burned (in combination with raking or disking) than on unburned raked sites, untreated controls, or those harvested with a whole-tree system.

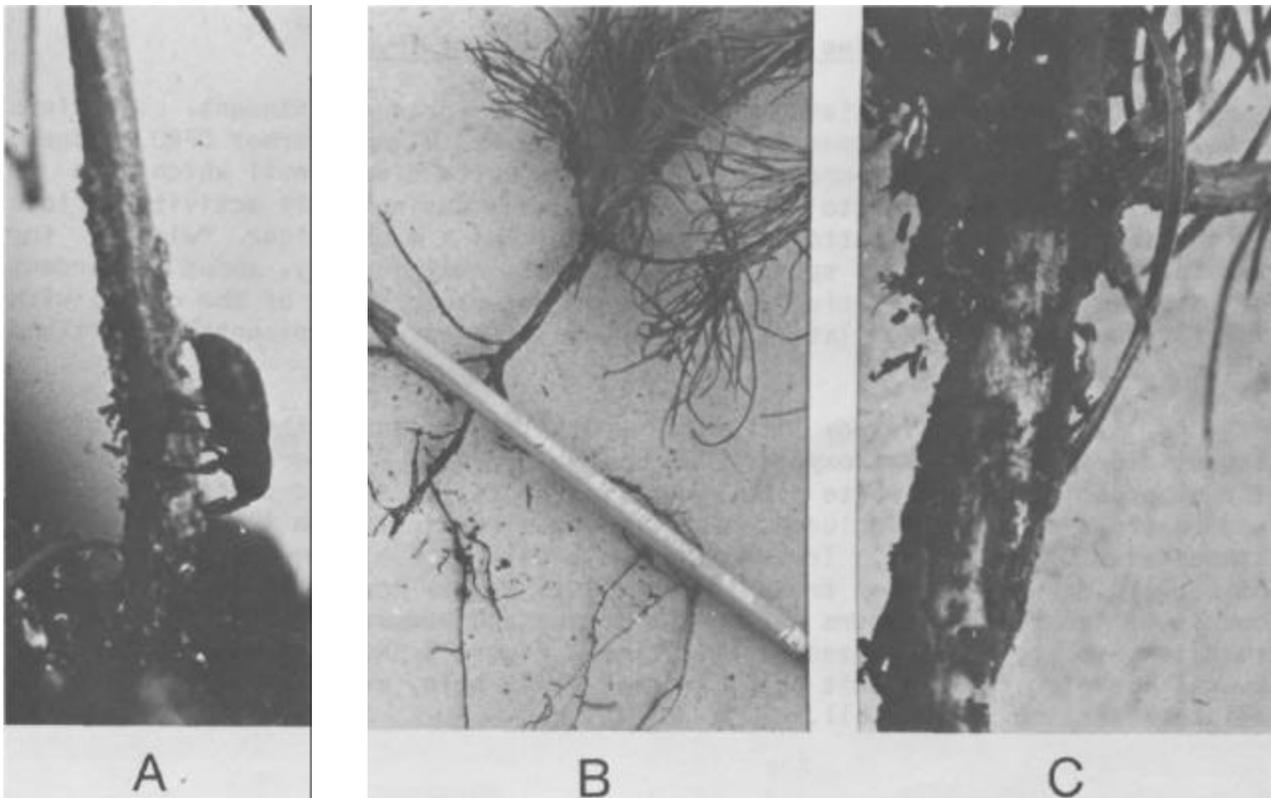


Figure 1. *Hylobius congener*, a seedling-debarking weevil: A. Adult weevil on stem of seedling. B. Debarking damage on white pine (*Pinus strobus* L.) seedling. C. Closeup of the girdled seedling.

Greenhouse experiments on host tree susceptibility to debarking conducted in 1982 and 1983 indicate that there were no consistent differences in susceptibility among the nine conifer species tested.

A more efficient version of the split-bolt traps used in 1982 was tested in 1983 to monitor U. congener population abundance in Glenwood and Rowland* Maine. These split-bolt traps were made of freshly cut red spruce (*Picea rubens* Sarg.) treated with an insecticide. These traps needed to be checked only weekly rather than daily* as required for the untreated bolts used in 1982. This technique may be developed as a suppression method to be used along plantation edges.

Spruce Budworm-Trichogramma Project

As in last year's annual report, the activity on this project has been directed toward writing and publishing the results obtained from previous field seasons. Only three manuscripts remain; two are in press at the Canadian Entomologist: "Field releases of *Trichogramma minutum* Riley for suppression of epidemic spruce budworm populations in Maine" and "Development and longevity of *I. minutum* ..." in two laboratory host species. The last in the series will be a CFRU Research Bulletin entitled "Alternate insect hosts and characteristics of forest stands supporting native populations of *I. minutum*."

White Pine Weevil *Issodes strobi* (Peck)

This project was initiated this fall by M.S. graduate student, Lise Dietz McGallaird. Previous research by Dr. Wayne N. Dixon, former CFRU graduate student, identified behavioral patterns of the white pine weevil which make it potentially susceptible to suppression measures during adult activity periods in the fall. Fall application of insecticides has a much wider "window" for the target population than spring applications. Additionally, about 85 percent of the fall brood population is located in the upper third of the crown, with weevils feeding on the lateral branches in exposed horizontal positions (Figure 2).

As a follow-up study of Dixon's results, we tested the efficacy of six insecticides (Rabon®, Methoxychlor®, Dursban®, Pydrin®, Pounce[^], and Sumithion®) for suppression of the white pine weevil in the fall. A hand-pruning treatment and controls were also included. The study was replicated on three white pine stands near Orono, Maine. Treatment effects will be evaluated by direct counts of weevils on nine monitor trees in each plot, weevil counts in drop trays, and counts of "weeviled" leaders during the spring and summer of 1984. Preliminary results are being analyzed at this time. Figure 3 shows an adult white pine weevil emerging from an exit hole, an empty exit hole, and a weevil feeding on a lateral branch in the fall.

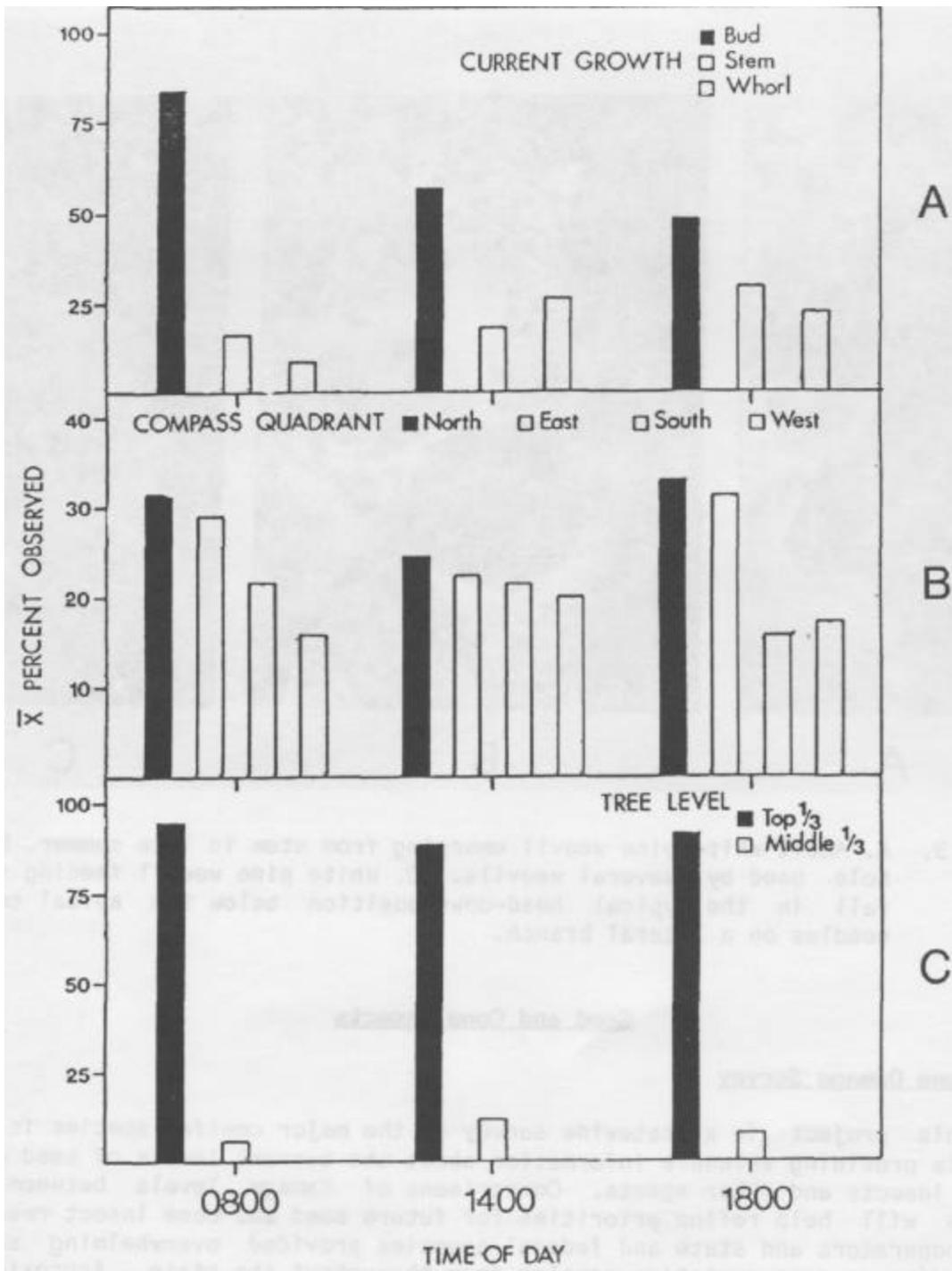


Figure 2. Location and timing of occurrence of white pine weevils on host trees in the fall by: A. current growth, B. compass quadrant, and C. tree crown level [Dixon, W.N. and M.W. Houseweart (1983)].

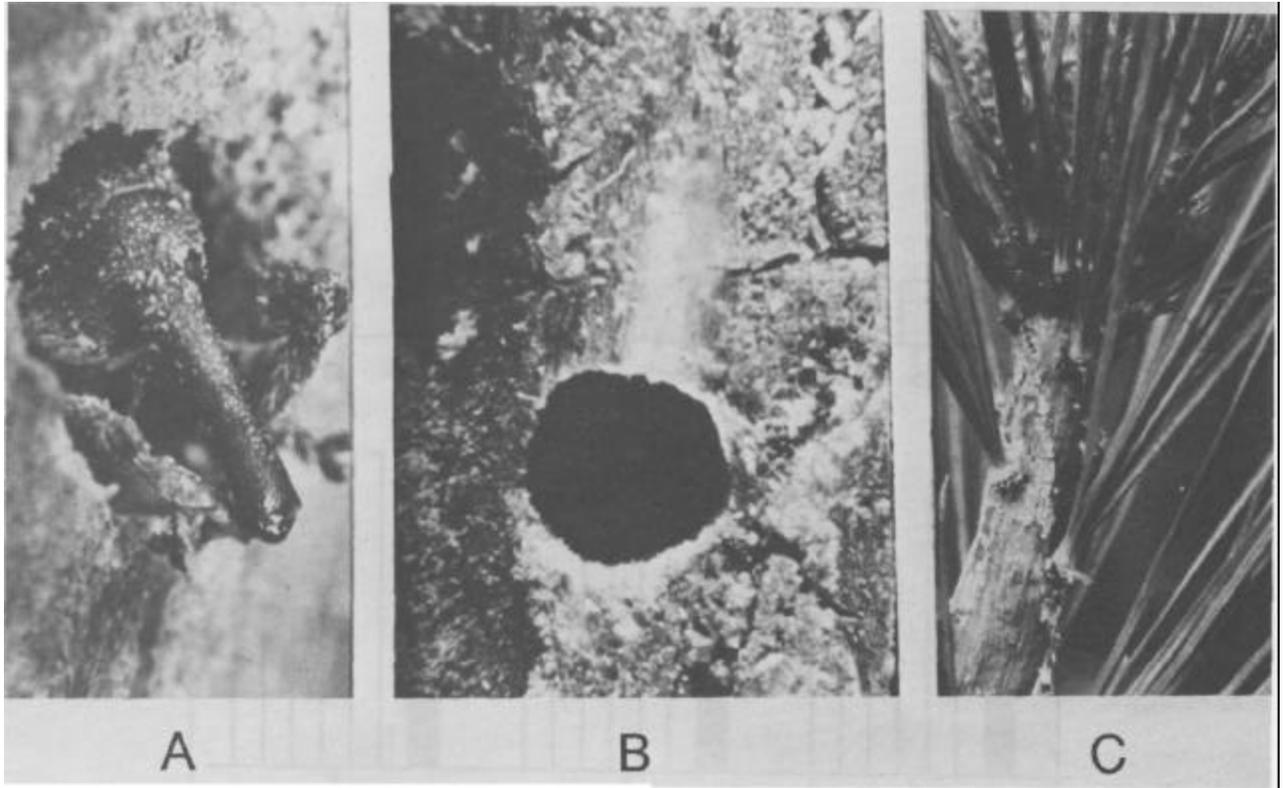


Figure 3. A. Adult white pine weevil emerging from stem in late summer. B. Exit hole used by several weevils. C. White pine weevil feeding in the fall in the typical head-down position below the apical tuft of needles on a lateral branch.

Seed and Cone Insects

State Cone Damage Survey

This project is a statewide survey of the major conifer species in Maine which is providing valuable information about the current levels of seed damage due to insects and other agents. Comparisons of damage levels between tree species will help refine priorities for future seed and cone insect research. CFRU cooperators and state and federal agencies provided overwhelming support by sending us representative samples from throughout the state. Approximately 3000 cones were collected from 14 species in August and September of 1983. Collections were made at more than 90 locations in Maine ranging from Comstock Twp. and Moro Pit. in the north, to Oxbow Twp. in the west, Woodstock and Sidney in the south, and Beddington and No. 21 Pit. in the east. Currently our laboratory personnel are busy dissecting the cones and assessing seed damage. Balsam fir [*Abies balsamea* (L.) Mill.] and tamarack [*Larix laricina* (DuRoi) K. Koch] are two of the tree species most severely damaged in the 1983 cone samples (Figure 4).

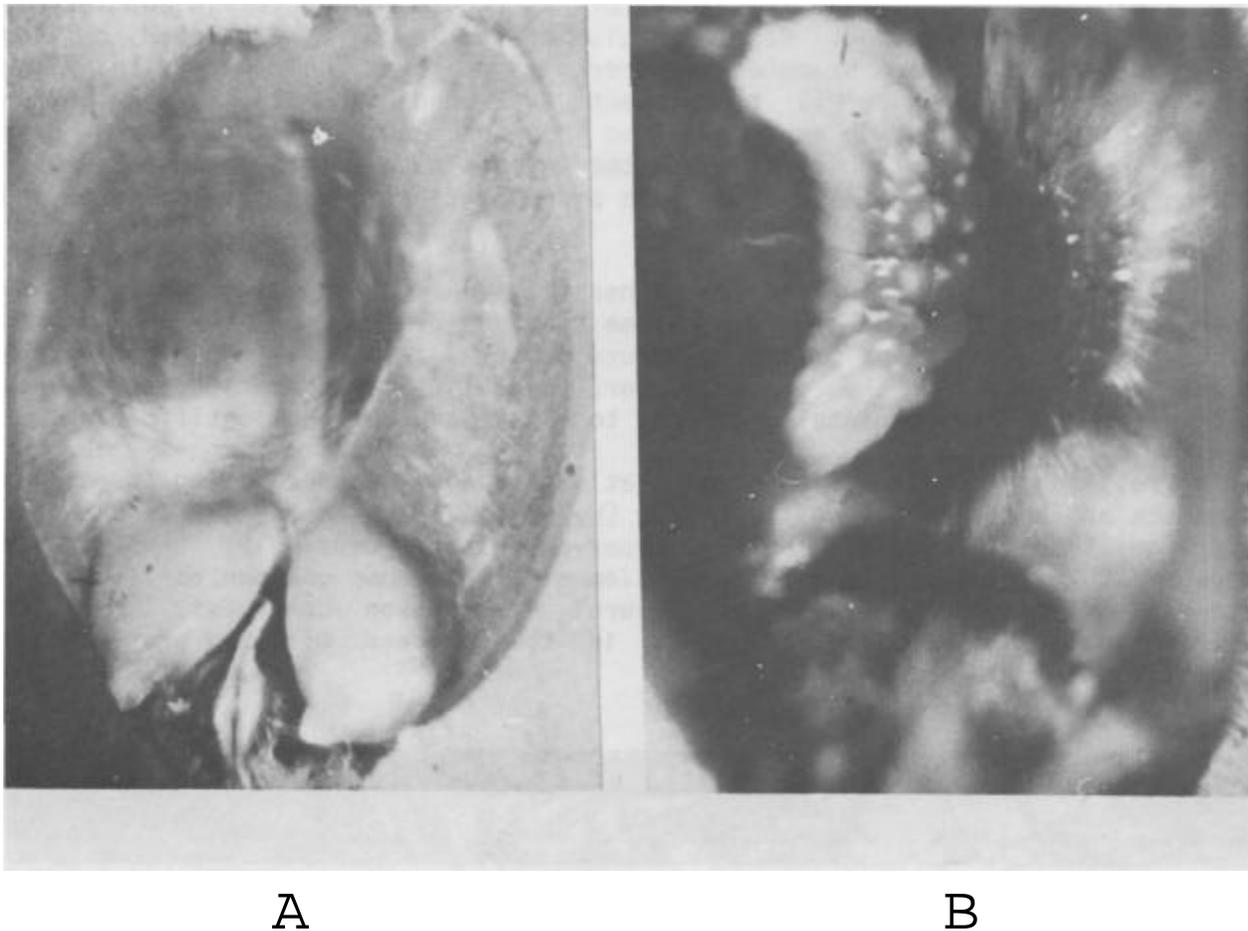


Figure 4. A. Sound tamarack seed and B. Damaged tamarack seed with larva of causal agent.

Intensive Studies on Tamarack and Exotic Larch

During 1983* intensive investigations were made on ecological factors of tamarack seed production, damage by seed -feeding insects of tamarack and hybrid exotic larches (*Larix* spp.), and identification of damaging insect species. Mr. A. Lee Eavy, a Ph.D. graduate student in Forest Resources, and our Assistant Scientist, Robert K. Lawrence, have been cooperating on this project. Ecological investigations included environmental monitoring for timing of tree and insect life cycle events, and investigation of pollination factors that may affect seed production in tamarack. Pollination factors were investigated in two experiments: 1) pollen dispersal was monitored from a single, isolated, mature tree to determine the pattern and distance of pollen transport, and 2) controlled pollinations were performed at two study sites (Old Town and Medford, Maine) on ten trees to define and evaluate inbreeding in natural populations of tamarack.

Seed-feeding insects received the most emphasis during the 1983 season. Two study sites were established in tamarack stands at Old Town and Medford, Maine. At four- and seven-day intervals, 60 tamarack cones were collected from

the field and dissected in the laboratory to record damage levels and insects responsible for the damage. Bagging/exclusion trials were conducted on ten trees per site. Fifteen branches per tree were selected and bagged with nylon mesh enclosures (Figure 5) to protect the cones from insects. At a pre-selected time, each branch was exposed to insect attack for four or seven days to define the activity periods of the various seed-feeding species. Post-season cone collections and examinations provided final seed yield data and damage levels for the exposure trials.

In addition to cone samples, insect life cycles were monitored by emergence traps on the ground, Malaise traps at ground level and 4 m high in trees, and by traps which collected mature insect larvae falling from study trees to pupate in the ground litter. Over 1,000 immature insects are now being reared in environmental chambers, to obtain adults for identification.

Preliminary results indicate that the major seed-damaging insects in tamarack are a spiral-boring fly maggot [*Hylemyia*? sp.] and small seed midges (Cecidomyiidae) (Figure 6). We also observed damage caused by the spruce budworm [*Choristoneura fumiferana* (Clemens)], and some unknown early-season, bud-mining lepidopteran larvae, and several late-season coneworms. Most of these specimens are in rearing or in the process of being prepared for identification.



Figure 5. Graduate Student, Lee Eavy,
(June 1983).

bagging a tamarack branch bearing cones

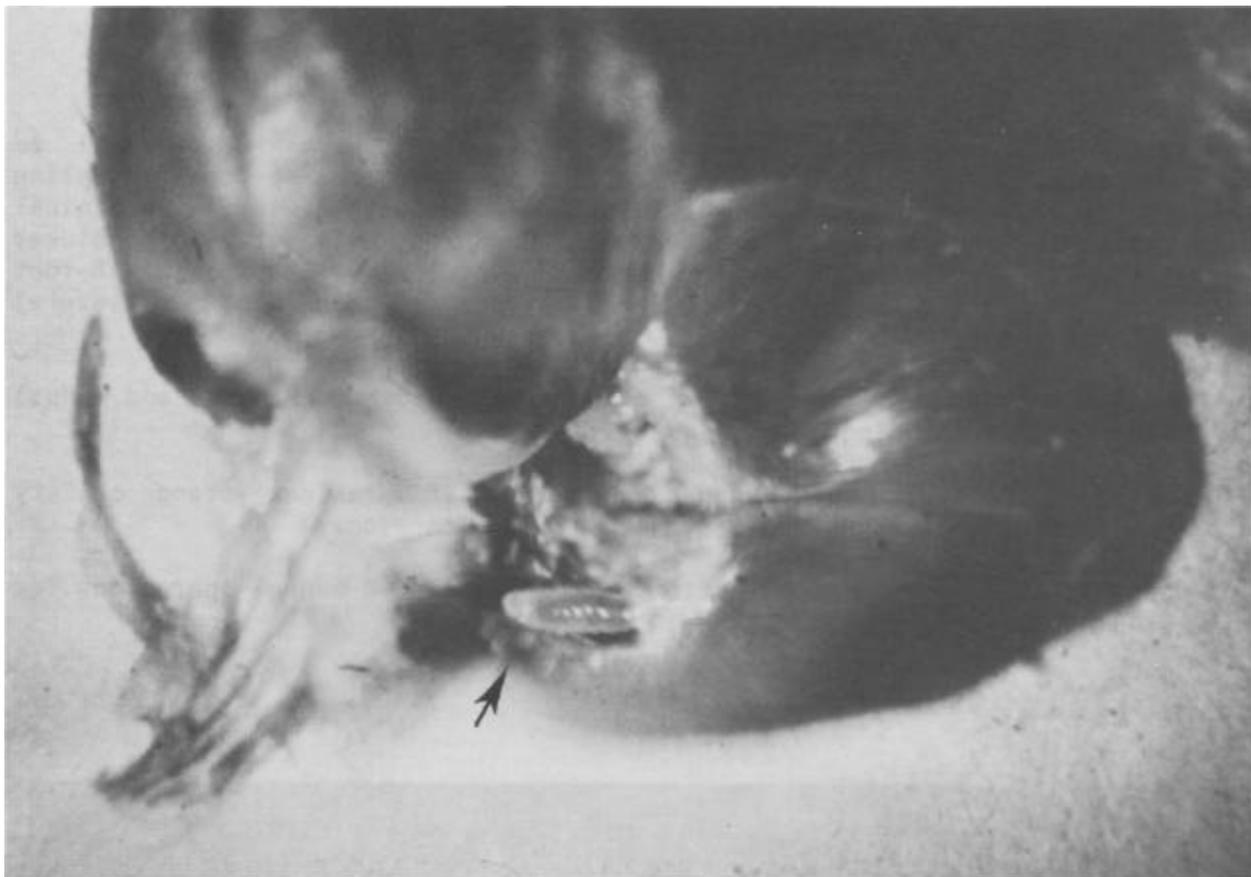


Figure 6. Seed midges (*Cecidomyiidae*) found in damaged tamarack seed (May 1983).

Cone and seed damage was also monitored in hybrid exotic larches in 1983. A study site was established in a Georgia-Pacific Corp. hybrid larch plantation in Talmadge, Maine. Cones were collected weekly from 15 trees and were examined for the presence of insects and seed damage. Insect life cycles were monitored using trapping techniques similar to those mentioned above. Data from these collections are currently being analyzed. Observations in the field indicate that the primary insect pests of cones at that site were spruce budworm and unidentified early-season lepidopteran larvae. We also believe that a very high proportion of the cone crop in that plantation was removed by red squirrels [*Tamiasciurus hudsonicus* (Erxleben)].

TIMBER MANAGEMENT AND HARVESTING

Dr. Robert S. Seymour

Operational Density Control in Young Spruce-Fir

At the April 13 meeting, the Advisory Committee approved a proposal to test a promising system for precommercial thinning in dense spruce -fir sapling stands. The approach involves an initial stand entry with a large mechanical swath cutter (Figure 7) to create access corridors and leave strips of residual trees. Then in a follow -up operation, crop trees are released on an 8 x 8 -foot spacing by workers using brush saws. The study was designed to address several important questions:

How do stand conditions affect production of both mechanical and manual precommercial thinning operations?

How do productivity of brush-saw workers and residual-stand quality compare with and without mechanically created corridors?

What is the optimum combination of mechanical and manual operations for thinning dense spruce-fir stands?



Figure 7. Hydro-Ax 520 equipped with a Rotary Ax brush cutter.

The study was conducted on Scott Paper's Northern District. Scott leased a Hydro-Ax 520 equipped with a Rotary Ax brush cutter, and operated the unit on a trial basis over a four -month period. Brush -saw operators under contract with Scott carried out the individual-tree spacing work.

Production of the Hydro -Ax and the brush -saw workers was timed in three stands aged 13, 18, and 22 years since harvesting, and was related to stand conditions by regression analysis. A detailed discussion of experimental procedures and preliminary results will be published as CFRU Research Note 14 (Seymour, Ebeling and Gadzik 1984). The following summary highlights the major findings:

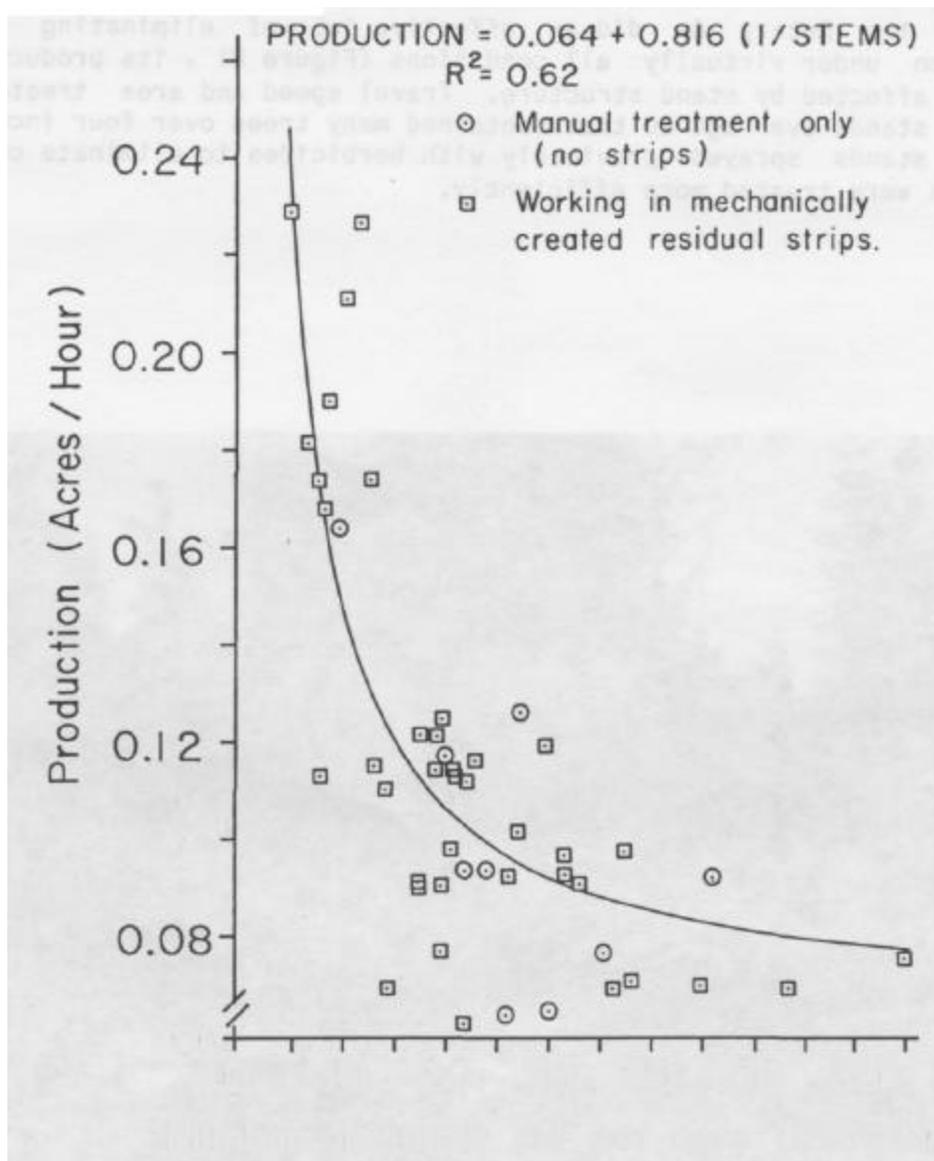
1. Although the Rotary Ax did an effective job of eliminating standing vegetation under virtually all conditions (Figure 8) , its production was strongly affected by stand structure. Travel speed and area treated were lower in stands over age 20 that contained many trees over four inches dbh; younger stands sprayed previously with herbicides to eliminate competing hardwoods were treated more efficiently.



Figure 8. Swaths cut by the Hydro-Ax.

Brush-saw production was also affected by stand density; as the number of stems cut increases from 5,000 to 15,000 stems per acre, area spaced drops from 0.23 to less than 0.12 acres per hour (Figure 9). Above this density, production drops more slowly, leveling off at about .06 acres per hour in the densest stands encountered.

The inherent efficiency of brush-saw operations apparently is not improved by prior mechanical treatment. Workers treated area in residual strips at the same rate as stands with no mechanical swaths. However, overall productivity of brush-saw workers is still higher in mechanically treated stands, because they need to thin only a portion of the total area.



0

0 10 20 30 40 50 60

Number of stems cut per acre (x1000)

Figure 9. Relationship between stand density and production of a skilled brush-saw operator in an 18-year-old spruce-fir stand, with and without mechanically created strips.

4. About sixteen percent of all residual crop trees had wounds with exposed wood; roughly equal proportions were damaged by the Hydro -Ax and the brush saw. However, any sacrifice in residual stand quality from mechanical thinning appears to be minor relative to the potential gain in area treated with the combined mechanical-manual system.

A detailed analysis of density -control costs and how they are affected by stand conditions and economic variables will be presented in Graduate Research Assistant Rob Ebeling's master's thesis and forthcoming publications.

In addition to the production studies, 45 0.05 -acre permanent plots, containing approximately 2000 individually numbered and measured crop trees, were established to evaluate growth response to the spacing treatments. Crop trees will be remeasured at 5-year intervals.

Commercial Thinning Systems for Small-Diameter Stands

No production studies of commercial thinning operations were undertaken in 1983. Analyses of data obtained in the 1982 study of prebunching and cable - logging systems were completed in early 1983, and several manus cripts documenting the findings are in various stages of preparation. Four CFRU publications are planned which will be entitled as follows:

Commercial Thinning in Small-Diameter Spruce-Fir Stands:

- I. Production, logging costs and residual stand damage from tree-length skidding and skyline yarding, with and without prebunching.
- II. Tree-length prebunching systems based on a radio-controlled portable winch.
- III. Case study of the Smith Timbermaster, a small skyline yarder. IV. Case study of a cable skidder operation with controlled job layout.

The first paper is virtually complete and should be published as a CFRU Research Bulletin in early 1984. Results are essentially unchanged from those reviewed in last year's annual report. A two -stage harvesting operation, involving prebunching butts -ahead with a radio -controlled winch before skidding, was slightly more efficient than a conventional two -man skidder crew, but the advantage was minor. Prebunching also reduced costs of log ging with the Smith Timbermaster cable yarder; however, skyline yarding, with or without prebunching, is significantly more costly than skidding.

Simulation of Spruce-Fir Wood Supplies and Forest Development

On March 15 -16, I led a workshop describing the structure and potential applications of the Green Woods model, which has been under development for several years. The workshop, sponsored jointly by the College of Forest Resources and the CANUSA spruce budworms research program of the US Forest Service, was attended by over 40 individuals, including representatives from all major spruce-fir landowners in Maine. A manuscript (Seymour, Mott et al.

1984) describing the scientific basis of the model and one of its applications has been completed* and will be published as a General Technical Report of the USFS Northeastern Forest Experiment Station.

In cooperation with analysts of the J.W. Sewall Company, I helped design and analyze the computer simulations which formed the basis for the projections in the recently released Maine spruce -fir supply/demand analysis (Sewall Co. 1983) funded by the Maine Forest Service .

Research Associate Position Vacant

In December, Charles Gadzik, CFRU Research Associate, left the Unit to become forester for the Baskahegan Company, a CFRU cooperator with timberlands in northern Washington County. Chuck's contributions to our thinning studies were invaluable, and his talents will be missed. I plan to fill the vacancy in spring of 1984, after a re-evaluation of the research direction of my program.

Reference Cited

Sewall, J.W., Co. 1983. Spruce-fir wood supply/demand analysis. Final Report prepared for: Maine Dept. Conservation. 94 p. + appendices.

HARDWOOD SILVICULTURE
 Dr. William D. Ostrofsky

Modified Shelter-wood System

Many hardwood stands in Maine contain a high number of low -quality, defective American beech (*Fagus grandifolia* Ehrh.) which is the result of past harvesting practices favoring shade tolerant species and the occurrence of the beech bark disease. However, American beech resistant to *Cryptococcus fagisuga* Lind., the scale insect which is a primary causal agent of the disease, are known to occur infrequently in Maine hardwood stands. Thus, a modified shelterwood system was designed to improve species composition and tree quality in these stands. The experiment was conducted on land owned by the Georgia - Pacific Corporation, near Lambert Lake, Maine.

Six plots 0.8 acres (0.33 ha) in size were established in the stand. The first step of the experiment was to apply either glyphosate (Roundup) or triclopyr (Garlon 3A) to the advanced regeneration in order to eliminate young beech (Table 6). Most beech regeneration is from root sprouts of older trees, which are known to be susceptible to the beech bark disease. Two plots were treated with glyphosate, two with triclopyr, and two left untreated to serve as controls. The herbicides were applied at labeled rates by backpack mist blower in mid-July.

Table 6. Stand size-class structure at Lambert Lake, Maine, 1983

Size Class	Species				
	Beech	Red Maple	Yellow Birch	Sugar Maple	Paper Birch
New Germinants	217	7117	234	0	0
Seedling	600	300	34	17	0
Sapling 1	3484	167	350	0	17
Sapling 2	567	167	251	0	68

Sapling 1 = 1.1'-8' in height. Sapling 2 = 8.1' in height to 4" dbh.

The next step was to inject the large, defective beech stems using an axe-frill method; glyphosate or triclopyr was used in the respective treatments (Table 7). This stem treatment was done in mid-August to prevent root sprouts of susceptible beech from developing in the stand after the parent trees had been harvested.

Table 7. Stem treatment of herbicides at Lambert Lake, Maine, 1983.

riOT	nerui ti ae	Number of Beech Stems Treated	
		Per Plot	Per Acre
1	Triclopyr	90	112
2	Triclopyr	141	176
3	Glyphosate	110	137
4	Glyphosate	113	141
Mean		114	142

^a Each plot is 0.8 acres (0.33 ha) in size.

The entire stand was then marked for a shelterwood harvest. Species comprising the residual stand (41 sq ft/a BA) included red maple (*Acer rubrum* L.)» sugar maple (*Acer saccharum* Marsh.), yellow birch (*Betula alleghaniensis* Britton), and beech judged to be resistant to the beech bark disease. Twenty-two resistant beech were found on the entire study site. Trees marked for removal were defective beech, which comprised 42 sq ft/a BA. The harvest was conducted in early October by conventional chainsaw felling followed by cable-skidding of whole trees (Figure 10). The harvested trees were then chipped at roadside for pulp.

Beech left in the residual stand were challenged with *f. fagisuga* to confirm resistance to the scale insect. Dr. David Houston, USDA Forest Service, Northeastern Forest Experiment Station, provided the necessary material and conducted this phase of the experiment (Figure 11). The technique involves placing a bark disk infested with *f. fagisuga* in contact with the bark of the tree being challenged. The disk is covered with a foam pad, which maintains ideal growth conditions for the insects. The trees will be checked annually for several years to determine if the insects have successfully colonized the bark of the challenged trees.

The herbicide treatments were successful in eliminating the advanced reproduction of beech sprouts. The effectiveness of stem injection in preventing new sprouts will be determined next summer. Seeding and sprouting of the other tree species present in the stand will also be evaluated. The successful establishment of desirable advanced reproduction will be used to determine when the final cutting (overstory removal) should be done.



Fig. 10. Appearance of the stand after herbicide treatments and the first (seed) cut of the shelterwood harvest* Lambert Lake, Maine, 1983.



Fig. 11. Application of the infested bark disks to the residual beech to confirm tree resistance to the scale insect. Lambert Lake, Maine 1983.

Acidic Precipitation and Hardwood Regeneration

In 1983, five large (7 X 7 m) "rain exclusion" sheds were built near Amherst, Maine to evaluate a number of forest ecosystem attributes which may be affected by acidic precipitation. Three of the sheds cover dense hardwood regeneration, and two others cover softwood regeneration. The CFRU project reported here is a small part of the overall acidic precipitation study coordinated and administered by Dr. C. Cronan, Department of Botany and Plant Pathology, UMO.

The objective of the CFRU project is to compare the relative abundance and diversity of fungi occurring on the bark of hardwood regeneration exposed to unaltered (acidic) precipitation with the fungi occurring on trees exposed to altered (neutralized) precipitation. Pretreatment (baseline) sampling was done during September, 1983 at which time twelve trees each of paper birch (*Betula papyrifera* Marsh.) red maple, and beech in each of the three hardwood plots were assayed for bark fungi. A total of eight genera of fungi has been identified to date, and approximately seven additional fungus isolates remain as unknowns. Identification of the unknowns by taxonomic specialists may be required.

The fungi identified include *Aureobasidium*, *Cladosporium*, *Penicillium*, *Trichoderma*, *Mucor*, *Geotrichum*, *Eurotium*, and *Alternaria*. *Aureobasidium* and *Cladosporium* were, by far, the most widespread and abundant fungi isolated. Both were recovered from all stems assayed. Commonly over 100 colonies were isolated from sampling a single stem. The abundance of the other identified genera is given in Table 8.

Table 8. Fungi isolated from bark of hardwood regeneration near Amherst, Maine, 1983.

Fungus	Species								
	Beech			Paper Birch			Red Maple		
	I ^a	II	III	I	I	III	I	II	II
					o				
					f				
<u>Alternaria</u>	0	8	12	0	2	7	1	11	2
<u>Eurotium</u>	0	14	0	0	6	0	12	2	1
<u>Geotrichum</u>	2	6	0	4	1	0	1	0	0
<u>Mucor</u>	4	0	6	2	1	2	0	0	4
<u>Penicillium</u>	3	12	5	2	1	6	9	42	1
<u>Trichoderma</u>	7	1	2	5	1	0	1	1	1

Roman numerals represent plots surveyed.

⁵ Each value represents 12 sampled trees.

The treatment (neutralization of intercepted precipitation) has not yet been applied, so large differences in the fungal population were not expected. The two fungi *Aureobasidium* and *Cladosporium* may be especially useful in providing a "barometer" of precipitation acidity. The presence of *Trichoderma* is also of particular interest because it is known to be an antagonist to many plant pathogens in the soil environment. It may play a similar role on bark surfaces.

Paper Birch Defects

During a preliminary investigation of the major defects of paper birch, some observations on bark and xylem characteristics of trees infected with *Inonotus obliquus* (Fr.) Pilat were made. *I. obliquus* is an important canker - rot fungus which causes extensive volume and value loss of paper and yellow birches. Bark was found to be significantly thicker on the "cankered" side of the tree than on the opposite side; the thicker bark was the result of abnormal phloem production. Thus a hypothesis was formulated that the fungus has a direct effect on the vascular cambium of infected trees. These preliminary results were reported at the international Phytopathology meetings, held in Quebec in August, 1983. A detailed histological study of cankers caused by *I. obliquus* is necessary to understand the disease etiology. Silvicultural prescriptions for reducing the impact of this disease can then be developed.

Tour of Biomass Harvesting and Hardwood Manufacturing

In May, Dave Clement and Steve Orach of the S.D. Warren Company provided an excellent tour of the biomass plant in Westbrook, and of several biomass harvesting operations in western Maine. In addition, Henry Saunders led the group on an informative tour of Saunders Brothers hardwood mill in Fryeburg. About 20 CFRU cooperators and USDA Forest Service personnel attended the two day tour.

COOPERATIVE FOREST FERTILIZATION PROJECT

Dr. Robert K. Shepard, Jr.

Spruce-Fir

Fertilization by Drainage Class

Thinning of plots in red spruce [*Picea rubens* Sarg.] and black spruce [*P. mariana* (Mill.) B.S.P.] stands at eleven locations in north central Maine was completed in 1983. These plots are part of the study that was established to assess differences in response of spruce to fertilization on soils derived from the same parent material but which differ in drainage. Details of the overall study were presented in the 1981 and 1982 Annual Reports. There are three categories of plots in this study:

1. Unthinned plots—These are arranged in pairs with one plot receiving 200 pounds of nitrogen per acre (224 kg per ha) and the other plot serving as the control.
2. Thinned plots—These are arranged in pairs with one plot receiving 200 pounds of nitrogen per acre (224 kg per ha) and the other serving as the control; each pair of thinned plots is situated within 200 ft (60 m) of a pair of unthinned plots to insure similar stand and soil conditions.
3. Multiple treatment plots—These are arranged in groups of four; one plot will serve as the control, and one plot each will receive one of the following treatments: 100, 200, and 300 pounds (112, 224, and 336 kg per a) of nitrogen per acre. These plots have not been thinned, but in the majority of cases, the groups of four plots are in close proximity to a pair of thinned plots to permit comparisons between the effects of thinning versus no thinning. Overall study design is summarized in Table 9.

Table 9. Number of sites on each soil group or series, by treatment.

Soil Drainage Class	Plot Category		
	Unthinned	Thinned	Multiple Treatment
Moderately-well and well-drained	10	0	0
Somewhat-poorly-drai ned	14	5	6 7
Poorly-drained	20	6	

Only a small number of plot pairs has been established on moderately -well and well-drained soils, because pure spruce -fir stands on these soils are not common. They are also small in area, and are often predominantly fir, which is in a weakened condition due to defoliation by the spruce budworm [*Choristoneura fumiferana* (Clemens)].

In October 1983, one increment core was taken from each of ten dominant or codominant trees in each of four unthinned plot pairs on the somewhat poorly-drained soil and from trees in five unthinned plot pairs on the poorly drained soil. One plot of each pair had been fertilized with nitrogen at a rate of 200 pounds per acre (224 kg per ha) in early June, 1982. Response to treatment was expressed in two ways: the ratio of ring width of the second growing season after treatment to ring width of the first growing season after treatment, and the ratio of the second growing season ring width to average ring width for the five growing seasons preceding treatment. These ratios indicate a relatively large early response to fertilization by virtue of the fact that the ratios for the fertilized trees are significantly greater than the ratios for the control trees (Table 10).

Table 10. Growth ratios of fertilized and non-fertilized red spruce and black spruce in north central Maine on soils of two different drainage classifications (unthinned plots; 10 dominant or codominant sample trees per plot).

Drainage Classification	Ratio of Second-Year Ring Width to First-Year Ring Width		Ratio of Second-Year Ring Width to Average Five-Year Pre-treatment Ring Width	
	Fertilized	Control	Fertilized	Control
Somewhat-poorly drained				
Site 1				
Site 2				
Site 3	1.64	1.16	1.30 ^U	.89
Site 4	1.72	1.67	1.23	.96
	2.02 ^b	1.51	2.09 ^o	.92
Mean	2.01 ^b	1.39	1.48 ^b	1.02
	1.85 [']	1.43	1.51 ¹	.95
Poorly-drained				
Site 1*				
Site 2				
Site 3	1.42	1.05	.91	.70
Site 4.	1.68 ^b	.97	1.63	.90
Site 5 ^C	1.44	1.11	1.09 ^b	1.21
	1.68 ^b	1.11	1.69 ^b	.96
Mean	1.40	1.21	1.36	.96
	1.52 ^L	1.09	1.34 ^C	.96

black spruce
significantly different from control (a = 0.05)

Wastewater Effects on Growth and Wood Properties

As part of an investigation on the effect of municipal wastewater on tree growth and wood properties, 15 balsam fir from the municipal spray area at

Greenville, Maine were felled and discs were removed from each tree at breast height. Diameter growth (determined from two increment cores per tree) was measured and compared with growth of 25 balsam fir outside of the spray area. Many of the overstory trees in this stand had been cut during the winter of

1982-82 to reduce damage to the irrigation pipes that was being caused by windthrow. Consequently* the trees sampled had been released for two growing seasons, making it difficult to separate the growth response due to the wastewater from the response due to the release. However, it appears that the increase in growth of trees in the spray area was immediate, beginning in 1982, whereas, growth rate of trees from outside of the spray area did not increase until 1983.

Additional Work

Increment cores were taken from young (approximately 20 years old) black spruce that had been thinned to a wide spacing (ca. 12 x 12 ft or 4 x 4 m) seven years ago and from black spruce of the same age that had not been thinned. The purpose of this study is to determine if thinning to a wide spacing at an early age has had an effect on wood properties.

Plots in four thinned stands and one unthinned stand in southeastern Maine were fertilized with nitrogen at rates of 50, 100, and 200 pounds per acre (56, 112, 224 kg per ha). One stand is a mixture of Norway spruce [*Abies* (L.) Karst.] and white spruce [*Picea glauca* (Moench) Voss], another is a mixture of black spruce and balsam fir [*Abies balsamea* (L.) Mill.], and the remaining three are predominantly red spruce with some white pine (*Pinus strobus* L.).

Pines

Diameters of trees in all plots fertilized in 1980 and in all plots fertilized in 1982 were measured. Analyses of the data lead to the following general conclusions: 1) Many of the stands have responded to 100 pounds of nitrogen per acre. 2) Potassium, at either 40 or 80 pounds per acre (45 or 90 kg per ha), has proven to be the next best treatment. (Potassium also has the advantage of being the least expensive of the three major nutrients.) 3) Combination treatments of nitrogen with potassium and/or phosphorus do not produce a substantially greater response than nitrogen alone, and based on the high cost of these combination treatments, it does not seem that they should be considered for use on an operational basis. 4) The above is also true of phosphorus (applied alone), which has produced response in only a few stands and which has a high cost per unit weight of element.

Many treatments have failed to produce a growth response in most stands. Thus, future plans call for applying nitrogen or potassium to some of the plots that initially received a treatment that has produced no response. This will provide more replications of nitrogen and potassium as well as more control plots and will increase the data base from which conclusions regarding the most favorable application rates of both can be drawn.

Fertilizer was applied to plots in twelve stands. Seven stands are composed of white pine, but red pine (*Pinus resinosa* Ait.) is dominant in three stands, and two other stands contain some red and/or black spruce. The majority of treatments consisted of different rates of nitrogen and potassium, although phosphorus and combination treatments were also used.

Plots were established in four white pine stands and one red pine stand in western Maine. These plots will be fertilized in 1984.

Hardwoods

Plots in two thinned stands were fertilized in June, 1983. One stand is northern red oak (*Quercus rubra* L.); the other is composed of several species, with sugar maple (*Acer saccharum* Marsh.) and yellow birch [*Betula alleghaniensis* (Britton)] being dominant. Many of the treatments consist of nitrogen applied at rates of 50, 100, and 200 pounds per acre; the primary objective is to establish a response curve for nitrogen.

Two increment cores were taken from each of 25 sugar maple and 25 bigtooth aspen (*Populus grandidentata* Michx.) both inside and outside of the wastewater spray area at Sugarloaf Mountain to determine whether the spraying has affected growth rates and wood properties.

TREE IMPROVEMENT

Dr. Katherine K. Carter

Western White Pine

Two test plantations of western white pine (*Pinus monticola* Dougl.) were established in the spring of 1982 through cooperation with the USDA Forest Service's Northeastern Forest Experiment Station and the Maine Forest Service. Western white pine has proven to be resistant to the white pine weevil (*Cipissodes strobi* (Peck)) in southern Maine. The two plantations established in 1983 will test the suitability of this species for planting in northern and western Maine. Both plantations contain 60 to 80 half-sib families from selected parents in the northern Rocky Mountains, primarily Idaho and Montana. Information on growth rate, weevil resistance, and susceptibility to white pine blister rust will be gathered as the trees mature.

Black Spruce Seed Collections

Seed collection from selected black spruce [*Picea mariana* (Mill.) B.S.P.] began in August 1983 and will form a base for the establishment of a black spruce seedling seed orchard. Seeds were collected from 79 trees in 22 different stands. Because trees in some parts of the state produced no seed in 1983, collections will be made again next year to increase the number of families available for inclusion in the seedling seed orchard.

Jack Pine Provenance Test

Two plantations containing 29 seed sources of jack pine (*Pinus banksiana* Lamb.) from the northern United States and southern Canada were measured at the end of the 1983 growing season. Trees in the Deblois plantation are seven years old from seed, while those in Dyer Township are eight years old. Growth in both plantations has averaged approximately 1.0 ft (0.3m) per year, with the fastest-growing seed sources being 11 to 13 percent above plantation mean heights in 1983 (Table 11). Seed sources #507, #505, #502, and #509 were at least 6 percent taller than the plantation mean at both sites. Trees from the two New Brunswick seed sources were below average in height at both sites.

Table 11. Relative performance of 29 seed sources
of jack pine in two Maine plantations,
at the end of 1983 growing season.

State or Province	Seed Source #	Percent of Mean Height	
		Dyer Twp.	Deblois
Manitoba	503	1.13	0.95
Michigan	502	1.12	1.08
Ontario	507	1.09	1.07
Wisconsin	505	1.06	1.08
Michigan	509	1.06	1.07
Wisconsin	506	1.06	1.05
Wisconsin	140	1.06	0.94
Ontario	146	1.04	1.04
Wisconsin	139	1.03	1.11
Ontario	149	1.03	0.89
Ontario	155	1.02	0.94
Wisconsin	508	1.01	1.10
Ontario	147	1.01	1.07
Ontario	157	1.01	1.04
Ontario	148	1.00	0.98
Michigan	141	0.98	0.98
Ontario	142	0.98	0.89
Ontario	153	0.96	0.95
Quebec	154	0.96	0.95
Michigan	158	0.95	1.05
Ontario	152	0.94	1.00
New Brunswick	151	0.94	0.97
Ontario	150	0.94	0.94
Wisconsin	504	0.94	0.94
Ontario	145	0.93	1.01
Quebec	143	0.91	0.77
Ontario	156	0.89	1.01
New Brunswick	144	0.81	0.97
Plantation Mean	Height (ft)	8.7	6.7
Range of Provenance	Means (ft)	7.1-9.9	5.2-7.5
	Age (yrs)	8	7

SPRUCE BUDWORM GROWTH IMPACT STUDY

Dr. Thomas B. Brann
 Dr. Dale S. Solomon

There has been a significant change in the spruce -fir resource of Maine since the initiation of the Spruce Budworm Growth Impact Study in 1975. A major portion of this change has been caused either by defoliation of host tree species by the spruce budworm [Choristoneura fumiferana (Clemens)] or by management practices intended to reduce the impact of the budworm on the forest. Table 12 illustrates the change in stand composition observed since 1975.

Table 12. Stocking of red spruce (*Picea rubens* Sarg.), black spruce [*Picea mariana* (Mill.) B.S.P.]> white spruce [*Picea glauca* (Moench) Voss], and fir [*Abies balsamea* (L.) Mill.] for 1975, 1980, 1981, and 1982, by forest cover type.

	1975	1980	1981	1982
-i-rtf				
SOFTWOOD :				
Fir	150	113	98	77
Spruce	136	130	128	123
MIXEDWOOD:				
Fir	104	88	81	77
Spruce	56	54	54	55

The fir component of the softwood cover type has been reduced to 52 percent of the 1975 level, and the fir component of the mixedwood cover type has been reduced to 75 percent of the 1975 level. Decline of spruce has been much less severe in both cover types.

Additionally, the data indicate a significant reduction in the accretion per acre since 1975 (Table 13). Two factors are largely responsible for the reduced accretion: fewer merchantable trees remain after spruce budworm -caused mortality (especially in fir), and the cumulative effects of continuous spruce budworm defoliation.

Table 13. Basal area accretion (all species) for 1976, 1980, 1981, and 1982 by forest cover type.

Forest Type	1975-76	1979-80	1980-81	1981-82
-ft ² /ac-				
Softwood	2.97	1.91	1.95	1.51
Mixedwood	3.32	2.07	2.30	2.17
Combined cover type	3.10	1.96	2.08	1.76

REGENERATION ASSESSMENTS USING AERIAL PHOTOGRAPHY

Dr. Marshall D. Ashley

This project has proceeded as planned during 1983. Both 9 -inch and 70mm color infrared photos were obtained early this spring over several stands in northern Maine representing recently cut (0 -2 years since harvest)* early regenerating (5-15 years since harvest) , and overtopped stand conditions. The photography was of good quality and at three scales, 1:1,200, 1:3,600 and 1:12,000.

Warren Cohen, Graduate Research Assistant in Forestry, spent most of the summer designing and carrying out the field work to determine if regeneration could be assessed successfully. Before the field work began a good deal of background work, literature search, and consultation with those already involved in ground surveys of regeneration was done to determine what regeneration information should be obtained from the photos.

Warren measured several hundred ground plots over the three photographed regeneration condition classes. Data analysis is underway. His initial impression is that the 1:1,200 photos can be used to provide very accurate assessments for 5-15 years old stands, and that the other scales can be successfully used under some conditions. More definitive results should be available within a few months.

An experimental regeneration-release area in T4R12 which had been sprayed with herbicides was flown, and 1:3,600 and 1:12,000 photos successfully obtained early this fall. This area is part of a site being studied by Dr. Maxwell McCormack, Jr. At present, only limited field work has been done on this site. However, it appears that there is a high probability that color infrared photos can be used to assess the efficacy of herbicide spray operations. This aspect of the project will be continued next summer with additional photo coverage and more extensive field work.

1983 PUBLICATIONS RESULTING FROM

RESEARCH SUPPORTED BY THE CFRU

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- _____, and M.W. Houseweart. 1983. Sticky-board trap for measuring dispersal of spruce budworm larvae. USDA For. Serv. Northeastern For. Exp. Stn. Res. Paper NE-526: 7 p.
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- Eavy, A.L. Working Group Panel -taxonomy at cone and seed insect working party conference IUFRO S2.07-01. Athens, Georgia, August 1-6, 1983.
- _____, and G. Simmons. A computer-assisted reporting system for biting pests in Michigan's Recreational Areas. Paper presented at the National Entomological Society of America Meeting, Detroit, Michigan, Nov. 28 -Dec. 2, 1983.
- Houseweart, M.W. Participated in Working Group Meeting at National Interdisciplinary Biological Control Conference. Feb. 15 -17, 1983. Las Vegas, Nevada.
- _____. Univ. of Maine host and coordinator for presentations of forest entomology research to People's Republic of China delegation (Office of International Cooperation and Development); Chinese Forest Insects IPM Investigation Team (Presented: Trichogramma research in Maine) August 22, 1983, Orono, Maine.
- _____, M.W. Insect Pest Management for Christmas Trees, Northeastern Forest Insect Work Conference (Panel Member). March 10, 1983, Portland, Maine.
- McCormack, M.L., Jr. Update on the herbicide Garlorr⁹. Pesticide recertification presentation to Maine Christmas Tree Assn., Augusta Trade Show. Jan. 18, 1983.
- _____. Use of herbicides in forestry. Maine Board of Pesticide Control, Training for recertification. Feb. 23, 1983.
- _____. Herbicide use in forestry. Seminar Presentation (invited). University of New Brunswick, Fredericton. April 6, 1983.
- _____. Forestry field tour conducted for Wildlife Management Summer Camp, UMO. May 17, 1983.
- _____. Participant, 32nd Forest Management Division Training Academy, Maine Forest Service (invited). Field tour of whole tree chipping operations. Sept. 14, 1983.
- _____. Vegetation management in forestry (invited). Presentation to Northeastern Technical Division, American Pulpwood Association Inc. Sept. 22, 1983.
- _____. Application systems for herbicide application (invited). Presentation to Annual Meeting, Atlantic Vegetation Management Association. Oct. 5, 1983.

_____. Consequences of herbicide use in Maine forests. Forestry Graduate Student Seminar, UMO. Oct. 25, 1983.

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_____. Defects and tree quality of northern hardwoods. Field tour presentation to the Forest Products Marketing and Manufacturing Association, Sebec, Maine, June 19, 1983.

_____. Minimizing taphole damage to sugar maple trees. Presentation to the Maine Maple Syrup Products Association, Augusta, Maine, Jan. 20, 1983.

_____. Damage to sugar maple trees from tapping for maple sap. Presentation, Penobscot County Extension meeting, Bangor, Maine, March 2, 1983.

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Seymour, R.S., D.T. Edson, and D.G. Mott. A workshop on the Green Woods wood supply model., (co-sponsored by CANUSA) March 15 -16, 1983, Univ. Maine, Orono.

_____. Co-leader, (with Dr. Benjamin Hoffman). Graduate Seminar on Advanced Timber Harvesting. Univ. Maine College Forest Resources, Spring Semester, 1983.

_____. Long-term effects of the spruce budworm outbreak in Maine. Univ. Maine College Forest Resources Wildlife Noontime Seminar, May 3, 1983.

_____. Review of 1982 commercial thinning study (slide presentation and field tour). Given to: Cont. Educ., Maritimes Forest Ranger School, Silviculture III, June 7-9, 1983.

_____. Spruce-fir management in Maine (field tour). Given to: G.L. Baskerville (Univ. N.B.), C.S. Binkley (Yale Univ.), D.S. Powell (U.S. Forest Service), T.A. Rumpf (Maine Forest Service). July 6, 1983.

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Welty, C. and M.W. Houseweart. Regeneration weevil research in Maine, Northeast Forest Pest Council. March 8-9, 1982, Portland, Maine.

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**COOPERATIVE FORESTRY RESEARCH UNIT ADVISORY COMMITTEE
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The CFRU Advisory Committee sets priorities and reviews proposals for the Cooperative Forestry Research Unit. Members active during all, or part, of 1983 were:

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Barton M. Blum, Project Leader, U.S. Forest Service
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(December 31, 1983)**

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Peter Caron, Research Technician (Tree Improvement)
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