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COOPERATIVE FORESTRY RESEARCH UNIT
ANNUAL REPORT - 1980

Nineteen hundred and eighty (1980) continued the excellent progress and performance of the Cooperative Forestry Research Unit. In addition to the research efforts directly funded by the CFRU cooperators, good progress was also made in the research efforts which were originally funded by specific cooperator donations prior to the formation of the CFRU in 1975. Both CFRU scientists and faculty members of the School of Forest Resources have presented specific results to the CFRU Advisory Committee and to cooperators and the general public via publications. Progress reports on specific areas of research are included as part of this 1980 Annual Report.

During 1980, the membership of the CFRU Advisory Committee was expanded from 8 members to 11 members. We welcome Mr. Dwight Newman, Mr. Oscar Selin, and Mr. Richard Griffith to the committee.

At our quarterly meeting in December 1980, Dr. Charles Webb was elected as our new Chairman and Mr. Richard Griffith was elected as our new Secretary.

In the past year our present organization, the Forest Resources Research Advisory Committee (FRRAC), was reorganized. As a result, what was formerly the CFRU Sub-committee of FRRAC has now become the CFRU Advisory Committee. Although we are no longer a Sub-committee of FRRAC, our ties to them are still intact for purposes of coordinating our research efforts. We do, however, enjoy more autonomy and greater operational efficiency as a separate committee. In past years our annual report has been a joint report with FRRAC. This year as a result of the organizational change, we have prepared a separate CFRU Annual Report. Mr. John Hartranft and Mr. Temple Bowen are the liaison between FRRAC and the CFRU Advisory Committee.

The 1981-85 research proposal is extremely significant. We will need an expanded level of financial support in order to fully implement the proposed program. We urge current and prospective cooperators to reap the benefits that the CFRU can provide by financially supporting the program.

During 1980 a special effort has been made to contact Cooperators to solicit financial support for the second 5-year program (1981-1985) of the Cooperative Unit. A special meeting with potential cooperators interested in hardwood utilization and research was arranged and hosted by Mr. Henry Saunders. We express our appreciation to Henry for this fine effort which has resulted in a number of new cooperators joining the unit.

Two additional scientists joined the Unit during 1980. Dr. Thomas Brann has taken on the responsibility for management of the spruce budworm growth impact studies and Dr. Katherine Carter has replaced Dr. David Canavera as forest geneticist for the Unit.

As Chairman of the CFRU Advisory Sub-committee, I am convinced that the CFRU has matured substantially in its first 5 years and that the unit has demonstrated that it "has arrived" as a significant contributor to forest resource management in Maine. I look forward to continued expansion and major contributions by the unit. I urge present and prospective cooperators to vigorously

support this unique opportunity to move forward in our understanding of the productive management of Maine's most important natural resource.

H. M. Klaiber, Chairman
CFRU Advisory Committee

REPORTS ON PROJECTS BY CFRU SCIENTISTS

SILVICULTURE PROGRAM - Dr. Maxwell L. McCormack, Jr.

Intensive Forest Harvesting, Residue Management Practices, and Nutrient Cycling in the Spruce-Fir Type of North-Central Maine:

C. Tattersall Smith, Jr., Ph.D. student, initiated this study in 1979. This research is in cooperation with the U.S. Forest Service and Great Northern Paper Company on a pair of watersheds located in the southwest corner of T4R12 WELS on the east side of Chesuncook Lake. It will evaluate different residue management alternatives on short-term nutrient cycling and on long-term site nutrient capital following whole-tree harvesting by feller-forwarder.

The treatment watershed (118 acres) will be harvested in the spring of 1981. Road construction for the planned harvest was completed in July, 1980. Water samples have been collected for chemical analyses at two locations on each stream since May, 1979. Permanent 0.04 ha (20m x 20m) study plots have been established; 12 on the treatment watershed, four on the reference watershed. Species composition estimates from the 12 treatment watershed plots are 48 percent spruce, 42 percent balsam fir, seven percent hardwoods (red maple, yellow birch, paper birch, striped maple), and three percent other conifers (white cedar, white pine, hemlock). Dissection of 40 trees (20 spruce and 20 fir) for confirmation of biomass equations was completed during summer, 1980.

Descriptions of soil pedons using Soil Conservation Service standards have been completed at the twelve treatment watershed plots. The predominant soil type is the Telos-Coffeelos association which is somewhat poorly drained, and poorly drained deep glacial till soils with hardpans on gentle slopes. Samples of the organic horizons (O-j and O2) have been taken at 144 locations associated with these plots. The Oj horizons averaged 2.63± 0.41 cm deep and the O2 horizons averaged 4.24± 1.55 cm deep. Chemical analyses of these samples are in progress.

Porous ceramic cup tension lysimeters were installed at depths of 25 cm and 50 cm on the study plots during November, 1979. Soil solutions were sampled once a month from May through November, 1980. Calcium and nitrate concentrations have been evaluated. These measurements, as well as other components of the nutrient cycle will be continued through the harvesting operation and into the development of the next stand.

Regeneration present, and stand development, will be studied along transects which have been located across the watersheds. This will provide an opportunity to observe the fate of different types of advanced regeneration following harvest.

Thinning Spruce and Spruce-Fir Stands

During 1980 Frank J. Conlon, Jr. (Boise-Cascade Fellow) completed his M.S. thesis (Conlon, 1980). This report is an evaluation of stem and crown analysis data from 51 red spruce, 26 balsam fir, and 18 black spruce on twelve sites across nine townships in western, northern, and eastern Maine. At time of release, diameters one meter above the ground for the largest trees measured were red spruce 28.9 cm (11.4 in), black spruce 25.7 cm (10.1 in), and balsam fir 19.2 cm (7.6 in).

Prediction equations were developed for each of the three species. These show significant variables for predicting basal area increment and percentage response in basal area growth after release.

Total tree age did not limit significantly the ability of trees to respond to release from competition. Size (diameter and height) was a more reliable predictor. Comparisons are made between smaller and larger trees within the population studied. Proportional response in basal area was greatest from smaller, slower-growing trees of each species. The five-year basal area growth rate doubled in red spruce, tripled in balsam fir, and nearly doubled in black spruce. Interpretation of data from this phase of the thinning research must recognize that study trees were residuals from past cuttings and were probably inferior to selected crop trees in a planned thinning.

Selecting a potential crop tree on the basis of live crown appears to be a good rule of thumb. Shorter-crowned trees (probably less than 30% live crown ratio) do not have the capacity to take immediate advantage of enlarged growing space. This is especially true when total height approaches maximum height attainable on a site, leaving no room for upward crown expansion. Work is underway to publish a summary of this work during 1981.

The long-term phase of the thinning research has continued with inclusion of an additional study site in Nashville Plantation. This area will incorporate a commercial harvesting operation through cooperation with Seven Islands Land Company.

Data collection from study trees on the four initial study sites previously reported has been completed and field checked. Referenced by location and species, individual study trees are computer recorded for the following characteristics at the time of their release:

- (1) Total height,
- (2) Length of live crown,
- (3) Live crown ratio,
- (4) Length of clear bole,
- (5) Diameter at breast height,
- (6) Tree condition - deformities and defects,
- (7) Crown radii: north, east, south, and west,
- (8) Crown condition - size and shape,
- (9) Number of competitors, and
- (10) Azimuth and distance to each competitor.

These data will serve as a basis for evaluating responses of the individual trees following their selection as crop trees in our thinnings of 1978. The following table is an updated summary of study trees for which characteristics have been recorded.

UPDATED SUMMARY OF INDIVIDUAL EVALUATION TREES ON
FOUR LONG-TERM THINNING STUDY SITES

Study Site	Red Spruce	White Spruce	Black Spruce	Balsam Fir	Total
1. Lakeville Plantation	120	—		15	135
2. Rowel 1 Brook	181			14	195
3. Scott Brook	40	18	15	14	87
4. Clayton Lake	69		72	—	141
Total	410	18	87	43	558

The size distribution, by species, of the individual study trees is summarized in the following table.

SUMMARY OF DIAMETER DISTRIBUTION, BY SPECIES,
OF INDIVIDUAL EVALUATION TREES ON
FOUR LONG-TERM THINNING STUDY SITES

Species	Diameter classes (cm)							Total
	10	11	12	13	14	15	16	
1. Red spruce	1	32	10	16	70	25	7	410
2. White spruce	—	11	7	—	—	—	—	18
3. Black spruce	—	17	54	16	—	—	—	87
4. Balsam fir	—	7	11	11	10	2	2	43
Total	1	67	178	19	80	27	9	558

Aerial Application of Herbicides for Management of Undesirable Vegetation in Maine Forests

During 1980 the treatment blocks of the Austin Pond (Scott Paper Company) and Alligator Lake (St. Regis) study sites were evaluated. This carried appraisal of the treatments through the third growing season. Efficacy of the glyphosate (Roundup^R) and triclopyr (Garlon^R) treatments has held up well releasing natural regeneration of red spruce, white spruce, balsam fir, and eastern white pine from a broad spectrum of undesirable woody species. A report on triclopyr for release was presented at the Northeastern Weed Science Society annual meeting (McCormack, Hendler, and Sprague, 1981).

Cooperative efforts toward mutual objectives have been continued with Dr. Thomas Saviello on the Northern Experiment Forest of International Paper Company in Rowland. Two subjects of study have produced results of special interest. Glyphosate applications should not be applied after fall coloration or first frost; the third week of September would be the latest possible period for silvicultural effectiveness (Saviello, McCormack, et al., 1980; Saviello, McCormack, and Blanck, 1981). Combinations of glyphosate and triclopyr in volumes as low as one pint plus one pint per acre have shown excellent possibilities for site preparation (McCormack and Saviello, 1981). This treatment can provide an effective broad spectrum control with no soil residuals at significantly reduced costs.

In addition, cooperative efforts have resulted in further evaluations of hexazinone (Velpar^R), including the gridball pellet formulation (Saviello, Sprague, et al., 1981). Sufficient interest and data have resulted to justify efforts toward a label for the State of Maine. The gridball applications are easily administered by hand, no equipment needed, and have been effective on aspen, brambles, and stump sprouts.

In early September, through cooperation with Georgia-Pacific and Dow Chemical, an aerial application trial was conducted. This was one of three study sites nationally for operational studies of a new nozzle system designed for brush suppression with greatly reduced risks of drift. This is another progressive step to assure accurate delivery of herbicide treatments in forest management.

Publication of past work on simazine (Princep^R) residues in soils was also completed (Flanagan and McCormack, 1981). Though this research did not receive direct support from the CFRU, fate-in-the-environment data are important and simazine is of interest for its value in plantation establishment in grassy vegetation.

Within the framework of the herbicide research program, Dr. McCormack worked with a subcommittee on herbicides from the Paper Industry Information Office. This resulted in effective interactions in the formulation of the new Maine Board of Pesticides Control. Organization of an herbicide training program for industry foresters and its execution was the primary product of this participation. A financial contribution to the silviculture operating budget was made in return for the training program efforts.

By invitation, Dr. McCormack participated in a workshop on herbicides in the boreal forest in Toronto, Canada and served on the Steering Committee for the 1981 Wright Conference, Weed Control in Forest Management, to be held at Purdue University.

Teaching

Necessitated by Dr. Canavera's resignation, approval was given for Dr. McCormack to teach Fy 10, Forest Planting, during the fall semester. This teaching was carried out with no reduction in the total research effort. During this period he served as Chairman, Search Committee to replace Dr. Canavera. In addition to the two graduate students previously mentioned, committee participation has been carried on for two M.S. students in forest genetics, three M.S. students in wildlife, and two Ph.D. students.

MARKETING, UTILIZATION, AND ECONOMICS - Dr. David B. Field

Public Benefits Project

Research into public benefits from private forest land ownership and management remains my highest-priority work. This project is so large that progress seems slow, but much was accomplished during 1980.

Two publications were completed during the year: The Economic Importance of Maine's Spruce-fir Resource and Highlights of Maine's Timber Economy. The first of these was previewed in last year's Annual Report. The findings, in brief, included the following: More than half of the six million cords of timber harvested annually in Maine is spruce and fir. Fifty-eight percent of the stumpage value of all timber cut in the state during 1978 was accounted for by these species. The state's leading manufacturing industry—pulp and paper—depends heavily on this forest resource, and the production of spruce-fir lumber has become a major enterprise in recent years. The spruce-fir supply is now severely pressed by the demands of existing mills and losses caused by an epidemic infestation of the eastern spruce budworm. Forecasts of spruce-fir demand show a potential increase from the 2,839,000 cords expected to be harvested for pulpwood and sawlogs in 1980 to 3,981,000 cords in the year 2020, but it appears unlikely that such a level could be supported even under intensive management.

The second publication summarizes some of the most recently-available statistics on the forestry and forest products sectors of Maine's economy, and emphasizes the relative importance of timber-based products to the state as a whole. Maine is the most heavily-forested (90%) state in the U.S. and contains a higher percentage (98%) of privately-owned forest land than any other state. It ranks first in the Nation in acreage of industrial forest land (More than 12 percent of all of the commercial timberland in the U.S. that is owned by forest industry is located in Maine.) and leads in paper production capacity. During 1979, 5,396,000 cords (73% softwood, 27% hardwood) of timber were cut in the state, of which 3,178,000 cords were pulpwood and 2,218,000 cords were sawtimber.

In 1979, Maine's 1,100 timber processors employed 33,950 workers and paid gross wages of \$468,361,000. The value added in manufacture during 1977 by the state's paper and solid wood products firms totaled \$965,600,000. The total value of product shipments from these firms in 1978 was \$2,413,943,000. From 1970-1978, the industry spent an average of \$168,500,000 each year for plant modernization and equipment in Maine. Maine's wood processors employ 28.9 percent of the state's manufacturing workers (7.9 percent of all workers), pay 37 percent of all Maine manufacturing wages, account for 41 percent of all the value

added in Maine manufacturing, and 42 percent of the value of all manufactured goods produced in the state. From ratios developed for earlier years by the U.S. Forest Service, I have estimated that the \$72,000,000 worth of stumpage cut in Maine during 1978 indicates a total value added to Maine's economy attributable to timber in that year of \$1,440,000,000.

The ultimate objective of the public benefits project is to model the relationship between Maine's forest economy (all economic activities based on Maine's forest resources) and the state's general economy. The data requirements of the project are very large. We are in the process of gathering thirty-year time series on nearly 400 variables relevant to this study. These raw data are being used, in turn, to generate other series needed for the analysis. (For example, all dollar-value data sets have been deflated by appropriate price indices to produce time series free of the influence of inflation.) By the early summer of 1981, we expect to publish information based on these data sets, along with the data, in a paper entitled "Trends in Maine's Forest Economy". Figure 1, a comparison between the current-dollar (including inflation) and constant dollar (adjusted for inflation) average gross wages paid in Maine's forest products industries from 1949-1978, illustrates the kind of material that will appear in that publication.

Forestry Investment Analysis/Forest Taxation

Several times during the past few years I have been asked to speak to groups of foresters and forest landowners on the subjects of timber taxation and forestry investment analysis. During 1980, I made such presentations in Portland at a Cooperative Extension Service meeting for owners of small woodlands, for the Maine Forest Service's Annual Training Academy, and to the Forest Products Management and Marketing Association in Dover-Foxcroft. Several industrial foresters have also expressed a great deal of interest in these subjects and have called me from time to time for information.

The material I've prepared for these talks should be of interest to a much wider audience than it has reached to date. Accordingly, I spent some time during 1980 working on basic references for both the capital gains taxation of timber income and forestry investment analysis. The first paper is still in very rough draft but the latter (An Introduction to the Financial Analysis of Forestry Investments—with Illustrations from Small Woodlands in Maine) is in review draft and should be published in March, 1981. This research bulletin deals with basic cash flow analysis, the cost of money, choosing an interest rate, incorporating effects of inflation and taxation into investment analysis, and the sensitivity of such analysis to changes in data values.

I have also continued an interest in Maine's Tree Growth Tax Law and testified at the capitalization rate hearing in January of 1980.

Losses of Commercial Timberland

Graduate student David Edson has been working to develop a procedure for measuring the area of land that has been removed from commercial timber production by either absolute conversion to other uses or by regulations that limit or prohibit timber harvest. Maine's unorganized territory is the focus of

AVG. GROSS WAGE

CURRENT \$'S

CONSTANT \$'S

- : LUMBER AND WOOD PRODUCTS
- : FURNITURE AND FIXTURES
- △ : PAPER AND ALLIED PRODUCTS
- + : ALL MAINE MANUFACTURING

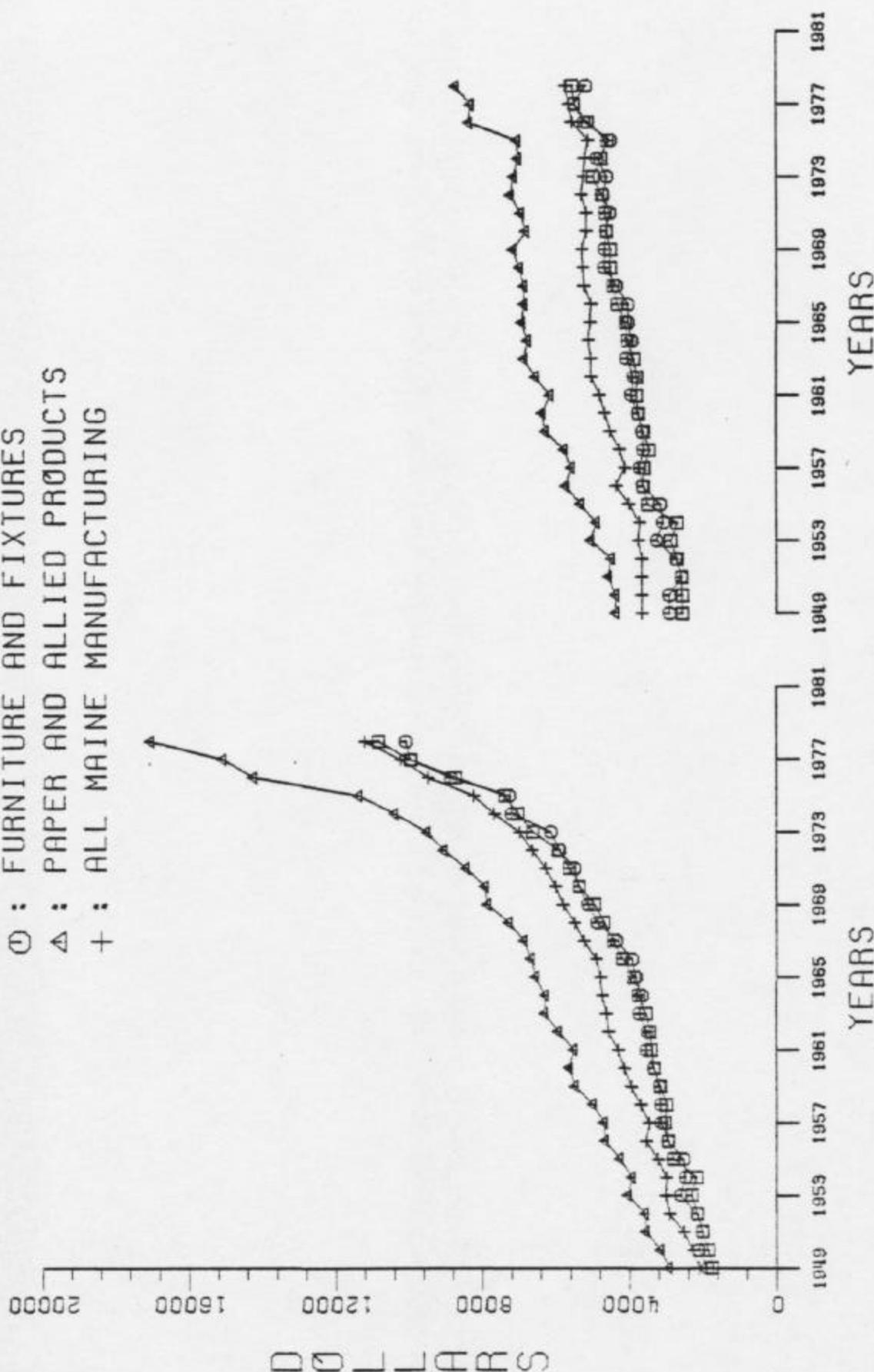


Figure 1. Trends in average gross wages paid by Maine's forest products industries.

this work, but the objective is not so much to determine the actual extent of land use changes as to develop a methodology for doing so. A single township is being used to demonstrate the application of the procedure. This project is supported by the CFRU only to the extent that my time is required for supervision as chairman of Edson's graduate committee. The work will probably be completed during 1981.

Charcoal Research

In last year's annual report I suggested a total low-grade hardwood utilization system which might include charcoal-powered logging and hauling equipment. Assistant Forest Technologist Paul Messier has drafted a paper entitled Portable Gas Producers which reviews the literature on the use of producer gas from wood, charcoal, or coal to power motor vehicles. This will be published as a CFRU Information report sometime during 1981.

Simulation of Regional Timber Markets

My doctoral research some years ago produced a large computer model designed to simulate the interactive behavior, over time, of the firms involved in the processing and exchange of all wood-based products in a defined market region. I proposed in 1978 that my CFRU work include adapting the model to the UMO computer system, preparing a user's manual, and validating the model through tests on an existing Maine market region. This project has been given low priority, but I have found the time to adapt the simulator to the UMO system and, during 1980, prepared a draft of a user's manual.

FOREST PROTECTION - Dr. Mark W. Houseweart

Life Tables of the White Pine Weevil in Central Maine (ms in preparation)

In completing his Ph.D. degree, Wayne N. Dixon, has constructed life tables for 3 generations (1977-1979) of the white pine weevil near Lamoine, Maine. This study was done to determine the mortality factors that influence changes in a weevil population infesting a white pine plantation. Typically, female weevils oviposited approximately 140 eggs/terminal leader of a host tree. The following spring, however, less than 2 progeny adults remained alive. The population trend appeared to be determined by survival of larvae, pupae, and winter adults. Principal mortality factors of these age-intervals were intraspecific competition of larvae, natural enemies and pitch-drowning of larvae and pupae, and abiotic elements acting against overwintering adults. Additional mortality was observed during the egg stage, adult brood emergence, and adult dispersal to overwintering sites.

Intraspecific competition mortality of the larvae for food and space within a leader seemed to function in a density-dependent manner, based on comparative analysis of weevil-infested leaders with natural enemies and leaders in which natural enemies were excluded. The importance of natural enemies was

substantiated by the excluded treatment leaders, because compensatory mortality did not result from increased intraspecific competition mortality and/or an apparent crowding mortality as would be expected. In addition, an insect predator (*Lonahaea aortic-is*) and 2 parasites (*Eurytoma p-issodis*, *Doliohotomitus terebrans nubilipenn-Ls*) appeared to exhibit a positive inter-generational response, i.e., species density increased during the 3-year monitoring period.

The average overall generation survival (GS = 0.008) of the experimental weevil population substantiates observations that a weevil population increases at a slow rate within a plantation. Total generation mortality (K) increased each year (K = 1.86/1977, 2.04/1978, 2.06/1979). The decreasing proportional rate of change in weevil infestation rate/year apparently reflects this trend as well: 82%/1977, 88%/1978, 89%/1979. Principal factors in the increasing K were the submortalities of the larval, pupal, and winter adult age-intervals.

The apparent importance of larval, pupal, and winter adult submortalities to total generation mortality suggests an emphasis on population suppression methods at these times to most influence weevil populations. Potential control methods might include biological control, resistant trees, and destruction of overwintering weevils/sites. The results of this investigation also point out the notably low mortality of weevil eggs and the lack of information on the actual fate of fall adults before overwintering.

Spring Temporal Activity of the White Pine Weevil in Central Maine (ms in preparation)

While collecting life table data, Wayne N. Dixon also monitored the spring behavioral activities of the white pine weevil from April to August 1979, and obtained the following results.

Spring adult weevils emerged from overwintering sites in late April, peaked in numbers/tree by mid-May, and none were found on host trees by early July (Figure 1). Activity of the spring weevils was highest in the late afternoon-early evening (1300, 1700 h checktimes) and decreased to low levels until the following morning (2100, 0100, 0500 h checktimes). The weevils occupied the terminal leaders of host trees the first 2 weeks of monitoring, but towards season's end were found more often on first whorl lateral branches.

Additionally, Figure 1 points out the importance of timing when using spring insecticide treatments on the terminals of white pine for suppression of white pine weevil. One should not wait until the population peaks (ca. May 11), but rather time spraying to occur before first weevil presence in mid-late April. This should reduce or prevent oviposition by gravid spring females.

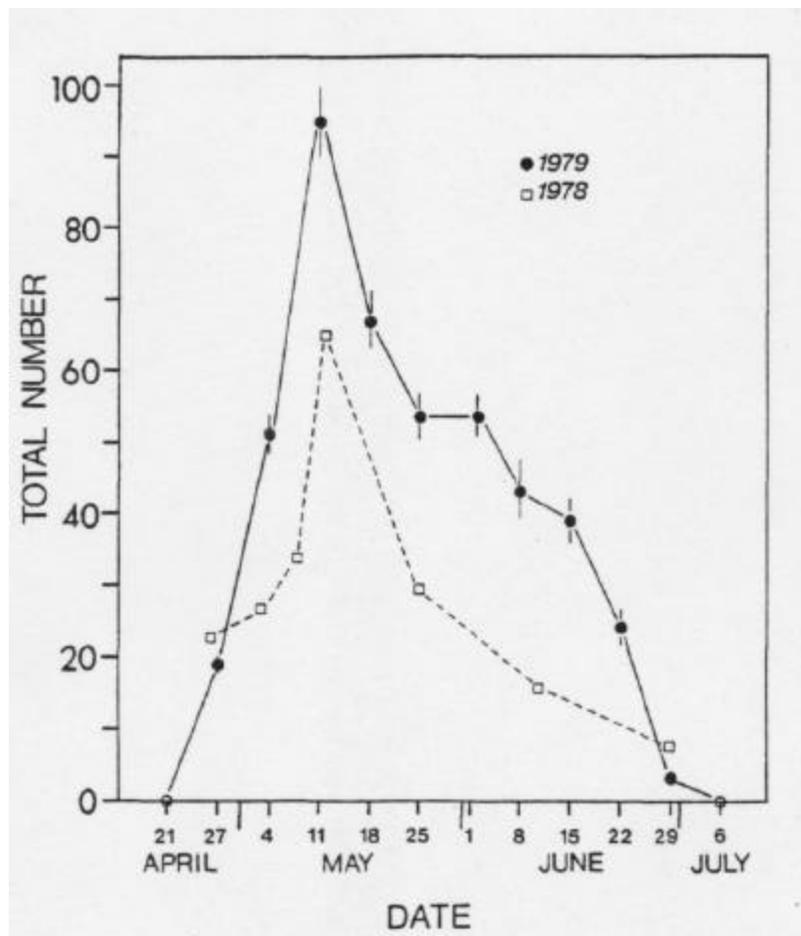


Figure 1. Seasonal numbers of white pine weevils on 20 host trees during 1978 and 1979. Based on weekly, 24-hr monitor periods for 1979, n = 3,470 observed weevils; intermittent counts for 1978, n = 717 observed weevils.

Length of current-year growth of terminal leaders was influenced by the magnitude of weevil damage or attack as depicted in Figure 2 for no (N)₅ partial (P), and complete (C) weevil attacked trees. Highest levels of adult and immature weevil damage (i.e., complete attack) resulted in leader mortality. Leaders that sustained an intermediate level of weevil damage (P-trees) remained alive; however, length of new growth was significantly less than leaders with almost no weevil damage.

Initially on 4 May, the numbers of adult weevils on all three types of trees were similar. By the third week of monitoring (May 18), differences were being manifested as follows:

Type of Attack (Tree)	Np	Mean . Weevils	Mean Ovipositional Sites	Mean Feeding Sites	August Progeny Success
Complete (C -Tree)		7.5	131.8	121.1	Brood
Partial (P -tree)		3.7	47.4	8.7	None
None (N-tree)		1.0	0.0	0.0	None

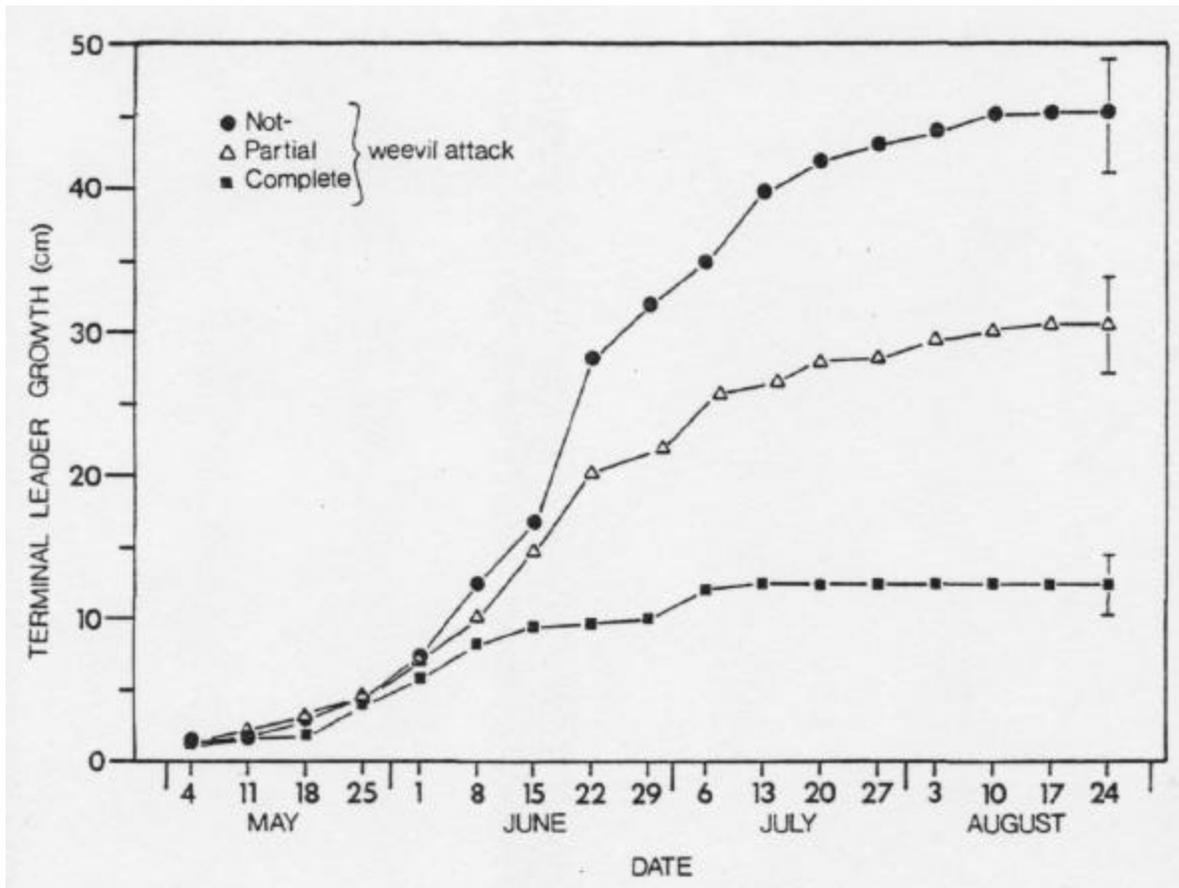


Figure 2. Length of new growth exhibited by host tree terminal leaders attacked at 3 levels of adult and immature weevil activity. Based on 10 C-trees, 6 P-trees, and 4 N-trees.

Predominance of weevils on the C-trees continued until the 7th week (15 June), as shown in Figure 3. For the following 3 weeks of monitoring, more weevils were observed on the P-trees than the C-trees. This was probably due to the reduced suitable feeding and/or oviposition areas as a result of utilization of the cambial tissues by the immature weevil larvae.

Leader mortality and significant reduction in potential height growth of white pine due to the white pine weevil has been well documented. However, the occurrence of substantial growth retardation due to unsuccessful weevil attacks (P-trees) which produce no adult brood may be more noteworthy and stresses the importance of this pest of white pine. The causal mechanisms of apparent aggregation of adult weevils on certain selected host trees (C-trees) prompts continued interest. More importantly, the mechanisms that have led to the N-trees sustaining low levels of weevil attack and damage, whether they be chemical, physical, or induced by weevil pheromone(s)/host tree odor complexes, warrant investigation.

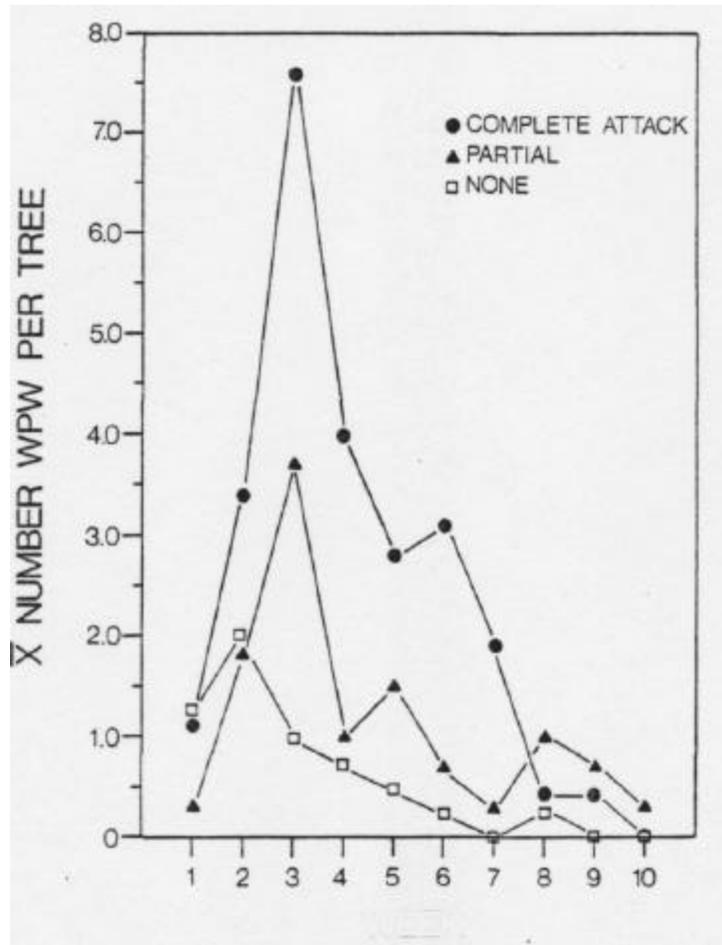


Figure 3. Average number of weevils observed on 3 types of host trees from April 27 through June 29, 1979. Based on 10 C-trees, 6 P-trees, and 4 N-trees.

Suppression of White Pine Weevil Population - Three pilot studies: Controlled burns, litter raking and litter insecticide treatments (1979-1980)(James P. Southard and W.N. Dixon)

Results from the life table studies have pointed to the fall and winter mortality as areas of concentration for suppression of the white pine weevil.

Controlled Burn and Litter-Rake Treatments, 1979-1980

The 1979 controlled burn and litter-raking experiment was conducted in two 18-year-old white pine plantations near Bethel, Maine. Two 0.1-acre and one 4.5-acre burns were performed, which incinerated the litter above the fermentation layer for 20 cm from each tree bole. There were four 0.05-acre and one 0.35-acre litter-rake treatments. In these plots, all litter was removed from around the tree boles (with a fire rake) a minimum of 20 cm and to the depth of the mineral soil.

Results from the litter-rake experiment are shown below (% = annual weevil infestation rate):

Year	Treatment (rake)	Control	Difference
1977	66.00%	63.00%	3.00
1978	65.50%	72.00%	-6.50
1979	70.50%	69.50%	1.00
Pre-trmt X (1977-79)	67.33%	68.16%	-0.83
Post-trmt X (1980)	56.75%	67.50%	-10.75
Difference	-10.58%	-0.66%	- 9.92

Within the control plots, a comparison of the mean percentage weevil infestation for the three pre-treatment years of 1977-79 (68.16%) vs the post-treatment year 1980 (67.50%) showed no significant differences. However, this comparison did detect a slight natural decrease (0.66%) in weevil infestation for the control plots.

When comparing pre-treatment years (1977-79) with post-treatment year (1980) for the litter-rake plots, the means are respectively, 67.33% and 56.75%. Although the difference was not significant, trends indicate approximately a 10.6% decrease in weevil infestation in the raked plots for a total net reduction of 9.92% in post-treatment year (1980).

The 1979 controlled burn experiment results are as follows (% = annual weevil infestation rate):

Year	Treatment (burn)	Control	Difference
1977 1978	76.39%	56.50%	19.89
1979	73.61%	58.75%	14.86
Pre-trmt X (1977-79)	75.00%	61.25%	13.75
Post-trmt X	75.00%	58.83%	16.17
Difference	58.33%	60.00%	-1.67
	-16.67%	1.17%	-17.84

Although no significant difference exists between the means of pre-treatment control plots for 1977-79 (58.83%) vs post-treatment control in 1980 (60.00%), a slight increase of 1.17% weeviling (natural increase) was noted.

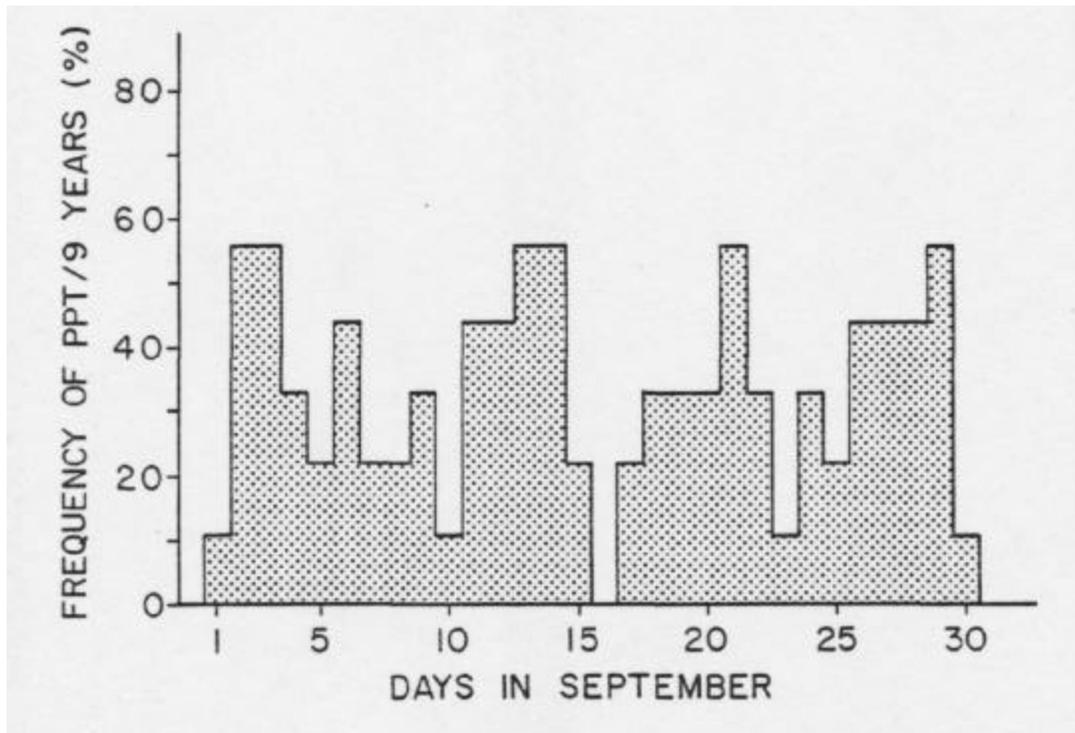
Likewise, there was no significant difference between the means of pre-treatment burn plots in 1977-79 (75.00%) vs post-treatment burn in 1980 (58.33%). But, a 16.67% decrease in weevil infestation rate indicates an encouraging trend as a result of burning in that the total net reduction in the treatment year (1980) was 17.84%. Although these reductions in weeviling percentages do not seem to be large by most control standards, the decreases may have come at the critical stage for the weevil population. In addition, these reductions were accomplished with no risk due to environmental contamination via insecticides.

In the two smaller controlled burn plots (0.1 acre each.), little difference was noted between the means of treatment vs control; however, in the larger plot (4.5-acre) a positive indication of the potentials for use of controlled burning to suppress overwintering white pine weevil populations was observed.

Controlled Burn, 1980

The 1980 fall burn attempts were discouraging at best. Problems of time delays occurred due to many reasons: obtaining landowner approval, coordination with the MFS fire wardens, checking our legal liability with the University lawyers, and the one most devastating - RAIN.

In fact after working out all the other problems, the one that terminated the burn attempts was rain. Rainfall continued sporadically into the season that made the burns (both early and late fall) infeasible. Our problems with rain led us to investigate the historical records as to the amounts of rain that would be expected during this time of year. The following graph indicates that precise timing is required to utilize this suppression method in September:



Fall Litter-Insecticide Treatment, 1980

The problems involved in conducting a controlled burn in the fall, as aforementioned, prompted an experiment on insecticide treatments of the litter. This was aimed at the suppression of the white pine weevil population as they seek overwintering sites in the pine litter beneath the trees. Also, this tactic capitalizes on all the previously occurring mortality, and concentrates suppression during the population's lowest level in the fall.

The design involves spraying 30 plots in the fall, 30 plots in the spring, and using 30 plots as controls. A total of 360 marked weevils was planted in the litter near the bases of six sample trees in each of ten fall, ten spring, and ten control plots. There are approximately 15-20 trees per plot at 6' x 6' spacing.

The fall-spray experimental plots were treated with Dursban 2% emulsifiable concentrate in water on October 16, 1980. The insecticide was applied at the recommended rate of 1# per acre. The spray was directed at the litter zone around the base of each tree bole using knapsack sprayers. The application time coincided with fall brood adults leaving the trees to seek overwintering sites in the litter. This was verified by tack-trap boards placed under the tree canopy drip line.

For preliminary results, litter was collected (N & W quadrants) from 1/2 of the six sample trees (with planted weevils) in the fall-spray plots on October 30, 1980. Likewise, the litter was removed from 1/2 the sample trees in the control plots on this date. Results from this preliminary sample collection are not yet available. During the spring of 1981, the same insecticide will be applied in the spring-spray plots. After which, both the planted and native weevils will be sampled in the fall, spring, and control plots. This experiment should provide preliminary information as to the feasibility of fall and spring litter-insecticide treatments for suppression, and provide data on which application time is more effective.

Spruce Budworm Research (Cooperation with Dr. D.T. Jennings, USFS, NEFES)

Since the 1979 Annual Report outlined our work on spruce budworm in great detail, I will only discuss the *T-richogvarma* project* and progress to-date.

Stand Measurements - The initial field work of locating and characterizing forest stands having high levels of *Tr-iahogyarma* parasitism was completed in 1980. A total of 60 field plots have now been measured, and computer analysis will proceed this winter. Intentions are to be able to identify which forest stands support high levels of *Trichogvarma* parasitism and why, in order to possibly modify other stands to enhance native parasitism levels.

**Trichogvarma minutum* is the only known egg parasitoid of spruce budworm egg masses. The project involves six objectives to increase *T. m-inutum* effectiveness and develop ways to utilize the parasitoid in suppression of the spruce budworm. (For specifics, see 1979 Annual Report.)

Alternate Hosts - As mentioned in the 1979 Annual Report, Scott Pease is coordinating this aspect of the project. Over the last two summers, Scott has collected more than 577 foliage samples from both hardwoods and conifers in his search for alternate hosts of *Trichogramma minutwn*. More than 50 specimens of this parasitoid have been verified by Carl! Goodpasture, a *Triahogramma* taxonomic specialist. We have identified the forest tent caterpillar as at least one overwintering host for the parasitoids. And the saddle prominent moth eggs on hardwoods (beech, birch, and maple) seem to be a key pre-budworm host.

Laboratory Studies - On March 31, 1980, Ms. Sue Southard was hired as a classified employee to conduct laboratory studies on the basic biology of the "Maine strain" *Triahogramma minutum*. Since that time we have maintained a colony of *T. minutwn* for research testing. In July-August of this year we rejuvenated our colony with fresh field samples of the parasitoid. Sue has conducted preliminary tests on the following to provide data to increase the practicality of aerial field releases: fecundity, longevity, sex ratio, developmental rates, spruce budworm egg-mass-age acceptability, percentage parasitism, and host-egg programming tests. To conduct these tests, temporary lab space was borrowed from Dr. S. Leach of the USDA Plant and Soil Science lab here in Orono. Some preliminary information on all these tests has been obtained; however, additional tests need to be replicated and the preliminary results verified. Interesting results thus far obtained show that 2-to 5-day-old spruce budworm (SBW) egg masses seem to be the most acceptable to *Triohogramma* in the laboratory at 80°F (SBW eggs usually hatch in 8 days). The developmental time of *T. minutum* is 8 to 12 days at 80°F, but lengthens to 22 days at 70°F, the "constant mean" temperature during a release in August. Further work will continue this winter, spring, and summer in anticipation of utilizing the results in an aerial field release during the summer of 1981.

Triahogramma Field Release - 1980

Five 10-acre blocks were established (range in basal area for balsam fir 40-59% of the total) on Georgia-Pacific ownership in Washington County. These areas were chosen since they were not sprayed in 1979 or 1980. Each 10-acre block was a minimum of 5 miles apart. Boundaries on 3 of the blocks (treatments) were made visible from the air by placing 24 orange-colored hoola hoops over the tree tops using GP's helicopter. (This required some "precision flying" on John Nichols' part-Thanks.)

Twenty-five balsam fir sample trees were located and labelled in each of five 0.2-acre circular plots inside the perimeter of each of the five 10-acre blocks. Releases in 1980 were cancelled on July 5, due to insufficient supplies of *T. minutum*. Problems developed in the production of the 45 million parasitoids for the 3 scheduled field releases. However, these same plots and blocks may be used in 1981, since no releases were made. On 28-30 July we pole-pruned 25 balsam fir and up to 5 spruce branches per 0.2-acre plot (n = 625 balsam fir and 125 spruce trees). The branches were examined for parasitism by native *T. minutum*. Although the cancellation was extremely disappointing, this turn of events will provide baseline data on native parasitism levels in these areas before the release in 1981. This will be extremely useful in assessing release effectiveness.

The 1981 plans are to utilize these same areas, and release a total of 1.5 million 2* *minutwn* per acre on a total of 30 acres.

Maine Spruce Budworm Growth Impact Study (R.K. Lawrence and M.W. Houseweart)

Since 1979 was the fifth year of the 5-year spruce budworm growth impact study, a major assessment of the project's future was conducted. A meeting of all participants resulted in the following strategy: All cooperators would continue their participation in 1980 in order to maintain consistency in obtaining the annual growth impact, mortality and defoliation data. In addition, a new proposal would be developed to encompass desired changes for the next 5-year study. After several meetings with CANUSA management personnel, S&PF (USFS) representatives, the growth impact proposal committee, Dale Solomon (NEFES, USFS), and Tom Brann (UMO, Sch. For. Resources), it seemed to us that the "new study" was becoming more and more removed from the entomological area in which we could provide assistance. Following discussions with Fred Knight and Tom Brann, we decided that Tom would be the most appropriate individual to provide future management of the growth impact study. The project primarily involves forest mensuration, and will require more sophisticated computer analysis and digitizer time which Tom is already coordinating. Thus, project transition was initiated. We will assist in training and explaining the normal operations and procedures to facilitate a smooth transition while finishing the first 5-year analysis. Tom Brann will develop the new proposal and initiate his management on the 1980 data.

Northeastern Forest Insect Work Conference (NEFIWC)

As 1980 chairman of the NEFIWC, some "winter time" has been spent coordinating the program and preparing final arrangements for Maine to host the 14th annual meeting of this conference on 24-25 February at the Ramada Inn in Bangor. Workshop topics have been selected to address the following: Tree Genetics; Seed and Cone Insects; Micro-, Macro-, and Aerial Photography; Hardwood Insects; Environmental Monitoring Techniques; and Softwood Insect Problems Associated with plantations and natural conifer stands.

The program committee included: Sue Goldman, International Paper Company; Eben Osgood, Entomology; John Dimond, Entomology; Terry May, Forest Resources; Kassie Gibbs, Entomology; Jon Stanley, Zoology; Dave Struble, Maine Forest Service.

FOREST FERTILIZATION - Dr. Robert K. Shepard

The 1980 field season was divided approximately equally between eastern white pine and spruce, primarily red spruce. This report of progress is divided into two parts, one describing the white pine work, the other describing the work with spruce.

White Pine

Plots were fertilized in four natural stands and one plantation. Treatments consisted of nitrogen, phosphorus, and potassium alone and in various combinations. Treatments were replicated once in each of the natural stands and three times in the plantation. Plots have been established in six other

natural stands. Five of these stands are exclusively pine; one stand is mixed pine, red spruce, and eastern hemlock. These plots will be fertilized in the spring of 1981.

An additional aspect is being incorporated into the white pine work. This involves combining fertilization with control of the dense hardwood and spruce-fir understories where these exist. The object of this work is to provide information on the effect of understory control alone on the growth of the pine overstory as well as the effect of fertilization with and without understory control on growth of the overstory. Plots have been established for this work in three stands.

Diameter measurements were made in two stands fertilized in June 1979. One stand is responding well, increase in diameter growth over no fertilization during the two-year period ranging from 35 to 55 percent, depending on treatment. The other stand, a 50-year-old plantation established on a site once occupied by an apple orchard has not responded, possibly because earlier cultural treatments resulted in relatively good nutrient conditions.

Spruce

Emphasis was placed on establishing plots on the major soil types of the spruce-fir region of northcentral Maine. The objective of this work is to determine the effect of soil type on response, as measured by changes in both growth and wood properties, to fertilization, thinning, and fertilization plus thinning. Ultimately, plots will be established on at least ten sites on each soil type. Either two or four plots will be located at a given site. Where soil and stand conditions are uniform over only a small area two plots are being put in. One plot will receive a nitrogen fertilizer treatment, and the other plot will serve as the control. Five pairs of plots on each soil type will be treated in the spring of 1981. Where soil and stand conditions are uniform over a relatively large area four plots are being put in. Two of these plots will be thinned in 1981. These groups of four plots as well as more pairs of plots will be fertilized in the spring of 1982.

As part of this study increment cores were taken from ten dominant or co-dominant trees at five sites on each soil type. Specific gravity determinations were made, and the results indicate large differences in specific gravity among soil types. Specific gravity is highest on the more poorly drained sites and lowest on the better drained sites. All work is being conducted in stands that average approximately 50 years old at breast height; the effect of age is thus essentially eliminated.

Diameter measurements were made in two stands fertilized in 1979. Results of these measurements indicate that response to thinning plus fertilization has been good, response to fertilization alone has been much less, and there has been no early response to thinning alone. As of yet no difference in response among rates of nitrogen application has appeared.

TREE IMPROVEMENT - (Prepared by Peter Caron for Katherine K. Carter)

Regretfully, Dr. David Canavera terminated his position as Geneticist of the Tree Improvement program with the University of Maine and is presently employed as the Head Geneticist for the Forest Research and Development Division, Westvaco Company. Dr. Katherine K. Carter has since accepted the position and will be on board in January 1981 to continue the research. Because of these changes no new projects were started for the spring, summer of 1980. Maintenance and measurements were continued through the summer and fall on existing plantings,

Plantings: 1979

As you are all aware, we had a relatively snow-free winter. This has caused a high rate of mortality in the 1979 plantings of Douglas-fir (*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco) and Norway spruce (*Picea abies* (L.) Karst.). The Scotch pine (*Pinus sylvestris* L.) and European alder (*Alnus glutinosa* (L.) Gaertn) plantings have fared very well in spite of the lack of snow cover. Measurements have been taken in the European alder planting on St. Anne-Nackawic Pulp and Paper Company land, Nackawic, New Brunswick. This planting has achieved an average of 38.5" in height growth the first year in the field.

Planting: 1980

The only planting done in 1980 was in cooperation with Don DeHayes, University of Vermont. This was a Black Walnut Provenance Study located on land belonging to the Nature Conservancy in Newport, Maine. The planting consists of 29 sources with 4 replications, planted May 14-15, 1980. This planting has shown excellent survival and will be checked next spring for cold hardiness.

1981 Projects

The Douglas-fir (*Pseudotsuga menziesii* var. *glauca*, (Beissn.) Franco.) study will again be attempted in a smaller scale in order to determine whether it was the extreme winter conditions that caused the high mortality or if other factors were involved.

A study of balsam fir (*Abies balsamea* (L.) Mill) will be done in the greenhouse to find some kind of growing schedule that will allow balsam fir to reach a plantable size in one year instead of two.

Other activities will depend on what ideas and directions Dr. Carter will have when she takes on the Geneticist position.

PUBLICATIONS RESULTING FROM RESEARCH
SUPPORTED BY THE CFRU IN 1980

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- Dixon, W.N. and M.W. Houseweart (IN PRESS). Life Tables of the white pine weevil in central Maine.
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- Flanagan, T.R. and M.L. McCormack, Jr. 1981. Simazine residues in soils of an old-field tree plantation. Northeastern Weed Science Society. 35:207-210.
- Houseweart, M.W., D.T. Jennings, L.P. Berkett, and T.B. Brann. 1980. Parasitic mites (Acari:Erythraeidae) on spruce budworm moths (Lepidoptera:Tortricidae) Can. Entomol. 112:193-197.
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- Kendall, David M., Daniel T. Jennings, and Mark W. Houseweart (IN PRESS). Large capacity pheromone traps for collecting and preserving spruce budworm moths.
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- McCormack, M.L., Jr. and T.B. Saviello. 1981. Glyphosate and triclopyr mixtures to control forest brush. Northeastern Weed Science Society. 35:218.
- Saviello, T.B., M.L. McCormack, Jr., J.H. Blanck and E.B. Sprague. 1980. Timing applications of Roundup to control forest brush in the Northeast. International Paper Company, Northern Forest Research Center, Research Letter No. 44. 3 pp.
- Saviello, T.B., M.L. McCormack, Jr. and J.H. Blanck. 1981. Timing applications of glyphosate to control forest brush. Northeastern Weed Science Society. 35:201-202.
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