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Report of the Tenth Annual Forest Pest Control Forum Government Conference Centre Ottawa, Ontario November 23-25, 1982

Canadian Forestry Service
Ottawa, Ontario
January, 1983

Not for Publication

ENVIRONMENT CANADA

Report of the

TENTH ANNUAL FOREST PEST CONTROL FORUM

GOVERNMENT CONFERENCE CENTRE

Ottawa, Ontario

November 23-25, 1982

The Forest Pest Control Forum is held under the aegis of the Canadian Forestry Service to provide the opportunity for representatives of provincial and federal governments and private agencies to review and discuss forest pest control operations in Canada and related research.

Canadian Forestry Service

Ottawa, Ontario

January, 1983

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NOTICE OF MEETING

The Eleventh Annual Forest Pest Control Forum
will be held in
Sussex Room, 1st Floor
Government Conference Centre
2 Rideau St., Ottawa
November 15-17, 1983
(8:30 a.m. - 5:00 p.m.)

List of Attendees

In Attendance (full- or part-time):

United States Forest Service

F.W. Honing, Washington, DC
P.W. Orr, Broomall, PA
D.M. Schmitt, Broomall, PA

Maine Forest Service

H. Trial, Old Town
S. Oliveri, Augusta

Newfoundland Department of Forest Resources and Lands

N.E. Carter, St. John's

Nova Scotia Department of Lands and Forests

T.D. Smith, Truro

New Brunswick Department of Natural Resources

J.R. Carrow, Fredericton
D.M. MacFarlane, Fredericton

New Brunswick Department of the Environment

C. MacLaggan, Fredericton

Quebec Department of Energy and Resources

L. Dorais, Quebec

Ontario Ministry of Natural Resources

C.S. Kirby, Maple
S.A. Nicholson, Maple
R.A. Campbell, Maple

Forest Protection Limited

H.J. Irving, Fredericton
L.K. Hartling, Fredericton
S. Holmes, Fredericton

J.D. Irving Limited

D.D. Oxley, Saint John

Fraser Incorporated

P.M. Belyea, Edmunston, N.B.

New Brunswick Research and Productivity Council

C.J. Wiesner, Fredericton

Eastern Spruce Budworm Council

G. Paquet, Quebec

Health and Welfare Canada

L. Ritter, Ottawa

National Research Council

L. Elias, Unsteady Aerodynamics Laboratory, Ottawa

Agriculture Canada

E.T.N. Caldwell, Pesticides Division, Ottawa
W. Stewart, Pesticides Division, Ottawa
A.C. Schmidt, Plant Health Division, Ottawa
H. Krehm, Research Program Service, Ottawa

Fisheries and Oceans Canada

P. Ryan, St. John's
N.Y. Khan, Ottawa

Environment Canada

Environmental Protection Service

W.R. Ernst, Halifax
P.A. Jones, Ottawa
H.S. Thompson, Ottawa
A.B. Cairnie, Ottawa

Canadian Wildlife Service

P.A. Pearce, Fredericton
P. Mineau, Ottawa

Parks Canada

T. Wallace, Ottawa
V. Bownell, Cornwall, Ont.

Canadian Forestry Service

A.G. Raske, St. John's
M.M. Neilson, Fredericton
D.C. Eidt, Fredericton
D.G. Embree, Fredericton
P.C. Nigam, Fredericton
L.P. Magasi, Fredericton
E.G. Kettela, Fredericton
A. Lavallée, Ste. Foy
W.A. Smirnoff, Ste. Foy
G.W. Green, Sault Ste. Marie
J.A. Armstrong, Sault Ste. Marie
J.C. Cunningham, Sault Ste. Marie
B.L. Cadogan, Sault Ste. Marie
P.D. Kingsbury, Sault Ste. Marie
K.M.S. Sundaram, Sault Ste. Marie

C.R. Sullivan, Sault Ste. Marie
G.M. Howse, Sault Ste. Marie
J.H. Meating, Sault Ste. Marie
W.H. Fogal, Chalk River
B.H. Moody, Edmonton
D.M. Shrimpton, Victoria
C.H. Winget, Ottawa (Chairman, November 23)
T.E. Sterner, Ottawa (Chairman, November 24)
C.H. Buckner, Ottawa
R.G. Taylor, Ottawa
D.A. Winston, Ottawa
A.G. Davidson, Ottawa (Secretary)

Agenda

November 23-24, 8:30 a.m. - 5:00 p.m.

1. Welcome and Opening Remarks - C.H. Winget

2. Pesticides Review
   - 2.1 Introductory Remarks - G.W. Green
   - 2.2 Overview of Pesticide Usage - J.A. Armstrong
   - 2.3 Report from Canadian Council of Resource and Environment Ministers (CCREM) Task Force on Pesticides for Forest Management - J.R. Carrow
   - 2.4 Registration of Forestry Pesticides - E.T.N. Caldwell
   - 2.5 Review of Research Underway or Planned with Reference to the Development of More Effective or Additional Materials for Controlling Pests (Including Program of Forest Pest Management Institute)

3. Spruce Budworm
   - 3.1 Report from Eastern Spruce Budworm Council
   - 3.2 Newfoundland
     Outbreak Status - 1982, Forecast - 1983
     Control Program - 1982
       - Reports on operations and assessments
       - Reports on environmental monitoring

     Prospects and Plans - 1983
   - 3.3 Maritime Provinces
     Outbreak Status - 1982, Forecast - 1983
     Control Programs - 1982
       - Reports on operations and assessments
       - Reports on environmental monitoring

     Prospects and Plans - 1983
   - 3.4 Quebec
     Outbreak Status - 1982
     Control Program - 1982
       - Reports on operations and assessments
       - Reports on environmental monitoring

     Prospects and Plans - 1983
   - 3.5 Ontario
     Outbreak Status - 1982, Forecast - 1983
     Control Program - 1982
       - Prospects and Plans - 1983

3.6 Other Provinces
Outbreak Status - 1982, Forecast - 1983

3.7 Maine
Control Program - 1982

Reports on operations and assessments
Reports on environmental monitoring

Forecast - 1983

3.8 Other United States

Reports on 1982 situation

4. Gypsy Moth

4.1 Report of the Activities of the Plant Health Division, Agriculture Canada, in 1982

4.2 Ontario
Outbreak Status - 1982
Experimental Trials 1982
Forecast and Plans 1983

4.3 Reports from other provinces and the United States

5. Mountain Pine Beetle

5.1 British Columbia
Status and Control - 1982, Outlook - 1983

5.2 Alberta - Saskatchewan
Status and Control - 1982, Outlook - 1983

6. Reports on the Status and Control of Other Pests

British Columbia
Prairie Provinces
Ontario
Quebec
Maritime Provinves
Newfoundland
United States

<u>November 25</u>

Informal discussions of topics of interest, working group or committee meetings.

10TH ANNUAL PEST CONTROL FORUM

OTTAWA, ONTARIO

23-25 NOVEMBER, 1982

Pesticide Review Section
Introductory Remarks
G.W. Green

In his introductory remarks to you last year, Jim Cayford drew attention to the dire straits that forestry in Canada was in with respect to the availability of pesticides, both chemical and biological, for use in many of the problems facing us. He referred to the fact that, at the very same time when Canada was committed to a program of intensive forest management to meet year 2000 harvest level targets endorsed by the Canadian Council of Resource and Environmental Ministers--as we moved from a 'mining' to a 'farming' stage in Canadian forestry--we found ourselves in the position with very few pesticides (insecticides, herbicides or fungicides) available for use and, for those that were registered and available, political reaction to often technically unfounded concerns raised by environmentalist and other public-interest groups severely constrained forestry's ability to use this woefully small arsenal of registered pesticides where and when necessary to meet forest management objectives.

In my introductory remarks to you today, I have been charged with starting out where Jim Cayford left off at last year's Forum and bringing you up to date on progress that has been made in improving forestry's position where pesticides are concerned and on new problems that are emerging. There are a number of speakers who will follow me in this and expand on certain items of concern and interest. My remarks, therefore, will be fairly general for the most part in an attempt not to steal too much of their thunder.

The situation has definitely improved in some respects over the past year, but it has worsened in others. On the negative side, one has only to lament the situation Nova Scotia has allowed itself to be placed in with virtual curtailment of a herbicide program--a program desparately needed now to begin to redress the very heavy losses of spruce and fir suffered when the Cape Breton Highlands were sacrificed to the spruce budworm several years ago. In somewhat the same vein, one might cite the continuing reluctance by many provinces to use 2-4-5T where it is sorely needed in site preparation and conifer release in the lack of effective registered alternatives. And, I cannot help but mention the situation New Brunswick found itself in this year, when provincial reaction to the draft Spitzer Report denied the use of ATLOX 3409F in pesticide tank mixes of budworm insecticides and resulted in a drastically modified and reduced protection program against the spruce budworm in that province in 1982. It should be noted that the federal regulatory authority did not change its stance with respect to registered tank mixes confirming ATLOX 3409F after reviewing the Spitzer Report.

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New Brunswick's reaction to the Spitzer Report not only resulted in a modified and reduced protection program, but also in the mounting of an extremely expensive joint undertaking at zero hour to find, through research and testing in 1982, alternative emulsifiers that might be registered in time for use in 1983. Not only was this program expensive, but even more importantly, it diverted significant research person resources from other research which is sorely needed to advance the science of enlightened pest management in general.

In the face of reactions such as these, we must collectively, continue to strive for injection of some true perspective into decision-making where pesticide use in forestry is concerned, such that these decisions are made on technical as opposed to emotional, political or theoretical grounds. In my estimation, this is the single most important problem facing the use of pesticides in forestry today. If forest managers are not allowed to use the registered pesticides available to them when there are no sound technical reasons for denying their use, then it makes little sense at all to continue to develop new products and improved methods for utilizing them, if subsequently, they are just going to gather dust on the shelves.

Well that is most of the bad news but there are some lights on the horizon. You will hear from Rod Carrow later on the CCREM Workshop on Pesticides held last year and of the activities of the CCREM Task Force on Forest Pesticides. The latter, in particular, has made some significant strides in defining the problems facing review and registration of a number of pesticides of immediate importance to forestry and in generally speeding up the review and registration process for these priority materials. Regular meetings of this Task Force has also provided another forum which contributes to a better mutual understanding of problems facing the many actors involved with both pesticide use and regulation. I understand that Rod Carrow and Errol Caldwell will bring you up to date on the status of these pesticides during their remarks, so I will not treat them here.

Still on the good news side and stemming from initiatives taken by the Federal Interdepartmental Committee on Pesticides, an ad-hoc committee has been struck to investigate the development of Canadian protocols for the registration of biological pesticides for both forestry and agricultural use. This committee has now met several times and has considered protocols developed, or under development, by WHO, EPA, and the United Kingdom. From considerations to date, it would appear that the Canadian protocols that will eventually emerge will likely approximate those under development by the EPA in the United States. One of the major problems to be resolved here will be the extent of toxicological safety data that will be required before biologicals can proceed to field efficacy testing. At the moment, this is very much a chicken or an egg situation--on the one hand it is not economically practical for a research institution to invest heavily in toxicological testing until it is clear that the specific biological has good potential for use--on the other, there are legitimate concerns for release of the biological into the environment without safety data available. I am confident that these problems will be faced and resolved in a technically sound, yet practical manner. While on the subject of biologicals, I am happy to report that the registration petition for the red-headed pine sawfly nuclear polyhedrosis virus has been reviewed by Agriculture Canada and by Health and Welfare Canada. Health and Welfare Canada has identified delayed dermal

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hypersensitivity tests as the only outstanding item as far as they are concerned, and have agreed to temporary registration for 1983 pending outcome of the outstanding toxicological test which FPMI will have initiated with a private contractor in the new fiscal year. It is expected that other reviewers will complete their reviews soon and that temporary registration will be obtained for 1983. Hopefully, this will pave the way for rapid consideration of the Douglas-fir tussock moth virus which will be submitted for registration in December, 1982, and which is sorely needed to control a resurging Douglas-fir tussock moth problem in British Columbia.

Progress has also been made in the past year to have a range of materials approved for use against the spruce budmoth and seed and cone insects on Douglas-fir and spruce, utilizing the Minor Use Registration program. You will hear more of this from Rod Carrow and/or Errol Caldwell. In addition, at the FPMI, a number of new pesticides for use against the spruce budworm are in various stages of development and testing including a new fenitrothion flowable formulation which will go to small scale field efficacy trials in 1983, as will the new Sevin FR formulation. It is of interest to note also that Union Carbide now has the rights for Zectran and are interested in reinstating its registration status which has lapsed in Canada. A good deal of efficacy data currently exists for this product and in 1983 plans are being made for detailed environmental testing and residue analyses where this product is concerned. You will hear more of these when Jack Armstrong makes his presentation later today.

Many of you are at least somewhat aware of the CFS/FPMI Action Plan which was initiated in May, 1982 in an attempt to help New Brunswick out of the very tight spot it found itself in as a result of its reaction to the Spitzer Report to the New Brunswick Ministry of Health. On the third day of this Forum, the Steering Committee and the Facilitation Committee of this Action Plan will meet to discuss progress and future requirements in detail, but a brief review here might be useful for those of you not so directly involved. In a nutshell, the objectives of the Action Plan were to register two additional tank mixes for aminocarb and fenitrothion, preferably in water emulsions with the constraints that no viral enhancing emulsifiers be contained, and that no registration requirements be by-passed. The program was initiated as a joint federal-provincial undertaking on 18-19 May with funding to facilitate the accelerated R & D program to be provided through Forest Protection Limited. Its successful undertaking depended on the complete cooperation and participation by a wide range of agencies, many of whom are involved in the pesticide review process. I will not go into the detail of these cooperative arrangements here except to say that for the most part, they were excellent in all respects. By May 28, it had been decided on the basis of preliminary screening, that Triton X-100 was the emulsifier of choice and that the tank mixes to be tested would be Aminocarb F/Triton-X-100/water; Fenitrothion/Triton-X-100/water; Fenitrothion/Triton-X-100/CycloSol 63/water; and Fenitrothion/Canola oil/Triton-X-100/water. These were to be tested for efficacy on small 50 ha research blocks and also in semi-operational trials on 5000 ha blocks using TBM's and with environmental impact and residue assessments to be made in all blocks. Because of difficulties in finding suitable experimental blocks in the short time available, coupled with very rapid development of the budworm in New Brunswick in 1982, the tank mix containing Canola oil had to be dropped from the tests. In addition, large block trials had to be cut to approximately 500 ha applied by smaller aircraft and with concentration in these blocks on environmental impact and residue analyses. When mixing in the field was initiated for the small block trials, temperatures were very low and difficulties were experienced with Triton-X-100 in that it congealed in the barrels, could not be pumped and it was difficult to put the mixtures into proper emulsion at

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temperatures below 7° C which is the pour-point for Triton-X-100. At higher temperatures, these problems were not encountered. With these modifications and attendant problems, field applications proceeded much as planned. While these field trials were in progress, plans were made with Bio-Research Laboratories in Montreal to conduct a full range of acute toxicity tests on the three tank mixes with Triton X-100 used in the field trials. Before these trials got underway, subsequent screening at FPMI indicated that Triton-X-114, with a pour-point of -9° C might provide better pumping and mixing characteristics under field conditions, and laboratory studies showed that it formed emulsions with the insecticides concerned, as well as or even better than Triton-X-100 (subsequent field mixing tests done this fall at temperatures between 0 and 4° C verified this). Since it is structurally identical to Triton-X-100 except that it has on the average, two fewer moles of ethylene oxide, it was felt prudent to also include tank mixes with it replacing Triton-X-100 in the acute toxicity tests. These tests using both emulsifiers are now in progress at Bio-Research Laboratories and final reports are expected by mid-January.

In addition to acute toxicity tests, viral enhancement testing on individual components of the tank mixes and all combinations of them are underway at three separate laboratories using identical protocols. While these tests are not requirements of current registration protocols, it was felt expedient to have them done to satisfy New Brunswick concerns and to validate the viral enhancement testing procedure.

The field testing side of the program is being backed up by laboratory toxicity testing of all experimental tank mixes against spruce budworm, additional fish toxicity testing of the tank mixes and their compounds and a whole gamut of spray tower and physical testing to determine stability of the mixes and characteristics of spray clouds attainable with them. Some of these data are provided in the Forum reports tabled by FPMI, others require further analysis. Suffice it to say here, that despite some problems encountered along the way, this crash program has gone forward perhaps even better than could reasonably be expected, given the short lead time available to initiate it. All cooperating agencies are to be commended and only careful review of the final data packages provided will determine if we have been successful in achieving the overall objective.

In concluding these introductory remarks which unfortunately were much more extensive than I had hoped, I must bring to the attention of the Forum a matter that I feel has the potential of being blown out of all proportion before required additional research and monitoring has allowed us to examine the situation further. Quite simply, it is this--in residue samples taken this year in conjunction with our programs in New Brunswick with aminocarb flowable in the south and Action Plan tank mixes in the north, analyses indicated the presence of fenitrothion residues where they would not be expected. In southern New Brunswick for example, in the two aminocarb flowable blocks just north and south of Fredericton and fairly well removed from operational spray blocks, pre-spray samples (i.e., taken before the aminocarb flowable applications were made) contained concentrations of fenitrothion approaching 60 ng/m^3 in air; .02 ppb in water; 200 ppb in watercress; 400 ppb in coniferous foliage; 120 ppb in litter; 100 ppb in exposed soil and 5 ppb in fish tissue. While these concentrations are low, there is no question that they are real, and while we have not seen the data yet, we know that other agencies have found

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similar residues elsewhere in the province. With such data available, there is the obvious danger of precipitous reaction to a situation for which we require much more data before we are in a position to know really what we have, how it got there, and what its potential for impact on the environment really is. FPMI would propose, therefore, that a Task Force to be formed immediately to lay plans for a cooperative approach to systematic sampling and analysis in 1983 designed to provide the sound data base required to fully understand the problem and to provide the technical base required for any rational decision making with respect to it. While the data we now have is from New Brunswick, it behooves us all to determine whether similar situations prevail elsewhere and with forestry use pesticides other than fenitrothion.

To consider the situation further, a meeting chaired by Jack Armstrong will be held immediately after lunch on Thursday, 25 November, 1982. Anyone from the Forum with data to contribute or with interest in the situation is urged to attend.

This has been a very cursory and superficial review of some of the progress and problems concerned with forest pesticides in the past year. As this Forum proceeds, and upon review of the reports that are tabled at it, other aspects of progress and problems will become evident. Despite the many problems that continue to face forestry's use of pesticides, I do think that significant progress has been made in the past year, as Jim Cayford said, "in delivering forestry from the dilemma it faces with respect to the registration and use of pesticides".

Pesticide Usage for Forest Management

J.A. Armstrong

The need to manage our forest resources to guarantee a continuing supply of wood and to remain competitive in the face of world markets will require more intensive management with greater effort into the areas of regeneration and forest protection. At present these aspects of forestry can only be achieved economically through the use of herbicides and insecticides. The only herbicides registered for use are those containing 2,4-D and 2,4,5-T and these are banned or severely restricted in some provinces. In the area of insect control we have fenitrothion, aminocarb, carbaryl, trichlorfon and B.t. for forestry use and B.t., methomyl and dimethoate for woodlands use. Although the list of chemical insecticides may seem impressive the realities are that only fenitrothion and aminocarb are economically effective.

The Forest Pest Management Institute is working towards the development of environmentally acceptable, efficaceous pesticides for forestry use. At present our concerns focus on three areas, (a) the high cost of generating the necessary safety data of all materials in general and the biological agents such as insect viruses, fungi and other pathogens, (b) the decrease in the number of new chemicals available from which we select materials for forestry use and (c) restrictions placed on pesticides, constituents of the spray mix or the use pattern by provincial agencies to meet concerns that are, in many cases, not based on sound scientific knowledge.

One area of weakness has been the lack of data pertaining to forestry use of pesticides. There have been statements made with reference to spray applications which indicate a belief that all sprays are of the multi-million hectare budworm type sprays in E. Canada and that huge quantities of pesticides are used. This is not so, and considering the need and the forestry pesticide use patterns, relative to agriculture very little material is used. The FPMI has initiated a program requesting information on forest pesticide use patterns. From the limited information we have received, if we take herbicides as an example, approximately 55,000 ha were treated with a total amount of material used between 50,000 and 75,000 Kg. Although this may seem large, in 1981 in the province of Alberta alone a total of approximately 4,000,000 Kg of herbicide were used for the control of weeds on farm lands. For wild oat control alone the weight of material used was 2.5 million Kg. The data for 1982 have now been received, unfortunately it has not been possible to analyse the use patterns in time for this meeting.

With respect to the timing of the requests for information we have been told that the timing is bad, some operations not completed, and also some provinces prepare an annual report which comes out early in the new year. For these reasons in future the request for information will be sent out in January. A centralized data base on forestry use patterns of pesticides will give the CFS more strength in its arguments to show the need for these materials and to support their use.

1982 FOREST PEST CONTROL FORUM

CCREM TASK FORCE ON PESTICIDES FOR FOREST MANAGEMENT

PROGRESS REPORT

One year ago, a Task Force was established by the Canadian Council of Resource and Environment Ministers (CCREM), composed of forestry representatives from every province (except Quebec) and each federal agency involved in the review and registration of pesticides. The Task Force was directed to identify the obstacles to registration of pesticides for forestry use, and to expedite their registration. To this end, the Task Force directed its attention to 14 pesticides for which registrations had been submitted, and has been attempting since to expedite registration where possible.

The Task Force has met 5 times and to date, registrations for 6 forestry uses have been completed or clarified:

1. Dipel. A label revision has been made, allowing general forestry use for gypsy moth control.

2. Dimethoate. Sys-tem 480 EC (Chipman) has been registered for control of seed and cone insects on Douglas-fir. Cygon Systemic insecticide is close to registration, the only obstacle being the development of appropriate label wording regarding phytotoxicity.

3. <u>Dimethoate</u>. has also been registered for control of seed and cone insects on spruce.

4. <u>MSMA</u>. ("Glow-on") is now registered for control of mountain pine beetle on lodgepole pine. Registrations for spruce beetle and Douglas-fir beetle are being sought.

5. <u>Acephate</u>. Orthene Tree and Ornamental Spray is registered for Woodlands use (woodlots, tree nurseries, plantations, etc.) for control of budworms, cankerworms, gypsy moth, tent caterpillars, tussock moth, bagworms (ground application).

6. <u>2,4-D</u>. While 2,4-D is fully registered for conifer release, instructions for use on the label varied among manufacturers. Action is being undertaken to standardize label instructions on the various products.

Registrations for 8 pesticides and/or specific uses remain incomplete. Several of these are vitally important to forest management.

7. <u>Roundup (glyphosate)</u>. The data review by the federal advisory agencies should be complete by the end of 1982. It appears likely that Roundup will receive a temporary registration for 1983.

8. <u>Velpar (hexazinone)</u>. The federal review is scheduled for completion in March 1983, and hopefully it will receive a temporary registration for 1983.

9. Krenite (fosamine ammonium). Major data gaps relating to soil persistence and mammalian toxicity prevent the registration of Krenite, and the manufacturer, (DuPont) is unwilling to complete the necessary tests. In view of this, and the very limited use potential across Canada, it seems unlikely that Krenite will be registered in the near future.

10. Orthene FSC (acephate). Acephate is still IBT-encumbered and this prevents new registrations from being issued until the IBT studies are replaced. Temporary registration was granted in 1982 and is anticipated again in 1983 for gypsy moth, Douglas-fir tussock moth, oak leaf shredder, and eastern and western spruce budworm.

11. Permethrin. The only submission for registration is for Woodlands-ground application against spruce budworm; no submissions have been made for Woodlands-aerial, or for Forestry use. Although the data review has been completed, registration is being delayed because of Fisheries and Oceans concerns about operational controls to protect aquatic ecosystems. The Task Force is now developing a label specification for buffer zones around aquatic ecosystems, to permit use of permethrin with air-blast equipment. The intention is to have this complete in time for the 1983 season.

12. Matacil Flowable (aminocarb). Federal review of the submission is apparently complete and registration for use against spruce budworm is expected before the end of 1982.

13. Sevin (carbaryl). Registration is being sought for Sevin-4-oil for control of Douglas-fir tussock moth. This product currently has a temporary registration. More data on efficacy and toxicity to aquatic organisms are required for full registration. The current data package for two new formulations, Sevin-XLF and Sevin-FR, are inadequate to permit registration.

14. Nuclear Polyhedrosis Virus. The Canadian Forestry Service applied for registration of red-headed pine sawfly virus. This is the first virus to be submitted for registration in Canada. Health and Welfare has requested additional data but the registrant (Canadian Forestry Service) may not be able to carry out the studies due to budget limitations. There is a good probability, however, that this virus will be registered for 1983.

Three developments resulting from the work of the Task Force also deserve mention. The Task Force recognized very quickly the need for regular communication of the status of various pesticides to forestry user groups. In response, the Forest Pest Management Institute inaugurated the "FPMI Newsletter" in 1982. This should serve as a valuable means of keeping forestry users informed about recent developments in pest control products and techniques.

Second, at the request of the Deputy Ministers of Forestry, the Task Force prepared two resolutions which resulted in letters being sent from the provincial Ministers of Forestry to the federal Ministers of Agriculture, Health and Welfare, Environment and Fisheries and Oceans. These letters emphasized the urgent need for the specific pesticides under consideration, and asked that the Ministers allocate sufficient resources to permit the review process to be completed in time to allow registration in 1983. The responses indicated that the federal Ministers were unwilling to make any firm commitment to completing the review and registration. However this dialogue served to reinforce the message at the highest level that certain pesticides are urgently needed to meet our forest management responsibilities.

Third, the Task Force believes that a single body, representing the pest control interests of forest managers across Canada, is essential. To this end, the Task Force is investigating the feasibility of a national Forest Pest Management Council. The feasibility of establishing such a group within CCREM, along with membership and terms of reference, is now being explored by the Task Force.

J.R. CARROW, CHAIRMAN
CCREM Task Force on Pesticides for Forest Management
November, 1982

REGISTRATION OF FORESTRY PESTICIDES

TENTH ANNUAL FOREST PEST CONTROL FORUM NOV. 23-25 1982

I would like to provide an update on the compounds that Dr. Carrow has just discussed for the CCREM Task Force.

UPDATES

1. Roundup (glyphosate)

   The environmental Health Directorate of Health and Welfare are now reviewing the data package for glyphosate. The results of this review should be available early in the new year.

2. Orthene FSC (acephate)

   The outstanding replacement study is expected next month. It may be possible to change the temporary registration to full if this study is submitted on time and the IBT classification is changed to "no longer of conceen with respect to IBT studies". Otherwise another year of temporary registration is likely.

3. Velpar - (hexazinone)

   This compound is currently under review by Health and Welfare and the results of this review should be available early next year.

4. Nuclear Polyhedrosis Virus (red-headed pine sawfly)

   Health and Welfare have agreed to a temporary registration. However neither Fisheries and Oceans nor Environment Canada consultants have provided a review of this submission to date. We hope to register this virus early in 1983.

5. Permethrin (spruce budworm)

   Fisheries and Oceans have been asked to provide their comments on the woodlands use by the end of this month. Unless there are strong objections to this use, we'd be prepared to grant registration with suitable label precautions regarding aquatic exposure. This may include establishment of suitable buffer zones.

6. Krenite (fosamine ammonium)

   No change.

7. Matacil Flowable (aminocarb)

   We have agreed to a temporary registration for 1983. Full registration is pending results of 1982 efficacy and environmental impact trials. This product will be registered for spruce budworm and budmoths in both forest and woodlands categories.

8. Sevin (Carbaryl)

Sevin FR registration request has been denied until additional efficacy and environmental impact data are submitted. Data may be available form 1982 trials in Maine. However it is expected that FPMI will have to carry out field work in Canada for both budworm and Douglas fir tussock moth.

9. Cygon (dimethoate)

No change.

10. Futura II (bacillus thuringiensis)

Still no submission

11. Automate red B dye

Still no submission

Other Items

1. Spruce budmoth - Minor use program

Registrations have been granted for Matacil, fenitrothion, Dylox and bacillus thruingiensis products under the minor use program for spruce budmoths.

2. Thuricide 32B and 32LV formulations were registered for woodlands & forestry uses. NOVABAC is now sold by Biochem and is also registered for both woodlands & forestry uses.

3. Matacil 1.8D O.S.C. and Folithion L.C. have undergone label modifications which include a wildlife precaution statements changes in total spray volumes, addition of spruce budmoth claims etc.

4. Zectron (mexacarbate)

Union Carbide has initiated work to support the registration of this "aminocarb - like" carbamate for spruce budworm control. Further studies are planned by FPMI.

5. IBT update

A press release (Nov. 2, 1982) provided the latest IBT update however, few forest pesticides are affected (except acephate).

3.

6. <u>Research Permit Memorandum</u>

A new T-1-216 memo will go out shortly for comments. There are proposed changed to the PCP Act Regulations and procedural changes in handling requests for research.

E. Caldwell
Pesticides Division

EC:cr

FPMI Report on Studies Carried out by the Use Strategies and Environmental Concerns Program
1982

J.A. Armstrong

The Use Strategies and environmental Concerns Program was heavily committed to meeting goals and objectives set out by the New Brunswick Action Plan. Following the release of the Spitzer Report to the Province of New Brunswick, prior to the start of the 1982 operational spray program, with the recommendation that the emulsifier Atlox 3409F not be used. The Action Plan, put forth by FPMI, MFRC and FPL laid out a program of research to identify and test a replacement emulsifier acceptable to the regulatory authorities. The target set was to have all available information ready by December 1982 for submission to Agriculture Canada with the ultimate objectives of approval and at least temporary registration in time for the 1983 spray program. The projects involved in the Action plan were FP9, 12, 13, 15 and 16.

The FPMI projects concerned with other aspects of pesticide testing continued according to plans put forth at the start of the planning year.

FP-9 Spray Kinetics and Physics

This project was charged with the responsibility of testing potentially acceptable emulsifiers to determine their usefulness, and developing a formulation to meet the requirements of the Action Plan. The emulsifier Triton®-X-100 was selected since there was toxicological data on it. Triton®-X-114; a close relative, was also tested and tank mixes of fenitrothion and aminocarb flowable with these emulsifiers and additives were developed. Data were generated on the physical characteristics, droplet spectrum and droplet behaviour.

This project was also involved in a joint study with Dr. E. Himel (U. of Georgia) and project FP-14 on the testing of encapsulated B.t. formulations.

FP-11 Special Applications

This project, under the direction of J. Turgeon was totally committed to biological studies of the spruce budmoth *Leiraphera canadensis*. The work was carried out in New Brunswick in cooperation with MFRC, FPL and J.D. Irving Ltd. Preliminary results indicate that the density of the spruce bud moth (referred to as Sbm) is affected by the age of the trees and that the highest larval densities are on the leaders of the trees. This insect, when in the pupal stage (on the ground) is susceptible to predation by ants (80-90% loss of pupae) and predatory mites. This work will continue in 1983 with completion of the biological studies and tests on pesticide application techniques.

FP-12 Toxicology and Screening of Chemical Insecticides

The toxicology and insecticide screening project was involved in the action plan carrying out tests to determine the base line toxicity of the new formulations being developed. Although there was some indication that changing the solvent carrier resulted in a change in toxicity the results were not conclusive and more work will be carried out in this area. Studies on new insecticides and new formulations of fenitrothion (known as Sumithion Flowable) and carbaryl (Sevin FR) were also initiated.

In a cooperative program with the National Aeronautics Establishment of NRC the effects of droplet size on the toxicity of insecticides to SBW larvae were continued (This work was initiated by P.C. Nigam, now with MFRC). The test insecticide was fenitrothion - 14% AI in Cyclosol-63 (35%) and ID 585 (54%). Preliminary results indicate that with droplets approximately 25 mμ in size 9-10 droplets gave a 72 hr LD_{50} and 21-22 gave a 72 hr LD_{95}; with droplets approximately 66 mμ in size 3 gave a 72 hr LD_{50} and 9 gave a 72 hr LD_{95}.

FP-13 Field Efficacy, Chemical and Biological Insecticides

The field efficacy team, working in close cooperation with MFRC and FPL, carried out a series of small block (50 ha) trials in the Charlo area of New Brunswick to assess the new tank mixes developed for the action plan. The materials tested were: (a) Fenitrothion: Triton-X-100: cyclosol 63: water; (b) Fenitrothion: Triton-X-100: water; and (c) Matacil® 180F: Triton-X-100: water. All spray mixes were dyed. Due to weather problems plus problems associated with implementing the action plan, sprays were applied later than preferred; however, in spite of these problems there was effective foliage protection with two of the three treatments and FPMI feel confident that the new tank mix can be recommended for use.

FP-14 Biological Control Strategies

The project leader, O.N. Morris left the CFS and joined Ag. Canada the end of June after completing a field project to assess the affect of volume of application on fixed dosages of B.t. Sprays were applied at 30 BIU/ha at volume emission rates of 2.34, 4.67 and 9.35 L/ha with each plot replicated 3 times. The tests were carried out in the Marathon area of N. Ontario; due to cold weather bud flush occurred ahead of the normal larval development rate. In spite of these problems budworm populations were reduced by 85% and effective foliage protection was achieved/ac of 55% for all three treatments. According to statistical analysis by USDAFS personnel there was no significant difference in the treatments and the CANUSA B.t. program is now prepared to recommend that B.t. will provide effective foliage protection at 30 BIU/ha, 2.34 L/ha applied using Micronair equipped aircraft. Dr. Morris has indicated that a full report will follow.

FP-15 Environmental Impact of Pest Management Strategies

The Environmental Impact Project was involved in two programs in New Brunswick; a study of the effect of aminocarb flowable on forest song birds, benthic invertebrates, Atlantic salmon and brook trout in operational blocks treated with TBM aircraft and the Action Plant Tank mix studies in which applications were made to 500 ha blocks using single engine aircraft and to individual streams by aircraft and stream injection. The Quebec Min des Terres of Forêts also applied aminocarb flowable in canola oil and observations were carried out in that block. The results of these studies indicate that aminocarb flowable had very little direct impact on the organisms studied and the action plan mixes were considered comparable to the previously used mixes in terms of impact.

The Icewater Creek project continued with focus on seasonal changes in fish populations at a number of sites and collection of emerging adult aquatic insects.

FP-16 Chemical accountability of Pest Control Products

This project ws also heavily involved in New Brunswick with teams working on the Action Plan and the Aminocarb flowable program. Pesticide residues ere measured in air, water, foliage, litter, the forest soils and organisms in the forest ecosystem collected by FP-15. Complete data are presented in the report.

During the cause of analysing the pre-spray (pre-experimental spray) ecosystem samples of fenitrothion in measurable amounts was recorded. The study was expanded with a more detailed analysis of samples from other locations being made. Although these samples may be considered on pre-spray, the operational program had started and there is thus the possibility of the fenitrothion having originated in 1982. The Institute plans are to repeat these analyses in 1983 before any operational sprays have started to check on these levels.

FP-19 Toxicology and Screening of Herbicides

This project now has a program in place to (a) evaluate new herbicides through a laboratory screening program which identifies activity against coniferous and deciduous trees, (b) further evaluation of promising materials in a series of greenhouse trials and (c) field trials with hand application techniques. A total of 21 materials were received for testing with 6 having been tested through all 3 stages.

<u>New Projects, other items of interest and future work</u>

Through an internal reorganization a new project has been started to carry out research on control measures of pest insects in plantations, nurseries, etc. This project (project leader Peter de Groot, technician Andrij Obarymskyj) will work on developing and perfecting application techniques in particular with ground equipment. In 1983 this team will work with J. Turgeon (FP-11) in developing pesticide application strategies for control of the spruce bud moth.

Through the minor use pattern label amendments have been approved by Ag. Canada for the use of MATACIL®, FOLITHION®, DYLOR®, NOVATHION® and THURICIDE® against other defoliating lepidopterous insects of conifers.

Staffing actions for the Meteorologist-Cloud Physicist and Herbicide Applications person are in the final stages and these two persons should be on staff shortly after the start of the New Year.

The program to test new insecticides is continuing with the following materials and studies proposed for 1983.

(a) Field efficacy trials - 50 ha blocks
Sumithion flowable and Sevin FR now appear to be ready for this stage of study. Application rates for the Sumithion flowable are 2 x 210 g AI/ha. For Sevin FR we are looking at something between 2 x 280 and 2 x 350 g AI/ha.

(b) Environmental Studies - 1000 ha-5000 ha
Union Carbide have purchased the complete rights to Lectran from Dow Chemical and are interested in reactivating the material (It is still registered in the USA, it is not registered in Canada). There will be no change in formulation and with the knowledge of its efficacy our only concern is with respect to its environmental effects, thus the detailed environmental and chemical residue studies are planned for 1983.

(c) Chemical residue studies
Chemical analysis to determine pesticide residue levels in the blocks being treated for environmental impact studies. These will also be pre-operational spray sampling and analysis to determine the background level of pesticides in the forest ecosystem.

STUDIES IN SPRAY KINETICS AND PHYSICS IN CANADIAN FOREST PEST CONTROL PROGRAMS IN SUMMER 1982

(i) Development, Physicochemical Properties and Spray Behavioral Characteristics of Fenitrothion and Aminocarb Emulsion Formulations

(ii) Spray Deposition Pattern and Droplet Spectra of *Bacillus thuringiensis* Formulations as Relatable to Spruce Budworm Mortality and Degree of Defoliation

(Study Ref. No. FP-9)

A REPORT TO THE ANNUAL PEST CONTROL FORUM

by

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November, 1982

STUDIES ON DEVELOPMENT, PHYSICOCHEMICAL PROPERTIES, AND SPRAY BEHAVIORAL CHARACTERISTICS OF FENITROTHION AND AMINOCARB EMULSION FORMULATIONS

By Alam Sundaram

Under the direction of the Action Plan, a program of research was initiated to identify a suitable emulsifier to replace ATLOX 3409F in the fenitrothion water emulsion mix used in New Brunswick. With the urgency of the program and the necessity of meeting the safety requirements of Health and Welfare Canada, first choice was given to Triton-X-100, since there were mammalian toxicology data on this product; second choice was Triton-X-114, a closely related compound to the X-100. The formulation tank mix properties and spray behavioral characteristics of both fenitrothion and aminocarb flowable using Triton-X-100 and X-114 were studied. For the sake of comparison, the two currently registered fenitrothion formulations, and the two currently proposed and field-tested aminocarb formulations (one of each is an emulsion containing ATLOX 3409F and the other is an oil based formulation containing ID 585) were also studied. Formulation properties were studied under variable temperature conditions. Data on spray deposition and droplet spectra were obtained using the Institute's spray chamber and under field conditions during the aerial spray trial in New Brunswick.

The following areas were investigated:

I Selection of a variety of suitable ingredients and their optimum proportions for good miscibility and emulsion characteristics at a wide temperature range.

II Stability of formulations with respect to phase separation and/or changes in viscosity, over a temperature range, and under the effect of pH and water hardness.

III Compatibility of the active ingredient with the inert ingredients over a defined period of time.

IV Mixing, storing and pumping capabilities under extreme cold weather conditions.

V Physicochemical properties and spray atomization characteristics with different nozzle systems and application equipment.

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VI Rate and degree of droplet evaporation.

VII Rate and degree of vapourization of the active ingredient from spray droplets.

VIII Spray droplet impaction characteristics on the intended target surface.

IX Droplet retention characteristics on the intended target surface.

X Droplet dissipation characteristics and phytotoxicity.

Results

Results of the research investigation are presented under each headline below:

I Selection of suitable ingredients and final choice among them, and percentage composition of ingredients

Table 1 lists the emulsifiers, diluent oils and polymeric additives that were tried in various combinations and proportions for good miscibility and emulsion characteristics.

TABLE 1

LISTS OF EMULSIFIERS, DILUENT OILS AND POLYMERIC ADDITIVES STUDIED WITH FENITROTHION TECHNICAL AND AMINOCARB FLOWABLE

Emulsifier	Cosolvents	Polymeric Additives
Tween® 80	ID 585	Nalco-Trol®
Tween® 60	Dowanol TPM	Polyvinyl alcohols
Triton® AG-460	Cyclo-Sol® 63	Acrylic polymers
Triton® X-45	Canola oil	Sodium silicates
Triton® X-100	Sunspray® 6N	Potassium silicates
Triton® X-114	Sunspray® 11N	
Triton® X-193	Glycerol	
Triton® B-1956	Propylene glycol	
Pluronic® L-31	Sorbo®	
Renex® 20		
Span® 20		
ATPLUS® 109		

Out of the list in Table 1, Triton® X-100 and Triton® X-114 were chosen and the following mixes were arrived at, based on good miscibility and emulsion characteristics. (For the purpose of comparision, the currently registered/proposed formulations are also listed below).

TABLE 2

1. Formulation No. FT-114: Fenitrothion, Triton® X-114 and Water

	w/v	w/w	v/v %
Fenitrothion technical*	15.3	14.7	11.6
Triton® X-114	14.5	13.9	13.8
Water	To a total vol. of 100 ml.	71.4	74.6
	100.0	100.0	100.0

2. Formulation No. FT-100: Fenitrothion, Triton® X-100 and Water

	w/v	w/w	v/v %
Fenitrothion technical*	15.3	14.7	11.6
Triton® X-100	14.5	13.9	13.7
Water	To a total vol. of 100 ml.	71.4	74.7
	100.0	100.0	100.0

3. Formulation No. FCT-114: Fenitrothion, Cyclo-Sol® 63, Triton® X-114 and Water

	w/v	w/w	v/v %
Fenitrothion technical*	15.3	15.1	11.6
Cyclo-Sol® 63	24.0	23.7	26.3
Triton® X-114	3.0	3.0	2.8
Water	To a total vol. of 100 ml.	58.2	59.3
	100.0	100.0	100.0

4. Formulation No. FCT-100: Fenitrothion, Cyclo-Sol® 63, Triton® X-100 and Water

	w/v	w/w	v/v %
Fenitrothion technical*	15.3	15.1	11.6
Cyclo-Sol® 63	24.0	23.7	26.3
Triton® X-100	3.0	3.0	2.8
Water	To a total vol. of 100 ml.	58.2	59.3
	100.0	100.0	100.0

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TABLE 2, Continued

5. Formulation No. FDA-3409: Fenitrothion, Dowanol TPM, ATLOX 3409F and Water

	w/v	w/w	v/v %
Fenitrothion technical*	15.3	14.8	11.6
Dowanol TPM	1.5	1.45	1.5
ATLOX 3409F	1.5	1.45	1.5
Water	To a total vol. of 100 ml.	82.3	85.4
	100.0	100.0	100.0

6. Formulation No. FCID-585: Fenitrothion, Cyclo-Sol® 63 and ID 585

	w/v	w/w	v/v %
Fenitrothion technical*	15.3	16.9	11.6
Cyclo-Sol® 63	32.0	35.3	35.0
ID 585	To a total vol. of 100 ml.	47.8	53.4
	100.0	100.0	100.0

*Weights were calculated working to 95% purity as per Sumithion® label.

7. Formulation No. AT-114: MATACIL® 180F, Triton® X-114 and Water

	w/v	w/w	v/v %
MATACIL® 180F	24.3	24.9	26.8
Triton® X-114	3.0	3.1	2.8
Water	To a total vol. of 100 ml.	72.0	70.4
	100.0	100.0	100.0

8. Formulation No. AT-100: MATACIL® 180F, Triton® X-100 and Water

	w/v	w/w	v/v %
MATACIL® 180F	24.3	24.9	26.8
Triton® X-100	3.0	3.1	2.8
Water	To a total vol. of 100 ml.	72.0	70.4
	100.0	100.0	100.0

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TABLE 2, Continued:

9. Formulation No. AA-3409: MATACIL® 180F, ATLOX 3409F and Water

	w/v	w/w	v/v %
MATACIL® 180F	24.3	25.0	26.8
ATLOX 3409F	1.5	1.5	1.5
Water	To a total vol. of 100 ml.	73.5	71.7
	100.0	100.0	100.0

10. Formulation No. AID-585: MATACIL® 180F and ID 585

	w/v	w/w	v/v %
MATACIL® 180F	24.3	29.0	26.8
ID 585	To a total vol. of 100 ml.	71.0	73.2
	100.0	100.0	100.0

The above ratios and proportions are applicable to room temperature only (20° to 22° C) and will vary slightly if the ratios are to be calculated at colder temperatures. Table 3 shows density values of ingredients which can be used for calculating the accurate proportions at the desired temperature, although it should be borne in mind that the data in Table 3 are applicable only for the lot number used in the study and may differ slightly for other lot numbers.

Formulation appearance, type and foaming properties were also studied, and the findings are listed in Table 4.

TABLE 3

DENSITY VALUES FOR INGREDIENTS

Ingredients		Density (g/ml)				
No.	Description	5° C	10° C	15° C	20° C	25° C
1.	Fenitrothion technical	1.336	1.328	1.322	1.318	1.315
2.	Triton® X-114	1.065	1.059	1.054	1.050	1.047
3.	Triton® X-100	1.074	1.069	1.065	1.060	1.055
4.	Cyclo-Sol® 63	0.923	0.920	0.917	0.914	0.911
5.	Dowanol TPM	0.996	0.992	0.988	0.983	0.979
6.	ATLOX 3409F	1.042	1.037	1.031	1.026	1.022
7.	ID 585	0.823	0.819	0.816	0.812	0.809
8.	MATACIL® 180F	0.917	0.914	0.911	0.908	0.906
9.	Water	1.000	0.9997	0.9991	0.9982	0.9971

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TABLE 4

APPEARANCE, FOAMING PROPERTIES AND FORMULATION TYPE

Formulation No.	Appearance	Colour	Type	% Solids (w/w)	Foaming Properties
FT-114	Creamy viscous liquid	Pale Yellow	Emulsion	None	Low-disappears in 30 min.
FT-100	Creamy light liquid	" "	"	"	Moderate-disappears in 1.5 hours
FCT-114	" " "	" "	"	"	Low-disappears in 15 min.
FCT-100	" " "	" "	"	"	" " " "
FDA-3409	" " "	White	"	1.13	High-stays for 6 hours
FCID-585	Clear oily liquid	Yellow	Oily solution	None	Not applicable
AT-114	Creamy light liquid	Beige	Emulsion/suspension	7.0	Low-disappears in 20 min.
AT-100	" " "	"	" "	7.0	Low-disappears in 30 min.
AA-3409	" " "	"	" "	8.13	Moderate-disappears in 1.5 hours
AID-585	Cloudy oily liquid	Yellow	Oily suspension	7.0	Not applicable

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For easy mixing under field conditions, it is advisable to follow optimum mixing procedures. For this purpose, the ten formulations were grouped into three distinct classes--A, B, and C.

A. Formulations FT-114, FT-100, FCT-114, FCT-100, FDA-3409 and AA-3409

These six formulations are aqueous emulsions. To ensure ready and thorough mixing, the non-aqueous ingredients must be added first, mixed very well before adding water. After adding water, the mixture should be thoroughly mixed for 20 to 30 minutes.

It is important to bear in mind that the two emulsifiers Triton® X-100 and Triton® X-114 should not be allowed to come into direct contact with water until thorough mixing with non-aqueous ingredients is completed.

B. Formulations AT-114 and AT-100

These two aminocarb formulations are aqueous emulsions with suspended particles. To ensure ready mixing with coagulation, the emulsifier should be added to MATACIL® 180F. The mixing should be so gentle that the emulsifier should be just dispersed in the medium without causing coagulation. Immediately after, the water should be added and the contents be thoroughly mixed for 20 to 30 minutes.

C. Formulations FCID-585 and AID-585

These are non-aqueous formulations, and are very simple to prepare. Ingredients can be added in any sequence and be thoroughly mixed by agitating for up to 20 to 30 min.

II Stability of formulations (phase separation and/or viscosity changes) and re-emulsifiability

The term stability refers to the tendency of the formulation to resist separation into its ingredients. Actual separation of component phases can occur if stability is low. This phenomenon is observed when the formulation is left standing with no stirring; however, phase separation may not be observed visually when the contents were stirred, but a reduction in viscosity can result due to changes in micelle formation and stability.

These aspects were studied at a wide range of temperatures, with tracer dyes and at variable pH and hardness of water. (See Table 5).

TABLE 5

STABILITY OF MIXES

Formulation No.	Time (hr) Required for Phase Separation With No Agitation 5-15° C	20-22° C	Reduction in Viscosity By Approx. 20% With Agitation* 5-15° C	20-22° C
FT-114	Exceptionally stable			
FT-100	2.0-2.5	1.5	12-18	6
FCT-114	2.0-4.0	2.0	24-36	10
FCT-100	3.0-4.0	2.0	24-36	10
FDA-3409	2.0-2.5	1.5	10-15	6
FCID-585	Not applicable			
AT-114	1.0-1.5	0.5	3- 5	3
AT-100	1.0-1.5	0.5	3- 5	3
AA-3409	1.5-2.0	0.75	6- 8	3
AID-585	2.0-3.0	1.0	10-15	5

* Constant stirring at 300 rpm

Stability at Water pH Values of 5 to 8 at 20° C

Distilled water was adjusted to pH values of 5 and 6 by adding dilute acetic acid. An alkaline pH of 8 was obtained by adding drops of 0.1M NaOH to part of the solution of pH 5. Optimum stability occured in water with a pH in the range of 6-8.

Stability at Variable Hardness of Water at 20° C to 22° C

Variable amounts of magnesium and calcium salts were added to water to prepare water with variable degree of hardness. Stability was tested by preparing formulations with these types of water. These tests showed minimal time (0.1-1.7 hr) to phase separation in very hard water with maximum times (0.5-2.0 hrs) in soft water.

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The term re-emulsifiability refers to the tendency of the separated phases to revert to the emulsion state having the same stability as that of the freshly prepared one. This aspect was studied after gentle and vigorous agitation. (See Table 6).

TABLE 6

RE-EMULSIFIABILITY UPON STORAGE AT 5° TO 15° C FOR UP TO FOUR DAYS

Formulation No.	Re-emulsifiability After Standing for 4 Days at 5° to 15° C: With Gentle Shaking (300 rpm)	With Good Agitation (Vigorous shaking)	Resettling Time (hr) After Vigorous Shaking
FT-114	No need to shake	No need to shake	Exceptionally stable
FT-100	Fair	Excellent	8 to 10
FCT-114	Good	Excellent	16 to 20
FCT-100	Good	Excellent	16 to 20
FDA-3409	Good	Excellent	2.5 to 4.5
FCID-585	Not applicable	Not applicable	Not applicable
AT-114	Poor	Good	0.2 to 0.5
AT-100	Poor	Good	0.2 to 0.5
AA-3409	Fair	Good	0.33 to 0.5
AID-585	Poor	Fair	0.2 to 0.4

III Compatibility of active ingredient

Very often, the inert ingredients in the formulation can interact chemically with the active ingredient reducing its pesticidal activity. This aspect was investigated after a lapse of six weeks after preparing formulations. The active ingredient was recovered almost completely (within the experimental error) in all formulations indicating a good compatibility between ingredients.

IV Mixing and pumping capabilities, viscosity, pour point and freezing point of ingredients

Viscosity, pour and freezing points of ingredients directly influence the mixing and pumping capabilities with the available equipment under field conditions. Tables 7 and 8 provide the required data.

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TABLE 7

VISCOSITY OF INGREDIENTS

Ingredient		Viscosity (cp)				
No.	Description	5° C	10° C	15° C	20° C	25° C
1.	Fenitrothion technical	126.0	82.5	53.4	40.0	27.7
2.	Triton® X-114	1470.0	974.0	600.0	380.0	204.0
3.	Triton® X-100	Solid	Extremely viscous	6880.0	1010.0	228.0
4.	Cyclo-Sol® 63	1.62	1.47	1.33	1.28	1.13
5.	Dowanol TPM	20.2	16.3	13.1	10.8	9.27
6.	ATLOX 3409F	Extremely viscous	5660.0	443.0	329.0	217.0
7.	ID 585	2.39	2.12	1.89	1.78	1.56
8.	MATACIL® 180F	157.0	111.0	80.0	62.0	45.8
9.	Water	1.52	1.31	1.14	1.05	0.894

TABLE 8

PROPERTIES OF INGREDIENTS

Ingredients No.	Ingredients Description	Appearance and Colour	Solubility in Water	Product Nature	Pour Point/ Freezing Point (° C)	Flash Point (° C)
1.	Fenitrothion technical	Clear brownish-yellow liquid	Insoluble	Single product	Below 0° C	---
2.	Triton® X-114	Clear colourless liquid	Soluble	" "	Pour point -9° C	> 150° C
3.	Triton® X-100	Clear to mildly cloudy colourless liquid	"	" "	Pour point 7° C Freezes at 6° C	> 150° C
4.	Cyclo-Sol® 63	Clear thin colourless liquid	Insoluble	Mixture of aromatic hydrocarbons	Below 0° C	57° C
5.	Dowanol TPM	Clear thin colourless liquid	Soluble	Single Product	" "	110° C
6.	ATLOX 3409F	Cloudy amber-coloured liquid	"	Formulated product	Pour point 4° C Freezes 3° C	12.2° C
7.	ID 585	Clear creamy yellow thin liquid	Insoluble	Mixture of hyrdocarbons	Below 0° C	52° C
8.	MATACIL® 180F	Heavy creamy beige liquid	"	Formulated product	" "	93° C
9.	Water	Clear colourless liquid	---	Single Product	Freezes at 0° C	---

Triton® X-100 is extremely viscous below 10° C and has a pour point of 7° C. ATLOX 3409F is very viscous below 7° C and has a pour point of 4° C. At extremely cold field temperatures (say 5° C and below), both Triton® X-100 and ATLOX 3409F were difficult to pump out; the Triton® X-100 was completely solid under these conditions. Triton® X-114 did not pose any of these problems, since it has a considerably low pour point (-9° C), and was easier to pump out and mix with other ingredients. Both Triton® X-114 and MATACIL® 180F were highly viscous at 5° C and below, and therefore, high powered pumps are required to pump these at cold field temperatures.

With regard to mixing procedures for Triton® X-100 or Triton® X-114, an additional problem will arise if the emulsifiers were allowed to come into direct contact with water; these two coemicals tend to form a gel when added directly to water, contributing to difficulties for pumping out and mixing. The gel-formation tendency is much higher for Triton® X-100 than for Triton® X-114. This problem can be totally avoided if all the non-aqueous ingredients were thoroughly mixed before adding water.

V. Spray atomization characteristics

(a) With hydraulic and spinning disc nozzle systems in the Institute's Spray Chamber

The efficiency of spray droplet targetability is related to droplet size spectrum. It is well known that the physical and chemical properties of ingredients contribute to the spray atomization efficiency of formulations and consequently contribute to the droplet size spectra. A study was therefore made on viscosity, density and surface tension values of the ten spray formulations and the data are listed in Tables 9 to 12. Spray atomization characteristics were studied using a hydraulic nozzle (a solid cone nozzle) and a spinning disc nozzle (Mini ULVA from Micron Corporation). Table 12 lists the linear regression equations for the spread factor data. Data on droplet spectra are presented in Tables 13 and 14.

(b) With aircraft containing Micronair nozzles when spray was applied under field conditions

Spray droplet spectra were obtained under field conditions only for FT-100, AT-100, FCT-100, AA-3409 and AID-585. Data are presented in Table 15.

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TABLE 9

VISCOSITY VALUES OF FORMULATIONS

Formulation		Viscosity (cp)				
No.	Description	5° C	10° C	15° C	20° C	25° C
1.	FT-114	365	158	1449	990	276
2.	FT-100	11.8	11.5	12.0	14.8	16.4
3.	FCT-114	6.80	6.32	6.20	4.50	3.90
4.	FCT-100	9.25	7.42	6.26	5.69	4.72
5.	FDA-3409	2.89	2.53	2.13	1.80	1.49
6.	FCID-585	2.80	2.38	2.06	1.95	1.56
7.	AT-114	4.05	3.35	2.87	2.74	2.39
8.	AT-100	5.89	3.69	3.18	2.66	1.26
9.	AA-3409	2.94	2.58	2.12	1.80	1.54
10.	AID-585	5.36	4.24	3.48	3.23	2.80

TABLE 10

DENSITY VALUES OF FORMULATIONS

Formulation		Density (g/ml)				
No.	Description	5° C	10° C	15° C	20° C	25° C
1.	FT-114	1.046	1.045	1.044	1.042	1.040
2.	FT-100	1.055	1.051	1.050	1.048	1.046
3.	FCT-114	1.012	1.011	1.008	1.005	0.984
4.	FCT-100	1.016	1.013	1.011	1.009	1.040
5.	FDA-3409	1.012	1.011	1.010	1.009	1.008
6.	FCID-585	0.9233	0.9199	0.9158	0.9122	0.9082
7.	AT-114	0.9924	0.9899	0.9866	0.9853	0.9839
8.	AT-100	1.001	1.000	0.9970	0.9940	0.9916
9.	AA-3409	1.0133	1.0125	1.0116	1.0108	1.0096
10.	AID-585	0.8418	0.8384	0.8347	0.8319	0.8294

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TABLE 11

SURFACE TENSION VALUES OF FORMULATIONS

Formulation No.	Description	Surface Tension (dyne/cm) 5° C	10° C	15° C	20° C	25° C
1.	FT-114	NR	NR	NR	NR	NR*
2.	FT-100	32.26	32.16	32.10	32.04	31.99
3.	FCT-114	32.24	32.22	32.10	32.03	31.35
4.	FCT-100	34.66	33.34	33.30	33.24	33.12
5.	FDA-3409	28.85	28.83	26.40	26.38	26.35
6.	FCID-585	27.87	27.14	26.70	27.22	26.79
7.	AT-114	23.01	22.76	22.42	22.33	21.92
8.	AT-100	32.53	31.86	30.40	31.48	30.06
9.	AA-3409	31.65	31.63	30.34	30.31	29.01
10.	AID-585	30.11	29.17	29.04	28.53	26.01

* NR--Not Ready Yet

TABLE 12

SPREAD FACTOR DATA OF FORMULATIONS

Formulation No.	Linear regression equation d = drop diam. D = stain diam.	(R = corr. coef.)^2 (%)
FT-114	d = 6.75 + 0.268 D	99.1
FT-100	d = 1.50 + 0.309 D	99.5
FCT-114	d = 2.60 + 0.308 D	99.6
FCT-100	d = 0.461 + 0.367 D	99.1
FDA-3409	d = 0.0671+ 0.328 D	99.9
FCID-585	d = 0.104 + 0.222 D	99.9
AT-114	d = 3.85 + 0.314 D	99.6
AT-100	d =-0.102 + 0.325 D	99.9
AA-3409	d = 0.480 + 0.325 D	99.6
AID-585	d = 1.77 + 0.171 D	99.9

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TABLE 13

LABORATORY STUDY

DATA ON DROPLET SPECTRUM USING SPINNING DISC NOZZLE (KROMEKOTE® CARD DATA)

Formulation No.	NMD (um)	VMD (um)	D max (um)	D min (um)	Number Mode (um)	Volume Mode (um)
FT-114	NR*	NR	155	10	35-55	NR
FT-100	31	123	149	5	35-55	NR
FCT-114	21	50	115	6	17-23	30-55
FCT-100	18	140	176	5	17-25	NR
FDA-3409	27	105	157	4	15-22	NR
FCID-585	28	51	156	3	25-50	NR
AT-114	30	140	154	7	30-40	NR
AT-100	26	79	137	4	29-37	NR
AA-3409	NR	NR	NR	NR	NR	NR
AID-585	25	115	166	4	30-40	NR

*NR--Not Ready Yet

TABLE 14

LABORATORY STUDY

DATA ON DROPLET SPECTRUM USING HYDRAULIC NOZZLE (KROMEKOTE® CARD DATA)

Formulation No.	NMD (um)	VMD (um)	D max (um)	D min (um)	Number Mode (um)	Volume Mode (um)
FT-114	74	140	195	16	95-110	NR*
FT-100	63	150	219	5	100-123	NR
FCT-114	60	110	174	6	75- 90	NR
FCT-100	66	115	176	5	60-100	NR
FDA-3409	58	138	182	4	75-110	NR
FCID-585	45	145	214	3	25- 50	NR
AT-114	50	165	225	8	55- 95	NR
AT-100	44	90	137	4	35- 55	NR
AA-3409	NR	NR	NR	NR	NR	NR
AID-585	45	108	122	4	40- 50	NR

*NR--Not Ready Yet

TABLE 15

FIELD STUDY

DATA ON DROPLET SPECTRUM USING AIRCRAFT WITH MICRONAIR NOZZLE (KROMEKOTE® CARD DATA)

Formulation No.	NMD (um)	VMD (um)	D max (um)	D min (um)	Number Mode (um)	Volume Mode (um)
FT-100	24	31	130	4	20-30	Bimodal Curve
FCT-100	34	99	138	4		110-160
AT-100	20	32	101	9	20-30	20-35
AA-3409	28	36	73	7	30-40	NR*
AID-585	35	41	85	16	35-45	NR

*NR--Not Ready Yet

VI Rate and Degree of Droplet Evaporation

The rate and degree of droplet evaporation affect drop size in flight and, therefore, contributes to targetability. The data will be available in a file report.

VII Rate of Vapourization of Active Ingredient from Droplet Surface and/or Codistillation

This aspect is being studied and preliminary results indicate that the higher concentration of emulsifiers the slower the rate of codistillation of active ingredient from droplet surface. There is also some evidence that certain volatile solvents tend to enhance the rate of vapourization of AI from droplet surface.

The results of this study will be available in a file report.

VIII Droplet Impaction Characteristics

This aspect is being pursued at present using balsam fir seedlings. Droplet impaction efficiency is being estimated on needles. Results will be available in a file report.

IX Droplet Retention Characteristics on Balsam, Fir and Spruce Needles

This is being pursued at present, and results will be available in a file report.

X Droplet Dissipation Characteristics

This has been studied and the findings will be available in a file report.

DISCUSSION

Out of the eight emulsions studied, fenitrothion - Triton® X-114 appears to be the most satisfactory formulation from the stability point of view, ease of handling, and mixing.

The drop size spectra obtained in the laboratory using the spinning disc nozzle are quite comparable to those obtained under field conditions, using Micronair nozzles. Data using the hydraulic nozzle indicate coarser spectra; however, the NMD, VMD, D max data are not totally unsatisfactory. The formulations with the new emulsifier Triton® X-114 appear to be quite comparable to the currently used/proposed ones.

The aminocarb flowable formulations either with ATLOX 3409F or with Triton® X-114 or with ID 585 should be sprayed once mixed. They should not be stored for more than 8 hours before spraying. The AID-585 oil-based formulation is the worst of all for instability upon storage.

Spray Deposition Pattern and Droplet Spectra of B.t. Formulations as Related to Spruce Budworm Mortality and Defoliation

A cooperative field research study was undertaken in summer 1982 in the Spray Kinetics and Physics Section to study spray deposition pattern of *B. thuringiensis* formulations on conifer forests as related to spruce budworm mortality and degree of defoliation. The study was carried out under the financial support of the eastern component of the CANUSA program. Scientists involved in the program are: A. Sundaram, P.G. Fast, and O.N. Morris of FPMI; C.M. Himel, University of Georgia; and N.R. Dubois, U.S.D.A. Forest Service, Hamden, CT. The objective of the study is to investigate if the addition of certain polymeric components to the *B.t.* formulation would enhance the foliar life of *B.t.* spores by reducing the rate of UV inactivation. The various components of the study were: development of a *B.t.* formulation containing the polymeric components; investigation of formulation properties as related to spray droplet spectrum; spray distribution pattern on conifer trees; droplet and deposit concentration on conifer needles and on ground sampling units by droplet counting and colorimetry; deposit concentration of *B.t.* on conifer foliage by laboratory bioassay using the sprayed buds; deposit concentration of *B.t.* on ground sampling units by spore counting techniques and diet bioassays, efficacy and percent defoliation.

The study was successfully completed and the various parameters have been almost measured. The results of the study will soon be available in an information report.

PRELIMINARY RESULTS OF 1982 FIELD RESEARCH ON THE SPRUCE BUDMOTH, *Zeiraphea canadensis* (LEPIDOPTERA: OLETHREUTIDAE)

(STUDY REF. NO. FP-11)

REPORT TO THE ANNUAL FOREST PEST CONTROL FORUM

JEAN TURGEON

FOREST PEST MANAGEMENT INSTITUTE

CANADIAN FORESTRY SERVICE

ENVIRONMENT CANADA

SAULT STE. MARIE, ONTARIO

P6A 5M7

NOVEMBER 1982

SUMMARY

During 1982, behavioral studies on Spruce Budmoth (Sbm), *Zeiraphera canadensis* Mutuura and Freeman (1st instar to adult), were carried out in 2 white spruce stands (8-17 year-old trees) growing in abandoned fields. Sites 1 and 2 were respectively located 10 and 35 km north of Bathurst, N.B. Information collected concerned:

1. the type of damage associated with each instar
2. the development of larvae and white spruce buds and
3. the characteristics of shoots and buds attacked.

In order to identify the best part of the tree to sample, we looked at the distribution of Sbm within the tree canopy. Therefore, we sampled branches from the east, south, west and north of the upper, mid and lower crown of the tree, and compared numbers of larvae per 100 buds. Leaders of trees were also sampled.

The effect of predation during the pupal development of Sbm was assessed at site 2 only.

We sampled some of J.D. Irving Ltd. white spruce plantations to find out if Sbm was evenly distributed among all the plantations, or if they preferred trees of certain ages. Also, preliminary tests necessary for the identification of a sexual attractant for Sbm were carried out in a 1973 plantation.

RESULTS

The eggs hatched sometime in May (unable to determine beginning or duration of eclosion due to late start of project). First intar larvae enter the base of the bud, where the scales covering the bud are thinner (so that they can enter by chewing through these scales even if the bud is not open), feed on the outer edges of young needles and move up to the distal end of the bud. Second instars remain in that area, enter the distal needles, destroying most of them. Third instar larvae cut needles at the base and start chewing on the bark, paying less attention to the needles. They will continue to feed that way (under the shoot, facing the ground) until they complete the 4th instar. The 3rd and 4th instars are responsible for the disfiguration of trees (Christmas candy cane). It is recommended that any form of control take place before they reach those instars.

After completing their larval development (which is estimated to last approximatively 30 days) they drop to the ground and remain as prepupae for 6 days. Emergence of adults starts 18 days later (mid-July). Females start ovipositing within a week.

Although the analysis is not complete, preliminary results indicate that the density of Sbm is greatly affected by the age of the host trees. The completion of the analysis will enable us to identify some of the plantations most likely to have higher densities of Sbm in 1983.

Highest larval densities of Sbm were observed on the leaders of trees. The mid crown had significantly less larvae per 100 buds than the upper crown but significantly more than the lower one. Sbm is evenly distributed around the tree, showing no preference for any direction. These results suggest that samples used to detect the presence of Z. *canadensis* larvae must be taken on terminal shoots of branches located in the upper crown of the tree.

Shoots of a branch with a high number of buds have a higher chance of being attacked than the ones with low number of buds. On these shoots, larvae will prefer to attack the terminal buds (as opposed to lateral buds).

Predation by ants resulted in the disappearance of 80 and 95% of the pupae placed under the trees during the 1^{st} and 2^{nd} week of experiments. Predatory mites were also observed killing Sbm pupae.

(E)9-14:AC revealed to be the best sex attractant for male Sbm. This compound will be useful for the monitoring of Sbm populations.

LABORATORY EVALUATION OF THE TOXICITY OF INSECTICIDES AGAINST FOREST INSECTS PESTS IN 1982

(Study Ref. FP-12)

Report to the Annual Forest Pest Control Forum

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November 1982

SUMMARY

The objectives of the program in 1982 were:

- to compare the toxicity of recent flowable formulations of Sumithion® and MATACIL® with existing formulations.

- to assess the potential of several insecticides for the control of forest insect pests, including 3 formulations of the carbamate Sevin® (carbaryl), the pyrethroid Decis® (deltamethrin), the carbamate UC72987, the amidinohydrazone AC217,300, the organophosphorous compounds MV770 and 3 new formulations of dimethoate.

- to determine the susceptibility of Zeiraphera spp. (spruce budmoth) larvae to fenitrothion and aminocarb.

- to evaluate the suitability of aqueous formulations of technical Sumithion® and MATACIL® 180F containing the emulsifiers Triton® X100 or Triton® X114 as replacements for Atlox 3409F. The results of this study are presented in a separate report.

- to compare the toxicity of formulations containing different concentrations of these emulsifiers.

These insecticides and formulations were evaluated primarily for their contact and/or residual toxicity against spruce budworm larvae (Choristoneura fumiferana). To determine contact toxicity, a selected concentration of the insecticide was sprayed at 6 standard dosages on fully exposed fifth instar larvae in a modified Potter's tower. Mortality was assessed at 24, 48 and 72 hr after treatment and LD_{50} and LD_{95} values determined by probit analysis. Field collected spruce budmoth larvae were treated in the same fashion. Residual toxicity was determined by spraying 4-5 year old balsam fir and white spruce trees with a selected concentration at a standard dosage of 11.2 L/ha. Untreated larvae were then exposed to clipped foliage from these trees shortly after treatment and again at 1, 3, 5 and 10 days after the trees had been exposed to natural weathering conditions. Mortality was recorded 24, 48 and 72 hr after each exposure.

RESULTS[1]

The results of the 1982 contact and residual toxicity studies are summarized in Tables 1 and 2 respectively.

Very preliminary tests indicate that spruce budmoth larvae are at least as susceptibe to fenitrothion as spruce budworm larvae.

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[1] Much of the data is preliminary and requires confirmation.

Decis® (deltamethrin) is a highly toxic contact insecticide to spruce budworm larvae and a preliminary residual toxicity trial indicates that at a very low dosage its residual activity is comparable to cypermethrin and permethrin at higher dosages.

The 3 Sevin® (carbaryl) formulations were comparable in their contact toxicity. In June, although treated at different times, their residual toxicity also appeared to be similar except for Sevin FR in Dowanol TPM which had much longer effectiveness than Sevin FR in PA-3. Direct comparison of these two formulations in August again indicated that the former provided better residual activity than the latter.

The contact toxicity of the carbamate UC72987 is comparable to aminocarb.

The contact toxicity of Sumithion® Flowable in water was slightly better than the New Brunswick formulation of fenitrothion and an aqueous formulation of technical Sumithion with 14.5% Triton X114. However, a reduction in the Triton X114 concentration to 0.7% increased the toxicity of such a formulation ca twofold to a level comparable with Sumithion Flowable. An oil formulation of technical Sumithion® was more toxic than corresponding aqueous formulations. In one test the residual toxicity of Sumithion Flowable on balsam fir was less than technical Sumithion but comparable on white spruce.

The contact toxicity of MATACIL 180F in ID585 was very similar to other MATACIL formulations in the same solvent. Oil formulations of MATACIL 180F were more potent than an aqueous formulaton containng ATLOX 3409F. The contact toxicities of MATACIL 180F formulations with Canola or Soya Cooking Oil were similar but slightly less than the corresponding ID585 formulation. No appreciable differences in residual toxicity were observed between MATACIL 180F in ID585 or Canola Oil + Cyclosol.

Dimethoate at 224 g AI/ha did not provide adequate residual activity in the test performed in 1982.

The residual and stomach toxicity of AC217,300, an amidinohydrazone compound, were also evaluated in 1982. Mortality occurred slowly after exposure to this compound with the result that drying of the foliage became a problem using conventional techniques. However, the results were sufficiently promising to warrant making the necessary modifications and continuing the evaluation of this compound for forest insect control.

In tests designed to assess the crawling contact and/or stomach toxicity of MV770, 72 hr LD_{50} and LD_{95} values were 0.168 and 0.427 µg AI/cm^2 respectively compared to 0.164 and 0.318 µg AI/cm^2 in contact toxicity tests performed in 1981.

Studies in cooperation with the National Research Council to determine the effects of droplet size on the toxicity of insecticides to spruce budworm larvae were also continued in 1982 using a fenitrothion formulation containing 14% AI in 35% Cyclosol 63 and 54% ID585. The NAE droplet generator was calibrated to deliver ca 25 mµ drops but the actual sizes produced are not yet available. Nine to 10 droplets per fifth instar larvae were required to give a 72 hr LD_{50} while 21-22 droplets were required for the 72 hr LD_{95}. In 1981, under Dr. P.C. Nigam's direction about 3 droplets gave the 72 hr LD_{50} and 9 droplets the 72 hr LD_{95} with a mean drop size of 66 mµ.

Table 1. The Contact Toxicity of Insecticides to Forest Insect Pests, 1982.

Insect	Instar	Insecticide/Formulation	% Conc. AI	# Tests	Time hr	LD50 µg AI/cm²	LD95 µg AI/cm²
Spruce Budmoth	2-3	Sumithion® Tech., ATLOX, TPM, H_2O	0.3	1	72	.086	.159
	4-5	Sumithion® Tech., ATLOX, TPM, H_2O	0.3	1	72	.197	.299
Spruce Budworm	4	Sumithion® Tech., ATLOX, TPM, H_2O	0.3	1	72	.125	.438
	5	Decis® EC, AR60	0.001	3	72	.0004	.0010
	5	Sevin® FR, PA3, H_2O	1.6	3	72	.788	2.606
	5	Sevin® 4 Oil, ID 585	2.0	3	72	.762	3.078
	5	Sevin® XLR, H_2O	1.6	3	72	.800	2.274
	5	UC72987 Tech., Dowar 7:3	0.07	2	72	.032	.067
	5	Sumithion® Flowable, H_2O	0.7	4	72	.228	.507
	5	Sumithion® Tech., ATLOX, TPM, H_2O	0.7	3	72	.400	.766
	5	Sumithion® Tech., 14.5% Triton X114, H_2O	0.7	4	72	.456	.875
	5	Sumithion® Tech., 0.7% Triton X114, H_2O	0.7	3	72	.226	.441
	5	Sumithion® Tech., Cyclosol, ID 585	0.2	4	72	.096	.178
	5	MATACIL® Tech., ID 585	0.1	2	72	.030	.065
	5	MATACIL® 1.8D, ID 585	0.1	2	72	.025	.067
	5	MATACIL® 180F, ID 585	0.1	2	72	.030	.070
	5	MATACIL® 180F, ATLOX, H_2O	0.1	4	72	.073	.155
	5	MATACIL® 180F, Canola Oil, Cyclosol	0.1	3	72	.052	.090
	5	MATACIL® 180F, Soya Oil	0.08	3	72	.058	.127

Table 2. The residual toxicity of insecticides on balsam fir (Bf) and white spruce (Ws) to spruce budworm larvae under natural weathering conditions

Insecticide/ formulation	Dosage g AI/ha	Treat. date	Host	% corrected mortality after 72 hr exposure to treated foliage — Days post 0	1	3	5	10
Decis® EC, Dowanol TPM	11.2	31.5	Bf	-	-	98	97	35
			Ws	-	-	92	59	28
Cypermethrin EC, Dowanol TPM	28	31.5	Bf	100	100	98	92	25
			Ws	98	98	77	44	13
Permethrin EC, Dowanol TPM	224	31.5	Bf	100	100	100	100	47
			Ws	100	100	95	92	16
Sumithion® Flowable SSS[1]	224	1.6[2]	Bf	100	44	43	0	2
		15.6[3]	Ws	100	22	13	0	0
Sumithion® Tech. SSS	224	1.6[2]	Bf	100	89	66	52	10
		15.6[3]	Ws	98	21	0	0	0
MATACIL®180F ID585	224	2.6[2]	Bf	100	100	100	88	97
		15.6[3]	Ws	100	100	95	52	8
MATACIL®180F Canola Oil Cyclosol	224	2.6[2]	Bf	100	100	97	90	88
		15.6[3]	Ws	100	100	93	59	26
Sevin Fr, PA₃ H_2O	560	15.6	Bf	100	95	27	-	-
			Ws	97	100	56	-	-
		27.8[4]	Bf	-	93	37	0	0
			El[5]	-	100	7	0	0
Sevin Fr, TPM H_2O	560	4.6	Bf	-	-	100	87	39
			Ws	-	-	77	63	22
		27.8[4]	Bf	-	97	63	28	3
			El	-	100	37	7	0
Sevin 4 Oil, ID585	560	4.6[2]	Bf	100	100	87	61	8
		15.6[3]	Ws	85	82	35	19	1
Sevin XLR, H_2O	560	16.6	Bf	100	87	57	54	6
			Ws	100	41	65	30	-
Dimethoate P	224	16.6	Bf	100	50	32	6	0
			Ws	49	7	7	0	-

[1] Standard Solvent Solution = 80% Ethylene Glycol + 20% Dowanol TPM
[2] 3, 5 and 10 day trees treated this date
[3] 0, 1 day trees treated this date
[4] Lab reared spruce budworm larvae used
[5] European larch

Table 3. Insecticides Tested in 1982.

Compound	Formulation	Type	Source
AC 217, 300	98.6% Tech.	Amidinohydrazone	Cyanamid
Bolstar	72.0% EC	Organophosphate	Chemagro
Decis	2.5% EC	Pyrethroid	Hoechst
Dimethoate	50% in Urea	Organophosphate	Cheminova
	50% in Glucose	Organophosphate	Cheminova
Dylox 4.2	41.9% EC	Organophosphate	Chemagro
MATACIL	98.0% Tech.	Carbamate	Chemagro
MATACIL	19.6% Flow.	Carbamate	Chemagro
MV 770-4E	47.93% EC	Organophosphate	Stauffer
Sevin	47.9% FR	Carbamate	Union Carbide
	47.9% 4-Oil	Carbamate	Union Carbide
	47.9% XLR	Carbamate	Union Carbide
Sumithion	99.8% Tech.	Organophosphate	Sumitomo
	21.6% Flow.	Organophosphate	Sumitomo
U-56295	85% WP	Carbamate	Upjohn
	99.0% Tech.	Carbamate	Upjohn
UC 70433	96.0% Tech.		Union Carbide
UC 72987	90.5% Tech.		Union Carbide

The Efficacy of Experimental Formulations of Matacil, Fenitrothion and Sunspray 6N - A SUMMARY OF PRELIMINARY RESULTS

Study Ref. No. - FP-13 (1982)

A REPORT TO THE PEST CONTROL FORUM

By

B.L. Cadogan

Forest Pest Management Institute
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THE EFFICACY OF EXPERIMENTAL FORMULATIONS OF MATACIL, FENITROTHION AND SUNSPRAY 6N--A SUMMARY OF PRELIMINARY RESULTS

B.L. Cadogan

During the spring of 1982, two research trials were conducted near Charlo, New Brunswick. In response to the Spitzer Report on Reye's Syndrome[1], a trial was conducted on short notice to determine the efficacy of three experimental tank formulations--two of fenitrothion and the other, Matacil--applied aerially to control spruce budworm (sbw) Choristoneura fumiferana (Clem.). Each formulation contained Triton X-100, which as an emulsifier was being investigated as a replacement for Atlox.

The other trial was conducted to determine if Sunspray 6N oil, an integral component of some 'flowable' insecticide concentrates, was by itself, insecticidal.

The experimental blocks were 50 ha (1.0 x 0.5 km) in area, and the test tree species Balsam fir, Abies balsamea (L) Mill. Two unsprayed areas were retained to monitor untreated sbw populations--one to compare with the insecticide blocks, and the other with Sunspray. Kromekote cards and glass slides were placed in the treated blocks on units described by Randall (1980)[2] to monitor the sprays. The Matacil at 70 g (AI)/ha and fenitrothion at 210 g (AI)/ha were applied twice in 1.5 l. of aqueous formulation per ha using a Cessna 188C Agtruck, fitted with four Micronair rotary atomizers. The oil was sprayed neat once at 1.5 l/ha. All the sprays were dyed (aqueous with Rhodamine B and oil with Automate B.) to facilitate analysis of the spray deposits. Data relating to the formulations, sprays, aircraft, and weather are summarized in Tables 1 and 2.

..../2

Table 1. Spray formulations mixed at Charlo, N.B. 1982.

Formulation no.	Block no.	Ingredients or materials	%(vol)	*Volume mixed per application (litre)
1	1	Fenitrothion conc.	10.9	12.3
		Triton X 100	3.0	3.6
		Cyclosol 63	24.0	27.3
		Water	61.1	69.3
		Rhodamine dye	1.0	1.1
2	2	Matacil 180F	26.7	30.3
		Triton X100	3.0	3.4
		Water	69.3	78.7
		Rhodamine dye	1.0	1.1
3	3	Fenitrothion conc.	10.9	12.3
		Triton X100	10.7	12.1
		Water	77.4	88.0
		Rhodamine dye	1.0	1.1

Ingredients of each formulation are listed in the order in which they were mixed.

* Includes surplus to optimize flow rate--only 75 L were applied.

Table 2. Summary of field data for research sprays conducted near Charlo, N.B. 1982.

	Block 1		Block 2		Block 3		Block 4
	*	**	*	**	*	**	*
Date	12/6/82 -	17/6/82	12/6/82 -	17/6/82	12/6/82 -	17/6/82	12/6/82
Spray time	2100 hr	0745 hr	2050 hr	0715 hr	0735 hr	0655 hr	0700 hr
Block size	50 ha		50 ha		50 ha		50 ha
Applic. rate	1.5 L/ha		1.5 L/ha		1.5 L/ha		1.5 /ha
Diluent	water		water		water		Sunspray 6N
Insecticide	Fenitrothion		Aminocarb 180F		Fenitrothion		none
Amount Active	210 g/ha		70 g/ha		210 g/ha		N/A
Aircraft Data	Cessna		188C				
Speed (km/hr)	160		160		160		160
Height (m)	30		30		30		30
Equipment	AU 3000 Micronairs		AU 3000 Micronairs		AU 3000 Micronairs		AU 3000 Micronairs
No. of units	4		4		4		4
Emission rate	23.7 L/min		23.7 L/min		23.7 L/min		23.7 L/min
Weather Data	*	**	*	**	*	**	*
Wind speed (km/hr)	3 ± 2	3 ± 1	3 ± 2	5 ± 3	3 ± 2	3 ± 1	0 - 1
Temp. °C	15.5	11.1	16.1	11.1	13.3	11.7	8.3
R.H. %	71	75	62	81	80	87	73
Inversion	INV 1.0°F	INV 1.0°F	INV 1.0°F	INV 2.0°F	INV 3.0°F	INV 4.0°F	INV 3.0°F

* 1st Application
** 2nd Application

Results

Mixing difficulties were experienced at temperatures less than 6° C due probably to the comparatively high pour point of Triton X-100. Preliminary analyses reveal that none of the formulations exhibited the high toxicity to sbw which is characteristic of both Matacil and fenitrothion. The data show corrected mortalities (which are usually those attributed to the treatments) did not exceed 60% and that reasonably high population remained 10 days after the 2nd application.

The sbw population in the Sunspray block did not differ significantly from that in the untreated area, thus inferring that the oil by itself displayed no insecticidal activity. Tables 3 and 4 summarize these data.

Because appreciable unmeasured defoliation occurred before the sprays were applied, the % defoliation cannot be used as a conclusive parameter by which the effectiveness of the formulations can be judged; however, the Matacil block was observed to be considerably less defoliated than the other blocks.

These preliminary findings suggest that (i) the formulations tested under cold conditions were not as effective in controlling C. fumiferana and (ii) Sunspray 6N oil is not discernibly toxic to sbw at the quantities applied.

1. New Brunswick Task Force on the Environment and Reye's Syndrome. Submitted to the Hon. Brenda Robertson, Minister of Health, at Fredericton. April 28, 1982.

2. A.P. Randall, 1980. A simple device for collecting aerial spray deposits from calibration trials and spray operations. CFS bi-monthly Research Notes. Vol. 30 (5): 23.

N.B. These data are very preliminary and should be acknowledged accordingly.

Table 3. Spray deposit and spruce budworm population reduction, Charlo, N.B. 1982.

Block no.	Treatment (formulation)	1st Application 82-06-12 Deposit				2nd Application 82-06-17 Deposit				Population reduction (larvae/branch) Sampling dates				
		drops/cm² (x)	L/ha (x)	VMD	Dmax	drops/cm² (x)	L/ha (x)	VMD	Dmax	June 8	June 15	June 19	June 24	June 27
1	Fenitrothion (Novathion) (1)	4.3	0.042	-	-	5.3	0.036	-	-	17.0	13.4	8.1	9.3	7.9
2	Matacil 180F (2)	3.3	0.054	-	-	2.9	0.047	-	-	20.8	12.0	6.8	5.6	3.5
3	Fenitrothion (Novathion) (3)	6.2	0.040	-	-	10.6	0.074	-	-	37.5	17.5	8.6	9.3	5.6
C1	Untreated									29.4	27.2	24.1	16.9	10.9
4	Sunspray 6N	10.2	0.515	-	-	N/A	N/A	N/A	N/A	18.7	33.9	24.1	21.0	N/A
C2	Untreated									20.0	26.6	17.5	24.0	N/A

\- At press time, these data were unavailable.
N/A Single application only.

Table 4. Spruce budworm population reduction due to treatment, Charlo, N.B. 1982

Block and formulation no.	Treatment [g(AI)/ha]	Spray date	No. sample per date	*Corrected larval mortality (%)				Defoliation (%)
				June 15[1]	June 19[2]	June 24[3]	June 27[4]	
1	Fenitrothion (Novathion) 210 g(AI)/ha	12-06-82 17-06-82	100	15	42	14	0	48
2	Matacil 70 g(AI)/ha	12-06-82 17-06-82	100	38	61	58	55	25
3	Fenitrothion (Novathion) 210 g(AI)/ha	12-06-82 17-06-82	100	50	72	61	60	90
4	Sunspray 6N 1.5 L/ha	12-06-82	100	0	0	0	--	68
C1	Untreated	Used for Blocks 1, 2 and 3						93
C2	Untreated	Used for Block 4 only						54

* Using a computerized adaptation of Abbott's formula (1925 - J. Econ. Entomol. 18:265-267).
[1] 2 days after 1st application.
[2] 2 days after 2nd application.
[3] 7 days after 2nd application.
[4] 10 days after 2nd application.

SUMMARY REPORT ON STUDIES OF THE IMPACT OF INSECTICIDES ON FOREST ECOSYSTEMS

(Study Ref. FP-15)

Report to the 1982 Forest Pest Control Forum

Environmental Impact Section

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November, 1982.

INTRODUCTION

Field studies carried out by the Environmental Impact Section of the Forest Pest Management Institute in 1982 evaluated the effects of semi-operational applications of MATACIL® 180F Flowable formulations and small block and ground applications of aminocarb and fenitrothion water based formulations with the emulsifier TRITON® X-100 on forest songbirds, aquatic organisms and some non-target insects. MATACIL® 180F studies carried out in 1982 were intended to complement studies reported in 1981 to provide required data for evaluating this new aminocarb formulation for registration as a spruce budworm, *Choristoneura fumiferana* Clem., control agent. Studies on formulations containing TRITON® X-100 were initiated as part of the CFS "Action Plan" to provide new registered tank mixes of aminocarb and fenitrothion set up in the late spring of 1982 in response to the decision not to allow the use of the emulsifier Atlox 3409F in forest spray programs in New Brunswick.

Field studies evaluating pesticide treatments are summarized in Table 1.

AMINOCARB FLOWABLE STUDIES

New Brunswick

Forest songbird, benthic invertebrate and native fish (Atlantic salmon and brook trout) populations were intensively monitored in 3000-5000 ha forest blocks treated by TBM aircraft with oil and water based aminocarb flowable (MATACIL® 180F) formulations. Territorial mapping and netting studies did not indicate any changes in the overall breeding patterns of songbirds on either treated block, and numbers and weights of fledgling birds captured after completion of the spray program were similar on treated and untreated check blocks. No increased drift of benthic invertebrates or subsequent depletions of benthos were found in streams in the aminocarb blocks. A modest increase was noted in terrestrial invertebrates entering the water based formulation treated stream after each application, and juvenile salmon showed some opportunistic feeding on this spray related knockdown. Changes in fish population density in treated and control streams were fairly similar, although juvenile salmon density in the water based treated stream decreased to a greater extent (48%) in late June than in the control stream (27%), probably in response to fluctuating water levels.

Overall, both aminocarb formulations had very little observable impact on the organisms studied. Details of this work are reported in:

Table 1. Field formulations evaluated by FPMI's Environmental Impact Section in 1982.

Field formulation tested	Application Equipment	Ecological components studied		
		Aquatics	Birds	Insects
MATACIL® 180F + ID 585 (2 x 70 g AI/ha)	TBM aircraft	X	X	
MATACIL® 180F + ATlox 3409F + water (2 x 70 g AI/ha)	TBM aircraft	X	X	
MATACIL® 180F + canola oil (2 x 52 g AI/ha)	DC-4G aircraft		X	X
MATACIL® 180F + TRITON® X-100 + water (2 x 70 g AI/ha)	AgCat + AgTruck aircraft	X	X*	X*
	Hand sprayer (MICRON ULVA)	X		
fenitrothion + TRITON® X-100 + water (2 x 210 g AI/ha)	AgTruck + AgTruck aircraft	X		
	Hand sprayer (MICRON ULVA)	X		
fenitrothion + TRITON X-100 + Cyclosol 63 + water (2 x 210 g AI/ha)	AgTruck aircraft	X	X*	X*
	Hand sprayer (MICRON ULVA)	X		

* only single application studied

Millikin, R.L. 1982. Songbird studies in New Brunswick forests treated with semi-operational applications of MATACIL® Flowable formulations in 1982. Forest Pest Management Institute File Report 39.

Kreutzweiser, D.P. 1982. Aquatic impact studies in New Brunswick forests treated with semi-operational applications of MATACIL® Flowable formulations in 1982. Forest Pest Management Institute File Report 40.

Quebec

Forest songbird and bumblebee populations were surveyed in a 5000 ha spray block in the lower St. Lawrence River area treated twice with aminocarb flowable delivered by DC-4G aircraft in a vegetable oil (canola oil) carrier. Songbird activity patterns and territorial mapping techniques did not indicate any damage to populations or their reproductive activities, but a single male Tennessee warbler was observed demonstrating symptoms of aminocarb poisoning in an area between two spray lines treated less than 10 hours apart due to completion the next morning of an interrupted spray application started the previous evening. Bumblebee populations and activity appear to have been affected by weather rather than the insecticide treatments as declining activity in the treatment block was paralleled in the untreated check area.

Details of these studies are reported in:

McLeod, B.B. and P.D. Kingsbury. 1982. Terrestrial impact studies of MATACIL® Flowable formulated in vegetable oil, Quebec, 1982. Forest Pest Management Institute Report No. 41.

ACTION PLAN STUDIES

New Brunswick

Forest songbird and terrestrial invertebrate populations were monitored in two approximately 500 ha spray blocks treated by single engine aircraft with aminocarb and fenitrothion aqueous formulations containing the emulsifier TRITON® X-100. Forest songbirds monitored through a single application did not suffer any measurable impact. Immediate knockdown of primarily larval insects from balsam fir and spruce was observed with both insecticides, and lasted for at least five days after treatment. Knockdown of winged insects on the untreated check plot some 70 km distant from the spray blocks was probably caused by insecticide drift from operational sprays in the general area.

Aquatic invertebrates were studied through double applications of one aminocarb formulation and two fenitrothion formulations containing TRITON® X-100 applied to streams by single engine aircraft, and also through applications by hand sprayer of the same formulations to produce residue levels in streams in excess of those present after the aerial applications. The two aerial and ground applications of aminocarb resulted in peak concentrations of 2.3, 0.5 and 6.2 ppb in stream water, respectively. Aerial applications caused modest increases in invertebrate drift, while the ground application caused an immediate increase in total invertebrate drift to about 14 times the level at the upstream control site, primarily due to increased drift of blackfly larvae. Aerial applications of fenitrothion introduced peak concentrations of 1.8 ppb or less into streams with little resulting increased drift of invertebrates. Ground applications of fenitrothion formulated with TRITON® X-100 resulted in peak residues of 4 and 21 ppb in stream water, and increased total drift by factors of up to 4 and 22 times upstream drift, respectively, primarily through effects on the stonefly nymph *Nemoura* and chironomid and blackfly larvae. Benthos populations of some genera of invertebrates showed significant decreases in numbers after some of the insecticide treatments, but these did not correlate with the organisms drifting in increased numbers and may simply reflect limitations of the sampling method (Surber sampling) dictated by the short lead time for the study.

In general, the impacts seen with the experimental formulations were considered comparable to those documented following previous aminocarb and fenitrothion applications of conventional formulations. Details of these studies are reported in:

McLeod, B.B. 1982. Terrestrial impact studies on experimental aqueous formulations of spruce budworm control agents containing TRITON® X-100, New Brunswick, 1982. Forest Pest Management Institute File Report 37.

Holmes, S.B. 1982. Aquatic impact studies on experimental aqueous formulations of spruce budworm control agents containing TRITON® X-100, New Brunswick, 1982. Forest Pest Management Institute File Report 38.

Labratory studies

Static laboratory bioassays were conducted to determine the toxicity of aminocarb and fenitrothion field formulations containing

TRITON® X-100 to fingerling rainbow trout. LC_{50} values and lethal thresholds were calculated and a toxicity curve was constructed for each formulation tested. 96-hour LC_{50} and 95% confidence limits expressed in terms of nominal concentration (i.e., mg of field formulation/L of test water) were: 296.2 (238.0 - 368.3) mg/L for the MATACIL® 180F + TRITON® X-100 + water formulation, 17.6 (15.5 - 19.9) mg/L for the fenitrothion + TRITON X-100 + water formulation and 17.4 (14.9 - 20.2) mg/L for the fenitrothion + Cyclosol 63 + TRITON® X-100 + water formulation. These are equivalent to 14.5 mg/L aminocarb and 2.4 and 2.5 mg/L fenitrothion respectively when expressed in terms of active ingredient content of the formulations.

Details of this work are reported in:

Holmes, S.B. 1982. Lethal toxicity of experimental aqueous formulations of spruce budworm control agents containing TRITON® X-100 to rainbow trout. Forest Pest Management Institute File Report 42.

ICEWATER CREEK RESEARCH PROGRAM

In 1980, the Environmental Impact Section of FPMI, through the cooperation of the Sault Ste. Marie District Office of the Ontario Ministry of Natural Resources, set up an ongoing research program in the Icewater Creek watershed about 50 km north of Sault Ste. Marie, Ontario. The objective of this programme is: To examine in depth a number of aquatic and terrestrial habitats and micro-habitats and their resident animal populations to determine: (1) the nature and degree of inherent risk, (2) the level of actual exposure, and (3) actual response to forest pest management strategies involving aerial applications of pest control agents.

The program will have three distinct phases designed to generate information on three aspects of the effects of forest pest control activities on the environment: (1) potential risk (2) actual exposure and (3) actual response. In general, the actual impact on each part of the environment is primarily a factor of the susceptibility of that portion of the ecosystem to the particular pest control procedure and its level of exposure to the pest control agent used, i.e., Risk + Exposure = Response. To this extent, part of the objective of the first two portions of the program will be to help predict potential hazards of any suggested pest control action. The third portion of the program will test actual responses and elucidate the nature of and ecosystem responses to actual impacts. This will involve relating impacts at lower trophic levels or among specific groups of organisms to secondary impacts on higher trophic levels and changes within the ecosystem (e.g., altered food supply, changes in basic processes such as predation or pollination, etc.).

In 1982, terrestrial field studies in the Icewater Creek research area continued to concentrate on pollinators and pollination processes. Pollinator visitation patterns were studied on some 28 flowering plants, shrubs and trees, and taxonomic evaluation of pollinating insects collected from various plants is underway. Honeybee utilization of pollen sources in the area was again studied in conjunction with a flowering plant survey, and ground insect fauna and activity on two distinct ecological sites were monitored over the entire season. Forest songbird studies evaluated the efficiency with which breeding populations could be censused with various census times in an effort to determine optimum plot shape and census time for various monitoring situations.

Aquatic studies in Icewater Creek in 1982 focused on seasonal changes in fish populations at a number of sites within the watershed, and collection of emerging adult aquatic insects for evaluation of both taxonomic and life history aspects of the invertebrate fauna. Benthos studies continued to evaluate two different sampling techniques used to study benthos populations throughout the watershed over the entire year.

Icewater Creek research studies contemplated for 1983 will focus on wild pollinator pollen and nectar source utilization and the potential pesticide exposure associated with the blossoms of various wild flowers, shrubs and trees. Aquatic studies will continue to focus on fish populations and their movements within the watershed, along with continued life history studies on aquatic invertebrates.

CHEMICAL ACCOUNTABILITY OF FOREST PEST CONTROL PRODUCTS

(Study Ref. No. FP-16)

Report to the Annual Forest Pest Control Forum

by

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November 1982

INTRODUCTION

The objective of this project falls in the following two major areas:

I. Analytical chemistry of various pest control products used in forestry at sub-microgram levels and their physicochemical and biological properties, and

II. Environmental chemistry of these chemicals which includes their distribution, degradation, persistence, toxicity, cycling and ultimate fate in different forestry components.

The former study pertains to the identification and quantification of the active ingredients (AI) and their adjuvants at trace levels requiring development of extremely sensitive analytical methods and the latter one, is needed to determine what happens to a pesticide once it enters the environment in order to understand their deleterious or harmful effects. This report outlines some of the major advances made in these two areas.

I. METHODOLOGY AND TOXICITY STUDIES

1) Microcolumn cleanup studies

A microcolumn cleanup technique utilizing glass columns of varying length (2 to 5 cm, ID 0.8 cm) with different adsorbents (SiO_2, Florisil® , Nuchar SN®, Celite-45, Cellulose® CF11, etc.) was evaluated for the quantification of fenitrothion and aminocarb residues from various forestry substrates. The measurement of column performance criteria to compare columns, column packings and column loadings was obtained for both insecticides using fortified forestry samples. Using the tech-nique, consistent and reliable residue data were obtained from forestry samples collected during the spray programs demonstrating that the residues of two insecticides from various forestry matrices and isolate them in a pure enough state for further analysis.

2) Insecticide residues in the air from spray blocks

For determination of vapour concentrations of airborne fenitrothion and aminocarb residues found in spray blocks, a dimethylformamide filled impinger technique has been developed, thoroughly tested (recoveries, sampling efficiency, minimum detection limit, cleanup and eventual quantification) and using the technique, monitored the residue levels in the air from spray blocks following the 1982 spray program in New Brunswick. Residue data obtained in this study are given in Tables 1 and 2 although critical evaluation and interpretation of the data at the time of writing are still incomplete.

3) High performance liquid chromatographic (HPLC) method in the analysis of insect growth regulators (IGRs)

A new analytical methodology for about ten IGRs of current interest in pest control programs has been developed using HPLC placing emphasis on sensitivity and selectivity. Evaluation of LC columns and the effect of mobile phase on reverse-phase chromatography has been studied. Highly significant findings are that (a) the eluting pattern of the IGRs in a chosen solvent system is relatable to their solubilities in the system, (b) the molecular structure of the sample determined the elution order; the greater the complexity, the higher the retention time and (c) IGRs that are thermally unstable or non-volatile, could be quantitated by this technique rather than resorting to gas chromatography which has its own inherent drawbacks in such cases.

TABLE 1

Average Concentrations of Fenitrothion in Air Sampled 30 cm Above the Forest Floor in Blocks 1 and 3 During the 1982 Experimental Spray Program in New Brunswick

Block 1C*						Block 3C*					
1st Application			2nd Application			1st Application			2nd Application		
Time	(hrs)	ng/m^3	Time	(hrs)	ng/m^3	Time	(hrs)	ng/m^3	Time	(hrs)	ng/m^3
2100	0	90 (N.D.)	0800	0	72 (N.D.)	0800	0	89 (N.D.)	0700	0	70 (N.D.)
2200	1	1997 (T)	0900	1	1281 (64)	0900	1	155 (T)	0800	1	107 (N.D.)
2400	3	470 (T)	1100	3	331 (77)	1100	3	145 (T)	1000	3	418 (N.D.)
0300	6	163 (T)	1400	6	308 (52)	1400	6	210 (T)	1300	6	629 (N.D.)
0900	12	102 (N.D.)	2000	12	115 (T)	2000	12	217 (T)	1900	12	89 (N.D.)
2100	24	448 (N.D.)	0800	24	(T) (N.D.)	0800	24	86 (N.D.)	0700	24	78 (N.D.)

Values in parentheses represent aminocarb concentrations detected in the same air samples. Although the chromotographic peaks corresponding to aminocab were noticeable, they were hard to quantify due to interference, especially when the concentrations were low. Therefore the values recorded in this table for aminocarb are only approximate.

N.D. Not detected.

T - Traces (50 ng/m^3).

* For explanation see footnotes in Table 3.

1) <u>Persistence of fenitrothion in New Brunswick forest environment</u>

The persistence of an insecticide in the environment is a function of the toxicant's properties (hydro- or lipo-philicity, partition coefficient, adsorption or chemisorption, vapour pressure, volatility, biodegradability), dosage, frequency of application and it is also equally influenced by the diverse physical and metabolic factors operating in different components of the forest environment. A preliminary residue monitoring study conducted during the spray season of 1982 showed that the chemical is persistent at detectable levels in various components of the New Brunswick forest environment. Results are given in Table 3.

Since measurable concentrations of fenitrothion are present in various forestry substrates either due to the inherent persistence characteristics of the chemical or due to drift, it is recommended that a planned and organized residue monitoring program be conducted in the spring of 1983 before any operational spraying, to determine if the residues are accumulated cumulatively, exhibiting long-term persistence. Such a study would establish a firm basis of background residue data on which to base any future actions and advice. In addition, future research programs should periodically investigate, refine and improve pesticide application technology to increase efficiency. Pesticide efficiency being a function of targetability and target distribution, sufficient emphasis should be placed on formulation improvement and transmission of the toxicant to the target to reduce dosage, which would ultimately result in reducing the insecticidal contamination of the environment.

Table 3

Average prespray concentrations of fenitrothion in various forestry samples collected during the 1982 spray program in New Brunswick.

Sample type \ Block no. and formulation	IB A/W	IIB F/W	IIIB F/O	1C F/O	2C A/W	3C F/W	82* A/O	86* A/W
Air (ng/m^3)[a] 1st				90	68	89	58	52
2nd				72	59	70	66	59
Glass plates (g/ha)[b] 1st				0.18	0.13	0.12	0.06	0.04
2nd				0.11	0.08	0.10	0.05	0.07
Water (stream) (ppb)	0.01	0.04	0.07				0.02	0.02
Sediment[c] (ppb)								
1st A.S.							64	110
O.D.							82	160
2nd A.S.							96	190
O.D.							155	260
Water cress (ppb)								
1st A.S.								140
O.D.								640
2nd A.S.								220
O.D.								1040
Moss (ppb)								
1st A.S.	29	62	128				3	3
O.D.	103	179	379				7	9
2nd A.S.	89	100	176				4	5
O.D.	317	354	646				12	13
Fish (ppb)								
1st	6						7	4
2nd	5						5	4
Foliage (ppb)[d]								
1st A.S.				431	270	1057	475	352
O.D.				844	537	2073	781	659
2nd A.S.					399		521	464
O.D.					685		805	721
Soil (ppb)								
1st A.S.				11	115	201	110	95
O.D.				16	163	286	192	139
2nd A.S.					124		88	81
O.D.					190		119	122
Litter (ppb)								
1st A.S.				24	66	540	77	108
O.D.				98	98	993	121	167
2nd A.S.					54		67	96
O.D.					87		118	159
Insects (ppb)								
SBW 2nd							N.D.	N.D.
TCP 2nd							N.D.	10

B = Bathurst; C = Charlo; * - near Fredericton; A/W = aminocarb in water; F/W = Fenitrothion in water; F/O = Fenitrothion in oil; A/O = aminocarb in oil; A.S. = as sampled; O.D. = oven-dry (105°C for 16 hr; AOAC 1955); SBW = spruce budworm; TCP = tent caterpillar.

a - Using density of dry air at 1 atm and 15°C as 12.255×10^{-4} g/mL (Lange's Handbook of Chemistry, 11 Edn. p. 10-146), these values range from 0.05 ppb to 0.08 ppb. Density of air depends upon R.H., P and T.

b - One hr exposure at ground level.

c - Petri dishes with sediment at stream bottom.

d - Needles only

2) <u>Distribution, persistence and fate of Matacil® 180F formulations</u>

[(a) Matacil® 180F (26%; v%) + Shell I.D. 585 (74%; v%) (Block 82) and (b) Matacil® 180F (26%; v%) + Atlox® 3409F (1.3%; v%) and water (72.7%; v%) (Block 86)] <u>in a Forest Ecosystem</u>.

Distribution, persistence and ultimate fate of aminocarb residues in various forestry substrates (Table 4) from the sprayed areas (Blocks 82 and 86) in N.B. forest were investigated by collecting different environmental samples at intervals of time following aerial applications of the above two formulations (a) and (b), experimentally at a dosage of 70 g AI/ha twice. Most of the prespray samples collected had detectable levels of fenitrothion as contamination. The maximum initial and final concentrations (i.e., after the scheduled sampling period) of aminocarb found in the substrates are given in Table 4.

In most of the substrate samples studied, the residue levels of aminocarb decreased rapidly but usually exponentially with extremely short half-lives. Aminocarb was found in all the air samples collected from spray areas (probably as vapor and as adsorbed state on particulate matter). Initial residue concentrations of the chemical in the samples ranged between 1201 and 210 ng/m^3 and were lost rapidly with time but its interaction (synergistic/additive action) with fenitrothion in the air is unknown. Similarly the uptake and rate of loss of the chemical from water, fish, soil, litter and moss were high due to various physical and metabolic factors operating in the ecosystem. The rate of loss

Table 5

Maximum initial and final concentrations (as sampled)* of fenitrothion and aminocarb in various forestry substrates collected from Blocks 1, 2 and 3 sprayed with formulations containing Triton®-X100 during the 1982 spray program in New Brunswick

Block, formulation application and concn. / Substrate	Block 1[a] (Fenitrothion)				Block 2[b] (Aminocarb)			
	1st Application		2nd Application		1st Application		2nd Application	
	Initial concn.	Final concn.	Initial concn.	Final concn.	Initial concn.	Final concn.	Initial concn.	Final concn.
Air (ng/m^3)[d]	1997 (1 hr)	448 (24 hr)	1281 (1 hr)	T (24 hr)	226 (3 hr)	N.D. (24 hr)	394 (3 hr)	63 (24 hr)
Water (ppb)[e]	0.10 (1 hr)	0.09 (24 hr)	1.84 (1 hr)	0.33 (24 hr)	2.26 (1 hr)	N.D. (24 hr)	0.53 (1 hr)	N.D. (24 hr)
Moss[e] (ppb)	60 (1 hr)	70 (24 hr)	166 (3 hr)	130 (24 hr)	48 (6 hr)	16 (24 hr)	152 (12 hr)	19 (24 hr)
Fish[e] (ppb)					25.1 (1 hr)	N.D. (24 hr)	84.6 (1 hr)	N.D. (24 hr)
Foliage[d] (b.f.)(ppb)	660 (12 hr)	230 (5 d)	820 (6 hr)	380 (5 d)	670 (12 hr)	390 (5 d)	670 (12 hr)	270 (5 d)
Soil[d] (ppb)	79 (24 hr)	70 (5 d)	130 (24 hr)	60 (5 d)	<10 (1 hr)	<10 (5 d)	90 (2 d)	<10 (5 d)
Forest litter[d] (ppb)	140 (1 hr)	70 (5 d)	270 (1 d)	160 (5 d)	<10 (1 hr)	<10 (5 d)	<10 (1 hr)	<10 (5 d)
Glass plates[d] (g/ha)	0.67 (1 hr)	--	2.17 (1hr)	--	1.68 (1 hr)	--	0.31 (1 hr)	--
Droplet density[d]	3.89	--	5.27	--	3.31	--	72.67	--

Table 5 (cont'd)

Maximum initial and final concentrations (as sampled)* of fenitrothion and aminocarb in various forestry substrates collected from Blocks 1, 2 and 3 sprayed with formulations containing Triton®-X100 during the 1982 spray program in New Brunswick

Block, formulation application and concn. / Substrate	Block 3[c] (Fenitrothion)			
	1st Application		2nd Application	
	Initial concn.	Final concn.	Initial concn.	Final concn.
Air (ng/m^3)[d]	217 (12 hr)	86 (24 hr)	629 (6 hr)	78 (24 hr)
Water (ppb)[e]	0.17 (1 hr)	0.03 (24 hr)	0.25 (1 hr)	0.11 (24 hr)
Moss[e] (ppb)	160 (3 hr)	40 (24 hr)	193 (3 hr)	118 (24 hr)
Fish[e] (ppb)	--	--	--	--
Foliage[d] (b.f.)(ppb)	1450 (12 hr)	710 (5 d)	1720 (1 hr)	640 (5 d)
Soil[d] (ppb)	480 (3 hr)	190 (5 d)	350 (12 hr)	90 (5 d)
Forest litter[d] (ppb)	630 (1 hr)	50 (5 d)	290 (3 hr)	70 (5 d)
Glass plates[d] (g/ha)	5.48 (1 hr)	--	6.88 (1hr)	--
Droplet density[d]	4.38	--	41.23	--

* Sampling times are given in parentheses. Final concn. represent the residue level present at the last sampling schedule.

Formulations (v%): a - Fenitrothion, 10.9; Cyclosol 63, 24.0; Triton®X-100, 3.0; Water, 61.1; Rhodamine WT, 1.0.
b - Aminocarb 180F, 27.7; Triton®X-100, 3.0; Water, 69.3; Rhodamine WT, 1.0.
c - Fenitrothion, 10.9; Triton®X-100, 10.7; Water, 77.4; Rhoamine WT, 1.0.
d - Small blocks near Charlo.
e - Large blocks near Bathurst.

SUMMARY REPORT ON STUDIES OF THE USE OF HERBICIDES IN CANADIAN FORESTS

(Study Ref. FP-19)

REPORT TO THE ANNUAL FOREST PEST CONTROL FORUM

By

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November, 1982

INTRODUCTION

The forest resource is not endless as it seemed to be; we are approaching or exceeding annual allowable cut in many parts of the country, and we are also falling behind in the effective regeneration of cut-over lands. Therefore, in order to meet the very significant demand in our fibre resource that will occur in the 21st century, we must embark upon a vital program of intensive management of coniferous forests that will include active and complete regeneration of cut-over forest land (including the backlog) and a significant shortening of rotation age. These goals can be achieved only by intelligent use of effective, economical and environmentally acceptable herbicides. At present, there are only 2 herbicides (2,4-D and 2,4, 5-T) registered for forestry use in Canada, and unfortunately because of some precipitous political reaction to their alleged public health problems (dioxins), some provinces are banning the continued use of 2,4, 5-T. Thus, there is a great dearth of forest herbicides for conifer release and site preparation, and therefore, a program of evaluation of newer products for this purpose was initiated.

Evaluation of Herbicides for Forestry Use

The screening of herbicides for conifer release and site preparation was carried out in three steps:

(a) Rapid and quick evaluation of scores of compounds by using a seed bioassay technique under the laboratory conditions. This procedure rapidly identified compounds active against coniferous or deciduous (weed) tree spp.;

(b) Further evaluation of some promising candidates in the greenhouse by using the seedlings of trees of pest and the crop spp.; and,

(c) Final evaluation of the selected candidates against the pest spp. under nursery and field conditions (so as to determine the effects of weather parameters on the efficacy of the selected compounds).

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TABLE I

Herbicide Samples Received for Screening Trials

Common Name	Trade Name	Source	Potential for Use
1. Blazer	Acifluorfen	Rohm & Haas	Broadleaf weeds
2. Banvel	Dicamba	Velsicol	" "
3. Caparol	Prometryne	Ciba-Geigy	Grass-annual weeds
4. Devrinol	Napromide	Stauffer	"
5. Antor 4 ES	Diethatyl	Hercules	"
6. Dowpon	Dalapon	Dow	"
7. Esteron 600	2,4-D	Dow	Brush-conifer release
8. Esteron T-6E	2,4,5,-T	Dow	" " "
9. Goal	Oxyfluorfen	Rohm & Haas	Grass
10. Herbec 20	Tebuthiuron	Elanco	Brush-conifer release
11. Kerb	Pronamide	Rohm & Haas	Grass & broadleaf
12. Primatol A	Atrazine	Ciba-Geigy	" "
13. Princep	Simazine	Ciba-Geigy	" "
14. Roundup	Glyphosate	Monsanto	Grass and brush
15. Spike 5% G	Tebuthiuron	Elanco	Total vegetative control
16. Spike 80W	Tebuthiuron	Elanco	" " "
17. BAS 9052	Poast	BASF	Grass
18. Dycleer 10	Diacamba	Velsicol	Grass & brush
19. Garlon 4	Trichlopyr	Dow	Brush-conifer release
20. Velpar L	Hexazinone	DuPont	" " "
21. HOE 39.866		Hoechst	Grass & broadleaf

TABLE II

Evaluation of Some Herbicides for Conifer Release by Using the Seed Bioassay Technique

(ED_{50} Values in ppm)

Species Tested	2,4-D		Spike		Garlon		Velpar	
	Germination	Growth	Germination	Growth	Germination	Growth	Germination	Growth
Jack pine	1527	103	27298	<1	1893	65	16004	1686
White Spruce	8473	51	35127	<1	2350	386	6213	1442
Black spruce	23341	51	151940	<1	3440	263	<1	<1
Lodgepole pine	156	<1	186	<1	455	158	T*	T*
Sitka spruce	T	T	<1	<1	730	112	T	T
Western hemlock	T	T	4	82	<1	<1	T	T
Douglas fir	T	T	3	<1	122	109	T	T
White pine	T	T	T	T	<1	<1	T	T
White birch	136	0.2	0.1	0.1	<1	<1	<1	<1
Ash	0.08	0.4	T	T	T	T	T	T
Alder	2	0.03	519	<1	5683	<1	<1	<1
Red maple	T	T	5390	<1	T	T	T	T
Yellow birch	T	T	T	T	105	18	T	T

* T - Testing in Progress

To begin with, 21 compounds of varying chemical structure and biological activity were obtained from the chemical companies (see Table 1, p. 2), and subjected to the screening procedure described above. Table II (p. 3) lists the effective dose (ED_{50}) of few promising herbicides causing 50% reduction in seed germination and radicle growth of eight conifers and five deciduous tree spp. As can be seen, the ED_{50} values are generally very high for conifers (resistant spp) and generally very low for deciduous (susceptible spp.). This suggested that these herbicides would be suitable candidates for conifer release operation, and that their further testing was warranted. Accordingly, they were then sprayed on seedling trees of conifers and pest spp. in the greenhouse, and their relative performance was assessed by ED_{50} values (see Table III below). These data provided the same trend (i.e., conifer spp. jack pine, black spruce, and white spruce) were highly resistant and the pest spp. (white birch, raspberries-varieties erect and trailing type) were susceptible to Roundup, Velpar, Garlon, and Spike 80W.

TABLE III

Evaluation of Some Candidate Herbicides Against Four Brush spp. Under Greenhouse Conditions

	Herbicide Response (ED_{50}) in ppm			
Species	Roundup	Velpar	Spike 80W	Garlon
Jack pine	No effect	No effect	No effect	188,606
Black spruce	No effect	No effect	No effect	55,738
White spruce	No effect	No effect	No effect	89,544
White birch	950 ppm	17,587	1,524	T*
Alder	413,233	T	T	2,300
Raspberry, trailing	49,143	T	2,038	T
Raspberry, erect	140,966	41,917	5,359	2,500

* T - Testing in progress

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The impact of weather conditions affecting the potency of these selected compounds was next evaluated under field conditions in cut-over areas and conifer plantations (red pine) in Searchmont and Thessalon. The seven-year-old plantation was severely infested with poplar, pincherry, alder and raspberries. Whereas, poplars dominated in the Thessalon area, alders were most preponderant at the Searchmont site. Spraying was carried out with a knapsack sprayer during August and soil applications were made with a "hand-gun" at the same time. Phytotoxicity rating was scored after three weeks and was based on the standards recommended by the Expert Committee on Weeds (eastern section). Table IV show the performance of six herbicides on weed control in cut-over area and red pine plantation sites. Clearly, all herbicides showed positive weed control and further studies are in progress to monitor their effects in spring, 1983. However, it is interesting to note that among the soil-applied herbicides, Velpar yielded the maximum brush control, followed by Spike 80W and Herbec, while Garlon was superior to 2,4-D and Roundup in foliarly applied compounds. No apparent phytotoxicity to conifer plantations was observed, and thus, these results confirm the findings of other investigations.

TABLE IV

Evaluation of Some Selected Herbicides on Brush Control in Cut-over Area and Red Pine Plantation in the Algoma Region

Herbicide	Dosage	Application Method	Percentage Weed Control: Cut-over Site	Percentage Weed Control: Plantation Site
Control	----	----	0	0
Herbec	14 kg/ha	Soil drench	20.0	26.7
Velpar	10 L/ha	Soil drench	84.2	97.5
Spike 80W	8 kg/ha	Soil drench	66.7	95.0
Roundup	5 L/ha	Foliar spray	9.20	33.5
2,4-D	6 L/ha	Foliar spray	53.3	70.0
Garlon	6.5 L/ha	Foliar spray	85.0	95.0

Studies Carried out by the Control Product Research and Development Program at the Forest Pest Management Institute

T.J. Ennis
Program Manager

There are six projects in this program that are directed towards the development of microbial control agent, Insect Growth Regulation and Pheromones for control of forest insect pests. On the microbial sides, the virus studies are the furthest advanced in their application to control forest pests; particularly with respect to aerial or ground application and effective control. Increasing emphasis is being placed on viral epizootiology - the spread and year-to-year carryover of virus in the insect population and its environment - with the aim of identifying those factors involved in viral epizootics that can be manipulated to improve the effectiveness of some viruses, and to improve the economic aspects involved in the production and application of others. For fungi and protozoa, studies are being extended to include determination of host-pathogen interaction in field population, and identification of the manner in which population cycling in the host and the pathogen affect extent and intensity of infection. The *B.t.* research in this program has been aimed primarily at crystal toxicity and mode of action, but in the past few years significant progress has been made on the interrelationships of *B.t.* dosage levels and ingestion to mortality, feeding inhibition, recovery, growth and survival. For pheromones, identification has continued to develop a library of compounds that be used for survey and/or control experiments. Candidate Insect Growth Regulators are screened in the laboratory and the field for activity against a number of forest insect pests. Companion laboratory studies are carried out to determine physiological effects of these IGR's and investigate structure-activity relationships.

There is also strong research activity in Cell Biology, Tissue Culture and Serology areas which provide essential information as well as providing systems and techniques that are complementary to the study of mode of action of the microbes, pheromones and IGR's described above.

Highlight of activities in projects directly involved with insect control agents are presented below. Detailed appendices of field applications are provided for the virus and IGR projects.

FP-1 Toxicity and Mode of Action of *B.T.*

Investigation has continued into determining the nature of the toxic fragment of the *B.T.* crystal protein. Isolation and purification of the apparent low molecular weight fragment have been refractory to conventional analytical methods, requiring a significant amount of development and adaptation. Extended diet feeding studies have confirmed the previously demonstrated relationship between dose and the ability of affected larvae to recover, resume feeding and develop. The effect is clearly dependent on concentration of *B.t.* dose consumed. At sublethal doses larval feeding is inhibited, and after a recovery period, larvae resume feeding. Clearly, effectiveness of *B.t.* on foliage is affected by concentration of *B.t.* delivered to the foliage as well as the length of time the *B.t.* remains available and toxic to larvae that resume feeding after initial inhibition and recovery from a sublethal dose.

FP-2 Mycology

Spruce budworm populations in field plots in Kirkwood and Rose Townships had very low (1 insect per 25-50 buds) budworm populations and fungal disease, which had been high the previous year was not observed. In a later experiment, where lab-reared insects were placed in the field after the wild insects had emerged as adults, one insect became infected with an entomophthoraceous species and one with *Beauveria bassiana*.

Because of the low population mentioned above a major study of the spruce budworm and its natural enemy complex was established in Lake Superior State Park north of Sault Ste. Marie. In the collaborative Study with other FPMI and GLFRC personnel, development of spruce budworm larvae is being related to the appearance, incidence and spread of naturally occurring pathogens (microsporidia, fungi and viruses) as well as other pathogens and predators. Distribution of pathogens in the micro habitat is being determined, particularly as it relates to coincidence with development movement and dispersal of the host insects and possible modes of contact infection and persistence. Coupled with analyses of influence of macro- and micro climatological factors, this study will lead to a better understanding of the dynamics of pathogen infection in field populations and the effects such infections have on insect host dynamics. Analysis of the first year data is now in progress.

A collaborative project with NFRC was continued in 1982 and expanded to include release trials in Ontario. In both cases, a conidial inoculum of *Zoophthora radicans* and *Entomophthora egrersa* was released in caged trees. In Newfoundland, field-collected larvae were added to the cage 48 hr after trees were exposed to conidia. Mortality in excess of 80% was observed 4 days later. In Sault Ste. marie, comparable mortality figures were also obtained.

FP-3 MICROSPORIDIA

The most common microsporidian parasite of the spruce budworm is *Nosema fumiferanae*. Studies were undertaken to determine the mode of transmission of this parasite to the spruce budworm. Results indicated that *N. fumiferanae* may be transmitted perorally, transovarially or by injection into its host. Infected females, but not infected males, readily transmit the microsporidium to their offspring.

Preliminary tests were conducted to develop a bioassay technique for microsporidia against the spruce budworm. Spore dosages of $3X10^4$, $3X10^5$, $3X10^6$, and $3X10^7$ *N. fumiferana* spores were tested against 4^{th} instar budworm larvae. The lowest dosage tested resulted in 92% infection with a significant reduction in pupal weights and adult female longevity. However, significant mortality of 68% (combined larval and pupal) did not occur until larvae ingested $3X10^7$ spores. In general ingestion of $3X10^7$ spores by 4^{th} instar larvae resulted in 48% larval and 20% pupal mortality, 6 and 3 days reduction in female and male adult longevity respectively, and 61 mg reduction in female pupal weight and 32 mg reduction in male pupal weight. Days to 50% mortality was 18, with a range of 11 - 37 days.

Testing of *Pleistophora schubergi* against the pine false webworm *Acantholyda erythrocephala* was also carried out. Spore suspensions were sprayed on the host's food under laboratory conditions. Although the results are inconclusive 16% of the dead larvae resulting from a treatment of 10^8 spores/ml were infected with *P. schubergi*.

FP-4 VIRUSES

1. Experimental aerial spray trials with Douglas-fir tussock moth nuclear polyhedrosis virus in British Columbia.

Four 10-ha plots infested with Douglas-fir tussock moth near Veasy Lake, north of Ashcroft B.C. were aerially sprayed with a nuclear polyhedrosis virus produced in white-marked tussock moth larvae. At time of application, larvae were mainly in the first instar. Four dosages were applied; 2.5×10^{11} polyhedral inclusion bodies (PIB)/ha in an emulsifiable oil formulation and in the previously used molasses formulation, and two treatments at reduced levels of 8.3×10^{10} and 1.6×10^{10}PIB/ha in the oil formulation. A fixed wing aircraft with boom and 42 Tee-Jet 8005 nozzles applied the sprays at 9.4 ℓ/ha. Four additional plots served as controls.

Population reductions due to treatment were 59.6% at the lowest dosage, and ranged from 90.1 to 93.1% on the other three plots. Percent successful pupal emergence and egg mass counts were also reduced by the treatments . These very satisfactory results make it feasible to reduce the recommended dosage of NPV from 2.5×10^{11} to 8.3×10^{10} PIB/ha and to use the emulsifiable oil formulation for virus application.

2. Experimental aerial spray trials with nuclear polyhedrosis and granulosis viruses for the regulation of western spruce budworm populations in British Columbia.

Ten 172 ha plots containing Douglas-fir trees infested with western spruce budwrom were sprayed with viruses formulated in 1 part emulsifiable oil and 3 parts water. Nuclear polyhedrosis virus (NPV) was applied at 5.4×10^{11} PIB/ha while granulosis virus (GV) was applied at 1.7×10^{14} capsules/ha. Applications were made at 9.4 ℓ/ha with a Cessna Agwagon equipped with a boom and 42 Tee-Jet 8005 nozzles at a time where larvae were at peak fourth instar. Population reduction due to treatment was 51.8% in the NPV treated plot compared to 34.6 in the GV treated plot. Treated larvae reared in the laboratory had incidences of virus-induced mortality ranging from 66.0 to 79.7% for NPV and 58.7 to 61.8% for GV. Percent successful emergence was reduced in both treated plots. In this multi-year experiment to evaluate which virus has the better potential for initiating and maintaining epizootics, satisfactory virus introduction was achieved this year and follow up assessment will be made in 1983.

3. Experimental ground spray trials with 'Lecontvirus' to control red-headed pine sawfly in Ontario.

Using nuclear polyhedrosis virus provided by FPMI, Ontario Ministry of Natural Resources staff in 7 districts and FPMI staff in one district carried out ground applications against red-headed pine sawfly populations in 49 red pine plantations with a total area of 374 ha. Dosages ranged from 1.5×10^8 to 6.5×10^{10} PIB/ha in volumes from 0.3 to 130 ℓ/ha. Both handsprayers and mistblowers were used. As in previous years results were satisfactory when applications were made prior to the fourth larval instar but in about 30% of the cases, treatments were too late to provide protection. Surveys were also carried out in plots treated in previous years.

A petition for registration of this virus was submitted to Agriculture canada in March 1981. Review by Health and Welfare has indicated supporting safety data is satisfactory, with the single exception of a delayed hypersensitivity test that will be conducted early in fiscal 1983-84. This virus appears to be progressing towards registration, hopefuly for the 1983 field season.

FP-5 Pheromones

Pheromone identification has continued to provide a selection of compounds that can be used for survey purposes or for experimental mating disruption. Field testing of the optimal blend of pheromone components for *Eucosma gloriola* has continued. A small trapping out trial was conducted against this insect but interpretation of success was confounded by needle droop on trees in the test area. Development of lures for the oak leaf shredder, *Croesia semipurpurana*, the maple leaf roller, *Cenopis acerivorana*, and the spruce seedworm, *Laspeyresia youngana* has continued to the point that they have proven useful in monitoring insect populations and are available for survey use. The pheromone that has been tentatively identified for the spruce coneworm, *Dioryctria reniculelloides* was subjected to further field testing to provide verification. Effectiveness of several formulation methods was also the subject of field testing.

FP-6 Insect Growth Regulators

Three new growth regulators were screened against the spruce budworm and found to be very effective. UC-6244, a very effective compound against the spruce budworm, has regained industry interest and is again under active development and should be available for further testing. In a field test against the oak leaf shredder, *Croesia semipurpurana*, Dimilin 25 WP suspended in 7-N oil was applied in two 20 ha plots at 70 and 140 g, respectively, in 4.7 ℓ/ha using the FPMI Cessna Ag Truck equipped with 4 Micronair AU-3000 units. The plots were located in Simcoe County Forest near the Wildman Main Tract. At 140 g/ha, both foliage protection and population reduction were excellent.

Field Work Proposal for 1982

Continuing field activities are planned for all projects described above. For *B.t.*, emphasis will be placed on extending the laboratory results on feeding inhibition and recovery to the interaction of *B.t.* and the budworm in the field. For fungi protozoa and viruses epizootiological studies will be carried out to further define the spread and carryover of these pathogens in field populations, as well as to determine host-pathogen interactions that determine both intensity and intensity of infection.

The western spruce budworm plots in British Columbia that were treated with NPV and GV will be intensively surveyed to determine the impact of these viruses in the year following application. With respect to the Douglas-fir tussock moth, the plots treated this year will be examined to determine the extent of carryover of the virus and the presence of a residual insect population. If suitable areas can be found, large blocks (400 ha or more) will be treated at 2.5×10^{11} and 8.3×10^{10} PIB/ha to determine if the lower dosage is effective operationally. The possibility that strip spraying, with subsequent spread of virus into unsprayed areas, could be an effective technique for virus application will be investigated if suitable areas and resources are available. A petition for registration of TM Biocontrol-1 (the U.S. tussock moth virus product) and Virtuss (the Canadaian product) is in the final stage of preparation and will be submitted to Agriculture Canada for review.

The candidate pheromones and components that have been identified for several forest insect pests, particularly those affecting seed and cone production, will be field tested to determine optimum blends and concentrations. The professional in this project is currently on Career Development Leave in England to broaden our capability in the use of these compounds for control.

With renewed industrial interest in the former UC-62644, now Ciba Geigy 112913, trials will be conducted against the spruce budworm if the necessary material and required toxicology data are available. If BAY SIR 8514 receives approval of supporting toxicological data, it will be tested against the Swaine jack pine sawfly, a pest for which the available virus has not proven to be as effective as those for other sawflies. Laboratory and greenhouse trials will continue for the new promising compounds.

EXPERIMENTAL AERIAL SPRAY TRIALS WITH NUCLEAR POLYHEDROSIS AND GRANULOSIS VIRUSES FOR THE REGULATION OF WESTERN SPRUCE BUDWORM IN BRITISH COLUMBIA

(Study Ref. Nos. FP-4-3 and PC-08-289)

Report to the Annual Forest Pest Control Forum, Ottawa

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November 1982

Experimental aerial spray trials with nuclear polyhedrosis and granulosis viruses for the regulation of western spruce budworm in British Columbia.

Summary

A Cessna AgWagon fitted with a boom and 42 Tee-Jet 8005 nozzles was used to spray one 172 ha plot containing Douglas-fir trees with nuclear polyhedrosis virus (NPV) at a dosage of 5.4×10^{11} PIB/ha and a second 172 ha with granulosis virus (GV) at a dosage of 1.7×10^{14} capsules/ha. Viruses were formulated in 1 part of emulsifiable oil to 3 parts water, emitted volume was 9.4 L/ha and larvae were at the peak of the fourth instar at the time of application.

The NPV had a greater initial impact than the GV on western spruce budworm larvae, with 51.8% population reduction due to treatment compared to 34.6%. In samples of larvae reared individually in the laboratory 66.0 to 79.7% died from NPV and 58.7 to 61.8% from GV; percent successful adult emergence was 52.7% in samples from the checks, ranged from 6.1 to 12.7% in samples from the NPV-treated plot and ranged from 11.8 to 23.8% in samples from the GV-treated plot.

This is a multi-year experiment designed to evaluate which virus has the greater potential for initiating and maintaining an epizootic in western spruce budworm populations. It was considered that satisfactory virus introductions resulted from this year's spray application and assessments will be made on these plots in 1983.

Introduction

Extensive aerial spray trials were conducted with NPV to regulate eastern spruce budworm, *Choristoneura fumiferana*, between 1971 and 1981. To a lesser extent mixtures of NPV and cytoplasmic polyhedrosis virus (CPV), mixtures of entomopoxvirus (EPV), NPV and CPV and EPV alone and GV alone have been tested. Impacts of these treatments have varied and the high dosages which gave acceptable results are expensive to produce. Presently, viruses cannot be recommended for regulation of this species.

The same viruses infect both eastern and western spruce budworm, *C. occidentalis*, and laboratory tests have shown that the western species is considerably more susceptible to both NPV and GV than the eastern species. The first aerial spray trial was conducted with NPV on western spruce budworm in 1976 using a dosage of 2.5×10^{11} PIB/ha and it was considered a failure. In 1978, three 20 ha plots were treated with 7.5×10^{11} PIB/ha. Some impact was obtained in the year of application with population reductions due to treatment of 0, 26, and 48% and incidence of virus infection, determined microscopically, recorded at 55, 87 and 25%. Follow-up studies on two of these three plots showed significant population declines in 1979 compared to untreated checks. However, this trend was reversed in 1980, probably due to massive immigration of moths into these small plots.

In 1981, ground spray trials were conducted with NPV and GV on plots of small trees. A range of dosages was tested. NPV is a faster-acting virus and gives higher levels of mortality at high dosages than GV. However, at reduced dosages GV gives higher levels of mortality than NPV. Both viruses are fairly slow acting, NPV taking about 14 to 20 days to kill larvae in the field and GV taking 20 to 30 days. When applied at budflush at the peak of the fourth instar, there is barely time for these viruses to kill larvae prior to pupation, and there is certainly no time for secondary infection to occur from virus inclusion bodies released on to foliage from virus-killed larvae. Also, negligible foliage protection can be expected following application of these viruses at budflush. There is evidence that virus-killed eastern spruce budworm larvae and pupae remain overwinter, webbed-up in nests on the foliage, and continue to release viable virus inclusion bodies on to the foliage the following season. It is presumed that the same thing happens with the western species.

The main goal of the 1982 trials was to compare the potential of NPV and GV to initiate a continuing virus epizootic which will regulate western spruce budworm populations. Large plots were selected to reduce the possibility of immigration of moths into the treated areas. Spectacular results were not anticipated in 1982, but it is hoped that in 1983, and in subsequent years, there is sufficient virus in the environment to regulate the spruce budworm population.

Plots and Spray Application

Two plots, 176 ha in area, containing mainly Douglas-fir and ponderosa pine, were selected south of Ashcroft, B.C. in the Kamloops district. As it is impossible to compare NPV and GV on the basis of viral inclusion bodies, these viruses were compared on the basis of weight of lyophilized, virus-infected larvae and 9 kg of each preparation were used to treat each plot. The viruses were formulated in an emulsifiable oil, the blank carrier vehicle for Dipel 88®, purchased from Abbott Laboratories, and 1 part of oil was mixed with 3 parts of water. Rhodamine B dye at 0.04% was added to the tank mix to monitor the deposit on Kromekote® cards.

A Cessna AgWagon, contracted from Crop Care Aviation, Clearbrook, B.C., and fitted with a boom and 42 Tee-Jet 8005 nozzles was used for the applications. The aircraft was calibrated to deliver 9.4 L/ha and four 414 L loads were sprayed on each plot. Larvae were at the peak of the fourth instar at the time of application and the GV-plot was sprayed first because larval and bud development were more advanced on this plot than on the NPV-plot. Details of the dosages applied, application dates and deposit recorded on Kromekote cards are given in Table 1.

Assessment

Three lines, with 15 Douglas-fir trees per line, were established in the two virus-treated plots and a further three plots with two lines of 15 trees per line were established as checks. For pre-spray population counts, paired 46 cm branch tips were collected from the mid-crown of each sample tree. A post-spray sample was collected at the onset of pupation and four 46 cm branch tips were collected from all treated and check sample trees. Foliage was placed in paper bags which were stapled closed and larvae were removed and counted in the laboratory. Population reductions due to treatment were calculated using a modified Abbott's formula.

As well as population studies, the incidence of virus infection was determined using three methods: 1) Larvae from the two treated and three check plots were reared individually on artificial diet until pupation or death. Dead larvae were smeared, then the smears were stained and examined microscopically using oil immersion to detect viruses and other pathogens. Collections were made from the virus-treated plots at 1, 2 and 3 weeks post-spray and from the check plots at 1 week post-spray. 2) Collections made from the NPV-treated plot were made 1, 2 and 3 weeks post-spray and from the check plots at 1 week post-spray. Squash preparations were prepared from gut and fat body tissue from the insects and examined under phase contrast optics for the presence of viruses and other pathogens. GV inclusion bodies are too small to detect with confidence using this method. 3) The same samples from both treated and check plots were frozen with a view to determining the incidence of viruses using a serological technique, enzyme-linked immunosorbent assay (ELIZA), but this has yet to be done.

It was not possible to make defoliation estimates because of high populations of Douglas-fir tussock moth, *Orgyia pseudotsugata*, in this area.

Results

Results of the population studies are shown in Table 2. Population reduction due to treatment in the GV-treated plot was 34.6% and in the NPV-treated plot was 51.8%.

In the samples reared on artificial diet, there was a significant difference in successful adult emergence between treated and check plots (Table 3). In the one week post-spray check sample 52.7% of the insects emerged as adults, in the three NPV-treated plot samples this figure ranged from 6.1 to 12.7% and in the three GV-treated plot samples from 11.8 to 23.8%. The percentage of insects killed by NPV in the NPV-treated plot ranged from 66.0 to 79.7% and the percentage killed by GV in the GV-treated plot ranged from 58.7 to 61.8%. Some NPV was found in the GV-treated plot with 4.2 to 16.1% of dead insects containing this virus often in combination with GV. In the check plots, 1.6% NPV mortality and 11.8% GV mortality were recorded. Percent parasitism in these samples ranged from 2.9 to 17.3%.

Incidence of NPV infection in larvae examined immediately after collection from the NPV-treated plot was lower than from larvae reared individually on artificial diet. This is to be expected as early and light NPV infections can not be detected by the former method. Results are shown in Table 4. At 1 week post-spray 34.4% of larvae showed evidence of NPV infection, at 2 weeks, 48.8% and at 3 weeks, 44.4%. None was found in the check plots. Traces of CPV, 1.2% and 2.1%, were found in two of the samples from the NPV-treated plots. In these samples incidence of parasitized larvae ranged from 2.8 to 11.3%.

Conclusions and Recommendations

Generally, the results are considered to be satisfactory; both viruses made significant impact on the spruce budworm population and great numbers of virus-killed larvae and pupae should be present on trees in the two virus-treated plots. The NPV had a greater initial impact on the western spruce budworm population than the GV. However, as GV can give significant levels of mortality at much lower dosages (on the basis of number or weight of infected larvae) than NPV, it may well be the better virus for development as a biocontrol agent.

It should be pointed out that the dosages used in this trial represent the equivalent of about 5,400 virus-infected larvae to treat 1 ha. This is very costly to produce and certainly would not be feasible for use on an operational scale. At this early stage of development, it was considered justifiable to use these dosages to determine if either NPV or GV will initiate a continuing epizootic and protect the forest over a period of several years. If these 1982 trials are considered successful when evaluated in 1983, then lower dosages of one or other of these viruses can be tested to ascertain the minimum required to initiate an epizootic.

Plans for 1983

To intensively survey the NPV- and GV-treated plots and three check plots to determine the impact of these two viruses in the year following the year of application.

Table 1. Application of nuclear polyhedrosis virus (NPV) and granulosis virus (GV) on western spruce budworm larvae at the peak of the fourth larval instar. Plots (176 ha) were located south of Ashcroft, B.C., the tank mix contained 1 part of emulsifiable oil to 3 parts of water and the emitted volume was 9.4 L/ha.

Virus applied	Dosage (inclusion bodies/ha)	Date of application	Mean no. of droplets/cm^2 on Kromekote cards
GV	1.7×10^{14}	June 15,16 a.m.	12.0
NPV	5.4×10^{11}	June 17,18 a.m.	9.9

Table 2. Population studies on plots treated with NPV and GV to control western spruce budworm near Ashcroft, B.C. in 1982.

Plot	Pre-spray mean number of larvae/ 46 cm branch tip	Post-spray mean number of larvae/ 46 cm branch tip	Percent population reduction due to treatment*
GV	10.8	4.0	34.6
Check	12.2	6.9	
NPV	14.3	3.9	51.8
Check	12.2	6.9	

* Calculated using a modified Abbott's formula.

Table 3. Samples of western spruce budworm larvae from plots treated with NPV and GV and untreated checks near Ashcroft, B.C. reared on artificial diet in the laboratory. Dead larvae were smeared, stained and examined for pathogens.

Plot	Number of weeks post-spray when sampled	Total number of insects reared	Percent dead containing NPV	Percent dead containing GV	Percent parasitized	Percent dead from unknown causes	Percent successful adult emergence
NPV	1	150	66.0	0	17.3	4.0	12.7
	2	147	74.8	0	9.5	9.5	6.1
	3	138	79.7	0	6.5	4.3	9.4
GV	1	143	16.1	58.7	7.7	9.8	23.8
	2	167	11.9	61.8	7.2	16.8	14.4
	3	169	4.2	61.5	2.9	22.5	11.8
Checks	1	313	1.6	11.8	15.7	19.8	52.7

Table 4. Microscopic examination of insects from the NPV-treated plot and check plots near Ashcroft, B.C. in 1982.

Plot	Number of weeks post-spray when sampled	Total number of insects examined	Percent infected with NPV	Percent infected with CPV	Percent parasitized
NPV	1	151	34.4	0	11.3
	2	164	48.8	1.2	10.4
	3	144	44.4	2.1	2.8
Check	1	317	0	0	7.6

EXPERIMENTAL GROUND SPRAY TRIALS WITH "LECONTVIRUS" (NUCLEAR POLYHEDROSIS VIRUS) TO CONTROL REDHEADED PINE SAWFLY IN ONTARIO

(Study Ref. No. FP-13-1, FP-4-3 and FP-4-4)

Report to the Annual Forest Pest Control Forum, Ottawa

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P6A 5M7

November 1982

ANNUAL FOREST PEST CONTROL FORUM - 1982

Experimental ground spray trials with "Lecontvirus" (nuclear polyhedrosis virus) to control redheaded pine sawfly in Ontario

Summary

Ontario Ministry of Natural Resources staff in 7 districts and Forest Pest Management Institute staff in 1 district conducted ground spray applications of nuclear polyhedrosis virus on 49 red pine plantations with a total area of 374 ha to control redheaded pine sawfly, Neodiprion lecontei. Dosages ranged from 1.5×10^8 to 6.5×10^{10} PIB/ha and application volumes from 0.3 to 130 L/ha. Lower dosages and volumes were applied on individual colonies or trees using handsprayers and the higher dosages and volumes were applied with mist blowers. Generally, results were satisfactory when treatments were made prior to the fourth larval instar, but about 30% of the treatments were made when larvae were too large.

Surveys were conducted on 1) plantations aerially sprayed in previous years 2) levels of virus in the soil in plantations sprayed in previous years and 3) impact of virus this year in a plantation treated at the fourth larval instar in 1981.

Introduction

"Lecontvirus" has been applied extensively both from the ground and aerially in Ontario and Quebec since 1976. "Lecontvirus" is the name given to a lyophilized preparation of nuclear polyhedrosis virus-infected redheaded pine sawfly larvae. A petition for the registration of this material was submitted to Agriculture Canada in March, 1981 and is currently being evaluated.

This year the virus preparation was distributed to OMNR clients in an emulsifiable oil. The oil is the blank carrier vehicle for the Bacillus thuringiensis preparation, Dipel 88®, and was purchased from Abbott Laboratories. When the lyophilized preparation of virus-infected redheaded pine sawfly is suspended in water, bacteria multiply and it smells foul. Suspending the powdered material in oil eliminates this problem. FPMI staff prepared a virus concentrate which contained 5×10^8 polyhedral inclusion bodies (PIB)/ml and recommended that for first and second instar larvae, 10 ml be added to 20 L of water and that 20 L be applied per hectare giving a dosage of 5×10^9 PIB/ha. On third and fourth instar larvae, the dosage should be doubled to give 10^{10} PIB/ha.

FPMI staff tested their preparation at 5.0, 10.0 and 20.0 ml per L to verify their recommendations. FPMI staff also conducted a survey of areas aerially sprayed in previous years to determine if re-invasion had occurred, studied incidence of virus in soil samples in areas treated in previous years and observed the impact of virus carry-over in a plantation treated late (at the fourth instar) in 1981.

OMNR Spray Applications

OMNR staff in 7 districts kindly supplied details of their spray operations and this information is summarized in Table 1. Two application methods were used, handspraying of individual colonies or individual trees and mist blowing. Mist blowing was on either "hot spots" only or on every second, third or fourth row. In total, 49 plantations with an area of 374 ha were treated. Dosages ranged from 1.5 x 10^8 to 6.5 x 10^{10} PIB/ha and application volumes from 0.3 to 130 L/ha. Generally, results were considered satisfactory, although problems were encountered when applications were made when larvae were large. Larval instars at the time of application were recorded by OMNR staff and it appeared that about 30% of the treatments were made when larvae were too large for successful control with NPV and for adequate foliage protection.

FPMI Spray Applications

Three plantations in the Blind River district were treated with mist blowers when larvae were 70% in the first instar, 20% in the second and 10% in the third. Applications were made using backpack mist blowers on July 20th and three dosages were tested, 2.5 x 10^9, 5 x 10^9 and 10^{10} PIB/ha. Every third row of red pine trees (about 2.0 to 2.5 m) was sprayed and the volume applied was 20 to 25 L/ha. There was little difference in the results from the three dosages; at 1 week post-spray no mortality or even symptoms of virus infection were observed, at 2 weeks post-spray only 4 to 12% of the colonies remained healthy and at 3 weeks post-spray no living larvae could be found.

Survey of Areas Aerially Sprayed in Previous Years

A total of 11 plantations were surveyed this year compared to 19 in 1981. Six of the plantations surveyed in 1981 were omitted from the survey because the trees are now large, crown closure has occurred and they are no longer susceptible to sawfly attack. Plots 1 and 2 in the Lindsay district, treated in 1976, are so badly damaged by *Cephalcia* sp. that further surveys are useless. Results from the 11 plantations are shown in Table 2 and colonies of redheaded pine sawfly were found in 4 of them. Numbers were low except in 1978 plot 2 in Tweed district with 62 colonies per 300 trees. In fact, one small area of this plantation was very heavily infested with counts of up to 10 colonies per tree. No evidence of virus-infection or mortality was observed in any of the colonies in these plantations.

Accumulation of Virus in the Soil

Soil is probably a major source of virus inoculum in plantations which have been treated with NPV and in which an epizootic has occurred. Polyhedral inclusion bodies are known to remain in a viable state in the soil over long periods of time and it is possible that virus from the soil can be transmitted to the foliage of trees by such vectors as ants or by the sawflies themselves when they enter the soil to pupate or emerge from the soil as adults.

Soil samples were collected from 3 plots in the Bancroft district, ground sprayed in 1981 and one plot ground sprayed in 1980. In the Bancroft district 10 trees were randomly selected and two samples collected from each tree, one 5 cm from the trunk and one at the edge of the crown. Of the 3 plots treated in 1981, 72% of the samples contained polyhedral inclusion bodies and in the plot treated in 1980, 85% of the samples contained polyhedral inclusion bodies. There were no colonies of sawflies on these trees in 1982.

From aerially sprayed plots, samples were collected, again 2 per tree, from trees infested with sawflies in 1982. In 1976 plot 2, (Lindsay), 5 out of 6 samples were positive, in 1977 plot 3 (Richmond), 10 out of 18 were positive, in 1978 plot 2 (Tweed), 5 out of 6 samples were positive and in 1979 plot 1 (Pembroke), 0 out of 2 samples were positive. The amount of virus in the positive samples from both the aerial and ground sprayed plantations ranged from 3.3×10^4 to 4.4×10^5 PIB/cm^3 of soil.

This survey shows that virus can be detected in the soil for several years following application of virus. Whether or not this virus is still viable requires testing by bioassay.

Impact of Virus in the Year Following a Late Virus Application

In 1981, a 3 ha red pine plantation in Rose Twp. north of Thessalon, was selected as a site for virus propagation. Larvae were sprayed with a mist blower when predominantly in the fourth instar with a dosage of 10^{10} PIB/ha in a volume of 30 L/ha. At 30 days post-spray larvae had either pupated or died and a considerable quantity of virus-infected larvae were collected and processed during this period. As it was known that some larvae survived, it was decided to observe this plantation in 1982 to determine if there were any sawfly colonies and, if present, whether or not they were killed with virus.

On July 20th, a few colonies of first and second instar larvae were seen in this plantation and 25 were marked and checked weekly for 7 weeks. Colonies were generally much smaller than usual, 10 to 20 per colony as compared to over 100 larvae. It was expected that they would soon die from virus. However, this was not the case and the decline caused by virus was slow. Results are shown in Table 3 and one of the 25 colonies reached pupation. These results may be atypical because many of the colonies infected with NPV in 1981 were removed from the plantation and taken to the laboratory. These observations do indicate, nevertheless, that one should not rely on a late spray application to give fast control and foliage protection in the year following the year of application.

Conclusions and Recommendations

Generally, results from this year's ground spray applications were considered successful and most clients were satisfied. Distributing the finely-ground, lyophilized, virus-infected larval powder in an emulsifiable oil eliminated problems of bacterial growth and this preparation was as effective as the aqueous concentrate distributed in previous years. Recommended dosages of 5×10^9 PIB/ha on first and second instar larvae and 10^{10} PIB/ha on third and fourth instar larvae appear to be adequate. Volumes applied varied greatly and this is a factor of the application method and spray equipment used.

The situation in each infested plantation varies and it is impossible to formulate a hard and fast set of guidelines. Such factors as stage of insect development, insect population density, tree height, damage in previous years and spray equipment available have to be assessed. It must be stressed, however, that early detection of the sawflies and early application of the virus are vital to ensure good control and to prevent defoliation.

When larvae molt into the fourth instar, they have black spots and this instar is easy to identify. Application on first, second and third instar larvae is recommended. If some larvae have black spots, it is getting late, but still worthwhile to apply virus. However, if all the larvae have black spots, it is certain that fifth and even sixth instar larvae are present and virus applications should not be attempted. If it is considered essential to treat a plantation at this stage of larval development to avoid severe damage, then a chemical insecticide should be applied and surveys should be made the following year to determine if the infestation has persisted. If it has, then virus can be applied at the recommended stage of development.

The ideal method of applying the virus is from the air. Then several plantations can be treated in one morning when insect development is at the correct stage. When the cost of manpower involved in ground spray applications is considered, this may also be the most economical method. Spot spraying individual colonies or individual trees probably leaves the greatest number of factors to chance when effective control is the objective. Colonies are bound to be missed; spread of this virus does occur, but such factors as insect population density and timing of application play a major role in governing spread. An early application on first and second instar larvae in a population with a high density has the greatest potential for effective virus spread.

When aerial application is not feasible, mist blowers are the second choice of equipment and districts in which a continuing programme with this virus is foreseen are well advised to invest in this equipment. It gives very effective coverage and every second, third, fourth or fifth row can be treated depending on the height of the trees. When populations are low, "hot spots" can be heavily sprayed and the remainder of the plantation lightly sprayed by making a few passes through it with a mist blower.

Plans for 1983

1. Hopefully, an evaluation of the "Lecontvirus" registration petition will be available soon. If further work is deemed necessary to meet registration requirements, this will receive prompt attention and be treated as a high priority.

2. Virus material will be available for use by provincial government forestry officials who have problems with redheaded pine sawfly infestations in their districts. If registration has been granted prior to the 1983 field season, it will not be necessary to apply for Experimental Permits, but if not granted, that procedure will have to be followed for another year.

3. Surveys will continue on plantations aerially sprayed between 1976 and 1980 to determine if re-invasion with sawflies has occurred and, if so, to what extent.

Table 1. Summary of ground spray applications with NPV on plantations infested with redheaded pine sawfly in 1982.

OMNR District	No. treated	Total area treated (ha)	Spray equipment used[1]	Method[2]	Volume applied (L/ha)
Algonquin Park	3	46	MB	R4	20-25
Bancroft	14	51	MB	TC,HSO	4-28
Bracebridge	7	37	MB	TC,HSO,R(4)	10-15
North Bay	2	23	MB	R(2),R(4)	130
Parry Sound	14	161	HS	SS(c),SS(t)	0.3-3
			MB	R[4]	6
Pembroke	4	25	HS	SS(c),SS(t)	25-45
Tweed	2	27	HS	SS(c),SS(t)	15-20
Blind River[3]	3	4	MB	R(3)	20-25
TOTAL	49	374			

1 MB = mist blower; HS = handsprayer

2 TC = total coverage; HSO = "hot spots" only; R(2,3,4etc) = row spraying every 2nd, 3rd or 4th row; SS(c) = spot spraying individual colonies; SS(t) = spot spraying individual trees

3 Trials conducted by FPMI staff

4 Only perimeter sprayed due to crown closure

Table 2. Survey of redheaded pine sawfly population densities in areas aerially sprayed with NPV between 1976 and 1980.

Year treated	Plot no.	Location	No. of colonies/ no. of trees examined
1976	2	Lindsay	3/300
1977	2	Renfrew	0/300
	3	Richmond	11/300
1978	2	Tweed	62/300
1979	1	Pembroke	1/300
	2	Pembroke	0/300
	3	Pembroke	0/300
1980	1	Minden	0/300
	2	Minden	0/300
	3	Minden	0/300
	4	Minden	0/300

Table 3. Observations on 25 redheaded pine sawfly colonies in a plantation which was sprayed in 1981 when larvae were mainly in the fourth instar.

Date surveyed	Healthy	Virus infected	Dead or vanished
20 July	25	0	0
27 July	24	0	1
4 Aug.	20	4	1
11 Aug.	16	2	7
18 Aug.	8	6	11
25 Aug.	3	7	15
1 Sept.	3	2	20
8 Sept.	1*	3	21

* About to pupate

INSECT GROWTH REGULATORS

(Study Ref. FP-6)

Report to the Annual Forest Pest Control Forum

by

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November 1982

INSECT GROWTH REGULATORS
by
Arthur Retnakaran

INTRODUCTION

Compounds that adversely interfere with the normal growth and development in insects are called insect growth regulators or IGRs. Benzoylphenyl ureas are a class of IGRs that inhibit the polymerisation step during the biosynthesis of chitin resulting in the disruption of normal molting. Several commercial manufacturers of pesticides are currently producing many experimental benzoylphenyl ureas, some of which are being tested for controlling forest insects.

1. Laboratory and greenhouse trials with new IGRs:

The test with EL-413 (Eli Lilly & Co.) initiated last year has been completed. This IGR is fast acting like the potent UC-62644 (or CGA-112913) on the spruce budworm. In addition we tested CME-13401 (Cela Merck Ltd.) which was found to be fast acting and potent. Avermectin (Merck, Sharp & Dome), a biproduct of streptomyces fermentation was very effective on the budworm.

UC-62644, found to be potent IGR against the budworm (Retnakaran, 1982, Can. Ent. 114:523-530) has been taken over by Ciba-Geigy with a new number, CGA-112913 and is under active development. Preliminary toxicology has been completed and the company is enthusiastic. I have done Ames mutagenicity assay on this compound and found it to be non-mutagenic.

2. Aerial application of Dimilin on oak leaf shredder:

Based on the favourable review of Health and Welfare of the 90-day toxicology studies on Dimilin, Agriculture Canada gave us the go ahead for limited aerial trials against the oak leaf shredder, *Croesia semipurpurana*.

Dimilin 25 WP suspended in 7-4 oil was sprayed at the rates of 1 oz in 0.5 US gal/acre (70 g in 4.7 L/ha) and 2 oz in 0.5 US gal/acre (140 g in 4.7 L/ha) on 2 plots, 20 ha each using the FPMI Cessna Agtruck equipped with 4 Micronair AU-3000 units. The plots were located in Simcoe County Forest near the Wildman Main Tract. Spraying was conducted on the 21 and 22 of May 1982. Plot 1 was sprayed in the evening and plot 2 in the morning. The oak trees had just flushed and the shredder was in the 2nd and 3rd instar stages.

In addition to branch sampling, post-spray sampling of pupae, adult emergence and male catch in pherotraps were conducted. The results of the spray trial is summarized in Table 1.

The population reduction and foliage protection was excellent at 2 oz/acre (140 g/ha). The pupal and male-moth sampling confirmed the results obtained from larvae.

Table 1

Effect of aerial application of Dimilin® on an oak forest infested with the oak leaf shredder, <u>Croesia semipurpurana</u> in Simcoe County in June 1982.
(All values are $\bar{x}$ of at least 25 samples.)

Plot no. and treatment	Spray deposit		Pre-spray sample (larvae/ 46 cm branch	Post-spray sample				% Population reduction*		
	Volume (L/ha)	Droplets per cm^2		Larvae/ 46 cm branch	Pupae/ m^2 of litter	Adult emergence/ m^2 of litter	♂♂/phero-mone trap	Larval	Pupal	♂♂
Check	--	--	27.3	2.7	73.4	17.0	33.6	--	--	--
1. - 1 oz in 0.5 US gal/acre (70 g in 4.7 L/ ha)	0.63	29.6	10.7	0.4	0.6	0	3.8	62.2	97.7	71.1
2. - 2 oz in 0.5 US gal/acre (140 g in 4.7 L/ha)	0.06	7.1	13.2	0.1	0.6	0	4.3	92.3	92.3	73.5

$$* - \% \text{ population reduction} = \left[1 - \left(\frac{\text{post-spray density in treatment}}{\text{pre-spray density in treatment}} \times \frac{\text{pre-spray density in control}}{\text{post-spray density in control}}\right)\right] \times 100.$$

3. Proposed trials for 1983 (tentative):

(1) Ciga-Geigy would like us to test CGA-112913 (fomerly UC-62644) on the budworm. They have promised to submit the 90-day toxicology data to health and welfare. We have selected 4 20-ha plots for aerial trials. If all goes well, the material will be retested against the budworm.

(11) BAY SIR-8514, 90-day toxicology report in German is being translated into English for submission to Health and Welfare. We have selected 2 plots to test this material against the Swaine jack pine sawfly (Neodiprion swainei). Virus has been found to be less effective against this species than for other sawflies.

(111) Laboratory and greenhouse trials will continue with Nihon's new IGR as well as Avermectin and Cela Merck's product.

Field test of a highly concentrated *Bacillus thuringiensis* formulation (Futura) by means of a DC-4 aircraft

Report presented to the Canadian Insect Pest Control Forum

Ottawa, November 23-25, 1982

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In 1982 a DC-4 dispersed 20 x 10^9 I.U. of Futura, a *Bacillus thuringiensis* formulation developed by us at the Laurentian Forest Reseach Centre in 1979, at 2.5 L/ha. One application covered 3 574 ha (8 500 acres) in 20 minutes. Details of the formulation are given in another paper also presented at the Canadian Insect Pest Control Forum this year (1982). Results are summarized in Table 1.

Pretreatment larval populations averaged 31.8 larvae/45 cm. Deposit was 222 400 viable spores/cm^2. Ten days after treatment larval mortality was 88.7% and treatment efficacity was 75%. On the same day in untreated plots larval mortality was 38.9%. Defoliation figures were also significant with an average of 24.9% defoliation in the treated plot and 100% in untreated plots. The current year foliage mass per 100 cm branch averaged 43.7 g in treated and only 0.6 g in untreated. Percentage of buds formed for the next year was 80.1% in treated and 10.2% in untreated. These results confirmed the possibility of using Futura with large capacity aircraft at a very low volume and achieving a valuable insect control and foliage protection.

During the fall of 1982 calibration tests were carried out with Futura and DC-4. Deposit was increased to 348 000 viable spores/cm^2, 56% more than that obtained during spring treatment. These results and larval mortality and foliage protection allow us to recommend Futura for operational use starting in 1983 with either the DC-4 or the Super-Constellation aircrafts.

TABLE 1

Results of spraying Futura by means of a DC-4 aircraft for the control of spruce budworm and those for the control

Plot No.	Deposit viable spores/ cm^2	Pretreatment populations lar./45cm	Larval mortal-ity %	Treatment efficacity %	Defolia-tion %	Current year foliage mass g	Loss of tree vitality (DT 82)	1983 buds formed %
				F U T U R A				
610	222 400	31.8	88.7	75.0	24.9	43.7	23.6	80.1
				U N T R E A T E D				
	-	30.1	38.9	-	100.0	0.6	92.4	10.2

Field tests of a highly concentrated *Bacillus thuringiensis* formulation (Futura II) dispersing 20×10^9 I.U. in 2.5 L/ha by means of a Grumman AgCat aircraft

Report to the Canadian Forest Insect Pest Control Forum

Ottawa, November 23-25, 1982

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After developing a highly concentrated *Bacillus thuringiensis* formulation in 1978-79, we tested it for calibration in 1979 and field tested it in 1980, 1981 and 1982 (Table 1). The present paper gives details of the formulation, reports results of the 1982 field test, and proposes final recommendations for its personal use.

The Futura formulation is composed of:

a) Futura II - concentrate delivered at the airfield:

15% *Bacillus thuringiensis* powder, 80 000 I.U./mg

44.8% Sorbo (a 70% sorbitol solution)

40.2% Water

b) Dilution for 1 ha:

1.5 L of concentrate (Futura II) described in a

1.0 L water

1.56 mL Chevron sticker

Only water needs to be added to Futura at the airport, thus eliminating costly transportation ans sophisticated mixing equipment. Because the concentrate is very thick, we recommend a membrane pump, which was highly effective to pump it into the sole mix tank.

A Grumman AgCat aircraft was used to treat six 40 ha plots with Futura at 2.5 L/ha. Deposit varied between 269 830 and 406 821 spores/cm^2 with an average of 359 574 spores/cm^2. Also, the average number of *B. thuringiensis* colonies/cm^2 ranged from 8.5 to 24.0 with 13.5 as an average. Pretreatment populations varied from 11.7 to 28.0 larvae per 45 cm branch tip in treated and from 25.2 to 27.4 larvae/45 cm in untreated plots. Larval mortality 10 days after treatment and assessed the same day in untreated plots was between 86.8 and 95.8% in treated and 47.4 and 49.0% in untreated plots. Treatment efficacity determined with the

Abbott formula was between 76 and 92.0%. Defoliation in treated plots was between 10.3 and 21.9% while in those untreated defoliation was 100%. Effect of treatments on foliage was also determined using the current year growth mass method and revealed an average of 49.4 g of foliage per 100 cm branch in treated and only an average of 0.15 g of foliage in untreated plots. Loss of tree vitality followed the same pattern with an average of 20.7% in treated and 96.8% in untreated plots. Also, the number of buds formed at the end of the growing season (1983 buds) were significant, 79.0% in treated and 2.7% in untreated plots.

These results confirmed the efficacy of Futura sprayed with a Grumman AgCat aircraft equipped with boom and nozzles. Futura represents a considerable improvement over formulations used to date:

Its concentrated form eliminates transportation of inert material resulting in an appreciable reduction of transportation costs.

- Only water is added prior to loading at the airport, eliminating most of the mixing previously required and the cost related to this operation.
- It uses the lowest volume for a B. thuringiensis formulation (2.5 L/ha, 35 ounces/acre) which results in lower treatment costs.
- It has a very good dispersion properties since loss through evaporation during dispersion is minimal.
- It is highly effective for larval mortality and foliage protection.

TABLE 1

Results of spraying Futura by means of a Grumman AgCat aircraft for the control of spruce budworm and for the control plots

lot No.		Deposit viable spores/ Cm²	Pretreatment populations lar./45 cm	Larval mortal-ity %	Treatment efficacity %	Defolia-tion %	Current year foliage mass g	Loss of tree vitality (DT 82)	1983 buds formed %
					TREATED				
1		336 380	28.0	95.8	92.0	21.9	33.4	26.6	77.8
2		384 780	17.3	87.8	76.0	12.5	46.6	21.8	77.9
3		269 830	11.7	88.0	80.0	19.6	42.9	17.4	77.8
4		406 821	24.8	91.5	90.0	12.9	67.4	21.3	81.1
5		398 211	19.7	86.8	84.0	10.8	51.8	20.4	74.2
6		361 427	12.2	92.2	90.5	10.3	54.7	17.1	85.3
	AVERAGE	359 574	18.9	90.3	85.4	14.6	49.4	20.7	79.0
					UNTREATED				
			25.2	49.0	-	100.0	0.03	98.9	1.5
			27.4	47.4	-	100.0	0.26	94.7	3.9
	AVERAGE		26.3	48.2	-	100.0	0.15	96.8	2.7

THE NEW BRUNSWICK SPRAY EFFICACY RESEARCH GROUP - A Review of Research Activities.

CHARLES J. WIESNER

The New Brunswick Spray Efficacy Research Group is essentially a voluntary association of individuals and agencies who have some stake in spray efficacy research or more particularly are actively involved in some aspect of such research. The aim of NBSERG is to promote and facilitate interdisciplinary research on all aspects of the chain of events which constitutes the spray process from the formulation of the tank mix through atomization, transport of the resulting droplet cloud down to canopy level by meteorological and wake effects, movement of the cloud through the canopy deposit of the droplets on the target foliage (particularly that portion which comprises the larval microhabitat) and finally the biological interface or interaction between the insecticide deposits and the larval behaviour at different development stages and on different host species.

Our premise is that this chain of events is so complex and interrelated that an indepth understanding of it cannot be accomplished by merely changing dosage on one hand and measuring defoliation on the other.

NBSERG consists of two bodies:

(a) the technical committee comprised of researchers and operators actively involved in spray related research, and

(b) the steering committee comprised of management level representatives of agencies having mandates or interests influenced by spray research.

Early in November NBSERG organized a workshop at which technical committee members and spray researchers from the U.S. and U.K. discussed recent results and future directions. The atmosphere of the meeting was very optimistic, reflecting the conviction that this multi-disciplinary approach was bearing fruit.

A series of field experiments have been undertaken since 1979 aimed at developing a predictive understanding of the influence of atmospheric turbulence and spray droplet size on both deposit on target and drift off target. These studies were funded by Forest Protection Ltd. of Fredericton and were designed and executed by various combinations of several agencies (Unsteady Aerodynamics Laboratory, NAE, NRC; Department of Chemical Engineering, UNB; Department of Forest Resources, UNB; Boundry Layer Research Division, AES; Chemistry Department, RPC).

While this line of research is not complete, two quantitative conclusions have already emerged:

(a) Contrary to popular wisdom spraying under moderately unstable conditions reduces drift and improves deposit, while spraying under stable atmospheric conditions generates more off-target drift and inferior deposit.

(b) Because of the physics of droplet impaction and the physical nature of spruce and fir foliage, a classification of the droplet spectrum takes place with the result that 90% of the droplets which reach the larval microhabitat are less than 60 microns in diameter.

This implies that droplets larger than about 80 microns are ineffective since they don't reach the larval microhabitat in any significant numbers.

Unfortunately, many nozzles produce a spectrum where the bulk of the insecticide is produced as droplets larger than 80 microns and therefore is wasted.

EASTERN SPRUCE BUDWORM COUNCIL
CONSEIL DE L'EST SUR LA TORDEUSE D'EPINETTE

REPORT FROM THE EASTERN SPRUCE BUDWORM COUNCIL (*)

The Eastern Spruce Budworm Council is a joint body made up of representatives from the various jurisdictions in eastern North America for the purposes of sharing their knowledge and experience of the spruce budworm problem and studying and collaborating in programs related to the various aspects of the problem. It was officially established in January 1979 by the signature of a Memorandum of Understanding. As provided in this document, the four signatory Provinces of Quebec, New Brunswick, Nova Scotia and Newfoundland are full members of the Council. It is also provided in the Memorandum that the Council may invite the participation of jurisdictions other than the signatories as associate members. The Province of Ontario, the Canadian Forestry Service and the State of Maine were accepted as associate members at a Council meeting held in Quebec City in April 1979. The USDA Forest Service was likewise accepted as associate member at a Council meeting held in Fredericton in April 1982. As it now stands, the membership of the Council is

(*) Presented at the Tenth Annual Forest Pest Control Forum, held in Ottawa on November 23-25, 1982 therefore made up of eight members, i.e. four full members and four associate members.

Two Council meetings were held in 1982, a spring meeting on April 13-14 in Fredericton and a fall meeting on November 9 in Quebec City. The Council has also been active in 1982 through its four working committees on (a) spray technology, (b) environmental monitoring, (c) human health issues, and (d) the standardization of survey and assessment techniques.

Again this year, the committee for the standardization of survey and assessment techniques has been working on the preparation of maps depicting the overall spruce budworm situation in eastern North America. These maps will be presented and commented by Mr. E. G. Kettela, the Canadian Forestry Service representative on the committee.

Gerard Paquet

Executive Secretary
Eastern Spruce Budworm Council

Spruce Budworm - 1982 - A Summary of Areas (ha):

Province or State	Defoliation (M-S)	1981 1982	Mortality	Forecast	1981 1982	Sprayed
Ontario	8,023,000	-	11,634,185	8,000,000	-	3,425
Quebec	7,400,000	+	10,500,000	21,000,000	+	1,141,035
New Brunswick	1,202,000	-	1,000,000	5,300,000	0	1,724,570
Nova Scotia	173,100	-	725,000	600,000	+	19,153
P.E.I.	13,100	-	30,000	50,000	0	0
Newfoundland	41,820	-	578,000	110,000	+	47,834
Maine	1,558,000	-	250,000	3,000,000	+	327,343
	18,411,020		24,717,185	38,060,000		3,263,360

- Presented at the Pest Control Forum.

E. Kettela
November 23, 1982

THE SPRUCE BUDWORM IN NEWFOUNDLAND IN 1982

Report prepared for the Tenth Annual Forest
Pest Control Forum, Ottawa
23-25 November 1982

J. Hudak, A.G. Raske, K.P. Lim, L.J. Clarke
Newfoundland Forest Research Centre
Canadian Forestry Service
St. John's, Newfoundland
23 November 1982

THE SPRUCE BUDWORM IN NEWFOUNDLAND IN 1982

Larval Development and Defoliation

Eggmass and overwintering larval surveys in the fall of 1981 indicated that in 1982 moderate and severe defoliation would occur in about 21 000 ha of fir-spruce forest distributed mostly in western Newfoundland and the remainder in three small isolated areas in central and eastern Newfoundland. Cool and wet weather prevailed during most of June and larval development was about two weeks behind that of last year, but shoot growth of balsam fir was ahead of insect development. Early July was warm and dry, larval development progressed rapidly and defoliation became evident. Moderate and severe defoliation occurred in several areas from St. Andrews to Deer Lake and in a small area on the Baie Verte Peninsula in western Newfoundland and along Noel Paul's Brook in central Newfoundland (Fig. 1). There was no severe defoliation recorded in eastern Newfoundland. The total area of moderate and severe defoliation on the Island in 1982 was about 41 000 ha, a major decrease from about 380 000 ha in 1981 (Table 1). Light defoliation in 1982 occurred in about 50 000 ha.

In Labrador two small infestations were active in mature balsam fir and white spruce stands near Goose Point and along the Beaver River near Goose Bay (Fig. 1). The area of moderate and severe defoliation was about 700 ha (Table 1).

During the week of 4-10 July an invasion by spruce budworm moths occurred throughout western and central Newfoundland. Pheromone traps distributed from Port aux Basques to Hawkes Bay and east to Bishops Falls all had catches of budworm moths. These moths were evidently transported to Newfoundland on warm air currents from the Maritime Provinces or Quebec. The local budworm population on the Island during this period were only in the developing larval or prepupal stages.

Biological Control Factors

Samples of spruce budworm were collected weekly across the Island and were reared in the laboratory. Results showed that about 11% of the budworm population was parasitized. The major larval parasites were *Apanteles fumiferanae* and *Glypta fumiferanae* and the most important pupal parasites were *Phaeogenes hariolus* and *Ephialtes ontario*.

Fungal diseases caused about 12% mortality of the reared budworm samples. The major fungal pathogen was *Zoophthora radicans*. The incidence of microsporidian disease caused by *Nosema fumiferana* was about 2%.

Damage Assessment

Damage assessment surveys in previous years were conducted in all productive young and merchantable stands where tree mortality was evident. The areas of these stands were delineated on 1:250,000 mapsheets and the volumes were determined using the most recent inventory figures. This method showed that in 1981 the cumulative area of merchantable stands with tree mortality was about 427 500 ha, the total volume of these stands about 40 000 000 m^3, and the volume of dead trees reached about 18 450 000 m^3. Beginning in 1982, in cooperation with the Inventory Section of the Provincial Department of Forest Resources and Lands, the damage assessment survey was intensified and a two-year transition period was initiated to produce damage maps at the 1:30,000 scale and to transfer this detailed damage assessment to the Inventory Section.

The comprehensive analysis of data from the 1982 detailed damage survey has not been completed but preliminary results indicate that the area of merchantable balsam fir stands containing tree mortality did not increase appreciably with the exception of an estimated 1 300 ha increase on Gander Bay Road (Fig. 2). However, the proportion of tree mortality increased from last year and the total volume of dead trees in balsam fir stands in 1982 reached about 20 000 000 m^3.

The 1982 damage survey also recorded a general deterioration of trees and much increased mortality in several major black spruce stands in central and eastern Newfoundland. These stands had been severely damaged by the spruce budworm but most of them had shown good recovery during the past two years following the decline of budworm populations. The most extensive and severe tree mortality occurred in the northwest Gander River Valley, in the South Brook Valley near Halls Bay, and north of Twin Lakes (Fig. 2). Several areas of lesser damage occurred from Red Indian Lake to Gander Lake and from Halls Bay to Deer Pond. Recently completed ground checks and preliminary surveys showed that the four-eyed spruce bark beetle, *Polygraphus rufipennis* and Armillaria root rot by *Armillaria mellea* are present in these stand and are hastening tree mortality. Both of these pests are native to Newfoundland and no previous widespread, severe damage has been recorded in healthy, natural stands. It is difficult to predict exactly the further development of the present damage but the unprecedented severity of budworm defoliation in most of the black spruce forest apparently favours the sudden buildup of these usually secondary pests. Other unknown factors may also play a role in the general, rapid deterioration of stand condition.

The actual area and volume of dead and dying black spruce stands have not been determined exactly but preliminary estimates indicate that severe tree mortality ranging from 20% to 80% occurred in about 30 000 ha, and poor tree condition with lesser amounts of mortality on an additional 50 000 ha. Assuming an average volume of 100 m^3 per ha, these areas contain 3 000 000 m^3 of dead stands and 5 000 000 m^3 of severely damaged, dying stands. The comprehensive analysis of mortality and damage in all productive forests and the establishment of permanent plots in black spruce stands are in progress to assess the problem in more detail.

Forecast for 1983

Eggmass surveys were conducted in over 800 sample points across the Island and in 20 points in Labrador. Based on this survey, the area of moderate and severe defoliation on the Island in 1982 is forecast to be about 110 000 ha distributed from South Branch to Deer Lake in western Newfoundland and along the Noel Pond River in central Newfoundland (Table 2, Fig. 3). Light defoliation is forecast in about 102 000 ha distributed in isolated patches from the Codroy Valley to Roddickton and east to the Avalon Peninsula. Based on tree condition and expected defoliation, the area of moderate and high hazard is forecast to be about 165 000 ha in 1983 (Table 2, Fig. 4).

In Labrador moderate and severe defoliation is forecast to occur in 1983 in about 1 000 ha near Beaver River (Table 2, Fig. 3). Light defoliation is expected in about 140 ha near Goose Point. The area of moderate and high hazard is forecast to be approximately 1 100 ha (Table 2, Fig. 4).

J. Hudak
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St. John's, Nfld.
23 November 1982

Table 1. Area (ha) of defoliation caused by the spruce budworm in productive forests of Newfoundland in 1982.

Management Unit No.	Defoliation class[1]			
	Light	Moderate	Severe	Total
9	864	-	207	1071
12	2827	-	843	3670
14	35297	2914	17989	56200
15	10208	1222	17985	29415
19	-	-	660	660
Total Island	49196	4136	37024	90356
Total Labrador	-	-	660	660

[1]Light: 1% to 25%
Moderate: 26% to 75%
Severe: 76% to 100%

Table 2. Areas of moderate and severe defoliation, and moderate and high hazard forecast in productive forests of Newfoundland for 1983.

Management Unit No.	Ownership	Moderate and severe defoliation (ha)	Moderate and high hazard (ha)
2	Crown	-	1183
7	Bowater	-	1659
8	Crown	-	1013
9	Bowater	-	1210
10	Abitibi	-	2214
11	Abitibi	-	5933
12	Abitibi	12858	12858
14	Crown	5282	28024
14	Bowater	36204	52504
15	Crown	-	272
15	Bowater	54474	54407
18	Bowater	-	1904
19	Crown	1013	1149
TNNP		408	408
All	Crown	6295	31641
	Bowater	90678	111684
	Abitibi	12858	21005
	TNNP	408	408
Total Island		109226	164738
Total Labrador		1013	1149

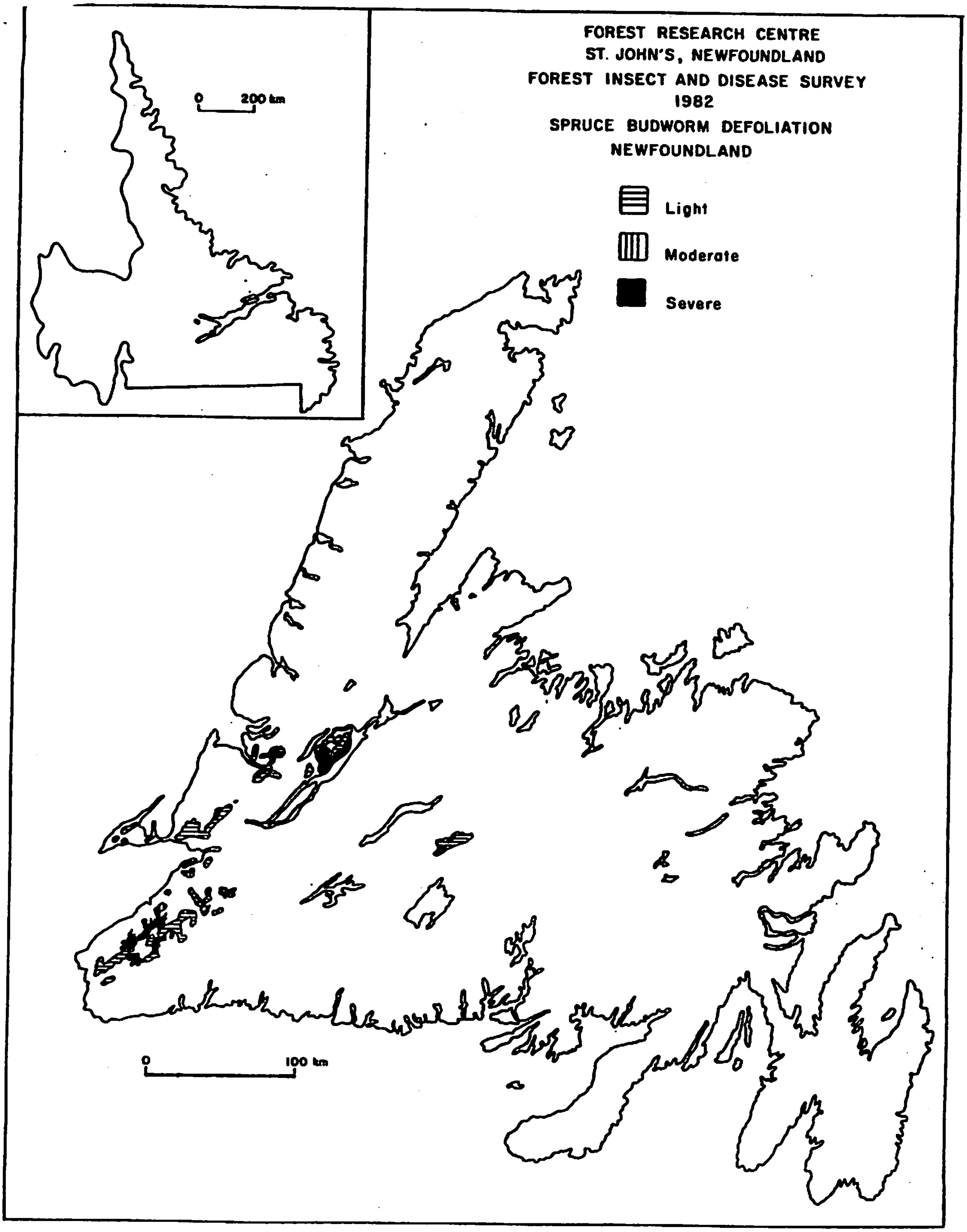

Figure 1. Areas of light, moderate and severe defoliation by the spruce budworm in Newfoundland in 1982.

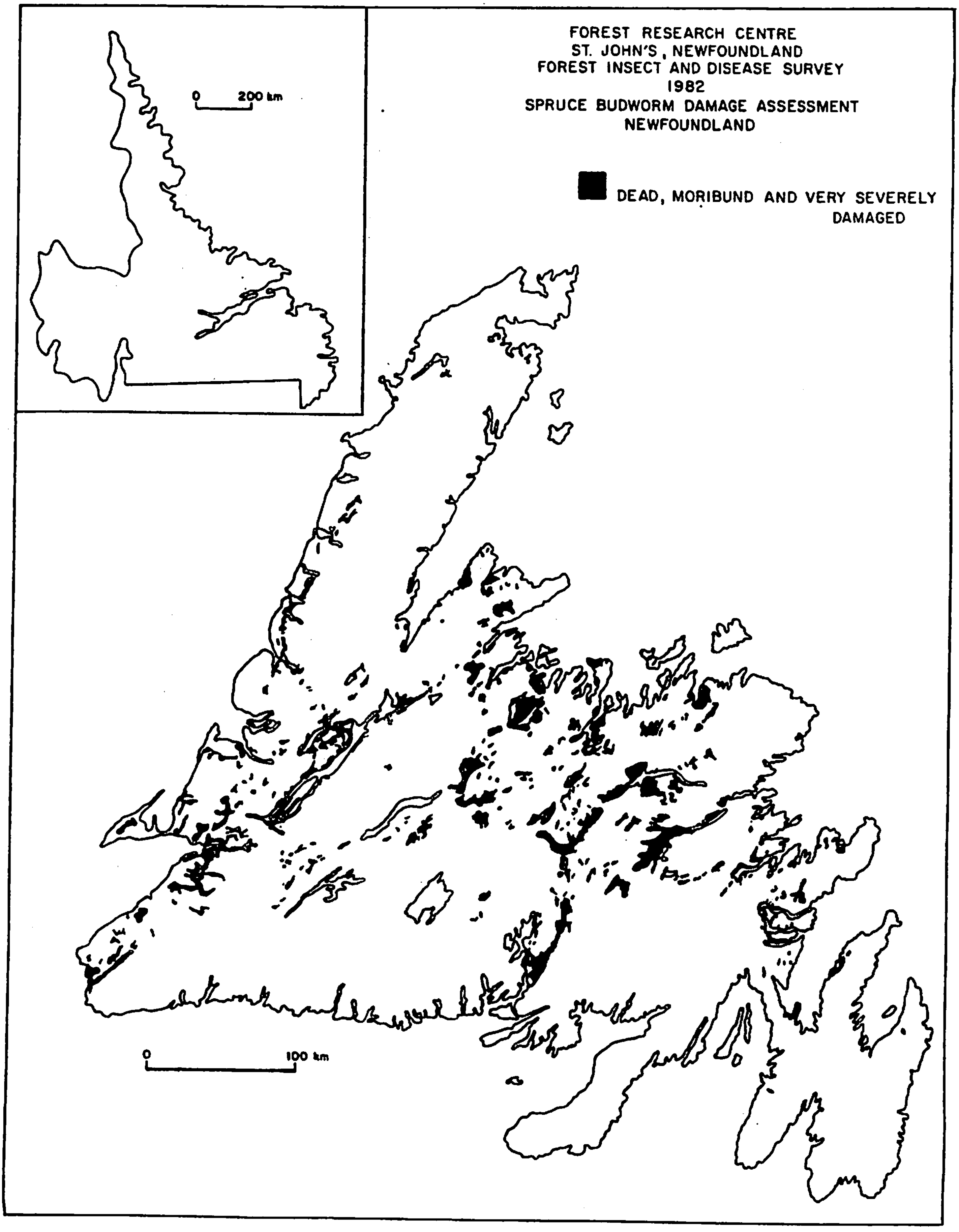

Figure 2. Areas of tree mortality from spruce budworm in Newfoundland in 1982.

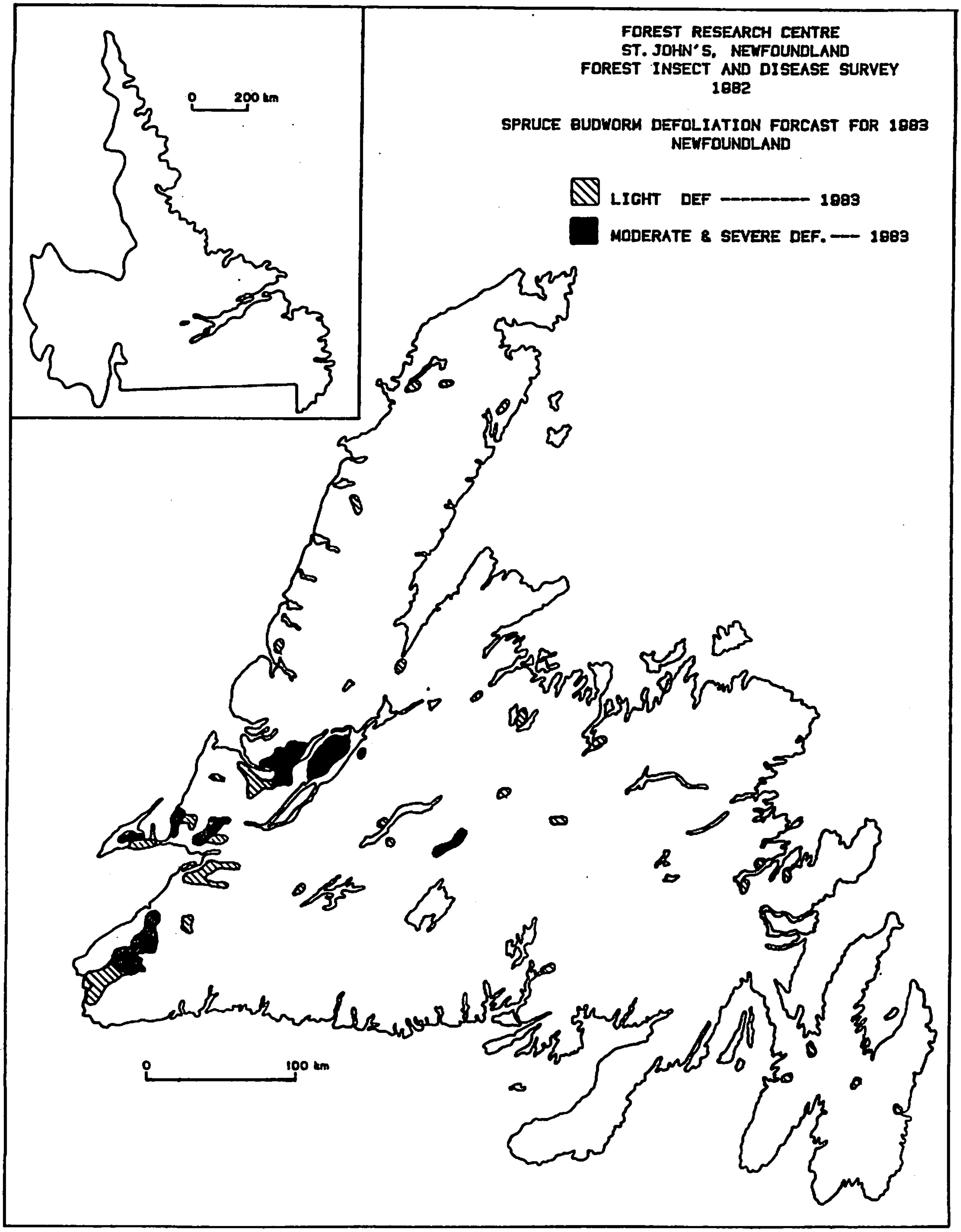

Figure 3. Areas of light, moderate and severe defoliation by the spruce budworm in Newfoundland forecast for 1983.

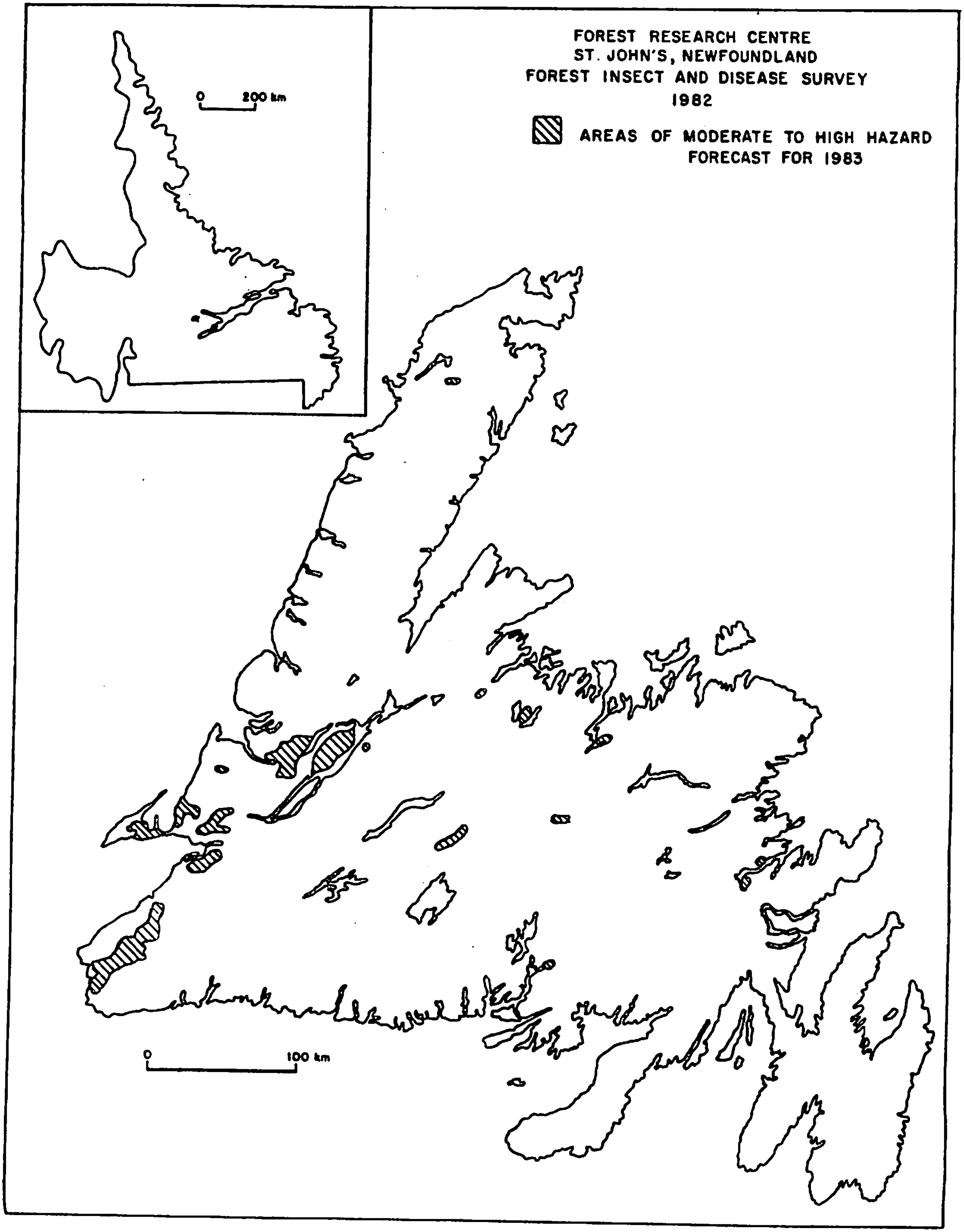

Figure 4. Areas of moderate and high spruce budworm hazard in Newfoundland forecast for 1983.

INFORMATION ON NEWFOUNDLAND'S 1982 SPRAY PROGRAM*

1. Original area selected for treatment included:
   91 708.3 ha with Matacil, and
   4 307.8 ha with Bt (Thuricide 16B).

2. Extremely low populations in a number of areas resulted in deleting 48 599.0 ha (51%) from the original program.

3. Total area treated consisted of:
   43 109.3 ha with Matacil, and
   4 724.7 ha with Bt.

4. 97 percent of the area treated with Matacil received a double application as prescribed.

5. Bt was only applied in a single application as prescribed.

6. The application rate for Matacil was 2 x 70 g/1.46L/ha with a minimum five-day interval between treatments.

7. Bt was applied at 20 BIU/7.0L/ha.

8. Two teams of single-engine Grumman AgCats were contracted from Kanata Aviation Ltd. of Charlottetown, P.E.I. One team consisted of four 600 horsepower AgCats and the other had four 450 horsepower AgCats. The latter performed well over flat terrain but not as well as the 600 hp AgCats in more hilly terrain.

9. Guidance was by aerial supervisors using 1:50,000 topographic maps with flight lines and designated no spray areas. One team was led by a navigator in a high-wing Cessna 172 with a spray supervisor in a Bell Jet Ranger 206B helicopter. The other team was led by a navigator in a similar helicopter with another spray supervisor in a twin-engine Cessna 337 aircraft.

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*Prepared by N. Carter for Annual Forest Pest Control Forum, 1982. Full report available from: Dept. Forest Resources and Lands, Bldg. 810, Pleasantville, St. John's, NF A1A 1P9.

10. The nominal swath widths adopted for each aircraft was 76 m when using Matacil and 38 m when using Bt.

11. When carrying a full load of insecticide, each team of four AgCats could treat 3 100 ha with Matacil or 540 ha with Bt at the nominal swath widths and selected treatment rates.

12. (a) When spraying Matacil, the AgCats were each fitted with equal numbers of 8002 and 8004 Spraying Systems Tee Jet tips (i.e. 12 of each size, with the 8004s outboard and 8002s inboard).

(b) When spraying Bt, the AgCats were each fitted with 45 number 8004 Spraying Systems Tee Jet tips.

13. The first areas were opened for treatment on June 21. Actual spraying began on the afternoon of June 22 and finished on the morning of July 15. Spraying took place in either the western or central region on 17 days of the 25-day period.

14. There were no emergencies necessitating the jettison of any insecticide this year. Nonetheless as a precaution each AgCat had a radio transmitter* placed in its spray hopper in the event a dump occurred. These shock-proof, water-proof transmitters were put in cases fabricated from cork for buoyancy and wrapped in several plastic bags to prevent the cork falling apart in the hoppers.

15. Weather conditions this spring and early summer were more normal than last year with larvae reaching peak third instar about June 20. Unlike last year, there was no significant late spring frost though June was generally cool and wet.

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*Telonics Inc., Mesa, Ariz. Model TMB-1, unit price = $312 U.S.

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16. Based on last year's experience (i.e. patchy larval distribution) it was decided to use random sampling throughout spray blocks to assess budworm levels. It was found that populations were essentially as predicted with low numbers of larvae throughout eastern, central and some western areas which also contained some "hot spots".

17. The attached table summarizes pertinent data indicating: population levels in terms of larvae per 45-cm branch tip and larvae per shoot; expected branch defoliation (based on relationship derived from 1981 data); observed branch defoliation; foliage protection; and unadjusted larval mortality.

18. With very few exceptions observed branch defoliation was significantly less than the level which was expected. Overall expected defoliation was reduced by about 86% in Matacil plots and 75% in Bt plots.

19. In most cases larval mortality exceeded 90% which is not surprising considering the relatively low initial population levels and the spray was applied during the optimum time as prescribed.

20. The spray program was therefore considered to be successful in reducing expected levels of branch defoliation through larval mortality.

21. A flight of spruce budworm moths invaded Newfoundland in early July in advance of local adult emergence. The local CFS established a network of pheromone traps which caught male moths over extensive areas. Whether this moth flight will significantly contribute to the size of infestation for 1983 remains unknown until the fall egg mass survey is completed.

Table 1. Summary of Spruce Budworm Data, 1982.

Block No.	Max. no. larvae per 45-cm	Max. no. larvae per shoot	Branch Defol. % Exp.	Branch Defol. % Obs.	% Fol. Prot.*	Unadj. Mort. %
113	5.4	0.12	58	12	79	100
114	1.0	0.01	7	1	86	100
115	7.6	0.23	88	3	97	79
205	1.6	0.06	35	16	54	75
	3.0	0.09	48	6	88	100
206	14.4	0.30	97	4	96	100
207	1.2	0.02	14	17	0	92
	2.2	0.04	25	1	96	100
208	2.4	0.03	20	5	75	92
210	5.0	0.17	75	3	96	98
	10.8	0.14	65	3	95	100
214	2.0	0.05	30	0	100	100
217	1.0	0.01	7	0	100	100
	0.8	0.01	7	1	86	88
218	1.4	0.02	14	0	100	93
	1.4	0.02	14	0	100	100
219	3.2	0.07	40	1	98	100
220	1.6	0.02	14	1	93	100
	1.6	0.01	7	1	86	94
221	2.8	0.02	14	1	93	96
222	3.6	0.03	20	0	100	100
	3.2	0.02	14	0	100	100
223	0.8	0.01	7	3	57	88
224	2.8	0.07	40	1	98	100
	2.4	0.04	25	1	96	96
	4.6	0.05	30	**	**	**
226	13.2	0.20	82	**	**	**
	13.4	0.18	77	19	75	100
227	12.4	0.17	75	**	**	**
228	7.0	0.07	40	**	**	**
	7.4	0.07	40	2	95	100
	0.6	0.01	7	3	57	100
229	8.6	0.11	55	1	98	99
	2.2	0.03	20	3	85	100
230	14.0	0.14	65	1	98	100
	11.6	0.16	73	21	71	84
231	17.6	0.20	82	**	**	**
	10.6	0.17	75	8	89	97
232	9.6	0.07	40	**	**	**
401***	7.0	0.10	52	27	48	60
	2.0	0.01	7	1	86	100
	2.0	0.01	7	2	71	100
	1.8	0.02	14	4	71	92
	1.2	0.02	14	0	100	100

* % Fol. Prot. $\% \text{ Fol. Prot.} = \frac{\text{Exp. Def.} - \text{Obs. Def}}{\text{Exp. Def.}} \times 100\%$

** no final post-spray sample

*** 401 done with Bt, rest with Matacil

1982 ENVIRONMENTAL MONITORING OF SPRUCE BUDWORM SPRAY PROGRAM *

The Department of Environment, Government of Newfoundland and Labrador, conducted an environmental monitoring program in 1982 to assess the impact of the spruce budworm spray program on non-target organisms in insular Newfoundland. 1982 is the 6th year in which monitoring has been conducted.

Experimental forest blocks, in use since 1978, were sprayed with aminocarb by the Department of Forest Resources and Lands. The Department of Biology, Memorial University, was contracted to perform the monitoring program. Studies included:

(1) Monitoring of the bird population using song census and mist-netting techniques.

(2) assessment of terrestrial arthropod communities using vegetation sampling and deadfall traps.

(3) evaluation of the aquatic arthropod community using artificial substrates (rock bags) and drift nets.

(4) analysis of air, water, soil and vegetation for matacil.

Results are not yet available, but are expected within a month.

1982 11 17

* (Summary statement for Pest Control Forum prepared by Dr. D. Barnes, Dept. of Environment, Elizabeth Towers, Elizabeth Ave, St. John's, NF).

Department of Fisheries and Oceans' Experiment to Determine the Long-Term Effects of Matacil on an Aquatic Ecosystem in Central Newfoundland

Report to the Tenth Annual Forest Pest Control Forum
Ottawa, Ontario, November 1982

by

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A1C 5X1

PURPOSE

The purpose of the project is to determine the long-term effects of aerially applied pesticides on aquatic ecosystems.

We are considering a long-term effect to be a direct or indirect effect of spraying which is not apparent immediately after spraying or that is immediately apparent and persists in the long term. Special consideration is being given to effects changing the value of the fishery resource.

In order to attain the objective we are taking two major experimental approaches.

EXPERIMENTAL DESIGN

The first approach involves the collection of biological data on Spruce Pond and its three streams for a number of years prior to a spray and a number of years during which the area will be experimentally sprayed. Spruce Pond is a brown-water pond of 36 ha with an average depth of about 1 m situated about halfway down the Bay D'Espoir Highway on the headwaters of the Northwest Gander River. The sixth year of data collection on the Spruce Pond system is 1982. It is hoped that a comparison of pre-spray to post-spray data will reveal any changes occurring as a result of the spray.

The second approach is the collection of biological data on the Spruce Pond and Headwater Pond systems during which time Spruce Pond will be experimentally sprayed and Headwater Pond will be a control. Headwater Pond is a brown-water pond of 78 ha with an average depth of about 1 m situated about 4 km upstream from Spruce Pond. It has two tributary streams. The fourth year of data collection on the Headwater Pond system is 1982. It is intended that an understanding of the similarities and differences between the two systems be had prior to experimental spraying. It is hoped that a comparison of the sprayed system to the unsprayed system will reveal changes caused by the spray.

DATA COLLECTED TO DATE

Data are collected on both pond systems from the last week in May to the first week in October. Stream counting fences are installed adjacent to the ponds and the kinds and numbers of migrating fish are monitored. Present in the ponds are brook trout, Atlantic salmon, American eels, and threespine sticklebacks. Population estimates of trout and salmon are conducted each spring and fall and growth rate and production data are obtained for each species except eels. Stream invertebrates are sampled twice monthly with Surber samplers and drift nets. Artificial substrates are harvested in September. Every 2 weeks, samples of phytoplankton, zooplankton, and bottom invertebrates are collected from the ponds and primary production is measured using the light and dark bottle Winkler method. Bottom invertebrates from each pond are also collected from 50 sq. ft. of Ekman dredge samples in July and from artificial substrates in September. Physical and chemical water quality are routinely monitored.

TIMING OF FUTURE ACTIVITIES

So far, much fluctuation in the aquatic biology of both systems has been observed on a year-to-year basis. Less variation has been observed between the two systems. The causes of year-to-year and between-pond variations are becoming better understood but it is unlikely that a predictive capacity has been sufficiently developed to allow for an experimental spraying in 1983. It is felt that because of the large fluctuations observed, common in such relatively simple systems, functional relationships are not sufficiently well defined to allow for a recognition of all but major effects of a spray on fishes. The decision of whether or not to spray Spruce Pond in 1984 will be made on the basis of results obtained up to that time. If the experiment will not provide a reasonable understanding of the long-term effects of Matacil on the aquatic environment, we will modify it.

PARTICIPATION FROM OTHER GROUPS

The Forest Pest Management Institute of Sault Ste. Marie, Ontario has expressed the wish to conduct an experimental spray and a short-term environmental study. The participation of other groups who wish to study aspects of the Experimental Ponds Area is welcome.

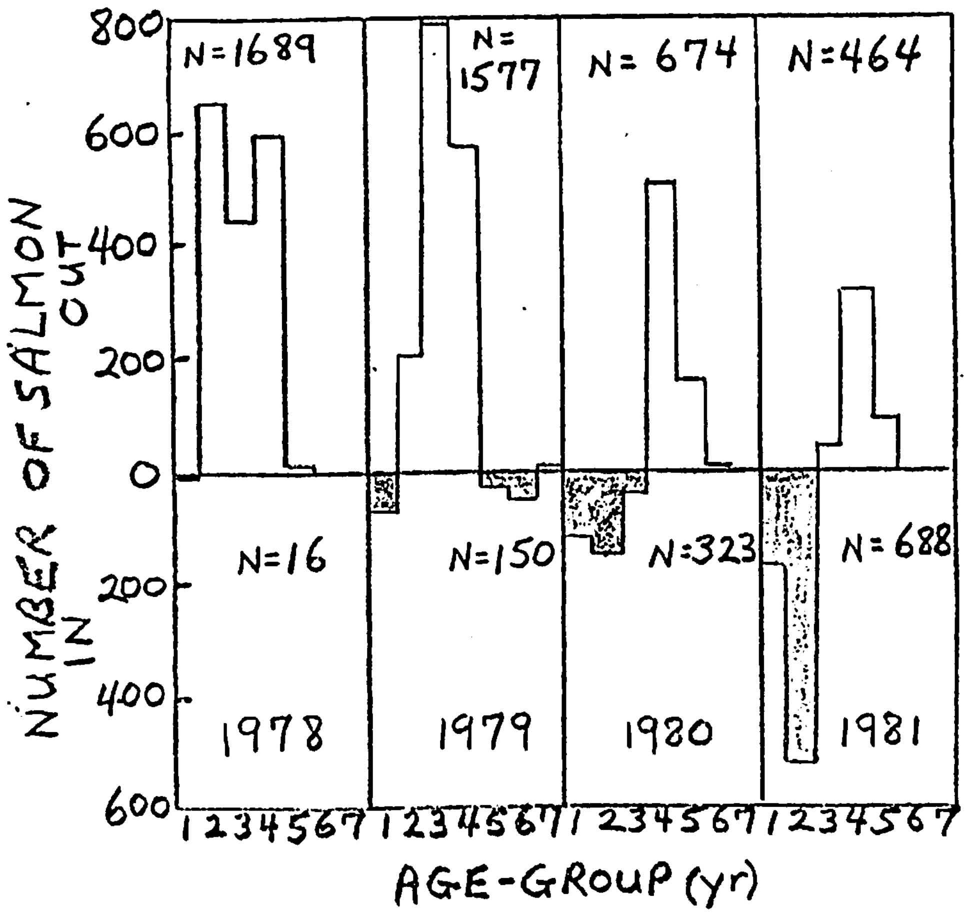

Fig. 1. Examples of fluctuations in the numbers of salmon entering Spruce Pond from streams (bottom panel) and leaving Spruce Pond for the ocean as smolts (upper panel).

Technical Note on the spraying of
Bacillus thuringiensis kurstaki
for the suppression of spruce budworm larvae
(*Choristoneura fumiferana* (Clemens, 1865))
in selected areas of Nova Scotia, 1982

by
Dr. T. D. Smith
October 25, 1982

Introduction

This report is to provide a synopsis of the result of the aerial application of a microbiological biocide (Bacillus thuringiensis kurstaki (B.t.k.)) to reduce population densities of larvae of spruce budworm (Choristoneura fumiferana (Clemens, 1865)) in selected high value spruce (Picea spp.) and/or balsam fir (Abies balsamea) in Nova Scotia in 1982.

Objective

The objective of the 1982 B.t.k. program was to maintain fifty percent or more of current foliage on spruce and/or balsam fir trees in the treatment areas.

Treatment Areas

There was a noticable reduction in population densities of spruce budworm larvae in susceptible trees on Cape Breton during 1981. These low population densities did not warrant a foliage protection on previously protected areas. The trees in the cone production areas were, however, protected. The spruce budworm infestation intensified in Cumberland County and additional areas were added to the program (Figures 1 and 2).

The total area flown was 19 153.2 ha, in Cape Breton Highlands 629.0 ha, and 18 524.2 ha on the Mainland (Tables 1 and 2).

Biocide

Three commercial preparations of Bacillus thuringiensis kurstaki were applied at the recommended concentration of 20 $BIU \cdot ha^{-1}$ (Table 3).

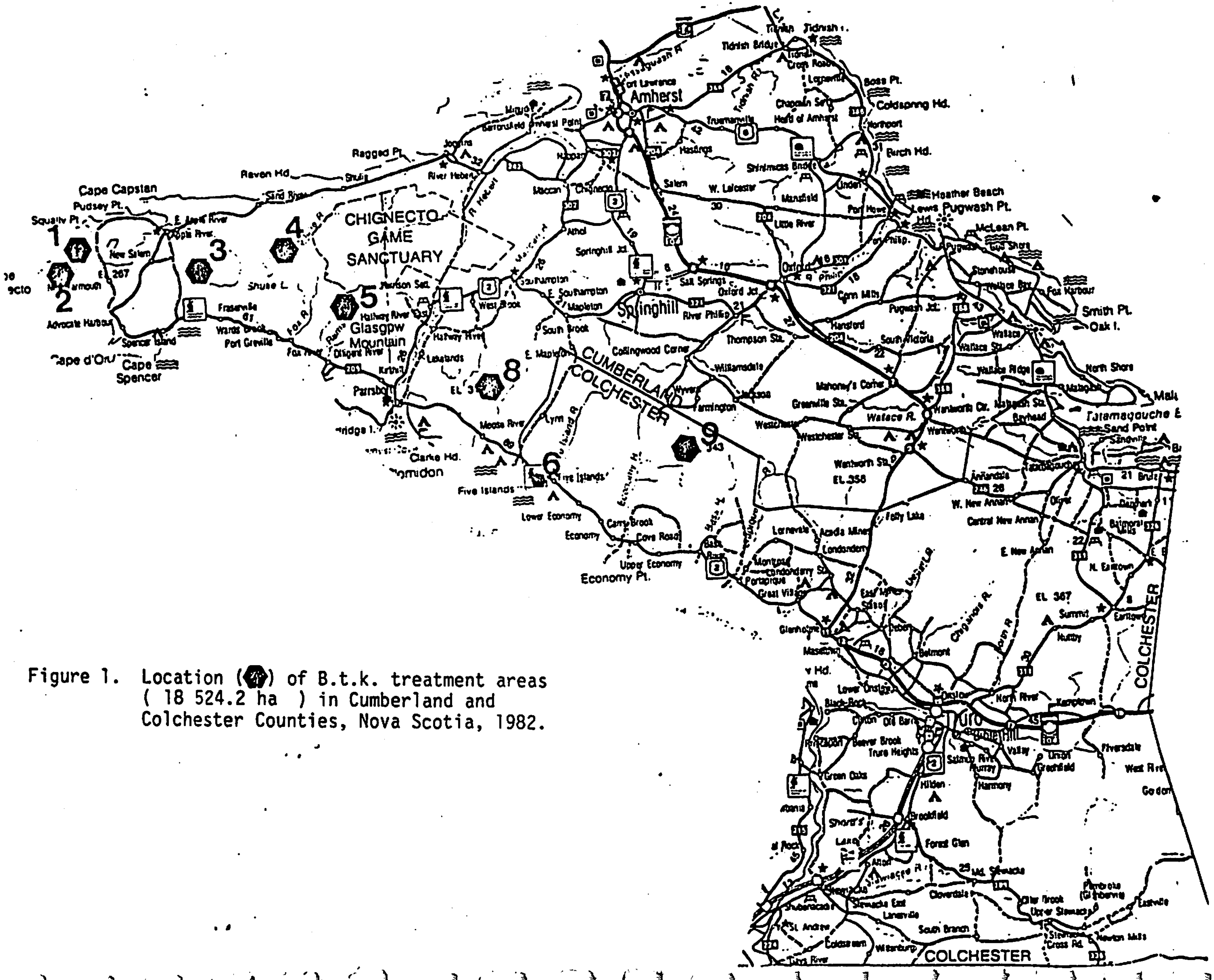

Figure 1. Location (⬣) of B.t.k. treatment areas (18 524.2 ha) in Cumberland and Colchester Counties, Nova Scotia, 1982.

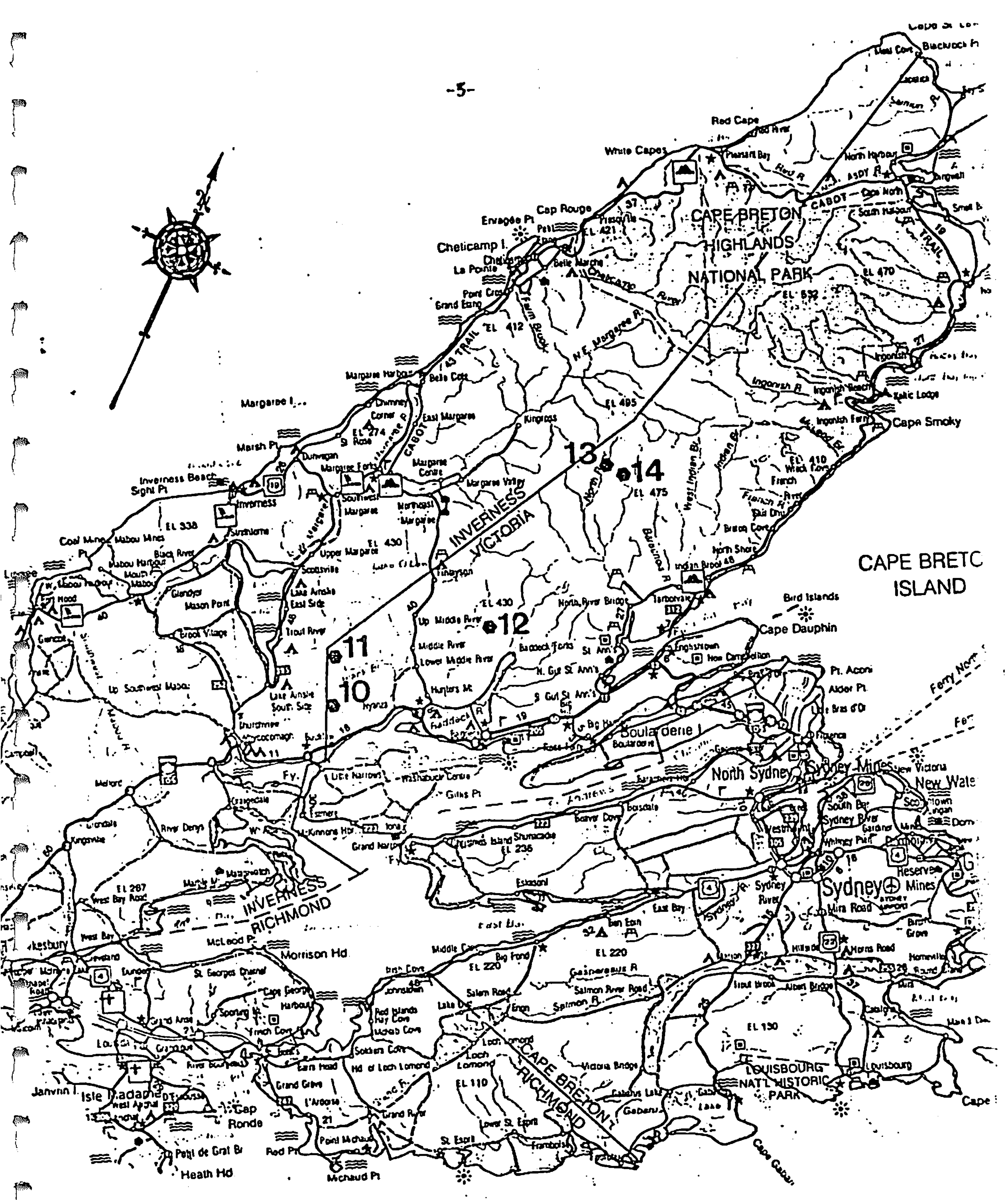

Figure 2. Location (⬣) of B.t.k. treatment areas (360 .0 ha) in Cape Breton, Nova Scotia, 1982.

Table 1a. Percent foliage protection of host trees and percent reduction in survival of larvae of spruce budworm (*Choristoneura fumiferana* (Clemens, 1865)) obtained by aerially applying a microbiological agent (*Bacillus thuringiensis kurstaki*) at 20 BIU·ha^{-1}, Nova Scotia, June, 1982.

Treatment Area							Spruce Budworm					
Name	No.	Cover Type[1]	No. of Applications[2]	Area Flown (ha)[3]	Foliage Protection %	Foliage Protection Abundance of Flowers	Mean No. Larvae per 45 cm branch tip	Predominant Larval Instar treated (%) 3rd	4th	5th	6th	Reduction in Survival
Mainland												
Eatonville N	1	rS	1	3253.8	43	Moderate	31	10	40	30	20	63
Eatonville S	2	rS	1	303.3	43	Moderate	31	10	40	3	20	63
Advocate	3	rS	1	1730.5	32	High	37	-	40	40	20	44
Shulie	4	rS	1	1807.5	31	High	38	10	40	40	10	63
Welton	5	rS	1	2409.6	23	High	33	30	50	20	-	53
Five Islands	6	wS(bF)	1	116.7	0	Low	30	30	70	-	-	0
Moose River	8	rS	1	6575.7	57	Low	14	-	30	50	20	57
Economy	9	bF	1	2327.0	43	Low	12	50	50	-	-	0
		rS		-	55	Low	10	50	50	-	-	40
Total Mainland				18524.2								
Cape Breton												
Hume	10	bS	2	68.7	NM	NM	NM		3-4			NM
Gairloch Mtn	11	wS	2	139.6	NM	NM	NM		3-4			NM
Muskrat Bk	12	bS	1	22.4	NM	NM	NM		3-4			NM
Miners Rd	13	wS	2	270.2	NM	NM	NM		3-4			NM
Kelly Rd	14	bS	1	128.1	NM	NM	NM		3-4			NM
Total Cape Breton				629.0								
Total Mainland and Cape Breton				19153.2								

1. Cover type based on Québec System - bF is balsam fir, wS is white spruce, rS is red spruce, bS is black spruce.
2. 1 is foliage protection areas, 2 is cone production areas, and 3, recreational areas.
3. Values determined from navigator reports.
4. NM means not measured in areas scheduled for multiple applications.

Table 1b. Summary of Results of Spraying in Nova Scotia with Btk. 1982

Block Location	Spruce Budworm per 45cm.tip Pre-spray L_3	Post-spray Pupae (P)	Survival (P/L_3) Obs.	Survival (P/L_3) Exp.	% Reduction in survival	Defoliation (%)* % Obs.	Defoliation (%)* % Exp.	% foliage saved (1)	% foliage saved (2)	Date Sprayed	Development at spray dates: Larvae % Instar III	IV	V	VI	Host % Total shoot growth	Tree % buds flushed	No Colonies 1 cm^2
		Red Spruce								June							
Eatonville	31	2.0	6	16	63	21	37	16	43	27-28	10	40	30	20	17	80	20.0
Advocate	37	3.7	10	18	44	28	41	13	32	23	0	40	40	20	16	80	29.2
Shulie	38	2.6	7	19	63	29	42	13	31	21-23	10	40	40	10	?	?	19.8
Welton	33	2.7	8	17	53	30	39	9	23	11-12	30	50	20	0	5	0	10.8
Moose R.	14	0.4	3	7	57	8	18	10	56	25-28	0	30	50	20	?	85	26.9
Economy	10	0.3	3	5	40	5	11	6	55	8-12	50	50	0	0	3	0	25.0
		White Spruce															
Five Islands	30	4.4	15	15	0	16	36	20	56	7	30	70	0	0	40	95	4.2
		Balsam Fir															
Economy	12	0.9	8	8	0	8	14	6	43	8-12	50	50	0	0	10	75	25.0

* % Foliage Saved

Method (1) Expected- Observed defoliation= Absolute Percentage saved by spraying.

Method (2) $\frac{\text{Expected- Observed}}{\text{Expected}}$ X 100 = Proportional amount of foliage saved.

Table 2. Area and precent area and total area and percent total area flown for the B.t.k. program, June, 1982.

Date June (1982)	Area ha	Area %	Total Area ha	Total Area %
7 AM	116.7	0.6	116.7	0.6
8 AM	779.7	4.1	896.4	4.7
11 AM	1587.6	8.3	2484.0	13.0
12 PM	2369.3	12.4	4843.3	25.4
18 PM	27.9	0.1	4881.2	25.5
19 AM	101.1	0.5	4982.3	26.0
PM	105.3	0.5	5087.6	26.5
21 AM	1266.5	6.6	6354.1	33.1
22 AM	424.9	2.2	6779.0	35.3
23 AM	1907.2	10.0	8686.2	45.3
25 AM	1425.3	7.4	10111.5	52.7
PM	147.8	0.8	10259.3	53.5
27 AM	899.6	4.7	11158.9	58.2
PM	1350.1	7.0	12509.0	65.2
28 AM	6644.2	34.7	19153.2	100.0

Table 3. The rates and total volume of three commercial preparations of Bacillus thuringiensis kurstaki used to protect current foliage of spruce (Picea spp.) and balsam fir (Abies balsamea) from feeding by larvae of spruce budworm (Choristoneura fumiferana (Clemens, 1865)) in selected areas of Nova Scotia, 1982.

Commercial Preparation	Formulation Concentrate (ℓ)	Formulation Water (ℓ)	Formulation Total (ℓ)	Total Volume l	Total Volume drums (202ℓ)
Thuricide 16B [1]	4.70	2.30	7.10	5 467.5 1148	27
Dipel 88 [2]	2.35	2.50	5.85	1 012.5 428	5
Thuricide 32LV [1]	2.35	2.50	5.85	32 400.0 13728	160

15304 Ha ?

1. Sandoz Inc. 480 Camino Del Rio South, San Diego, Cal. USA 92108

2. Abbott Lab. Ltée., C.P. 6150, Stn. A., Montreal, CUM, Qué. H3C 3K6

Monitoring

Monitoring of spruce budworm life stages, population density trends, timing of application of the biocide and the efficacy of the biocide is done under the direction of personnel of the Canadian Forestry Service (Table 3). This year ten people were involved with monitoring activities which began in mid-May and ended during the first week of August.

Host Conditions

This year the spruce and balsam fir trees produced an abundance of flowers. Flowers are the preferred food of spruce budworm larvae and feeding was confined to the flowers when they were available. This tended to reduce feeding pressure on current foliage until the supply of flowers was exhausted and/or larvae were forced from the flowers.

Weather

As with previous years, the predominant factor affecting the conduct of the B.t.k. program was weather. Poor flying conditions at the Parrsboro Airport caused a loss of approximately 33 percent of flight time.

Results

In general the results of the 1982 B.t.k. program can be considered as moot. On the mainland the percent of current spruce foliage protected ranged from 23 in Welton to 57 in Moose River treatment areas.

The larval populations varied from 10 to 38 . The percent reduction in survival ranged from 40 to 63 on the Mainland. Spray efficacy was not determined on the seed production areas as these areas were scheduled for two applications. Subjectively there was improvement in living trees in the 1981 treatment areas, however, these trees remain as ideal sites for spruce budworm.

Expenditures

The total expenditure of the B.t.k. program from 30 September 1981 to 30 September 1982 was $ 749,229.61. The cost per hectare flown was $39.12 (Table 4).

Summary

The total area flown for the 1982 B.t.k. program was 19 153.2 ha, 18 524.2 ha on Mainland and 629.0 ha in Cape Breton. The total volume of Thuricide 16B used was 5 467.5 l, Dipel 88 was 1 012.5 l and Thuricide 32LV was 32 400.0 l. The number of larvae per 45 cm branch tip ranged from 10 to 38 . Foliage protection ranged from 23 to 57 for red spruce species complex, was 0 for white spruce in Five Island Park and was 0 for balsam fir in Economy Treatment Area.

Data for larval mortality and foliage protection should be treated with caution and are not comparable to previous year's data. The high number of flowers provided ideal feeding sites for larvae thus significantly reducing feeding pressure on the foliage in both the treatment and untreated areas. The low foliage protection and high larval survival reflect the preference of spruce budworm larvae for flowers.

Table 4. Expenditures of the operational project to suppress larvae of spruce budworm (Choristoneura fumiferana (Clemens, 1865)) with the aerial application of a microbiological agent (Bacillus thuringiensis kurstaki) (20 BIU·ha^{-1}) in selected areas of Nova Scotia, 1 October 1981 to 30 September, 1982.

Category	$	%	$ per ha flown
Salaries	129 534.94	17.29	6.70
Travel	11 552.75	1.54	0.60
Special Services	14 880.39	1.99	0.78
Supplies & Services	530 681.01	70.83	27.21
Biocide	166 023.95[1]	22.16	8.67
Aircraft	320 193.19	42.74	16.72
Lodging	24 070.84[1]	3.21	1.26
Rentals	15 664.18	2.09	0.82
Trucking	4 728.85	0.63	0.25
Equipment	9 554.94	1.27	0.50
Others	53 025.58	7.08	2.77
Total	749 229.61	100.00	39.12

1. Biocides & Lodging for gypsy moth suppression included.

Disclaimer Statements:

The use of trade, firm, or corporation names is for the information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement or approval of any product or service to the exclusion of others which may be suitable.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the used discussed here have been registered. All uses of pesticides must be registered by appropriate Provincial and/or Federal agencies before they can be recommended.

MARITIMES FOREST RESEARCH CENTRE

TECHNICAL NOTE NO. 63

SPRUCE BUDWORM INFESTATIONS IN NOVA SCOTIA IN 1982 AND A FORECAST FOR 1983

The status of spruce budworm infestations in Nova Scotia are determined annually from aerial surveys of current defoliation and surveys of egg-mass infestations. In 1982 the extent and severity of spruce budworm feeding was determined from an aerial survey conducted by the Canadian Forestry Service. Surveys for egg-mass infestations (which are used to forecast infestations in the coming year) were a joint survey effort of the Canadian Forestry Service, Nova Scotia Department of Lands & Forests and Bowater-Mersey Paper Co. The Nova Scotia Department of Lands and Forests provided major manpower and financial support for this survey. Figures 1 and 2 show the results of these surveys in 1982. Tables 1 and 2 show the results in 1982 as well as in previous years.

Defoliation

Defoliation occurred on 212 000 ha of spruce, fir and mixed wood forest in 1982. Of this area, 23% (49 700 ha) was severely defoliated, 59% (125 000 ha) moderately defoliated and 17% (36 900 ha) lightly defoliated. Cumberland and Colchester counties and areas along the Northumberland Strait sustained the majority of the damage.

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Comparison with 1981:

Based on the results of egg-mass surveys in 1981, the forecast was for significantly less defoliation on Cape Breton Island, Annapolis Valley and along the Northumberland Strait but for only slightly less in Cumberland County.

However, the 1982 defoliation survey (Figure 1 and Table 1) showed that in Cumberland and Colchester counties, the area of all categories of defoliation were greater (154 500 ha) than in 1981 when 141 600 ha of defoliation were mapped. There were fewer hectares of severe defoliation in 1982 (48 900) than in 1981 (69 000) but significantly more moderate defoliation (92 000) as compared to (31 800) (Figures 1 & 3).

In the Northumberland Strait area (Pictou and Antigonish counties) there was a pronounced increase in the total area defoliated in 1982 which was a third higher with 40 500 hectares defoliated compared to 26 600 hectares in 1981. There were fewer hectares of severe defoliation in 1982 (800) than in 1981 (1 600).

In the Annapolis Valley the forecasted reduction in severity of damage did occur and only 4 100 hectares of defoliation (all moderate) were mapped compared to 136 200 hectares in 1981 of which 89 300 hectares were moderate to severe.

Similarly, on Cape Breton Island, the forecasted reduction in new damage occurred. Only 12 700 hectares of defoliation (12 300 of light and 400 hectares of moderate) were mapped compared with 396 100 hectares in 1981.

Egg Masses

The results of spruce budworm egg-mass surveys from 1974 to 1982 are presented by county in Table 2.

Cape Breton: Infestations on Cape Breton Island in Richmond and Cape Breton Counties have declined to a very low level but a resurgence occurred in Inverness County in the Creignish - Kingsville - Little Judique area, and in the area from Cap Le Moine, Inverness County north to Cape North in Victoria County. Isolated high infestations were also detected at North Shore and west of New Glen in Victoria County.

Mainland: In Antigonish and Pictou Counties, infestations have increased significantly and moderate to severe defoliation may occur over a greater area in 1983 than in 1982 particularly in the Cape George Peninsula of Antigonish county and in the forest about Stellarton, Pictou County. In Cumberland and Colchester Counties egg mass infestation have increased significantly. Moderate to severe defoliation should be more extensive in 1983 than in 1982 particularly in the Chignecto peninsula and throughout the susceptible forest from Salem east to Tatamagouche in Colchester County (Figure 2).

Infestations also increased significantly in the North and South Mountain regions of Annapolis and Kings Counties and in the northwest sector of Digby County. Extensive areas of moderate to severe defoliation can be anticipated in susceptible forest stands in this region in 1983.

Elsewhere on the mainland spruce budworm infestations are low and pose no threat of moderate to severe defoliation in 1983.

The resurgence of infestations in the four main infestation areas of the province result from high survivals of budworm larvae, and adults. Weather favourable to the budworm occurred in 1982 and an abundant crop of fir and spruce flowers which are a very nutritious budworm food was also available. There is also some evidence of moth invasions into Cape Breton Island from infested areas to the west of Cape Breton. Such an invasion would enhance any locally high budworm survival, hence causing a resurgence of infestations.

- E. G. Kettela
Technical & Information Services

October 1982

Table 1. Summary of areas of spruce budworm defoliation * in Nova Scotia from 1978 to 1982.

Sector of province	Year	Defoliation categories (hectares X 1000) light	moderate	variable	severe
Mainland					
Cumberland Colchester	1978	3.2	20.3	0	74.5
	1979	3.6	17.8	0	77.0
	1980	3.2	66.0	45.8	102.1
	1981	40.8	31.8	0	69.0
	1982	13.6	92.0	0	48.9
Northumberland Coast	1978	10.9	11.7	0	1.2
	1979	31.6	8.9	0	15.8
	1980	13.8	1.2	56.3	7.3
	1981	13.5	11.0	0	1.6
	1982	11.0	28.7	0	0.8
Annapolis Valley	1978	0	0	0	0
	1979	20.7	11.3	0	9.7
	1980	40.1	36.0	0	21.5
	1981	46.9	42.0	0	47.3
	1982	0	4.1	0	0
Cape Breton Island	1978	0	68.9	203.3	376.7
	1979	164.4	129.6	339.4	256.8
	1980	47.4	121.1	456.8	361.3
	1981	31.8	71.4	0	292.9
	1982	12.3	0.4	0	0
Total area of all categories of defoliation (thousand of hectares)	1978	1979	1980	1981	1982
	771	1 087	1 380	700	212

* from maps developed from aerial surveys of spruce budworm defoliation.

Table 2: Spruce Budworm egg-mass infestation counts per 10^2m in Nova Scotia by county from 1974 to 1982.

County	1974	1975	1976	1977	1978	1979	1980	1981	1982
Richmond	125	203	430	649	364	403	423	51	2
Cape Breton	—	496	1608	524	437	349	378	17	7
Inverness	468	552	1319	758	389	316	308	50	151
Victoria	370	676	1832	771	435	647	258	27	50
Cumberland	293	263	191	71	218	307	235	197	622
Colchester	24	20	104	23	165	52	10	22	52
Pictou	—	23	29	125	140	214	116	13	103
Antigonish	204	135	196	182	252	65	136	79	228
Guysborough	0	0	6	78	—	8	0	8	19
Kings	14	12	12	25	73	183	245	86	245
Annapolis	19	16	18	27	121	165	224	72	331
Hants	36	11	6	6	0	19	61	12	5
Digby	12	6	11	20	—	3	86	36	42
Halifax	0	37	0	5	—	0	30	24	21
Lunenburg	0	6	0	6	9	16	10	15	20
Shelburne	0	3	0	12	—	8	28	4	2
Queens	0	3	4	4	0	0	—	6	11
Yarmouth	0	0	16	20	—	28	29	4	4

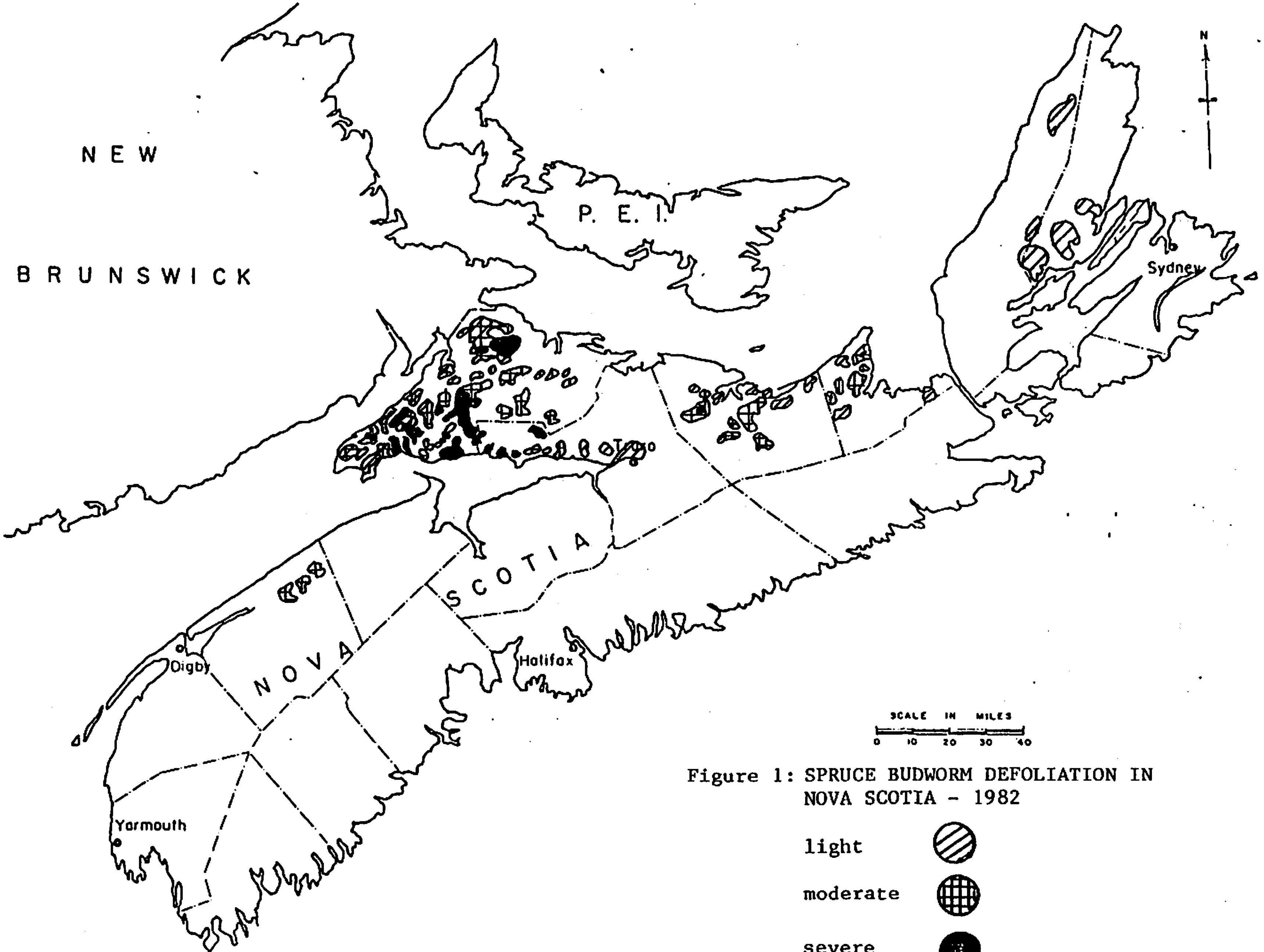

Figure 1: SPRUCE BUDWORM DEFOLIATION IN NOVA SCOTIA - 1982

light

moderate

severe

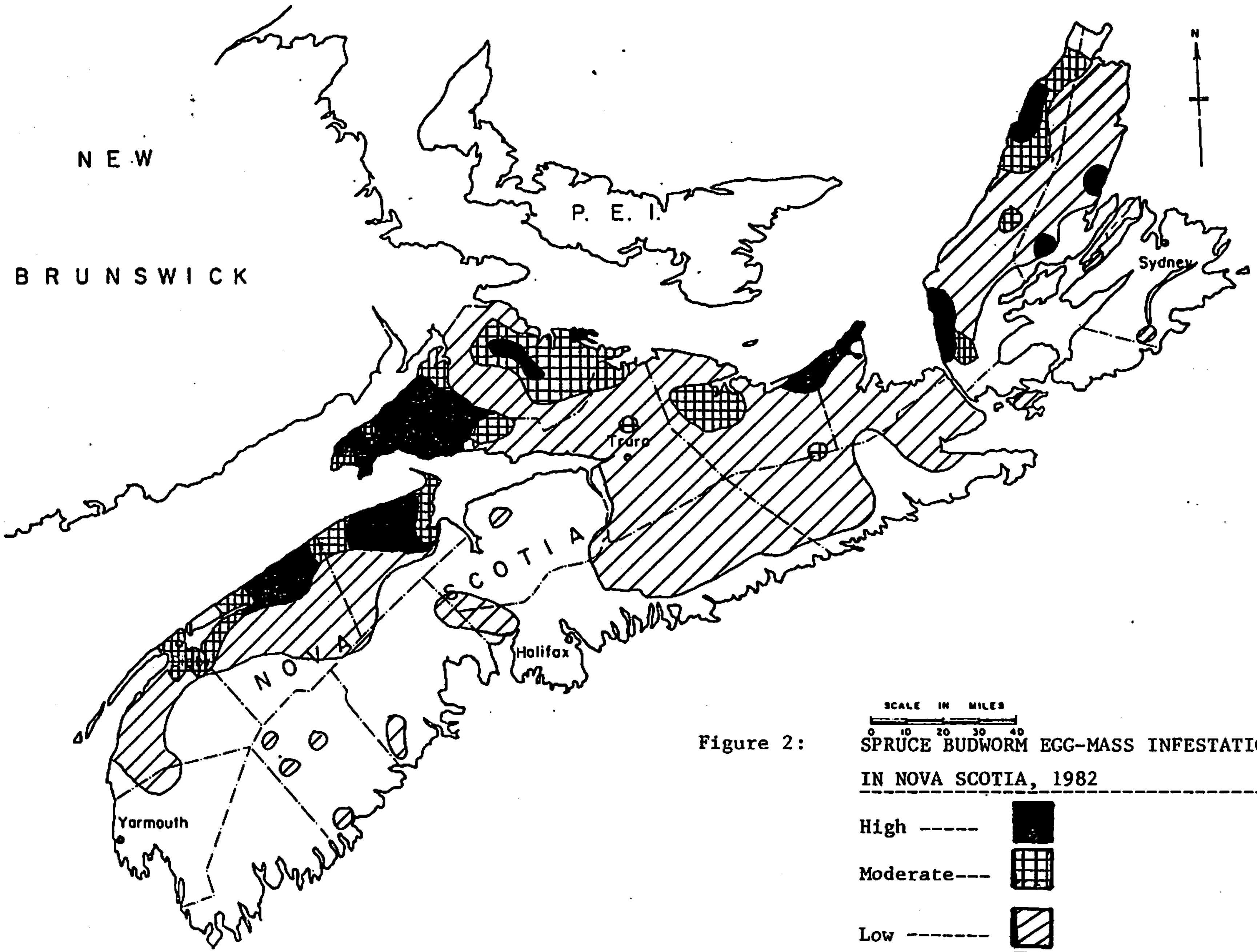

Figure 2: SPRUCE BUDWORM EGG-MASS INFESTATIONS IN NOVA SCOTIA, 1982

High -----

Moderate---

Low -------

Very Low- - -

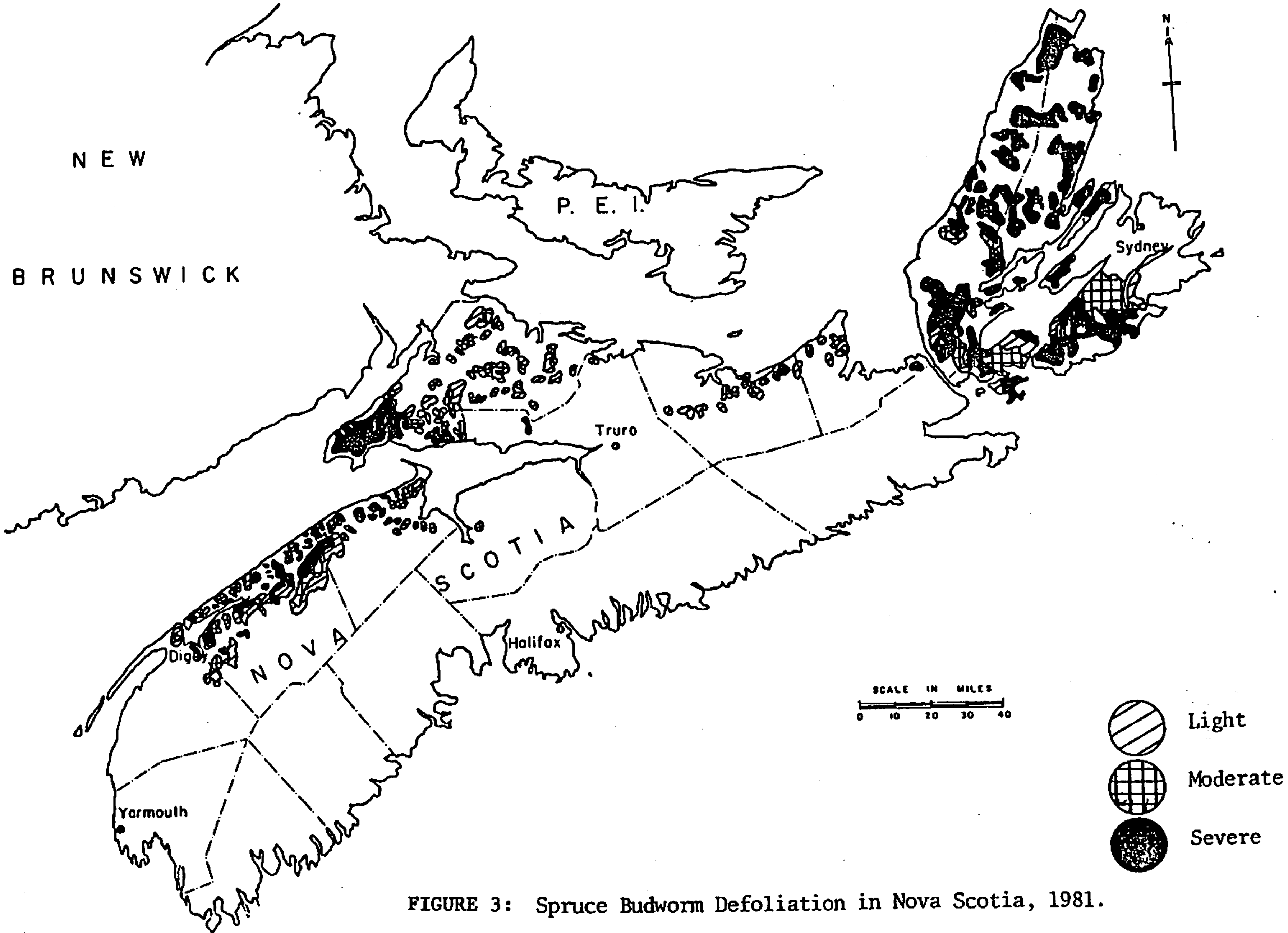

FIGURE 3: Spruce Budworm Defoliation in Nova Scotia, 1981.

MARITIMES FOREST RESEARCH CENTRE

TECHNICAL NOTE NO. 64

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CONDITION OF FOREST STANDS ON CAPE BRETON ISLAND - 1982
- AN AERIAL VIEW -

A survey of the condition of forest stands of western Cape Breton Island (Inverness and Victoria Counties) suggests that 74% of the Highland's softwood stands show high mortality of the spruce and fir component.

Areas of grey trees, indicating that they are either dead or moribund, were mapped from the air. At the same time the forest was classified according to cover type (softwood, mixed-wood, predominately hardwood).

Figures 1a, b classify the forest into three degrees of damage. Thirty-six percent of Inverness and Victoria Counties had stands where the spruce and fir was 66-100% grey, 31% had stands ranging from 36-65% grey and 33% had stands less than 36% grey. The Highland region shows even more extensive damage.

An evaluation of cover types showed some interesting comparisons. Figures 2a, b illustrate the extent of grey trees encountered in each cover type. In 56% of the softwood stands, 35% of the mixed-wood stands and 16% of the hardwood stands, 66-100% of the spruce and fir were grey. Again, the Highland area, a portion of this region, sustained even greater damage.

Four flight lines situated 10 km apart and running the length of the island were flown. Our technique was to group similar forest types viewed within a 1/4 km strip and to estimate the percentage of the spruce and fir which was grey.

Environment Canada / Environnement Canada
Canadian Forestry Service / Service canadien des forêts

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Given a sharp decline in budworm populations on Cape Breton Island since 1980 this survey was seen partly as an epilogue to 10 years of outbreak. Certainly we cannot expect a return of spectacular and massive defoliation because of the limited food resource left. The possibility of a continued outbreak on a lesser scale is still real.

In any event the spruce and fir forest of Cape Breton Island has been largely destroyed.

- B. A. Pendrel
Forest Insect and Disease Survey

October 25, 1982

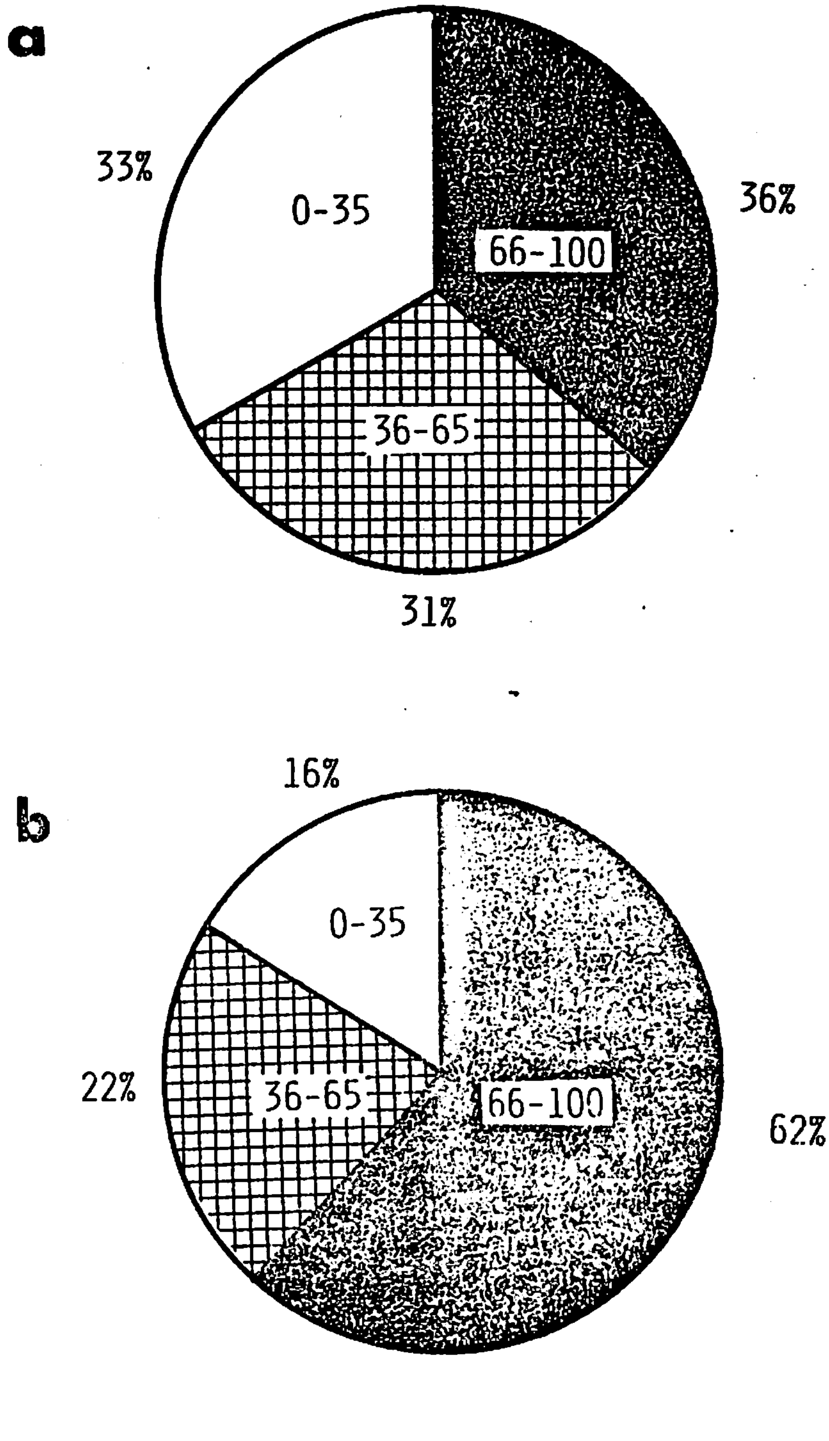


Figure 1. Proportion of the forested areas of (a) western Cape Breton Island and (b) the Highlands where grey trees make-up 66-100% (solid), 36-65 (cross-hatch) and 0-35% (open) of the spruce and fir in the stands.

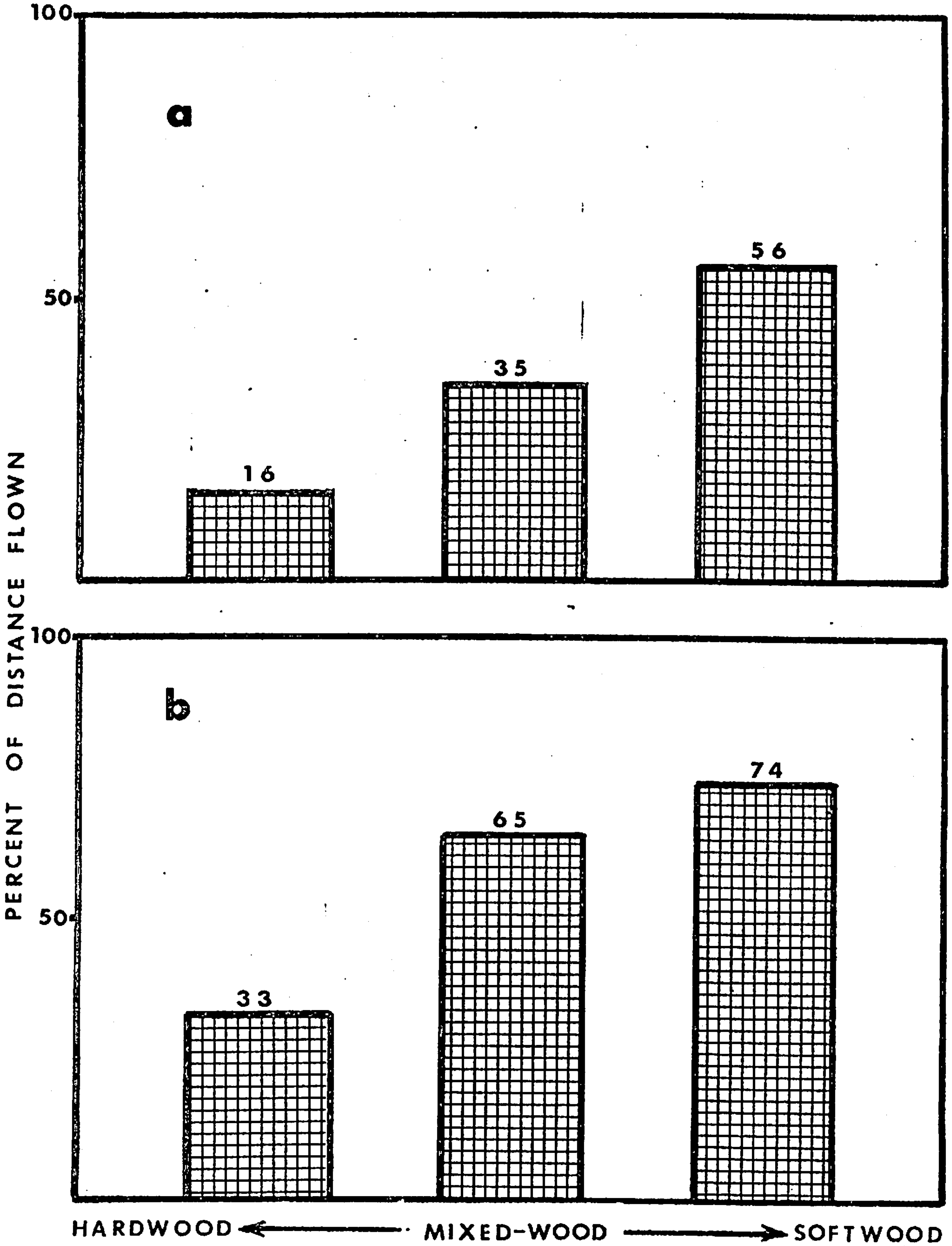
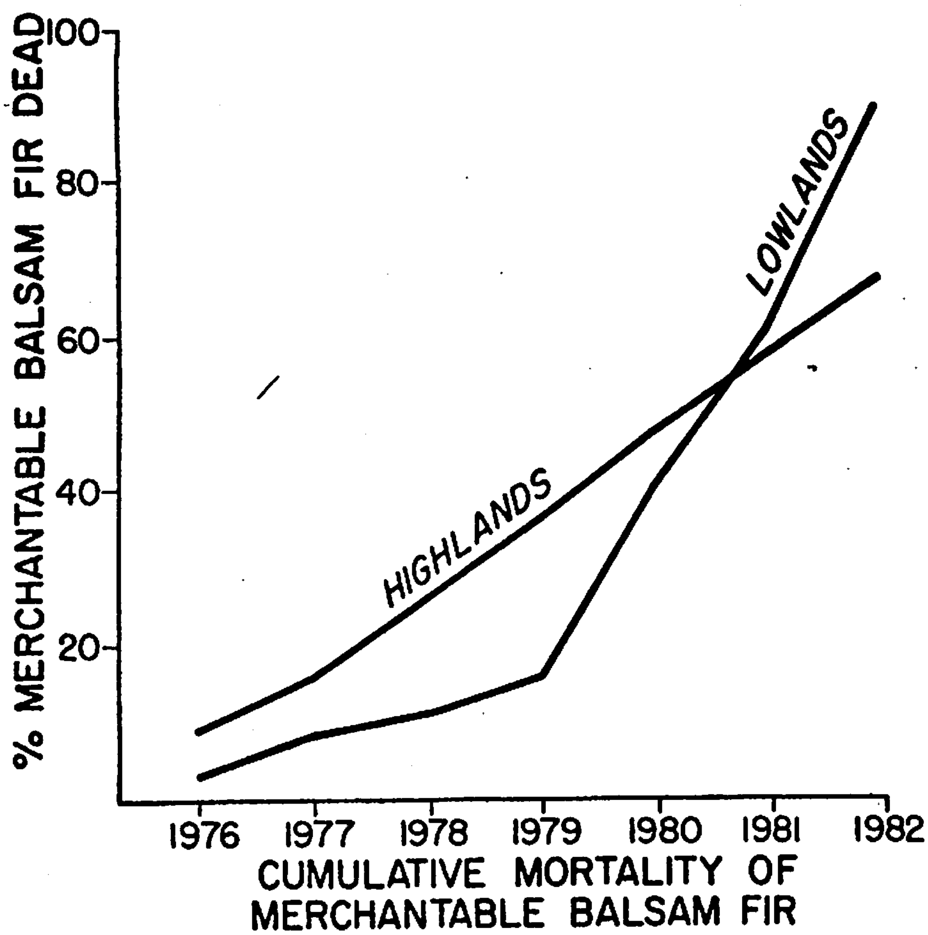


Figure 2. Percentage of Cape Breton forests with grey trees in three cover types. Stands with 66-100% grey-tree content (a. western Cape Breton Island, b. Highlands).

MARITIMES FOREST RESEARCH CENTRE
TECHNICAL NOTE NO. 65

CONDITION OF BALSAM FIR ON RESEARCH PLOTS ON CAPE BRETON ISLAND TEN YEARS AFTER THE START OF A SPRUCE BUDWORM OUTBREAK



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The mortality of balsam fir during the current spruce budworm outbreak on Cape Breton Island has been assessed annually since 1976 on twenty-five permanent research plots. As of 1982, ten years after the start of the outbreak, the proportion of dead merchantable balsam fir is 67% on the highlands and 88% on the lowlands (see Figure). An additional 5% on the highlands and 1% on the lowlands has been blown down. Another 5% and 1% are classed as moribund. Over the past six years an average of 10% of the merchantable balsam fir died annually in the highlands and 13% on the lowlands.

During the last two years, trees have been dying at a faster rate, even though the spruce budworm populations are lower. On the highlands, 27% of the fir living in 1981 died. Two years ago only 17% of the living fir died. On the lowlands the 1982 rate was 67% as compared to 28% in 1980. Of the remaining merchantable balsam fir on the highlands and lowlands 76% and 81% respectively are in the 50-75% total defoliation class with 19% and 6% moribund.

Condition of Balsam Fir on Permanent Plots on Cape Breton Island in 1982 (expressed as a % of stems 10 cm and over)

Tree Condition	Highlands	Lowlands
LIVING		
Less than 50% Total Defoliation	1.5	1.3
50-75% Total Defoliation	21.5	8.4
75-90% Total Defoliation	4.7	0.6
Greater than 90% Total Defoliation	0.6	0
DEAD		
Less than 1 year	11.7	27.7
Greater than 1 year	55.1	60.6
Blowndown	4.8	1.3

-Don Ostaff, Entomologist
Forest Insect and Disease Survey

October 25, 1982

FOREST PROTECTION LIMITED

1982 BUDWORM LARVAL SPRAY PROJECT

H.J. Irving

In accordance with recommendations from the Department of Natural Resources based on tree condition and forecast budworm populations for the coming spring, the Board of Directors of Forest Protection Limited in December 1981 authorized the purchase of insecticide and the contracting of aircraft sufficient for a 2.3 million hectare (5.6 million acre) spray project in 1982. Also in December 1981 approval in principle was received from the Minister of Environment of New Brunswick for the purchase of fenitrothion for use in 1982.

Accordingly insecticide, additives and other materials were purchased, personnel were retained, and other necessary preparations were made adequate for the treatment of 2.3 million hectares using the two formulations of fenitrothion approved and applied in previous years:

(a) Technical fenitrothion - 11%; Dowanol - 1½%; Atlox - 1½%; water - 86% by volume; and
(b) Technical fenitrothion - 11%; Cyclosol 63 - 35%; and 585 oil - 54% by volume.

Contracts were negotiated for aircraft in addition to those owned by Forest Protection Limited to provide a fleet of fifty-six spray aircraft which included two four engine DC-6s and three helicopters.

On April 12, 1982 the "First Report - New Brunswick Task Force on the Environment and Reye's Syndrome", commonly referred to as the Spitzer Report, was submitted to the Minister of Health of New Brunswick. Certain recommendations in this report, particularly regarding the use of Atlox and Cyclosol 63, conflicted with the use of the planned formulations listed above and under these circumstances the regulatory authorities of New Brunswick were unwilling to issue spray permits for such formulations. However, without the use of these formulations no desirable options could be implemented at such a late date.

At a meeting of the Board of Directors of Forest Protection Limited which concluded on May 17, 1982 it was decided to attempt to keep all feasible options open for a reduced program of 1.6 million hectares to include, if possible, some 80 thousand hectares between 300 meters and 3.2 kilometers from habitations.

This reduction in project size eliminated the areas scheduled for treatment by the DC-6s and the helicopters and the cancellation clauses in those contracts were invoked with the designated penalty paid to the contractors. Also the contractor of the M-18s encountered difficulty in providing more than four aircraft and was allowed to reduce his contract to four without penalty.

TABLE 2

Average Concentrations of Aminocarb in Air Sampled 30 cm Above the Forest Floor in Blocks 2, 82 and 86 During the 1982 Experimental Spray Program in New Brunswick

Block 2C*						Block 82*						Block 86*					
1st Application			2nd Application			1st Application			2nd Application			1st Application			2nd Application		
Time (hrs)		ng/m^3	Time (hrs)		ng/m^3	Time (hrs)		ng/m^3	Time (hrs)		ng/m^3	Time (hrs)		ng/m^3	Time (hrs)		ng/m^3
2000	0	N.D. (68)	0600	0	N.D. (59)	0700	0	N.D. (58)	1900	0	N.D. (66)	1900	0	N.D. (52)	0600	0	N.D. (59)
2100	1	198 (77)	0700	1	329 (58)	0800	1	211 (98)	2000	1	210 (108)	2000	1	835 (58)	0700	1	433 (66)
2300	3	226 (66)	0900	3	394 (87)	1000	3	158 (89)	2200	3	208 (119)	2200	3	1201 (56)	0900	3	650 (69)
0200	6	177 (54)	1200	6	191 (91)	1300	6	142 (84)	0100	6	113 (79)	0100	6	1060 (57)	1200	6	264 (57)
0800	12	N.D. (54)	1800	12	178 (77)	1900	12	189 (64)	0700	12	55 (69)	0700	12	313 (T)	1800	12	103 (56)
2000	24	N.D. (86)	0600	24	63 (59)	0700	24	N.D. (66)	1900	24	61 (74)	1900	24	149 (56)	0600	24	N.D. (50)

Values in parentheses represent fenitrothion concentrations detected in the same air samples.
N.D. - Not detected.
T - Traces (50 ng/m^3).
* For explanation se footnotes in Table 3.

4) *In vitro* and *in vivo* study on the brain AChE inhibition of brook trout by aminocarb and its metabolite

Inhibition and recovery of brain AChE of fingerling brook trout [Salvelinus fontinalis (Mitchill)] by aminocarb insecticide and its major metabolite, MA (monodemethylated aminocarb) were studied after exposing the fish samples for 96 hrs to different sublethal concentrations of the chemicals. The extent of inhibition and recovery period varied according to the toxicity of the materials as well as the body residue levels. The rate of inhibition and elimination are also to a certain extent influenced by the molecular structure and related physicochemical properties of the toxic moieties. The in vitro studies showed that MA is six times more potent than aminocarb as inhibitor of brain AChE.

II. ENVIRONMENTAL CHEMISTRY STUDIES

Investigations conducted in 1982 with regard to the environmental behaviour and fate of aminocarb and fenitrothion in N.B. forests consisted of the following three studies.

1) Determination of the environmental persistence of fenitrothion in various forestry substrates.
2) Field studies conducted to generate data required to support the registration of MATACIL 180F formulations, and
3) Studies carried out under the auspices of "Action Plan" on the stability, persistence and fate of new formulations of aminocarb and fenitrothion containing Triton-X100 to evaluate their effects on nontarget components of the environment.

The development of both insects and tree foliage in phenological category "0" was declared appropriate for spraying as of the morning of May 25 but the necessary permits for these areas (which were all less than 3.2 kilometers from habitations) were not yet available.

On May 26 appropriate authorizations were completed for the spraying of formulation (b) in areas more than 3.2 kilometers from habitations but no formulations were approved for areas closer to dwellings.

Also on May 26 six TBM and four M-18 spray aircraft as well as the Forest Protection Limited Chief Navigator and his aircraft were conscripted by the Department of Natural Resources to fight forest fires.

Development of insects and foliage in phenological category "1" was adequate for treatment on May 27 and spraying commenced on areas 3.2 kilometers and more from habitations.

On the afternoon of June 1 the 6 TBM spray aircraft and Chief Navigator were released from firebombing to be converted to their spray configuration. The four M-18 aircraft were retained for fire fighting for an additional day.

On June 5, 1982 - (12 days after the phenological category "0" was ready) appropriate authorizations were completed for the spraying of areas up to 300 meters from habitations at an application rate of 0.73 litres/hectare with a formulation of 22% technical fenitrothion and 78% Dowanol by volume. Spraying of this formulation commenced on the evening of June 5. However, at this date it was judged too late to carry out any useful spraying on the areas in phenological category "0". Subsequently it was judged too late to carry out the second application in several other areas.

Spraying was terminated on June 19. Some 265 thousand hectares received only one application primarily because of insect development. Areas treated by number of applications, formulation, application rate and aircraft type are summarized on page 3. Our records indicate a total area treated of 1,693 thousand hectares (4,186 thousand acres).

H.J. Irving
November 15, 1982

AREAS TREATED
FOREST PROTECTION LIMITED

Area Sprayed in Hectares and Acres, by Insecticide, Dosage, Application Rate, Carrier and Aircraft Type - 1982

Operational	Hectares Thousands	Acres Thousands	A/C Type
One Application			
(a) 210 g/ha Fenitrothion in .73 l/ha - Dowanol	6	16	Ag Type
(b) 120 g/ha Fenitrothion in .73 l/ha - Cyclosol 63	7	18	Ag Type
(c) 210 g/ha Fenitrothion in 1.46 l/ha - Cyclosol 63 & 585 Oil	217	537	TBM
(d) B.t. @ Various App. rates	4	10	Ag Type
Two Applications			
(e) 210 g/ha Fenitrothion in .73 l/ha + 210 g/ha Fenitrothion in .73 l/ha - Dowanol	23	56	Ag Type
(f) 210 g/ha Fenitrothion in .73 l/ha Dowanol + 210 g/ha Fenitrothion in 1.46 l/ha - Cyclosol 63 & 585 Oil	5	13	Ag Type & TBM
(g) 210 g/ha Fenitrothion in .73 l/ha Cyclosol 63 + 210 g/ha Fenitrothion in 1.46 l/ha-Cyclosol 63 & 585 Oil	51	125	AG Type & TBM
(h) 210 G/ha Fenitrothion in 1.46 l/ha+ 210 g/ha Fenitrothion in 1.46 l/ha-Cyclosol 63 + 585 Oil	1,275	3,150	TBM
(i) 70 g/ha Matacil (Flowable) in 1.46 l/ha+ 70 g/ha Matacil (Flowable) in 1.46 l/ha-585 Oil	5	12	TBM
(j) 70 g/ha Matacil (Flowable) in 1.46 l/ha+ 70 g/ha Matacil (Flowable) in 1.46 l/ha-Water & Atlox	3	8	TBM
TOTAL	1,596	3,945	
Small Spray Operations			
One Application			
(a) 210 g/ha Fenitrothion in .73 l/ha-Dowanol	34	85	Ag Type
Two Applications			
(b) 210 g/ha Fenitrothion in .73 l/ha+ 210 g/ha Fenitrothion in .73 l/ha-Dowanol	11	27	Ag Type
TOTAL	45	112	
J.D. Irving Ltd. (under contract to Forest Protection Limited)			
Two Application			
(a) 210 g/ha Fenitrothion in .73 l/ha+ 210 g/ha Fenitrothion in .73 l/ha-Cyclosol 63	32	79	Ag Type
(b) 210 g/ha Fenitrothion in .73 l/ha+ 210 g/ha Fenitrothion in .73 l/ha-Dowanol	20	50	Ag Type
TOTAL	52	129	
GRAND TOTAL	,693	4,186	

DRAFT

Preview of the Results of Aerial Spraying in New Brunswick in 1982: Operational Status Report

In 1982 some 1,724,570 hectares of forest land were sprayed in New Brunswick in an attempt to save as much foliage as possible from the spruce budworm. (Figure 1). Included in this area of spraying were 12,000 hectares of experimental spraying; 8,000 hectares with Matacil Flowable and 4,000 hectares with various commercial formulations of *Bacillus thuringiensis*.

Large scale operations were conducted by Forest Protection Ltd (1,693,000 ha) and by Forest Patrol Ltd (31,570 ha). The 31,570 ha sprayed by Forest Patrol Ltd were over and above the 48,380 ha that they sprayed for Forest Protection Ltd.

Operational Spraying: Spray operations by Forest Protection Ltd commenced on 27 May and finished on 19 June, 1982. Ninety-four areas in the operational spray program were sampled to determine efficacy of spraying. Assessment is based on a comparison of budworm survival and defoliation. in treated and non treated plots. Detailed analysis of the data is underway. However for the purpose of this preview a quick scan of the data indicates:

1. that in the woodlot operation, areas treated twice had substantially more foliage saved than in areas treated once but that the results in all areas treated appear quite variable; (Tables 1&2)

2. that in areas treated at a dosage of 210 g fenitrothion in 0.73 l formulation/ha the results seem more variable than in areas treated at 210 g fenitrothion in 1.46 l formulation/ha application; and

3. that in the large blocks, areas treated twice had a higher level of foliage protection than in areas treated once.

On the average the results appear to be similar to those obtained in 1981.

This statement has been provided for use in the Forest Pest Control Forum. As detailed analysis of the spray data is incomplete observations made here are of a preliminary nature only.

E. G. Kettela
Maritimes Forest Research Center
November 19, 1982

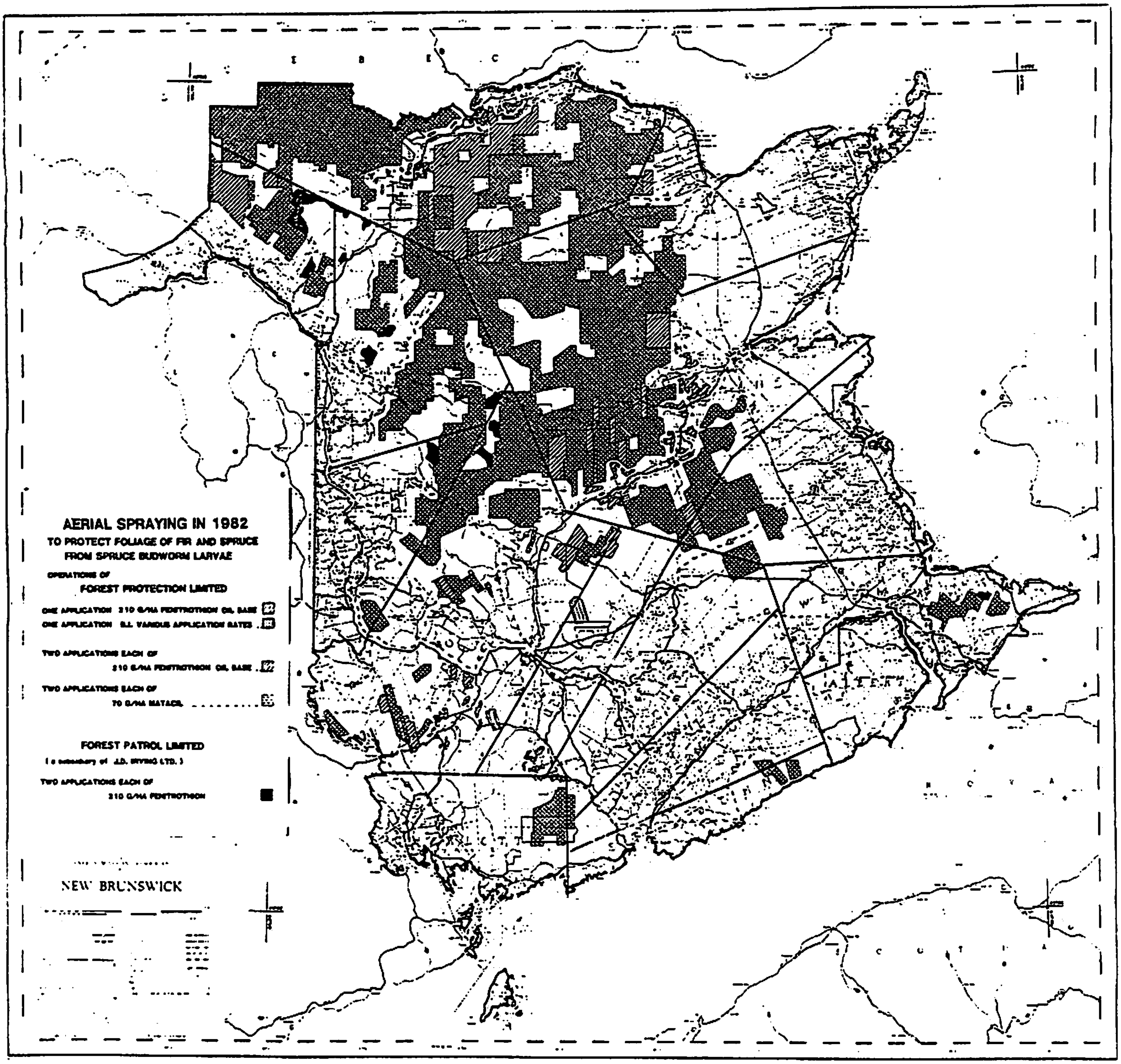

Figure 1. Aerial spraying operations against spruce budworm larvae in New Brunswick , 1982.

Table 1: Summary of the results of spraying in selected woodlots treated with fenitrothion & Dowanol, 1982

BALSAM FIR

Woodlot	Budworm / 45/cm.br. Pre-Spray Larval	Pupae Post-spray	Survival (%) Obs	Survival (%) Exp(a)	$\bar{x}$ % Reduction in Survival(c)	Defoliation Obs.	Defoliation Exp.	% foliage Saved (d)	Date Sprayed	Estimated Larval Development Index
SPRAYED ONCE (210 g/ha)										
A 275	10.1	1.5	15	32	53	65	66	1	June 5&6	4.04
B 22	13.2	4.1	31	35	12	75	71	0	" 7&8	3.86
B 24	12.1	1.7	14	34	59	56	68	12	" 7	3.86
B 25	14	1.5	11	35	67	69	70	1	" 5	3.86
B 27	7.1	1.4	20	28	29	44	60	16	" 6&7	3.86
B 29	21.5	2.6	12	32	63	90	87	0	" 6	3.86
SPRAYED TWICE (210 g/ha/application)										
A 50	8.1	0.5	6	30	80	70	63	0	June 9 " 14	4.98 5.57
A 51	7.1	0.4	6	28	79	44	61	17	" 9 " 14	4.98 5.57
A 52	8.4	0.4	5	31	84	26	63	37	" 9 " 14	4.98 5.57
B 14	8.8	0.3	3	32	91	29	64	35	" 9 " 14	4.98 5.57

a) determined from survival/ L_3 graph developed from unsprayed woodlot controls (Fig.1)

b) " " defoliation / L_3 graph for unsprayed woodlot controls (Fig.2)

c) % reduction in survival due to spraying = $\frac{(\text{Expt. surv.} = \text{obs. surv.})}{\text{Exp. Surv.}} \times 100$

- (Modified Abbott's Formula)

d) % foliage saved = (Expected - Observed).

Table 2 : Summary of the results of spraying in selected woodlots treated with Fenitrothion & Dowanol, 1982

RED/BLACK SPRUCE

Woodlot	Budworm 45 cm/br		Survival %		$\bar{x}$ % Reduction	Defoliation		Date	Estimated Larval
	Pre-Spray	Pupae	Obs.	Exp. (a)	in Survival (c)	Obs.	Exp. (b)	Sprayed	Development Index
	S P R A Y E D O N C E (210g/ha)								
A 275	17.5	1.5	9	23	61	M-S	M-S	June 5&6	4.0
B 22	15.7	3.1	20	23	13	L-M	M	" 7&8	4.3
B 24	6.1	1.5	25	26	4	L-M	M	" 7	4.3
B 25	14.5	1.8	12	24	50	L-M	M	" 5	4.3
B 27	16.4	1.2	7	23	70	M	M	" 6&7	4.3
B 29	27.6	1.2	4	18	78	M	M	" 6	4.3
	S P R A Y E D T W I C E (210g/ha/application)								
A 50	—	—	—	—	—	—	—	June 9 " 14	3.8 5.1
A 51	—	—	—	—	—	—	—	" 9 " 14	3.8 5.1
A 52	7.7	1.6	21	28	25	M	M	" 9 " 14	3.8 5.1
B 14	—	—	—	—	—	—	—	" 9 " 14	3.8 5.1

a) determined from survival /L_3 graph developed from unsprayed woodlot controls (Fig.1)

b) " " defoliation /L_3 graph developed from unsprayed woodlot controls (Fig.2)

c) % reduction in survival due to spraying = $\frac{\text{(Expt. surv. obs. surv.)}}{\text{Expt. Surv.}}$ X 100
- (Modified Abbott's Formula)

d) % foliage saved = (Expected - Observed).

MARITIMES FOREST RESEARCH CENTRE
TECHNICAL NOTE NO. 66

1982 RESULTS OF AERIAL SURVEYS FOR CURRENT SPRUCE BUDWORM DEFOLIATION IN NEW BRUNSWICK AND A REVIEW OF THE METHODOLOGY

In 1982 an estimated 1 387 000 ha of defoliation were mapped in NB of which 811 000 ha were categorized as severe, 391 000 ha as moderate, and 185 000 ha as light. This represents a slight increase in the level of defoliation (2%) over 1981 when a total of 1 356 000 ha of defoliation was mapped. Most of this increase was the result of an increase in the area of severe defoliation (Table 1). The level of defoliation does not approach that recorded in 1975 which was typical of the level of defoliation in the period from 1972 to 1975.

Defoliation occurred in variable sized patches throughout the province except in the areas south of Grand Lake and east of the St. John River to Moncton where only a few isolated cases of defoliation were detected.

Extensive areas of moderate or severe defoliation were detected as follows: along the Fundy Coast from Fundy National Park west to the area around St. Martins; south and west of Fredericton to the Maine border; generally north and west of Fredericton to Juniper and Perth-Andover; from Perth-Andover north along the Tobique River with large contiguous areas around Sisson Reservoir and in the Trousers Lake areas; in large patches throughout the forest north of Grand Lake along and adjacent to the St. John River Valley to Edmundston and through the "Panhandle" area of Madawaska County; in the

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northwest corner of N.B. adjacent to Quebec, along the Patapedia River Valley; throughout much of the forest south of Campbellton, in the Popple Depot area and east along the Nepisiguit River; in the forest north and south of Newcastle and Chatham and throughout the main southwest Miramichi River Valley, and Nashwaak River Valley from Newcastle to Fredericton.

Although the boundary of the spray program is not shown on the map, an estimate of the amount of defoliation that occurred inside the general outline of the sprayed area as compared to the amount outside the sprayed area was determined from the working maps of defoliation and area sprayed from 1981 and 1982 (Table 2). In this analysis, the sprayed area was taken to be all that area delineated on the maps which included omissions from spraying such as shut-offs for streams, lakes, roads, unsusceptible forest, etc.

In 1982, 364 000 ha of light, moderate and severe defoliation were detected in the sprayed area compared to 320 000 ha in 1981. Further, in 1982, 21.5% of the sprayed area was defoliated compared to 1981 when 16.8% of the spray area was defoliated.

Looking at it from a different point of view, of the total defoliation, 81% of the severe defoliation, 70% of the moderate defoliation and 51% of the light defoliation occurred outside the spray area.

Operations and Data Processing:

The 1982 aerial survey in N.B. was conducted under the general supervision of the Canadian Forestry Service with major manpower and financial support provided by Forest Protection Limited and the N.B. Department of Natural Resources. Experienced personnel with an aggregate total of 59 field seasons on aerial surveys came from F.P.L. (3 people - 11 seasons), D.N.R. (4 people - 17 seasons) and C.F.S. (2 people and 31 seasons of experience). A total of 146 hours of aircraft time and in excess of 12 500 km of flight line were flown. Base Gagetown, south of Fredericton, was not surveyed in 1982.

Initially, 10 categories of defoliation were mapped in provincial map books (scale 1 inch: 3 miles) then transferred to a 1:250 000 scale map. Four copies of defoliation maps were prepared and are available for inspection at the Maritimes Forest Research Centre.

In the preparation of a more easily read map (Figure 1) defoliation categories were pooled as follows:

Defoliation Categories Mapped	Categories pooled (on map as)	For simplicity in Tables
patches of light light	light and patches of light	light
light with moderate or severe patches patches of moderate moderate	light to moderate	moderate
moderate with patches of severe patches of severe severe	moderate to severe	severe

The area of defoliation in each category was determined from the 1:250 000 scale defoliation map with the aid of dot grid (36 dots/in², 1 dot = 249 acres or 105 ha).

Limitations and Use of Aerial Surveys:

Aerial surveys, using ocular estimation and sketch mapping methodology, have been conducted annually since 1950 in New Brunswick (Webb & Williams, 1956 and Knox & Webb, 1980) to provide a cartographic representation of the nature and extent of current spruce budworm defoliation. Within the limitations of such aerial surveys an attempt has been made to provide as complete a picture as possible on aerially visible current spruce budworm defoliation. Initially these surveys varied in intensity depending on resources and the extent of the infestation, but for the past 12 years they have been conducted in a more systematic fashion on a province-wide basis. East-west flight lines about 5 kilometres apart are flown at an altitude of 300 meters and the intensity and limits of defoliation (the characteristic red-brown coloration of spruce and fir foliage resulting from feeding by spruce budworm larvae) are categorized and sketch-mapped to a distance of at least 2.5 kilometres on either side of the flight lines.

The reliability and utility of sketch mapping techniques in forest pest damage appraisal has been reviewed by Harris and Dawson (1979). In the New Brunswick context, survey accuracy is dependent on at least 11 factors.

These are:

1. timing of surveys (including time of day)
2. duration of survey
3. weather conditions (lighting, clouds, haze, turbulence)
4. experience and skills of observers
5. training of observers
6. experience of pilots
7. fatigue (resulting from heat and hours of flight time)
8. conditions and type of forest
9. topography
10. infestation make-up (continuous or patchy)
11. efficient co-ordination and logistics

Weather, experience of observers and fatigue are critical factors. However, the most critical factor is perhaps the extent and configuration of defoliation.

It is relatively easy to map defoliation when it is severe and occurs over extensive areas, but it is much more difficult to map defoliation in heterogeneous, discontinuous forests that have a history of past damage and in which defoliation occurs in patches. Cloud, and particularly haze, makes the distant edges of the defoliation difficult to define which accounts for the stripping pattern on some defoliation maps. Some years it is impossible to carry out an aerial survey (1973 for example) and in such occasions attempts are made to determine the extent of defoliation from ground surveys. In any event, limited ground surveys for defoliation are made on a regular basis to verify defoliation intensity estimations from the air.

The results of defoliation surveys provide a statement on the nature and extent of spruce budworm caused damage on a year-to-year basis. These surveys can influence forest management decisions such as cutting plans and the planning of protection operations. In addition, information from defoliation surveys, particularly in New Brunswick, is one of two sets of data used to assess the efficacy of foliage protection programs. The aerial defoliation surveys give an estimate of the spatial extent of damage in large treatment areas while ground sampling of defoliation and spruce budworm populations before and after spraying provide detailed quantitative data from individual sample trees and plots.

- E.G. Kettela
Technical and Information Services
October 1982

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Webb, F.E. and L.E. Williams. (1956). Studies of Aerial Spraying against the Spruce Budworm in New Brunswick. IV. Techniques for aerial surveys of defoliation and damage 1954-55. Interim Report 1955-4. Forest Biology Laboratory, Fredericton, N.B.

Table 1: Estimated area of Spruce Budworm caused defoliation in New Brunswick from 1975 to 1982 as determined from maps showing the results of aerial defoliation surveys.

Year	Light	Defoliation Category* ('000 ha) Moderate	Severe	Total
1975	820	861	2,706	4,387
1976	192	174	230	596
1977	123	134	347	604
1978	141	219	450	810
1979	105	235	1,085	1,425
1980	176	226	447	849
1981	135	382	839	1,356
1982	185	391	811	1,387

*Light, moderate, severe - see text for explanation of pooling categories

Table 2: Comparison of defoliation in sprayed and non sprayed areas, 1981 - 1982 (ha x 1000)

	Defoliation			Total Defoliation
	Light	Moderate	Severe	
		1981 (Area sprayed 1,900)		
Provincial Total	135	382	839	1,356
Area of Defoliation in sprayed area	52	104	164	320
As a % of Provincial Total	39	27	20	24
Defoliation in treated areas as % of sprayed area	2.7	5.5	8.6	16.8
		1982 (Area sprayed 1,693)		
Provincial Total	185	391	811	1,387
Area of Defoliation in sprayed area	90	116	158	364
As a % of Provincial Total	49	30	19	33
Defoliation in treated areas as % of sprayed area	5.3	6.9	9.3	21.5

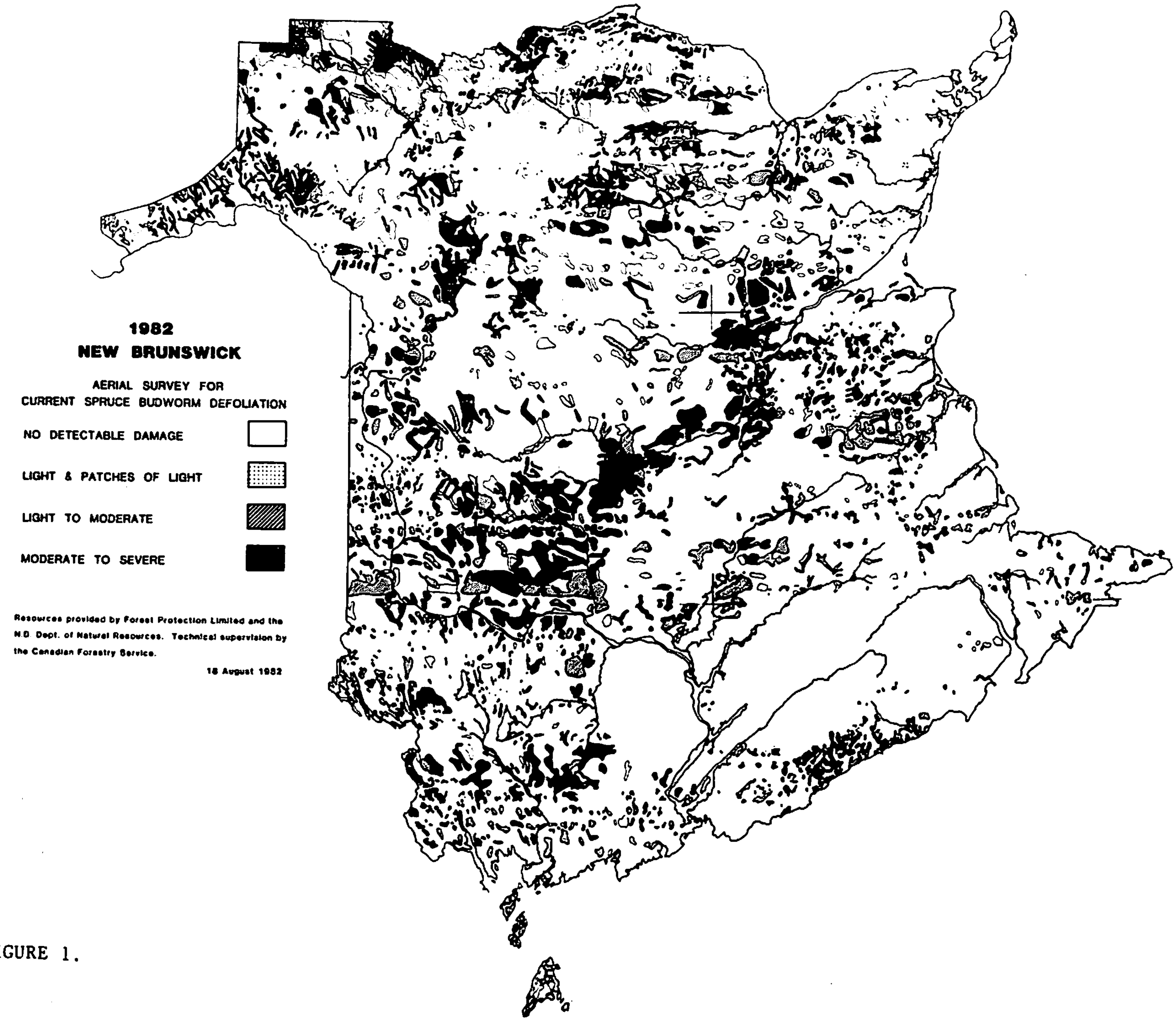
1982
NEW BRUNSWICK
AERIAL SURVEY FOR
CURRENT SPRUCE BUDWORM DEFOLIATION
NO DETECTABLE DAMAGE
LIGHT & PATCHES OF LIGHT
LIGHT TO MODERATE
MODERATE TO SEVERE
Resources provided by Forest Protection Limited and the N.B. Dept. of Natural Resources. Technical supervision by the Canadian Forestry Service.
18 August 1982

FIGURE 1.

MARITIMES FOREST RESEARCH CENTRE
TECHNICAL NOTE NO. 67

SPRUCE BUDWORM INFESTATIONS ON PRINCE EDWARD ISLAND IN 1982 AND A FORECAST FOR 1983

Surveys for spruce budworm defoliation and egg-mass infestations are carried out annually on Prince Edward Island by the Technical Services section of the Maritimes Forest Research Centre with assistance from the Forestry Branch of the PEI Department of Agriculture and Forestry.

Aerial surveys provide information on the severity and extent of current spruce budworm defoliation and egg-mass surveys are used to forecast infestation levels for the coming year. Aerial tree mortality surveys are conducted periodically to estimate the impact of spruce budworm feeding on the forest. The methodology of aerial surveys is reviewed in Technical Note 66.

Defoliation:

In 1982, 15 300 hectares of defoliation were mapped (Table 1, Figure 1). A breakdown of defoliation by category and county in Table 1 shows that of the 10 400 hectares of severe defoliation 6 500 were in Kings County, 2 800 in Queen's County and 1 100 in Prince County. Forecasts for 1982, based on egg-mass surveys in 1981, indicated infestation levels similar to 1980-81. However, the amount of defoliation recorded in 1982 was far less than predicted. Some 107 000 hectares of defoliation were mapped in 1981 compared to 15 300 in 1982 (Table 2). The results of defoliation surveys from 1977 to 1982 (Table 2) show a steady decline in defoliation from 1977 to 1980, a significant increase in 1981, then an equally significant drop in the amount of defoliation in 1982.

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Forecast for 1983:

The results of egg-mass surveys from 1972 to 1982 are shown in Table 3. For 1982, data pooled by county shows moderate egg-mass infestations which are not significantly different from those recorded in the previous three years. The general location of moderate to high egg-mass infestations is shown in Figure 2. For 1983, defoliation should be evident in many areas of the Province, however, the acreage affected will depend on the weather which influences budworm larvae survival and feeding.

Impact:

In 1982, as part of the aerial survey for defoliation, estimates of tree mortality (occurrence of "grey" trees) by stand type were made. Analysis of this survey is still ongoing but preliminary data indicates that over 30 000 hectares of PEI forests have a measurable level of spruce budworm induced tree mortality and that, conservatively, 30% of the province's merchantable white and red spruce and fir in the stands observed are either dead, dying or seriously damaged.

E.G. Kettela
Technical and Information Services
November 1982

Table 1: 1982 Summary of Spruce Budworm Defoliation on Prince Edward Island from an Aerial Survey

	Hectares of Defoliation			
County	Light	Moderate	Severe	Total
Prince	1 700	2 700	1 100	5 500
Queen's	0	0	2 800	2 800
King's	500	0	6 500	7 000
Total	2 200	2 700	10 400	15 300

Total moderate to severe defoliation as determined from an aerial survey - 13 100 hectares

Table 2: Summary of Spruce Budworm Defoliation on Prince Edward Island from 1977 to 1982

Year	Defoliation (hectares)			
	Light	Moderate	Severe	Total
1977	28 900	39 600	69 600	138 100
1978	9 900	26 700	84 900	121 500
1979	7 700	11 100	17 600	36 400
1980	2 100	7 100	23 900	33 100
1981	15 900	36 600	54 500	107 000
1982	2 200	2 700	10 400	15 300

Table 3: Spruce budworm egg-mass* infestations on Prince Edward Island by County from 1972 to 1982.

	Egg-masses per 10m², * mean for counties										
	Year										
County	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
King's	103	564	414	446	377	287	196	188	122	118	141
Queen's	39	587	422	456	350	273	418	153	121	107	211
Prince	211	477	586	452	271	234	441	167	124	221	209

* Category — Egg-masses/ 10m²

Category	Egg-masses/ 10m²
Low	1 - 99
Moderate	100 - 239
High	240+

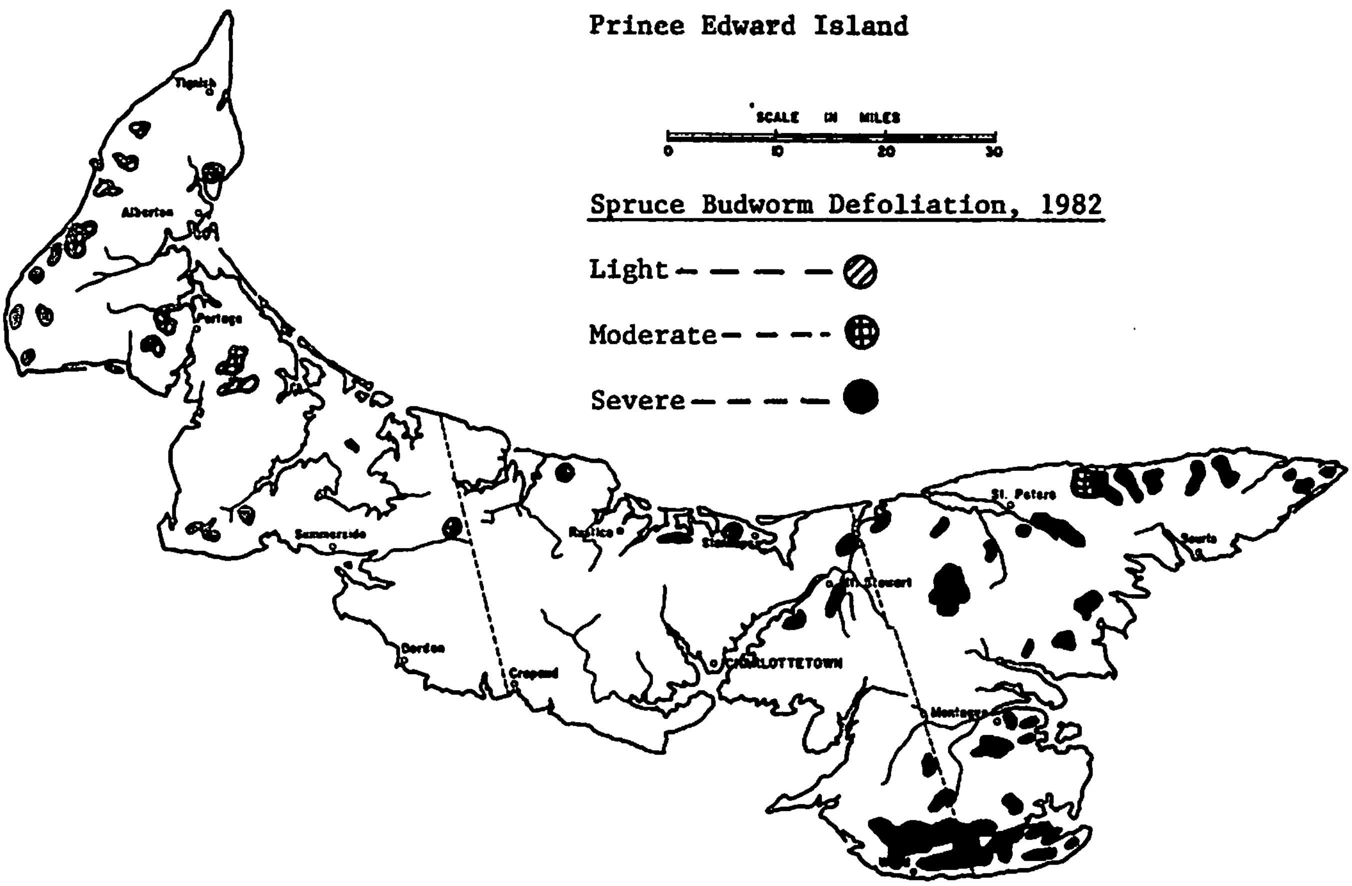

Figure 1: Results of an Aerial Survey for Spruce Budworm Defoliation on Prince Edward Island, 1982

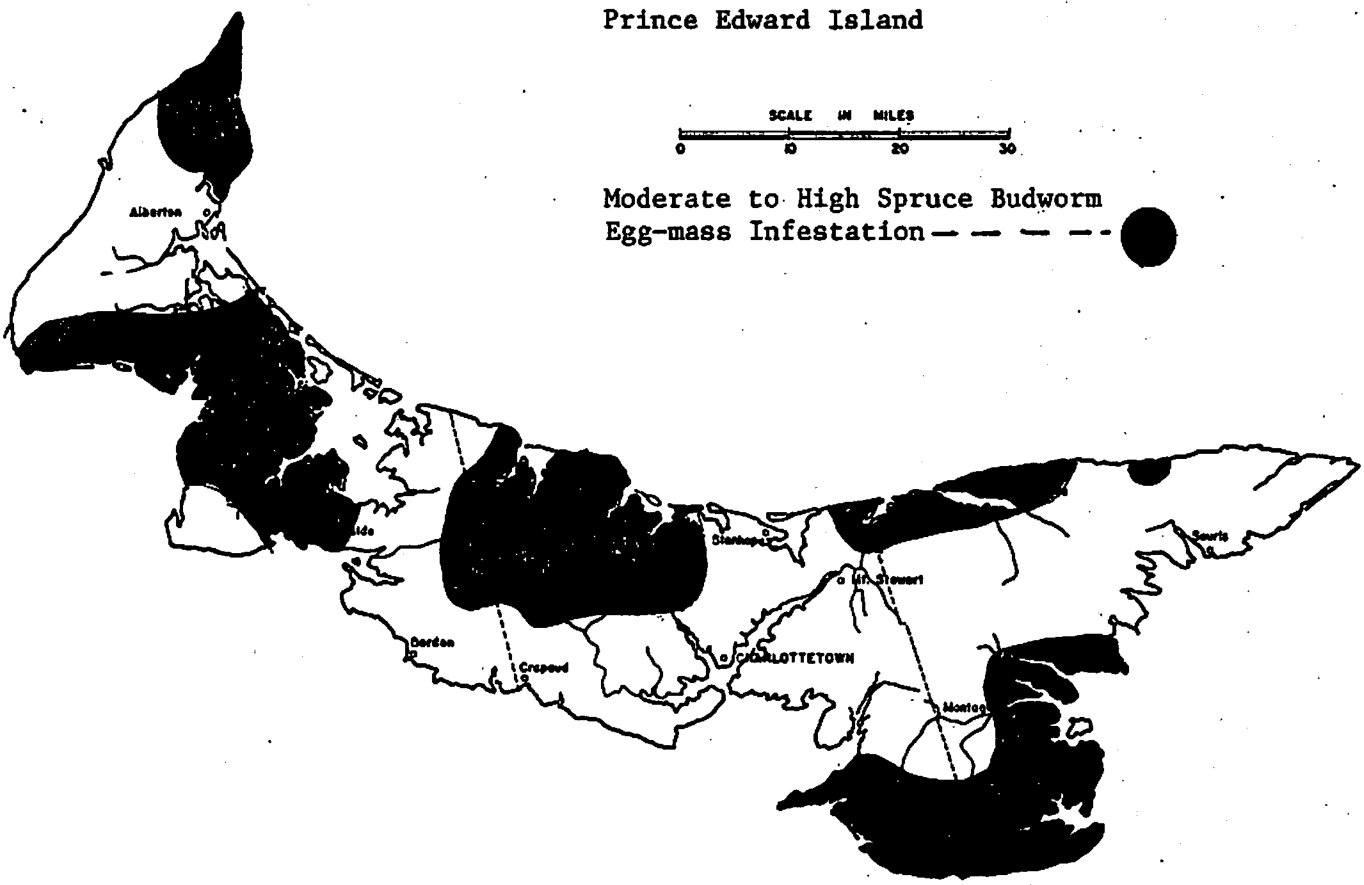

Figure 2 : Area of Moderate to High Spruce Budworm Egg-mass Infestation on Prince Edward Island 1982, a forecast for 1983.

MARITIMES FOREST RESEARCH CENTRE
TECHNICAL NOTE NO. 68

STATUS OF SPRUCE BUDWORM INFESTATIONS IN THE MARITIME PROVINCES - 1982

In the Maritimes, moderate to severe spruce budworm caused defoliation was detected over some 1 388 200 hectares: 1 202 000 in New Brunswick, 173 100 in Nova Scotia, and 13 100 in Prince Edward Island (Figure 1). This represents a decrease of 493 700 hectares of defoliation during 1981 when 1 881 900 hectares of moderate to severe defoliation were recorded. The level of defoliation was down in all the three provinces with the largest decreases in Nova Scotia and Prince Edward Island. Detailed information is available in Technical Notes 63, 66 and 67.

Table 1: Comparison of the area of moderate to severe defoliation in the Maritimes, 1981-1982.

Province	Year 1981	Year 1982	Difference
	ha	ha	ha
New Brunswick	1 221 000	1 202 000	19 000
Nova Scotia	567 000	173 100	393 900
Prince Edward Island	93 900	13 100	80 800
Total for Maritimes	1 881 900	1 388 200	493 700

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Aerial spray operations in the Maritimes covered some 1 743 723 hectares; 1 724 570 in New Brunswick and 19 153 in Nova Scotia. To our knowledge, no aerial spray operations against spruce budworm were conducted in Prince Edward Island.

Egg-mass surveys in 1982 in the Maritimes show that in New Brunswick the level and extent of infestations are similar to those recorded in 1981 with a major portion of the province's forests moderately to severely infested. On Prince Edward Island, infestation levels are similar to a year ago and patches of moderate to severe defoliation are expected in many areas of the province in 1983. In Nova Scotia, significant increases in infestation were detected in the Annapolis Valley, Cumberland County, Pictou and Antigonish Counties, and Inverness and Victoria counties on Cape Breton Island (Figure 2).

E.G. Kettela
Technical and Information Services
November, 1982

Acknowledgement: Information on 1982 egg mass infestations in New Brunswick were supplied by Forest Protection Limited of Fredericton, N.B.

Canada

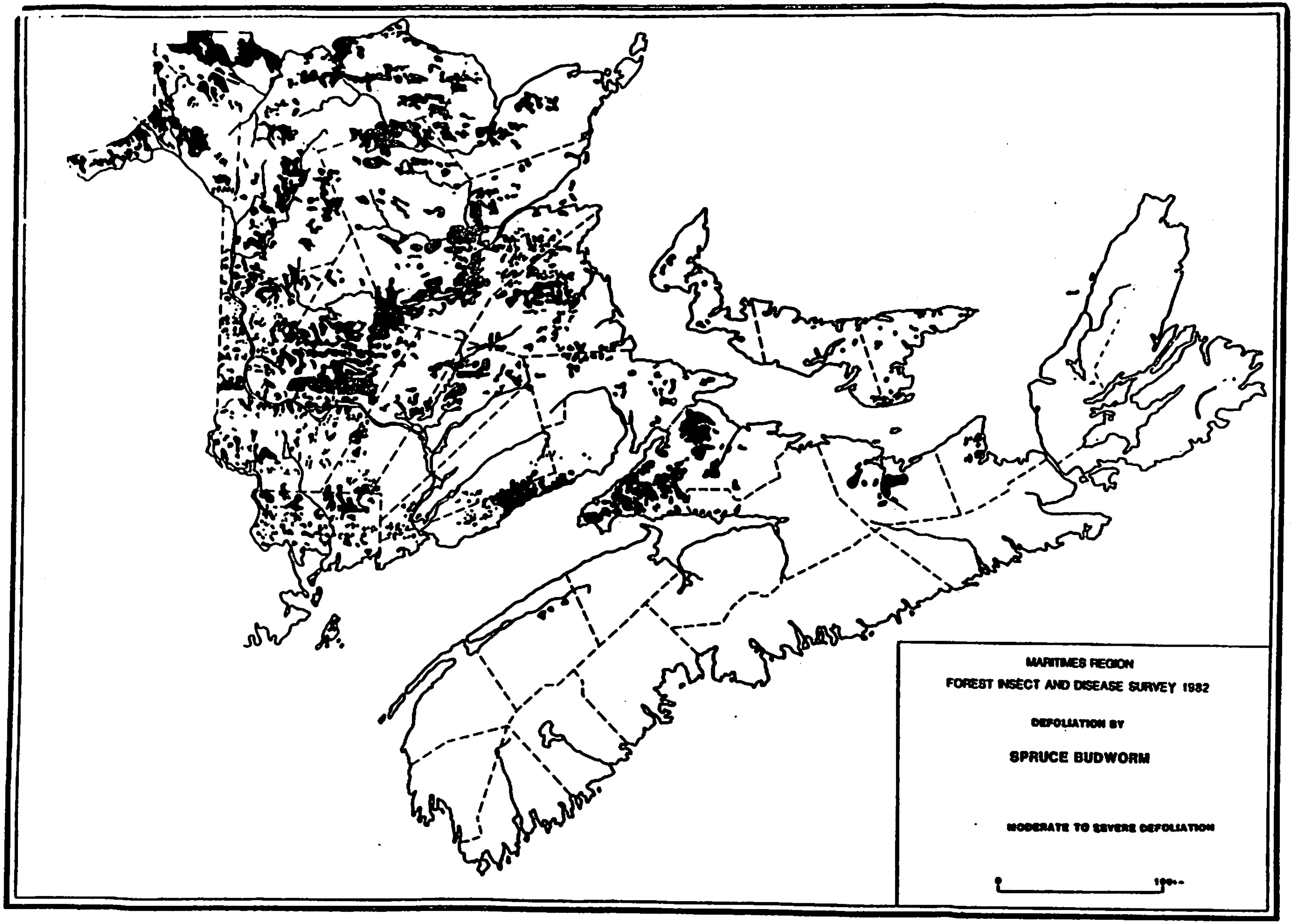

Figure 1: Spruce Budworm Defoliation in the Maritimes, 1982.

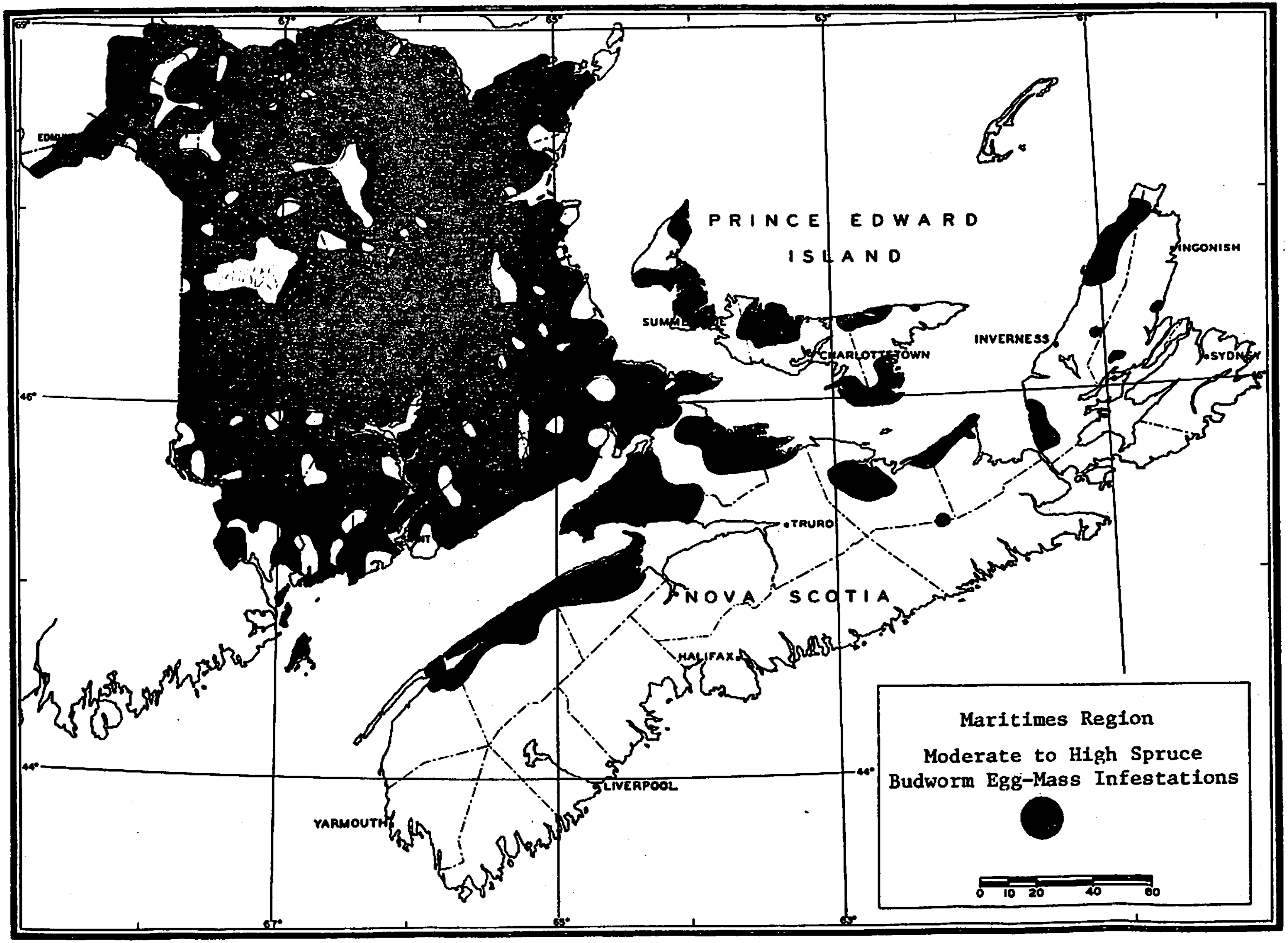

Figure 2: Spruce Budworm Egg-mass Infestations in the Maritimes, 1982.

MARITIMES FOREST RESEARCH CENTRE

TECHNICAL NOTE NO. 69

REVIEW OF THE RESULTS OF EXPERIMENTAL SPRAY TRIALS IN NEW BRUNSWICK IN 1982

In 1982, the Maritimes Forest Research Center was involved in the assessment of ten experimental spray treatments. MFRC's role in these trials was to evaluate spray efficacy in reducing spruce budworm survival and in protection to current foliage. Three sets of trials were conducted: 1) Bacillus thuringiensis (B.t.) trials in cooperation with Forest Protection Limited (FPL), 2) Matacil Flowable large-block trials in cooperation with the Forest Pest Management Institute (FPMI) and FPL, and 3) the Emergency Test Program to test a new emulsifier with fenitrothion and Matacil Flowable water-based formulations in cooperation with FPMI, FPL and the N.B. Dept. Natural Resources. Spray efficacy (results) are summarized in Tables 1, 2 and 3.

B.t. trials

Some 4 000 hectares of forest were treated with B.t., 3 200 hectares with Dipel-88, and the remainder with either Novabec-3 or Bactospeine. Small agricultural-type aircraft equipped with Micronaire rotary atomizers dispersed the B.T. over the designated treatment blocks. Dipel-88 was applied unmixed straight from the drum in accordance with the manufacturer's instructions. The results with Dipel-88 at 30 BIU/ha are confusing as excellent "percent reduction in survival" was achieved but the amount of foliage saved was minimal. However, with Novabac-3 and Bactospeine at 30 BIU/ha, encouraging results were obtained both in terms of foliage protection and percentage reduction in survival. With Bactospeine it is of interest that the block that received half the dosage had about half as much folaige protection and that the higher the volume of spray applied, the better the results (Table 1).

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Environment Canada / Environnement Canada
Canadian Forestry Service / Service canadien des forêts

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Matacil Flowable: Two large blocks in the Fredericton area were treated with Matacil Flowable. Block 82 received two applications of Matacil Flowable in 585 oil at a dosage of 70 g/ha in 1.46 l/ha per application and Block 86 was treated at a similar dosage but with an Atlox + water formulation. Teams of T.B.M. spray aircraft were used to apply the insecticide. In Block 82 an error in navigation resulted in one of the environmental monitoring plots not getting sprayed. At the request of FPMI, FPL treated this small area (100 ha) late in June with a Cessna 188 spray aircraft. Delays in spraying the two blocks resulted in treatment not being applied at the optimum time. Results are summarized in Table 2 and are compared with results in a fenitrothion spray block located in the same type of forest and phenological category. Percent reduction in budworm survival in the Matacil flowable blocks was higher than in the fenitrothion block but foliage protection was about half that of the fenitrothion treatment. The results with Matacil Flowable are encouraging but this new formulation of aminocarb needs extensive trial use to measure its operational performance.

Emergency Test Program: As a result of health concerns expressed in the 1982 "Spitzer Report", FPL and the N.B. Department of Natural Resources requested the Canadian Forestry Service to undertake an emergency spray program in N.B. to test a new emulsifier in formulations with fenitrothion and Matacil Flowable. Two series of spray blocks were established in northern N.B. One set of blocks were 40 ha in size and treated using Cessna 88 spray aircraft. The second set of blocks were initially 5 000 ha each and were to be treated with TBM aircraft. Because of delays in permit approval, and problems encountered with the Triton-X-100 emulsifier, and the occurrence of visible defoliation in these large blocks prior to treatment, block size was reduced to about 500 ha/block and sprayed with either Grunman Ag-Cat or Cessna 188 aircraft equipped with Micronaire rotary atomizers.

The results (Table 3) show that both fenitrothion formulations in terms of percent reduction in survival performed well on both fir and spruce and that results with Matacil Flowable + Triton-X-100 + water were lower on both fir and spruce than in the fenitrothion blocks. Because of the lateness of treatment, moderate to severe defoliation was evident in the blocks prior to treatment. However, about 28% of the foliage was saved in the fenitrothion-Triton-X-100-water spray block.

E.G.Kettela
Technical and Information Services
November, 1982

Canada

Table 1: Summary of Results of Experimental Spraying in NB with Formulations of B.t.k., 1982.

Block No. & Treatment	Budworm/45 cm/br		Survival (%)		% Reduction in Survival	Defoliation		% foliage Saved	Date Sprayed	Estimated Larval Development Index on Dates Sprayed
	Pre-Spray Larvae	Pupae Post Spray	Obs.	Exp.		Obs.	Exp.			
Block X1										
Dipel 88: 30 BIU in 1.5 l/ha										
Balsam Fir	19.2	0.4	2.0	35	94	74	84	10	June 6&7	4.14
Red Spruce	17.8	.26	1.4	22	94	Mod.	Mod.	N.C.*		3.69
White Spruce	16.8	.87	5.1	44	88	Sev.	Sev.	N.C.		3.69
A65										
Novabac-3: 30 BIU in 7 l/ha										
Balsam Fir	15.9	1.1	6.9	36	81	47	77	30	June 4&5	4.53
Red Spruce	9.1	0.3	3.2	28	89	Low	Mod.			3.08
A66 - area 1										
Bactospeine: 15 BIU in 2.4 l/ha										
Balsam Fir	10.6	1.9	17.6	32	45	51	66	15	June 5	4.53
Red Spruce	9.3	2.1	22.5	28	20	Low-Mod.	Mod.			3.08
A66 - area 2:										
Bactospeine: 30 BIU in 4.7 l/ha										
Balsam Fir	15.3	.29	1.8	36	95	38	77	39	June 5	4.53
Red Spruce	7.4	.6	8.1	28	71	Low	Low-Mod.			3.08
A66 - area 3 & 4:										
Bactospeine: 30 BIU in 7 l/ha										
Balsam Fir	18.6	.94	5.0	35	86	35	82	47	June 5	4.53
Red Spruce	19.6	.86	4.3	21	80	Low	Mod.			3.8

*N.C. = No Change

Table 2: Summary of Results of Spraying in New Brunswick with Formulation of Matacil Flowable and Fenitrothion, 1982.

Block No. & Treatment	Tree Species	Budworm/45 cm/br Pre-Spray Larvae	Budworm/45 cm/br Pupae Post Spray	Survival (%) Obs.	Survival (%) Exp.	% Reduction in Survival	Defoliation Obs.	Defoliation Exp.	% foliage Saved	Date Sprayed	Estimated Larval Development Index on Dates Sprayed
97 Fenitrothion 210 g/ha in 1.46 l/ha 2x (cyclosol 585)	Balsam Fir	8.8	1.30	15	31	52	32	64	32	May 27 June 3	3.02 5.08
	Red Spruce	10.2	1.00	10	27	63	Low	Mod.			3.00 3.48
82 Matacil Flowable 70 g/ha in 1.46 l/ha 2x (in 585 oil)	Balsam Fir	12.2	0.70	6	34	83	51	68	17	June 4 June 9	4.69 5.16
	Red Spruce	16.0	0.60	4	23	84	Low	Mod.			3.72 4.24
86 Matacil Flowable 70 g/ha in 1.46 l/ha 2x (in water plus Atlox)	Balsam Fir	10.6	0.60	6	33	83	53	66	13		3.92 4.84
	Red Spruce	10.7	0.54	5	26	81	Low	Mod.		May 31 June 8	2.76 3.57
	White Spruce	7.2	0.88	12	30	60	50	57	7		

Table 3: Summary of Spray Efficacy Results in Experimental Spray Blocks Treated as Part of the Emergency Test Program, 1982

Block Treatment	Tree Species	Budworm/45 cm/br Pre-Spray Larvae	Budworm/45 cm/br Pupae Post Spray	Survival (%) Obs.	Survival (%) Exp.	% Reduction in Survival	Defoliation Obs.	Defoliation Exp.	% Foliage Saved	Date Sprayed	Estimated Larval Development Index on Dates Sprayed
1 Matacil Flowable + Triton x 100 + water (70 g/ha/applic) 2x	Balsam Fir	15.3	1.08	7	36	81	71	76	5	17 June AM	5.5
	Red Spruce	6.9	1.02	15	28	46	Sev.	Sev.	0	25 June AM	6.2
	White Spruce	16.1	1.90	12	35	66	59	68	9		
2 Fenitrothion + Triton x 100 + water (210g/ha/applic) 2x	Balsam Fir	16.2	0.20	1	36	97	48	76	28	17 June AM	5.5 6.1
	Red Spruce	11.7	0.20	2	26	92	Low	Mod.		24 June PM	
3 Fenitrothion Triton x 100 + cyclosol 63 + water	Balsam Fir	9.3	0.10	1	32	97	9	9	0	22 June PM	5.8 6.7
	Red Spruce	6.2	0.25	4	29	86	Mod.	Mod.	0	29 Jume PM	

N. B. Committee for Environmental Monitoring of Forest Insect Control Operations (EMOFICO)

Report to Forest Pest Control Forum, Nov. 23-25, 1982

Copies of the draft 1980-81 EMOFICO Report are now available by contacting the Secretary of EMOFICO. The draft report summarizes 1982 research and monitoring activities carried out in conjunction with operational and experimental spruce budworm spraying in New Brunswick. The report is now being translated; final release is expected in the late spring of 1983.

Summaries of 1982 monitoring and research projects will be contained in an interim report to be available before the end of February, 1983. Many of the projects to be included in the 1982 Interim Report are mentioned in the attached list.

The next meeting of EMOFICO is planned for January or February, 1982. Those interested are invited to attend.

Requests for EMOFICO reports or other information should be directed to:

Cathy MacLaggan
Secretary of EMOFICO
Environment New Brunswick
P. O. Box 6000
Fredericton, N. B. E3B 5H1
Phone: (506) 453-2669

Attach. Preliminary list of 1982 projects

1982 Environmental Monitoring
of Forest Pest Control Operations

Preliminary List of Projects

1. Brain Cholinesterase Response in Songbirds Exposed to Experimental Field Applications of Matacil 180F in New Brunswick: P. A. Pearce (Canadian Wildlife Service)

2. Ingestion Toxicity Studies: Effects of Oral Dosing with Matacil 180F on the Growth and Development of Nestling Songbirds: P. A. Pearce (Canadian Wildlife Service)
   This was a field study in which songbirds were artificially dosed with aminocarb.

3. PAH Levels in Blue Herons and Their Food Supply: P. A. Pearce (Canadian Wildlife Service)
   This work was a small-scale field study in Cape Breton carried out in response to a recent EPS report on PAH's in water

4. * Effects of Forest Spraying of Aminocarb Flowable on Aquatic Invertebrates: Doug Eidt (Canadian Forestry Service) and Vic Mallet (University of Moncton)
   Objectives of the study were:
   (a) to determine the distribution of aminocarb in the water column, vertically, horizontally and downstream
   (b) to determine the partitioning of aminocarb between water and suspended particles
   (c) to determine the fate of aminocarb in organic and inorganic sediments
   (d) to determine the downstream and temporal distribution of disturbed drift

5. Effects of Forest Spraying on Soil Litter Decomposition Rates: Doug Eidt (Canadian Forestry Service)
   Litter bags containing conifer needles were treated with applications of fenitrothion in oil, fenitrothion in water and spray adjuvants at registered emission rates and at ten times the emission rate. Litter bags will be collected later and decomposition rates compared. It is hoped that indirectly this will give an indication of forest spray effects upon soil arthropods.

6. * Chemical Residue Survey in Relation to the 1982 Spruce Budworm Spray Program: Vic Mallet (University of Moncton)
   Various substrates (air, water, sediment, soil litter, and coniferous foliage) were sampled at five sites in the Moncton area of New Brunswick. Samples were analysed for fenitrothion and some of its breakdown products (nitrocresol, aminofenitrothion, fenitrooxon, s-methyl fenitrothion). This study is a continuation of work done in 1980 and 1981.

7. * The Impact of Two Experimentally-Applied Aminocarb Formulations on Stream Periphyton Communities: G. B. Bacon (Research and Productivity Council)
The objective of this study was to examine the impact of aminocarb flowable and aminocarb flowable in 585 oil formulations on stream periphyton communities when applied experimentally in a concentration of 50 g/l. Assessment was made of the impact on benthic diatom community structure, periphyton drift and the presence of selected degradation products. Benthic diatoms as well as components of periphyton are sensitive biological indicators and are important links in food webs.

8. * Fenitrothion Accumulation by Plants and Sediments in Otter Brook, New Brunswick, Year II; M. DeGraeve (Monenco).
The objective of this study was to determine the persistence of fenitrothion in a species of bryophyte and in the stream sediment. It is a continuation of 1981 work completed by A. J. Sosiak which showed persistence of fenitrothion in Solenostoma (a bryophyte) up to 168 hours after the spray application.

9. * Accumulation and Persistence of Aminocarb and Aminocarb Phenol in Plant and Animal Tissues: M. DeGraeve (Monenco)
Two streams were treated and studied for bioaccumulation of aminocarb and aminocarb phenol in two benthic invertebrates and two vascular plants

10. * Extension of Accumulation and Persistence Study (9) to Include Aminocarb Flowable Field Trials Conducted by Forest Pest Management Institute: M. DeGraeve (Monenco)
Bioaccumulation of aminocarb water and oil formulations (applied aerially) by benthic invertebrates and vascular plants was studied in the FPMI experimental spray blocks

11. * Literature Summary of Forest Herbicides (2,4-D, 2,4,5-T, Round-Up, Krenite, Velpar, Garlon): M. DeGraeve, Monenco
A computerized literature search and preparation of an annotated bibliography are in progress. Environmental (terrestrial and aquatic plants and animals) effects will be included in the study. Agricultural and human health effects are excluded from the terms of reference.

12. Density of Insecticide Distribution and Budworm Larval Response Within the Spray Swath: I. W. Varty, Canadian Forestry Service

13. Effectiveness of Stream Buffer Zones: W. Ernst, Environmental Protection Service.
The deposit of aerially applied forest spray (fenitrothion in Cyclosol and 585 oil) along an unbuffered stream was compared with that along a stream with a 400 foot setback.

14. Effects of Experimental Aerially Applied Fenitrothion/Triton and Aminocarb/Triton Formulations on Fish: W. Ernst, Environmental Protection Service
In conjunction field trials of a new emulsifier (Triton) carried out by Forest Protection Ltd. and Forest Pest Management Institute, EPS studied the effects of the sprays on fish. Analysis of gut contents, lipids and cholinesterase inhibition will be conducted. Actual spray drift from aerial application and ground application to streams were compared.

15. Lab Bioassay of Fenitrothion, Aminocarb, 2,4-D, Fenvalerate, and Glyphosate: W. Ernst, Environmental Protection Service. Daphnia and trout bioassays of the above mentioned pesticides are underway.

16. Field Study of Effect of Atmospheric Stability on Target Deposit and Effective Swath Width for Aerial Forest Sprays in New Brunswick: R. Crabb, National Research Council

17. 1982 Pesticide Study: Monitoring of Off-target Fall-out During Spruce Budworm Spray Programs: P. E. Belliveau, Inland Waters Directorate

18. Lab Studies of the Effects of Sevin Flowable Formulation and PA3 Diluent on Fish: Dr. Zitko, Fisheries and Oceans Canada

19. Environmental Impact Studies of Experimentally Applied Aminocarb Flowable, New Brunswick, 1982 - Songbirds and Aquatics. P. Kingsbury (Forest Pest Management Institute)

20. Environmental Impact of Experimentally Applied Aminocarb Flowable and Fenitrothion Flowable Formulations in Combination with the Emulsifier Triton - Songbirds and Aquatics: P. Kingsbury. (Forest Pest Management Institute)

21. Lab Toxicity Studies Using Triton: P. Kingsbury (Forest Pest Management Institute)

Note:

Projects number 4, 7 and 9 were a cooperative study
Projects marked with an asterisk (*) were funded by ENB
Projects numbered 3, 11, 12, 16 do not relate directly to "environmental monitoring" as defined by EMOFICO
Projects numbered 1, 10, 14 were carried out with the cooperation of FPMI

Summary of forest insecticide studies conducted by the Canadian Wildlife Service in New Brunswick in 1982. — D.G. Busby and P.A. Pearce.

1. The influence of application methodology on brain cholinesterase inhibition in songbirds exposed to aerial Matacil® 1.8F spraying

It is recognized that the specific technique of applying a pesticide may influence the effects produced on target and non-target fauna, even though the active ingredient dosage may remain constant. During the field seasons of 1981 and 1982 we had the opportunity of observing the impact on songbirds of three different applications of Matacil® 1.8F, a new flowable preparation of aminocarb. The results of the first application were reported to this forum in 1981. For that study, Matacil® 1.8F was formulated as follows: 25.93% Matacil® 1.8F, 1.27% Atlox®, 72.2% water and 0.53% Rhodamine Red dye. The emulsion was applied at a rate of 1.46 L/ha and active ingredient dosage of 70 g/ha. The spraying was by Cessna 188 Ag-Truck fitted with four Micronair AU3000 rotary atomizers. Bird exposure to spraying was assessed by determination of brain cholinesterase (ChE) activity in five species of warblers. None of the species-samples showed depression of ChE after spraying. Only four individual birds exhibited ChE inhibition of more than 20%, the level of inhibition strongly indicative of exposure to the toxin.

In the 1982 field season we examined brain ChE activity in five species of songbirds exposed to two different formulations of Matacil® 1.8F. The species sampled were: Tennessee Warbler (Vermivora peregrina), Magnolia Warbler (Dendroica magnolia), Bay-breasted Warbler (D. castanea), American Redstart (Setophaga ruticilla) and White-throated Sparrow (Zonotrichia albicollis). The two formulations were: (1) oil formulation consisting of 25.93% Matacil® 1.8F and 74.4% I.D. 585 oil; (2) emulsion formulation consisting of 25.93% Matacil® 1.8F, 1.27% Atlox® and 72.8% water. Both formulations were applied twice according to routine operational spraying protocol. Application was by TBM aircraft using boom and nozzle hardware equipped with 110-10 Tee-jet nozzles. Each formulation was emitted at a rate of 1.46 L/ha and an active ingredient dosage of 70 g/ha, as in 1981.

The results of brain ChE analyses of birds from the two spray blocks are quite different. Species-samples from the oil block had brain ChE activities very similar to the control birds - there was no statistically significant decreases after spraying. Data from only a few birds suggested exposure to the spray (i.e. brain ChE was inhibited more than 20%). A sample of Tennessee Warbler collected on day two after the first spray showed a significant increase in brain ChE activity. All species sampled from the emulsion block exhibited a decrease in brain ChE activity. Bay-breasted and Tennessee Warblers were most affected; however, Magnolia Warblers and American Redstarts also showed consistently lower brain ChE activity than did control birds. Interestingly, no more birds from the emulsion block exceeded the 20% ChE inhibition level than in the oil block.

The results of this study suggest that the application method can influence the impact of the spray on songbirds. An interesting contrast is found

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when the two identical formulations (except for presence of the dye) are compared. The TBM aircraft using boom and nozzle hardware produced considerably more impact than did the Cessna aircraft using rotary atomizer hardware. Results from the oil-sprayed block are inconclusive. Little ChE inhibition was observed: however, the spraying of that block was irregular, some parts being completely missed during the spraying operations. It is possible that some of our birds were collected from those unsprayed sections.

Even though there appears to be measurable differences between different application techniques of Matacil® 1.8F, the level of impact in all cases was minor. In all sprays only a small number of birds exhibited brain ChE inhibition of more than 20% and no birds exceeded 50% depression, the level at which direct mortality may occur. All of our evidence suggests that Matacil® 1.8F sprayed at 70 g A.I./ha has less of an impact on birds than does fenitrothion sprayed at 210 g A.I./ha.

2. Oral toxicity of Matacil® 1.8F to nestling White-throated Sparrows

To complement an investigation of the effect of a simulated operational aerial spray of aminocarb on brain cholinesterase activity in selected forest passerines, a study was undertaken on the oral toxicity of that insecticide to nestling White-throated Sparrows (Zonotrichia albicollis), and to smaller numbers of the young of other ground-nesting songbirds. The work was carried out in forest cutovers, prime nesting habitat, at the Acadia Forest Experiment Station during the spring and summer of 1982. The study paralleled an earlier one on fenitrothion, reported to this forum in 1980. Active ingredient was in technical Matacil® 1.8F, a new flowable preparation of aminocarb, as supplied by the manufacturer. Nestlings were dosed in situ using a microsyringe technique to introduce known amounts of the insecticide into capsules of the hair-cap moss (Polytrichum commune) which were then fed to the birds. (At high dosages it was necessary to administer the chemical directly to the nestlings through intubation.) Untreated individuals in each nest served as controls.

In initial range-finding trials it was found that an insecticide dosage of 150 µg A.I./g was lethal to all treated nestlings. Thereafter, single insecticide dosages of 0, 50, 75, or 100 µg/g were each administered to at least ten individuals determined to be four days old. A much smaller number of birds were dosed at ages other than four days. To quantify any potential effect on growth and development, treated birds and controls were weighed daily at which time the length of tarsus, wing, and outer primary were measured. Results, briefly, were as follows: six of 13 nestlings died at a dosage of 100 µg/g, one nestling of 11 succumbed at a dosage of 75 µg/g, and a dosage of 50 µg/g was lethal to none of the ten birds treated. One control bird died from unknown causes. There was

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no measurable inhibitory effect of the treatments on the growth of the birds: weight increased as rapidly as in control birds, as did the other growth parameters measured. While the birds were being handled, overt behavioral signs of poisoning were rarely noted. A few nestlings of Hermit Thrush (Catharus guttatus), Nashville Warbler (Vermivora ruficapilla), and Common Yellowthroat (Geothlypis trichas) were subjected to the same testing protocol, which induced essentially similar responses, i.e. lethality at highest dosages but universal lack of observed impact on growth and development.

Compared with fenitrothion, which we earlier found to induce measurable growth perturbations in a test population of nestling White-throated Sparrows at a dosage of 7 μg/g, and to cause some mortality at 50 μg/g, aminocarb was considerably less toxic. Although both insecticides are cholinesterase inhibitors, recovery from exposure to aminocarb, a typical carbamate, may be relatively much more rapid and dosed nestlings less likely to fail to respond to feeding visits to the nest by parent birds. The few published data on the oral toxicity of aminocarb to passerines suggest that the birds we treated should have been less tolerant of the lower dosage regimes we employed. Our experience in the present and other studies also suggests that the response of songbirds to administered insecticide may be relevant to species, age, and also the manner of formulation of the insecticide active ingredient in the technical material used.

Although this study not surprisingly raised several questions it supported the position that at dosage rates conventionally applied for spruce budworm suppression in New Brunswick, the use of aminocarb should, to reduce hazard to songbirds, be preferred to that of fenitrothion - a recommendation contained in the 1980-81 report of the province's Committee for Environmental Monitoring of Forest Insect Control Operations.

PRELIMINARY DATA REPORT ON STUDIES CONDUCTED BY THE ENVIRONMENTAL PROTECTION SERVICE IN RELATION TO FORESTRY PESTICIDE PROGRAMS IN THE MARITIME REGION

REPORT TO THE 1982
CANADIAN FOREST PEST CONTROL FORUM
NOVEMBER 23-25, OTTAWA

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During the past year, the Environmental Protection Service undertook a number of field and laboratory studies related to forest spray activities.

The first of these was a study to determine if the watercourse buffer zones which are observed in the Province of New Brunswick are effective in reducing the deposit of spray formulation in the protected watercourse. The design consisted of the selection of two small streams within an operational block and running two transects of deposit samplers extending to 400 metres on either side of each stream, as well as the assembly of pumping systems to monitor the surface concentrations of active ingredient. One stream was buffered with a 400 metre no spray zone while on the other spray booms were shut off and reactivated at the margin. Both streams were in a block which received two applications of a fenitrothion (11%), Cyclosol 63 (35%), and 585 oil (54%) formulation at 210 g ai/ha. Deposit and residue concentrations were monitored after each spray event.

The results (Figure 1) indicate that while the deposit was much more variable adjacent to and on the unbuffered stream, there was no appreciable difference in the amount of pesticide deposited on the buffered and unbuffered streams. The greatest individual stream residues were also observed in the unbuffered stream (Figure 2), however, there was no substantial difference in the two streams when the two spray events were averaged. While these results were obtained from a limited number of samples, they do question the utility of buffer zones on streams and indicate that a much closer examination is probably warranted.

During the past year, EPS also conducted field studies in order to monitor the effect on fish of a number of experimental formulations as part of the CFS/FPMI Action Plan

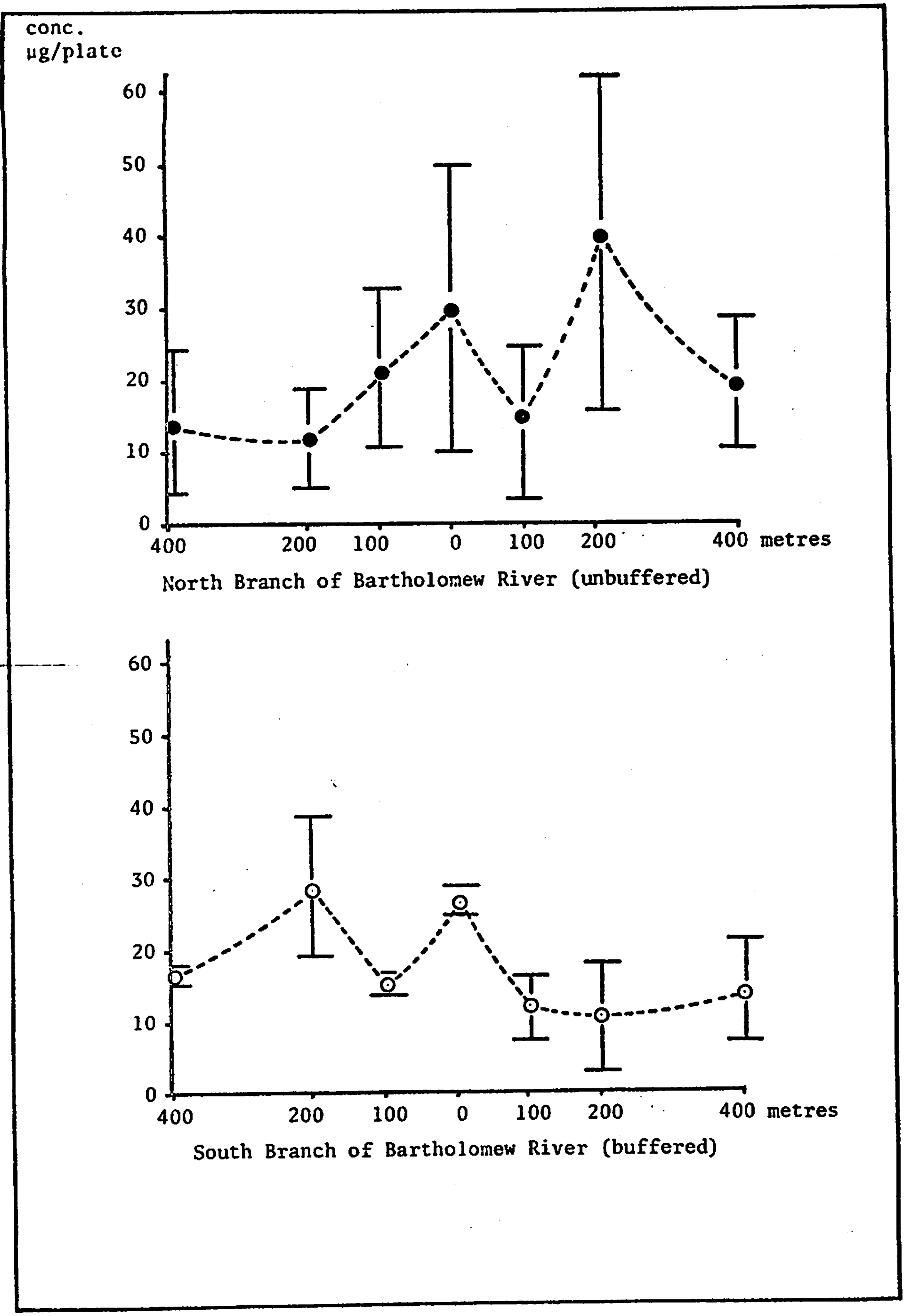

FIGURE 1 MEAN RESIDUE DEPOSITS NORTH AND SOUTH BRANCH BARTHOLOMEW RIVERS

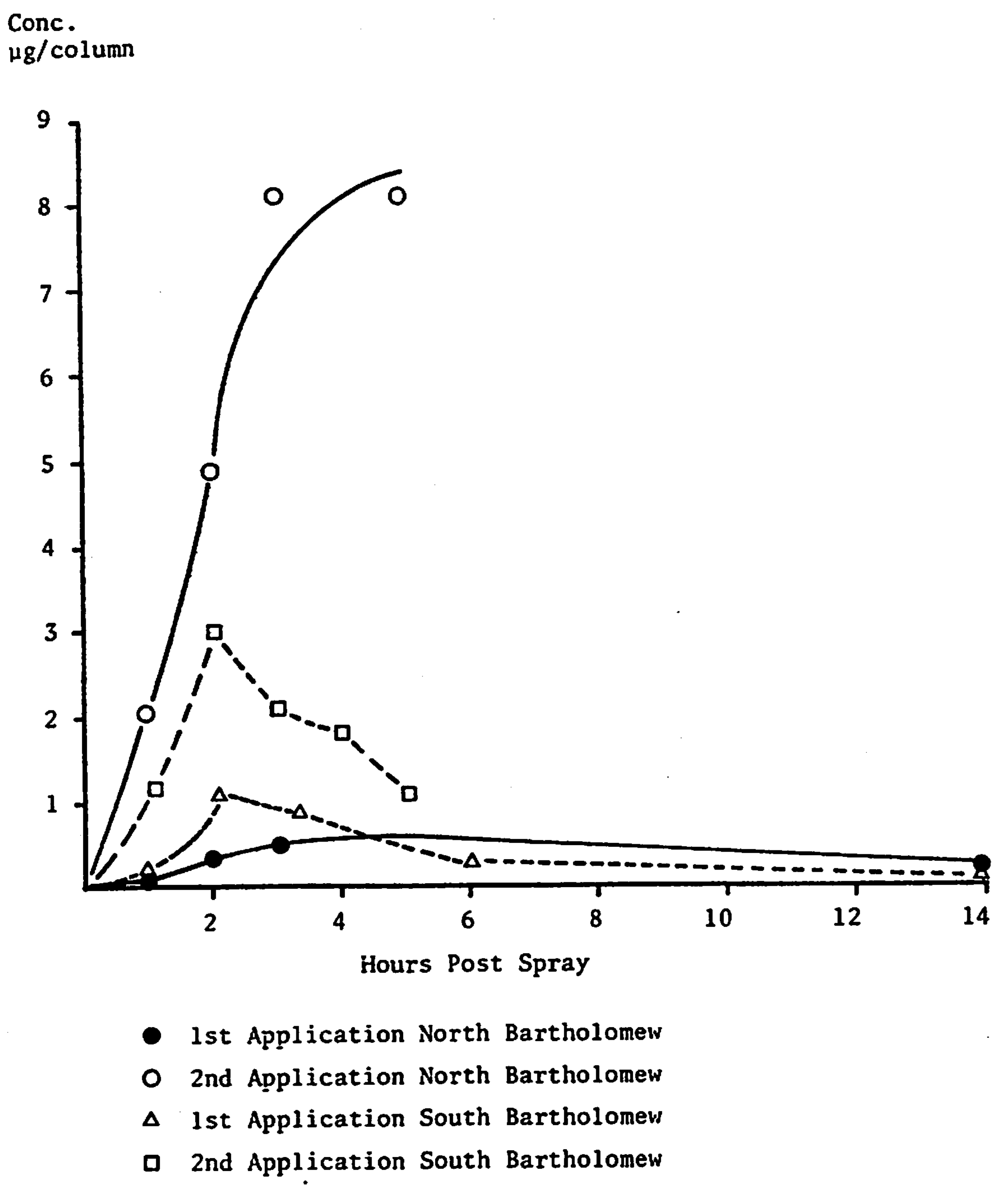

FIGURE 2 FENITROTHION RESIDUES N.B. BUDWORM SPRAY PROGRAM 1982

to test alternative emulsifying agents to Atlox 3409. The work was done in the Nepisiguit River drainage area, southwest of Bathurst, New Brunswick. Three experimental blocks received two sequential applications of the experimental formulations delivered by TBM aircraft and one manual application directly to the stream. The formulations were:

1. Fenitrothion (10.9%), Triton X100 (10.7%), and water (78.4%);

2. Fenitrothion (10.9%), Cyclosol 63 (24%), Triton X 100 (3%) and water (62%);

3. Matacil 180 F (26.7%), Triton X 100 (3%), and water (70.3%).

The doseage rates for aerial applications were 210 g ai/ha fenitrothion and 70 g ai/ha aminocarb. Streams received a direct treatment. The calculated stream concentrations for the manual treatment were 125 ug/L fenitrothion and 250 ug/L aminocarb.

Fish in streams situated in the three experimental blocks and a control area were sampled before and after treatments. Their brain cholinesterase activities and gut contents were determined.

There was a considerable amount of individual variability in cholinesterase activities within treatments.(Table 1). Fish in treated streams displayed a decrease in cholinesterase activity within 72 hours of aerial applications when compared with fish from the control stream. The decrease in cholinesterase activity was most pronounced, and significantly different from control values, in the fish from the block treated with the aminocarb formulation (Figure 3). Fish from the brook treated with the fenitrothion, Triton,

TABLE 1 BRAIN CHOLINESTERASE ACTIVITIES IN BROOK TROUT TAKEN FROM STREAMS IN EXPERIMENTAL BLOCKS AT VARIOUS TIMES AFTER TREATMENT

TREATMENT	DATE	TIMING	NO. ANIMALS SAMPLED	BRAIN ChE ACTIVITY mU/mg Brain MEAN ± S.D.	RANGE
Fenitrothion, Triton X 100 Water	June 20	72 hrs post 1st aerial	4	8.1 ± 0.3	7.8 - 8.4
	June 25	12 hrs post 2nd aerial	6	7.4 ± 1.0	6.6 - 8.7
	June 27	72 hrs post 2nd aerial	6	6.6 ± 1.1	5.2 - 8.2
	July 7	Pre-spray hand appl.	6	9.6 ± 2.0	6.6 -11.7
	July 7	2 hrs post hand appl.	5	7.4 ± 2.3	5.4 -11.2
Fenitrothion, Triton X 100 Cyclosol 63 Water	June 23	12 hrs post 1st aerial	6	7.2 ± 0.5	6.8 - 7.7
	June 26	72 hrs post 1st aerial	6	5.9 ± 1.7	4.3 - 7.9
	June 29	12 hrs post 2nd aerial	6	5.9 ± 2.1	3.7 - 7.9
	July 7	pre-spray hand appl.	6	8.1 ± 1.0	7.4 - 9.3
	July 7	2-6 hrs post hand appl.	10	9.6 ± 1.4	7.8 -10.9
Matacil 1.8 F Triton X 100 Water	June 20	72 hrs post 1st aerial	6	5.0 ± 0.9	4.5 - 6.1
	June 25	6 hrs post 2nd aerial	7	4.8 ± 1.9	2.3 - 7.3
	June 28	72 hrs post 2nd aerial	4	4.9 ± 1.4	4.8 - 5.5
	July 7	pre hand appl.	5	6.6 ± 0.7	5.9 - 7.3
	July 7	2-6 hrs post hand appl.	10	5.7 ± 1.4	3.9 - 8.8
Control	June 20		6	7.9	7.7 - 8.1
	June 23		6	8.0 ± 1.1	6.8 - 8.5
	June 27		6	8.2 ± 2.5	6.0 -11.0
		TOTAL	18	8.1 ± 1.5	6.0 -11.0

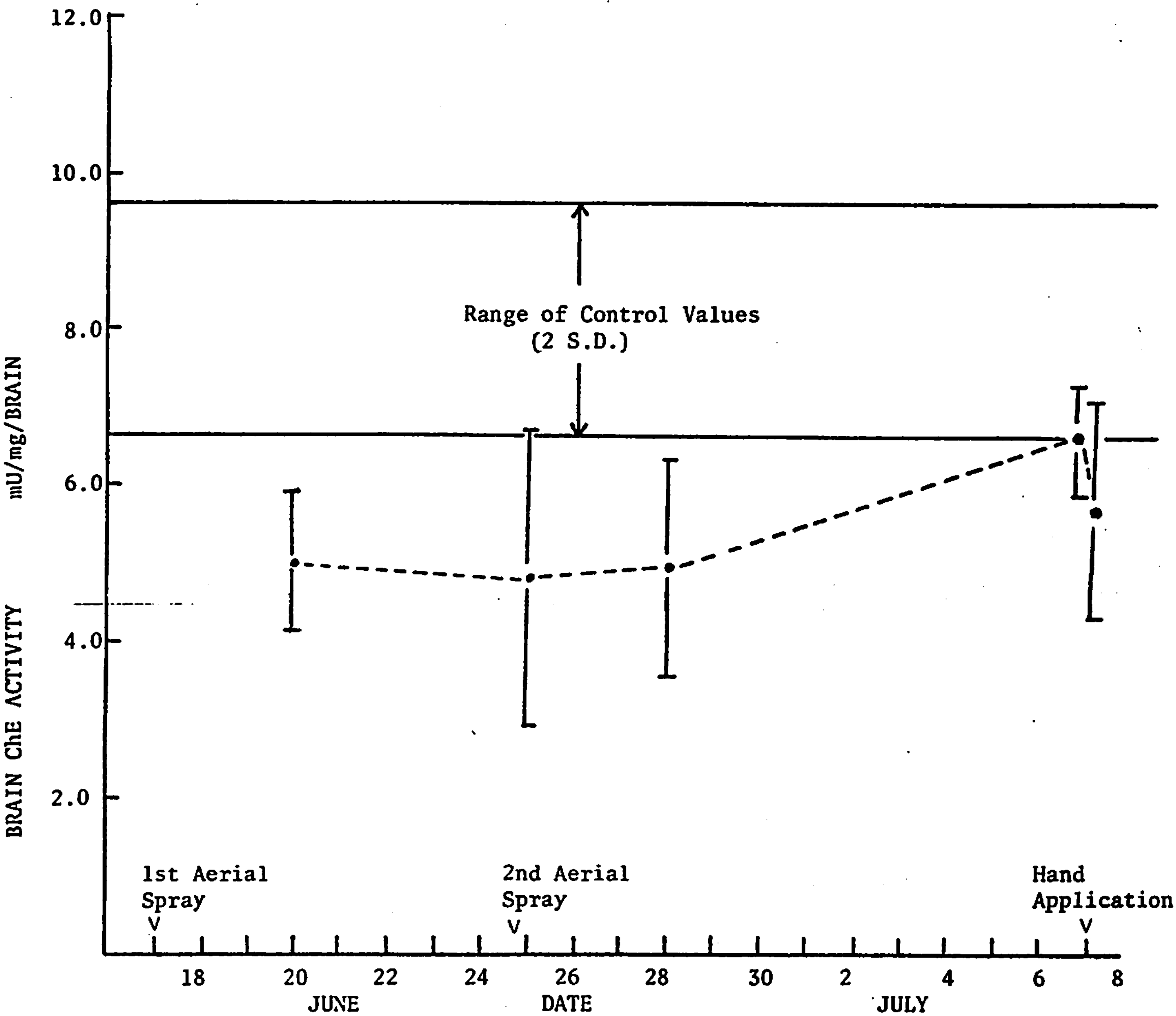

FIGURE 3 BRAIN CHOLINESTERASE ACTIVITY IN BROOK TROUT (*Salvelinus fontinalis*) FROM A BROOK TREATED WITH A FORMULATION OF MATACIL 1.8 F, TRITON X 100, WATER

Cyclosol formulation demonstrated the next greatest depression in ChE activity (Figure 4). Fish from the stream which received the fenitrothion and Triton formulation displayed the least pronounced depression in cholinesterase activity and the difference was not significant compared with controls (Figure 5). Maximum mean cholinesterase depression in treated streams, compared with control mean values, were: 19% for fish from the fenitrothion, Triton block; 26% for fish from the fenitrothion, Triton and Cyclosol block; and 39% in fish from the aminocarb and Triton block.

These results are somewhat consistent with the pesticide residue analyses performed at the Forest Pest Management Institute, which indicated that the highest active ingredient concentrations after aerial applications were obseved in the stream within the aminocarb block (peak concentrations after first and second spray events were 2.26 and 0.53 ppb respectively). The analytical results also indicated there were probably no real differences in the peak fenitrothion concentrations in the two streams treated with the different formulations (a maximum concentration of 1.84 ppb occurred in the fenitrothion, Triton stream after the second application).

After the ground applications, up to 6 hours after spray, the cholinesterase activity in fish from the aminocarb and the fenitrothion and Triton treated blocks dropped. In contrast, fish from the fenitrothion, Triton, and Cyclosol treated block demonstrated an increase in cholinesterase activity. No changes were significant, however.

The results of qualitating and quantifying the gut contents of fish taken from the treated areas after various applications have not been entirely completed at present. It appears, however, that the greatest changes in the feeding

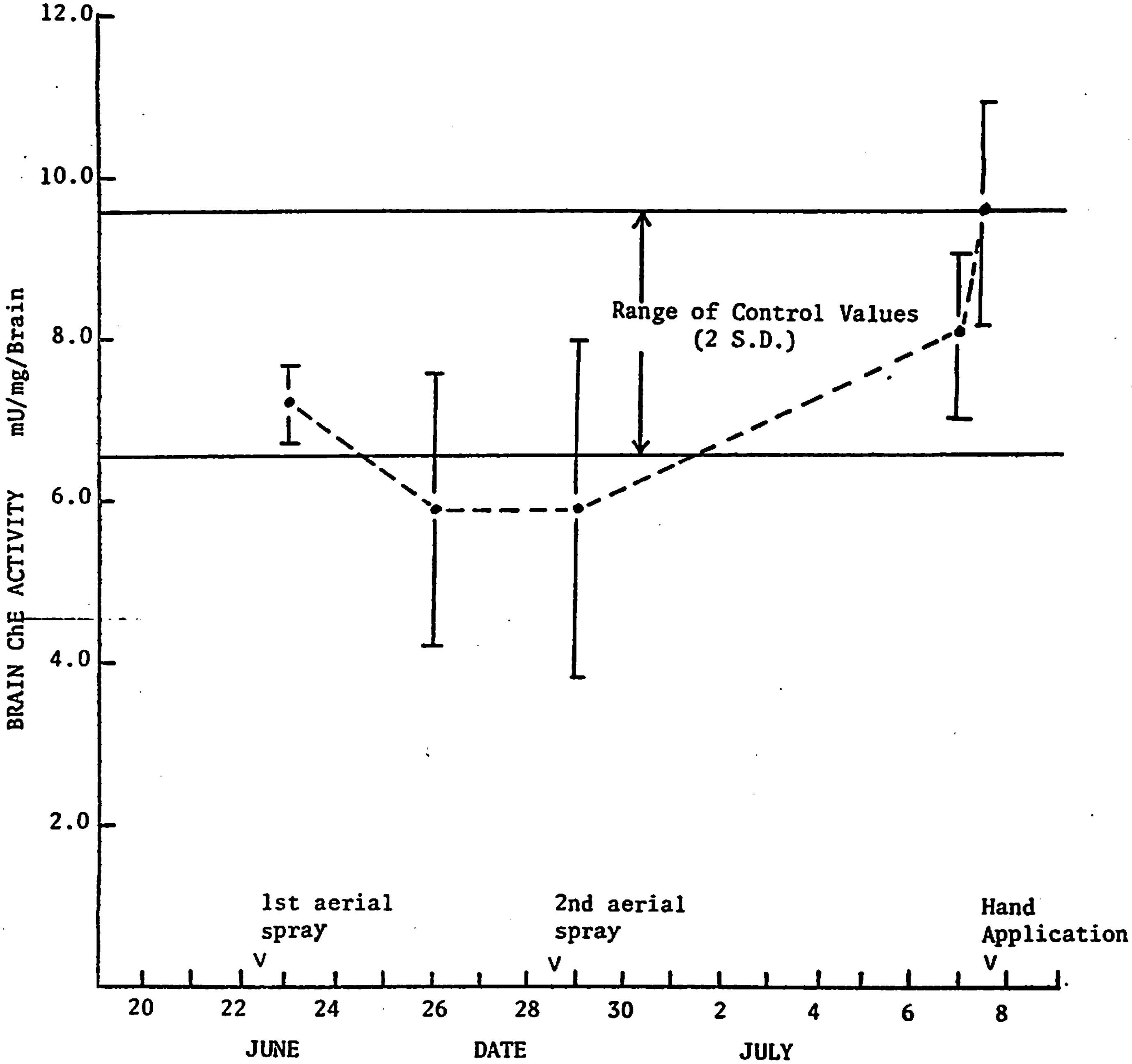

FIGURE 4 BRAIN CHOLINESTERASE ACTIVITY IN BROOK TROUT (*Salvelinus fontinalis*) FROM A BROOK TREATED WITH A FORMULATION OF FENITROTHION, TRITON X 100, CYCLOSOL 63, WATER

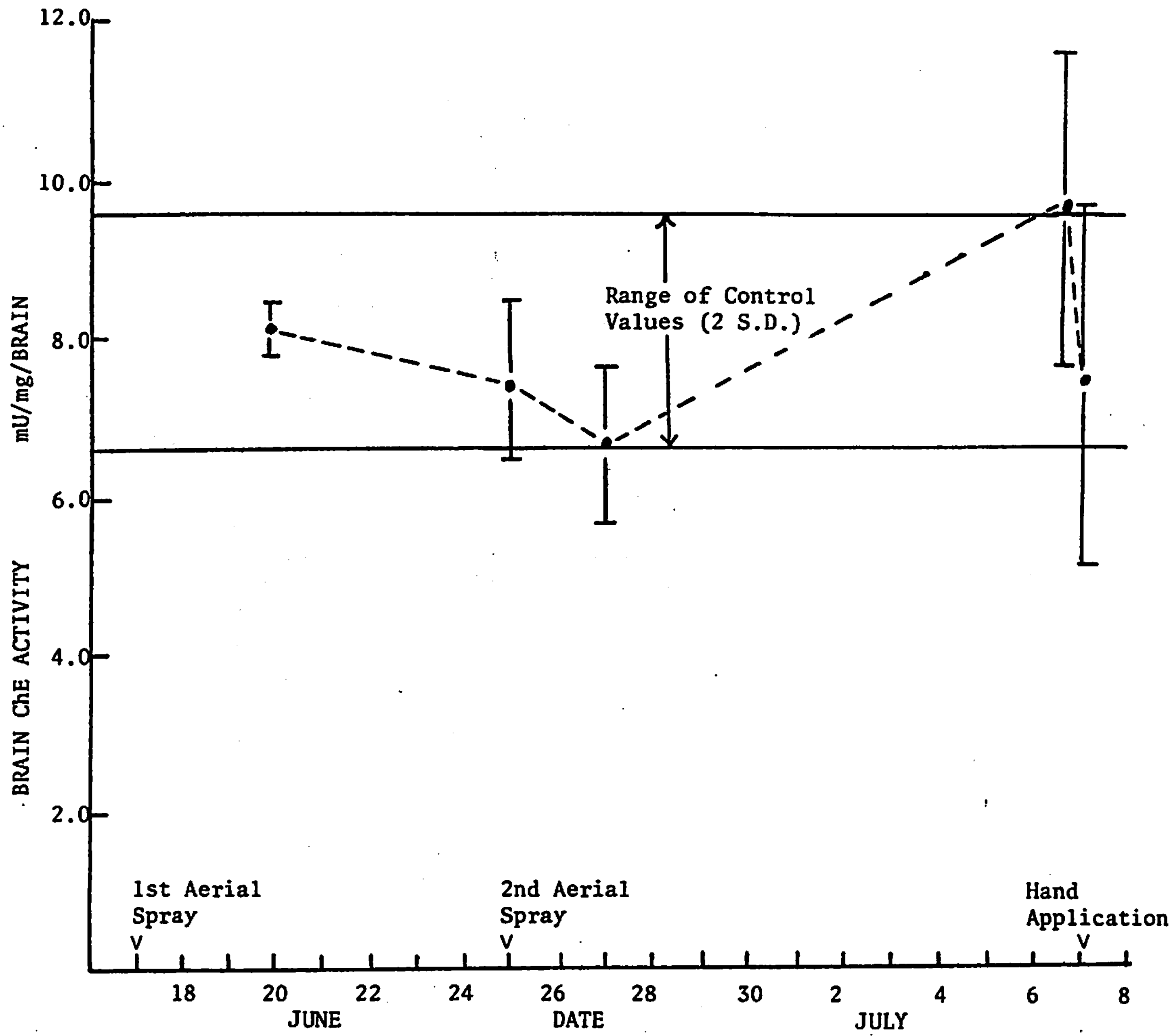

FIGURE 5 BRAIN CHOLINESTERASE ACTIVITY IN BROOK TROUT (<u>Salvelinus fontinalis</u>) FROM A BROOK TREATED WITH A FORMULATION OF FENITROTHION, TRITON X 100, AND WATER

activities of fish took place after the first aerial application in the brook treated with the fenitrothion and Triton only formulation (Figure 6). Within one day of the spray event, the stomachs of fish taken from this stream contained approximately ten times as many food items as those of fish taken one day prior to the spray event. Most of the additional numbers consisted of knocked down Lepidoptera, primarily budworm. The Lepidoptera species formed approximately 92% of the total diet at this time.

The changes in feeding activity of fish from the fenitrothion, Triton, Cyclosol block were similar in pattern although not as pronounced and somewhat delayed.

Fish from the aminocarb, Triton treated block demonstrated a significant shift towards the ingestion of Lepidoptera after the spray events, however, this was much less marked than in the fenitrothion blocks and total numbers decreased. The cause for this remains to be determined, however, it is possible that the significant cholinesterase depression in these fish may have resulted in a decreased ability to catch food organisms.

A small study was also undertaken to compare the drift potential of ground and aerially applied forestry herbicides. Three sites were monitored for deposit and air concentrations of herbicide with distance from the target site after application of a water formulation of a 50:50 mixture of the iso-octyl ester of 2,4-D and the propylene butyl ester of 2,4,5-T. The two helicopter treated sites received 3360 grams of total active ingredient per hectare, in a formulation of one part product to five parts water. The single ground application site received 5380 grams of total active ingredient per hectare in a formulation of one part product to five parts water. The helicopter, which was equipped with a boom and TEE Jet nozzles (boom pressure 2800 gm/m^2),

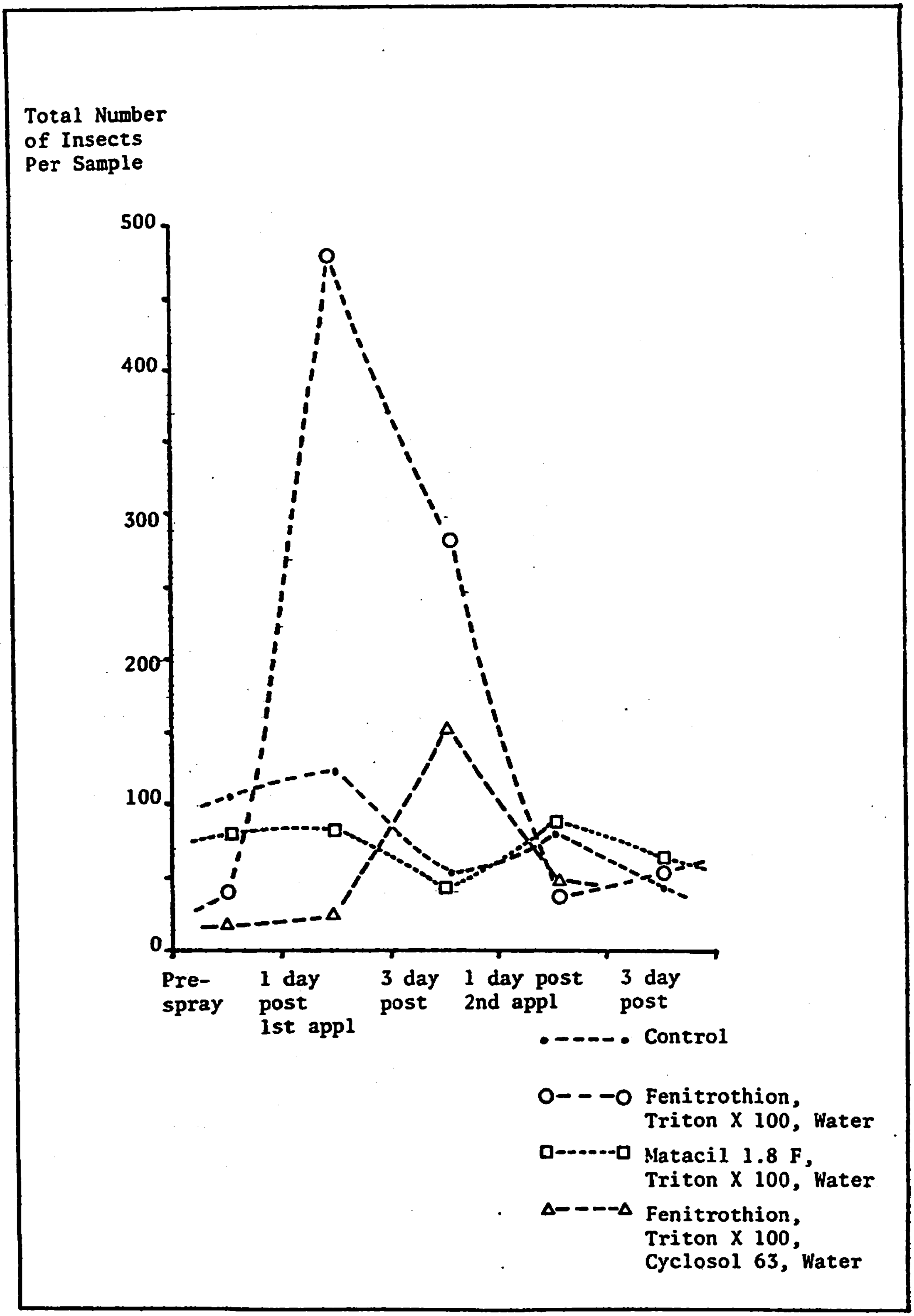

FIGURE 6 TOTAL NUMBER OF INSECTS IN STOMACHS OF BROOK TROUT (Salvelinus fontinalis) TAKEN FROM STREAMS TREATED WITH EXPERIMENTAL SPRAY FORMULATIONS

flew 15 metres above the ground at a speed of approximately 100 km/hr. The ground delivery was with hand-held spray wands (wand pressure 10.5 kg/cm^2) mounted on a Tree Farmer Forwarder.

Samples collected one hour after spray events indicated that deposit decreased rapidly and relatively linearly with distance from the spray block. A regression model provided a reasonably good fit of the data. Of interest is the fact that there was no substantial difference in the off-target drift between the two types of application. Since meteorlogical conditions were very similar during all spray events, and since the aircraft delivery had a considerably greater fall distance, the lack of a difference in drift potential is probably due to the smaller droplet spectrum produced by the higher pressures of the ground equipment.

Detection limits for air samples were not low enough to provide usefull results.

Finally, a series of laboratory toxicity studies were conducted in order to assess the interactive effect of ambient water pH on pesticide toxicity to rainbow trout. The chemicals which have been tested to date are fenitrothion, aminocarb and 2,4-D. All tests were acute (96hr) lethal bioasays and the pHs tested ranged from 4.5 to 8.5.

Calculated LC50s for fenitrothion (Table 2), based on nominal concentrations, were not obseved to change significantly throughout the range of pHs tested. The toxicity of aminocarb, on the other hand, increased dramatically with increasing pH, the LC50 at pH 4.5 being approximately 15 times the LC50 at pH 4.5. The 2,4-D tests indicated that the toxicity increased dramatically as pH decreased, the reverse of the aminocarb change, with the magnitude of change approximating that obseved for the aminocarb.

TABLE 2 TOXICITY OF INSECTICIDES AT DIFFERENT pHs

Values are 96-hour LC50s to Rainbow Trout

pH of Test Solution	Insecticide Fenitrothion	2,4-D	Aminocarb
4.5	1.9 (CL:* 1.5-2.3)	67.3 (CL: 48.3-74.3)	106.7 (CL: 92-121.4)
5.5	2.9 (R:** 1.8-5.6)	420 (R: 320-560)	61.2 (CL: 35.5-86.9)
7.0	3.3 (R: 1.8-5.6)	1000 (Limits not calculable)	56 (R: 32-100)
8.5	3.0 (R: 1.8-5.6)	>1000	7.5 (R: 5.6-10)

* CL = 95% confidence limits.

** R = Range from 0% mortality to 100% mortality.

The reasons for the dramatic changes in pesticide toxicty with pH change remain to be determined. It is probable that they relate to chemical changes or to physiological changes of the test species. A better estimate of such changes should be available upon completion of the analyses for test concentrations of the pesticides during the duration of the experiments. The tests appeared to be highly reproducible, as evidenced by the fact that a triplicate test of the aminocarb toxicty at pH 7.0 yielded LC50s which varied by no more than 6%

Of additional interest is the fact that the same test solution of aminocarb lost little of it's toxicity, as measured by five separate LC50 determinations, over a period of approximately one month. During this time, LC50s were determined at pH 8.5, pH7.0, pH 4.5 and again at pH 7.0. Analysis of test solutions for aminocarb content during this time remain to be completed and should help to explain some of these findings.

AMINOCARB PARTITIONING IN A STREAM

Report to the Forest Pest Control Forum

D.C. Eidt, Maritimes Forest Research Centre

V.N. Mallet, and Univêrsité de Moncton

November 1982

Our objective was to determine where aminocarb goes in a stream environment. The reason for doing this was the same one as that for our work with fenitrothion in 1981. It has been suggested that, with partitioning in the aqueous environment, toxic concentrations of pesticides and their derivatives could occur in some niches and thereby threaten the organisms that live there. The work was done in cooperation with Dr. G.B. Bacon of the New Brunswick Research and Productivity Council and Mr. M. DeGraeve of Monenco, Ltd. who studied residues in algae, bryophytes, higher plants and aquatic insects. Their results are not reported here.

A stretch of Manzer Brook, New Brunswick, was treated using a backpack mist blower with aminocarb in aqueous formation (99.6 mL Matacil ® 180F + 3.7 mL Atlox 3409F applied in 1h 7 min when streamflow was 92.2 L/sec). Concentrations in water up to 23.5 ug aminocarb/L + 2.7 ug aminocarb phenol/L were found. Aminocarb phenol formed almost immediately. Complete mixing of insecticide from top to bottom and into the stream bottom interstices occurred within an hour, 68 m downstream of the treated stretch.

In a like manner a stretch of Manzer Brook upstream was teated by injection two weeks later with aminocarb in oil formulation (22 mL Matacil ® 180F + 66 ml 585 oil applied in 1 h 7 min when streamflow was 26.7 L/sec.). The maximum concentration found was 12.9 ug/L of aminocarb + 0.5 ug aminocarb phenol. Again aminocarb phenol was found almost immediately and a complete mixing of aminocarb occurred within one hour, 93 m downstream of the injection site.

Water was filtered and both filtrates and residues were analysed. Only at the most upstream site in the stretch treated with aqueous formulation was aminocarb found in the residue. This probably occurred because the aminocarb particles had not yet dissolved, and there is thus no reason to believe that aminocarb was sorbed on suspended particles. Aminocarb phenol was not found in the residues but was found along with aminocarb in every filtrate analysed.

In sediments collected the day of treatment, and 1, 7 and 15 days after, from the stretch treated with aqueous formulation, traces of aminocarb were found in four and measurable amounts in only two of 24 samples taken. Trace amounts of aminocarb phenol were found in two and a measurable amount in only one of 24 samples.

Water samples and sediment samples were routinely analysed for fenitrothion. In 42 water samples analysed, all but one contained some fenitrothion ranging from 0.01 to 0.6 ug/L or not measurable due to interference but nonetheless present. In residues from filtered samples, traces to 0.56 ug of fenitrothion/g of residue were found and 0.04 to 2.3

ug/L were found in the filtrate. In sediment, amounts ranging from traces to 0.12 ug/g dry weight were found in most samples. Operational spraying had begun 6 km and farther to the west and north before these samples were taken.

EFFECTS OF FENITROTHION ON FOREST LITTER DECOMPOSITION

Report to the Forest Pest Control Forum

D.C. Eidt and C.A.A. Weaver

Maritimes Forest Research Centre

The objective was to determine if forest litter decomposition is affected by large doses of fenitrothion and the usual adjuvents used in operational spraying. This was regarded as a measure of the activity of the effects of the chemicals on organisms involved in decomposition, in particular the soil arthropods. Direct observations of arthropods were contemplated but the idea was abandoned because of the poor state of our knowledge of arthropods inhabiting forest litter.

Plots 10m x 10m were established in a uniform spruce forest in the UNB woodlot. There were seven treatments each replicated 4 times as follows:

Formulation	Rate (A.I.)
2.1 ml emulsifiable concentrate in water (includes 0.22 ml Atlox 3409 F)	210 g/ha
21 ml emulsifiable concentrate in water (includes 2.2 ml Atlox 3409F)	2100 g/ha
2.2 ml Atlox in water	2100 g/ha equivalent
approx. 16.6 ml fenitrothion + 53 ml Cyclosol + 81 ml 585 oil	approx. 2140 g/ha
approx. 3.0 ml fenitrothion + 10 ml Cyclosol + 15 ml 585 oil	approx. 400 g/ha
approx. 53 ml cyclosol + 81 ml 585 oil	approx. 2100 g/ha equivalent
control, no treatment	0

Saran litter bags were filled with weighed amounts of preleached spruce needles and placed on the plots before treatment. Ten bags were collected 30, 60 and 120 days after treatment. Needles were dried, weighed and compared with pretreatment weights. No differences have been found between treatment and controls to date. A fourth collection is scheduled for 365 days after treatment.

Spruce Budworm Infestation and Hazard Forecasts in New Brunswick for 1983

L.K. Hartling
Entomologist, Forest Protection Limited

Surveys for this purpose were conducted under the direct supervision of the author with technical advice provided by E.G. Kettela, Maritimes Forest Research Centre. They were completed between July 26 and September 3, 1982, employing a staff of 75, chiefly seasonal employees, for a person-day total of approximately 1,900. Assessments were made at 1,753 locations throughout the province, 292 by helicopter.

The purpose of the survey is to measure the extent and degree of infestation to be expected the following year and to gauge the degree of hazard to susceptible forests. The distribution of egg mass populations does not provide a meaningful measure of the effectiveness of the preceding spray operation because of the usually extensive invasion by highly mobile moths from unsprayed areas both within and beyond New Brunswick.

A brief description of the survey is as follows: at each sample location the forest stand is assessed with respect to current defoliation, previous defoliation, and tree vigor. One mid-crown branch is removed from each of four balsam fir trees. The length and width of each branch is measured to determine its foliar area. The foliage is returned to Fredericton where trained personnel examine the material for the presence of budworm egg masses. The number of branches examined from each location is determined by a sequential sampling technique. Populations are expressed in terms of branch area.

Hazard, or the risk of tree death or deterioration if there is further budworm attack, is a composite estimate derived from egg mass and tree condition data as indicated in Table 1.

Egg mass and hazard ratings were plotted daily on maps (1:250,000 scale) to provide a continuous update on survey results. Upon completion of the survey all data were entered on computer cards and contour maps (1:500,000 scale) were generated.

A comparison of the density of budworm egg masses and hazard level for 1982 with 1981 is provided for the province as a whole in Table 2.

Table 1. Calculation of hazard at locations sampled for budworm egg masses.[1]

The hazard rating is calculated by adding the appropriate hazard values assigned to (1) current defoliation, (2) previous defoliation, (3) tree vigor, and (4) egg mass density.

(1) Current Defoliation

Tally Code	% Defoliation	Hazard Value
0	0	0
T-2	1-25	1
3-6	26-65	2
7-10a	66-100	3
10b	100 with shoot axils destroyed	4

(2) Previous Defoliation

Tally Code	Hazard Value
0	0
L (light)	3
M (moderate)	6
S (severe)	9

(3) Tree Vigor

Tally Code	Hazard Value
N/A	0
P (poor)	+2
F (fair)	0
G (good)	-2

(4) Egg-masses/10 sq. m of balsam fir foliage

Tally Code	Hazard Value
0	0
1-100	1
101-240	2
241-399	3
400-999	4
1000+	5

(5) Computed Hazard Rating

Hazard Rating	Hazard Category
0-7	Low
8-10	Moderate
11-14	High
15+	Extreme

1 Adapted from Webb, F.E., D.G. Cameron and D.R. Macdonald, 1956. Studies of Aerial Spraying against the Spruce Budworm. V Techniques for Large-Scale Egg and Defoliation Ground Surveys 1953-55. Interim Report. For. Biol. Lab. Fredericton, N.B., For. Biol. Div., Agric. Canada.

Table 2. Egg mass density and hazard rating for 1981 and 1982.

Egg Masses/10^2 of Foliage

	Low (0-99)	Moderate (100-239)	High (240-999)	Very High (1000+)	Total
			1981		
Number of Locations	591 34%	441 25%	660 38%	48 3%	1,740 100%
			1982		
Number of Locations	458 26%	512 29%	701 40%	82 5%	1,753 100%

Hazard Rating

	Low (0-7)	Moderate (8-10)	High (11-14)	Extreme (15+)	Total
			1981		
Number of Locations	1,022 59%	381 22%	231 13%	106 6%	1,740 100%
			1982		
Number of Locations	1,020 59%	332 19%	287 16%	114 6%	1,753 100%

The data reveal that little change can be expected in the over-all density of budworm populations in 1983 from 1982. To determine shifts in population density within the province and the relative levels of hazard in particular areas, New Brunswick was divided into sectors using the transverse mercator grid system and mean egg mass density and hazard within each sector were compared for 1981 and 1982 (Figures 1 and 2). Statistical analysis (Wilcoxin Test for Paired Observations) reveal no significant change in egg mass density or hazard in the province as a whole from 1981 to 1982. The essence of this is that New Brunswick can continue to expect moderate to severe budworm attack in 1983, that substantial areas of susceptible forests will remain in moderate to high hazard, and will therefore be in need of continued protection in selected areas if further serious mortality and growth loss is to be forestalled.

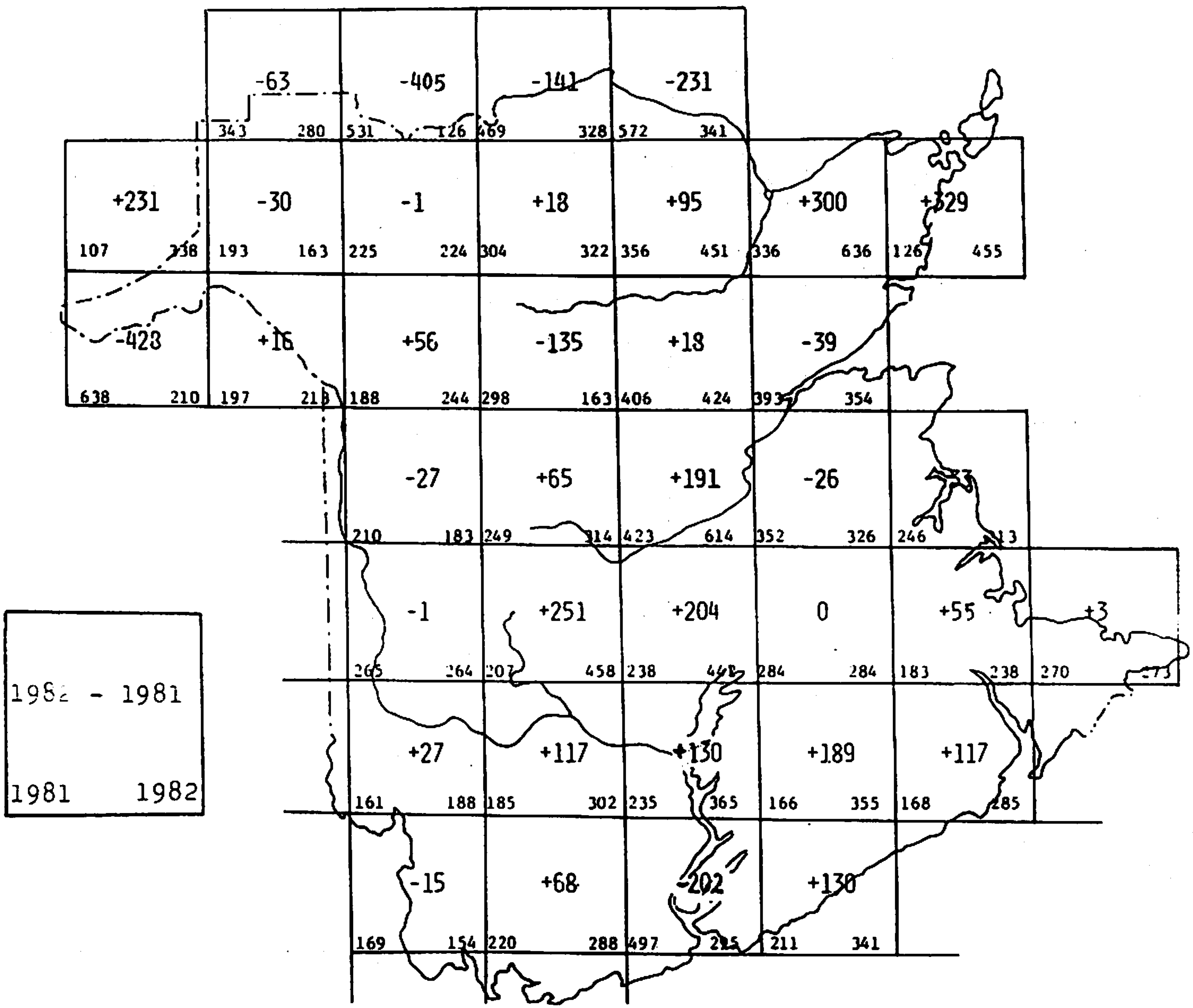

Fig. 1 A comparison of budworm egg mass densities in New Brunswick for 1981 and 1982

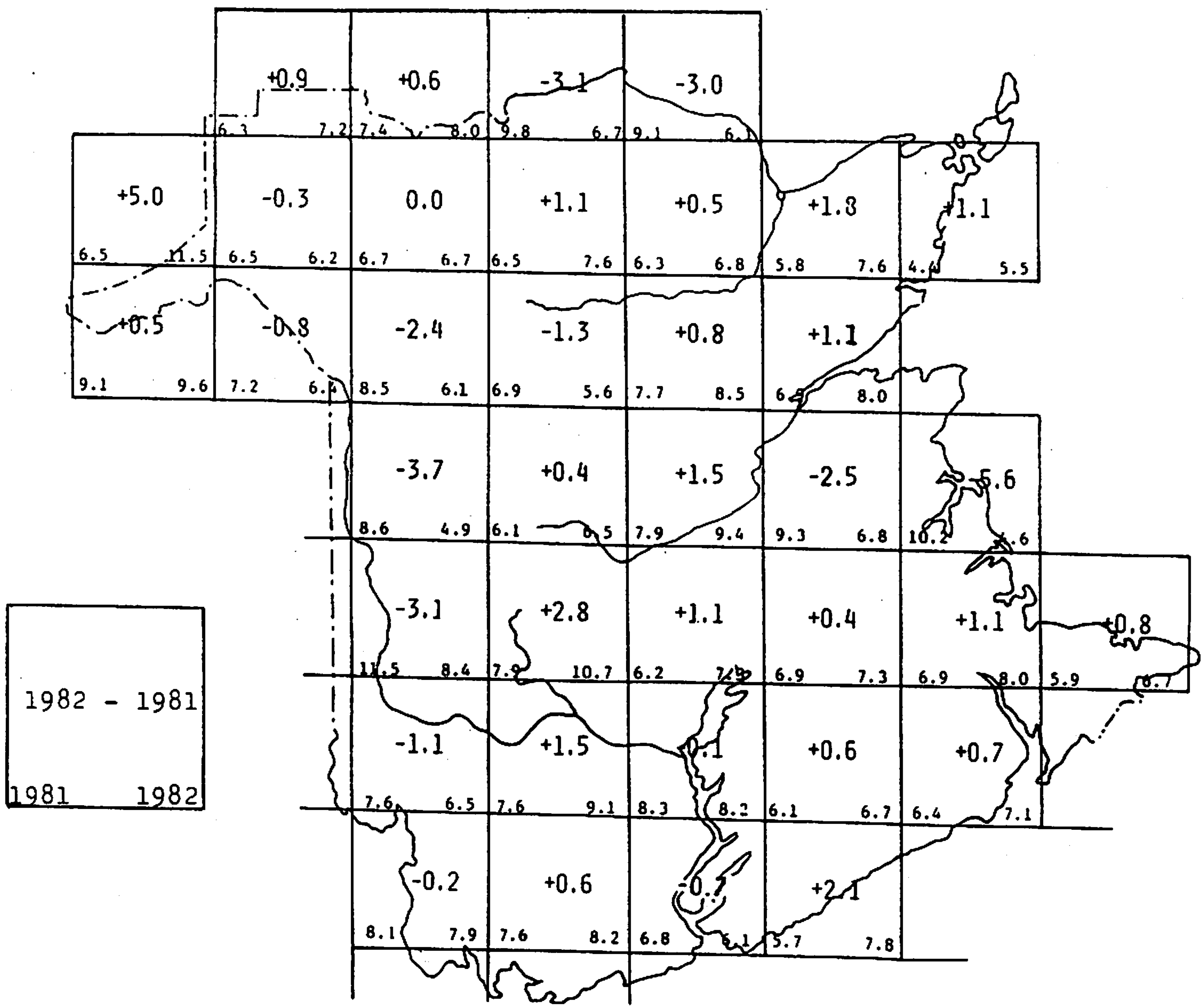

Fig. 2 A comparison of hazard in New Brunswick for 1981 and 1982

At this date the specific information for each of the 1,753 geographic locations along with a computer map analysis is being analyzed by the Department of Natural Resources to ascertain more detailed protection requirements for 1983.

Fredericton, N.B.
November 16, 1982

PULVERISATIONS AERIENNES REALISEES CONTRE LA TORDEUSE DES BOURGEONS DE L'EPINETTE AU QUEBEC EN 1981 ET PREVISION POUR 1982

Par:

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Rapport présenté devant l'Association des Industries Forestières Québécoises
Décembre 1981

Tiré du rapport interne: EP-82-01

INTRODUCTION

Le Ministère de l'Energie et des Ressources réalisait en 1981 son 12e programme de pulvérisation aérienne d'insecticide contre la Tordeuse des bourgeons de l'épinette. Amorcés dans l'ouest du Québec en 1970, les traitements ont couvert une superficie totale de 18,7 millions d'hectares et sont maintenant concentrés dans l'est du Québec suivant l'évolution de l'infestation.

Les territoires traités étaient localisés principalement dans la région du Bas-St-Laurent et de la Gaspésie où de fortes populations larvaires avaient été prévues et englobaient des peuplements très endommagés sur la rive nord du St-Laurent comprenant un certain pourcentage de sapins morts. L'intervention dans le premier cas visait à réduire les dommages pour la durée de l'infestation (politique conventionnelle) alors que dans le deuxième cas l'intervention visait à limiter la progression de la mortalité. Ces derniers traitements étaient localisés dans la région du Saguenay - Lac-St-Jean, de la Malbaie et des Escoumins.

1. - PROGRAMME 1981

1.1 Superficies traitées et bases d'opération

Le programme de pulvérisation 1981 a couvert une superficie totale de 705 164 hectares répartis dans les régions du Bas St-Laurent - Gaspésie, du Saguenay - Lac-St-Jean, de Québec et de la Côte-Nord. (Figure 1). Les traitements chimiques ont été réalisés sur une superficie de 690 163 hectares alors que les traitements biologiques ont couvert une superficie de 15 001 hectares (TABLEAUX 1 - 3).

Les superficies faisant l'objet de traitement chimique furent pulvérisées telles que prévues alors que la moitié seulement des superficies devant initialement faire l'objet de traitements biologiques ont pu être réalisées. Face aux retards enregistrés dans l'application d'insecticide chimique ainsi qu'aux fortes populations rencontrées en Gaspésie certains blocs prévus pour un traitement biologique dans le Bas St-Laurent furent cancellés au profit des traitements chimiques dans la Gaspésie.

Les traitements ont été principalement réalisés à partir des aéroports de Rivière-du-Loup et de Bonaventure alors que les aéroports de St-Honoré et de Matane ont servi à quelques occasions pour traiter les blocs trop éloignés des bases principales. Le programme a débuté le 27 mai et a été complété le 2 juillet.

1.2 Nombre et période d'application

La majorité des blocs ont reçu deux applications d'insecticide:

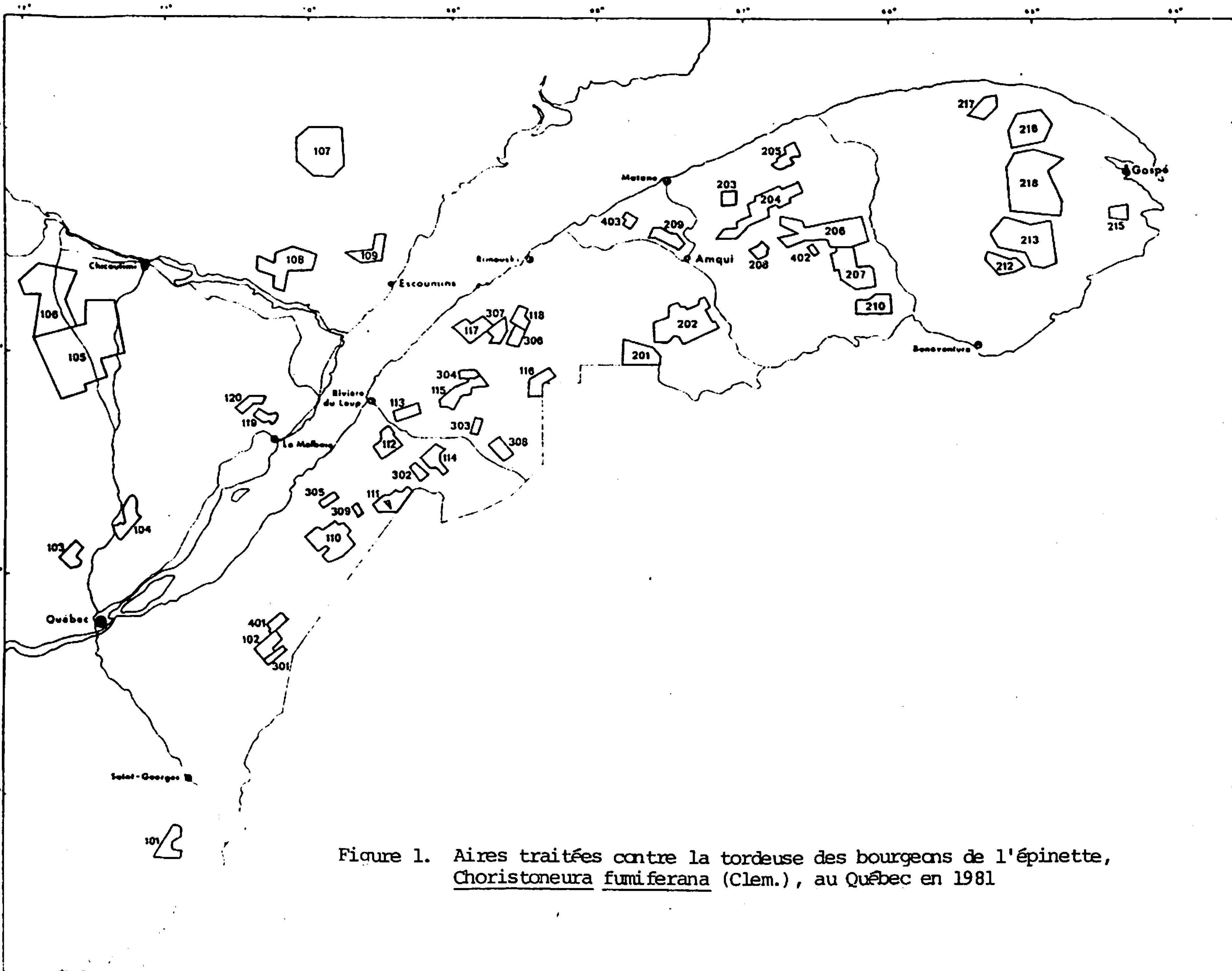

Figure 1. Aires traitées contre la tordeuse des bourgeons de l'épinette, Choristoneura fumiferana (Clem.), au Québec en 1981

TABLEAU 1 Superficies et traitements chimiques réalisés en 1981

Blocs	Superficies (ha)	1ère application	2e application
101	12 188	Mat.	Mat.
102	7 344	Fén.	Fén.
103	10 000	Mat.	-
104	7 968	Mat.	Mat.
105	42 812	Mat.	Mat.
106	52 032	Mat.	Mat.
107	40 313	Mat.	Mat.
108	27 969	Mat.	Mat.
109*	7 969	Fén.	Mat.
110	27 813	Mat.	Mat.
111	18 281	Fén.	Mat.
112	20 937	Mat.	Fén.
113	5 469	Mat.	Fén.
114	9 375	Mat.	Fén.
115	9 844	Mat.	Fén.
116	10 782	Mat.	Fén.
117	15 625	Mat.	Fén.
118	7 344	Mat.	Fén.
119*	5 313	Mat.	Mat.
120	4 063	Mat.	Mat.
201	19 531	Mat.	Mat.
202	44 531	Mat.	Fén. (Mat. sur les li 1 à 5)
203	5 469	Mat.	Mat.
204	27 656	Mat.	Mat.
205	5 469	Mat.	Fén.
206	33 281	Mat.	Mat.
207	27 656	Mat.	Mat.
208	6 406	Mat.	Mat.
209	7 344	Mat.	Fén.
210	7 500	Mat.	Fén.
212	6 094	Mat.	Mat.
213	29 532	Mat.	Mat.
215	4 688	Mat.	Fén.
216	19 063	Mat.	Mat.
217	12 813	Mat.	Mat.
218	29 376	Mat.	Mat.
219	29 376	Mat.	Mat.
401	2 500	Fén.	-
402	625	Fén.	Fén.
403	1 563	Mat.	-
TOTAL	690 163		

* Ces blocs ont reçu une application supplémentaire d'insecticide dès le début de l'étalement des pousses.

TABLEAU 3   Superficies et traitements biologiques réalisés en 1981

Blocs	Superficies (ha)	Traitement
301	2 500	Dipel 88
302	1 719	Dipel 88
303	1 406	Dipel 88
304	2 344	Dipel 88
308	4 219	Dipel 88
<u>Expérimental</u>		
305	1 875	Thuricide (32B)
309	938	Futura (64B)

la première a été effectuée dès que la pousse était suffisamment étalée pour capter l'insecticide et la seconde cinq (5) jours après le premier traitement. Certains blocs (2) où de très fortes populations étaient prévues ont fait l'objet d'une application supplémentaire pratiquée à cinq (5) jours de la deuxième intervention.

Tous les blocs faisant l'objet de traitement biologique ont reçu une seule application d'insecticide dès que les pousses étaient bien étalées.

1.3 Insecticide, dosage et volume

Les insecticides employés furent l'aminocarb, Matacil (MD), au taux de 52g d'ingrédient actif à l'hectare et le fénitrothion, Sumithion (MD), au taux de 210g d'ingrédient actif à l'hectare. L'un et l'autre insecticides ont été pulvérisés dans un mélange total de 1,403ℓ/ha; l'aminocarb, compte tenu son coût moindre en 1981, fut utilisé sur 80% de la superficie et le fénitrothion sur 20%.

L'insecticide biologique utilisé fut le *Bacillus thuringiensis*, Dipel 88 (MD), au taux de 19,76 UI/ha et pulvérisé dans un volume de 7,0ℓ/ha.

Au niveau des traitements expérimentaux, deux préparations de *Bacillus thuringiensis* (Thuricide 32B et Futura 64B) au taux de 19,76 UI/ha furent pulvérisés dans des volumes réduits de 5,85ℓ/ha et de 2,34ℓ/ha dans le but de réduire les coûts d'application.

1.4 Techniques de pulvérisation

Pour la réalisation du programme 1981, cinq (5) avions quadrimoteurs, deux (2) avions de type Constellation et trois(3) de type DC-4 furent nolisés de la Compagnie Conifair Aviation. Par ailleurs, deux (2) monomoteurs de type Grumman AgCat "B" de la Compagnie "Les Arrosages Aériens Castor Inc." ont été utilisés pour traiter certains blocs de petite superficie totalisant 4 688 hectares.

Tous les appareils étaient munis de système de pulvérisation à longerons et à buses; la navigation était par ailleurs assurée par des systèmes de navigation par inertie de Litton pour les quadrimoteurs alors que les monomoteurs étaient guidés par un avion pointeur.

2. - DEVELOPPEMENT DE L'INSECTE ET SYNCHRONISATION DES APPLICATIONS

Le développement de l'insecte en 1981 a été plus rapide que l'an passé mais si l'on considère son comportement par rapport à celui des cinq (5) dernières années, la tordeuse a progressé normalement.

Les conditions climatiques rencontrées au début du mois de juin (surtout le vent) n'ont pas permis la pulvérisation d'insecticide et des retards importants ont été enregistrés. Il convient de mentionner que l'éloigenement des blocs par rapport aux aéroports, le nombre d'avions et la configuration des blocs ont aussi été responsables d'une partie des retards.

La première application d'insecticide s'est étirée jusqu'au 5e âge larvaire de l'insecte (24% du territoire) ce qui a eu pour effet de décaler la deuxième application où 46% du territoire fut traité durant le 6e âge larvaire de l'insecte. Une application réalisée à un stade aussi avancé permet de protéger une certaine partie du feuillage qui ne serait pas encore détruit mais contribue surtout à réduire les populations résiduelles pour l'an prochain, les populations étant alors plus exposées (TABLEAU 7).

3. - DEPOT D'INSECTICIDE

Les traitements chimiques réalisés dans un volume total de 1,403ℓ/ha ont donné un dépôt au sol pouvant être considéré comme satisfaisant sur 70% du territoire vérifié, alors que 30% des échantillons récoltés étaient sous la normale.

TABLEAU 7 Pourcentage du territoire ouvert et traité selon le développement de l'insecte (IDI) et le développement de la pousse (IDP)

A. - Développement de l'insecte (IDI)

Classe IDI	Ouverture		Pulvérisation	
	App. I	App. II	App. I	App. II
2.5 - 3.0	35	-	8	-
3.1 - 3.5	23	6	16	-
3.6 - 4.0	21	4	20	-
4.1 - 4.5	5	40	16	8
4.6 - 5.0	15	14	16	27
5.1 - 5.5	1	15	20	19
5.6 - 6.0	-	16	4	32
6.1 - 6.5	-	5	-	14

B. - Développement de la pousse (IDP)

Classe IDP	Ouverture		Pulvérisation	
	App. I	App. II	App. I	App. II
2.8 - 3.1	3	-	-	-
3.2 - 3.5	25	-	9	-
3.6 - 3.9	33	-	14	-
4.0 - 4.3	17	-	19	-
4.4 - 4.7	21	-	13	-
4.8 - 5.0	1	100	45	100

TABLEAU 10 Populations larvaires pré et post-traitement ainsi que les mortalités larvaires obtenues à l'intérieur et à l'extérieur des aires traitées contre la tordeuse des bourgeons de l'épinette, <u>Choristoneura fumiferana</u> (Clem.), dans l'est de la province de Québec de 1975 à 1981

Année	Nbre P.E.	Populations Pré-traitement (Lar/br 45cm)	Populations Post-traitement (Lar/br 45cm)	Mortalité (%)	Mortalité Abbott (1)
Traitées					
1975	89	34.0	4.9	85.6	16.8
1976	88	49.2	4.4	91.1	35.5
1977	38	20.4	2.6	87.2	51.9
1978	23	15.9	1.0	93.7	79.2
1979	97	13.3	1.5	88.7	63.4
1980	110	10.4	2.1	79.8	64.0
1981	170	24.6	2.1	91.5	67.0
Témoins					
1975	15	50.3	8.7	82.7	-
1976	39	40.8	5.6	86.2	-
1977	33	21.0	5.8	73.4	-
1978	50	15.2	4.6	69.7	-
1979	61	14.9	4.6	69.1	-
1980	69	8.9	4.9	45.0	-
1981	141	21.8	5.9	72.9	-

(1) $$\frac{\text{Survie (témoins)} - \text{Survie (traitées)}}{\text{Survie (témoins)}} \times 100$$

4. - EFFICACITE DES TRAITEMENTS

4.1 Traitements chimiques

La population larvaire retrouvée avant traitement fut évaluée à 24,6 larves par branche alors qu'elle était de 21,8 larves à l'extérieur des aires traitées (TABLEAU 10).

Les populations les plus élevées furent enregistrées à l'est de Rimouski et dans Charlesvoix variant de 17 à 77 larves par branche; dans les régions de Beauce, Bas St-Laurent et du parc des Laurentides, par ailleurs, les populations retrouvées étaient inférieures à 16 larves par branche.

La mortalité larvaire enregistrée dans les blocs de la Beauce et du Bas St-Laurent fut de 86% comparativement à 61.7% dans les aires non traitées alors que la défoliation de la pousse annuelle se chiffrait à 28% comparativement à 52% en dehors des blocs.

En Gaspésie, les populations étaient très élevées (36 larves/branche) et les traitements furent réalisés tardivement: la mortalité larvaire fut évaluée à 90% comparativement à 78% dans les aires non traitées. Au niveau de la protection accordée au feuillage par ailleurs, le rendement fut médiocre avec 78% de défoliation dans les aires traitées comparativement à 90% à l'extérieur des aires traitées.

Dans les régions situées au nord et au sud du Parc des Laurentides ainsi que celles situées dans la région des Escoumins, majoritairement composées de peuplements très endommagés, les blocs ont reçu une très bonne protection alors que la mortalité larvaire fut excellente (90%) et la défoliation annuelle fut de 65% comparativement à 90% dans les zones non traitées.

4.2 Traitements biologiques

Les populations rencontrées dans les blocs traités au *Bacillus thuringiensis* étaient faibles variant de 9.5 à 15.7 larves par branche. La réduction des populations fut importante (85% à 97%) et la défoliation fut de 20% comparativement à 50% en dehors des aires traitées.

4.3 Traitements expérimentaux

Le traitement réalisé au Thuricide 32B dans un volume réduit à 5,85ℓ/ha a donné de très bons résultats: les populations rencontrées étaient élevées (24.4 larves/branche), la mortalité fut importante (82.7%) et la défoliation fut limitée à 32%. Suite à des problèmes de calibration, le traitement fut cependant réalisé en deux applications et la préparation testée quoique prometteuse doit faire l'objet de nouveaux tests avant d'être utilisée sur une base opérationnelle.

Le traitement réalisé au Futura 64B (MD) a couvert une superficie de 938 hectares à cause du peu de matériel disponible. La population retrouvée était très variable (3 à 24 larves/branche) et le traitement n'a pas donné de bons résultats: la réduction des populations fut de 57.1% et la défoliation fut aussi importante à l'intérieur qu'à l'extérieur des aires traitées associée principalement à un dépot irrégulier.

CONCLUSION

Compte tenu des niveaux de population rencontrés et de la condition de la forêt, les traitements ont contribué à garantir une très bonne protection sur 47% de la superficie traitée, une protection variant de bonne à médiocre sur 42% du territoire alors que 11% du territoire ne recevait aucune protection.

5. - INFESTATION 1981

Un inventaire aérien des dommages annuels causés par la Tordeuse fut réalisé comme à tous les ans sur l'ensemble de la province pour juger de la progression de l'infestation.

Après avoir connu une nette régression de 1976 à 1979, l'infestation poursuit sa recrudescence amorcée en 1980. La progression de l'infestation s'est manifestée principalement dans l'est du Québec, soit dans les régions de Québec, du Bas St-Laurent - Gaspésie et de la Côte-Nord; les dommages y ont été particulièrement intenses et la mortalité des arbres y a considérablement progressé. Les dommages se sont aussi intensifiés dans les zones de mortalité localisées au nord du Saguenay - Lac-St-Jean. Par contre, le Témiscamingue et le Témiscouata ont connu une certaine régression de l'infestation (Figure 3).

Les dommages observés en 1981 ont couvert une superficie de 17,1 millions d'hectares ce qui constitue une progression de l'insecte sur 1,6 millions d'hectares par rapport à 1980. Cet accroissement constitue une augmentation de l'ordre de 10% dont les deux tiers proviennent de la région du Bas St-Laurent - Gaspésie et l'autre tiers de la région de Québec et de la Côte-Nord. Les dommages furent légers sur 0,6 million d'hectares, modérés sur 1,9 millions d'hectares et sévères sur 4,4 millions d'hectares comparativement à 1,0, 0,9 et 4,3 millions d'hectares en 1980. La mortalité des arbres par ailleurs, s'est accrue de 0,9 million d'hectares et occupe présentement 10,2 millions d'hectares (TABLEAU 13).

6. - <u>INVENTAIRE DES OEUFS</u>

En collaboration avec le Centre de recherches forestières des Laurentides du Service canadien des forêts, un inventaire des oeufs de la Tordeuse fut réalisé sur toute la province dans le but de connaître les niveaux de populations prévus pour l'année suivante.

A l'intérieur des aires traitées en 1981, les populations d'oeufs sont faibles dans un (1) bloc, moyennes dans neuf (9) blocs, élevées dans vingt-quatre (24) blocs et très élevées dans treize (13) blocs, laissant à

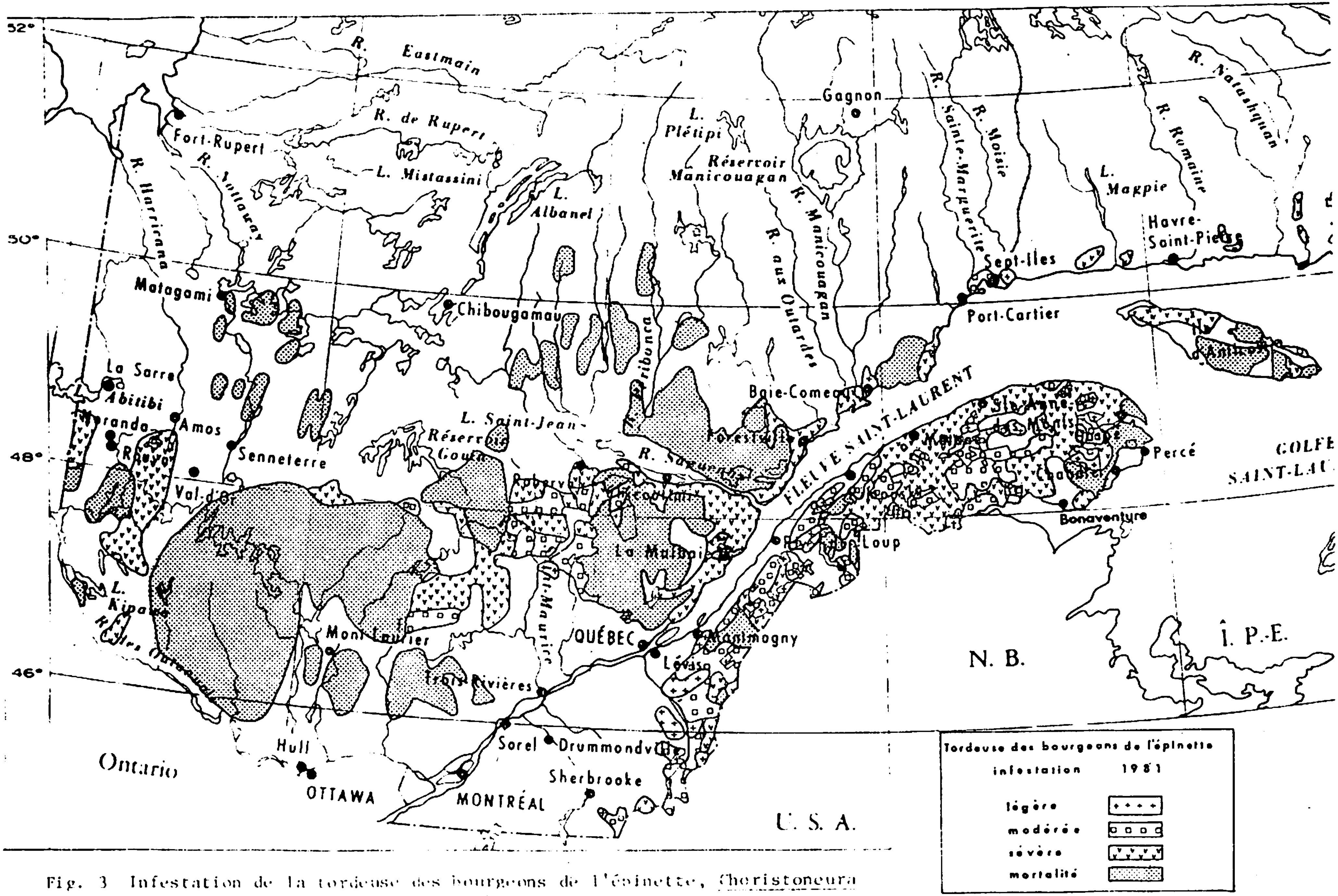

Fig. 3 Infestation de la tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clem.), au Québec en 1981

TABLEAU 13 Superficies (hectares) infestées par la tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clem.), dans les régions administratives du Québec en 1981

REGIONS	CLASSES DE DEFOLIATION							
	LEGER	MODERE	SEVERE	MORTALITE				TOTAL
				1 - 25%	26 - 50%	51 - 75%	76 - 100%	
Bas St-Laurent-Gaspésie	275 629	833 752	1 874 815	236 404	84 532	36 875	5 469	3 320 476
Saguenay-Lac St-Jean	35 625	139 845	263 441	1 233 284	402 659	129 063	781	2 204 698
Québec	159 999	401 564	654 534	532 503	142 033	-	-	1 890 633
Trois-Rivières	51 876	311 095	464 845	451 720	185 626	210 938	27 188	1 703 288
Cantons de l'Est	19 844	81 562	23 594	6 250	-	-	-	131 250
Montréal	3 907	60 469	47 656	224 375	18 750	13 593		368 750
Outaouais	-	2 500	72 031	503 432	276 900	120 679	2 867 582	3 843 124
Nord-Ouest	-	8 376	518 909	137 659	245 160	407 969	900 484	2 218 557
Côte-Nord	85 470	80 938	490 002	493 597	164 531	51 874	52 500	1 418 912
TOTAL	632 350	1 920 101	4 382 827	3 819 224	1 520 191	970 991	3 854 004	17 099 688

penser que la majeure partie du territoire devrait être considérée pour traitement en 1982.

L'inventaire des masses d'oeufs effectué au niveau de la province révèle que les régions du Bas St-Laurent - Gaspésie, du Saguenay - Lac-St-Jean, de Trois-Rivières et de Montréal connaîtront des hausses de populations en 1982. Dans la région de Québec, l'inventaire indique une recrudescence de l'épidémie dans le secteur compris entre Baie St-Paul et le Saguenay ainsi que dans la région de Montmagny alors qu'une baisse est à prévoir dans le parc des Laurentides et dans la Beauce (Figure 4).

Malgré une légère baisse de population prévue en 1982 sur la Côte-Nord, de très fortes populations sont à prévoir entre Baie Comeau et Sept-Iles. Dans le secteur des Escoumins, les populations seront légèrement plus faibles qu'en 1981 mais des dommages très importants sont à prévoir. L'Ile d'Anticosti ne sera pas épargnée car l'inventaire indique une hausse de population et une progression des superficies affectées par l'insecte pour l'an prochain (TABLEAU 20).

CONCLUSION

Compte tenu la reprise générale de l'infestation dans l'est du Québec, un programme de 1 250 000 hectares est envisagé en 1982.

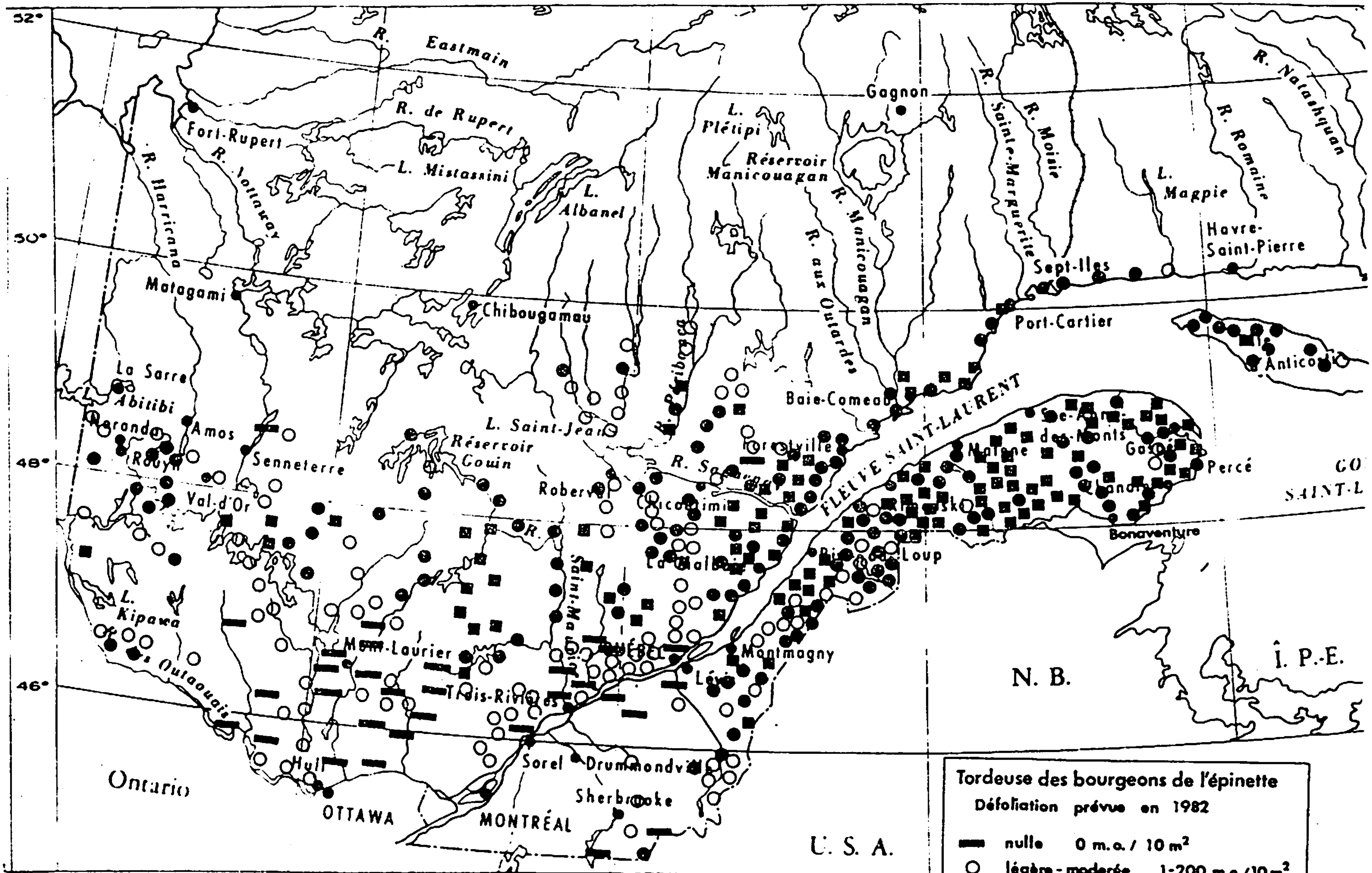

Fig. 4 Défoliation prévue au Québec en 1982 à partir des populations d'oeufs de la tordeuse des bourgeons de l'épinette, Choristoneura fumiferana (Clem.) enregistrées en 1981

TABLEAU 20 Populations d'oeufs enregistrées en 1978, 1979, 1980 et 1981 dans les aires infestées par la tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clem.)

Régions administratives	1978 MO	1978 (PE)	1979 MO	1979 (PE)	1980 MO	1980 (PE)	1981 MO	1981 (PE)	1981/1980	Niveaux de défoliation prévue pour 1981
Bas St-Laurent-Gaspésie	157	(565)	120	(38)	514	(485)	711	(516)	1.38	Sévère
Saguenay-Lac St-Jean	149	(61)	139	(63)	175	(88)	227	(108)	1.29	Sévère
Québec	270	(128)	213	(208)	299	(178)	279	(218)	0.93	Sévère
Trois-Rivières	66	(55)	156	(53)	304	(53)	363	(61)	1.19	Sévère
Cantons de l'Est	40	(17)	140	(23)	406	(17)	64	(25)	0.16	Léger
Montréal	5	(52)	111	(26)	39	(26)	130	(24)	3.33	Modérée
Outaouais	159	(83)	167	(95)	150	(86)	113	(88)	0.75	Modérée
Nord-Ouest	228	(43)	412	(53)	297	(50)	176	(49)	0.59	Modérée
Côte-Nord	91	(77)	80	(75)	661	(63)	482	(115)	0.73	Sévère
Total	154	(1081)	167	(983)	400	(996)	459	(1204)	1.14	Sévère

Superficies (hectares) infestées par la tordeuse des bourgeons de l'épinette, Choristoneura fumiferana (Clem.), selon la tenure des terres dans les aires traitées au Québec en 1981

TENURE	CLASSES DE DEFOLIATION								TOTAL
	NUL	LEGER	MODERE	SEVERE	MORTALITE				
					1 - 25%	26 - 50%	51 - 75%	76 - 100%	
Conc. for. 069-08	-	2 032	1 406	-	469	156	-	-	4 063
071-06	-	4 531	-	938	33 438	2 031	313	-	41 251
110-08	-	2 344	-	3 125	3 907	-	-	-	9 376
164-08	-	17 031	20 781	1 719	1 250	3 751	1 719	-	46 251
242-19	-	-	-	-	156	-	-	-	156
359-21	-	-	-	2 344	1 094	-	-	-	3 438
Grands terrains privés									
Domtar	-	11 719	4 844	-	781	-	-	-	17 344
N.B.I.P.	-	-	29 376	-	-	-	-	-	29 376
Petits terrains privés	-	18 439	2 344	-	2 656	625	-	-	24 064
Forêts domaniales	3 281	159 532	193 437	27 814	99 532	30 625	7 500	156	521 877

Superficies (hectares) infestées par la tordeuse des bourgeons de l'épinette, <u>Choristoneura fumiferana</u> (Clem.), selon la tenure des terres dans les aires traitées au Québec en 1981

	CLASSES DE DEFOLIATION								
					MORTALITE				
	NUL	LEGER	MODERE	SEVERE	1 - 25%	26 - 50%	51 - 75%	76 - 100%	TOTAL
Camp Mercier	-	937	-	-	625	-	-	-	1 562
Forêt [illegible]tmorency (U. .)	-	7 219	2 031	-	-	156	-	-	6 406
TOTAL	3 281	220 784	254 219	35 940	143 908	37 244	9 532	156	705 164

PULVERISATIONS AERIENNES REALISEES CONTRE LA TORDEUSE DES BOURGEONS DE L'EPINETTE AU QUEBEC EN 1982 ET PREVISIONS POUR 1983

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Rapport présenté devant l'Association
des Industries Forestières Québécoises
Février 1983

(Tiré du rapport interne: EP-83-01)

INTRODUCTION

Le Ministère de l'Energie et des Ressources réalisait en 1982 son 13e programme de pulvérisation aérienne d'insecticide pour lutter contre la tordeuse des bourgeons de l'épinette en milieu forestier. Amorçés dans l'ouest du Québec en 1970, les traitements ont couvert depuis lors une superficie totale de 20,0 millions d'hectares au coût de $79,4 millions. Les traitements sont maintenant concentrés dans l'est du Québec suivant l'évolution de l'infestation.

Après avoir connu une certaine régression de 1976 à 1979, l'infestation en recrudescence depuis 1980 dans l'est du Québec, nous obligeait à intensifier les programmes de pulvérisation qui sont passés de 188 500 hectares en 1980 à 1,3 million d'hectares en 1982.

Les territoires traités en 1982 étaient principalement localisés dans la région du Bas St-Laurent et de la Gaspésie où la forêt était très sévèrement infestée et où de très fortes populations étaient anticipées. Le programme englobait en outre, pour une seconde année consécutive, certains territoires situés sur la rive nord du St-Laurent (Régions 02 et 03) où un certain taux de mortalité des arbres avait déjà été enregistré . L'intervention dans le premier cas visait à réduire les dommages causés pour la durée de l'infestation (politique conventionnelle) alors que dans le deuxième cas l'intervention visait à ralentir la progression de la mortalité et ainsi permettre la récupération des peuplements avant que ceux-ci ne soient trop détériorés. Ces derniers traitements étaient localisés dans la région du Saguenay-Lac St-Jean, de la Malbaie et des Escoumins (Figure 1).

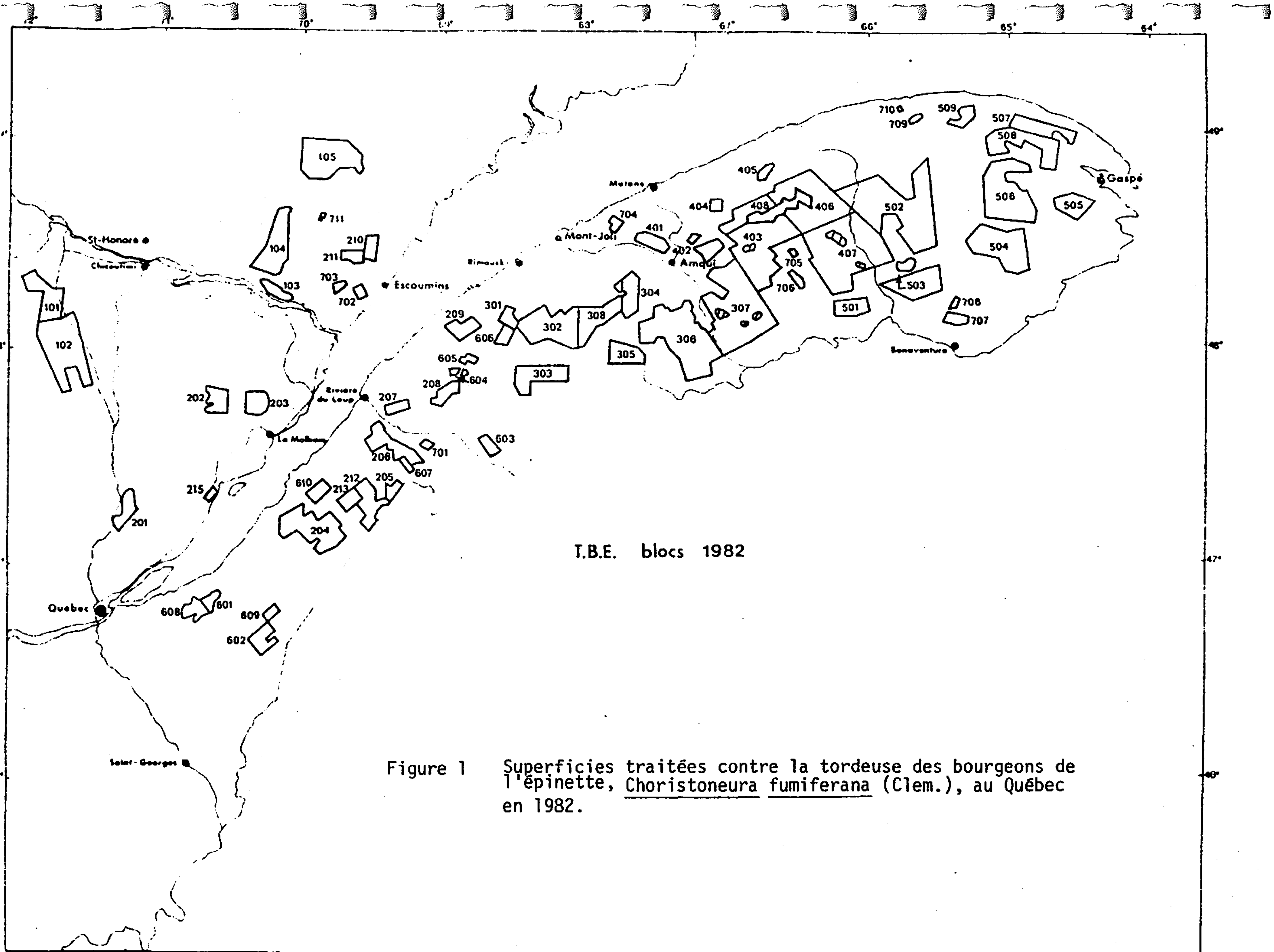

Figure 1 Superficies traitées contre la tordeuse des bourgeons de l'épinette, Choristoneura fumiferana (Clem.), au Québec en 1982.

PROGRAMME 1982

1.1 - Superficies traitées et bases d'opération

Le programme 1982 a couvert une superficie totale de 1 298 495 hectares répartis dans les régions du Bas St-Laurent-Gaspésie (1 062 353 ha), du Saguenay-Lac St-Jean (63 907 ha), de Québec (76 253 ha) et de la Côte-Nord (95 982 ha).

Les traitements au moyen de quadrimoteurs furent réalisés à partir des aéroports de Rivière-du-Loup, Mont-Joli, Matane, St-Honoré et Bonaventure alors que des pistes situées à Nouvelle, Ste-Lucie de Beauregard, Rivière Madeleine, Montmagny, Rivière Bleue, Grandes Bergeronnes et Rimouski furent utilisées pour le traitement de certains petits blocs de moindre envergure au moyen d'appareils monomoteurs.

Le programme a débuté le 2 juin pour se terminer le 11 juillet.

1.2 - Traitements

Deux types de traitements ont été pratiqués: des traitements chimiques et des traitements biologiques. Les traitements chimiques ont couvert une superficie de 1 266 618 hectares alors que les traitements biologiques couvraient une superficie de 31 877 hectares.

Les insecticides chimiques (blocs 100 à 599) utilisés pour les traitements opérationnels aux quadrimoteurs furent l'aminocarb, Matacil [MD], pulvérisé au taux de 52g I.A./ha et le fénitrothion, Sumithion [MD], pulvérisé au taux de 210g I.A./ha. L'un et l'autre produits étaient dilués dans un volume de 1,403ℓ/ha de solution pour être appliqués. Ceux-ci sont considérés comme sensiblement égaux en terme d'efficacité mais le Matacil fut utilisé sur environ 80% du territoire et le Sumithion sur 20% sur une base purement économique (coût des produits).

Lors des traitements chimiques (blocs 700) aux monomoteurs le Matacil fut utilisé au taux de 87,5g I.A. par hectare dilué dans 2,34 litres de solution.

L'insecticide biologique (blocs 600) utilisé pour les traitements opérationnels fut le <u>Bacillus thuringiensis</u>, Thuricide 32LV [MD], Dipel 88 [MD], pulvérisé aux taux de 20, 30 et 40 BIU/ha. Le produit était dilué dans un volume variant de 3,5 à 8,8ℓ/ha pour être pulvérisé.

Sur une base expérimentale une nouvelle préparation de Matacil en suspension ne contenant pas de Nonyl-Phénol «Matacil flowable» fut testée de même qu'un nouveau diluant soit une huile végétale (de CANOLA) susceptible d'améliorer la déposition du produit au sol et réduire la dérive hors des aires traitées. Finalement, toujours à titre expérimental, une nouvelle préparation de <u>Bacillus thuringiensis</u>, Futura II [MD], fut aussi expérimentée en collaboration avec le Centre de Recherches forestières des Laurentides (Dr Smirnoff) dans l'optique de réduire le volume épandu (et par tant le coût) tout en gardant la même efficacité. Le traitement réalisé au niveau de chacun des blocs apparaît au TABLEAU 1.

1.3 - Nombre et période d'application

Compte tenu du niveau de populations rencontrées et de la condition de la forêt, deux applications étaient normalement requises pour donner le rendement escompté avec les produits chimiques: la première application était pratiquée à l'ouverture du bourgeon coïncidant avec le 4e âge larvaire de l'insecte et l'autre 5 jours plus tard. Les préparations utilisées pour les traitements chimiques sont présentés aux TABLEAUX 2, 3 et 4.

Pour des raisons d'opération, une seule application à dose maximale (87,5g I.A./2,34ℓ/ha) fut pratiquée dans les traitements chimiques aux monomoteurs.

Dans le cas du produit biologique en considérant les populations rencontrées et la condition de la forêt une seule application con-

TABLEAU 1 Traitements contre la tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clem.) effectués dans chacun des blocs de pulvérisation 1982

Blocs	Superficies (ha)	1ère appl. INS.	1ère appl. Dosage (g/ha)	1ère appl. Volume (ℓ/ha)	2ième appl. INS.	2ième appl. Dosage (g/ha)	2ième appl. Volume (ℓ/ha)
AEROPORT ST-HONORE							
101	17 344	A	52,0	1,403	A	52,0	1,4
102	46 563		..			..	
103	13 906		..			..	
104	31 719		..			-	
105	37 657		..			-	
AEROPORT RIVIERE DU LOUP							
201	7 344	F	210,0	1,403	A	52,0	1,4
202	12 656		..			..	
203	14 063		..			..	
204	30 626		..			..	
205	7 813		..			..	
206	32 344		..			..	
207	4 844		..			..	
208	7 969		..			..	
209	15 157		..			..	
210	5 938		..			..	
211	2 656		..			..	
212	15 938		..			..	
213*	4 688	A	52,0			..	
214*	5 625	A	..			..	
215	3 438	A	..	1,403		..	
AEROPORT MONT-JOLI							
301	8 594	A	52,0	1,403	A	52,0	1,4
302	58 282		..		F	210,0	1,4
303	28 751		..			..	
304	19 063		..			..	
305 (1)	18 281		..			..	
306 (1)	82 344		..		A	52,0	1,4
307	72 812		..		F	210,0	1,4
308	28 438		..		A	52,0	1,4

(*) Bloc expérimental: Matacil en suspension
(1) 2ième application non complétée

TABLEAU 1 (SUITE)

<u>AEROPORT MATANE</u>							
401	6 875	A	52,0	1,403	A	52,0	1,4
402	13 750		..			..	
403	56 250		..			..	
404	5 469		..			..	
405	6 250		..			-	
406	76 407		..		A	52,0	
407 (1)	112 344		..			..	
408	20 313		..			..	
<u>AEROPORT BONAVENTURE</u>							
501	9 531	A	52,0	1,403	A	52,0	1,4
502 (1)	107 500		..			..	
503	31 875		..			..	
504 (1)	29 844		..			..	
505	17 656		..			..	
506	50 001		..			..	
507	20 937		..			..	
508 (1)	43 594		..			..	
509	110 938		..			-	
<u>MONOMOTEURS BIOLOGIQUES</u>							
601	938	T	30 UI	4,68			
602	3 594	T	20 UI	4,68			
603	625	D	20 UI	5,9			
604	469	D	20 UI	5,9			
605	2 344	D	20 UI	5,9			
606 (**)	7 344	D	30 UI	3,5			
607	1 563	D	30 UI	8,8			
608	4 844	T	20 UI	4,68			
609	1 250	T	40 UI	4,68			
610	3 906	F	54 UI	2,5			
<u>MONOMOTEURS CHIMIQUES</u>							
701	2 187	A	87,5	2,34			
702	2 031		..				
703	1 875		..				
704	1 562		..				
705	625		..				
706	1 719		..				
707	781		..				
708	313		..				
709	469		..				
710	469		..				
711	200		..				

(**) Traité avec un quadrimoteur (DC-4)
(1) 1ère application non terminée

TABLEAU 1 (SUITE)

(2) 2ième application non terminée

A - Aminocarb

F - Fénitrothion

T - Thuricide

D - Dipel

F - Futura

TABLEAU 2 Préparations utilisées dans le cadre du programme opérationnel de lutte au moyen de quadrimoteurs contre la tordeuse au Québec en 1982

TRAITEMENTS CHIMIQUES

Produit	Dosage	Volume	Préparations (V/V) Insecticide	Cyclo-Sol 63	Diluant 585	Colorant
Fénitrothion (96%)	210 g/ha	1,403 ℓ/ha	11.3%	28.0%	59.7%	1%
Aminocarb	52 g/ha	1,403 ℓ/ha	20.8%	-	78.2%	1%

TRAITEMENT BIOLOGIQUE

Dipel 88	30 UI/ha	3,5 ℓ/ha	100%

TABLEAU 3 Préparations utilisées dans le cadre du programme opérationnel aux monomoteurs contre la tordeuse au Québec en 1982

MONOMOTEUR CHIMIQUE (Piper Pawnee)

Produit	Dosage	Volume	Préparations (V/V)		
			Insecticide	Diluant	Colorant
Aminocarb (180 g/ℓ)	87,5 g/ha	2,341 ℓ/ha	20.8%	78.2%	1%

MONOMOTEUR BIOLOGIQUE (AgCat)

Produit	Dosage	Volume	Insecticide	Eau	Chevron
Dipel 88 (32B/G)	20 UI/ha	5,85 ℓ/ha	40%	60%	1/1600
	30 UI/ha	8,8 ℓ/ha	40%	60%	
Thuricide 32LV (32 BIU/g)	20 UI/ha	4,68 ℓ/ha	50%	50%	1/1600
	30 UI/ha		75%	25%	1/1600
	40 UI/ha		100%	-	1/1600

TABLEAU 4 Préparations utilisées dans le cadre du programme expérimental de lutte au moyen de quadrimoteurs contre la tordeuse des bourgeons de l'épinette, *Choristoneura fumiferana* (Clem.) au Québec en 1982

Produit	Dosage	Volume	Préparation (V/V)			
			Insecticide	Diluant 585		Colorant
Matacil en suspension dans l'huile	52g/ha	1,403ℓ/ha	20,8%	78,2%		1%
			Insecticide	Huile végétale		Colorant
Matacil en suspension dans l'huile végétale	52g/ha	1,403ℓ/ha	20,8%	78,2%		1%
			Insecticide	Eau	Chevron	Chitinase
Futura II	20UI/ha	2,5ℓ/ha	60%	40%	1/1600	

centrée à 20, 30 ou 40 BIU/ha était pratiquée à l'ouverture du bourgeon.

1.4 - Techniques de pulvérisation

Un total de 8 quadrimoteurs de type L-749 (2) et DC-4G (6) de la Compagnie Conifair Aviation furent utilisés pour les traitements chimiques de grande envergure alors que 2 monomoteurs de type Piper Pawnee de la Compagnie Agric-Air étaient affectés à certains blocs de superficie plus restreinte. Finalement 3 monomoteurs de type Grumman Ag-Cat B de la Compagnie Les Arrosages Aériens Castor furent utilisés pour les traitements biologiques.

Tous les appareils étaient munis de système à longerons et à buses; la navigation par ailleurs était assurée par des systèmes de navigation par inerti. de Litton pour les quadrimoteurs alors que les monomoteurs étaient guidés par un avion pointeur.

Le TABLEAU 5 donne les caractéristiques techniques de chacun des appareils utilisés.

TABLEAU 5 Caractéristiques des avions de pulvérisation

Type d'avion	Vitesse Km/h (MPH)	Charge ℓ (USg)	Largeur de pulvérisation mètres (pieds)	Volume/acre ℓ/ha (USg/acre)	Débit ℓ/min (USg/min.)	Superficie/ voyage hectares (acres)	Durée pulvérisation (min. sec.)
A) <u>QUADRIMOTEURS-CHIMIQUE</u>							
DC-4	280 (175)	10 976 (2,900)	915 (3,000)	1 403 (0.15)	602 (159)	7 820 (19,322)	18'14"
L-749 Constellation	330 (205)	11 735 (3,100)	915 (3,000)	1 403 (0.15)	706 (186.3)	8 364 (20,667)	16'37"
B) <u>MONOMOTEURS-CHIMIQUE</u>							
Piper Pawnee	176 (110)	475 (125)	61 (200)	2,34 (0.25)	84 (11)	203 (500)	5'39" 11'20"
C) <u>MONOMOTEURS-BIOLOGIQUE</u>							
AgCat B	176 (110)	950 (250)	30,5 (100)	4,68 (0.50)	42 (11,0)	203 (500)	22'37"
D) <u>EXPERIMENTAL-BIOLOGIQUE</u>							
DC-4G	280 (175)	9 463 (2,500)	305 (1,000)	2,34 (0.25)	335 (88)	4 000 (1,000)	28'15"
E) <u>DEMANDES SPECIALES</u>							
CH Piper PA18	176 (110)	340 (90)	30,5 (100)	2.34 (0.25)	21 (5,5)	145 (360)	16'11"
BT Piper PA18	176 (110)	340 (90)	15 (50)	9.36 (1.0)	42 (11,0)	36 (90)	8'06"

2. DEVELOPPEMENT DE L'INSECTE ET SYNCHRONISATION DES APPLICATIONS

La tordeuse a débuté son activité 3 à 5 jours plus tard cette année par rapport aux trois dernières années. Cependant, favorisé par une température chaude et sèche, l'insecte a complété son émergence très rapidement alors que le débourrement de la pousse fut retardé d'environ 4 jours.

Le mois de juin a été également plus sec surtout au début du mois et les températures furent nettement plus froides que la normale à la fin de juin et juillet. Ces conditions climatiques ont eu pour effet de ralentir le développement de l'insecte alors que le stade de la chrysalide fut atteint le 9 juillet soit environ 8 jours plus tard que les 7 dernières années.

Cette situation favorisa d'abord l'insecte par rapport à la pousse rendant particulièrement critique tout retard dans l'application. En outre des conditions météorologiques particulièrement défavorables à la pulvérisation en fin de saison nous ont obligé à canceller totalement ou partiellement la seconde application de certains blocs pour se concentrer sur les blocs plus affectés. Ainsi 230 000 hectares ne reçurent pas de seconde application.

Le TABLEAU 6 résume la période en terme de développement de l'insecte (IDI) et de développement de la pousse (IDP) durant laquelle le traitement fut réalisé. Idéalement le traitement aurait dû être pratiqué entre un indice de 3.4 et 6.0 pour l'insecte et à partir de 4.0 pour la pousse.

La pulvérisation s'est effectuée sur une période de 39 jours comparativement à 36 en 1981. Malgré tout lors de la seconde application 3% de la superficie a été traitée très tardivement (IDI: 6.1), 55% du territoire a reçu une application tardive (IDI: 5.6) et 9% du programme n'a pu être complété. La période de traitement pour chacun des blocs peut être retrouvée au TABLEAU 7.

3. EFFICACITE DES TRAITEMENTS

Dans tous les blocs inclus au programme de pulvérisation, les populations larvaires étaient suffisantes pour causer des dommages sévères à la pousse annuelle. La population larvaire moyenne dans l'ensemble des blocs traités fut estimée à 23 larves par branche de 45cm.

Sur un total de 63 blocs, 28% ont enregistré des populations inférieures à 15 larves par branche, 43% des blocs avaient des populations

TABLEAU 6 Proportion du territoire ouvert et traité selon le développement de l'insecte et de son hôte au moment de chacune des applications d'insecticide

A - Développement de l'insecte (IDI)

Classe IDI	1ère application (%)	2ième application (%)
2,5 - 3,0	3	-
3,1 - 3,5	26	5
3,6 - 4,0	24	12
4,1 - 4,5	16	1
4,6 - 5,0	12	11
5,1 - 5,5	16	13
5,6 - 6,0	3	55
6,1 - 6,5	-	3

B - Développement de la pousse (IDP)

Classe IDP	1ère application (%)	2ième application (%)
2,8 - 3,1	4	-
3,2 - 3,5	4	1
3,6 - 3,9	23	4
4,0 - 4,3	12	4
4,4 - 4,7	23	9
4,8 - 5,0	34	82

TABLEAU 7 Dates de la pulvérisation d'insecticide et développement de la tordeuse des bourgeons de l'épinette et de la pousse du sapin au moment du traitement de chacun des blocs 1982

		1ère application				2ième application			
Bloc	Date Ouverture	Date Arrosage	Portion du bloc (%)	IDI(1)	IDP(2)	Date Arrosage	Portion du bloc (%)	IDI(1)	IDP(2)
101	03/06	04/06	83	3,5	3,9	09/06	61	3,5	3,9
		05/06	17			10/06	39		
102	05/06	06/06	36			20/06	12	5,5	4,4
		09/06	40			23/06	45		
		10/06	24			25/06	43		
103	05/06	05/06	100	3,3	3,4	12/06	100		
104	12/06	06/06	17	4,3	4,5	-	-	-	-
		17/06	28						
		19/06	55						
105	10/06	19/06	14	4,5	4,2	-	-	-	-
		27/06	9						
		05/07	77						
201	09/06	10/06	100	4,0	4,4	26/06	100	5,4	5,0
202	10/06	19/06	100	5,1	4,8	24/06	78		
						28/06	22	5,9	5,0
203	09/06	17/06	56	5,1	4,8	28/06	100	5,9	5,0
		19/06	44						
204	03/06	04/06	55	3,4	4,1	09/06	91		
		05/06	24			12/06	9	5,1	4,9
		06/06	21						

TABLEAU 7 Dates de la pulvérisation d'insecticide et développement de la tordeuse des bourgeons de l'épinette et de la pousse du sapin au moment du traitement de chacun des blocs 1982

		1ère application				2ième application			
Bloc	Date Ouverture	Date Arrosage	Portion du bloc (%)	IDI (1)	IDP (2)	Date Arrosage	Portion du bloc (%)	IDI (1)	IDP (2)
205	04/06	07/06	100	3,5	3,9	27/06	61	6,1	5,0
206	04/06	04/06	63	3,8	4,4	18/06	18		
		06/06	22			25/06	74		
		07/06	15			27/06	8	6,0	5,0
207	06/06	07/06	100	3,8	4,4	27/06	100	6,0	5,0
208	03/06	04/06	100	3,5	4,0	08/06	100	3,8	4,2
209	07/06	07/06	30	3,3	3,7	22/06	62	3,5	3,9
		09/06	70			27/06	38		
210	08/06	08/06	100	3,1	-	27/06	100	5,1	5,0
211	08/06	08/06	100	3,1	-	27/06	100	5,1	5,0
212	03/06	05/06	52	3,5	3,9	09/06	48		
		06/06	48			12/06	29		
						15/06	23	5,5	4,9
213	03/06	03/06	100	3,4	4,1	06/06	33		
						07/06	67	3,8	4,1
214	01/06	02/06	100	3,4	4,1	05/06	100	3,5	3,9
215	10/06	27/06	100	5,4	5,0	04/06	100	5,9	5,0
301	06/06	08/06	100	3,6	4,2	19/06	100	5,1	4,9

TABLEAU 7 Dates de la pulvérisation d'insecticide et développement de la tordeuse des bourgeons de l'épinette et de la pousse du sapin au moment du traitement de chacun des blocs 1982

		1ère application				2ième application			
Bloc	Date Ouverture	Date Arrosage	Portion du bloc (%)	IDI[1]	IDP[2]	Date Arrosage	Portion du bloc (%)	IDI[1]	IDP[2]
302	06/06	06/06	50	3,6	3,9	25/06	61		
		07/06	45			27/06	39	5,7	5,0
		08/06	5						
303	05/06	07/06	78	3,6	3,9	26/06	26		
		08/06	22			27/06	74	5,7	5,0
304	09/06	15/06	31	4,7	4,8	24/06	46	5,6	5,0
		18/06	20			25/06	48	5,7	5,0
		19/06	49			27/06	6	5,7	5,0
305	08/06	09/06	80	3,8	4,4		-	-	-
306	06/06	07/06	41	3,4	4,4				
		08/06	53						
		09/06	6						
307	07/06	08/06	20	3,5	4,2	17/06	10		
		09/06	60			18/06	36		
		12/06	20			19/06	16		
						22/06	16		
						24/06	22	5,6	5,0
308	08/06	08/06	100	3,6	3,9	15/06	38		
						17/06	38		
						18/06	24	5,0	4,9

TABLEAU 7 Dates de la pulvérisation d'insecticide et développement de la tordeuse des bourgeons de l'épinette et de la pousse du sapin au moment du traitement de chacun des blocs 1982

Bloc	Date Ouverture	1ère application Date Arrosage	Portion du bloc (%)	IDI[1]	IDP[2]	2ième application Date Arrosage	Portion du bloc (%)	IDI[1]	IDP[2]
401	07/06	07/06	100	3,4	4,2	25/06	100	5,0	4,7
402	08/06	09/06	100	3,9	4,4	17/06	70	4,4	4,9
						18/06	30		
403	09/06	25/06	4	5,1	5,0	09/06	87	6,0	5,0
		27/06	96			10/06	13		
404	08/06	08/06	100	3,4	4,0	05/07	100	5,9	5,0
405	09/06	12/06	100	3,8	4,6	-	-	-	-
406	11/06	18/06	4	4,4	4,9	05/07	50	5,9	5,0
		19/06	23			05/07	50		
		22/06	30						
		24/06	23						
		27/06	20	5,1	5,0				
407	10/06	22/06	37	5,0	4,7	09/07	48		
		26/06	50			10/07	30		
		28/06	13			11/07	22	6,4	5,0
408	08/06	09/06	100	3,4	3,9	27/06	45	5,7	4,9
						28/06	55		
501	08/06	09/06	100	3,6	3,9	27/06	100	5,2	5,0

TABLEAU 7 Dates de la pulvérisation d'insecticide et développement de la tordeuse des bourgeons de l'épinette et de la pousse du sapin au moment du traitement de chacun des blocs 1982

Bloc	Date Ouverture	1ère application Date Arrosage	Portion du bloc (%)	IDI (1)	IDP (2)	2ième application Date Arrosage	Portion du bloc (%)	IDI (1)	IDP (2)
502	11/06	17/06	10	4,4	4,8	27/06	28	5,2	5,0
		18/06	38			28/06	72		
		19/06	47						
		24/06	5						
503	05/06	05/06	100	3,4	4,2	10/06	100	3,9	4,4
504	11/06	24/06	30	4,7	5,0	[illegible]			
		25/06	70						
505	12/06	19/06	56	4,4	4,2	05/07	100	5,6	5,0
		25/06	44						
506	10/06	10/06	46	3,5	4,0	26/06	40	4,9	5,0
		11/06	54			27/06	60		
507	12/06	19/06	62	4,6	4,7	09/07	47		
		25/06	38			11/07	53	5,8	5,0
508	11/06	11/06	4	4,0	4,4	09/07	39	5,8	5,0
		13/06	52			10/07	40		
		05/07	44			11/07	21		
509	12/06	27/06	100	5,2	5,0	-	-	-	-

TABLEAU 7 Dates de la pulvérisation d'insecticide et développement de la tordeuse des bourgeons de l'épinette et de la pousse du sapin au moment du traitement de chacun des blocs 1982

		1ère application				2ième application			
Bloc	Date Ouverture	Date Arrosage	Portion du bloc (%)	IDI(1)	IDP(2)	Date Arrosage	Portion du bloc (%)	IDI(1)	IDP(2)
601	03/06	28-29/06							
602	03/06	8-9-10-15 17/06							
603	03/06	25-28/06							
604	05/06	25/06							
605	05/06	27-28/06							
606	04/06	9-12-15/06							
607	03/06	4-5-6/06							
608	03/06	24-25-27/06							
609	03/06	17-18/06							
701	05/06	5-6-7/06							
702	06/06	08/06							
703	06/06	8-9/06							
704	06/06	9-12/06							
705	08/06	18/06							
706	08/06	15-17-18/06							
707	09/06	18/06							
708	09/06	19/06							

TABLEAU 7 Dates de la pulvérisation d'insecticide et développement de la tordeuse des bourgeons de l'épinette et de la pousse du sapin au moment du traitement de chacun des blocs 1982

Bloc	1ère application					2ième application			
	Date Ouverture	Date Arrosage	Portion du bloc (%)	IDI[1]	IDP[2]	Date Arrosage	Portion du bloc (%)	IDI[1]	IDP[2]
709	14/06	19/06							
710	14/06	19/06							
711	07/06	09/06							

(1) Indice de développement de l'insecte au début et à la fin de la pulvérisation

(2) Indice de développement de la pousse au début de la pulvérisation

évaluées entre 16 et 25 larves et 29% étaient très sévèrement infestés alors que la population dépassait 25 larves par branche. La plupart des blocs sévèrement infestés étaient situés dans la région de la Pocatière, dans la réserve de Rimouski, dans la Vallée de la Matapédia et au centre de la Gaspésie (Figure 2).

- Traitements chimiques aux quadrimoteurs

La mortalité larvaire enregistrée dans les aires traitées fut de 88% comparativement à 58% à l'extérieur des aires traitées. La défoliation annuelle moyenne a été de 57% sur l'ensemble des aires traitées et de 77% à l'extérieur. Le traitement aurait permis de protéger adéquatement 56% du territoire. Le détail par bloc apparaît au TABLEAU 8.

Dans les régions du Saguenay-Lac St-Jean et des Escoumins les populations larvaires avant traitement étaient généralement faibles variant de 3 à 20 larves par branche de 45cm. La protection dans l'ensemble ne fut pas uniforme, certaines portions de blocs ayant subi une défoliation sévère et d'autres ayant bénéficié d'une bonne protection, associée à l'état de détérioration de la forêt.

Les blocs localisés au sud du Parc des Laurentides à la Malbaie

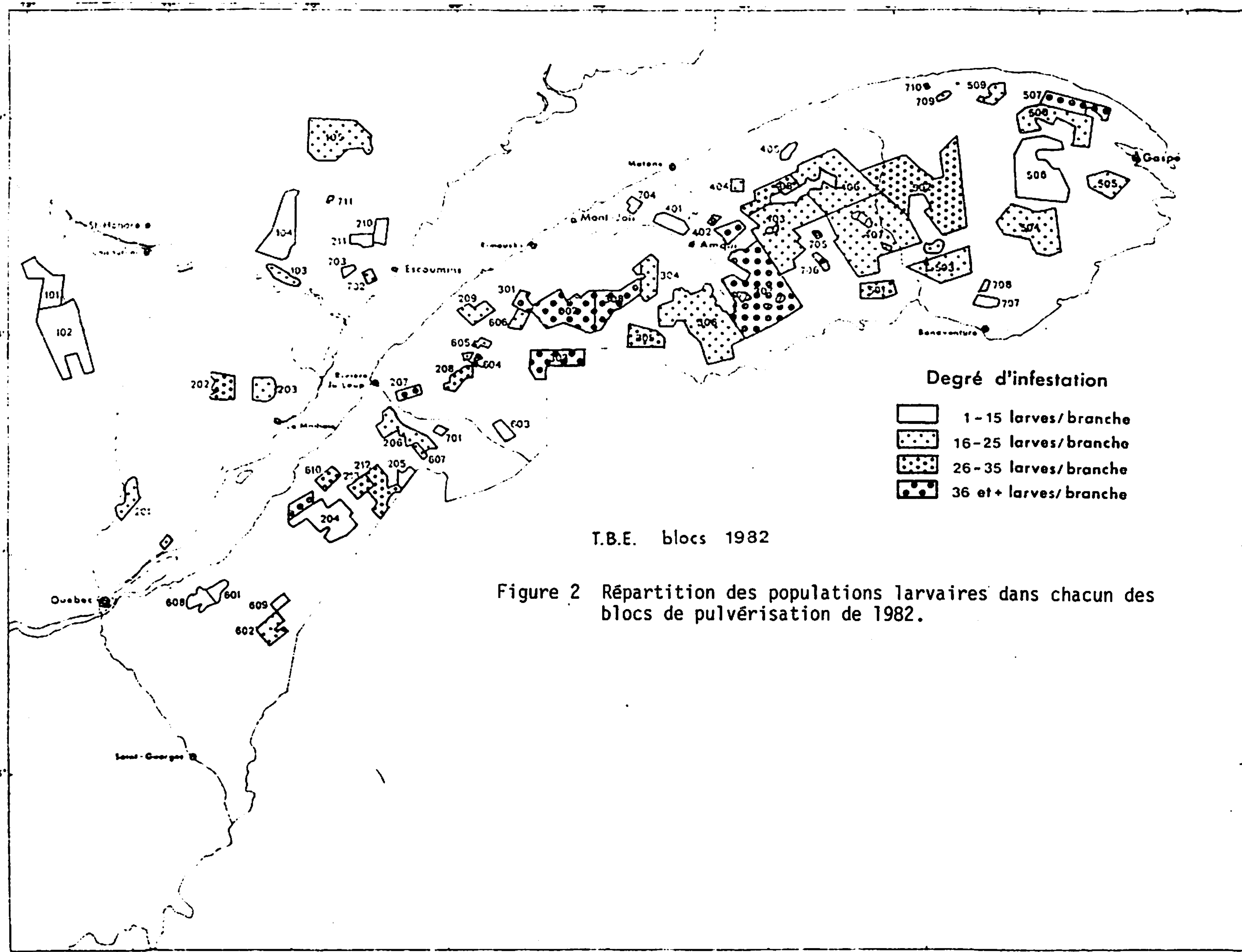

Figure 2 Répartition des populations larvaires dans chacun des blocs de pulvérisation de 1982.

ainsi que sur la rive sud du St-Laurent à l'ouest de Rimouski ont reçu en général une bonne protection.

La région de Mont-Joli a été particulièrement touchée en 1982 alors que les populations se situaient entre 22 et 54 larves par branche. La défoliation dans les aires traitées fut très élevée (61 à 94%), alors qu'à l'extérieur des aires traitées la défoliation fut quasi-totale dans la majorité des cas.

Dans les blocs situés à l'est de la Vallée de la Matapédia, la population fut évaluée à 24 larves par branche. La superficie traitée dans cette région fut sévèrement défoliée, celle-ci ayant été traitée à un développement très avancé de l'insecte. Le traitement a permis d'éviter une destruction complète du feuillage mais la défoliation a été très forte (85%).

- Traitements chimiques aux monomoteurs (Blocs 700)

Répartis dans les régions du Bas St-Laurent-Gaspésie et des Escoumins ces blocs (700) n'ont pas dépassé en superficie 10 000 hectares et le degré d'infestation a varié de léger (5 larves/br) à très sévère

(92 larves/br). Tous ces blocs ont reçu une seule application d'insecticide à double dosage et dans la majorité des cas le traitement a été très efficace. Seul le bloc 706 très sévèrement attaqué n'a pas été protégé la défoliation des pousses étant déjà importante même avant le début du traitement (TABLEAU 8).

- Traitements biologiques aux monomoteurs (Blocs 600)

Les traitements biologiques ont réduit efficacement (82%) les populations de tordeuse qui variaient selon les blocs de 11 à 25 larves par branche de 45cm. La défoliation a été évaluée à 54% dans les aires traitées alors qu'elle aurait été de 86% sans aucun traitement (TABLEAU 8). Dans l'ensemble, le traitement a accordé une protection satisfaisante des peuplements malgré le retard très important dans la pulvérisation de certains blocs. Tous les produits ou préparations employés ont donné des résultats comparables. Le produit Dipel 88 MD utilisé au taux de 30 UI à l'hectare dans un mélange final de 8,8ℓ/ha semble toutefois légèrement supérieur aux autres produits (TABLEAU 9).

- Traitements expérimentaux

  - Futura II

Une préparation de Bacillus thuringiensis, Futura II MD,

TABLEAU 8 Résultats des traitements chimiques réalisés en 1982 contre la tordeuse des bourgeons de l'épinette selon les secteurs de pulvérisation et les blocs d'arrosage (avions quadrimoteurs)

Bloc	Nb PE	Populations Pré		Populations Post	Mortalité totale	Défoliation Prév.	Défoliation Obs.	Défoliation Prot.	Inventaire aérien
ST-HONORE									
101	5	9	.11	1	89	78	37	53	TV
102	5	14	.13	2	86	80	15	81	STV
103	4	20	.17	5	75	87	65	25	STV
104	4	10	.09	4	60	71	42	41	STV
105	5	18	.15	1	94	84	66	21	STV
TOTAL	23	14	.11	2.4	82	78	44	44	-
TEMOINS	15	15	.14	6.0	60	-	-	-	-
RIVIERE-DU-LOUP									
201	4	16	.13	1	94	80	24	70	TV
202	4	29	.35	6	79	100	95	5	STV
203	5	22	.15	8	64	84	53	37	STV
204	8	13	.12	2	85	79	32	59	TV
205	3	13	.12	0	100	79	21	73	TV
206	10	18	.14	7	61	83	64	23	STV
207	4	43	.26	8	81	97	87	10	TV
208	5	27	.25	3	89	96	42	56	TV
209	6	18	.17	3	83	87	34	61	TV
210	3	3	.03	0	100	37	1	97	STV
211	3	3	.04	1	67	46	15	67	STV
212	4	35	.25	4	89	96	64	33	TV
215	3	23	.20	3	87	92	74	20	S
TOTAL	62	20.2	.15	4.0	80	84	48	43	-
TEMOINS	53	25.0	.19	9.6	62	-	-	-	-

TABLEAU 8 Résultats des traitements chimiques réalisés en 1982 contre la tordeuse des bourgeons de l'épinette selon les secteurs de pulvérisation et les blocs d'arrosage (avions quadrimoteurs)

Bloc	Nb PE	Populations Pré		Populations Post	Mortalité totale	Défoliation Prév.	Défoliation Obs.	Défoliation Prot.	Inventaire aérien
MONT-JOLI									
301	5	43	.44	3	93	100	94	6	TV
302	9	37	.29	2	95	98	76	23	S
303	6	36	.26	2	94	97	65	33	STV
304	5	25	.21	4	84	93	68	27	STV
305	4	26	.29	2	92	97	61	37	STV
306	9	22	.15	6	73	84	54	36	STV
307	8	54	.45	3	94	100	77	23	S
308	5	54	.76	5	91	100	87	13	S
TOTAL	51	37.1	.34	3.5	91	99	72	27	-
TEMOINS	24	16.7	.15	7.9	53	-	-	-	-
MATANE									
401	4	13	.13	2	85	80	37	54	TV
402	5	54	.68	5	91	100	80	20	STV
403	6	22	.16	2	91	86	48	44	STV
404	4	20	.14	2	90	82	31	62	TV
405	3	9	.07	2	78	65	22	66	TV
406	5	16	.26	4	75	96	92	4	S
407	11	25	.21	3	88	93	67	28	S
408	4	26	.23	8	69	95	61	36	TV
TOTAL	42	24.3	.24	3.4	86	95	59	38	-
TEMOINS	21	18.8	.16	7.9	58	-	-	-	-

TABLEAU 8 Résultats des traitements chimiques réalisés en 1982 contre la tordeuse des bourgeons de l'épinette selon les secteurs de pulvérisation et les blocs d'arrosage (avions quadrimoteurs)

Bloc	Nb PE	Populations Pré		Post	Mortalité totale	Défoliation Prév.	Obs.	Prot.	Inventaire aérien
BONAVENTURE									
501	4	28	.21	2	93	93	62	33	TV
502	9	29	.39	1	97	99	85	14	S
503	6	22	.27	2	91	97	57	41	TV
504	5	17	.17	0	100	87	17	80	TV
505	4	22	.12	2	91	79	49	38	STV
506	7	24	.21	1	96	93	51	45	TV
507	2	50	.34	1	98	99	93	6	S
508	5	22	.15	2	91	84	49	42	STV
509	2	18	.10	1	94	74	15	80	STV
TOTAL	44	24.8	.24	1.3	95	96	56	42	-
TEMOINS	34	22.3	.18	7.4	67	-	-	-	-
GRAND TOTAL	222	25.2	.22	3.1	88	94	57	39	-
TEMOINS	147	21.1	.17	8.2	61	-	-	-	-

TABLEAU 8 Résultats des traitements biologiques et chimiques effectués contre la tordeuse des bourgeons de l'épinette en 1982 avec des avions monomoteurs selon les blocs de pulvérisation

Bloc	NB PE	Population Pré		Population Post	Mortalité totale	Défoliation Prév.	Défoliation Obs.	Défoliation Prot.	Inventaire aérien
TRAITEMENTS BIOLOGIQUES									
601	Pas de place échantillon								
602	11	18	.15	2	89	84	39	54	STV
603									TV
604	1	16	.13	1	94	80	68	15	STV
605	3	25	.19	4	84	90	78	13	STV
606	5	22	.20	2	91	92	69	25	STV
607	3	18	.19	3	83	90	40	56	TV
608	9	14	.16	5	64	86	59	31	STV
609	9	11	.12	2	82	79	56	29	TV
TOTAL	41	16.5	.16	2.9	82	86	54	37	-
TEMOINS	40	13.0	.13	6.4	51	-	-	-	-
TRAITEMENTS CHIMIQUES									
701	3	7	.06	1	86	60	17	72	TV
702	4	26	.16	3	88	86	52	40	TV
703	3	7	.08	1	86	68	20	71	TV
704	3	4	.03	0	100	37	7	81	TV
705	4	44	.47	4	91	100	59	41	STV
706	4	92	.90	0	100	100	95	5	S
707	4	8	.09	1	88	71	21	70	TV
708	4	5	.08	0	100	68	8	88	TV
709	3	23	.29	0	100	98	17	83	STV
710	3	18	.13	0	100	80	28	65	STV
711	2	11	.10	4	64	74	43	42	S
TOTAL	37	24.3	.24	1.2	95	78	35	55	-
TEMOINS	25	22.2	.19	7.5	66	-	-	-	-

TABLEAU 9 Résultats des traitements chimiques et biologiques réalisés en 1982 contre la tordeuse des bourgeons de l'épinette

Traitements	Superf. (ha)	N. PE	Pop. PRE L/br	L/bourg.	POST	Mort.(%) totale	Défoliation Prév.	Obs.	Protecti (%)
CHIMIQUES									
A52 + A52	626 391	120	25.0	.25	2.8	89	96	59	39
F210 + A52	138 746	59	20.0	.17	4.0	80	87	47	46
A52 + F210	177 423	32	38.0	.31	2.7	93	99	71	28
A52	63 967	11	14.7	.12	2.1	86	79	47	41
A87	10 107	37	24.3	.24	1.2	95	96	35	64
BIOLOGIQUES									
Thuricide 20 UI/ha 4,68ℓ/ha	13 354	20	16.2	.17	3.4	79	85	48	44
Dipel 20 UI/ha 5,9ℓ/ha	2 670	4	22.7	.14	3.3	85	85	76	11
Dipel 30 UI/ha 3,5ℓ/ha	6 804	5	22.0	.20	2.0	91	92	69	25
Dipel 30 UI/ha 8,8ℓ/ha	1 501	3	18.0	.19	3.0	83	90	40	56
Thuricide 40 UI/ha 4,68ℓ/ha	1 525	9	11.0	.12	2.0	82	79	57	29

concentré à 51 BIU/US gallon fut pulvérisée au taux de 20 BIU dans un volume de 2,5ℓ/hectare. Le traitement fut très efficace réduisant de 87% la population moyenne de 30 larves par branche. La défoliation fut de 43% comparativement à 100% à l'extérieur des aires traitées.

- Matacil flowable + Huile 585

Une nouvelle préparation de Matacil fut pulvérisée suivant la dose et le volume conventionnels. Les populations retrouvées étaient particulièrement élevées (53 larves/branche) et furent réduites de 85%; la défoliation annuelle fut évaluée à 87% dans le bloc comparativement à 99% dans les aires non traitées.

- Matacil flowable + Huile végétale

La même expérience fut répétée avec l'huile végétale comme véhicule de l'insecticide: la population larvaire fut évaluée à 32 larves par branche avant traitement.

La mortalité larvaire fut de 85% dans les aires traitées alors que la défoliation s'élevait à 70% comparativement à 99% à l'extérieur des aires traitées.

La nouvelle préparation de Matacil s'avère donc sensiblement égale à la préparation conventionnelle malgré qu'expérimentée dans des conditions de populations extrêmes; ceci nous oblige à une autre année d'expérimentation (semi-opérationnelle) avant de l'introduire définitivement sur l'opération. L'huile végétale en contrepartie améliore la déposition du produit au sol mais des tests de calibration sont requis avant de l'introduire sur l'opération. Le Futura II enfin semble des plus prometteurs mais une seconde année d'expérimentation est requise avant de l'introduire sur l'opération.

4. INFESTATION 1982

L'infestation de la tordeuse des bourgeons de l'épinette a connu en 1982 une régression dans l'ouest et le sud du Québec. Dans l'est de la province par ailleurs, l'infestation s'est maintenue sévère pratiquement partout alors qu'elle connaissait une progression importante dans le centre du Québec ainsi que sur la Côte-Nord.

Comparativement aux 17,1 millions d'hectares affectés (défoliation et mortalité) en 1981, l'infestation couvre en 1982 quelque 18,6 millions d'hectares, soit 1,5 million de plus qu'en 1981. Compte tenu l'importance des dommages causés et les utilisations multiples qu'on faisait de l'inventaire aérien annuel des dommages causés par la tordeuse (programme d'arrosage et de récupération, réduction de droits de coupe, etc.), nous avons cru bon de séparer à partir de 1982 la défoliation annuelle avec la mortalité des arbres.

Ainsi les dommages causés sur la pousse annuelle furent observés sur 9,85 millions d'hectares en 1982; soit légers sur 1,0 million, modérés sur 1,2 million et sévères sur 7,6 millions d'hectares.

Par ailleurs la mortalité des arbres fut rapportée sur 11,2 millions d'hectares, soit 1,0 million de plus qu'en 1981. Cette augmentation cependant doit être principalement associée à un inventaire spécial conduit de façon plus intensive sur les forêts privées des régions du Bas St-Laurent-Gaspésie, du Saguenay-Lac St-Jean, de Québec, de l'Estrie et de la Côte-Nord qui a permis de rapporter quantité de nouveaux foyers de faible superficie non détectés auparavant vu le morcellement du territoire. La répartition des superficies par catégories de mortalité 1-25%, 25-50%, 50-75% et 75-100% fut de 4,7, 1,75, 0,94 et 3,81 millions d'hectares.

On pourra retrouver aux TABLEAUX 10 et 11 les superficies in-

TABLEAU 10 Superficies infestées par la tordeuse des bourgeons de l'épinette au Québec en 1982

REGIONS	Léger	Modéré	Sévère	TOTAL
1	435 320	152 186	3 422 035	4 009 541
2	59 533	49 375	740 158	849 066
3	133 747	125 784	885 158	1 144 689
4	179 687	254 687	1 123 594	1 557 968
5	-	-	-	-
6	3 594	81 877	226 405	311 876
7	2 501	9 532	5 469	17 502
8	6 094	27 346	8 125	41 565
9	241 253	505 314	1 169 732	1 916 299
TOTAL	1 061 729	1 206 101	7 580 676	9 848 506

TABLEAU 11 Superficies avec mortalité causée par la tordeuse des bourgeons de l'épinette au Québec en 1982

REGIONS	1 - 25%	26 - 50%	51 - 75%	76 - 100%	TOTAL
1	511 414	126 096	32 812	3 438	673 760
2	1 337 347	447 658	124 999	781	1 910 785
3	797 814	223 593	16 876	-	1 038 283
4	455 314	197 498	206 406	31 094	890 312
5	69 844	20 781	312	-	90 937
6	231 720	17 500	-	-	249 220
7	538 276	283 933	119 118	2 826 957	3 768 284
8	187 970	244 062	379 219	884 420	1 695 671
9	569 845	185 199	58 438	59 375	872 857
TOTAL	4 699 544	1 746 320	938 180	3 806 065	11 190 109

festées et les superficies avec mortalité par région administrative.

5. PREVISIONS POUR 1983

L'inventaire des masses d'oeufs indique une hausse des populations de tordeuse en 1983 pour l'ensemble des régions du Québec. Les régions du Bas St-Laurent-Gaspésie, Trois-Rivières, Québec et de la Côte-Nord seront les plus affectées alors que les régions de l'Outaouais et du Nord-Ouest connaîtront une légère hausse des populations tout en demeurant beaucoup moins infestées que les autres régions (Figure 3). (TABLEAU 12).

Dans la région de Trois-Rivières, l'infestation s'intensifie particulièrement au sud de la Tuque où la progression de l'épidémie ne fait plus aucun doute depuis 1980. Par contre, au sud et à l'est de Shawinigan, les populations des masses d'oeufs demeurent en général faibles ou nulles.

Au nord et à l'est du parc du Mont-Tremblant où des dommages sévères ont été décelés cette année, la hausse des populations sera très marquée. Les dommages dans cette région seront plus intenses et plus étendus.

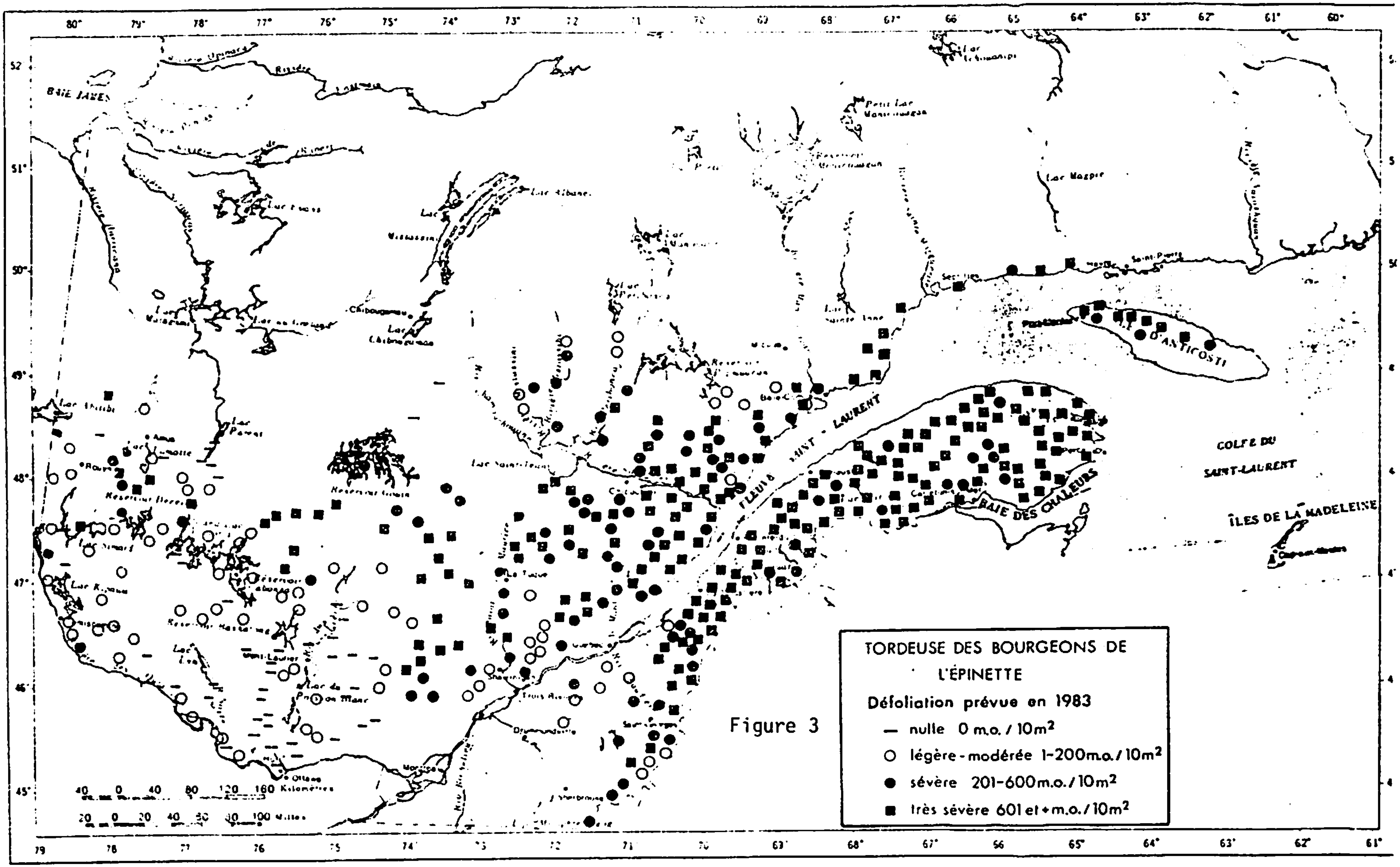
TORDEUSE DES BOURGEONS DE L'ÉPINETTE
Défoliation prévue en 1983
— nulle 0 m.o. / 10m²
○ légère-modérée 1-200m.o. / 10m²
● sévère 201-600m.o. / 10m²
■ très sévère 601 et + m.o. / 10m²
BAIE JAMES
GOLFE DU SAINT-LAURENT
ÎLES DE LA MADELEINE
BAIE DES CHALEURS
FLEUVE SAINT-LAURENT
D'ANTICOSTI

Figure 3

TABLEAU 12 Populations d'oeufs enregistrées en 1979, 1980, 1981 et 1982 dans les aires infestées par la tordeuse des bourgeons de l'épinette, Choristoneura fumiferana (Clem.)

Régions administratives	1979 MO	(PE)	1980 MO	(PE)	1981 MO	(PE)	1982 MO	(PE)	1982/1981	Niveaux de défoliation prévus pour 1983
Bas St-Laurent-Gaspésie	120	(38)	514	(485)	711	(516)	1255	(645)	1,77	Très sévère
Saguenay-Lac St-Jean	139	(63)	175	(88)	227	(108)	579	(96)	2,55	Sévère
Québec	213	(208)	299	(178)	279	(218)	737	(270)	2,82	Très sévère
Trois-Rivières	156	(53)	304	(53)	363	(61)	844	(70)	2,33	Très sévère
Estrie	140	(23)	406	(17)	64	(25)	263	(25)	4,10	Sévère
Montréal	111	(26)	39	(26)	130	(24)	474	(26)	3,60	Sévère
Outaouais	167	(95)	150	(86)	113	(88)	148	(87)	1,31	Modérée
Abitibi-Témiscamingue	412	(53)	297	(50)	176	(49)	263	(49)	1,50	Sévère
Côte-Nord	80	(75)	661	(63)	482	(115)	898	(172)	1,86	Très sévère
TOTAL	167	(983)	400	(996)	459	(1204)	927	(1440)	2,02	Sévère

Dans l'Outaouais la progression de l'épidémie sera plutôt faible. Seule la région au nord du Réservoir Cabonga sera très affectée l'an prochain.

Dans la région de l'Abitibi-Témiscamingue, les populations seront légèrement plus élevées. Des dommages sévères sont prévus près de Val d'Or alors qu'ailleurs les populations seront en général très faibles à part quelques îlots où les populations seront plus élevées près de Ville-Marie et de Témiscamingue.

La région du Saguenay-Lac St-Jean connaîtra une hausse générale des populations de tordeuse. Les dommages sont prévus plus intenses et couvriront de plus grandes superficies. Seul le nord-ouest du Lac St-Jean sera épargné alors que les dommages seront légers.

Une augmentation des populations de tordeuse est à prévoir également dans la région de Québec principalement dans le Parc des Laurentides et au sud du Saguenay. Au sud du fleuve St-Laurent, l'épidémie devrait couvrir les mêmes secteurs qu'en 1982 et les dommages seront peu importants sauf dans la Beauce et à Montmagny où l'inventaire des oeufs indique une recrudescence importante de l'infestation.

La plus forte hausse des populations a été enregistrée dans la région de l'Estrie où l'on prévoit des dommages sévères à l'est de Sherbrooke. Ailleurs, les populations d'oeufs sont très faibles.

La région du Bas St-Laurent-Gaspésie sera très sévèrement touchée en 1983 alors que le nombre de masses d'oeufs moyen est passé de 711 à 1255. Le secteur du Lac Témiscouata moins affecté depuis quelques années subira des dommages importants l'an prochain.

Sur la Côte-Nord, l'épidémie s'intensifie partout dans les secteurs déjà touchés incluant l'Ile d'Anticosti.

En 1983, l'infestation de la tordeuse sera plus intense et les superficies affectées seront plus importantes. Les régions du Bas St-Laurent-Gaspésie, Saguenay-Lac St-Jean et de la Côte-Nord seront particulièrement touchées par les fortes populations larvaires qui sont prévues. Les régions de l'ouest du Québec épargnées par la tordeuse au cours des dernières années semblent connaître une légère reprise de l'infestation.

Afin de déceler une recrudescence possible de l'infestation dans cette partie de la province, on devra intensifier l'inventaire des oeufs en 1983.

Compte tenu de la progression de l'infestation, le projet de pulvérisation en 1983 devrait couvrir 1,6 million d'hectares dont 80% localisé dans la région du Bas St-Laurent-Gaspésie.

Dans le cadre de la Loi sur la qualité de l'Environnement adoptée en décembre 1980, le MER après avoir été exempté en 1981 et 1982 se voit dès lors obligé de présenter au Ministère de l'Environnement une étude d'impact pour conduire tout projet(de plus de 600 hectares)susceptible de causer une contamination environnementale quelconque et éventuellement défendre cette étude devant le bureau d'Audiences publiques. C'est dans un tel contexte qu'un projet annuel de 1,6 million d'hectares fut proposé au Ministère de l'Environnement pour 1983 à 1986 et débattu en audiences à l'automne dernier. Le rapport du bureau des Audiences est attendu pour la mi-mars.

TABLEAU 13 Aires traitées en 1982 en fonction de la tenure des terres (Résumé I.A. 82)

Tenure	Tête verte	Sévère tête verte	Sévère	Total	Nul	Total avec nul
Forêt domaniale	408 912	134 690	431 562	975 164	782	975 946
Petits terrains privés	20 783	10 313	6 718	37 814	625	38 439
Grands terrains privés	24 689	7 655	33 751	66 095	-	66 095
Camp Mercier	1 250	-	-	1 250	-	1 250
Forêt Montmorency	6 094	-	-	6 094	-	6 094
069-08	10 469	12 813	74 062	97 344	-	97 344
071-06	7 969	22 188	6 450	36 607	156	36 763
104-29	-	312	2 500	2 812	-	2 812
110-08	10 156	7 657	8 594	26 407	-	26 407
164-08	37 813	2 344	469	40 626	-	40 626
308-05	-	3 281	313	3 594	-	3 594
359-21	2 813	312	-	3 125	-	3 125
TOTAL	530 948	201 565	564 419	1 296 932	1 563	1 298 495

SPRUCE BUDWORM IN ONTARIO

BY

G. M. HOWSE

GREAT LAKES FOREST RESEARCH CENTRE

INTRODUCTION

Nine outbreaks of spruce budworm have occurred in Ontario since the early 1700's. One outbreak was recorded in the 18th century, three in the 19th century and five (so far) in the 20th century. The pattern of outbreak occurrence and character has apparently changed in the last 60 years. Outbreaks prior to 1920 were fewer in occurrence, of shorter duration and more or less local in nature. Since 1920, outbreaks have occurred more frequently, lasted longer and have become quite widespread. This change has occurred coincident with mans increasing utilization and management of the forests of Ontario.

CURRENT OUTBREAK

The most recent outbreak of spruce budworm in Ontario began in 1967 when three separate infestations became evident. Each has followed a different pattern over the years (Table 1).

The outbreak in southern Ontario has gone through periods of increase and decline and is at present on the decline. The infestation in northeastern Ontario seems to have reached a peak (in 1980) and is on the decline. In northwestern Ontario infestations have followed a different pattern, possibly as a result of the influence of suppression spraying conducted from 1968 to 1976. Subsequent to 1976, however, we have witnessed a slow but steady buildup in this part of the province.

SPRAYING

Spraying operations have been conducted by the Ontario Ministry of Natural Resources every year since 1968 (Table 1). The total area treated during the past 15 years amounts to some 344,000 ha or an annual average of about 23,000 ha. The area treated each year varies considerably as can be seen in Table 1. From 1968 to 1976, most of the spraying was conducted for the purpose of population suppression in northwestern Ontario. Elsewhere in the province, starting in 1970, small operations were conducted each year for the purpose of protecting high value stands and in 1979 spraying for the protection of commercial forests was started. High value stands include provincial parks, regeneration, nurseries, seed production areas and wildlife habitats. Bacillus thuringiensis (B.t.) is now the main operational insecticide although chemical insecticides such as Matacil and Orthene are used in some situations.

...2

IMPACT

In 1982, budworm-associated tree mortality is present within an area of approximately 11.6 million ha. A large proportion of the area affected is in northeastern Ontario (Table 2). Most of the impact to date has occurred to balsam fir with white spruce and black spruce affected to a lesser degree. Budworm-associated tree mortality and growth loss from 1970 to the present for the three major host species totals some 85-100 million m^3. During the period 1977-81, approximately 66.7 million m^3 of wood fiber have been lost because of budworm; balsam fir - 50.6 million m^3; white spruce - 8.5 million m^3 and black spruce - 7.6 million m^3. In 1981, approximately 12.2 million m^3 of balsam fir, 2.2 million m^3 of white spruce and 1.8 million m^3 of black spruce were killed. Although balsam fir is generally not an important economic component of the forests in Ontario, loss of this species can be a serious problem in some management units with localized concentrations of balsam. Another impact on industry could be a reduction of annual allowable cuts to compensate for budworm mortality. Salvage logging is being conducted in a number of situations to utilize as much of the loss as possible. Concentrations of dead fir and spruce may represent a serious fire hazard.

CURRENT SITUATION

The outbreak reached a peak in 1980 and, at least overall, has been declining since although there are regional differences. In 1982, the gross area infested by budworm declined to a total of slightly more than 8 million ha compared to 18.217 million ha in 1981. In southern Ontario, the outbreak declined from .6 million ha in 1981 to .423 million ha in 1982. The largest change this year occurred in northeastern Ontario where more than 10 million ha which had been heavily infested in 1980 was virtually free of budworm in 1982. Most of this area is in the same part of the province in which cold damage caused varying degrees of larval mortality in early June 1980 and in which budworm defoliation was extremely variable in 1981. In northwestern Ontario, however, the extent of budworm infested area increased to .93 million ha in 1982 compared to .658 million ha in 1981.

Tree mortality surveys for 1982 have mapped 11.6 million ha of budworm-caused tree mortality compared to 11.2 million ha in 1981. Egg-mass surveys indicate further decline in southern and northeastern Ontario compared to increases in northwestern Ontario in 1983.

THE FUTURE

Certainly no person can state with certainty what the long term future course of spruce budworm in Ontario will be. It is a fact, however, that since about 1920, a 62 year period, there has been only about 8 years free of significant infestation somewhere in Ontario or that for the past 45 years, from 1937-1982, Ontario has not had significant infestations for only three or so of those years 1964, 1965 and 1966. Thus, history indicates that budworm infestations will occur constantly in Ontario. Although the outbreaks in southern and northeastern Ontario are declining, the northwestern infestations are expanding. A devasting pattern of impact may well occur in the northwest similar to what has occurred in the northeast.

Table 1. Gross area of moderate-to-severe defoliation mapped each year for the three regional outbreaks in Ontario and total area treated in Ontario for spruce budworm each year since 1968

	Gross area of moderate-to-severe defoliation in hectares				Area Treated (ha)
	Southern	Northeastern	Northwestern	Total	Total
1967	60 704	3 035	16 188	79 927	0
1968	121 408	202 347	0	323 755	111 291
1969	310 805	667 746	1 619	980 170	10 117
1970	647 511	2 104 411	52 610	2 804 532	9 308
1971	1 821 125	3 480 372	52 610	5 354 107	32 942
1972	2 347 228	5 422 906	28 329	7 798 463	19 628
1973	2 428 167	5 058 681	4 047	7 490 895	38 062
1974	2 225 820	7 486 847	4 735	9 717 402	19 425
1975	2 428 167	11 007 689	18 211	13 454 067	13 500
1976	647 511	14 042 898	61 514	14 751 923	40 469
1977	407 932	13 468 231	211 979	14 088 142	4 249
1978	24 282	14 789 543	342 663	15 156 488	648
1979	1 001 534	16 939 972	487 873	18 429 379	20 235
1980	1 007 000	17 119 000	724 000	18 850 000	10 500
1981	601 000	16 958 000	658 000	18 217 000	10 233
1982	423 057	6 669 069	931 361	8 023 487	3 425

Table 2. Gross area of budworm-associated tree mortality mapped each year for the three regional outbreaks in Ontario

	Gross area of budworm-associated tree mortality in hectares			
	Southern	Northeastern	Northwestern	Total
1970				
1971				
1972	a	80 939		80 939
1973	a	202 347		202 347
1974	a	667 746		667 746
1975	121 408	1 214 083		1 335 491
1976	647 511	2 630 514		3 278 025
1977	1 315 257	4 168 353	405	5 484 015
1978	1 347 025	4 734 925	8 095	6 090 045
1979	1 384 055	6 110 886	20 235	7 515 176
1980	1 493 000	6 839 000	24 000	8 356 000
1981	1 550 000	9 572 000	88 000	11 210 000
1982	1 550 000	9 934 000	150 000	11 634 000

[a] Mortality present but area not determined

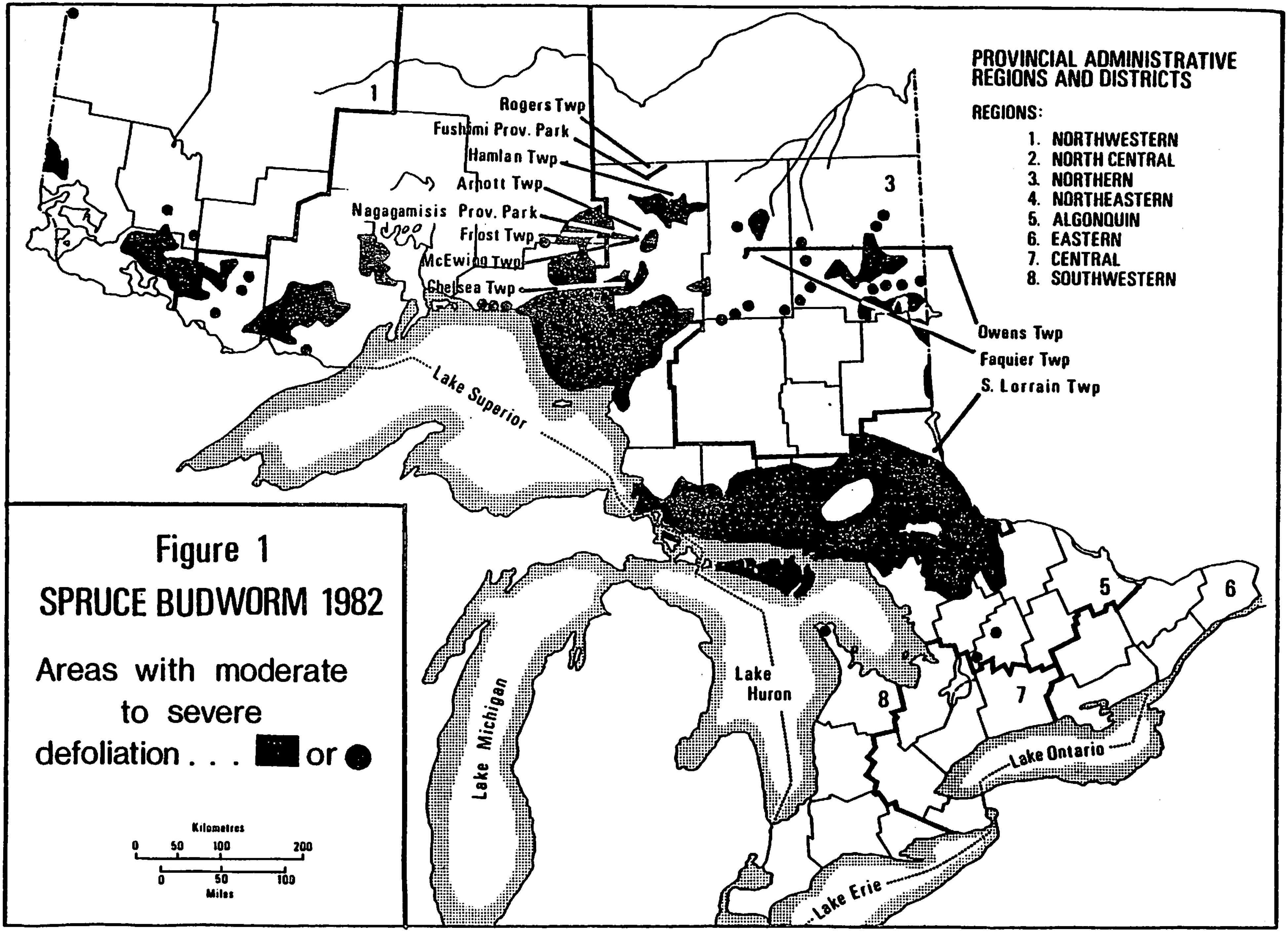

Figure 1
SPRUCE BUDWORM 1982

Areas with moderate to severe defoliation . . . ■ or ●

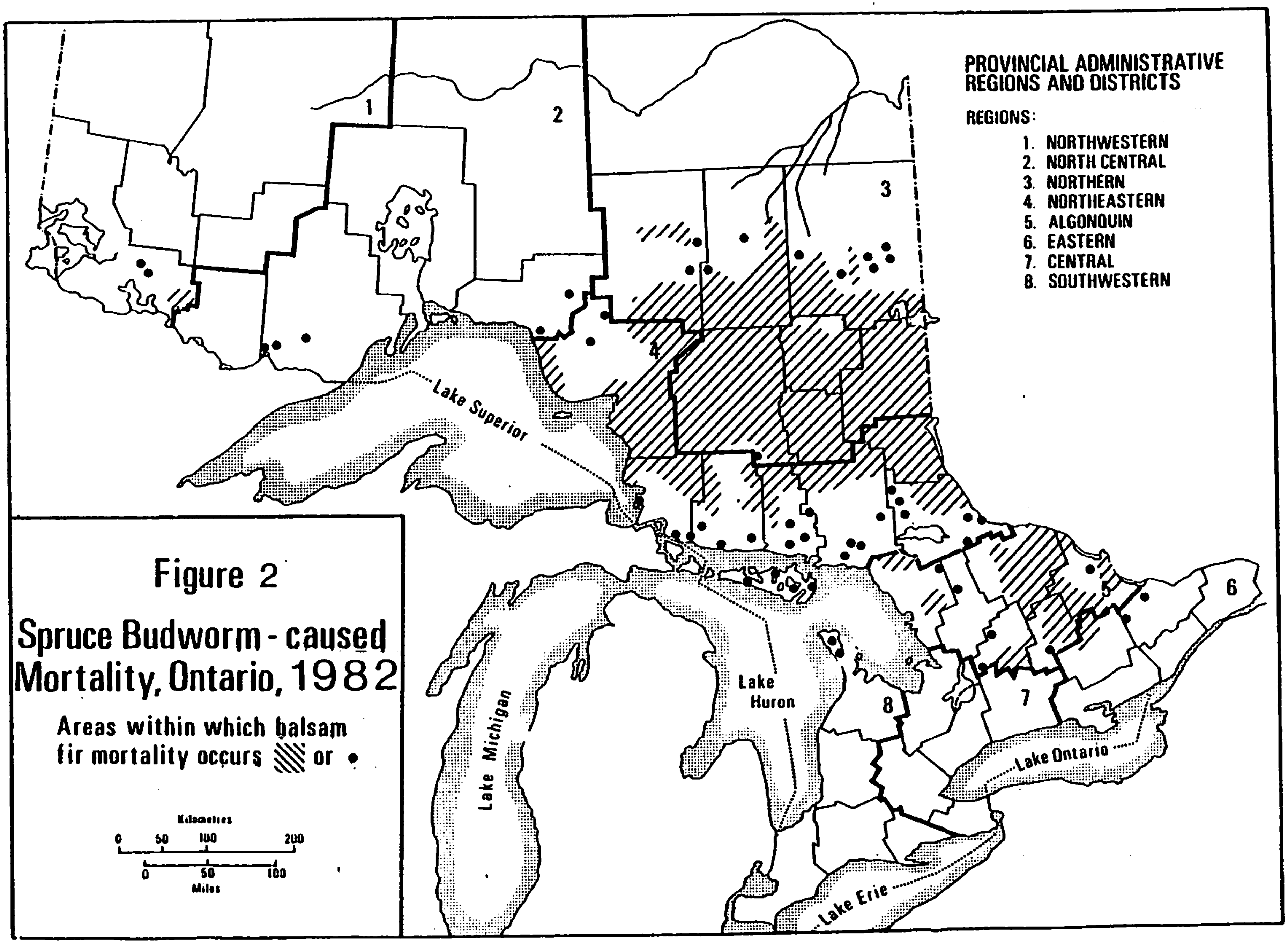

Figure 2

Spruce Budworm - caused Mortality, Ontario, 1982

Areas within which balsam fir mortality occurs [hatched] or •

SPRUCE BUDWORM IN ONTARIO, 1982[1]

- Outbreak Status 1982
- Forecasts 1983
- Results of Spraying Operations
- Plans for 1983

by

J.H. Meating,[2] G.M. Howse[2] and J.R. Carrow[3]

[1]Report prepared for the Annual Forest Pest Control Forum, Ottawa, November 23-25, 1982.

[2]Environment Canada, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario.

[3]Ontario Ministry of Natural Resources (now with the New Brunswick Department of Natural Resources, Fredericton)

OUTBREAK STATUS 1982

Major changes occurred in the spruce budworm situation in Ontario in 1982 (Fig. 1). The overall area suffering moderate-to-severe defoliation in 1982 totalled some 8,023,000 ha, a decrease of slightly more than 10 million ha from 1981. Aerial and ground surveys conducted by the CFS showed that regionally, infestations declined in northeastern and southern Ontario and increased in northwestern Ontario. By far the largest decline was recorded in northeastern Ontario (Table 1). These results were generally in line with forecasts made on the basis of egg-mass counts in the fall of 1981 which indicated reductions in the 50% range in northeastern and southern Ontario and an overall increase of more than 100% in northwestern Ontario.

Temperatures remained cool during April following a severe winter. Warmer than normal temperatures in early May resulted in budworm emergence during the first week of May in the vicinity of North Bay and during the second week of May near Hearst. Budworm larval development proceeded somewhat ahead of normal during the latter part of May and early June. The latter part of June was cooler than normal and indeed, was the coolest June on record for some locations in Ontario and as a result budworm development reverted to normal or slowed to less than normal.

Aerial surveys are carried out with flying time provided by the Ontario Ministry of Natural Resources (OMNR), in early to mid-July when the distinctive color of budworm-damaged white spruce *(Picea glauca* [Moench] Voss) and balsam fir *(Abies balsamea* [L.] Mill.) is at its peak. Further ground examinations are then made to check on aerial observations. Data presented in this bulletin are preliminary estimates and subject to revision.

Throughout northeastern Ontario, current defoliation (1982) in most stands was far less than expected based on 1981 egg-mass counts. For example, the average egg-mass count for some 11 locations in Chapleau, Gogama, Kirkland Lake and Timmins districts in 1981 was 175 egg-masses per 9.3 m^2 of foliage. This density has a forecast of moderate-to-severe defoliation, approximately 50-65% and yet the average defoliation for these 11 locations in 1982 was 6%. By contrast, the average egg-mass density for 11 locations in Hearst, Geraldton and Terrace Bay districts in 1981 was 177 with a moderate-to-severe forecast and defoliation averaged 53% in 1982. Reasons for the apparent larval mortality are not known but it is noteworthy that the unusual larval mortality has occurred in the area affected by cold and snow in June, 1980.

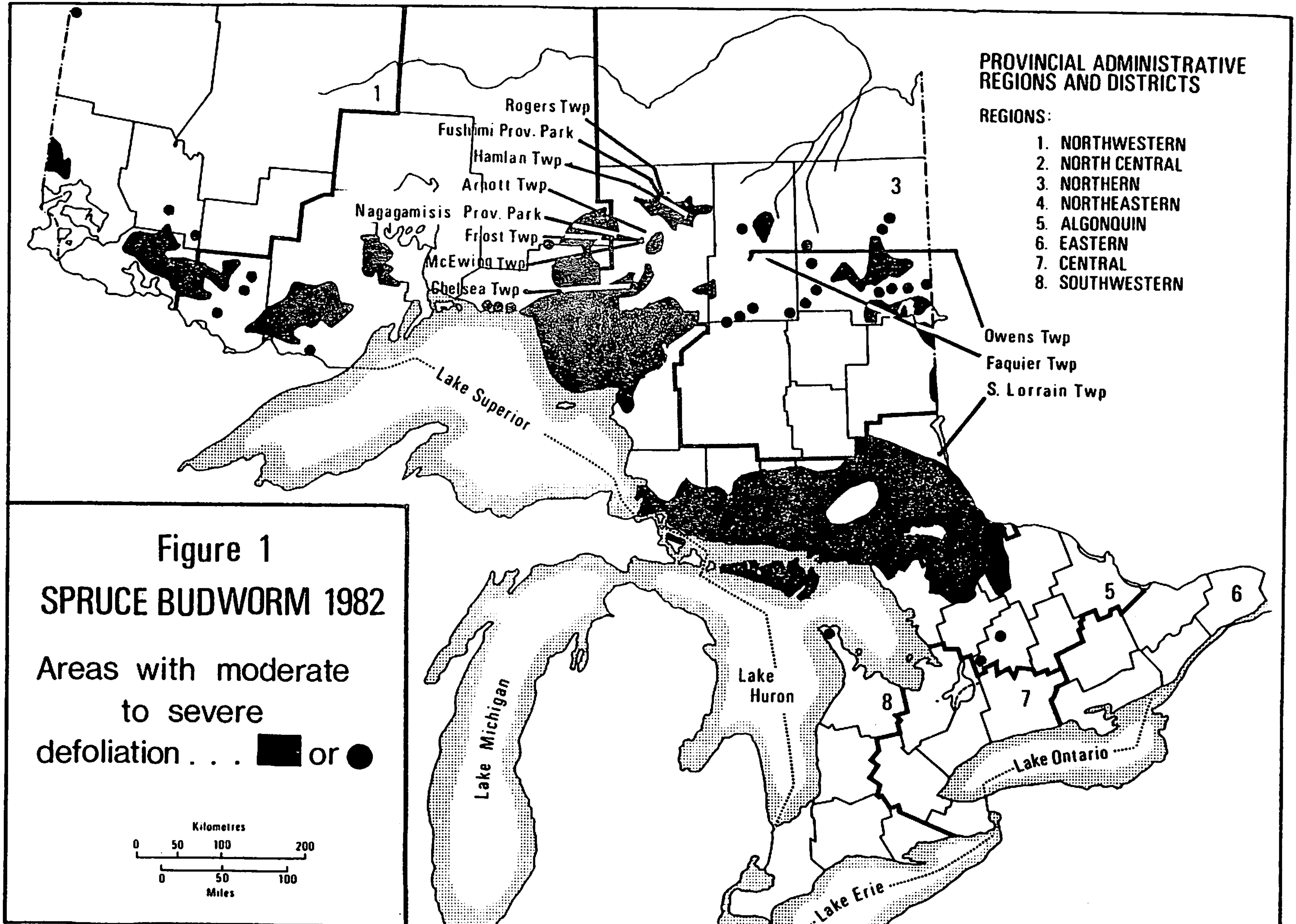

Figure 1
SPRUCE BUDWORM 1982
Areas with moderate to severe defoliation . . . ■ or ●

In northwestern Ontario, the area of moderate-to-severe defoliation increased by 273,000 ha this year to a total of 931,000 ha. A number of boundary changes were evident in the infestation in the Fort Frances District between Bennett Township and Lower Manitou Lake. These boundary changes account for an increase of 70,118 ha: the infestation now totals 352,474 ha and extends from White Otter Lake in Atikokan District to Stoneham Lake in Fort Frances District. This infestation has been present since 1974 and considerable mortality of balsam fir has resulted. Similarly, changes around the edges of the infestation between Kawnipi Lake in Atikokan District and Lower Shebandowan Lake in Thunder Bay District resulted in a net increase of 70,678 ha, for a total of 371,325 ha of moderate-to-severe defoliation. This infestation now stretches from Horne Township in Thunder Bay District to Agnes Lake in Atikokan District. The infestation in the Poshkokagan Lake area of Thunder Bay District, which decreased in 1981, expanded to the north and southwest and now totals some 124,500 ha, extending from Kabatotikwia Lake southeast to Black Mountain Lake in Nipigon District. Small infestations in the Sandstone and Arrow lakes area of Thunder Bay District merged to form a single infestation of about 16,440 ha. Similarly, infestations at Wolseley and Beaverhouse lakes in Atikokan District merged to form a single infestation of 16,659 ha.

A number of new medium-to-heavy infestations were discovered in northwestern Ontario in 1982. The largest, approximately 26,962 ha, occurs in Kenora District, along the Manitoba border between Eaglenest and Mantario lakes, and extends southeast to Signet Lake. Other small areas of new infestation, totalling 19,727 ha, were located as follows: west of Umfreville Lake, Kenora District, in the adjoining townships of Kalkirk and Wattan and in the Kishkutena Lake area of Fort Frances District, north and south of Pickerel Lake and between Stormy and Wapageisi lakes in Dryden District, and in the vicintiy of Crowrock and Eye lakes in Atikokan District. The small infestation at Umfreville Lake, Kenora District increased to 3,069 ha on the east and west sides of the lake and a small infestation of about 200 ha on the shorelines and islands of Moar Lake in Red Lake District remained at approximately the same level as in 1981. The infestation at Moar Lake is 250 km north of Kenora and is nearly 180 km from the nearest known infestation in Ontario.

This year, the largest changes occurred in northeastern Ontario. In 1982, the total area of moderate-to-severe defoliatin was 6.67 million ha, a decline of 10.29 million ha from the 16.96 million ha of a year ago. Populations declined throughout a large area in the central part of the outbreak, stretching from Agawa Bay on Lake Superior to the Quebec border, including the southern portion of Wawa, Hearst, Kapuskasing and Cochrane districts, all of the Chapleau, Timmins, Gogama and Kirkland Lake districts and the northern parts of Sault Ste. Marie, Blind River and Temagami districts. Low budworm populations were present on balsam fir and white spruce trees within this area, which totals approximately 10 million ha, and current defoliation was trace or light. Most of this area is in the same part of the province in which cold damage caused varying degrees of larval mortality in early June, 1980 and in which budworm defoliation was extremely variable in 1981. This development effectively split the area of moderate-to-severe damage into two large portions and a number of smaller pockets. In the southern area which includes the southern parts of the Sault Ste. Marie, Blind River and Temagami districts and virtually all of the Sudbury, Espanola and North Day districts, damage remained moderate-to-sèvere over about 3,590,088 ha, and there was little change in infestation boundaries. The northern area includes the eastern Terrace Bay District, most of Wawa District and smaller areas in the southeastern Geraldton and southwestern Hearst districts totalling approximately 2,113,265 ha. In this area, there were modest increases in Terrace Bay District along the western edge of the main body of infestation, and small pockets of new infestations were mapped in the Caramat-Stevens area. In addition, small pockets of medium-to-heavy infestation along the north shore of Lake Superior between Priske and Walsh townships increased in size. Small increases in area infested were also mapped in Tiernan and Redsky townships in Wawa District. Several other sizeable blocks of medium-to-heavy infestation persist as follows: 33,099 ha in Frost, Arnott and McEwing townships, and 134,151 ha in the area between McMillan and Richie townships in Hearst District, 115,519 ha east and west of Little Abitibi Lake in Cochrane District and 150,176 ha around the west end of Lake Abitibi adjacent to the Quebec border in the Cochrane and Kirkland Lake districts. In addition, approximately 60 smaller pockets of medium-to-heavy infestation totalling about 176,400 ha are scattered throughout the Hearst, Kapuskasing, Cochrane, Chapleau and Kirkland Lake districts.

In southern Ontario, the infestation decline which began in 1981 continued in 1982. Changes around the edge of the main body of infestation resulted in a decline of 150,650 ha in the Parry Sound, Bracebridge and Algonquin Park districts. Some 31 scattered pockets of medium-to-heavy infestation totalling 4,822 ha remained in the southern Bracebridge and Minden districts. Two small pockets of medium-to-heavy infestation persisted in St. Edmunds Township, Owen Sound District, along with a single area of medium infestation in West Oxford Township, Aylmer District. Elsewhere in southern Ontario populations were low and damage was negligible.

As expected, the area of budworm-associated tree mortality continued to increase in 1982. The extent of tree mortality in 1982 is compared with that in 1981 in Table 2. A total of 11.634

million ha of tree mortality was mapped this year (Fig. 2). The overall increase of only 424,000 ha in the area of tree mortality was considerably less than expected. There were no new areas of tree mortality found in southern Ontario whereas an increase of 362,000 ha occurred in northeastern Ontario. In northwestern Ontario the extent of tree mortality increased in Fort Frances District and was mapped for the first time in Thunder Bay District with an overall increase of 62,000 ha to a total of 150,000 ha.

FORECASTS 1982

Egg-mass counts and defoliation estimates were obtained at 623 locations during August and September in a province-wide survey. On an overall basis, egg-mass densities increased by some 12% although there were declines in three of the four regions sampled (Table 3).

Egg-mass numbers declined about 17% in southern Ontario and as a result, the total area of moderate-to-severe defoliation should decline further in 1983. Forecasts call for generally trace or light defoliation interspersed with numerous scattered small pockets of moderate-to-severe defoliation as the total amount of infestation in southern Ontario will likely be reduced to 200,000 ha or less.

In northeastern Ontario, egg-mass populations changed only slightly, a decrease of 4%. In all, four districts showed increases including Sudbury, Hearst, Sault Ste. Marie and Cochrane. The other 10 districts had declines ranging from 7 to 89%. In the eastern part of the North Central Region, egg-mass densities decreased by 10% overall although there were increases in Geraldton and Nipigon districts contrasted to a decline in Terrace Bay District. Forecasts call for moderate-to-severe defoliation totalling about 2,000,000 ha to occur in the eastern Terrace Bay District, northern part of Wawa District, southeastern Geraldton and southwestern Hearst districts. Another major area of defoliation totalling some 3.5 million ha should recur in the northeastern region from Sault Ste. Marie to North Bay. A number of small pockets of defoliation should occur elsewhere throughout the two regions.

In northwestern Ontario, egg-mass densities increased by some 60% in 1982. Large increases occurred in Atikokan District (+ 136%) and Fort Frances District (80%) whereas a smaller increase of 22% occurred in Thunder Bay District. It is expected that the area of moderate-to-severe defoliation will double in extent in 1983 to approximately 2.0 million ha.

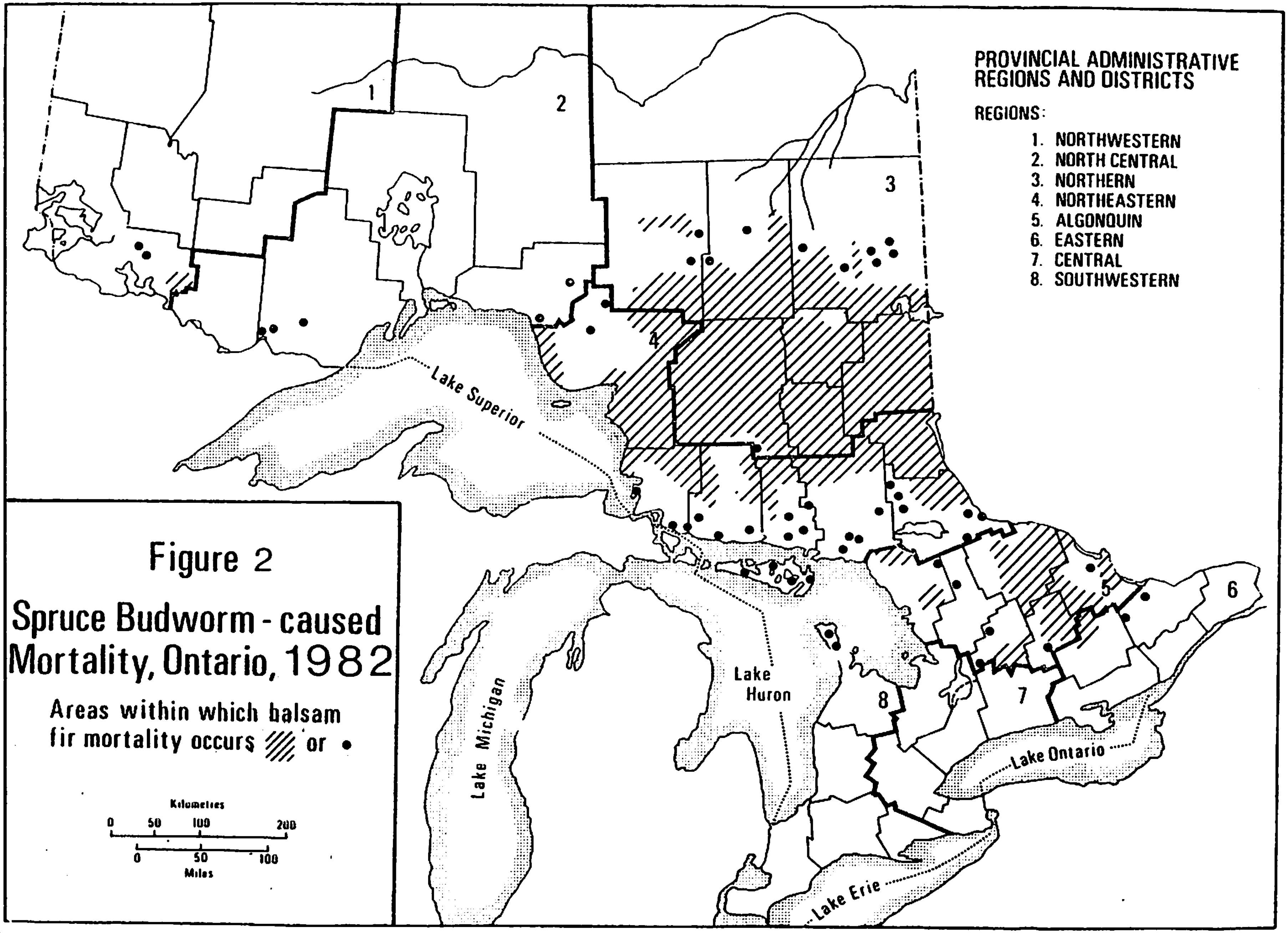

Figure 2

Spruce Budworm - caused Mortality, Ontario, 1982

Areas within which balsam fir mortality occurs ▨ or •

RESULTS OF SPRAYING OPERATIONS

In 1982, aerial spraying operations were conducted against the spruce budworm in high value forests and commercial forests in the northern Ontario districts of Hearst, Kapuskasing and Temagami. A total of 3,454 ha were treated in late May and June with a variety of chemical and biological insecticides. Approximately 10% (361 ha) of the total area was treated with either a single application of Matacil, a double application of Orthene or a single application of Orthene followed by Matacil. The remaining 3,093 ha (90%) of forest was treated with various formulations of the biological insecticide *Bacillus thuringiensis (B.t.)*. Dipel 88 was applied to 2,744 ha, Novabac 3-e to 247 ha and two formulations of Thuricide, 32B and 48B were applied to 102 ha. Areas sprayed included commercial forests (1,842 ha) seed production areas (120 ha), provincial parks (1,151 ha) plantations (136 ha) and a moose yard (180 ha). A summary of the 1982 spruce budworm aerial spraying program is provided in Table 4.

Spruce budworm larval development is summarized in Table 5. In Temagami District emergence of second instar larvae began around May 5 or 6, and in Hearst District about May 11 or 12. In these areas these are the approximate dates when budworm emergence occurs in a 'normal' year. However, warm day weather in May resulted in rapid development of the larvae in many areas. On June 3 in Hearst District, budworm larvae were at the peak of the fourth instar, almost a full instar ahead of normal. This rapid development slowed somewhat in June as a result of less favourable weather conditions.

The results of the various spray treatments used in Ontario in 1982 are summarized in tables 6 to 11. Basic data such as pre- and post-spray population densities, larval mortality (due to treatment) and foliage protection are presented in each table.

In 1981 the Ontario Ministry of Natural Resources (OMNR) attempted to protect female flowers in Seed Production Areas (SPA) from budworm feeding with an early or pre-emergence application of Matacil followed by a second application 5-7 days later. Flower development, rather than budworm development, was used to time this operation. Assessment of this program was difficult due to the lack of flower production in 1981. In 1982 a similar program was planned to protect 4 white spruce SPA's, two in Temagami District and two in Hearst District. This year, however, the first application of insecticide was scheduled to go on at the first sign of budworm emergence. Several unforeseen problems delayed the first spray by some three weeks in both districts.

As a result this year's operation cannot be assessed in terms of flower protection, although good cone crops were observed in all areas, but has been assessed in terms of population reduction and foliage protection. In Temagami District, the two SPA's Friday Lake and Matabitchuan, were treated with a double application of Orthene. The first application occurred on May 30 when budworm were predominantly third and fourth instars and was followed by a second application on June 3. Results of this particular operation were excellent both in terms of larval mortality and foliage protection (Table 6). The two SPA's, Arnott and Hanlan, in Hearst District were each to be treated with a single application of Orthene followed by an application of Matacil five to seven days later. The Orthene was applied on June 6 when the budworm larvae were in the fourth and fifth instars and the Matacil was applied on June 12. Results of this operation were not quite as good as in Temagami in terms of population reduction but in terms of foliage protection this too was a very successful program (Table 7).

The chemical insecticide Matacil was also used to treat two other areas in Hearst District; a white spruce plantation in Rogers Township, and a balsam fir moose yard in Chelsea Township. This is the third consecutive year that an aerial spraying program has been conducted in a wildlife management area. In 1980 and 1981, a successful program of foliage protection was undertaken in a deer yard in Parry Sound District. The Chelsea Township moose yard was treated on June 12 when the majority of budworm larvae were in the fifth instar. Because of the lateness of this spray, foliage protection was not what it could have been (Table 8) even though larval mortality due to treatment was very high. In the Rogers Township plantation, where population reduction was relatively poor, defoliation on both balsam fir and white spruce was light. This is undoubtedly due to the relatively low pre-spray populations in this area which, it should be noted, was treated with Matacil in 1981.

As was mentioned earlier, 90% of this year's budworm spraying program involved the use of the biological insecticide *B.t.* In Kapuskasing District, two SPA's were treated with the *B.t.* product Novabac 3-e. Very low pre-spray populations in both of these SPA's make assessment impractical (Table 9). However, the same product was tested on 172 ha of one of the commercial spray blocks in McEwing Township, Hearst District. The results in Table 9 indicate that Novabac 3-e was very effective on the balsam fir and somewhat less effective but still very acceptable on white spruce. Another *B.t.* product, Thuricide 48B, was tested on a 25 ha block of white spruce in Frost Township. Results of this particular test were rather poor in terms of population reduction, however, some foliage protection was provided (Table 9).

The main material used in the 1982 aerial spraying program in Ontario was another *B.t.* product, Dipel 88, which was applied to almost 80% of the forests treated. It was used extensively in Hearst District in two provincial parks and three blocks of commercial forests that are scheduled for harvest within the next five years. Results of the Dipel 88 treatments are shown in Table 10. Both Fushimi and Nagagamisis provincial parks were sprayed between June 13-17 when budworm larvae were in the fourth to sixth instars. While budworm mortality was not spectacular, a greater degree of foliage protection could have been afforded with an earlier application. Relatively better results were attained in the McEwing Township commercial blocks which were treated somewhat earlier (June 8-16) than the two parks. It has been observed in earlier programs that *B.t.* is generally more effective on balsam fir than on spruce and an examination of tables 9 and 10 show that this trend contined in 1982.

Two ground spraying operations were conducted in the province this year. Both areas, the Bonner Tree Improvement Centre in Kapuskasing District and the Barbara Lake white spruce SPA in Terrace Bay District,were treated in 1981 and both were treated with the chemical insecticide Orthene in 1982. Because of extremely low pre- and post-spray populations in the Bonner Tree Improvement Centre, analysis of this operation was impossible. Excellent results were achieved at the Barbara Lake SPA which was sprayed June 11 (Table 11).

In 1981, three high value areas in the Northern Region were treated with the nuclear polyhedrosis virus (NPV). These treatments were carried out by OMNR with the help and cooperation of Dr. J.C. Cunningham (Forest Pest Management Institute) and GLFRC. The three areas; Reeves Township SPA in Chapleau District, Rogers Township Plantation 31 in Hearst District and Indington Township Plantation 7 in Kapuskasing District, were sampled again in 1982 to determine if any virus carryover had occurred. Larvae were collected periodically from each area and examined for the presence of NPV. Results indicate that very few larvae were infected with NPV (personal communication, J.C. Cunningham, FPMI). Very low budworm populations in two of the three plots made conventional assessment very difficult.

PLANS FOR 1983

Two events, which occurred in 1982, will undoubtedly have an effect on the amount of aerial spraying conducted in 1983 and indeed beyond. The first, which was described earlier, is the dramatic decline in the area of budworm infestation that occurred in northeastern Ontario this year. The second event is the bumper crop of white spruce seed that was collected in northeastern Ontario in 1982. As a result of this crop, most OMNR districts are in the process of reviewing their SPA programs and the need for protection in these areas.

There are, however, plans to conduct aerial spraying operations on several thousand hectares of commercial forest in Hearst District. This district has also expressed interest in continuing protection spraying in the two provincial parks treated this year.

Table 1. Comparison of the area of forest in Ontario defoliated by spruce budworm in 1981 and 1982.

Outbreak region	Gross area of moderate-to-severe defoliation (000,000 ha)		
	1981	1982	Change
Northwestern	.658	.931	+ .273
Northeastern	16.958	6.669	-10.289
Southern	.601	.423	- .178
Total	18.217	8.023	-10.194

Table 2. Comparison of the area of budworm-associated tree mortality in Ontario in 1981 and 1982

Outbreak region	Gross area of budworm-associated tree mortality (000,000 ha)		
	1981	1982	Change
Northwestern	0.088	.150	+ .062
Northeastern	9.572	9.934	+ .362
Southern	1.550	1.550	0
Total	11.210	11.634	+ .424

Table 3. Comparison of the average egg-mass density for four regionsin Ontario in 1981 and 1982.

Outbreak region	No. of locations	Average no. of egg-masses/9.3m^2		
		1981	1982	% Change
Southern	92	67	56	- 17
Northeastern	224	224	215	- 4
North Central	56	430	386	- 10
Northwestern	108	300	481	+ 60
Overall	480	235	264	+ 12

Table 4. Summary of aerial spraying in Ontario against spruce budworm in 1982.

Location	Hectares	Date sprayed	Treatment
Temagami District			
South Lorraine Twp (2 SPA's)[a]	22	30,31 May 3,4 June	Orthene 85 SP, 560 g/9.4 l/ha 2 applications
Kapuskasing District			
Owens Twp SPA	10	9 June	Novabac 3-e, 20 BIU/7.0 l/ha 1 application
Fauquier Twp SPA	65	9 June	Novabac 3-e, 20 BIU/7.0 l/ha 1 application
Hearst District			
Arnott Twp SPA	16	6 June	First application Orthene 85SP, 560 g/9.4 l/ha
		12 June	Second application Matacil 1.8D, 90 g/9.4 l/ha
Hanlan Twp SPA	7	6 June	First application Orthene 85 SP, 560 g/9.4 l/ha
		13 June	Second application Matacil 1.8D 90 g/9.4 l/ha
Chelsea Twp Moose Yard	180	12 June	Matacil 1.8D, 90 g/4.7 l/ha, 1 application
Rogers Twp Plantation 43	136	17 June	Matacil 1.8D, 90 g/3.0 l/ha, 1 application
Fushimi Provincial Park	481	16,17 June	Dipel 88, 20 BIU/5.9 l/ha 1 application
Nagagamisis Provincial Park	593	13,14,16 June	Dipel 88, 20 BIU/5.9 l/ha 1 application
	77	16 June	Thuricide 32B, 20 BIU/5.9 l/ha 1 application
McEwing Twp - Block B	465	12,13,16 June	Dipel 88, 20 BIU/5.9 l/ha 1 application
	172	14 June	Novabac 3-e, 20 BIU/5.9 l/ha 1 application
- Block C	900	11,12,14 June	Dipel 88, 20 BIU/5.9 l/ha 1 application
- Block A	305	8 June	Dipel 88, 13 BIU/5.9 l/ha 1 application
Frost Township Experimental Blocks	25	16 June	Thuricide 48B, 30 BIU/2.36 l/ha 1 application
	3454		

Program Total = 3454 ha

[a] SPA - Seed Production Area

Table 5. Spruce budworm development, 1982.

Area	Date	Tree species	Larval Development (%) II	III	IV	V	VI	Pupae
<u>Hearst District</u>								
Arnott, Frost and McEwing twps	May 11	bF	Emergence					
		wS	"					
	June 3	bF		32	68			
		wS		24	44	32		
	June 8	bF			32	68		
		wS			4	72	24	
	June 10	bF			18	78	4	
		wS			12	56	32	
	June 16	bF			8	52	40	
		wS				16	84	
Rogers Twp	May 12	bF	Emergence					
		wS	"					
	June 1	bF		44	44	12		
		wS	4	40	52	4		
	June 9	bF			8	32	60	
		wS		4	16	28	52	
	June 17	bF				12	88	
		wS				20	80	

Table 6. Population reduction, pupal survival and foliage protection attributable to two applications of Orthene (560 g/9.4 L/ha) on high value stands in Temagami District in 1982.

	Host	Prespray larvae per 46 cm branch tip	Surviving pupae per 46 cm branch tip	Population reduction due to treatment (%)	1982 Defoliation (%)
Friday Lake SPA	wS	14.6	0.3	93	6
Check	wS	20.6	5.7		34
Matabitchuan SPA	wS	11.3	0.1	97	10
Check	wS	20.6	5.7		34

Table 7. Population reduction, pupal survival and foliage protection attributable to an aerial application of Orthene (560 g/9.4 L/ha) followed by an application of Matacil (90 g/9.4 L/ha) in Hearst District in 1982.

	Host	Prespray larvae per 46 cm branch tip	Surviving pupae per 46 cm branch tip	Population reduction due to treatment (%)	1982 defoliation (%)
Arnott SPA	wS	28.3	0.4	76	20
Check	wS	22.3	1.4		52
Hanlan SPA	wS	7.4	0.1	92	1
Check	wS	18.4	3.5		70

15)

Table 8. Population reduction, pupal survival and foliage protection attributable to a single aerial application of Matacil in Hearst District in 1982.

	Host	Prespray larvae per 46 cm branch tip	Surviving pupae per 46 cm branch tip	Population reduction due to treatment (%)	1982 defoliation (%)
Matacil 90 g/4.7 L/ha					
Chelsea Twp. Moose Yard	bF	24.7	0.6	93	54
Check	bF	19.8	6.7		76
Matacil 90 g/3.0 L/ha					
Rogers Twp. Plantation #43	bF	5.6	1.1	50	12
Check	bF	21.3	8.4		74
Rogers Twp. Plantation #43	wS	7.1	0.3	77	9
Check	wS	24.2	4.4		35

Table 9. Population reduction, pupal survival and foliage protection attributable to aerial applications of Novabac 3-e (*B.t.*) and Thuricide 48B (*B.t.*) in 1982.

	Host	Prespray larvae per 46 cm branch tip	Surviving pupae per 46 cm branch tip	Population reduction due to treatment (%)	1982 Defoliation (%)
Novabac 3-e					
Kapuskasing Dist. 20 BIU/ 7.0 L/ha					
Owens Twp SPA	bS	2.3	0.1	0	2
Check	bS	0.7	0		0
Fauquier Twp SPA	wS	0.5	0	0	0
Check	wS	1.4	0		1
Fauquier Twp SPA	bS	0.3	0	0	0
Check	bS	0.2	0		0
Hearst Dist. 20 BIU/5.9 L/ha					
McEwing Twp Block B	bF	9.6	0.3	85	14
Check	bF	15.1	3.2		79
McEwing Twp Block B	wS	12.8	1.0	58	32
Check	wS	18.4	3.5		70
Thuricide 48B					
Hearst Dist. 30 BIU/2.4 L/ha					
Frost Twp Block 2	wS	12.9	2.4	4	37
Check	wS	18.4	3.5		70

Table 10. Population reduction, pupal survival and foliage protection attributable to aerial applications of Dipel 88 (20 BIU/5.9 L/ha) in Hearst District in 1982.

		Prespray larvae per 46 cm branch tip	Surviving pupae per 46 cm branch tip	Population reduction due to treatment (%)	1982 defoliation (%)
Fushimi Provincial Park	bF	26.2	1.2	77	32
Check	bF	25.0	5.1		43
Nagagamisis Provincial Park	bF	5.1	0.7	40	13
Check	bF	11.7	2.7		71
Nagagamisis Provincial Park	wS	19.7	2.1	43	33
Check	wS	18.4	3.5		70
*McEwing Twp, Block A	wS	15.0	1.4	52	25
Check	wS	18.4	3.5		70
McEwing Twp., Block B	wS	18.7	1.3	64	22
Check	wS	18.4	3.5		70
McEwing Twp., Block C	bF	22.9	0.4	92	36
Check	bF	15.1	3.2		79
McEwing Twp., Block C	wS	17.6	0.6	82	38
Check	wS	18.4	3.5		70

* Dosage for this block 13 BIU/5.9 l/ha

Table 11. Population Reduction, pupal survival and foliage protection attributable to a ground application of Orthene at the Barbara Lake SPA in Terrace Bay District in 1982.

Location	Host	Pre-spray larvae per 46 cm branch tip	Surviving pupae per 46 cm branch tip	Population reduction due to treatment (%)	1982 defoliation (%)
Barbara Lake SPA	wS	31.0	1.4	83	19
Check	wS	27.7	7.1		43

1982 PEST CONTROL FORUM

SPRUCE BUDWORM SPRAYING IN ONTARIO

OPERATIONAL REPORT

The Ontario Ministry of Natural Resources protection spraying program against spruce budworm was greatly reduced in size (as compared with recent year's programs) primarily due to a declining budworm population in the northeastern sector of the province. In 1982, 3,454 hectares of forest were sprayed including:

(1) 1,867 ha of commercial forest in Hearst District
(2) 1,407 ha of high value seed production areas, white spruce regeneration and provincial parks in Hearst, Kapuskasing and Temagami Districts
(3) 180 ha of a wildlife management area, a moose yard near Hornepayne, considered as part of our high value forest spraying program

Commercial Forests

Using two Micronair equipped Piper Pawnees, a variety of B.t. formulations and application rates were applied. Dipel 88 was applied to 1,365 ha and 305 ha at the rates of 20 BIU/5.9 L/ha and 13 BIU/3.9 L/ha respectively. Novabac-3 was applied to 172 ha (20 BIU/5.9 L/ha) while Thuricide 48 BXLV was applied experimentally at a rate of 30 BIU/2.36 L/ha (undiluted) to approximately 25 ha of commercial forest. This spraying program was completed between June 8th and 17th with costs (aircraft and materials only) ranging from a low of $12.10/ha for Dipel 88 (13 BIU/ha) to $28.00/ha for Novabac-3 (20 BIU/ha); nearly 25% of the program was treated with Dipel 88 (20 BIU/ha) at a cost of $15.00/ha. Program size did not warrant usage of any auxilliary navigational aids.

High Value Forests

Ten areas including 6 seed production areas (120 ha), one white spruce plantation (136 ha), two provincial parks (shorelines and campgrounds, 1151 ha) and one wildlife management area (moose yard, 180 ha) were treated with a variety of insecticides. Two SPA's were treated with a double application of Orthene (560 g/9.4 L/ha), two with a single application of Orthene (560 g/9.4 L/ha), followed by Matacil (90 g/9.4 L/ha) while the remaining two SPA's were treated with Novabac-3 (20 BIU/7.0 L/ha). All applications were completed using a Hiller 12-E helicopter, boon and nozzle equipped. As equipment and labour were supplied by the contractor, costs ranged from $76.25/ha (Novabac, 1X) to $121.35/ha (Orthene, 2X) and $119.70/ha (Orthene, Matacil).

Of special interest in the program was the protection of deverely defoliated balsam fir in the Chelsea Hill moose yard (Hearst District). As this area is of extreme importance to provincial wildlife biologists, their request for protection specified the application of a chemical insecticide for maximum foliage preservation. A single application of Matacil (90 g/4.7 L/ha) was used to halt further stand deterioration. Again, high costs were incurred ($56.65/ha) as the helicopter contractor supplied all equipment and labour.

Protection of a 20-year-old white spruce plantation (Matacil, 90 g/4.7 L/ha) was initiated as part of a long-term volume loss study while the two provincial parks were sprayed for aesthetic purposes only. Shorelines and developed campgrounds of Fushimi and Nagagamisis Provincial Parks were treated with Dipel 88 or Thuricide 32B at 20 BIU/5.9 L/ha. Cost of protection for the parks was approximately $15/ha, while the plantation was protected at a cost of $10.60/ha.

Environmental Monitoring

As over 90% of the 1982 spraying program was completed using B.t., the minimal use of chemical insecticides in a variety of scattered locations did not warrant an environmental monitoring program. A sampling program to determine residues of Matacil remaining in foliage two years after application was undertaken; results are not yet available.

Biocontrol Program

In addition to traditional budworm control programs, the Ontario Ministry of Natural Resources successfully completed a small scale dispersal of a spruce budworm parasite, Trichogramma minutum. Indigenous parasites, reared at the University of Guelph and in southern Texas were released aerially as well as from the ground in white spruce plantations in Hearst District during the

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period of spruce budworm oviposition. Monitoring and evaluation were carried out by staff of the Great Lakes Forest Research Centre and a Ph.D. candidate at the University of Toronto.

Future program plans (1983) include continued protection of selected commercial forests (ca 3000 ha) in Hearst District. Bumper seed crops in 1982 have reduced the need for continued protection of SPA's in 1983 while campgrounds and selected shorelines of the provincial parks will be protected.

Albeit much more biological information is needed concerning behavioural characteristics of Trichogramma minutum in the boreal forest, all agencies involved are anticipating further research trials in 1983.

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REPORT ON THE SPRUCE BUDWORMS IN THE PRAIRIE PROVINCES

Prepared by B.H. Moody, NoFRC

For the Tenth Annual Forest Pest Control Forum
November 23-25, 1982, Ottawa

There was a general increase in spruce budworm (Choristoneura fumiferana) infestations in the three prairie provinces and the Northwest Territories in 1982 (see map) compared to 1981.

In Manitoba, the number of spurce budworm infestations increased and moderate-to-severe defoliation occurred over 17 predominantly white spruce areas. Seven of these were grouped in the Whiteshell Provincial Park near southeastern Manitoba to the Ontario border. Moderate-to-severe defoliation occurred on 4 090 ha of white spruce/balsam fir stands scattered over 31 480 ha of forests. No control program was conducted in 1982. Egg-mass surveys indicated that the infestation will intensify and moderate-to-high budworm population will occur on about 6 000 ha of spruce/fir stands in 1983.

In Saskatchewan, an infestation of spruce was reported for the first time since 1969. Moderate-to-severe defoliation occurred over 2 000 ha of white spruce forests in east central Saskatchewan. Budworm populations are forecast to be high in 1983.

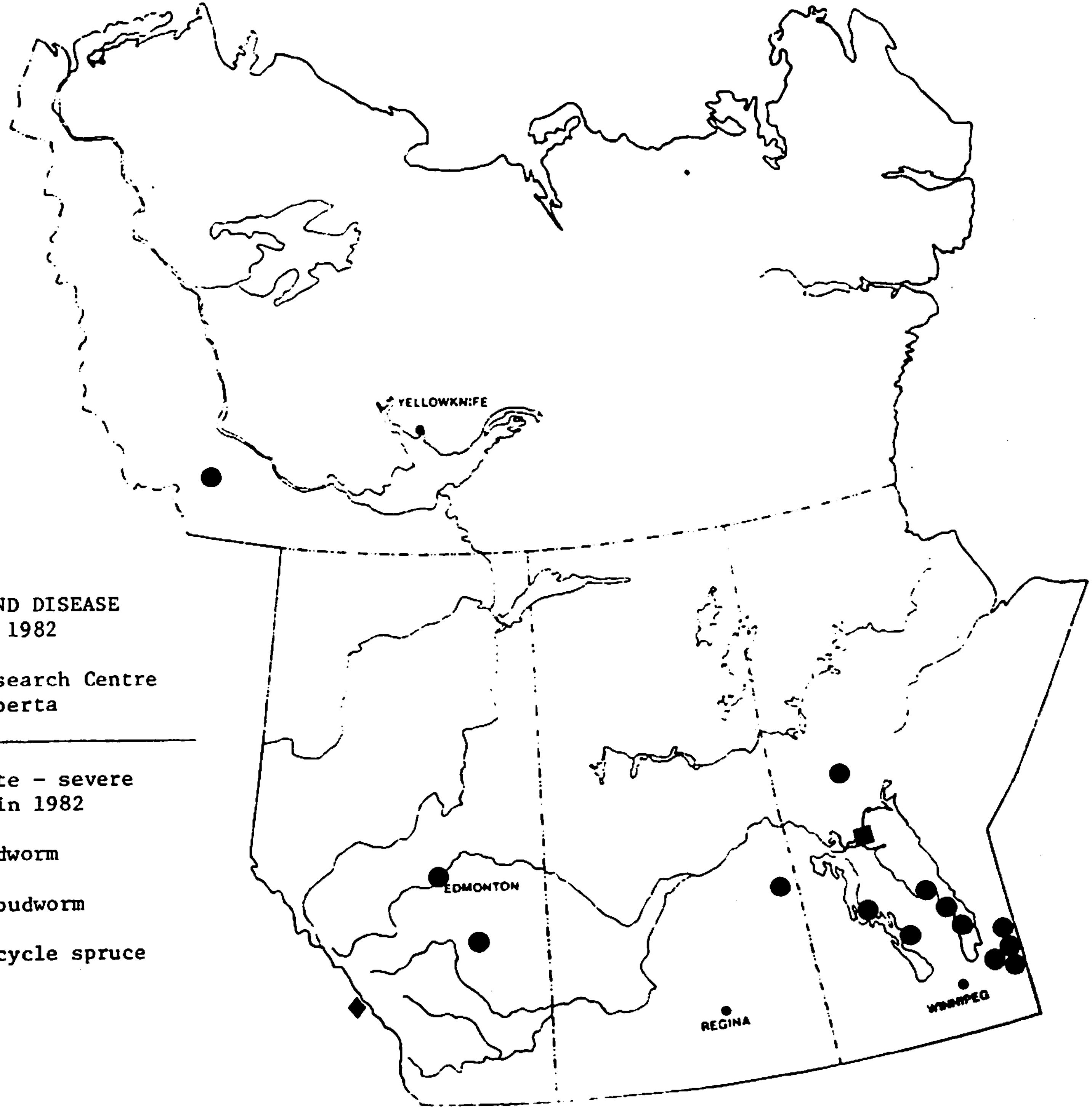
In Alberta, spruce budworm infestations increased and moderate-to-severe defoliation re-occurred within the city of Edmonton in white spruce stands along the Saskatchewan River valley. Some control spraying with Dipel (Bt) and malathion was conducted by the City. Results were poor and very little foliage was saved. New budworm outbreaks occurred on a few hundred hectares of white spruce at Big Knife Provincial Park and near Castor in central Alberta. Egg-mass surveys indicated that budworm populations will be high in these areas in 1983.

FOREST INSECT AND DISEASE SURVEYS, 1982

Northern Forest Research Centre
Edmonton, Alberta

Areas of moderate - severe defoliation in 1982

- ● Spruce budworm
- ■ Jackpine budworm
- ◆ Two-year cycle spruce budworm



In Kootenay National Park beetle infestations have been plotted from aerial photographs taken this summer covering part of the area and from aerial sketch-map surveys. A total of 3,400 red trees (1981-attacked trees) were estimated. About 500 beetle-attacked trees were removed early in 1982 at the north end of the infestation in the Park, in an effort to prevent spread of beetles into provincial forests.

The mountain pine beetle did not spread beyond the 37 locations (shelterbelts, park and urban areas) in the prairie zone of southern Alberta, reported in 1981.

The general beetle outbreak is expected to continue in 1983, although there is an indication that beetle populations will continue to decline in southwestern Alberta.

Pacific Region

1982

Status of Important Pests

and

Experimental Control Projects

Compiled by

D.M. Shrimpton

Pacific Forest Research Centre

Victoria, B.C.

Prepared for

10th Annual Forest Pest Control Forum

November 23-25, 1982

Ottawa, Ont.

Summary of Important Pests for Forest Pest Control Forum report

In 1982, the mountain pine beetle continued to spread and intensify affecting pine forests from the International border north to Prince George and Prince Rupert. The area of mature pine forests in which mortality was mapped during aerial surveys, 290 000 ha, was almost double that of 1981. Decreases in area of attack occurred only in localized areas such as the Flathead Valley because of depletion of susceptible host material. More than 55.5 million mature trees, about 19.5 million m^3, were killed by the 1981 attack. The incidence of current attack ranged from 6 to 33% of the trees in the stands cruised, and although less than 1981, it indicates a continuation of the infestation in 1983. Large scale salvage and rescheduled harvesting operations were planned or were in progress prior to the major downturn in demand for forest products. Some experimentation with pheromones continues.

An interagency mountain pine beetle committee includes Alberta, British Columbia, CFS, National and provincial parks representatives for the purpose of liaison, and discussion and proposal of control actions. Progress is encouraging in the National Parks and Alberta and was in British Columbia prior to imposition of economic restraints.

A memorandum of understanding between the USA and Canada on cooperation in the field of forestry-related programs, signed August 3, 1982, includes a supplement concerning mountain pine beetle. Final revisions are now being made to the Executive Summary and Action Plan.

Spruce beetle infestations continued over more than 99 000 ha, primarily in the Prince George-Prince Rupert-Cariboo regions with more than 6.5 million m^3 of mature white and Engelmann spruce killed in 1982. As expected, 1982 was a major flight year and the incidence of attack increased, with from 14 to 28% of the trees attacked in the stands cruised. This will be evident in 1983 by expansion and intensification of the infestations. In the Prince Rupert region favorable climatic and host conditions enabled much of the population to complete development and attack fresh trees in 1 year rather than the normal 2 year cycle. Trap tree program and rescheduled harvests continue to be widely used control measures.

Defoliation of Douglas-fir stands by western budworm was mostly light or moderate and confined to 17 000 ha in the Kamloops and Cariboo region. This was a further decline in area and intensity from the 21 000 ha in 1981 and the more than 270 000 ha in 1977. For the first time in more than a decade defoliation was not observed in the Fraser drainage in the Vancouver Region. Based on egg counts within the area of current feeding, populations in 1983 should remain at low levels with generally light defoliation except for some scattered heavier patches.

The two-year cycle budworm which normally feeds most heavily in even numbered years caused light to moderate defoliation of alpine fir and white spruce over 350 000 ha in 1980, but was at unexpectedly low levels in 1982 with little apparent defoliation. In the Prince Rupert Region, larval development indicated that the population was on a one-year cycle and generally light defoliation was mapped over more than 90 000 ha. Efforts to identify this budworm correctly are continuing.

The defoliator of greatest current concern in British Columbia is the Douglas-fir tussock moth which severely defoliated trees over more than 12 000 ha, an elevenfold increase over 1981. Patches of defoliation occurred from the International border through the Okanagan Valley and the Kamloops area. While older infestations show evidence of decline largely due to a naturally occurring virus, pheromone trappings and egg surveys indicate a general continuation of defoliation with some severe patches in 1983.

Other defoliator populations also appear to be increasing. Douglas-fir stands totalling 1 150 ha were lightly and moderately defoliated for the second year in the Salmon Arm area by western false hemlock looper. Although larch casebearer activity was further reduced from the low 1981 levels and larch foliage diseases declined significantly, larch sawfly affected 12 000 ha in the Nelson Region and Western hemlock looper caused light defoliation of hemlock and cedar over 6 500 ha in the Revelstoke area. Populations and resulting defoliation of the phantom hemlock looper occurred in the Vancouver watershed for the first time since 1973 but levels of parasitism and disease are high enough to suggest only limited defoliation in 1983.

In widely scattered areas of the Kamloops, Prince George and Prince Rupert regions Black army cutworm severely defoliated many lodgepole pine and white spruce seedlings, killing more than 20 000. Early spring assessments of populations and revision of the planting schedules or locations will be employed, as necessary, to reduce losses in 1983.

Root diseases, dwarf mistletoes and stem rust or cankers continue to be widespread perennial problems in western coniferous forests causing mortality, growth loss and understocking in many productive stands. Forest management planning and thinning, spacing and reforestation programs also are frequently affected.

A fungus which causes terminal crook disease of pine in New Zealand was found for the first time on western hemlock in an Aldergrove, B.C. forest nursery. It was detected in 6 of the 8 1-0 hemlock seedlots in the nursery and the stock was destroyed as directed by Canada Department of Agriculture, Quarantine Division. Surveys during June and September of the 70 000 seedlings outplanted on Vancouver Island before the problem was identified, indicated that at least one infected seedling had been outplanted. However, there was no evidence of new infections so direct controls were not applied, but the plantation will be closely observed again in 1983.

SUMMARY OF ESTIMATED ANNUAL LOSSES FROM SELECTED PESTS IN BRITISH COLUMBIA FORESTS, 1967-1981

Pest	Total growth loss and mortality 1967 - 1976 (,000m^3)	Growth loss 1977 - 1981 (,000m^3)	Mortality 1977 - 1981 (,000m^3)
Defoliators			
Western spruce budworm	93	600	120
Budworm - other	4	2	
Western hemlock looper	12	)	
Western blackheaded budworm	309	) not active during	
Douglas-fir tussock moth	9	)	
False hemlock looper	3	) period	
Green-striped forest looper	3	)	
Bark beetles			
Mountain pine beetle	106		5,077
Spruce beetle	726		3,012
Douglas-fir beetle	17		3
Western balsam bark beetle	19		19
Dwarf mistletoes			
Lodgepole pine	)	2,000	
Western hemlock	)	1,180	
Douglas-fir	) 4,200	75	
Western larch	)	83	

(Cont'd)

SUMMARY OF ESTIMATED ANNUAL LOSSES FROM SELECTED PESTS IN BRITISH COLUMBIA FORESTS, 1967-1981 (CONT'D)

Pest	Total growth loss and mortality 1967 - 1976 (,000m^3)	Growth loss 1977 - (,000m^3)	Mortality 1981
Root and butt rots	2,260	2,000	1,400
Decay in mature forests	8,100	10,000	
	15,860	15,940	9,631
	Loss equivalent to 32% of 1975 harvest.	25,571 Equivalent to 34% of 1980 harvest; 50% of 1975 harvest.	

Experimental Control Projects

Experimental control projects have been carried out against a variety of pests during 1982. Projects have been done with cooperation of the British Columbia Ministry of Forests, Forest companies, the British Columbia Ministry of Agriculture and FPMI.

Cone, seed and nursery pests

A sex attractant has been identified for the Douglas fir cone moth and factors affecting trap catches are being examined. A pest management system for Douglas fir cone gall midge in seed orchards is now operational. The system is based upon egg counts on the conelets just after pollination and treatment with dimethylate when necessary.

Fungicide trials with ferbam against inland spruce cone rust at the Skimikan seed orchard showed no phytotoxicity to cones on the trees, however, the disease incidence was too low to determine control. Preliminary studies showed promise for detecting Sirococcus infected seedlots using immunoassay techniques.

Winter moth - Operophtera brumata

There are four species of Operophtera in North America. One of these, the winter moth, was accidently introduced first into Nova Scotia in the mid 1930's, then into B.C. in the late 1960's. It reached outbreak proportions by 1977 on the Saanich Peninsula in B.C. causing severe defoliation on Garry Oak, an endemic species which is the principal shade tree in the Victoria area. Other shade trees and fruit trees were also defoliated.

In Nova Scotia the winter moth was controlled by Cyzenis albicans and Agrypon flaveolatum, the two species that became established of the original six that were introduced. On the basis of this success in cooperation with Agriculture Canada, B.C. Ministry of Forests and the Maritimes Forest Research Centre, the same two species of parasites were imported into B.C. Between 1979 and 1981, over 17,000 Cyzenis albicans and 10,000 Agrypon flaveolatum were released in the greater Victoria area at 33 locations. In 1982, 351 C. albicans and 269 A. flaveolatum were liberated at one of the 33 previous release sites.

The establishment of the parasites has been monitored and in 1982, the fourth summer after the first introduction, both parasites have been recovered for the first time from the winter moth. Based on experience in Nova Scotia, it is possible that winter moth populations on Vancouver Island will also be controlled by these two introduced parasites.

Larch casebearer

Monitoring percent parasitism of the larch casebearer continues. Average level of parasitism decreased to about 12% in 1982 and most of it was caused by Chrysocharis laricinellae. This is a change from 1981 when Dicladocerus was the most common species parasitizing about 35% of casebearer in the samples.

Western Spruce Budworm

In cooperation with FPMI, in a multi-year experiment, two viruses [a nuclear polyhedrosis virus (NPV) and granulosis virus (GV)] were applied near Ashcroft in B.C. in 1982 to determine which virus has the greater potential for initiating an epizootic and maintaining it for several years.

Initial analysis of the data indicate that NPV had a greater impact than GV. Population reduction was 52% in the NPV treated plot compared to 35% in the GV treated plot. In the check plots about 2% of the larval mortality was caused by NPV and about 12% by GV.

These results suggest a satisfactory increase in virus caused mortality as a result of the treatments in the year of application. However, the success of the virus application of 1982 may only be determined after intensive monitoring of budworm populations for one or two years in NPV- and GV-treated plots as well as in the check plots.

Details of this experiment will be presented by FPMI.

Douglas-fir Tussock Moth

In cooperation with FPMI and B.C. Ministry of Forests, four 10 ha plots were treated with NPV near Cache Creek in 1982 to test the effectiveness of reduced virus dosages against Douglas-fir tussock moth.

Population reduction due to treatment was good (about 60%) in the plot receiving the lowest dosage, and excellent (between 90 and 93%) in the other three plots. The incidence of naturally occurring NPV in the check plots was low. These results suggest that the amount of NPV can be reduced from that originally recommended in the U.S. (2.5×10^{11} PIB/ha) to 8.3×10^{10} PIB/ha in oil formulation. We intend to monitor Douglas-fir tussock moth population both in the treated and check plots for 1-2 years.

Details of this experiment will be reported by FPMI.

Fomes annosus

In spaced stands with large numbers of stumps greater than 15 cm diameter, alarming amounts of Fomes annosus have been found in hemlock, Douglas-fir and especially Abies spp. Treatment of stumps to prevent spore germination is strongly recommended in these stands.

Phellinus weirii

Aerial photography has been completed in infected stands of three age classes: 20, 40 and 100 yrs. and at four scales: 1:1500, 1:3000, 1:6000; 1:15,000. Detection of P. weirii infection centers in the youngest stands was better than 90% at the largest scale. Analysis is continuing.

Spruce beetle - Dendroctonus rufipennis (Kirby)

Six weeks of continuous and complete submersion into water of spruce bolts containing larvae and young adults resulted in complete mortality. It was estimated that 22 days of continuous submersion would be required to kill 50% of the brood. Development ceased in the submerged bolts even though water temperature, which increased from 13.3° to 17.8°C during the experiments, was well above the larval development threshold.

Mountain pine beetle - D. ponderosae Hopk.

Pine oil has been shown to be an effective repellant, protecting treated trees as well as trees within 10 m from attack for 2 years prior to 1981. Additional monitoring of treatments, in 1982 in cooperation with Safer Agrochem Ltd., were inconclusive due to insufficient attack on either check or treated trees.

Mountain pine beetle reproduced successfully in jack pine bolts from the natural range of this tree species under laboratory conditions. Egg gallery length, brood production, and the size and sex ratio of the adult beetles were comparable to those reared from lodgepole pine logs. The natural infestation by mountain pine beetle on planted jack pine in Idaho and our results indicate that this beetle can maintain populations in jackpine.

Work is continuing to evaluate the potential of Beauveria bassiana for direct control of mountain pine beetle. Current emphasis is on evaluation of this pathogen as a "bioinsecticide". An improved version of a portable tree debarking machine, the "tree monkey", is being built by FERIC under contract to PFRC to facilitate killing of mountain pine beetle broods in lodgepole pine. A working model is expected to be ready for field trials by late fall 1982. Such a machine will greatly increase our ability to treat small infestations in remote locations quickly in situations where more conventional treatments, such as logging or pesticide treatments, are not acceptable.

B.C. MINISTRY OF FORESTS SUMMARY OF PEST CONTROL ACTIONS

Prepared by: P.M. Hall, Protection Branch, B.C. Ministry of Forests

The B.C. Ministry of Forests took action on several priority pest problems. Most notable pests include: bark beetles, Douglas-fir tussock moth, white pine weevil (on spruce), dwarf mistletoe and root rots.

Bark beetles. Mountain pine beetle continues to be the most damaging insect pest in the province. The report attached from the C.F.S. FIDS of Pacific Forest Research Centre gives an overview picture of the current situation. Infestations in most areas of the province are expected to increase in size or intensify in the next year.

Priority areas for beetle control have been identified in all the affected forest regions. Control programs incorporating detection, single tree disposal and harvesting of infested stands were vigorously exercised until funding restraints drastically reduced the capability to deal with the size of the problem. Helicopter rappel teams were utilized in otherwise inaccessible areas for damage surveys, single tree disposal and construction of heliports for future access. Such work as can be done with remaining funding is being done. Industry capacity to harvest priority stands is also greatly reduced due to poor markets. As harvesting of infested wood is the most efficient direct control method, the decline in industry capability will lessen the effect of past efforts to slow the spread of outbreaks in many areas.

The Provincial Parks Branch co-operated extremely well with the Ministry of Forests in pine beetle control operations. With Forest Service financial support, Parks Branch staff removed and disposed of over 5,000 infested trees in Manning Park. The infestation was fairly isolated from other population sources and it is believed that routine follow-up will maintain the beetle population at acceptable levels and prevent the spread of the infestation onto adjacent forest-use lands.

The Ministry also provided support for further development of effective pine beetle pheromone and use strategies. Preliminary results indicate that a usable pheromone may be available in the near future. Pheromones are expected to aid in management by being placed in such a way as to limit the dispersal of beetle populations. This would allow more efficient placement of cut boundaries and allow for greater ease of disposal. This use, however, would require more than a "monitoring level" of pheromone but less than a confusion application. In the near future, it will be necessary to define the registration status of pheromones in accordance with the Pest Control Products Act. It is hoped that registration requirements, if needed at all, will be far less stringent than those for conventional pesticides.

Spruce beetle infestations occurred on approximately 60 000 hectares, primarily in the Prince George, Prince Rupert and Cariboo Forest Regions. As with mountain pine beetle, harvesting of currently infested stands is the most effective treatment for reducing subsequent attack and utilizing the wood before significant degrade occurs. Licensees are being directed into priority areas and are co-operating to the fullest in light of the poor market conditions. Extensive trap tree programs are also being conducted to reduce beetle populations.

The Ministry of Forests is currently seeking minor use registration for the herbicide M.S.M.A. The proposed use will be pre-treatment of trap trees to form lethal trap trees which will kill arriving insects and eliminate the need to remove trap trees before the next flight can occur. Such a technique is advantageous in remote areas where new infestations occur and access for removal is difficult.

Douglas-fir tussock moth defoliated over 6 300 hectares in the Kamloops Forest Region primarily on private lands. No large-scale aerial sprays were undertaken on private lands but funds were provided to the regional Districts to undertake ground spray of valuable trees. The ground spray operation was marginally successful at best. The Neskainlith Indian Band undertook an aerial spray program using Sevin over 316 hectares. This operation was quite successful in fall egg mass surveys indicating a return to endemic levels and good foliage protection.

The Ministry supported a joint BCMF/CFS program for further development of the tussock moth nuclear polyhedrosis virus. Various concentrations and formulations were tested. The use of virus appears to be effective and safe. Such a material is required for operational use and there may be operational opportunities in the 1983 season. It is imperative that registration be obtained for the virus prior to the summer of 1983.

White pine weevil (Pissodes strobi) is a pest of engelmann and sitka spruce plantations in B.C. Both coastal and interior plantings are affected. Vancouver Forest Region has implemented surveys for damage assessment over 4 600 hectares of plantations. Leader clipping trials are being carried out on 2 300 hectares to determine the effectiveness of the technique at maintaining low-level populations and damage. Further research is also being supported to develop alternatives for prevention and direct management.

Dwarf mistletoes are a major loss factor of many tree species in most areas of the province. Eradication clauses are incorporated into cutting permits and old blocks are being cleaned of infection. Funds supplied under the Federal/Provincial Employment Bridging Assistance Program are being used, in part, against mistletoe infection. Calibration data is also being obtained to adapt a mistletoe predictive model to B.C. conditions.

Vancouver Forest Region has surveyed approximately 4 000 hectares in 20 hectare plots throughout the region to obtain a more accurate estimate of losses due to root rots. Stand tending guidelines are being developed in conjunction with Silviculture Branch to reduce losses to rots and other agents.

In many areas, Ministry personnel conducted detailed aerial and ground surveys for bark beetles and Douglas fir tussock moth. The C.F.S. - F.I.D.S. unit was also supported in their surveys. Close co-operation and co-ordination between the two agencies should provide excellent survey results on which to base management decisions.

The forests of British Columbia suffer losses caused by a wide variety of forest pests. Priorities and management strategies must be devised to deal with the losses to protect and preserve the resource. Proper allocation of resources becomes even more important in times of reduced funding. As new potentially cost/beneficial techniques such as specific viruses, pheromones and other pesticides become operationally viable, more efficient pest management will be possible. These new methodologies, developed at considerable cost to a variety of agencies, must be made available for use by management organizations as soon as possible.

PRELIMINARY RESULTS

MAINE SPRUCE BUDWORM SUPPRESSION PROJECT, 1982

PREPARED BY

HENRY TRIAL, JR.
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JULY, 1982

PRELIMINARY RESULTS

MAINE SPRUCE BUDWORM SUPPRESSION PROJECT, 1982

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INTRODUCTION

In 1982, the Maine Forest Service conducted an aerial spray program against the spruce budworm beginning on May 21st and ending on June 15th. The project covered 822,790 acres. As in the past, the major portion of the acreage (686,402 acres) was sprayed with Sevin-4-Oil in a split or single application. The remaining project area was sprayed with Orthene (46,882 acres) or with one of three Bt products (89,506 acres). Bt products used were Dipel, Thuricide, and Bactospiene.

Many of the blocks treated in 1982 have been actively protected for several years and were in fair or good condition. Some areas, mostly in the southern half of the infested area, have not been protected recently and were in critical condition. Many blocks in the southeast had large volumes of dead fir and were treated to protect surviving spruce. Hemlock was also in poor condition in the southeast.

The 1982 project was extremely complicated operationally, involving seven insecticides, eleven application rates, and many timing variations. Much of the Sevin was applied in a split application timed to protect spruce. All Bt materials were applied at the 12 BIU rate, but volume and application aircraft varied. Orthene was applied at one rate, but with variable timing.

DEVELOPMENT, SPRAY TIMING, AND WEATHER

Larval instar development and the expansion of host tree buds were closely monitored in order to properly time the release of spray blocks. Data were collected every three days from fifteen permanent development locations throughout the State. Each sample evaluated provided a larval index and a bud index. When the index of a permanent point in the vicinity of treatment blocks approached the desired release timing, spot developments were initiated within the blocks for final timing. The desired timing for each treatment variation is shown in Table 1.

TABLE 1. TREATMENT VARIATIONS EVALUATED IN 1982 MAINE SPRUCE BUDWORM CONTROL PROJECT INCLUDING PLANNED TREATMENT TIMING.

INSECTICIDE	RATE ACTIVE INGREDIENT (LBS.)	FINAL SPRAY VOLUME OZ.	AIRCRAFT	NUMBER OF APPLICATIONS	HOST*	TIMING**
Sevin 4-Oil	0.46	30 oz.	C-54 Thrush Helicopter	2	1,2 4,5	1,2
	0.375	24 oz.	C-54 Thrush Helicopter	2	1,2 4,5	1
	0.75	30 oz.	C-54 Thrush Helicopter	1	1,3	3
Sevin FR	0.375	24 oz.	Thrush	2	1,3	1
	0.75	30 oz.	Thrush	1	1,3	3
Orthene	0.50	64 oz.	Helicopter	1	2	4
	0.50	64 oz.	Helicopter	1	2,4,5	3
Dipel 4L (Bt)	12 BIU	120 oz.	Helicopter	1	1,2,4	3
	12 BIU	96 oz.	Helicopter Thrush/Micronair	1	1,2,4	3
Thuricide 32 LV	12 BIU	96 oz.	Helicopter Thrush/Micronair	1	1,2,4	3
***Thuricide 24 B	12 BIU	96 oz.	Heli./Thrush	1	1,2,4	3
Bactospiene	12 BIU	96 oz.	Helicopter	1	1,2,4	3

*Hosts: 1 = Fir, 2 = Spruce, 3 = Fir priority and Spruce, 4 = Spruce priority and Fir, 5 = Fir, Spruce and Hemlock.

**Timing-

1. 1st application before larvae enter Spruce buds; 2nd application late 5th or early 6th instars.
2. Both applications before larvae enter Spruce buds.
3. Peak 4th instar and bud index near 4.
4. Before larvae enter Spruce buds.

*** Not evaluated in this report

X

The complexity of the 1982 operation extended to timing and block release. Many more spot developments were required than in the past because each application regime required different timing. In one case, seven different timing assessments were required in one small cluster of spray blocks.

Another complicating factor was that spruce timing was based on behavior (feeding behavior and exposure of the insect) rather than on instar or bud development. This type of timing required on-site inspection by a trained Entomologist.

Conditions in 1982 were very unusual and changed frequently. Normal favorable conditions consist of a bud index which is higher than the larval index. Generally, the more advanced the bud index is over the larval index the more favorable the chances are for spray success. Luckily, the end result in 1982 was favorable spray conditions in early June and a favorable insect to host relationship in most areas.

Development was slower than normal early in the 1982 season and insect development was well ahead of bud development. By the late third instar, bud development surged and soon was advanced compared to normal insect development. This change occurred because a cool dry period apparently favored shoot development and retarded insect development. During the middle instars, a very warm period began in northern Maine while the south remained cool.

High temperatures in the north resulted in very rapid development of insects and buds. By early June, development in the north was ahead of development in the southeast. The rapid advance in development in the north caused increased host damage, but ideal spray weather allowed rapid completion of the project thus holding defoliation to acceptable limits. Prespray damage in the north was greater than any other area, but prespray defoliation levels were acceptable.

Most blocks were sprayed near the desired release date.

APPLICATION VARIATIONS AND TIMING

Many application variations were used in 1982 (Table 1). Most split Sevin applications were timed for spruce protection using the first application in the late third instar and the second application as late as operationally possible in the fifth and sixth instars. This strategy also protects fir and hemlock. Two small split Sevin blocks had both applications sprayed before the peak of the fourth instar. All Orthene blocks were treated with the same rate, but timing varied from early applications before most insects entered the spruce buds to late applications in the fifth and sixth instars. Most Bt was applied in the fifth and early sixth instars to protect both fir and spruce.

PRE-SPRAY POPULATION LEVELS

Population levels in all spray areas were evaluated prior to spraying (Figure 1). These evaluations allow for deletion of low population areas and for finalization of block release timing based on spring populations.

Major features of the 1982 survey were very high populations (30 to 60 larvae per 18" branch) in the northwest and southeast and low (less than 10 larvae per 18" branch) populations in the central and southern portions of western Maine. Population levels in all these areas were comparable to 1981 levels. Populations in most other spray areas varied from 10 to 25 larvae.

As a direct results of the 1982 prespray evaluations 12 blocks containing 31,028 acres in west central Maine and southern Aroostook were dropped from the project. These blocks were all found to have low populations.

Prespray counts also caused adjustments in spray timing in Washington County and in western Maine. High counts in Washington County resulted in early release of some blocks to prevent damage. In the west, low counts delayed release to allow further shoot and insect development.

PRE-SPRAY HOST CONDITION

Host tree condition was fair or good (terms referring to the stands ability to recover if sprayed) in blocks which had been sprayed two or three times since 1978. Most of these protected blocks were in northwestern or northeastern Maine. Some blocks in the northwest were sprayed for the first time in several years and these blocks were in poor condition.

Generally speaking, blocks in Washington, Hancock, Penobscot and extreme southern Aroostook Counties have not been protected repeatedly in the recent past and host trees in these areas were in poor or critical condition. Many blocks in these areas had some volume of dead fir and were designated for spruce protection. Blocks in Washington and southern Aroostook Counties which were treated in 1981 were generally improved by 1981 spraying and were in fair condition.

Stands in the southwestern treatment area were variable ranging from good to critical, largely depending on their spray histories and spray success. Low population throughout the southwest in 1981 resulted in a good 1981 foliage crop on trees still able to produce buds.

The amount of dead wood in unprotected areas and buffers in the Spring of 1982 was impressively high. Large volumes of dead wood can now be found anywhere in the infested area where diligent protection has been withheld.

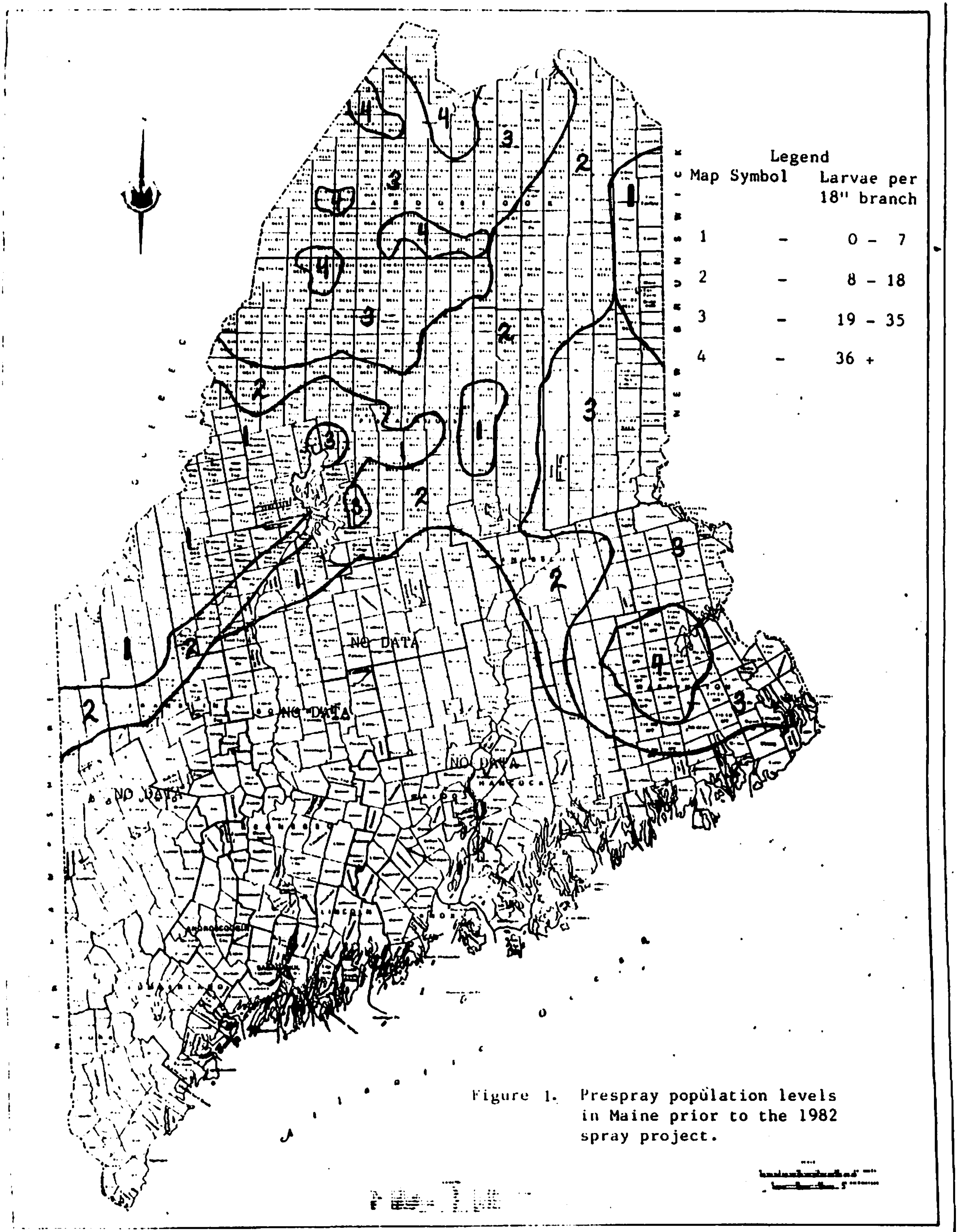


Figure 1. Prespray population levels in Maine prior to the 1982 spray project.

SPRAY RESULTS

Spray results will be reported for each treatment variation employed in the 1982 operation. Many of the treatment variations used were evaluated in several areas and each area listed separately. Table 2, 3, and 4 list spray results for Sevin, Orthene, and Bt respectively. Results are presented as the number of survivors per 18" tip, unadjusted mortality, adjusted mortality (Abbott's Formula), defoliation in sprayed areas, and foliage saved (defoliation in the unsprayed check minus defoliation in the blocks) for fir, spruce, and in some areas, hemlock.

Methods for efficacy determination of the 1982 project are shown in Sampling and Analysis Design For Experimental Insecticide Monitoring (Maine Forest Service Technical Report No. 12, Kemp, et. al., 1979) and the Maine Forest Service Spruce Budworm Survey and Assessment Manual (MFS Technical Report in preparation, Spring 1983).

Data presented is preliminary and results may change somewhat in the final report due to additional analysis.

Examination of 1982 spray project results showed a high degree of protection in nearly all spray blocks with all materials used. Nearly all areas assessed showed population reduction of at least 90% and many areas had reductions exceeding 95%. In general, the highest population reductions occurred in high population areas such as the northwest and southeast.

Defoliation in spray areas was generally less than half the defoliation level in the comparable unsprayed check areas. The highest defoliation levels observed in spray areas were recorded in the northwest and southeast on fir. In the southeast area, high defoliation of fir was recorded in blocks treated with Orthene timed for spruce protection. The most heavily defoliated areas in the northwest were due to early defoliation from extreme population pressure. Part of these blocks, as well as some in the southeast, were sprayed somewhat later than desired.

Results in areas of low to moderate populations in the central and southwestern areas were good, but population reductions were not generally as high as in other areas because the percentage survival of larvae is normally higher in low population areas. Defoliation in these areas was low due to the lower initial populations and the effects of spraying.

Results in Sevin-4-Oil treated areas were consistently excellent with high larval mortality and generally low defoliation. Defoliation in most Sevin areas was 60% less than defoliation levels in comparison to unsprayed areas. The single application treatment was not used in blocks comparable to blocks where split treatments were used, but generally split application efficacy was better than that for the single spray. Data showed no differences in success between the light and heavy split rates.

Results in areas where both applications of a split treatment were made before larvae entered spruce buds were not significantly different from results in early/late blocks. Defoliation on fir was somewhat higher

TABLE 2. RESULTS OF SEVIN-4-OIL AND SEVIN FR TREATMENT VARIATIONS BY AREA FOR THE 1982 MAINE SPRUCE BUDWORM CONTROL PROJECT.

TREATMENT	AREA	HOST	# SUR. PER 18" TIP	% RED. UNADJ.	% RED. ADJ.	% DEF.	% FOL. SAVED
SEVIN 4 OIL							
Split Application 0.46 + 0.46 LBS. AI in 30 oz.							
Early/Early	M70, 71 Alligator Lake	F	0.71	94.2	82.3	46.3	42.3
		S	0.95	90.1	55.6	22.1	40.1
Early/Late	M2 Baskahegan Lake	S	1.10	94.9	80.4	38.0	23.5
	M77, 78 First Machias Area	F	0.55	98.1	94.0	30.7	65.1
		S	0.92	95.5	77.7	27.3	38.9
		H	0.30	97.7	87.0	12.7	30.8
	C54, 55 Long Lake, T12R14	F	0.73	97.0	94.5	46.7	43.0
		S	0.70	96.3	86.7	25.0	36.7
	A9, 12 Little Black River	F	0.95	97.0	92.7	52.7	42.6
		S	0.48	96.9	84.2	47.5	26.0
	J3, 8 Millinocket Area	F	0.15	97.6	91.5	19.0	18.6
		S	0.62	88.6	37.4	17.0	16.1
Split Application 0.375 + 0.375 LBS. AI in 24 oz.	G33 Umcolcus Lake, T8R6	F	1.30	87.6	80.0	14.5	32.8
		S	1.85	85.5	40.7	13.5	25.8
	F23, 29 Mattagamon Lake Area	F	0.06	98.5	96.3	17.2	18.9
		S	0.54	88.0	45.3	15.4	14.6
	J1, 10 Millinocket Area	F	0.05	99.2	97.3	28.3	27.5
		S	0.33	94.6	70.1	18.3	12.6
	A42, 44 St. Pamphile Area	F	0.03	99.9	99.7	32.7	48.3
		S	0.07	99.6	98.4	16.7	42.1
	E46, 47 Loon Lake Area, T5R15	F	0.43	97.1	93.8	11.3	50.3
		S	0.28	97.0	89.1	9.5	29.5
Single Application 0.75 LBS. AI in 30 oz.	G26 No. 9 Area, T9R3	F	1.42	89.6	83.6	17.3	30.0
		S	1.40	85.1	39.0	10.0	9.3
SEVIN FR							
Split Application 0.375 + 0.375 LBS. AI in 24 oz.	G4, 8 T10R6	F	0.18	98.8	98.1	14.0	31.7
		S	0.28	98.0	91.9	9.0	10.3
Single Application 0.75 LBS AI in 30 oz.	G34, 36, 37 T8R5, St. Croix Lake Area	F	0.60	96.5	94.5	15.0	30.7
		S	1.03	90.4	60.8	9.7	9.6

TABLE 3. RESULTS OF ORTHENE TRERATMENT VARIATIONS BY AREA
FOR THE 1982 MAINE SPRUCE BUDWORM CONTROL PROJECT.

TREATMENT		AREA	HOST	# SUR. PER 18" TIP	% RED. UNADJ.	% RED. ADJ.	% DEF.	% FOL. SAVED
ORTHENE								
0.50 LBS. in 64 oz.								
	Early	M 81 Big Lake Area, T27 ED	F	0.10	97.6	91.9	70.0	29.5
			S	0.50	96.7	92.1	33.0	21.5
			H	0.10	99.8	98.7	24.0	19.0
		M 69 Eagle Lake, T40MD	F	1.98	92.9	39.6	74.0	25.5
			S	2.18	82.9	15.6	32.5	22.0
			H	2.55	82.3	1.0	35.0	8.0
	Late	M57. 59 West Grand Lake Area	F	0.80	97.5	77.1	78.0	12.0
			S	1.57	88.0	71.5	43.5	11.0
			H	0.45	97.1	81.4	27.7	15.3
		K29, 33 Rangeley Plt.	F	0.35	94.9	81.0	6.5	33.5
			S	0.60	92.5	72.4	5.5	32.0

TABLE 4. RESULTS OF BT TREATMENT VARIATIONS BY AREA FOR THE 1982 MAINE SPRUCE BUDWORM CONTROL PROJECT.

TREATMENT	AREA	HOST	# SUR. PER 18" TIP	% RED. UNADJ.	% RED. ADJ.	% DEF.	% FOL. SAVED
DIPEL 4L							
12 BIU in 120 oz.							
Helicopter	M72, 73, 74 Narraguagus River Area, T34MD	F	1.00	95.3	85.0	36.0	44.1
		S	1.40	87.5	70.3	28.7	22.3
12 BIU in 96 oz.							
Thrush/Micro	J5 Long A	F	0.05	98.0	96.3	10.7	25.1
		S	0.08	98.4	91.2	5.7	21.6
THURICIDE 32 LV							
12 BIU in 96 oz.							
Thrush/Micro	J5 Long A	F	0.07	98.7	95.5	17.3	18.5
		S	0.07	98.9	94.2	9.7	17.6
*BACTOSPIENE							
12 BIU in 96 oz.							
Helicopter	B13 Stockholm	F	0.30	91.3	72.2	12.0	22.8
		S	0.65	91.9	55.3	8.0	21.5
**THURICIDE 24B							

* This area received rain within 4 hours of application.

** Data was collected in area treated with Thuricide but results were not available for this report.

in the early/early area than in the early/late area. Defoliation on spruce was somewhat lower in the early/early area suggesting this may be an effective spruce timing.

Efficacy of Sevin FR in both the split and single treatments was comparable to efficacy for Sevin-4-Oil.

Defoliation of fir was high in areas treated with Orthene. Results on hemlock were fair and spruce results were fair to good. The same observations applied to the early and late timing for Orthene. Late spruce timing used on some blocks was not expected to protect fir and hemlock due to the amount of damage which occurred before spraying, but better results were predicted for the early timing blocks. Population reduction was lower in some early application Orthene blocks than the average for other treatments. All Orthene evaluations except the one made in the southwest were made on blocks with very high prespray counts and on blocks not treated in the recent past. These combined factors make successful application very difficult.

Bt application at the 12 BIU rate was very effective in most areas. Population reduction and defoliation in most blocks was comparable to that seen in chemical areas. Blocks in the southeast and the Millinocket area were excellent in terms of kill and defoliation. Some Bt blocks in the northeast showed inconsistent results, possibly due to late application or rain following treatment.

Dipel 4L and Thuricide 32LV were both effective at the 12 BIU rate and the 96 oz. volume. Final analysis is not likely to show any significant difference between the two products. Bactospiene was not applied under the same population host conditions as the other two products, but did seem effective. A rain shower occurred shortly after application of the Bactospiene which seems to have reduced efficacy somewhat.

Bt application made with Micronair-equipped Thrushes seemed as effective as those made with jet helicopters. Spray deposits, in terms of droplets per square cm., was better with the Thrush than with the helicopter, but both aircraft gave excellent results.

SUMMARY

1. Treatment of approximately 822,790 acreas of spruce-fir forest began on May 21, 1982 and ended on June 15th.

2. The 1982 spray project was extremely complex due to numerous insecticides, rates, and timing variations used. Each treatment variation employed required individualized timing and observation.

3. Bud expansion was somewhat advanced compared to insect development during the spray period resulting in generally favorable efficacy conditions.

4. Spray weather was generally excellent for nearly the entire spray treatment period. Some blocks in the northwest and southeast were delayed slightly by weather or operational factors resulting in some additional defoliation.

5. Prespray larval counts were generally very high in the northwest and southeast, but were generally low in the southwest, westcentral and southcentral blocks.

6. Examination of 1982 spray project results shows a high degree of protection in nearly all spray blocks with all materials used.

7. All application rates of Sevin-4-Oil gave excellent protection with high larval mortality and low defoliation.

8. Efficacy of Sevin FR was as good as that with Sevin-4-Oil.

9. Efficacy of split applications of Sevin-4-Oil and Sevin FR was somewhat better on fir and noticeably better on spruce than efficacy with single application of either material.

10. Efficacy with Orthene was acceptable, but foliage protection was not as good as with Sevin. Early applications of Orthene gave only fair population reduction and foliage protection was not better than in late application blocks.

11. Application of 12 BIU's of Dipel, Thuricide, and Bactospiene were all highly successful in most blocks. Blocks in the northeast had inconsistent results. Population reduction and larval mortality was equal to chemical results in most blocks.

12. Thrush aircraft equipped with Micronairs gave excellent Bt deposit as did jet helicopters.

1982 Surveys and Forecast for 1983

Introduction

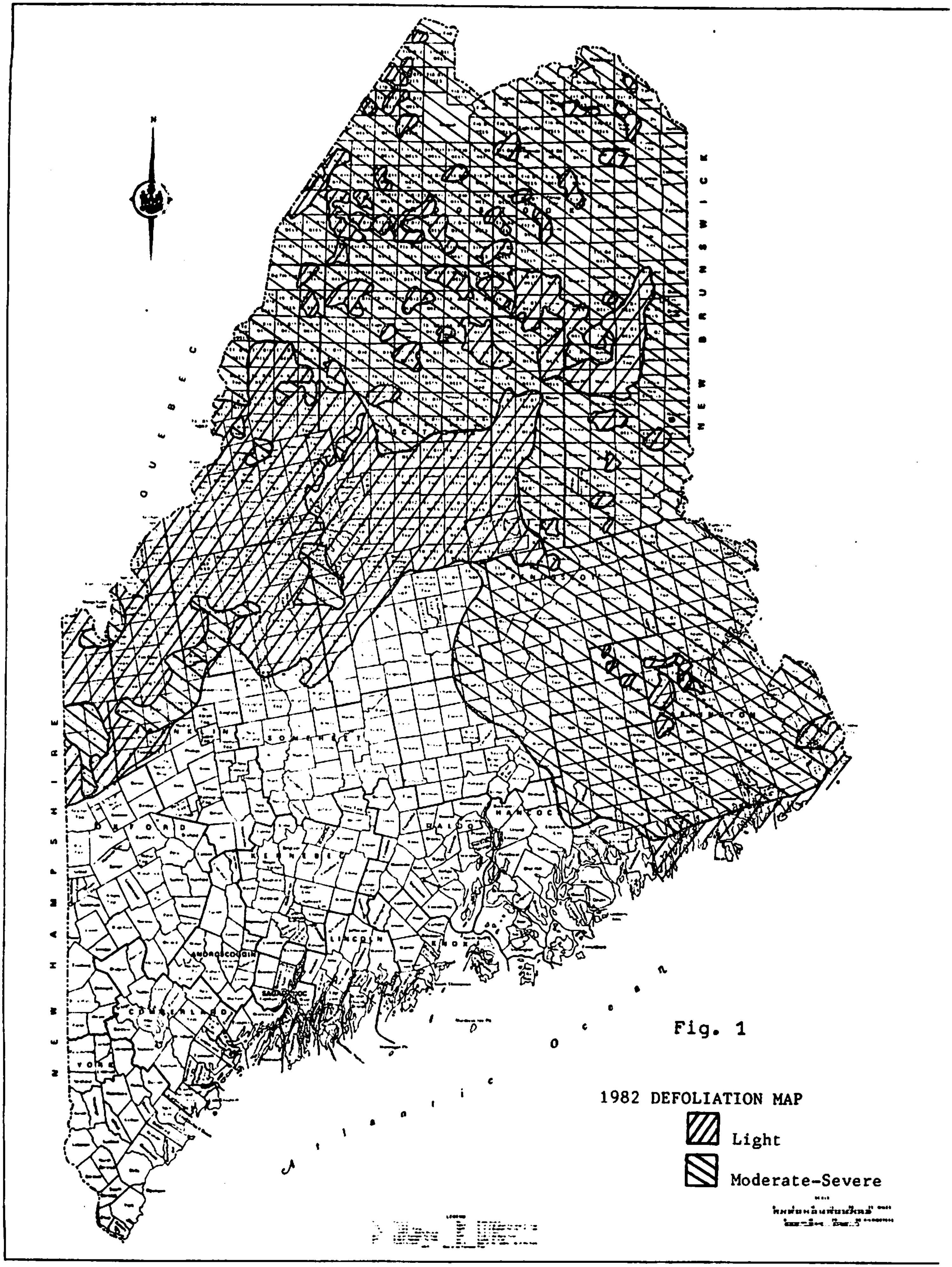
Following the 1982 spray project, surveys were begun to evaluate the post-season 1982 conditions and to predict conditions for 1983. Surveys included an aerial defoliation survey, a population prediction survey, a ground tree condition evaluation, and an aerial tree condition survey. Data gathered in these surveys was used to establish a hazard rating for 1983 and to prepare a treatment recommendation for the landowners.

Results

An aerial survey conducted in late June and early July showed a slight reduction in the moderate to severe defoliation class compared to 1981 (Figure 1). Total area in this class was approximately 3.8 million in 1982 compared to approximately 4.0 acres in 1981. This reduction was due to low defoliation in the spray area, and low population in the southwest and central areas resulting in low defoliation in those portions of the State.

Predicted Population Survey

In 1982, the Maine general population prediction survey was modified substantially from the traditional egg mass survey used in past years. Past general surveys have employed egg mass sampling as the only population estimate, and nearly all samples were collected from fir. The modified procedure used in 1982 employed egg sampling in areas expected to be heavily infested and the L-II overwintering


QUEBEC
NEW BRUNSWICK
NEW HAMPSHIRE
Atlantic Ocean
OXFORD
KENNEBEC
ANDROSCOGGIN
LINCOLN
KNOX
HANCOCK
SOMERSET
CUMBERLAND
YORK
Fig. 1
1982 DEFOLIATION MAP
Light
Moderate-Severe

method in areas where variable, low, or undetermined population levels were expected. Another variation used in Maine this year involved changing the sample unit from 4 fir branches to 3 branches each from fir and red spruce.

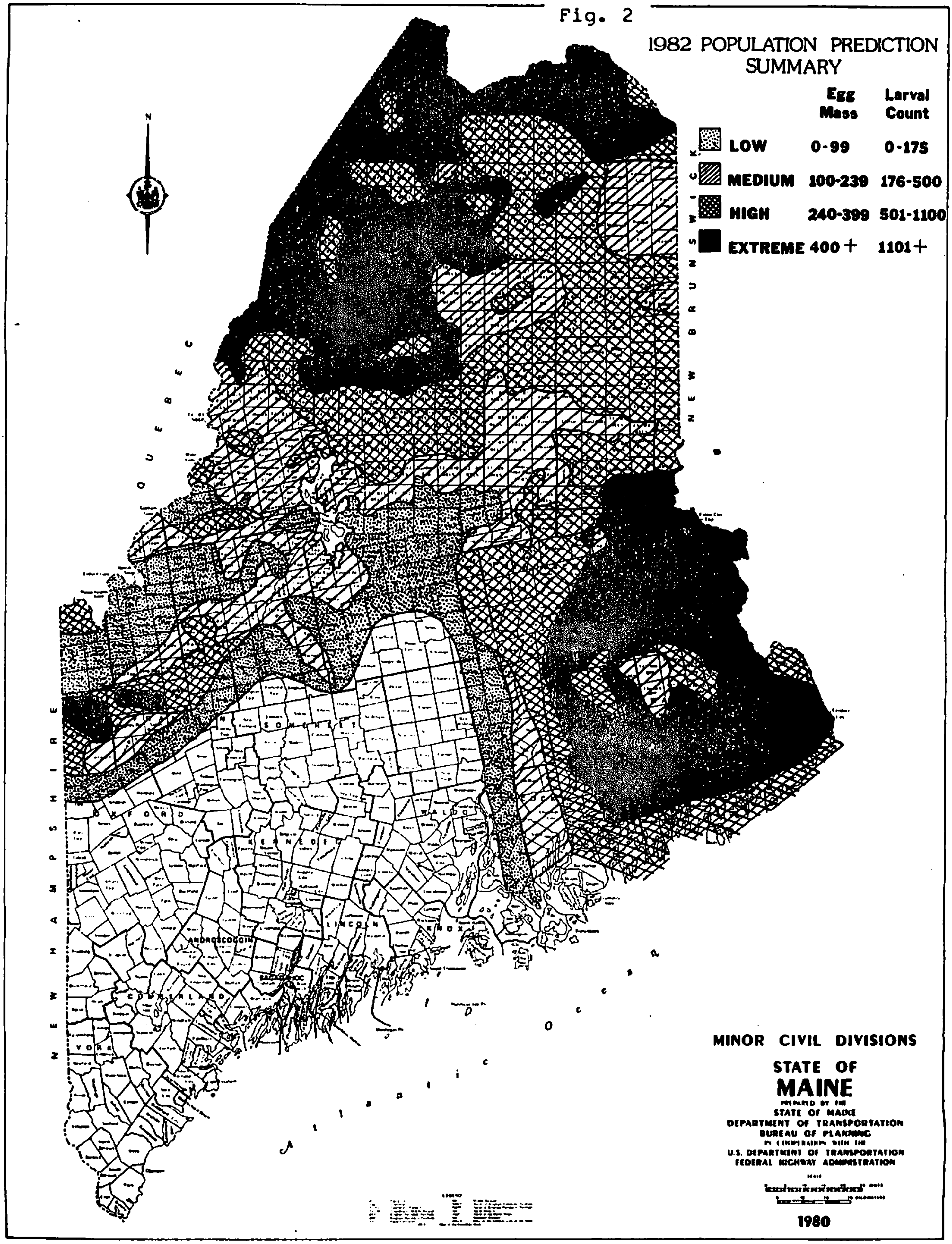
The major reason for the above changes was expected accuracy of the prediction. Past data strongly suggest the L-II method provides a much more accurate prediction than does the egg method. Other reasons for the change included the longer time period available for L-II sampling and lower costs of the L-II searching method.

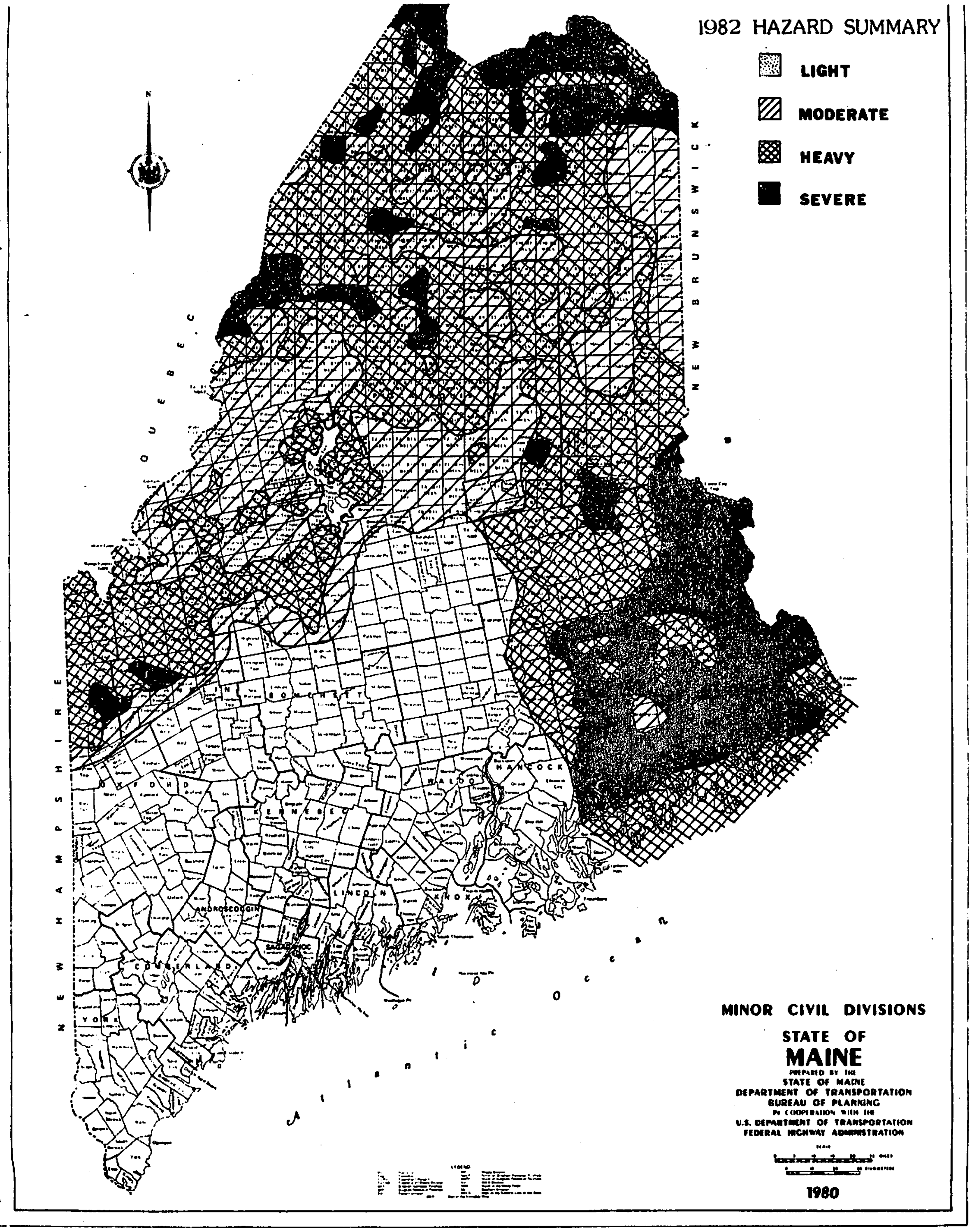
Results of the 1982 survey show increases in population in many portions of the state (Figure 2). The most significant increase occurred in the northern third of Maine where both the size of the infested area and the level of infestation increased sharply. In the southeast portion of the State, population levels remained high and the area is somewhat expanded. In southwestern and central Maine several small areas of moderate to high populations have appeared in an area which was nearly all low in 1981. A large area of high population has developed in the southwestern portion west of Rangeley.

Hazard Forecast

A hazard rating was determined for each egg mass sample point using the same system used in Maine for several years. The rating includes predicted populations (from egg mass and L-II sampling), current defoliation, past defoliation (2 previous years), and tree vigor. Hazard is classed as low, moderate, high, or extreme and is mapped as a summary of point conditions (Figure 3). An aerial

Fig. 2


1982 POPULATION PREDICTION SUMMARY
Egg Mass
Larval Count
LOW 0-99 0-175
MEDIUM 100-239 176-500
HIGH 240-399 501-1100
EXTREME 400+ 1101+
QUEBEC
NEW BRUNSWICK
NEW HAMPSHIRE
Atlantic Ocean
SOMERSET
OXFORD
KENNEBEC
WALDO
LINCOLN
KNOX
ANDROSCOGGIN
SAGADAHOC
CUMBERLAND
YORK
MINOR CIVIL DIVISIONS
STATE OF
MAINE
PREPARED BY THE
STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
BUREAU OF PLANNING
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
1980


1982 HAZARD SUMMARY
LIGHT
MODERATE
HEAVY
SEVERE
QUEBEC
NEW BRUNSWICK
NEW HAMPSHIRE
Atlantic Ocean
OXFORD
SOMERSET
KENNEBEC
WALDO
HANCOCK
LINCOLN
KNOX
ANDROSCOGGIN
SAGADAHOC
CUMBERLAND
YORK
MINOR CIVIL DIVISIONS
STATE OF
MAINE
PREPARED BY THE
STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
BUREAU OF PLANNING
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
1980

damage survey is used in conjunction with point data to construct this summary.

The area in high and extreme hazard is approximately the same size as in 1981 or about 4.5 million acres. The spray project was effective in lowering hazard in most treatment areas but hazard increased in most unsprayed areas. Increases in egg deposit or L-II level resulted in increased hazard values in many areas.

Hazard was found to be greatest in unsprayed portions of northwest and southeast. Tree condition has improved in much of the southwest and central areas due to relatively low defoliation levels in 1981 and 1982. Tree condition is generally good or improving in sprayed areas throughout the state.

<u>Host Mortality</u>

A map of host mortality (Figure 4) was updated in 1982. Black areas on the map show concentrations of 100 acre plus patches of fir mortality. A total of 240,000 acres of these 100+ acre patches was mapped. Cross hatched areas on the map show areas of 5 to 100 acre patches of land where 10 to 25% of the stand is dead due to budworm.

Mortality is greatest in the southern half of the infested area where buffers to humans most influence spray policy and in unsprayed areas in the northwest. It is estimated that more than 90% of host mortality in Maine is in some sort of unsprayed buffer or generally unprotected area.

Mortality in the southeast include most of the fir, some hemlock, and a rapidly increasing volume of spruce. Large volumes of spruce are also beginning to die in unsprayed parts of northwest

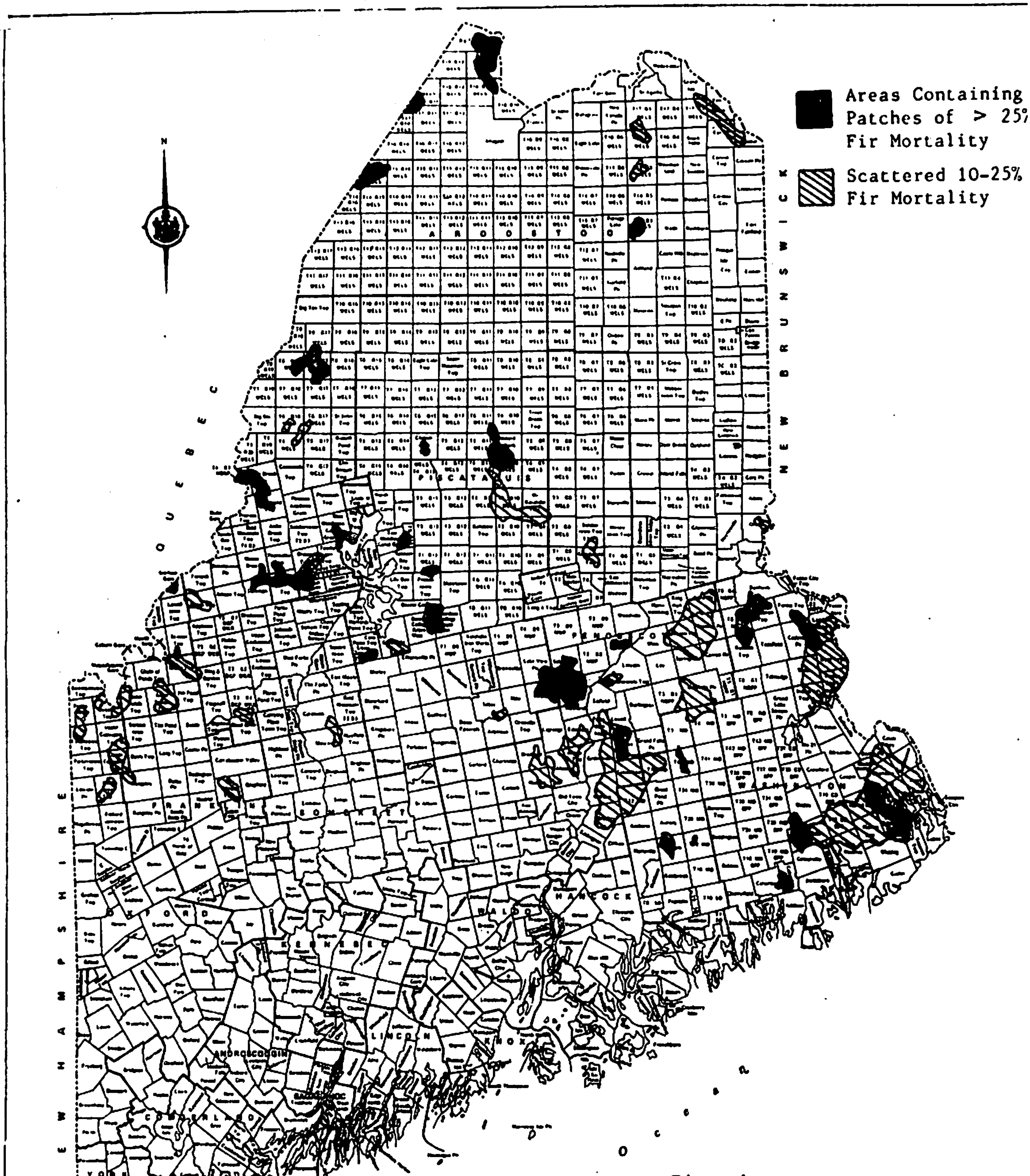


Fig. 4 Fir Mortality in Maine Due to Damage by Spruce Budworm.

and north central areas.

Forecast for 1983

A treatment area of from .5 to 1 million acres is expected. Land to be treated will be widely scattered throughout the infestation. As in 1982, Sevin, Orthene and Bt will be recommended for use. Bt will be used at the 12 BIU rate. In addition to chemicals used in the past Matacil, Zectran or Sumithion may be used.

Heavy host mortality is expected to continue in unprotected areas.

Environmental Monitoring in Maine, 1982

By

Stephen Oliveri
Maine Forest Service
State House Station #22
Augusta, Maine 04333

There were seven projects conducted in Maine in conjunction with the 1982 spruce budworm suppression project. Several studies were continuations of projects begun in previous years. All of them are designed to help the Maine Forest Service address important environmental concerns and, whenever possible, modify policies to reduce environmental impact. The summaries below are based on preliminary reports. Final reports will be available in early 1983.

I. A long-term environmental monitoring program for the spruce budworm suppression project.

Principal Investigators: Dr. Malcolm Hunter, Jr., and Dr. K. Elizabeth Gibbs. University of Maine, Orono, Maine.

The most important project in 1982 was the development of a long-term environmental program. This program will focus on the effects of insecticides as well as budworm-caused defoliation and mortality of spruce and fir. It is expected to run for five years and will involve areas of varying spray histories and budworm infestation levels. An initial field survey has identified 30 sites throughout the state which could be used in the environmental monitoring network, although the final number of sites will be closer to 20. A field protocol has been developed which includes both aquatic and terrestrial habitats. A panel of researchers has decided to concentrate monitoring efforts upon fish populations, leaf-processing by aquatic invertebrates, bird populations, spruce budworm populations, tree condition and wildlife habitat. A techniques manual should be ready by early 1983. We hope to initiate the system in the spring of 1983 on a pilot test basis.

II. A bioassay to determine the toxicity of Sevin-4-Oil to crayfish.

Principal Investigators: Eco-Analysts, Inc. of Georgetown, Maine, and Peck Environmental Laboratories, Inc. of Hampton Falls, New Hampshire

In order to assess whether or not the Maine spray project was having an adverse effect upon crayfish it was decided to conduct a bioassy upon the two species most common in Maine, Cambarus bartoni and Orconectes virilis. Tests were conducted using technical carbaryl, alpha-naphthol (the principal breakdown product), and Sevin-4-Oil tank mix, that is the actual spray formulation. None of the three materials proved toxic to either species at levels commonly detected in streams, generally less than 30 ppb. The apparent lethal threshold to both species for carbaryl appears to be around 500 ppb, a much higher level than is likely to occur in Maine under current spray policy.

III. Leaf-processing disruption in streams within spruce budworm suppression project carbaryl spray blocks.

Principal Investigator: Joan Trial, University of Maine, Orono, Maine.

Although leaf-processing has been measured before in Maine, this project was designed to take this investigation several steps further. Leaves that are naturally available along stream banks, such as alder (Alnus rugosa) are being used and the placement and retrival of leaf-packs is taking place in the fall to coincide with natural leaf-fall. In addition stream insects which depend upon the fine particulate matter which is produced during the leaf shredding process will be monitored to determine if their growth rates are adversely affected.

IV. Differential effects of temperature when spraying with Sevin-4-Oil[R] on pollinators and fruit-set in a spruce-fir forest.

Principal Investigators. Dr. Eben A. Osgood and Richard W. Hansen, University of Maine, Orono, Maine.

This project was undertaken to continue our investigations of the effects of spraying upon fruit set. Earlier studies had suggested a relationship between temperature at time of spraying and amount of fruit-set. This year's results do not seem to support this relationship, at least for the two plant species which were studied this year; Aralia hispida (bristly sarsaparilla) and Maianthemum canadense (wild lily-of-the-valley). However, the researchers did determine activity temperature thresholds for the major pollinators and have also documented flowering and fruiting times for approximately 40 species of forest plants.

V. The long-term effects for forest spraying of carbaryl (Sevin-4-Oil[R]) in 1980 on pond macroinvertebrates and its persistence in water and sediment.

Principal Investigator: Dr. K. Elizabeth Gibbs, University of Maine, Orono, Maine

In 1980 two ponds were intentionally sprayed to simulate an accidental overspray. These ponds have now been monitored for three field seasons. Included in the observations are measurements of carbaryl residues and recovery rates of aquatic invertebrates. Carbaryl was found to persist in small amounts in pond-bottom sediments up to 16 months after spraying had occurred, however no residues have been detected in 1982. The most severely affected organisms were the Amphipoda. One species, Hyalella azteca, was reduced to or near 0 following spray application. In one treated pond it has begun to show signs of recovery, though it remains well below pre-spray levels. H. azteca is still absent from the other treated pond. Another species Gammarus lacustris has apparently been eliminated from one of the treated ponds. The Odonata (dragon flies) have also not recovered to pre-spray levels, but Ephemeroptera, Trichoptera and Diptera have all apparently regained pre-spray population levels.

VI. A comparison of bird populations in moribund and healthy spruce-fir stands in Maine

Principal Investigators: Stephen Oliveri, and Norman Famous, Maine Forest Service, Augusta, Maine .

Bird populations were censured using the spot-mapping method in a moribund spruce-fir stand and a relatively healthy stand of similar composition. Data have not been analyzed yet, but suggest changes in species composition in response to changes in live canopy density and understory growth.

VII. Human Health Monitoring

Principal Investigator: Dr. Greg Bogdan, Maine Department of Human Services

Maine annually collects data on school attendance, and chronic disease rates in communities close to the spray areas. This year ambient air sampling to determine potential exposure levels were also taken.

These data are being analyzed to determine if there is a population at risk and if so, what are the potential risks to human health.

Summary of 1982 Project

Spraying commenced on block M070 (T34 MD) Downeast on May 21, a.m. spray period and finished spraying on evening of June 15 out of Red Pine airstrip.

COST: Approximately 8.5 million

PLANNING: (new developments)

1. First all volunteer spray program - landowners submitted a 5-year plan as well as acreage for this year. Title 12 MRSA Chapter 803 § IV-A.
2. Posting of boat launching sites where a person could travel a reasonable distance and upon beaching the boat could step directly into a buffer zone.
3. Posting commonly known hiking trails where the trail passes within one mile or directly through a spray block.
4. Micronaires were used for the first time on thrush aircraft with Bt and Sevin.
5. No security contract.

CONTRACTORS:

Biegert Aviation, Inc.	Fixed Wing
Evergreen Helicopters, Inc.	Rotary Wing
Chempro of Oregon	Mixing and loading

FACILITIES:

Project Headquarters - Andrews Hall, N.M.V.T.I., Presque Isle

Aircraft sites: Presque Isle airport
Red Pine airport
Millinocket airport
Jackman airport
several heliports

Laboratory: Howland

INSECTICIDES:

I. Insecticide Formulations

	Acres	Gallons	Percentage by acre
Bactospein 96 oz.	2526	1894	1
Orthene 64 oz.	46882	23431	6
Dipel at 96 oz.	9990	7492	1
Dipel at 120 oz.	5542	5192	1
Thuricide at 96 oz.	71448	53575	9
Sevin Single at 30 oz.	164170	38448	20
Sevin Split at 24 oz.	315075	118102	38
Sevin Split at 30 oz.	180832	84712	22
Sevin FR Single 30 oz.	11394	2669	1
Sevin FR Split 24 oz.	12192	4571	1
TOTALS	820051	340086	
TOTALS	820051	340086	100%

*Gallons determined from acreage treated, not gallons pumped.

TOTAL SEVIN	683,663	248,502
TOTAL ORTHENE	46,882	23,431
TOTAL BT	89,506	68,153

II. Percentage of 1982 program by location

	Percentage by acreage	Percentage by gallons
Presque Isle	31%	29%
Millinocket	18	18
Jackman	9	6
Red Pine	22	20
Eastern Helicopters	9	11
Northern Helicopters	9	13
Western Helicopters	2	3
	100%	100%

III. Percentage of 1982 program by aircraft type

	By Acreage	By Gallons
[1]Large Fixed Wing	22%	20%
[2]Small Fixed Wing	58%	52%
[3]Helicopters	20%	28%
	100%	100%

1 - C-54 (4 engine)
2 - Light Spray Units (Thrush Commanders, "Bull Thrushes", etc)
3 - Large Helicopters (Bell 205, etc)

IV. Percentage of 1982 program by major landowners (by acreage)

Seven Islands	15.1
Great Northern Paper	56.8
International Paper	5.1
Prentiss & Carlisle	2.4
Baxter Park	0.3
Diamond International	3.4
Corburn Land Trust	0.2
Scott Paper	4.6
Georgia Pacific	3.9
St. Regis	3.1
Baskahegan	0.1
Boise Cascade	5.0
	100%

MAPPING:

Continued work on computer mapping of spray blocks primarily for taxation but also maps for operational use.

BPC MONITORING:

1982 brought about a more intensive monitoring program, with all but one BPC officer out in the field - conducting water samples, observing spray behavior etc.

INCIDENTS:

There were no major incidents reported during the 1982 project.

7/14/82

Update on 1982 Environmental Monitoring and Research

Following are brief summaries of the progress to date of the 1982 Environmental Monitoring and Research projects.

1. A Long-Term environmental monitoring program for the spruce budworm suppression project

Dr. Malcolm L. Hunter, Jr., and Dr. K. Elizabeth Gibbs, University or Maine, Orono.

The organisms and ecosystem functions to be monitored have been selected. Most of the study sites have been visited and sites fitting most of the slection criteria have been found.

2. A Bioassay to determine the toxicity of Sevin-4-Oil to Crayfish.

Peck Environmental Labs and Eco-Analysts, Inc.

Collection of Cambarus crayfish has been completed. Orconectes are not as abundant and collection is still ongoing, but expected to be completed soon.

The range-finding bioassay on Cambarus has been completed for carbaryl, Sevin-4-Oil tank mix, and alpha-naphthol. Results are quite interesting. Carbaryl at 10 ppm killed all exposed crayfish within 96 hours, but at 1 ppm none were killed. One ppm is greatly in excess of the expected level in buffered streams. Alpha-naphthol is approximately 10 times less toxic than carbaryl to Cambarus. Definitive bioassays for Cambarus and range-finding bioassays for Orconectes are scheduled to start by the third week in july.

3. Leaf-processing disrupton in streams within spruce budworm suppression project carbaryl spray blocks.

Joan G. Trial, University of Maine, Orono.

Most of the field work for this project will take place in the fall, corresponding with the peak of natural leaf processing. Representative insects have been collected to determine the best means of measuring growth rates.

4. Differential effects of temperature, when spraying with Sevin-4-Oil, on pollinators and fruit-set in a spruce fir forests.

Richard Hansen and Dr. Ebsen Osgood, University of Maine, Orono.

Field collection of pollinating insects is complete and populations are being analyzed. Collection of fruiting plants will take place over the next few weeks at the peak of fruit development. The investigators were able to have the desired spray blocks sprayed at the appropriate temperatures and anticipate good results.

5. A continuation study of the short-and long-term effects from forest spraying of carbaryl on pond macroinvertebrates and its persistence in water and sediment.

Dr. K. Elizabeth Gibbs, University of Maine, Orono.

Water and sediment samples were collected in May and June. Laboratory analysis has shown that none of the water samples contain any carbaryl or alpha naphthol (minimum detection level = .033 ppb) One half (3) of the sediment samples have been analyzed and no carbaryl or alpha-naphthol was detected in any of them (minimum detection level = 7.58 ppb).

6. A comparison of bird populations in moribund and healthy spruce-fir stands in Maine.

Stephen Olvieri and Norman Famous, Maine Forest Service

All spot-mapping censuses have been completed; there are a total of nine for each plot. Territorial maps are being prepared for each species on both plots and will be completed in August. Vegetation sampling will be completed by August 1.

7. Human Health Monitoring Project.

Dr. Greg Bogdan, Department of Human Services.

Attendance data from schools has been collected and is being analyzed. All ambient air sampling is completed but results are not yet available. The next step will be the development of maps depicting potential exposure risks locations.

COMMENTS ON FOREST PESTS OF MUTUAL CONCERN - 1982-83 [1/]

SPRUCE BUDWORM

Spruce budworm conditions in the Northeast are summarized in Table 1.

LAKE STATES

Defoliation of balsam fir and white spruce by the spruce budworm occurred on 99,000 ha of state, private, and federal lands. This was a slight decrease from 1981.

All defoliation was in the very light to moderate category except in Minnesota where 20,000 ha were heavily defoliated.

A survey is underway to determine the volume of timber killed by the spruce budworm during the period 1974 to 1981 that occured in Minnesota, Michigan, and Wisconsin. Preliminary results show that tree mortality occurred on 420,000 ha.

Budworm population trends are expected to rise in Minnesota and fall in Wisconsin and Michigan in 1983.

CANUSA funded the Pacific Southwest Forest Experiment Station to conduct a research project on about 405 ha in Michigan. The objective was to determine the efficacy of three dosage rates of *B.t.* against the spruce budworm. Preliminary reports indicate that 30 BIU *per* ha in 5.6 L is equally as effective as the 30 BIU per ha in 11.2 L.

MAINE

In 1982 defoliation in the light category was 1.62 million ha and, moderate to severe on 1.34 million ha. Defoliation was more severe in some areas in 1982 than in 1981, especially in Washington County and in northwestern Maine. Budworm populations are increasing.

Tree mortality in 1982 was recorded on 218,000 ha. 121,500 ha are showing up to 25% fir mortality and 97,000 ha are showing up to 50% fir mortality. Spruce is under considerable stress and is beginning to succumb.

The 1982 Maine Forest Service aerial spray program against the spruce budworm began on May 21 and ended on June 15. The project covered 333,230 ha. As in the past most of the area, (277,993 ha) was sprayed with carbaryl in split or single applications. The remaining project area was treated with acephate (18,987 ha) or with one of three *B.t.* products (36,250 ha). *B.t.* products used

1/ Presented at 10th Annual Forest Pest Control Forum, Ottawa, Ontario by Peter W. Orr, Staff Director, Forest Pest Management, USDA Forest Service, Northeastern Area, State and Private Forestry, Broomall, Pennsylvania.

were Dipel, Thuricide, and Bactospiene. Private owners sprayed over 12,150 ha with aminocarb. Another 6,075 ha of Indian lands were treated with B.t. Control was reported as excellent with all insecticides. In addition, 80,625 ha of silvicultural treatments were made in 1982.

The 1982 project was extremely complicated operationally; it involved seven insecticides, 11 application rates, and many timing variations. Much of the carbaryl was applied in split applications timed to protect spruce. All B.t. materials were applied at one application of 30 BIU per ha (volume per ha varied). Acephate was applied at one rate, but with variable timing.

For 1983 the area of heavy infestation is expected to increase to about 2.23 million ha. Populations are building in lightly defoliated areas and those with heavy defoliation are showing a marked increase in intensity.

The State of Maine proposes to treat approximately 405,000 ha in 1983. Insecticides of choice are acephate, aminocarb, carbaryl, fenitrothion, zectran, and the biological B.t.

NEW HAMPSHIRE

4,000 ha of spruce/fir were lightly defoliated in 1982. Tree mortality is occurring on over 25 percent of this area. Dead, dying and severely stressed trees are being salvaged.

For 1983 defoliation intensity is expected to be low, but the infestation is expected to expand to about 8,100 ha. The State of New Hampshire does not plan on a suppression project in 1983. Salvage of dead and dying trees will continue.

VERMONT

In 1982 defoliation occurred on 67,750 ha. This is an increase of over 20,250 ha from 1981. Defoliation has been on a steady rise over the last seven years. Tree mortality is occurring on over 34,425 ha. The dollar value attributed to timber killed by the budworm exceeds $2 million per year. Salvage of dead and dying trees, which include fuel wood, is being conducted wherever possible.

In 1983, Vermont proposes to treat approximately 6,075 ha. In addition, a demonstration project involving silviculture, targeted harvesting, timber management, deer habitat management, and suppression is planned on about 4,050 ha. This demonstration project is planned as a long term effort (10 years). Public support for this effort in northern Vermont is strong.

TABLE 1. -- SUMMARY OF SPRUCE BUDWORM CONDITIONS IN THE NORTHEAST - 1982, 1983

STATE	AREA OF VISIBLE DEFOLIATION	AREA WITH DEAD AND DYING TREES	AREA SPRAYED	AREA OF DEFOLIATION FORECAST FOR 1983	
		Hectares (X 1,000)			
Minnesota	51	75	--	72	(+)
Wisconsin	1	20	--	0	(-)
Michigan	47	325	1*	20	(-)
Maine	2,960	218	351	2,228	(-)
New Hampshire	4	4	--	8	(+)
Vermont	68	34	--	61	(-)
Total	3,124	676	334	2,389	( )

* Pilot control project by PSWFES.

GYPSY MOTH STATUS

During the spring of 1982, cooperative gypsy moth suppression projects in the nine northeastern States resulted in the treatment of 292,988.3 ha of high value forests and forested recreation or residential areas. Total project costs are estimated at $8,219,000, averaging $36.37 per hectar.

Chemical insecticides were applied to 267,574.3 ha and biologicals to 25,414 ha. Dylox was the primary chemical, while B.t. was the primary biological insecticide used (Table 3). In general, all suppression objectives were met. Of special note was the success in using one application of B.t. at 30 B.I.U's per ha.

Gypsy moth defoliation in 1982 amounted to 3.3 million ha, down from 5.2 million in 1981. This still represents the second highest level of defoliation recorded in the U.S.

While the amount of defoliation is down in most states, increases were recorded in Michigan and Rhode Island and the peripheral states of Delaware and Maryland. In addition, populations are building in northern Virginia, West Virginia, and eastern Ohio.

Vigorous populations still remain in portions of Pennsylvania, west central New York, Delaware and Maryland. Population collapse, due primarily to the natural occurrence of the gypsy moth virus, has occurred in isolated areas throughout the northeast. A general collapse of the gypsy moth population is not expected to occur in 1983.

State agencies have been informed of the possible absence of Forest Service funding for cooperative insect and disease suppression on State and private lands in FY 83. However, the Northeastern Area is proceeding with the environmental analysis process and related technical assistance with State cooperators in planning suppression for the gypsy moth. 1983 projections are summarized in Table 2.

In 1983, we expect to see a significant increase in the use of biological insecticides and chemical growth regulators such as dimilin. Pennsylvania plans to use B.t. as the primary insecticide in their 1983 suppression project; dimilin will be the insecticide of choice for New Jersey Forestry and for the Maryland Department of Agriculture. The use of the insecticide Sevin will be significantly reduced.

TABLE 2.--- ANTICIPATED STATE AGENCY INVOLVLLEMENT IN GYPSY MOTH SUPPRESSION PROJECTS FY 1983

STATE/AGENCY	SUPPRESSION COSTS	SUPPRESSION ha	COST/HECTARES
CT-FORESTRY	-0-	-0-	
DE-FORESTRY	$ 20,000	405	$ 49.38
ME-FORESTRY	1,000,000	8,100	123.46
MD-AGR	800,000	40,500	19.75
NH-FORESTRY	250,000	4,050	61.73
NJ-FORESTRY	250,000	12,150	20.57
NJ-AGR	1,438,000	34,830	41.28
NY-FORESTRY	375,000	6,075	61.73
PA-FORESTRY	3,000,000	81,000	37.04
RI-FORESTRY	1,000,000	20,250	49.38
VT-FORESTRY	12,000	405	29.63
TOTALS	$8,145,000	207,765	

TABLE 3.---1982 GYPSY MOTH COOPERATIVE SUPPRESSION [1/]

STATE/AGENCY	INSECTICIDE	HECTARES FEDERAL	NON FEDERAL PUBLIC	PRIVATE	SUB TOTAL BY STATE	TOTAL STATE
ME-FOR	*B.t.*	0	8	802	810	810
MD-AGR	Dimilin	0	1,215	10,865	12,080	
	B.t.	2,361	530	1,754	4,645	
	Sevin 4 Oil	0	25	2,837	2,862	19,587
MA-FOR	*B.t.*	0	178	0	178	178
NJ-FOR	Sevin 4 Oil	0	3,732	1,606	5,338	5,338
NJ-AGR	Sevin 4 Oil	0	0	30,553	30,553	
	B.t.	0	0	5,285	5,285	
	Dylox	0	0	207	207	36,045
NY-FOR	Dylox				1,746	
	B.t.				1,238	
	Dimilin				930	3,914
PA-FOR	Dylox	825	13,324	154,856	169,005	
	Dimilin	0	18,370	136	18,506	
	B.t.	0	549	12,684	13,233	200,744
RI-FOR	Sevin 4 Oil	0	918	25,294	26,212	
	B.t.	0	25	0	25	
	Dylox	0	13	0	13	26,250
VT-FOR	Sevin 4 Oil	0	0	122	122	122
		3,186	38,887	24,001	292,988	292,988

1/ Estimated 11/16/82

OTHER PESTS

RED PINE SCALE (Matsucoccus reinosae)

In 1982, the red pine scale was reported from Connecticut, several southern New York counties, northern New Jersey and a single find in a Philadelphia arboretum (Figure 3). The acreage of the infested area is not large because of the limited distribution of red pine.

Attempts to control the scale have not been successful, and thus, once a red pine plantation is infested, it is expected to die over a period of years. The red pine scale, formerly thought to be limited by cold temperatures in its northward movement, now appears to be moving north and west. The spread of the insect might be more limited by the sparse northward occurrence of red pine seedlings, and the sporadic occurrence of red pine in the present range of the scale.

RED PINE ADELGID (Pineus boerneri)

The red pine adelgid was discovered in Connecticut in 1979. In a survey conducted by Dr. McClure, Connecticut Agricultural Experiment Station, in 1980, the pest was found in Connecticut, most of Rhode Island, and along the Connecticut-Massachusetts border. Collections have been made up to the Canadian border, but no other infestations have been found.

The red pine adelgid was probably was introduced in Connecticut more than 25 years ago. The rather limited distribution might suggest that movement is slow. However, greenhouse experiments and field observations suggest that spread on nursery stock is possible, and that cold temperature may not limit its growth in the red pine range in the United States.

Damage on red pine is similar to the red pine scale, and frequently is erroneously identified as being caused by the scale. Damage progresses from twig and branch mortality to the death of the whole tree. The early impression is that the adelgid might be a more agressive pest than the scale.

SCLERODERRIS CANKER (Gremmeniella abietina)

For the past few years the spread of Scleroderris canker has abated in all of the affected States. The more virulent European strain of the fungus has not been found in the Lake States. It has been found in New York, Vermont, New Hampshire and Maine.

Since no new infections were found in New York this year the quarantine line remains the same as in 1981 -- 13 counties quarantined, including about 729 ha of Christmas tree plantations. Some scattered heavy infections have occurred within previously infected areas and mortality varies from stand to stand. In Vermont, no new towns have been found infected in the last 2 years. However, infection is up a bit over 1981 levels within old infection sites. Presently, about 324 ha in 55 towns are quarantined. No infection has been found in New Hampshire since the initial find in 1978. In Maine, where only 3 towns were infected, a newly infected 162 ha red pine plantation was discovered in Washington County this year. Twelve hectares were pruned in an attempt to eliminate the infection. The strain of the fungus involved has not yet been determined.

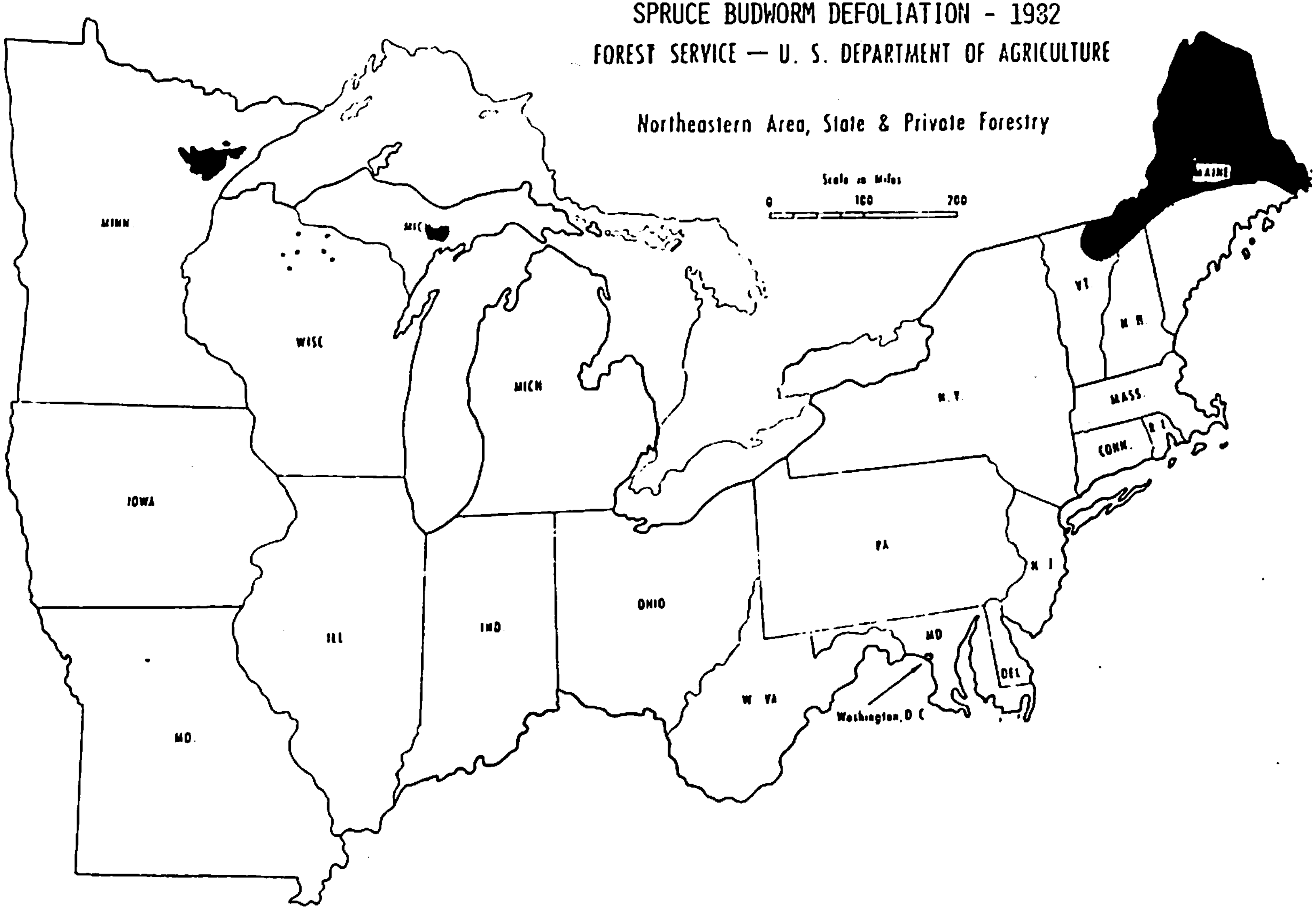
In Michigan, Minnesota and Wisconsin, where only the less virulent North American strain occurs, infection has been down and no new tree mortality has been observed.

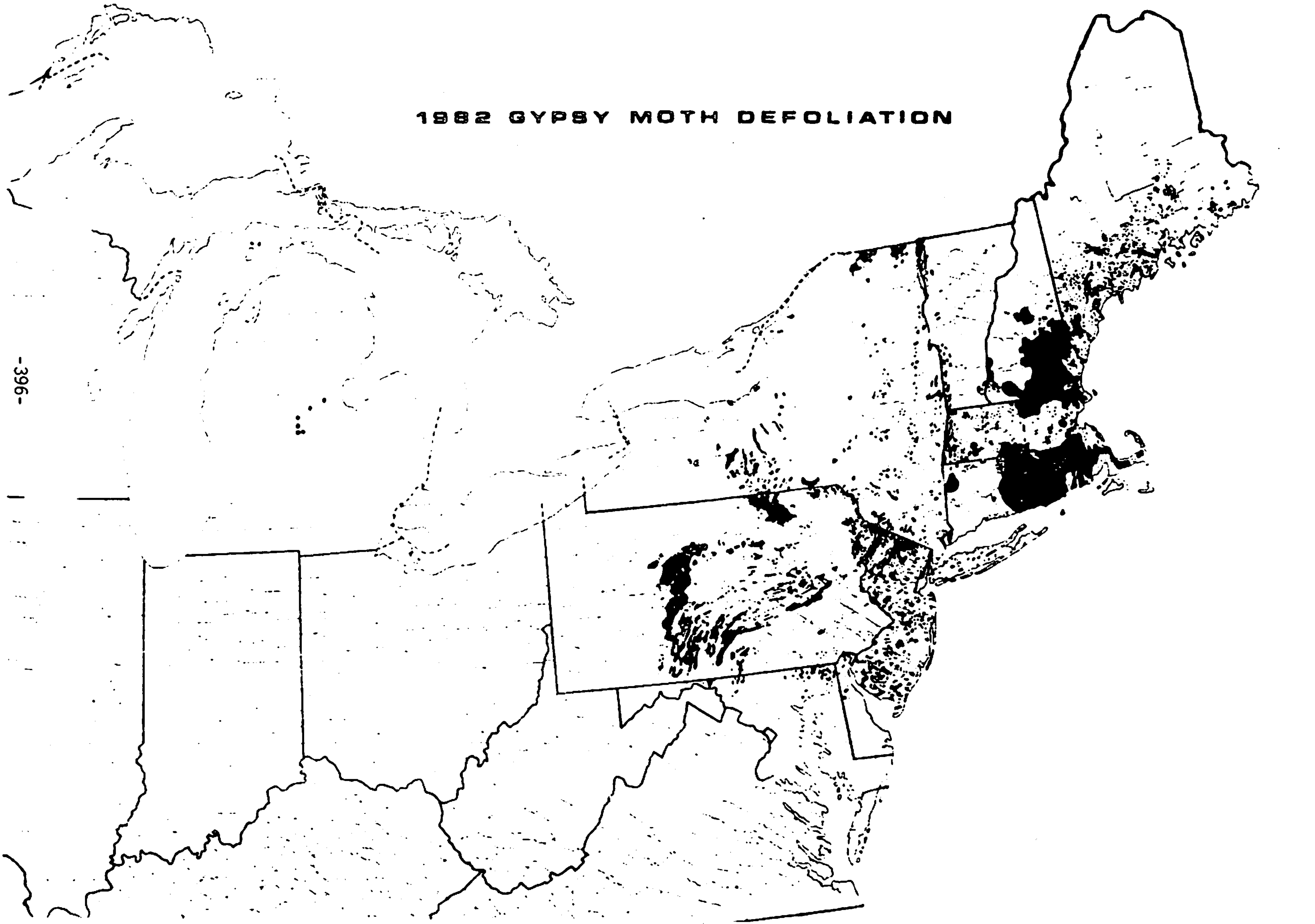
EUROPEAN LARCH CANKER (Lachnellula willkommii)

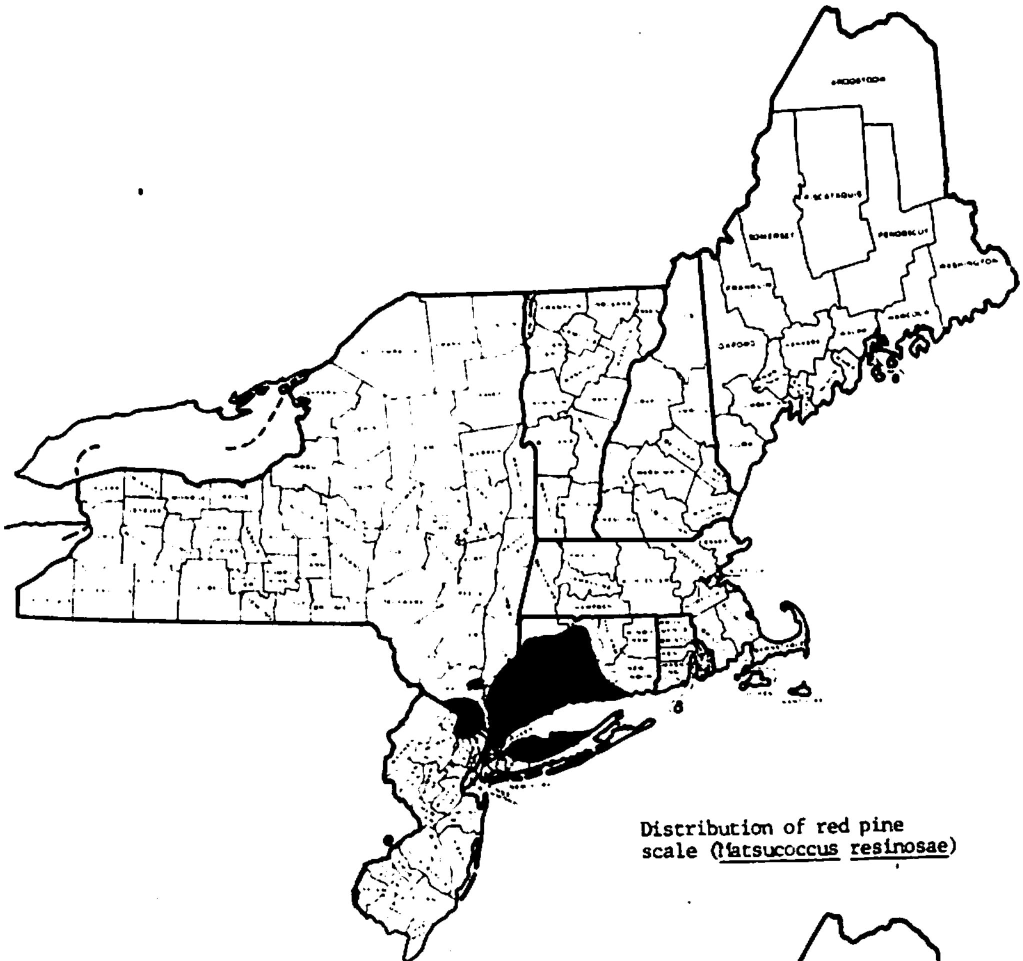
In 1981, the European larch canker was found on eastern larch in Lubec, Maine. This is the first report of the disease in the United States since an infection in Massachusetts was eradicated in 1924. The survey was prompted by recent reports of the disease in New Brunswick and Nova Scotia. To date the disease has been found on eastern larch in 12 towns in Washington County.

Trees ranging from 3 to 14 inches DBH have been infected. Branch cankers are most common. The age of the oldest canker indicate the disease has been in the area for at least 11 years. Surveys will be expanded in 1983 to further define the infected area and evaluate damage due to the disease.

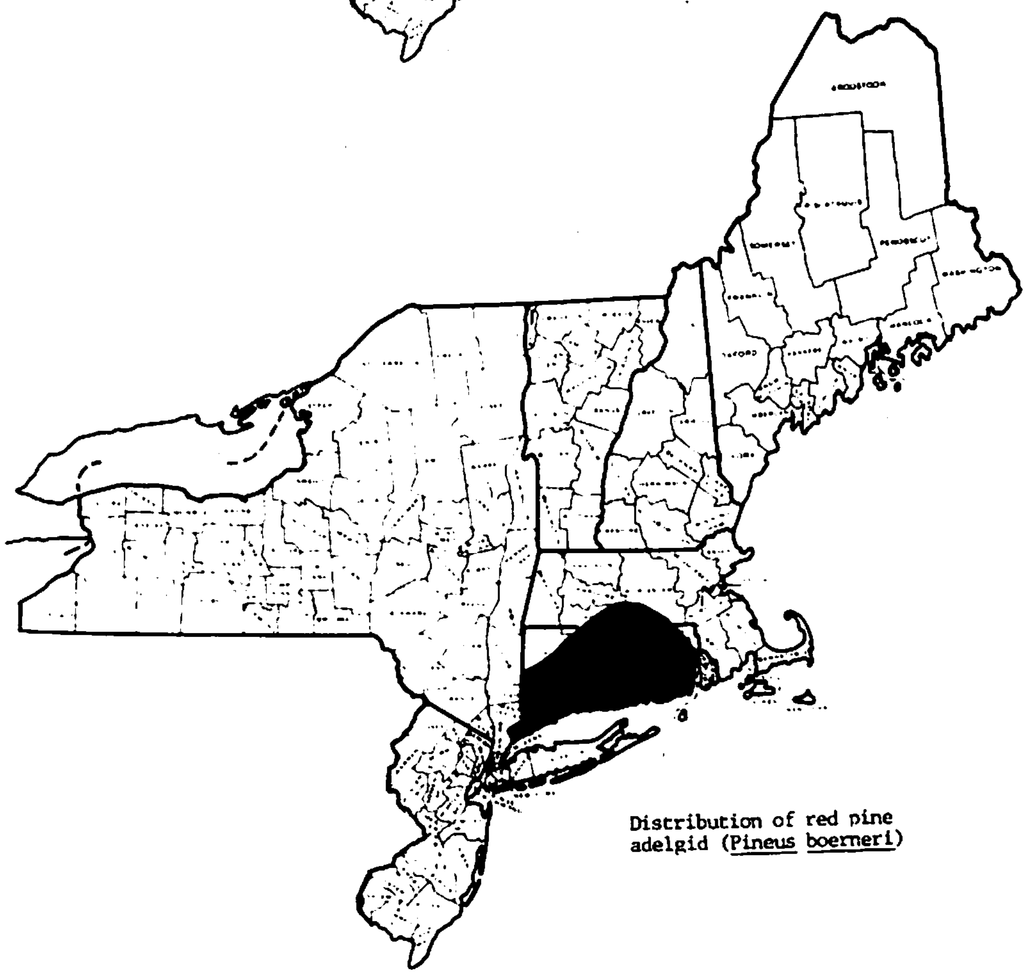
Since all species of larch are susceptible, care should be taken to prevent the spread of the disease through larch tree improvement programs which are expanding in Maine and New Brunswick.


SPRUCE BUDWORM DEFOLIATION - 1932
FOREST SERVICE — U. S. DEPARTMENT OF AGRICULTURE
Northeastern Area, State & Private Forestry
Scale in Miles
0
100
200
MINN
WISC
MICH
IOWA
ILL
IND
OHIO
MO.
PA
N. Y.
VT.
N. H.
MASS.
CONN.
MAINE
DEL
MD
W. VA
Washington, D. C.

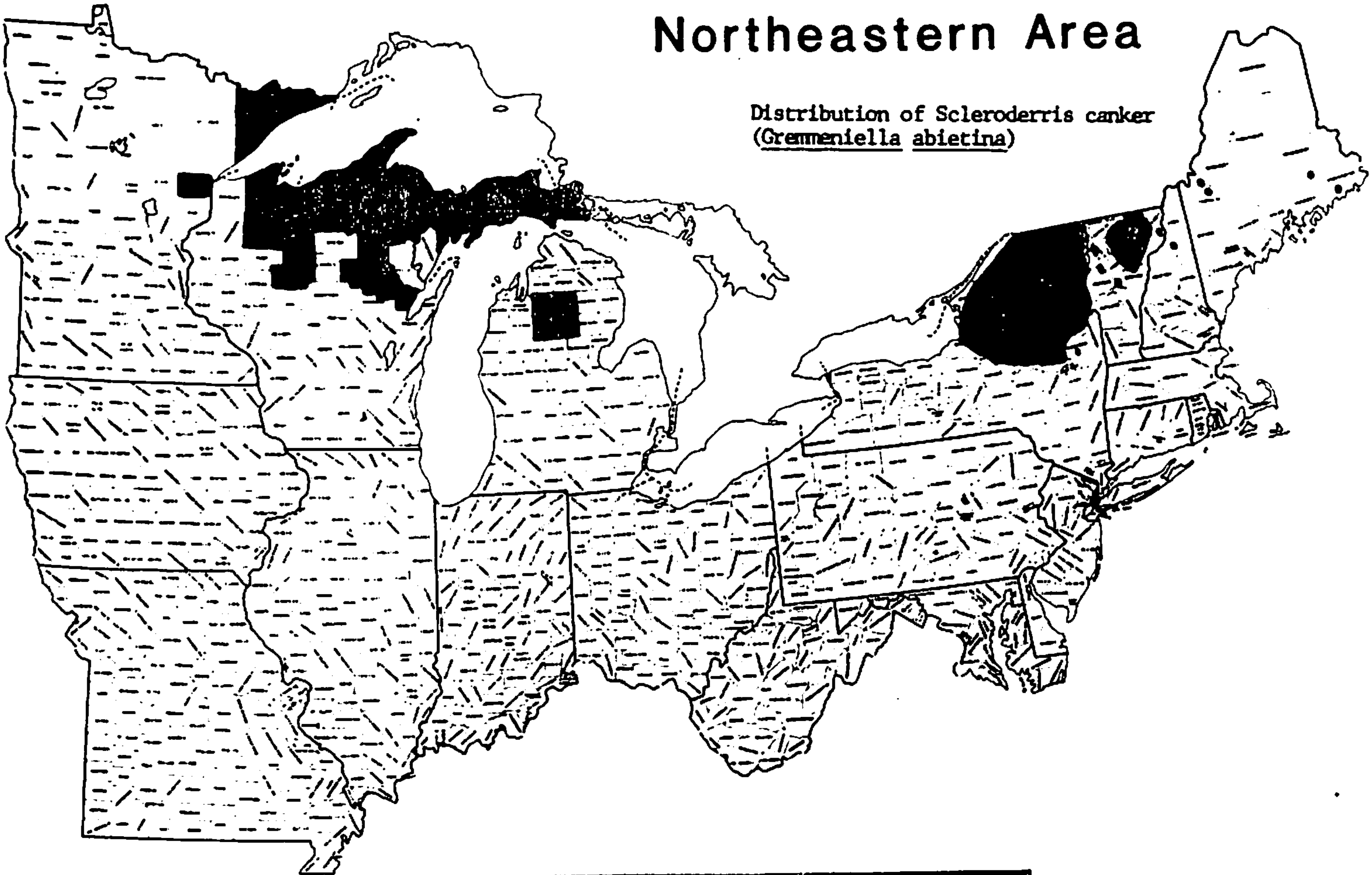

1982 GYPSY MOTH DEFOLIATION

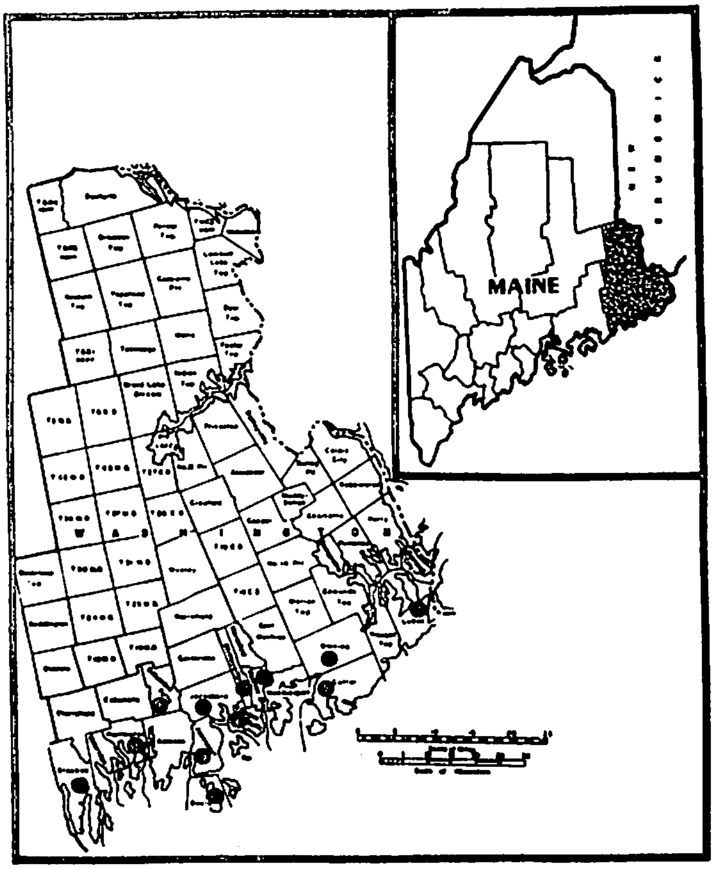


Distribution of red pine scale (*Matsucoccus resinosae*)



Distribution of red pine adelgid (*Pineus boerneri*)





Distribution of European larch canker on eastern larch in Washington County, Maine. •=Township where infection was found. (Lachnellula willkommii)

THE GYPSY MOTH IN CANADA: 1982
DISTRIBUTION SURVEY AND REGULATORY TREATMENTS

by
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Plant Health Division
Agriculture Canada

Report prepared for the Annual Forest Pest Control Forum

INTRODUCTION

The gypsy moth situation in Canada is rapidly changing as the pest moves into new areas. Nova Scotia, New Brunswick and southwestern Ontario are all being invaded and it not possible to say exactly where the insect occurs in these areas. In recent years there has been a gypsy moth population explosion in the U.S.A. which has caused direct movement of the pest into southwestern New Brunswick and probably into the Niagara region of Ontario. In addition, it has been carried into Nova Scotia, some of the urban centres of Ontario and possibly into British Columbia, probably via vehicles or household goods moving from infested areas of eastern North America. Meanwhile, fiscal restraints are limiting the possibilities of action by government agencies to detect and combat the insect.

TREATMENTS FOR QUARANTINE PURPOSES DURING 1982

Agriculture Canada is no longer conducting treatment operations in infested areas where there is no hope of eradication, except in limited circumstances where the possibility of reducing the chances of long-distance spread can be identified. In this latter regard, a few campgrounds in Quebec and Ontario, where there were increasing gypsy moth populations, were combed by survey crews and the egg masses were individually treated with Pine Sol®.

In Ontario, small infestations in the cities of London and Niagara Falls were treated because these infestations were considerable distances from the generally infested area in eastern Ontario and from the developing infested area of Mississauga/Oakville. The latter infestation was not treated because it was clear after the 1981 egg mass survey that our treatment of the area in the spring of 1981 had not been successful and the infestation was spreading in that intensely urban area.

In Niagara Falls, an urban campground, associated boulevard trees and part of a cemetery were treated. The trees in the area (approximately 6 hectares) were examined, the egg masses were individually soaked with Pine Sol® in April, and each tree was sprayed with carbaryl in May. This treatment seemed to be successful but later in the summer it became apparent that there were other small infestations in the city.

In London, a total of about 7 hectares of urban woodland (most undeveloped land) was sprayed twice with Bacillus thuringiensis from a helicopter, while adjoining residential properties were sprayed with B. t. from the ground. Results of this treatment could not be properly assessed since, as in Niagara Falls, it was found that in fact there were other scattered pockets of infestation nearby that had not been found in 1981.

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1982 PHEROMONE TRAP SURVEY

For the first time, (+) disparlure was used in all traps across Canada.

	Agriculture Canada	Canadian Forestry Service	Provincial Forestry	Total Traps
Newfoundland	200	50	-	250
Prince Edward Island	50	19	-	69
Nova Scotia	248	89	51	388
New Brunswick	293	159	-	452
Quebec	708	-	-	708
Ontario	3,965	250	-	4,215
Manitoba	276	-	-	276
Saskatchewan	43	-	-	43
Alberta	81	-	-	81
British Columbia	1,630	84		1,714
CANADA	7,494	651	51	8,196

SIGNIFICANT SURVEY RESULTS

- No moths were caught in Newfoundland, Manitoba, Saskatchewan or Alberta.

- A few moths were caught near Summerside and Charlottetown, Prince Edward Island, for the second year in a row. The captures were not in a particularly suspicious pattern and they were believed to represent moths blown to the province on storm winds from Maine,, but they might indicate trace infestations.

- A great many moths were trapped in Nova Scotia, most blown in from the U.S.A. and obscuring the detection in incipient infestations in Nova Scotia. However, egg mass scouting by Agriculture Canada, Canadian Forestry Service and Nova Scotia Department of Lands and Forests personnel revealed approximately 50 egg masses at Yarmouth and small numbers of egg masses near the villages of Church Point, Smith's Cove, Clementsport and Paradise (along the highways between Yarmouth and Kentville). These infestations are suspected to have been introduced on vehicles arriving in southern Nova Scotia by ferry from the U.S.A., but there is a remote possibility that early-instar larvae might be blown across the Bay of Fundy (95 km from Maine or 65 km from Grand Manan Island, N.B.). An introduced larva which developed into a female moth would have a good chance of attracting a mate from all the male moths being blown from the U.S.A.

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- In New Brunswick, larval survey by CFS personnel revealed an active infestation covering some 800 hectares near Milltown, and single larvae at Oak Hill and Bocabec, both within 25 km of the large infestation. Large numbers of blown-in U.S. moths obscured the male moth survey in late summer, but the fall egg-mass survey (by CFS, New Brunswick Department of Natural Resources and Agriculture Canada personnel) turned up two eggmasses at St. George, a larval skin at Lynnfield and a dead female pupa at Saint John.

- The known infested area of Quebec, which includes most of that part of the province believed to be favourable for the insect, was extended to the Quebec City area with the finding of a few egg masses at Ste-Foy by CFS personnel.

- The main infested area of Ontario took a jump to the northwest with egg mass discoveries at Renfrew, Almonte, Lanark and Calabogie, and larvae at Bon Echo Provincial Park. The scattered infestation in the Toronto area is now believed to extend from Hamilton around the Lake Ontario shore to Pickering, although it is difficult to find. A few egg masses were also found at Peterborough, Port Hope and Presqu'ile Provincial Park. The cities of Kitchener, London and Niagara Falls are now infested but the extent of the infestations is unknown. High moth counts in St. Catherines and Woodstock indicate infestations, although no egg masses have been found. In short, the gypsy moth appears to be rapidly colonizing southwestern Ontario due to the movement of infested vehicles and commodities, and we no longer can say we know where it occurs or does not occur in southern Ontario.

- Ten moths were picked up in seven traps in the lower Fraser Valley of British Columbia. The pattern of captures indicates possible trace infestations in North Vancouver and Fort Langley, but no egg masses could be found.

PROJECTIONS FOR 1983

There are so many unknowns in the gypsy moth situation that at this time no definite predictions are possible and only problems can be identified. It would seem that there are three definite areas where quarantine controls may have to be applied, i.e., Nova Scotia, New Brunswick and British Columbia.

The British Colubmia situation seems least confusing; meetings have already been held there between appropriate federal and provincial agencies and a tentative plan of action has been agreed upon. Efforts to locate egg masses will continue over winter and, if successful, some limited local spray treatments may be called for. If no egg masses are found, a very intensive pheromone trapping

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program will be carried out with the dual objective of pinpointing the infestations while suppressing any population increase (recent U.S. research has shown this to be a promising technique for trace infestations).

In New Brunswick, the gypsy moth may have already established itself and eradication attempts may be futile. Nevertheless, the situation is not yet clear and it is worthwhile to continue an eradication policy until it becomes clear that such a policy is impractical. The outbreak in Maine seems to be dying down and the infestation can be expected to recede away from the New Brunswick border, back toward southern Maine where it has persisted for many years. If this happens, there will be less chance of natural reinvasion of New Brunswick and it may be possible to eradicate the insect from the province. The Canadian Forestry Service and the New Brunswick Department of Natural Resources are assuming the lead in addressing this problem and it has not yet been decided what will be done in 1983. Since the natural expansion of the gypsy moth-infested area of northeastern North America is not a clear-cut plant quarantine situation, the role of Agriculture Canada in New Brunswick has yet to be defined.

The scattered infestations in Nova Scotia are believed to have originated as a result of "unnatural" spread (i.e., introduced on vehicles or household articles), although the possibility of young larvae being blown from Maine cannot be entirely ruled out. It seems clear that an eradication policy should be pursued and the Nova Scotia Department of Lands and Forests has adopted the leading role. The Canadian Forestry Service and Agriculture Canada should be meeting with the provincial agency soon to make plans for action in 1983. The overwhelming complication in Nova Scotia is that the ordinary pheromone trap survey will have to be refined in some manner if spot infestations are to be detected in this area where so many male moths are blown in from the U.S.A.

In Prince Edward Island, it will be necessary to intensively trap around those few areas where moths have been caught two years in succession. Many tourists visit the province and it is possible that introductions of gypsy moth have taken place.

Survey activity in Quebec will continue to diminish, since the insect has already invaded most of the area considered to be suitable for infestation, but an attempt will be made to monitor any natural spread eastward.

In Ontario, survey activity in the southwest should be increased in order to provide a clear picture of the situation there, but unfortunately this is not possible due to resource limitations. It is apparent that a huge amount of money could be spent for

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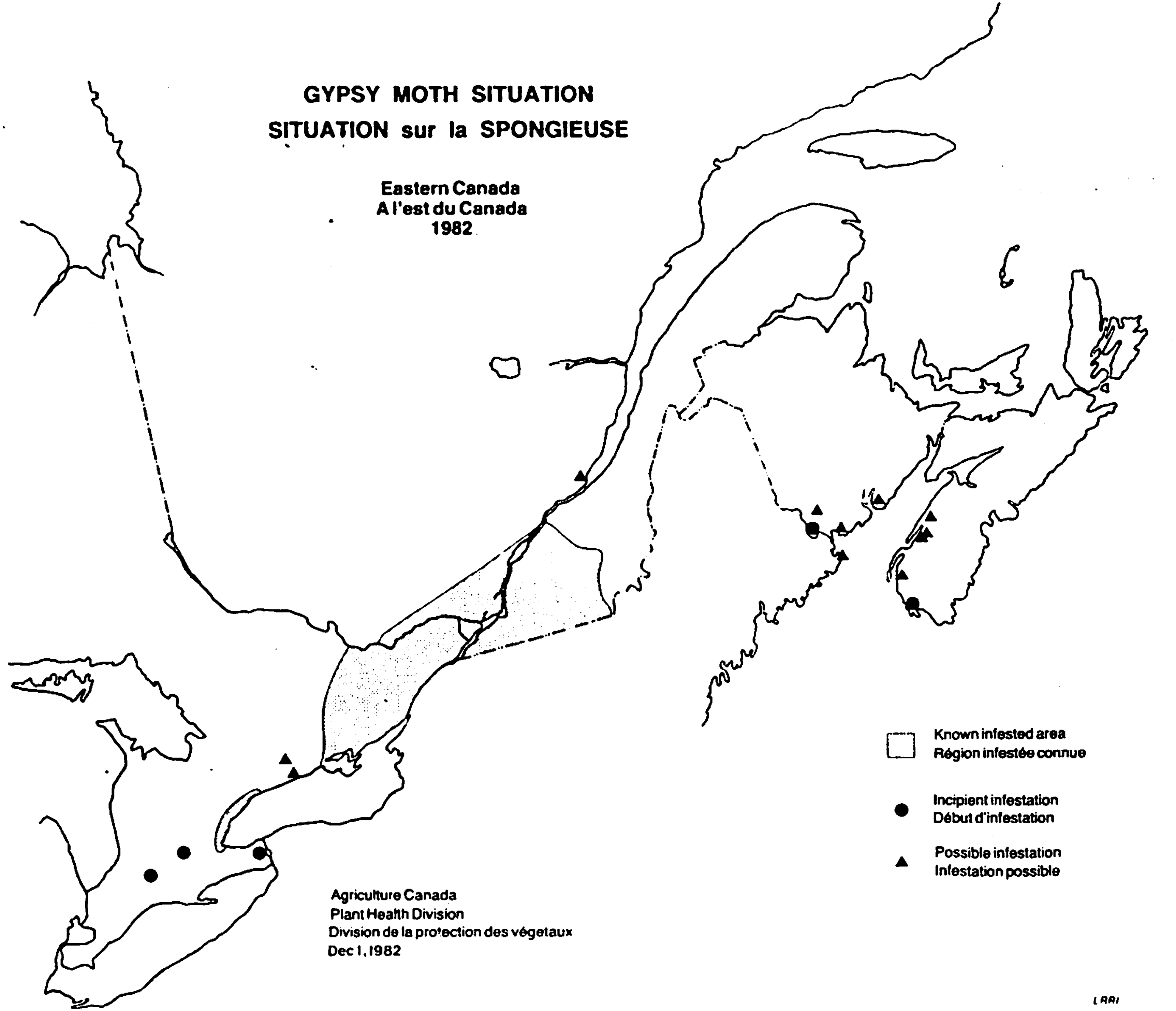
detection and suppression of gypsy moth infestations in southwestern Ontario, but it is not clear that the expenditure of such funds would be worthwhile in the long run. Discussions are underway involving Agriculture Canada, Canadian Forestry Service and the Ontario Ministry of Natural Resources but at this time it would seem that no significant regulatory treatments will be undertaken by Agriculture Canada in 1983, and even the survey activity may be reduced in Ontario.


GYPSY MOTH SITUATION
SITUATION sur la SPONGIEUSE
Eastern Canada
A l'est du Canada
1982
Known infested area
Région infestée connue
Incipient infestation
Début d'infestation
Possible infestation
Infestation possible
Agriculture Canada
Plant Health Division
Division de la protection des végetaux
Dec 1, 1982

GYPSY MOTH IN ONTARIO, 1982[1]

- Situation in 1982 Based on Defoliation and Other Surveys
- Experimental Spray Trials, 1982
- Forecasts and Plans for 1983

by

J.H. Meating[2], G.M. Howse[2]
J.C. Cunningham[3] and J.R. Carrow[4]

[1]Report prepared for the Annual Forest Pest Control Forum, Ottawa, November 23-25, 1982

[2]Environment Canada, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario

[3]Forest Pest Management Institute, Sault Ste. Marie, Ontario

[4]Ontario Ministry of Natural Resources (now with the New Brunswick Department of Natural Resources, Fredericton)

SITUATION IN 1982 BASED ON DEFOLIATION SURVEYS

This insect was first detected in Ontario in 1969 on Wolfe Island near the City of Kingston. Since then the Gypsy moth has remained relatively obscure in southern Ontario until 1981 when some 23 pockets of defoliation were detected in the Eastern Region. In July of this year FIDS staff conducted aerial surveys throughout southern Ontario to detect areas of gypsy moth defoliation. The results of this survey are shown in Figure 1, a map of the Eastern Region which was the only region where gypsy moth-associated defoliation was detected. Six pockets of severe defoliation totalling 269 ha and 12 pockets of moderate defoliation totalling another 3,341 ha were detected in the Kaladar area of Tweed District. This is the same general area where 1,450 ha suffered moderate-to-severe damage in 1981. New light infestations were mapped in a 130 ha area south of Fifth Depot Lake in Tweed District and in an area of about 1,000 ha in Frontenac Provincial Park in Napanee District. Other pockets of light-to-moderate defoliation were detected in the Pitts Ferry (2 ha) and Wolfe Island (scattered) areas near Kingston. A number of other pockets were detected as a result of ground surveys. Generally these pockets were very small, ranging in size from single trees to about 10 ha and populations were also generally very low. The largest area involved approximately 10 ha of trembling aspen in Lochiel Township, Cornwall District that suffered moderate defoliation. Another 7 ha of aspen along Hwy 417 in Caledonia Township was severely defoliated. There was also scattered moderate-to-severe defoliation within the City of Belleville on the east side of the river. The rest of the sightings generally involved only one or two trees and were located in South Plantagenet Township, Caledonia Township, Charlottenburgh Township, Osnabruck Township, Winchester Township and the City of Cornwall and Cornwall Township in Cornwall District, and Tyendinaga Township and Fredericksburgh Township in Napanee District.

OTHER SURVEYS

Since 1979, the FIDS Unit at GLFRC, in cooperation with Agriculture Canada, has deployed gypsy moth pheromone traps in 36 provincial parks and campgrounds throughout the Northern, North Central and Northeastern regions of the province. Pheromone traps were also placed in thirteen oak stands in southern Ontario in 1982. These oak stands have been monitored for a number of years for a condition known as oak decline which is believed associated with repeated defoliation by insects. A single adult male was trapped at White Lake Provincial Park in Wawa District, two moths in Alice Township, one at Petawawa National Forestry Institute in Pembroke District and a total of thirty moths in two traps

EASTERN REGION

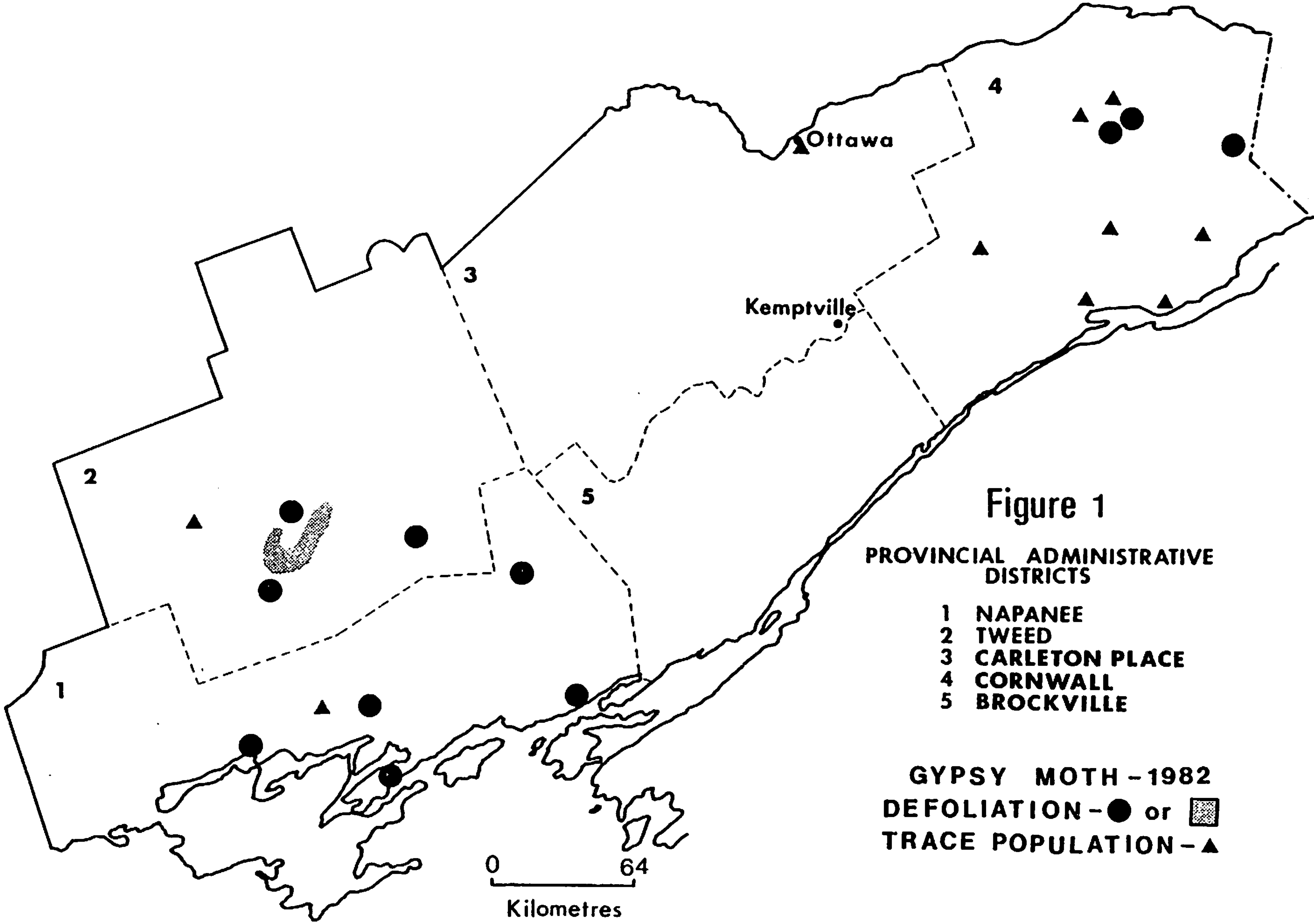


Figure 1

PROVINCIAL ADMINISTRATIVE DISTRICTS

1 NAPANEE
2 TWEED
3 CARLETON PLACE
4 CORNWALL
5 BROCKVILLE

GYPSY MOTH - 1982
DEFOLIATION - ● or ▩
TRACE POPULATION - ▲

in Lanark Township in Carleton Place District (Figure 2). In all of these cases FIDS staff were unable to detect any further evidence of a resident population.

In order to improve our knowledge of gypsy moth distribution in southern Ontario outside of the generally infested area, FIDS staff conducted larval surveys this past summer. Stands initially selected for larval trapping were locations where Agriculture Canada had trapped substantial numbers of moths in 1980 or 1981 but where no other evidence of a population had been observed. These potential hot spots were trapped for large larvae by tying strips of burlap to the trunks of the trees. A total of 37 plots, with 10 traps per plot, were set up in early June and checked several times during the next four weeks. As can be seen from Figure 3 several plots were located as far north as Sault Ste. Marie. Some plots were established in the pheromone hot spots, others were located in the oak decline plots and the rest were set up in areas where there was an abundance of oak, the preferred host, or in areas of unexplained defoliation. Larvae or pupae were observed at six locations: in Barrie, Olden and Bedford townships in Tweed District, the cities of Kitchener and Oakville in Cambridge District, and in the City of Niagara Falls in Niagara District. Egg-masses and adult moths were observed in the City of London but not on burlap traps.

OPERATIONAL SPRAY TRIALS AND FORECASTS FOR 1983

Initially in 1982, the Ontario Ministry of Natural Resources (OMNR) planned to spray about 2,000 ha of gypsy moth infested forests as well as buffer zones near Kaladar, Tweed District for the purpose of population suppression. The chemical insecticide (Sevin) was to be used on about 1,600 ha. Land ownership was about equally divided between crown and private. All private land spraying was to be done with the consent of the owner. Unfortunately, the proposed operation became a heated issue, particularly the intended use of carbaryl, and involved citizens, a municipal government and OMNR. Consequently, the original goal of population suppression was abandoned. However, a series of previously planned trials by the CFS involving *B.t.* and the NP virus, Gypchek, were carried out as planned. In addition, a small block of crown land was sprayed with Sevin by OMNR as a type of check plot. A total of 402 ha were treated with both biological and chemical pesticides (Figure 4). Sevin-4-Oil was applied to 90 ha, Dipel 88 to 249 ha at two dosages and Gypchek (NPV) to 63 ha (Table 1).

A number of special surveys were conducted in the Kaladar area to assess populations, spray efficacy, gypsy moth damage and impact, and potential damage in 1983. The results of several surveys have not yet been analyzed but enough information is available to draw some conclusions as to the effectiveness of this year's aerial spraying trials.

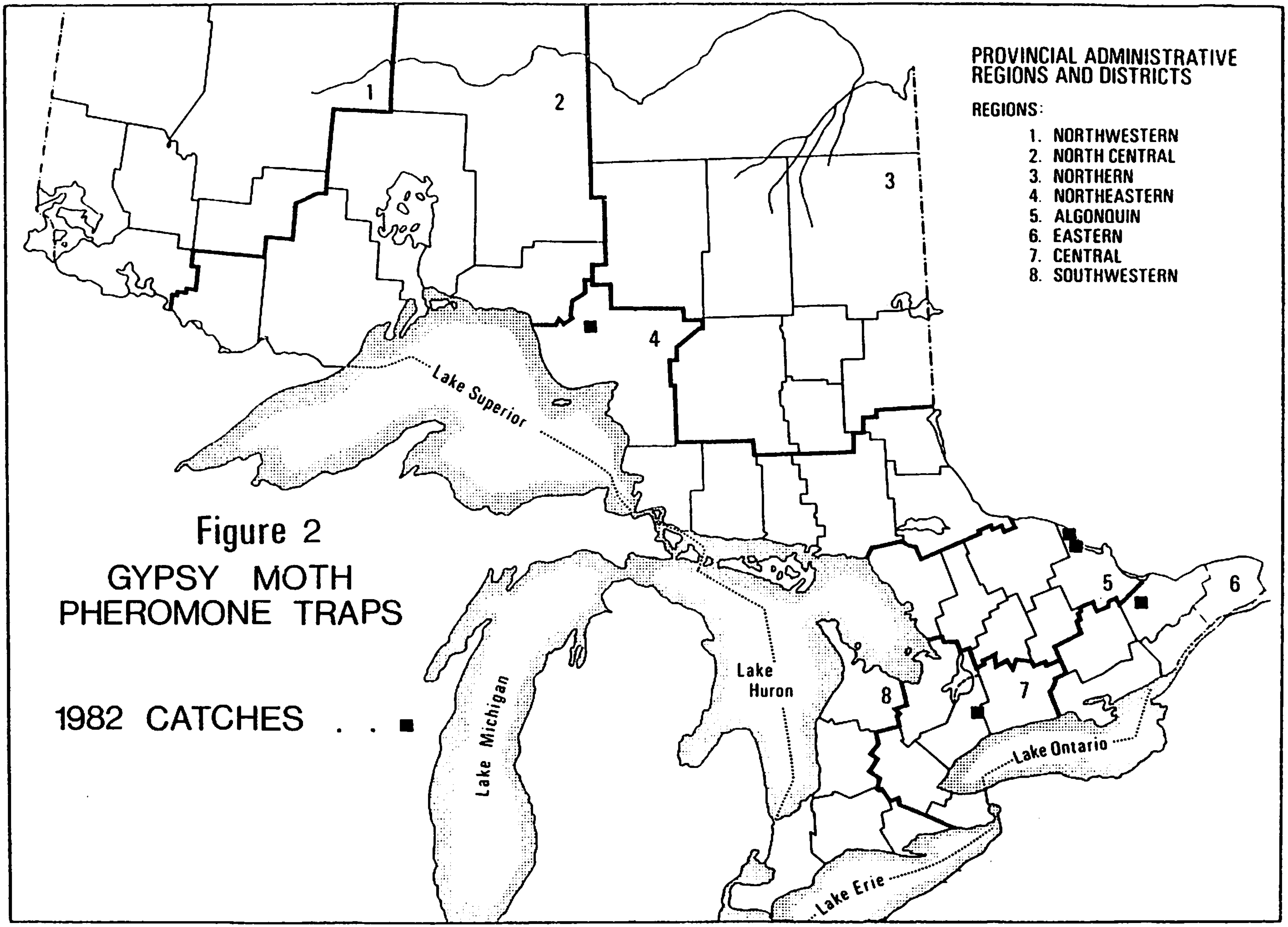


Figure 2
GYPSY MOTH PHEROMONE TRAPS

5)

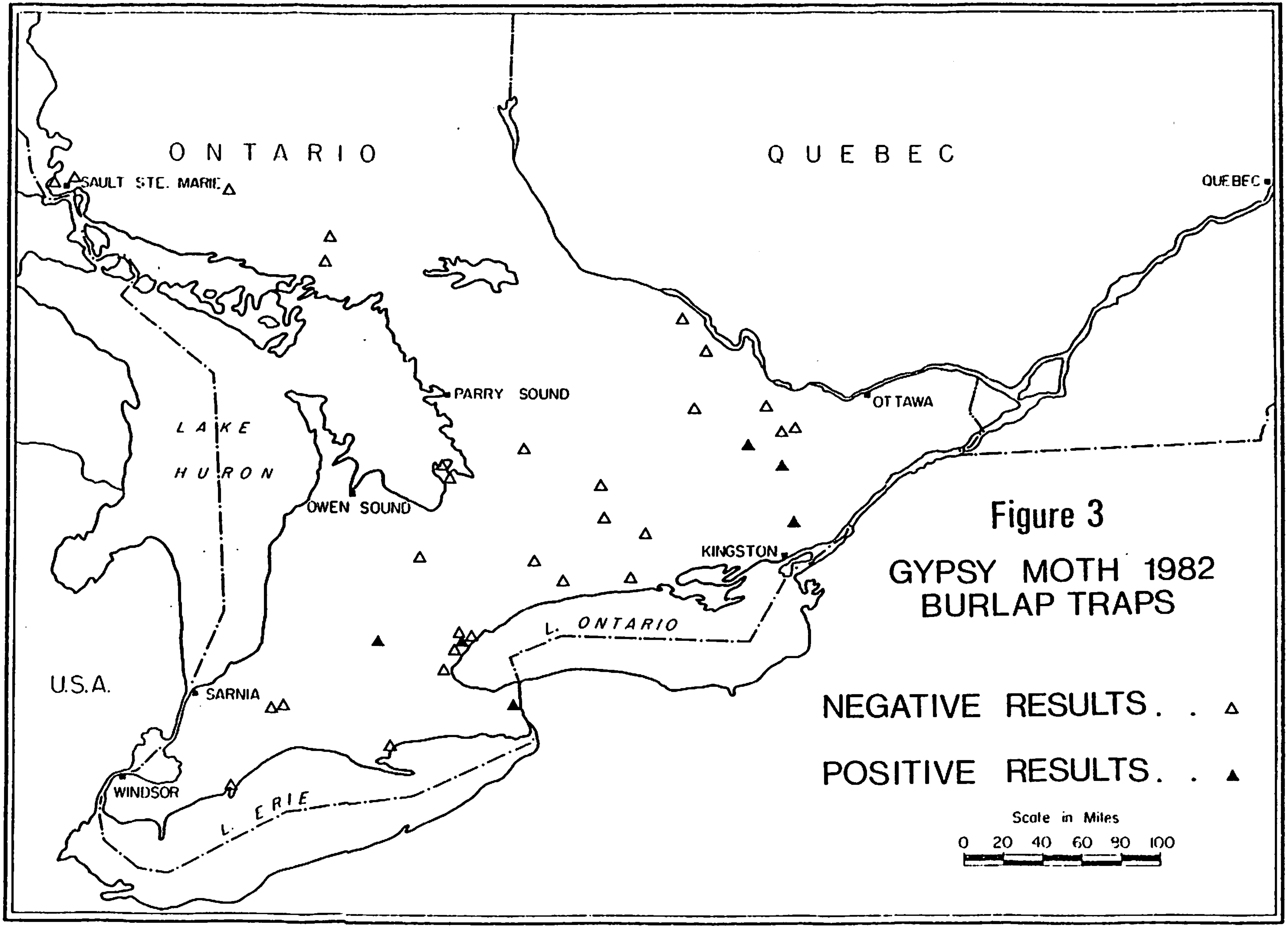


Figure 3
GYPSY MOTH 1982
BURLAP TRAPS

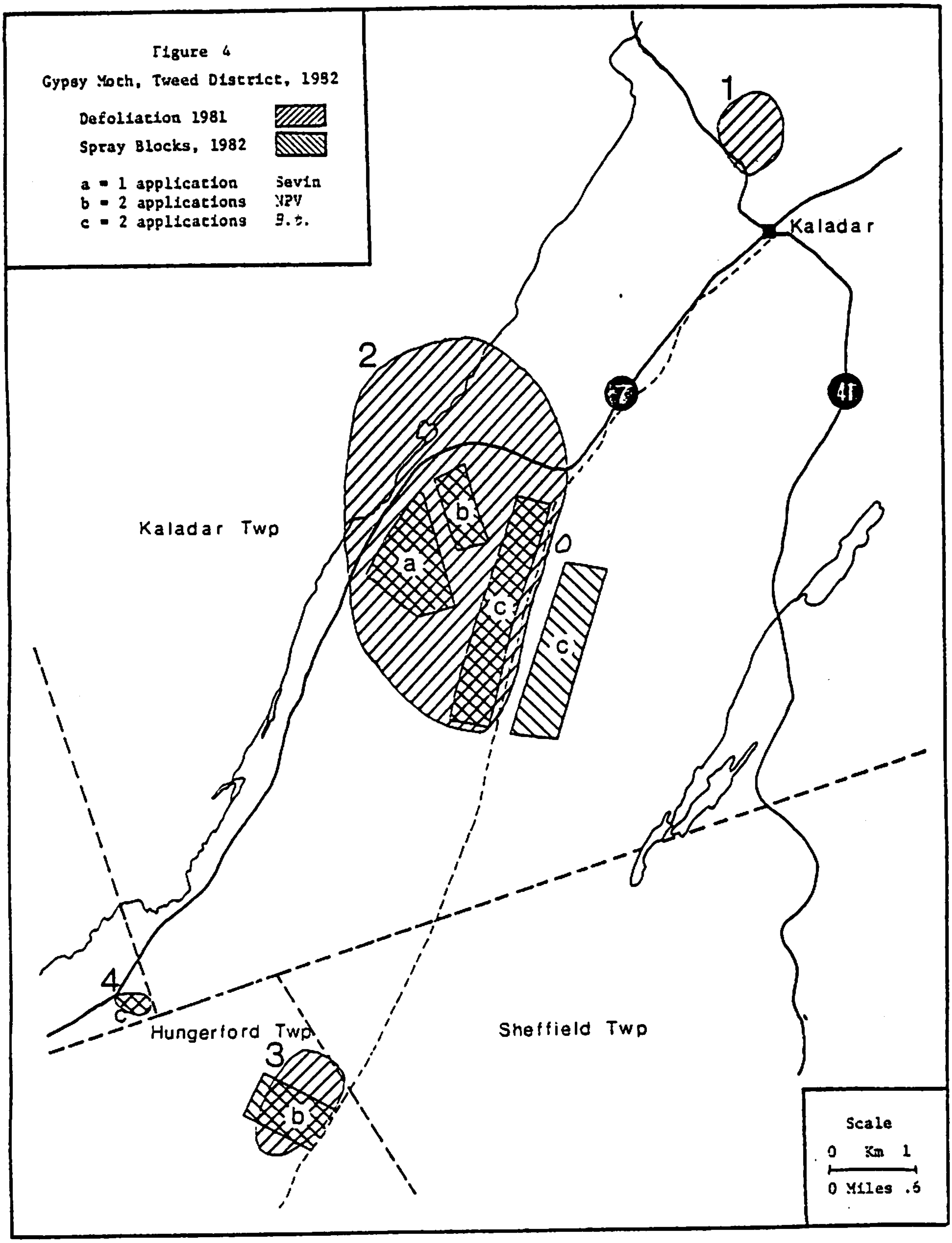


Figure 4
Gypsy Moth, Tweed District, 1982
Defoliation 1981
Spray Blocks, 1982
a = 1 application Sevin
b = 2 applications NPV
c = 2 applications B.t.
1
Kaladar
2
7
41
b
a
c
c
Kaladar Twp
4
c
Hungerford Twp
3
b
Sheffield Twp
Scale
0 Km 1
0 Miles .6

Larval emergence began about May 5 and continued for two or three weeks. This was somewhat earlier than expected as the earliest record of gypsy moth emergence in Quebec is May 5. Surveys revealed that overwintering mortality was quite high in egg-masses deposited above ground level and extremely high in those deposited higher than 30 cm (Table 2). The survival rate of those egg-masses on the ground was about 71 percent compared to 5 percent for those above ground (Table 2). Larval development was monitored before, during and after the control operations and is briefly summarized in Table 3. All spraying was conducted between May 25 and June 2 when the larvae were between the first and fourth instars.

An attempt was made to monitor first instar larval dispersal from infestation No. 2 prior to the first insecticide application. Sheets of plastic (30 cm x 60 cm) coated with tanglefoot were taped to trees at 100 m intervals for a maximum distance of 500 m outside the infestation along the north, south, east and west compass lines. A total of 80 traps were set out and checked before and after the first spray. Results of this survey indicate that dispersal of first instar larvae was minimal.

Generally, the rest of the surveys were conducted in or near the 10 m x 10 m plots used for the 1981 egg-mass survey. Burlap traps, described earlier as a detection tool, were used in the Kaladar spray areas to compare gypsy moth densities in treated and untreated stands. A total of 230 traps were set out in 23 plots and checked twice during the later stages of larval development. Each tree with a trap was also examined with binoculars and the total number of larvae counted within one minute was recorded. The results of these two surveys are not yet available.

In the area treated with Sevin, a survey was conducted using 45 cm branch tips to determine pre- and post-spray larval densities. The results of this treatment, as shown in Table 4, were excellent in terms of larval mortality and foliage protection. Because of the time lag between application and effect of the biological insecticides, and behavioral changes in the later larval instars, this method was not used to assess the effectiveness of the *B.t.* or virus treatments. Some idea of the effectiveness of these treatments can be derived from the results of the defoliation and egg-mass surveys described below.

In late July a defoliation survey was conducted in the Kaladar infestations. This was considered one of the more critical surveys used to evaluate spray efficacy and, quite understandably, is one of the results that foresters are most interested in. The method used was developed by GLFRC(FIDS) for other hardwood defoliatiors in Ontario such as oak leaf shredder and forest tent caterpillar and involves estimating the proportion of damaged leaves and loss of foliage on these leaves from 45 cm branch tips. Results of this survey are summarized in Table 5. Generally defoliation was much lighter in the treated areas than in the untreated check plots. As mentioned earlier, excellent foliage protection was afforded the areas treated with Sevin. Considering their mode of action very good results were also achieved in the areas treated with *B.t.* and Gypchek, It should be noted that the Gypchek trials were conducted with the cooperation of Dr. J.C. Cunningham of the Forest Pest Management Institute who in turn received the cooperation of the U.S. Forest Service in Hamden, Connecticut. Dr. F.B. Lewis provided the Gypchek. This was the first time that this particular virus was used in Ontario and based on the results of the defoliation survey seems to have been reasonably effective. The incidence of virus-infected larvae was determined weekly over a six-week period (Table 6) and while no dramatic virus epizootic developed, many dead larvae were seen hanging by their prolegs in the treated plots. Data from week 1, 2 and 3 post-spray indicate relatively high infection levels in treated areas compared to non-treated areas. However, the situation is not as obvious by weeks 4 and 5 post-spray although based on average, treated areas have higher infection levels than non-treated.

Two hundred (200) pupae were collected to determine emergence success from each of the treated and check plots. The intent was to collect 100 females and 100 males from each plot, however, the field workers were not able to accurately distinguish females from males. In any case, as indicated in Table 7, on the average adult emergence was about the same in the treated plots as the checks. Finally, although there is uncertainty as to the initial proportion of males and females, there is no strong indication of a sex differential effect of NPV. There was evidence of some natural virus-caused mortality in the infestation north of Kaladar which was not treated and there are plans to check these areas in 1983 for signs of virus carryover.

Egg-mass surveys are frequently used as a means of evaluating the effectiveness of control programs and as a means of forecasting potential defoliation the following year. Results of the egg-mass survey conducted in the Kaladar area in October 1982 are summarized and compared to the 1981 results in Table 8. In Table 9 forecasts of potential oak defoliation in 1983 are made on the basis of total egg-masses per hectare and then on the basis of egg-masses per hectare on the ground only. In view of the high mortality rate in egg-masses deposited above ground level, it is likely that the latter forecast is the most realistic. Another infestation was discovered this summer just south of the Village of Kaladar on the west side of Hwy 41. This area was also surveyed for egg-masses in October and the results and forecast included in Table 9.

In summary, the aerial spraying trials conducted in 1982 against gypsy moth in the Kaladar area were very effective in terms of population reduction, foliage protection and egg-mass reduction. All materials tested were effective as Sevin and *B.t.* at 30 BIU/ha were about equal and were closely followed by *B.t.* at 20 BIU/ha and Gypchek.

PLANS FOR 1983

A committee of intergovernmental (federal and provincial) representatives (Environment Canada, Agriculture Canada, OMNR and Ministry of Agriculture & Food) is currently developing a management strategy for the gypsy moth in Ontario. Recommendations developed by this committee will likely serve as guidelines for any future actions concerning gypsy moth within the province. As a result, at present, there are no definite plans; however, GLFRC intends to conduct, in cooperation with OMNR, additional operational trials with materials such as *B.t.* and/or Orthene in 1983 against the gypsy moth.

Table 1. Summary of the aerial suppression program against Gypsy moth in the Kaladar area of Tweed District, Ontario in 1982.

Treatment	Area ha	Date sprayed	Dosage	No. Applications
Sevin-4-Oil	90	May 25	1.1 kg/2.4 l/ha	1
Dipel 88	119	May 28 & June 2	20 BIU/5.9 l/ha	2
"	130	May 26 & May 30	30 BIU/8.8 l/ha	2
Gypchek	36	May 25	2.5×10^{11} PIB/18.8 l/ha	2
	27	May 30	2.5×10^{11} PIB/18.8 l/ha	2
Total Area	402 ha			

Table 2. Summary of overwintering survival of gypsy moth egg-masses collected from two strata (ground and bole) in the Kaladar area, 1981-82, April 1982.

Infestation	Strata	Number of egg-masses	Number of egg-masses hatched (%)	Mean number larvae per egg mass	% eggs per mass hatched
1	G	10	10 (100)	371	98
	B	10	0 (0)	-	-
2	G	70	48 (69)	251	93
	B	70	5 (7)	157	78
3	G	20	13 (65)	102	85
	B	20	0 (0)	-	-
Overall	G	100	71 (71)	240	92
	B	100	5 (5)	157	78

G = Ground

B = Bole (anything above ground level)

Table 3. Summary of gypsy moth larval development in the Kaladar area of Tweed District in 1982.

Date	Species	% Larval Development					
		I	II	III	IV	V	VI
May 5		EGGS HATCHING					
May 17	wO	42	52	6			
	rO	32	44	24			
May 28	wO	24	48	24	4		
	rO	18	34	46	2		
June 1	wO		8	76	16		
	rO		4	44	44	8	
June 3	wO		4	48	36	12	
	rO		4	28	44	24	
June 10	wO			8	36	56	
	rO				60	28	12

13)

Table 4. Population reduction and foliage protection attributable to an aerial application of Sevin-4-Oil (1.1 kg/2.4 l/ha) in the Kaladar area of Tweed District, 1982.

	Species	Pre-spray larvae per 45 cm tip	Post-spray larvae per 45 cm tip	% Population reduction due to treatment	% 1982 Defoliation
Treated	wO	4.4	0.3	88	10
Check	wO	13.0	7.3		46
Treated	rO	2.5	0	100	10
Check	rO	4.1	3.1		44

Table 5. Summary of gypsy moth defoliation of red and white oak in the Kaladar spray areas, 1982.

Treatment	No. of plots*	Average defoliation %		
		wO	(range)	rO
Sevin	4	10(9-12)		10(7-14)
B.t. 20 BIU	3	15(10-18)		15(14-17)
B.t. 30 BIU	3	9(5-14)		10(9-12)
Gypchek (Infestation 3)	3	21(16-28)		24(11-43)
Gypchek (Infestation 2)	3	15(11-23)		20(9-36)
Checks	4	46(23-81)		44(24-84)

*10 or more trees per plot

Table 6. Levels of NPV infection in 4 populations of gypsy moth (2 sprayed with NPV, 2 untreated) in eastern Ontario, 1982.

Plot	Pre-spray		1 week post-spray		2 weeks post-spray		3 weeks post-spray		4 weeks post-spray		5 weeks post-spray	
	No. exam.	% NPV	No. exam.	% NPV	No. exam.	% NPV	No. exam.	% NPV	No. exam.	% NPV	No. exam.	% NPV
Treated												
NPV 1 (Beatty)	177	1.7	196	17.3	198	17.2	161	32.3	195	14.4	164	21.3
NPV 2	188	0.5	187	13.9	194	17.0	200	20.0	203	19.2	187	48.1
Check												
North of Kaladar	209	0	188	2.1	207	2.9	142	5.6	193	15.0	182	41.2
Pitt's Ferry	195	0	192	0	205	0.5	180	0	200	2.5	182	19.8

Table 7. Emergence of 200* gypsy moth pupae from 4 collection sites (2 sprayed with NPV, 2 untreated) in eastern Ontario, 1982.

Plot	Percent adult emergence	Percent apparently diseased	Percent parasitized	Actual no. ♂ and ♀ out of 200 ♂	♀
Treated					
NPV #1 (Beatty)	66.0	29.0	3.0	88	44
NPV #2	66.5	27.5	6.0	63	70
Check					
North of Kaladar	43.0	52.5	4.5	54	32
Pitt's Ferry	81.0	13.5	5.5	99	63

*There were supposed to be 100 ♂ and 100 ♀ but there were errors in sexing the pupae.

Table 8. A comparison of 1981 and 1982 egg-mass densities in treated and untreated gypsy moth infestations in the Kaladar area.

Infestation	Egg masses per ha 1981	1982	% Change
1 (U)	1,350	5,725	+ 324
2 (T)	28,900	1,336	- 95
3 (T)	14,000	1,450	- 90

U - Untreated T - Treated 1982

Table 9. Gypsy moth egg-mass densities and forecasts of potential oak defoliation in 1983 in the Kaladar infestations.

Infestation	Total egg masses/ha	Defol. 1983	Egg masses per ha (Ground)	Defol. 1983
1	5,725	M	2,325	L-M
2	1,336	L-M	729	L
3	1,450	L-M	150	L
Hwy 41 South	32,650	S	9,850	S

1982 PEST CONTROL FORUM

GYPSY MOTH SPRAYING IN ONTARIO

by

ONTARIO MINISTRY OF NATURAL RESOURCES

OPERATIONAL REPORT

The Ontario Ministry of Natural Resources conducted its first gypsy moth spraying program near Kaladar, Ontario in May 1982.

The infestation was distributed through four locations west and north of the village of Kaladar on Crown and private land. At the request of the local municipal council the Ministry planned an aerial control program designed to suppress further infestation from these centres.

As it was the province's first involvement in gypsy moth control, the Ministry relied upon control recommendations provided by Agriculture Canada and the Canadian Forestry Service. The original program design margined the four mapped centres of infestation to minimize the possibility of not treating scattered undetected populations adjacent to the known infestation centres.

Although the initial program included double applications of Sevin-4-Oil, Dipel 88, and Gypchek virus, the municipal council, under fire from local opposition, reversed its decision and withdrew its support of the program. The consequence was a greatly reduced program with application of Sevin-4-Oil restricted to Crown land only and biological insecticides primarily to private lands.

The 416 hectare program was completed between May 25 and June 2 using one Boeing Stearman and one Bell 47 helicopter, both boom & nozzle equipped.

Sevin-4-Oil was applied at the maximum rate of 1.12 kg/2.4 L/ha, in a single application on 90 ha. Dipel 88 was applied at the rates of 20 BIU/5.8 L/ha, 2x, on 133 ha and 30 BIU/8.75 L/ha, 2X on 130 ha. Gypchek virus, provided to the Canadian Forestry Service from USDA Forest Service was field formulated with Dipel carrier oil and applied at a rate of 250 billion PIB/18.8 L/ha, double application, to blocks totally 63 ha in area. Results of the program will be tabled by the Canadian Forestry Service. Program plans for 1983 are yet to be formulated; experimental applications of B.t. and acephate are considerations.

Stephen A. Nicholson
Ontario Ministry of Natural Resources
Maple, Ontario
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GYPSY MOTH IN QUEBEC, 1982

Report to the Canadian Forest Insect Pest Control Forum

Ottawa, November 23-25, 1982

André Lavallée

Laurentian Forest Research Centre

Canadian Forestry Service

Department of the Environment

Sainte-Foy, Québec -

G1V 4C7

Situation in 1982

Basically, gypsy moth distribution did not change since 1981 and is adequately delimited on the map presented by "Plant Health Division of Agriculture Canada" (page 405). However, egg masses were detected in Ste. Foy, near Québec City, where 21 moths had been trapped this Summer. This most easterly point in the province represents the only major change to the border of gypsy moth distribution.

In general, larval populations were low except in 52 widely scattered infested woodlots of various sizes representing some 8300 ha and showing moderate to severe defoliation; virus disease was present in the areas of recorded high populations. Severe defoliation was recorded only in a maximum of 3800 hectares. Major host trees were trembling aspen, grey birch and a few red oaks.

Treatment in 1982

No treatment was undertaken in 1982, in the province of Québec. The dispersion of 17 000 egg parasites (Ooencyrtus kuwanai) in five localities of the province can be reported as one of the action taken against "gypsy moth". The parasites obtained from Maine Forestry Service (Mr. G. Labonté) were reared in the lab and released in nature under controlled conditions.

Projection for 1983

From the first analysis of data available, high populations are not expected on a large scale. The numerous scattered infested areas might present slightly more defoliated stand since gypsy moth populations were sometimes recorded high in 1982.

REPORT ON THE MOUNTAIN PINE BEETLE IN THE PRAIRIE PROVINCES

Prepared by B.H. Moody, NoFRC

For the Tenth Annual Forest Pest Control Forum
November 23-25, 1982. Ottawa

Infestations of the mountain pine beetle (Dendroctonus ponderosae) intensified within the lodgepole pine stands of southwestern Alberta, reported in 1981 but did not expand beyond this zone. In southwestern Alberta, patches of infested pine are scattered over 240 000 ha of forest lands, of which 180 000 ha are on provincial lands, the remainder are in National Parks and Indian Reserves. Besides this, the Cypress Hills area on the Alberta-Saskatchewan border includes about 40 000 ha of forest with scattered beetle infestations.

Increases in beetle-killed trees were also reported in Kootenay and Yoho National Parks. In Banff National Park, a total of 33 beetle-attacked trees were identified in 1982, of this total 9 trees were attacked in 1982 and the others were old beetle-killed trees. Examination of the older attacked trees suggests little brood emergence and therefore no local build up of beetle population. Infestations also intensified in Waterton Lakes Naitonal Park where the outbreak was first reported in 1977 and most of the mature pine trees are now dead.

The Alberta Forest Service has reported that 1982 beetle-attacked trees (mostly wind blown) were found for the first time in Kananaskis Provincial Park and immediately to the north of the Park. Control action was initiated immediately.

Since 1980, Alberta Forest Service has spent almost 3.7 million dollars in support of a beetle control action program. Two zones of the outbreak on provincial lands were delineated for beetle management purposes. The southern zone extending between Highway 3 and Waterton Lakes National Park was considered beyond control and was designated for salvage. Affected lodgepole pine harvested in Alberta have been identified, harvested and scaled separately. Figures supplied by the Alberta Forest Service indicated that for the first half of 1982 the volume of pine salvaged was 40 680 m^3. Surveys conducted in 1982 on provincial forest lands showed that the number of red beetle-attacked trees was over 570,000 with a volume of about 190 000 m^3.

The northern zone extending north of Highway 3 was considered controllable even though small infestations were widely scattered throughout a forested area about 60 km long. The procedure used was to fall infested trees and either salvage them for lumber, peel bark or burn logs prior to beetle emergency. Most of the logs were salvaged. The control program appears to be a success. The Alberta Forest Service have apparently arrested the northerly spread, and the number of recent beetle-attacked trees within the control zone has declined drastically.

Provincial parks staff in both Saskatchewan and Alberta portions of the Cypress Hills continued their control program in 1982. Since 1980, over 700 beetle-attacked trees have been removed in the control program on the Saskatchewan side. Further control work will take place this winter and early 1983. The beetle was not recorded in any other areas of Saskatchewan in 1982. On the Alberta side 850 current beetle-attacked pine trees were identified and will be cut this winter.

In Kootenay National Park beetle infestations have been plotted from aerial photographs taken this summer covering part of the area and from aerial sketch-map surveys. A total of 3,400 red trees (1981-attacked trees) were estimated. About 500 beetle-attacked trees were removed early in 1982 at the north end of the infestation in the Park, in an effort to prevent spread of beetles into provincial forests.

The mountain pine beetle did not spread beyond the 37 locations (shelterbelts, park and urban areas) in the prairie zone of southern Alberta, reported in 1981.

The general beetle outbreak is expected to continue in 1983, although there is an indication that beetle populations will continue to decline in southwestern Alberta.

REPORT ON THE STATUS AND CONTROL OF OTHER PESTS IN THE PRAIRIE PROVINCES AND NORTHWEST TERRITORIES

Prepared by B.H. Moody, NoFRC

For the Tenth Annual Forest Pest Control Forum Meeting
November 23-25, 1982, Ottawa

Forest Tent Caterpillar (*Malacosoma disstria* Hbn.)

The outbreaks of the forest tent caterpillar continued through central and northern Alberta, Saskatchewan and western Manitoba, with some reduction in aspen defoliation in Saskatchewan (see map).

In Alberta, an estimated 130 000 km^2 of continuous and scattered aspen forests were moderately to severely defoliated about the same as in 1981. Approximately two-thirds of this area is in the agricultural zone. Various municipalities, campground managers and private landowners in central and northwestern Alberta attempted control in high-use areas to combat the nuisance aspect of forest tent caterpillars and to protect foliage. Several hectares of aspen were sprayed with Dipel (Bt) and malathion. Results with Dipel were reported to be generally poor.

In Saskatchewan, the forest tent caterpillar infestations declined in 1982. Moderate-to-severe defoliaton of trembling aspen ranged over approximately 21 000 km^2 compared to 82 000 km^2 in 1981. Possible factors that might have contributed to the decline included: decreased fecundity, significant overwintering egg and early post-hatch larval mortality.

In Manitoba, forest tent caterpillar infestation increased and aerial surveys indicated patches of moderate-to-severe defoliation of trembling aspen (and miscellaneous hardwood species) extended from the Saskatchewan border east over an area of approximately 6 000 km^2.

Other defoliators were associated with the forest tent caterpillar but played minor roles. Of these, the large aspen tortrix (Choristoneura conflictana) was the most frequently encountered pest. In 1981, high populatons of the large aspen tortrix severely defoliated aspen stands in Wood Buffalo National Park, however populations declined markedly in 1982.

Forest tent caterpillar egg-band surveys were conducted in Alberta, Saskatchewan and Manitoba to predict infestation levels in 1983. The results indicated that defoliation intensity and distribution will be about the same as in 1982 in Alberta (slight decrease) and Manitoba. A further decline in populations is expected in Saskatchewan.

Dutch Elm Disease

The incidence of Dutch Elm Disease in Manitoba showed a steady increase in 1982, as indicated in the following table.

Year	No. trees sampled	No. trees DED Infected	% of DED Infected
1980	3115	1217	39
1981	4726	2744	58
1982	5587	2952	53

There were 5,587 trees sampled and 2,952 or 53% were found to be affected by Dutch Elm Disease. The disease is spreading along the Manitoba-North Dakota border and also westward from Brandon towards Saskatchewan. Increases were also recorded in the cities of Winnipeg and Brandon. These increases may be attributed in part to an increase in surveillance in the western region.

No control operations are directed toward control of the Disease in the rural areas because of the large number of trees involved and the frequent difficulty of access along rivers and streams. The provincial DED program is directed towards control of the disease in cities and towns. The control program consists of:

1. Removal of diseased trees and other dead or dying trees which are active or potentially active brood sites for elm bark beetles.

2. Pruning of dead branches on living elm trees.

3. Basal spraying of boulevard trees with Dursban insecticide.

4. Injection of high value elm trees with Lignasan BLP or Arbotect 20-S fungicides.

In Saskatchewan, no Dutch Elm Disease was found since the only DED-infected elm was located in Regina in 1981. No Dutch Elm Disease or bark beetles have been found in Alberta.

Dwarf Mistletoes (Arceuthobium americanum)

Dwarf mistletoe is a perrenial problem, especially in jack pine stands in northeastern Alberta, northern and central Saskatchewan and central and southeastern Manitoba. In northern Alberta, a program is being directed toward sanitation treatments of infected residual stands following recent forest fires. In Saskatchewan, timber cruises in jack pine stands started in 1982 to locate stands with severe mistletoe infection, and to direct harvest operations to these infected stands. In Manitoba, study plots have been established in infected forests to evaluate sanitation treatments aimed at reducing infection and spread of misteltoe, and to study the effect of this disease on tree growth. In both Manitoba and Saskatchewan a percentage of harvest cuts are being or will be directed toward mistletoe-infected stands.

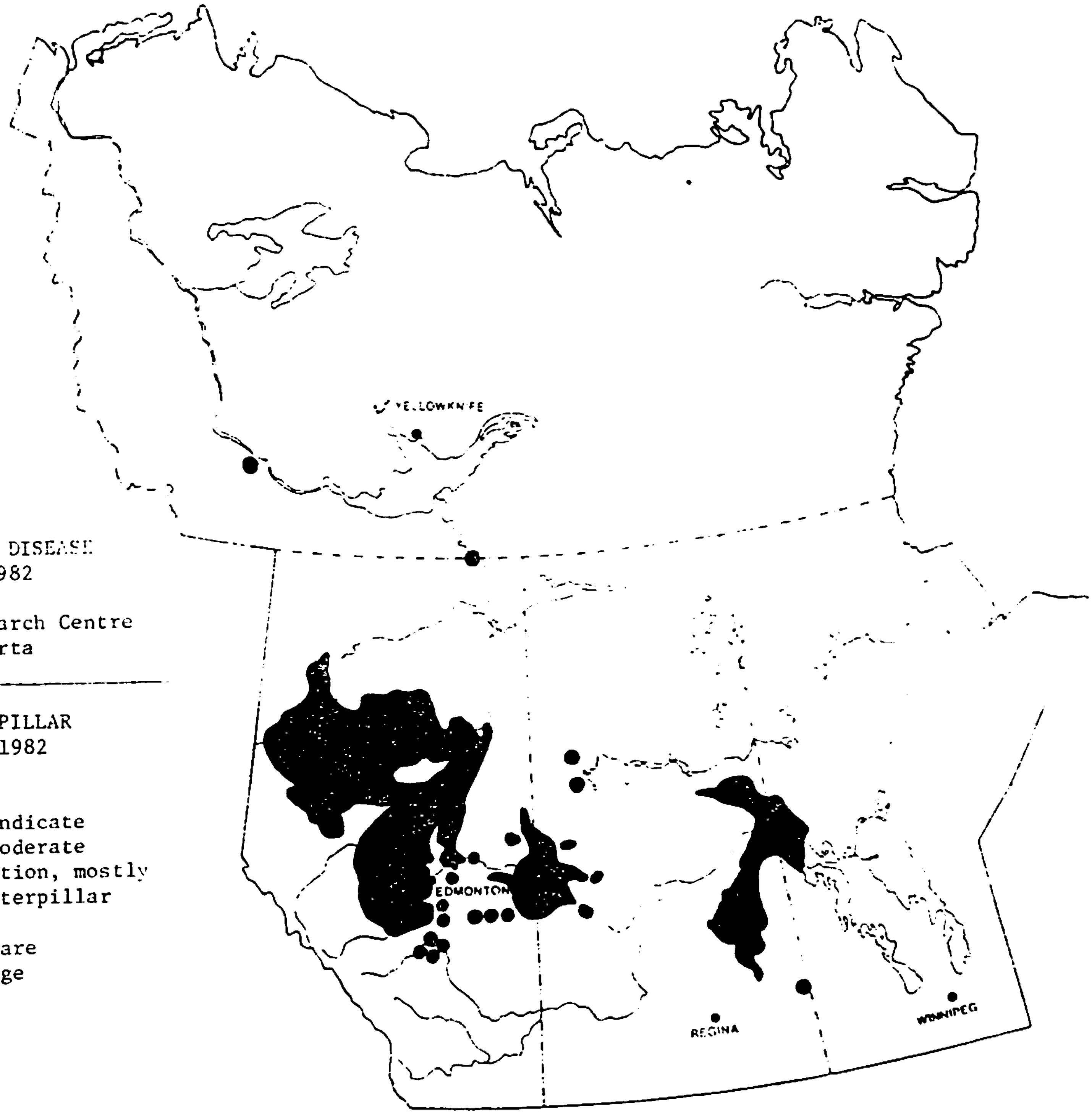
FOREST INSECT AND DISEASE SURVEYS, 1982

Northern Forest Research Centre
Edmonton, Alberta

FOREST TENT CATERPILLAR OUTBREAK AREAS, 1982

Black shaded areas indicate mapped areas of moderate to severe defoliation, mostly by forest tent caterpillar

Locations in N.W.T. are attributed to large aspen tortrix



STATUS OF OTHER IMPORTANT FOREST PESTS

IN ONTARIO, 1982

- Jack pine budworm
- Swaine jack pine sawfly
- Oak leaf shredder

by

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Prepared for

the Annual Forest Pest Control Forum

Ottawa, Ontario

NOVEMBER 23-25, 1982

JACK PINE BUDWORM

The last jack pine budworm outbreak in Ontario occurred between 1966 and 1973 when heavy infestations damaged jack pine stands in northwestern and central Ontario. Considerable tree mortality occurred in Kenora, Dryden, Sudbury, North Bay, Parry Sound, Pembroke and Algonquin districts. Spraying operations totalling almost 6,000 ha were conducted by the Ontario Ministry of Natural Resources in 1968, 1969 and 1972 for the purpose of protecting high value areas such as provincial parks, plantations, and stands of high-quality timber. The Canadian Forces Base, Petawawa and pine plantations at the Petawawa National Forestry Institute were sprayed by the Canadian Forestry Service in cooperation with OMNR in 1969. Fenitrothion was used in 1968 and 1969 and Zectran in 1972. Since the early 1970's, jack pine budworm populations have remained generally low except for an upsurge in the Kenora area in 1979 which subsided quickly.

In 1982, population increases became evident in the Georgian Bay area where several pockets of moderate and severe defoliation were mapped in the Owen Sound, Huronia and Parry Sound districts (Figure 1). The following table lists the location, area affected, level of current defoliation and forecasts for 1983.

Location	Area affected (ha)	% Defoliation	Forecast
Owen Sound District			
St. Edmunds Twp (Johnstons Harbour)	300	54	M-S
Amabel Twp (Sauble Falls)	8	47	S
Huronia District			
Vespray Twp (Hendrie Forest)	75	52	M
Oro Twp	5	53	M-S
Parry Sound District			
Carling Twp			
- South of Imrie Lake	45	48	M
- North of Sand Bay	39	10	L
- East of Remmie Bay	355	18	M-S
- Snug Harbor	193	59	M-S

SWAINE JACK PINE SAWFLY

In 1981, there was a dramatic increase in Swaine sawfly populations in the Elk Lake Management Unit, Temagami District, Northeastern Region. Moderate-to-severe defoliation was mapped at two locations. One, near Banks-Makobie lakes, expanded to 4,660 ha in 1981 from 325 ha in 1980. The other infestation, around Big Boot Lake, also increased considerably from 450 ha of moderate-to-severe defoliation in 1980 to 1,035 ha in 1981. Both infestations decreased in size in 1982 (Figure 2). The Banks-Makobie lakes infestation declined mainly to moderate levels of defoliation and the area affected was about 3,950 ha. The infestation in the Big Boot Lake area decreased to 700 ha in 1982 and defoliation was lighter than the previous year. Pockets of light and moderate defoliation were also reported in jack pine plantations in the general area as well as on several islands in Lake Temagami.

OAK LEAF SHREDDER

The oak leaf shredder has been a persistent pest of red oak in recent years in many locations in southern Ontario. Defoliation by this insect is probably a major predisposing factor in oak decline, dieback and mortality. OMNR has sprayed a total of 2,440 ha of oak-maple forest in provincial parks and county forests in Huronia and Maple districts of the Central Region from 1977-1980.

In 1981, an overall decline in population levels occurred and most infestations subsided except for a few areas in the Central Region. In 1982, populations remained generally low except in the Central and Southwestern regions. In the Southwestern Region, defoliation was recorded in the Turkey Point area of the Simcoe District and the Pinery Provincial Park area of the Chatham District. In the Central Region,high populations and defoliation occurred in the Cayuga-Fonthill and St. Catherines area of the Niagara Falls District, Durham Regional Forest and in the Uxbridge-Vivian area of Maple District and the Dufferin County Forest and adjacent parts of the Simcoe County Forest in the Huronia District.

Forecasts for 1983 indicate that populations will generally remain low with the exception of the Dufferin County Forest where severe defoliation is expected next year.

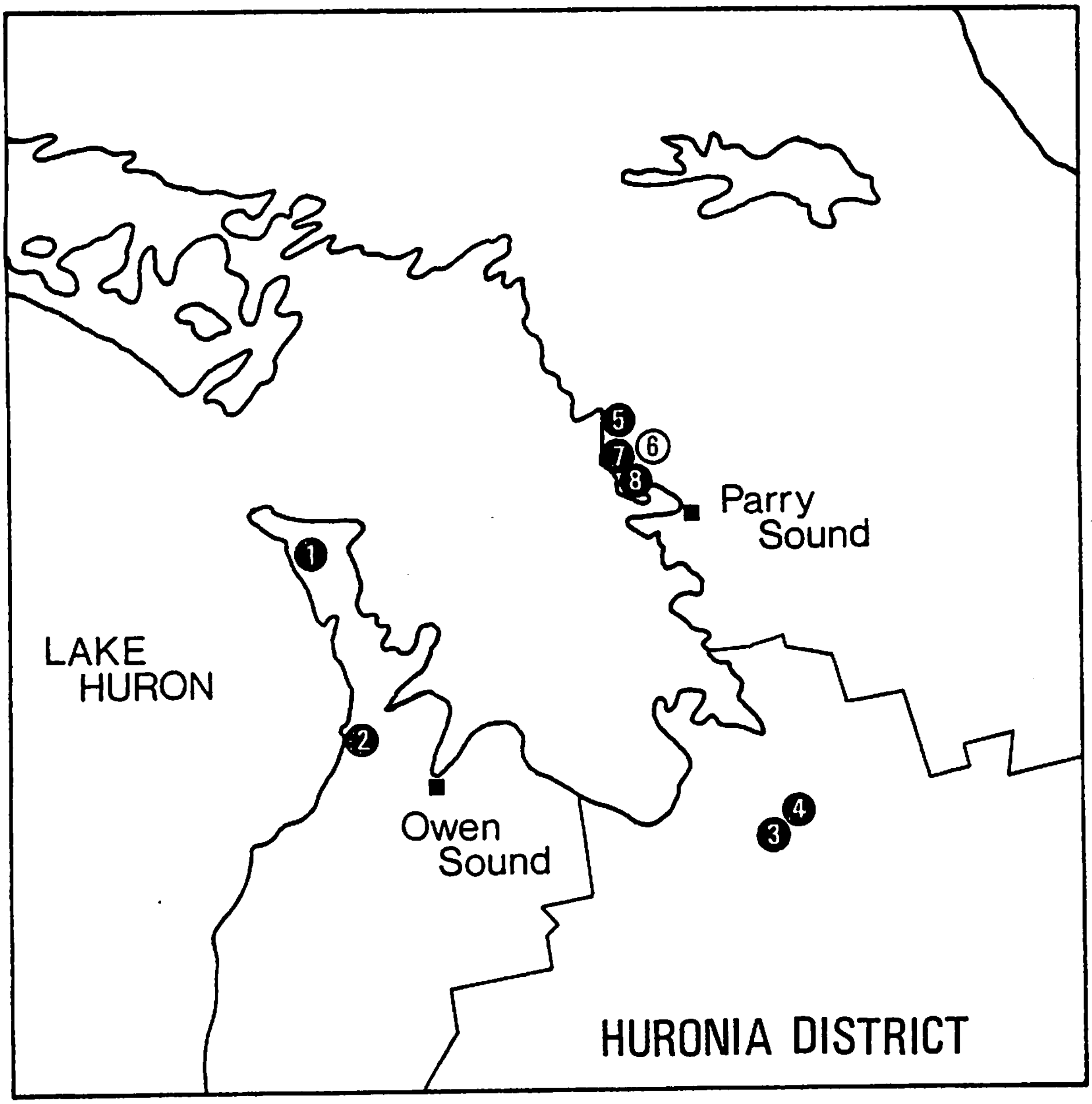
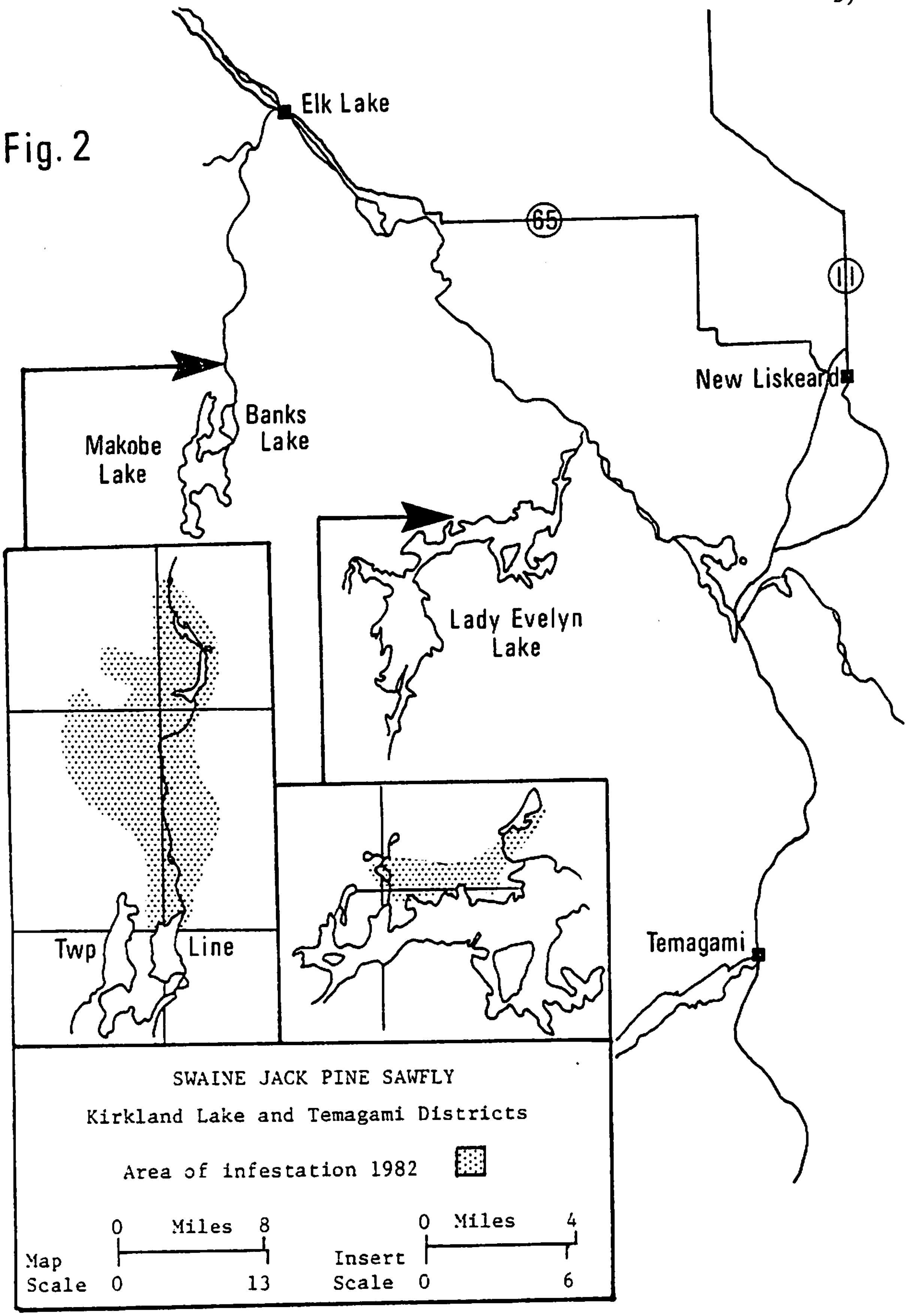


Fig. 1 JACK PINE BUDWORM 1982

Areas within which defoliation on jack pine occurred.

Moderate-to-severe defoliation . . ●
Light defoliation . . . . ○

Fig. 2


Elk Lake
65
11
New Liskeard
Banks Lake
Makobe Lake
Lady Evelyn Lake
Twp
Line
Temagami
SWAINE JACK PINE SAWFLY
Kirkland Lake and Temagami Districts
Area of infestation 1982
Map Scale
0 Miles 8
0 13
Insert Scale
0 Miles 4
0 6

Reports on the Status and Control of other Pests.

Québec - Swaine Jack Pine Sawfly (*Neodiprion swainei*)

as presented by André Lavallée at the Canadian Forest Insect Pest Control Forum, Ottawa, November 23-25, 1982

Since 1980-81 top mortality in jack pine of the Upper St. Maurice is recorded. In 1982, the Québec Department of Energy and Resources treated 2600 ha of jack pine in that area with Fenitrothion. Results are not available at this time but additional patches of jack pine scattered around treated areas were observed this summer.

A SUMMARY OF THE 1982 SPRAY PROGRAM AGAINST THE SPRUCE BUDMOTH (ZEIRAPHERA SPP.)

Lester Hartling
Entomologist
Forest Protection Limited

INTRODUCTION

The spruce budmoth (*Zeiraphera* spp.) is a lepidopterous insect pest with white spruce as its primary host. At epidemic levels the insect can cause destruction of tree leaders and other shoots, thus arresting height growth and distorting tree shape.

Attention focussed on the budmoth in 1980 when an infestation arose in white spruce plantations in north-western New Brunswick. The company owning the plantations, J.D. Irving Limited feared a prolonged outbreak would reduce the quality and commercial value of their trees which were earmarked for lumber.

In 1981 the author, with the technical advice of Mr. E.G. Kettela of the Canadian Forestry Service, initiated a program to study (1) the natural history of the budmoth, (2) the insect's impact on plantation white spruce, and (3) the efficacy of the insecticides fenitrothion and trichlorphon (Dylox®) on larval populations. In summary, the insecticide applications were ineffective due to the lateness of treatments and to the protection afforded to larvae feeding under the budcaps. A preliminary report was presented to the *Forest Pest Control Forum* in Ottawa on December 2, 1981. A detailed analysis of the program was prepared in draft form and made available to interested parties on request after December 14, 1981.

In 1982 the Forest Pest Management Institute (CFS), under Dr. Jean Turgeon, began its own research program on the spruce budmoth. The approach of FPMI is to study the species in detail to find the most vulnerable stage(s) on which to effect population supression.

Owing to the urgency of the problem, however, J.D. Irving Limited treated approximately 11,000 ha of budmoth infested plantations with two applications of the insecticide fenitrothion in hopes of effecting some measure of control. In the absence of any established control technique, the company applied insecticides at the time larvae were feeding on the current year's foliage. The author, upon the request of Mr. E.G. Kettela (CFS) monitored the efficacy of the treatments. This report is intended as a summary of the results.

METHODS

The insecticide was applied with Thrush aircraft equipped with a Micronair atomization system. The aircraft were owned and operated by Forest Patrol Ltd. Each treatment was applied at a rate of 210 g of active ingredient per hectare. The first application was made on June 6 and 7 when the larvae were in third instar, followed by a second application on June 11 to 13 when the larvae were in their ultimate (fourth) instar.

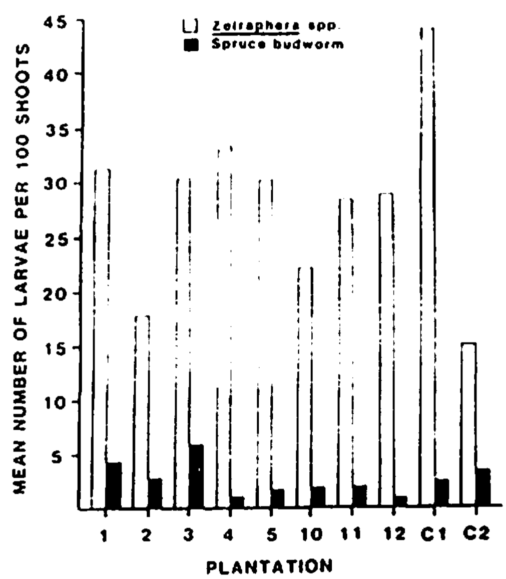
Plots were established in 8 white spruce plantations treated with insecticide and 2 natural stands serving as controls. All 10 plots were sampled for insects before and after an insecticide was applied to the treatment areas. A third sample was taken in 3 of the sprayed plots and the 2 control plots following a second application in the treatment areas. A fourth sample was subsequently made in the 2 control plots.

The sampling procedure was as follows. Within each plot 30 trees were selected and marked for identification purposes. A mid- and upper-crown branch was removed from each tree every sampling period. The larvae of spruce budmoth, spruce budworm, and other defoliating insects were counted on each branch sample. All shoots from the current years growth were counted so that population density could be expressed as larvae per 100 shoots of new foliage. Other parameters measured during the program were (1) the number of shoots containing one or more budmoth larvae, (2) the number of trees with budmoth feeding on the leader, and (3) percent needle loss caused by insect defoliation.

RESULTS AND DISCUSSION

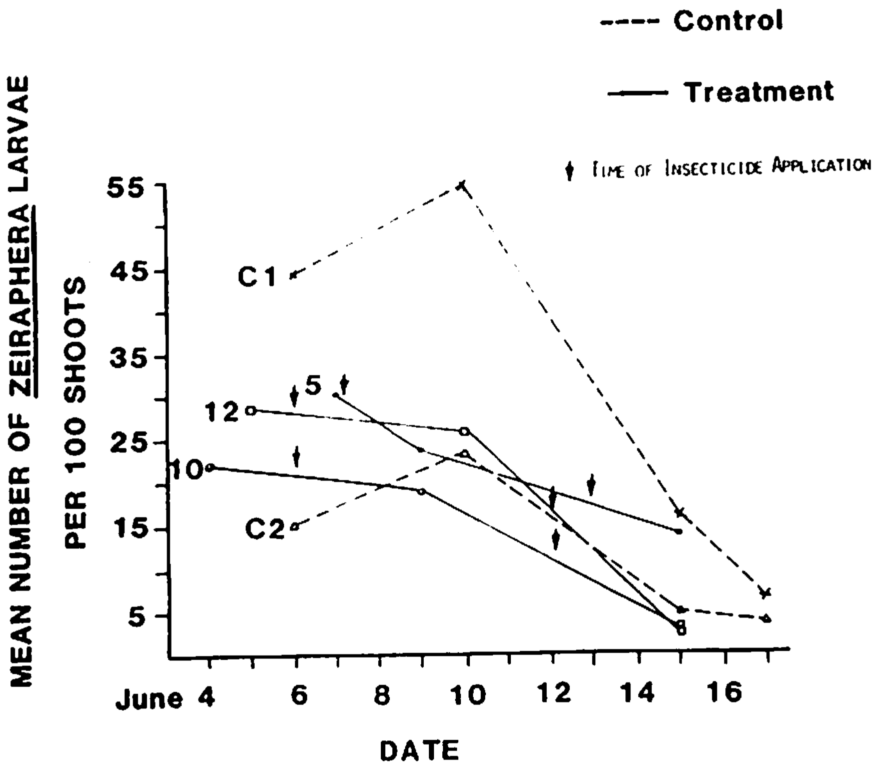
Infestation Level

Larval populations of budmoth were as high in 1982 as in 1981 with an average of 15-44 insects per 100 shoots in any of the monitored plots. Budmoths were the most abundant of the insect defoliators found on white spruce foliage with the spruce budworm the second most common species. Their relative abundance is compared in the following figure.



Efficacy of Insecticide Treatments

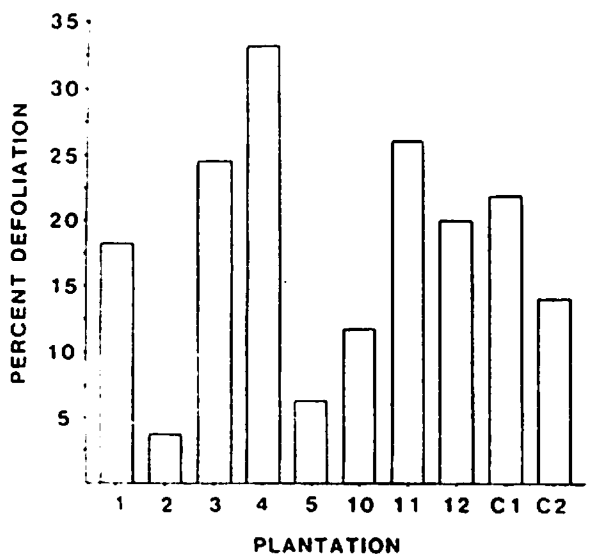
The change in budmoth populations on study plots as monitored by branch sampling is presented in the following figure.

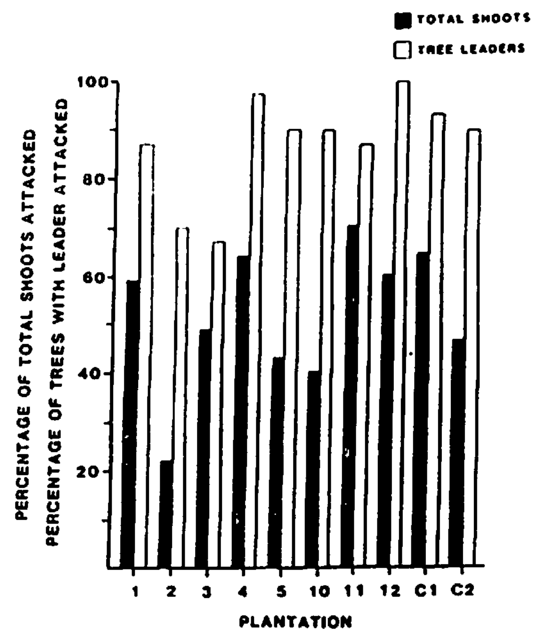


Insecticide treatments could not be considered efficacious in reducing larval populations. The larvae were mostly third instar at the time of the first application and were feeding under budcaps firmly attached with the insect's silk. The insecticide apparently did not penetrate through this barrier. Subsequent to the second application there was an abrupt decrease in the number of budmoth larvae found on foliage in the treated plots. This decrease is attributed to larvae dropping from the foliage to pupate in the leaf litter rather than insecticide-induced mortality effects. A similar response occurred in the untreated plots.

Impact of Larval Feeding on White Spruce Host

Defoliation is plotted in the following (left) figure. Although the control program was unsuccessful in reducing populations of budmoth larvae, needle loss was still quite low in most monitored plots. Clearly, such convential measurements as defoliation estimates are inadequate in evaluating the impact of the budmoth and more appropriate measurements need be designed. Since the insect's status as a pest does not come from this ability to defoliate, per se but rather that the larvae may weaken elongating shoots and increase their chances of breaking-off, it is of more than academic interest to know what proportion of shoots are attacked on the tree and specifically whether the tree leader is attacked. This data are plotted on the following graph to the right.





CONCLUSIONS/RECOMMENDATIONS

(1) Insecticide treatments in 1982, as in 1981 had a negligible impact on budmoth populations.

(2) In 1981 and 1982 the first application of insecticide had been made when budmoth larvae were safely feeding under the budcaps of white spruce. The second application coincided with insect pre-pupation. These spray tactics were ineffective suggesting that such convential application strategies are inadequate for dealing with the budmoth. Although a systemic insecticide offers more potential for success than a contact insecticide, the best spray strategy might be to apply several treatments in succession when the larvae are migrating to the new buds after emerging from the over-wintering eggs. Obviously, to be effective this approach would require precise monitoring of the insect.

(3) Optimal timing of spray and evaluation of the efficacy of several insecticides under field conditions remain the key needs for further investigation.

(4) An accurate method of sampling overwintering egg-populations is needed in order to forecast infestation levels in the subsequent year.

(5) Conventional measurements used to evaluate feeding damage of such insects as spruce budworm are inadequate for dealing with the spruce budmoth. Studies are needed to describe and quantify the short and long term effects of a budmoth infestation on tree condition, especially on potential growth loss and tree shape.

Fredericton, N.B.
November 17, 1982

MARITIMES FOREST RESEARCH CENTRE

TECHNICAL NOTE NO. 62

MAJOR FOREST PESTS IN NOVA SCOTIA IN 1982

Many pests interfere each year with the production of wood in the forest or with the aesthetic appearance of trees. One of these, the spruce budworm, has caused widespread damage to Nova Scotia's forests in the past eight years. For the 'budworm story' for 1982 see Technical Notes 63, 64 and 65. Other pests of economic importance are briefly mentioned here. These and others will be discussed in detail in the annual report of the Forest Insect and Disease Survey.

GYPSY MOTH severely defoliated hardwoods on over 8 million acres in the eastern half of the United States and caused discomfort, inconvenience and financial burden to people in many areas in 1982. Eggmasses of the insect were found in Nova Scotia for the first time in the fall of 1981 at Yarmouth. No larvae were seen in the Town in the summer of 1982 in the few blocks area where a control program, involving ground application of B.t. and implantation of a systemic chemical, was carried out in May. However, this year's search, a coordinated multi-agency effort, has already located eggmasses at two locations in southwestern Nova Scotia. In excess of 50 eggmasses were found at Yarmouth and several more at Church Point, Digby County. Although gypsy moth is a rather indiscriminate feeder its favorite host is oak on which populations can build up rapidly. Oak stands are numerous in the western half of the Province and the proximity of the known gypsy moth infestations to these stands is of considerable concern.

SPRUCE BEETLE has killed more than 9% of the Province's total white spruce since the mid 1960's when its populations built up following extensive storm damage. Although losses are most extensive on Cape Breton Island and in the northwestern part of

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the Province damage is widespread throughout Nova Scotia. In 1982 beetle attack has intensified resulting in further increase in mortality.

EASTERN LARCH BEETLE has killed over 60% of merchantable size larch since 1978 and has also successfully attacked and killed smaller trees. There are some early indications that the outbreak, probably triggered by the weakening of mature trees by larch sawfly in the 1970's, may have peaked. However, further tree mortality is expected to continue throughout the Province for a number of years.

EUROPEAN LARCH CANKER is widespread throughout much of mainland Nova Scotia. Recently re-discovered in North America after an absence of several decades, it also oocurs in southern New Brunswick and eastern Maine. The disease, which causes extensive branch dieback and mortality in younger trees, has been found only on native larch to date. However, in Europe it has caused the exclusion of larch from plantation programs in many areas. Tree improvement programs, within the framework of increased emphasis on forest renewal, rely on hybrids for wood production. The presence of this disease could seriously hamper the effort.

DUTCH ELM DISEASE continued to intensify within its known range especially in Cumberland, northern Colchester and Pictou counties, and also to spread to new areas. The most extensive spread in 1982 occurred in Pictou and Antigonish counties. The range was further extended in the Annapolis Valley with the discovery of the disease in Middleton. The first infected trees were found in the City of Halifax and in the Town of Truro. About 18% of the Nova Scotia's rural elm trees have been killed or infected by the disease but the concentration of dead and dying trees is highest in the north-northcentral part of the Province where more than half of the trees are affected.

FOREST TENT CATERPILLAR populations increased again in 1982. Although defoliation occurred only in small areas, these "pockets" were more numerous than last year indicating an impending outbreak in the near future.

SUGAR MAPLE BORER damaged trees were found in several areas in Cumberland, Colchester, Pictou and Antigonish counties. This insect has not been known as a problem in the Maritimes in the past but its presence has implications in maple syrup production areas.

Other pests of note include OAK LEAF SHREDDER, OAK LEAFROLLER, DWARF MISTLETOE, MAPLE LEAFROLLER, RED PINE SAWFLY, NEEDLE RUST, DOUGLAS FIR NEEDLE BLIGHT and more.

-L.P. Magasi
Forest Insect and Disease Survey

October 25, 1982