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ENVIRONMENT CANADA

Report of the
ANNUAL FOREST PEST CONTROL FORUM
Place Vincent Massey, Hull, P.Q.
November 14, 1974.
19

The Annual 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, 1975

REPORT OF THE ANNUAL FOREST PEST CONTROL FORUM

Place Vincent Massey, Hull, P.Q.

November 19, 1974

In Attendance:

Newfoundland Forest Service

Mr. J.A. Brennan , St. John's

Nova Scotia Department of Lands and Forests

Mr. R.P. Michaud, Truro

New Brunswick Department of Natural Resources

Mr. H.H. Hoyt, Fredericton

Quebec Department of Lands and Forests

Mr. G. Paquet, Quebec
Mr. R. Desaulniers, Quebec

Quebec Wildlife Service

Mr. R. Sarrazin, Quebec

Ontario Ministry of Natural Resources

Mr. K.B. Turner, Toronto

British Columbia Department of Lands, Forests and Water Resources

Mr. J.M. Finnis, Victoria

Council of Forest Industries of British Columbia

Mr. H.A. Richmond, Nanaimo

Forest Protection Limited

Mr. B.W. Flieger, Fredericton
Mr. B.A. MacDougall, Fredericton

Canada Department of Agriculture

Mr. E.R. Houghton, Plant Products Division, Ottawa

Canada Department of Indian Affairs and Northern Development

Mr. H.A. Peacock, Indian - Eskimo Economic Development Branch, Ottawa
Mr. J.P.G. de Lestard, Northern Natural Resources and Environment Branch, Ottawa
Mr. R. Kroll, National Parks Branch, Ottawa

Canada Department of Health and Welfare

Dr. T.F. McCarthy, Medical Services Branch, Ottawa

Canada Department of Environment

Fisheries and Marine Service

Mr. C. Morry, St. John's
Dr. W. Watt, Halifax
Dr. D. Scarratt, St. Andrew's
Mr. R. Poirier, Quebec
Mr. A.S. Rosemarin, Ottawa
Dr. N.Y. Khan, Ottawa
Mr. C.L. Dominy, Ottawa

Canadian Wildlife Service

Mr. P.A. Pearce, Fredericton
Mr. J.A. Keith, Ottawa

Environmental Protection Service

Dr. P. Eaton, Halifax
Dr. H.A. Hall, Halifax
Mr. D. Wilson, Vancouver
Dr. H.S. Thompson, Ottawa

Environmental Management Service

Mr. V.V. Spence, Ottawa

Canadian Forestry Service

Dr. G.P. Thomas (Chairman)
Mr. A.C. Molnar (Secretary)

Mr. G.L. Warren, St. John's
Mr. R.C. Clark, St. John's
Dr. M.M. Neilson, Fredericton
Mr. E.G. Kettela, Fredericton
Mr. R. Martineau, Quebec
Dr. W.A. Smirnoff, Quebec
Dr. C.J. Sanders, Sault Ste. Marie
Dr. W.L. Sippell, Sault Ste. Marie
Dr. G.M. Howse, Sault Ste. Marie
Dr. G.W. Green, Sault Ste. Marie
Dr. T.A. Angus, Sault Ste. Marie
Dr. J.C. Cunningham, Sault Ste. Marie
Dr. R.W. Reid, Edmonton
Dr. R.F. Shepherd, Victoria
Mr. H.A. Tripp, Victoria
Dr. J.J. Fettes, Ottawa
Dr. C.H. Buckner, Ottawa
Dr. J.A. Armstrong, Ottawa
Dr. P.C. Nigam, Ottawa
Mr. A.P. Randall, Ottawa
Mr. G. Taylor, Ottawa
Mr. R.M. Prentice, Ottawa
Dr. F.E. Webb, Ottawa
Dr. A.G. Davidson, Ottawa

Dr. G.P. Thomas, Director General, Canadian Forestry Service welcomed the delegates representing provincial and federal governments and private agencies remarking on the large attendance. He introduced those present and for the benefit of the new participants, he reviewed the objectives of the Forest Pest Control Forum as follows:

> The Forum is to enable discussions of forest pest control operations recently undertaken in Canada; to discuss current active, and planned future research and trials bearing on forest pest control in Canada, and to allow an opportunity to review forest pest conditions that might require control action in the upcoming year and, where appropriate, to discuss operational plans. The Forum continues to function on the initiative of the Canadian Forestry Service. The Forum can, at any time, give rise to specific actions or projects involving inter-agency cooperation, but is not necessarily obliged to do so.

Dr. Thomas stressed that the Forum is first of all a mechanism for information exchange. It will continue to be successful to the extent that its members make it so. Judging from the interest in the Forum over the past two years of its existence, he felt that there was a fair indication of its usefulness.

The agenda was adopted as circulated. Dr. Thomas explained that certain persons had been designated as speakers but these persons could refer to others if they so wished.

The Chairman presented the following agenda which was accepted without modification:

1. Spruce budworm

   1.1. Maritime Provinces

   Control Program - 1974

   Reports on Operations
   - NBNR - Mr. Hoyt
   - FPL - Mr. Flieger

   Reports on technical services and assessments
   - MFRC - Mr. Kettela
   - CCRI - Dr. Fettes

Reports on environmental monitoring

MFRC - Dr. Neilson
CCRI - Dr. Fettes
CWS - Mr. Keith
EPS - Dr. Thompson
F&MS - Mr. Rosemarin
NH&W - Dr. McCarthy

<u>Prospects and Plans - 1975</u>

MFRC - Mr. Kettela
NBNR - Mr. Hoyt
FPL - Mr. Flieger

1.2 Quebec

<u>Control Program - 1974</u>

Report on Operations
QL&F - Mr. Paquet

Reports on technical services and assessments
QL&F - Mr. Paquet
LFRC - Mr. Martineau
CCRI - Dr. Fettes

Reports on environmental monitoring
QL&F - Mr. Paquet
CCRI - Dr. Buckner
NH&W - Dr. McCarthy

<u>Prospects and Plans - 1975</u>

QL&F - Mr. Paquet
LFRC - Mr. Martineau

1.3 Ontario

<u>Outbreak status and control operations - 1974</u>

ONR - Mr. Turner
GLFRC - Mr. Howse

<u>Prospects and Plans - 1975</u>

GLFRC - Mr. Howse
ONR - Mr. Turner

1.4 Newfoundland

<u>Outbreak status, 1974, prospects and plans - 1975</u>

NFRC - Mr. Clark (Mr. Brennan)

1.5 Maine

Comments by representatives of state and federal agencies.

1.6 Review of research underway, and planned, with reference to more effective and less-damaging control techniques and long-term management of the budworm problem.

Topic to be introduced by Dr. C.J. Sanders, Chairman of CFS Spruce Budworm Working Committee, with assistance, as appropriate, from representatives of agencies active in such research.

2. Reports on 1974 control operations against other pests and prospective or possible operations in 1975.

(Time limitations may dictate that reports on minor problem situations be tabled or dealt with briefly)

3. Pest Control Products Act: new restrictions on use of pesticide products in forest pest management.

Mr. E.R. Houghton, CDA

4. Other business.

INDEX OF ABBREVIATED AGENCY NAMES

CCRI	Chemical Control Research Institute, CFS, DOE
CDA	Canada Department of Agriculture
CWS	Canadian Wildlife Service, DOE
EPS	Environmental Protection Service, DOE
F&MS	Fisheries and Marine Service, DOE
FPL	Forest Protection Limited, N.B.
GLFRC	Great Lakes Forest Research Centre, CFS, DOE
IPRI	Insect Pathology Research Institute, CFS, DOE
LFRC	Laurentian Forest Research Centre, CFS, DOE
MFRC	Maritimes Forest Research Centre, CFS, DOE
NBNR	N.B. Department of Natural Resources
NFRC	Newfoundland Forest Research Centre, CFS, DOE
NH&W	National Health & Welfare Department
ONR	Ontario Ministry of Natural Resources
QL&F	Quebec Lands & Forests Department

1. SPRUCE BUDWORM AERIAL SPRAYING OPERATIONS

1.1 Maritimes Provinces

Control Program - 1974

Operations - Mr. Hoyt deferred to Mr. Flieger who did not table a report but gave a brief verbal account of the 1974 spray operations in New Brunswick. While things went fairly well according to plan, neither the optimum spray mix nor the optimum coverage was achieved in 1974. As a result, protection was a little below expectation in some areas. Unfortunately a few airplanes were lost, and sadly, one pilot lost his life. Timing, if anything, was a little early and as a result there was a long lay over for the adult spray trials. Mr. Flieger estimated the cost of the larval spraying at about 60¢ per acre but noted that costs for 1975 could run considerably higher. Mr. Kettela (APPENDIX 1) reported that FPL sprayed 3.9 million acres of forests in New Brunswick against budworm larvae in 1974 with the chemicals fenitrothion (2,415,000 acres), Dimecron (1,458,000 acres) and Dylox (33,000 acres).

Technical Services and Assessments - Mr. Kettela reported (APPENDIX 1) that the fenitrothion applied at the usual 3 oz active ingredient per acre in 0.15 U.S. gallons provided protection comparable to previous years (15-60% of foliage crop saved). Spray operations commenced on May 18 and ended June 20 and were most effective against the later instar larvae. Foliage protection with 6.4 oz Dylox per acre was about 25%, which is equivalent to protection with fenitrothion used on second instar budworm. The results obtained with Dimecron at 2 oz per acre were poor with about 5% of the foliage crop protected. The overall average reduction in larval survival was 70% on balsam fir and 25% of the new foliage was saved. Mr. Kettela pointed out that both these figures were lower than those obtained in the past few years and reflect the poor results attained with Dimecron.

Mr. Kettela reported that defoliation surveys in 1974 mapped 8.3 million acres of moderate to severe defoliation, an increase of 1.1 million acres over 1973. Egg-mass surveys showed that moderate to high infestations covered most of the spruce-fir forests of New Brunswick and that the largest increases were in the northwest and southeast areas of the Province. Egg-mass densities also increased by 50% over those recorded in 1973. He noted that, although spring was cold and wet, weather conditions from the fourth instar to the adult stage of the budworm were excellent, and an average 33% of the population attained the adult stage. The hazard to trees as determined by Canadian Forestry Service computation was recorded as high over 4.5 million acres and high to extreme over 2.3 million acres.

An aerial assessment of the budworm situation in Nova Scotia revealed 380,000 of moderate and 87,000 acres of severe defoliation, a large proportion of which occurred on Cape Breton Island. Egg-mass surveys indicated that the moderate to severe infestation in Cumberland, Antigonish, Victoria and Inverness counties had increased in area and density and that some 1.5 million acres have a moderate to high infestation.

On Prince Edward Island aerial surveys showed that there were patches of light to moderate defoliation over the whole Island and that severe defoliation affected 42,000 acres. Egg-mass surveys indicated that a moderate to severe infestation still covered the Island but it was one-half the intensity it was a year ago.

In a brief discussion period on the New Brunswick control operations, Dr. Fettes said it should be clarified that the reported poor performance of Dimecron (R) was attributable to the low dosage used, not to the quality or capability of the chemical. He said at the optimum dosage of 6 oz per acre the insecticide is at least as good as fenitrothion. Two oz per acre is not enough, he added, but 2 + 2 oz or 3 + 2 gives good results.

Mr. Flieger added further clarification with respect to the apparent failure of Dimecron. He said that the limited supply of the chemical and the extraordinarily high budworm population were also factors. The limited availability of the chemical dictated the low dosage rate, but the high survival rate of the insect was also affected by the extraordinarily high larval population.

Dr. Fettes, in response to the Chairman's request for a comment on the input of the Chemical Control Research Institute, into the budworm spray operations indicated that a set of thumbnail sketches of studies had been prepared by CCRI officers for inclusion in the minutes. These included observations on deposition of chemicals, and the fate of chemicals in the various zones of the forest environment (APPENDIX 2, 16 and 17). It was noted that most of these studies have more relevance under agenda item 1.6 "Review of Research".

Environmental Monitoring - The Chairman called on Dr. Neilson of MFRC to lead off the discussion on the topic. Dr. Neilson did so by reporting briefly on the studies of Dr. Varty, who is the main contributor to environmental monitoring studies of MFRC (APPENDIX 3). These studies included (1) monitoring the effect of larvicide sprays on parasitism in spruce budworm populations with various spray histories; (2) monitoring short-term effects of adulticide sprays on predators and parasitoids; (3) monitoring the short-term effect of growth regulator chemicals on non-target insects; (4) establishing methodology whereby insecticidal stress on the arthropod community on red maple could be measured; (5) investigating the environmental persistence of phosphamidon applied aerially; (6) measuring the effect of insecticide drift on the activity of pollinators and its significance on the blueberry crop.

Dr. Neilson gave a brief summary of interim results of this work. The evidence of several successive seasons indicates that parasitism as a function has not been substantially disturbed by intervention with larvicide sprays of fenitrothion. The adulticide sprays with phosphamidon hit parasitoids at a far more vulnerable stage than larvicide sprays and dramatic kills of Apanteles and Glypta adults, often in excess of 100,000 per acre, have been recorded in three experimental years. It appears, however that the recuperation of parasitoid populations is rapid.

Monitoring predaceous arthropod abundance in fir crowns in an area subject to recurrent larvicide sprays of fenitrothion has shown immediate mortality but no long-term decline over several years, with some specific exceptions. Thus the function of predation in the ecosystem does not appear to be endangered. Adulticide operations may pose a more severe hazard because in July, peak populations are exposed. Monitoring the effects of growth regulator sprays suggested that predators and other groups of non-target insects were not drastically affected, but methodology for this type of monitoring is underdeveloped. The effect of insecticide drift on the activity of pollinators was not resolved. The results confirmed that drift can be heavy and distant from spray blocks but the evidence of correlation between drift and bee activity was conflicting. However, some pertinent data were collected.

Dr. Thomas invited Dr. Fettes to present any lead comments he may have concerning CCRI environmental monitoring in New Brunswick. Introducing Dr. Buckner as the leader of this monitoring group, Dr. Fettes made special note of the fact that persistence studies were started on phosphamidon as a result of renewed interest in the use of the chemical. He referred also to the difficulties of tracing the fate of Matacil (aminocarb) which has some 20 possible break-down products (APPENDIX 2). Dr. Buckner discussed CCRI monitoring activities in New Brunswick, stressing the collaboration with the Maritimes Forest Research Centre, Canadian Wildlife Service and the Environmental Protection Service. He indicated that the larvicide monitoring program was "rather modest" and comparable to this phase of the work in previous years. Again there was a very slight impact of both chemicals in the larvicide area on birds and no evident effect on mammals (APPENDIX 2). He said that monitoring of the moth flight control operation phase of the work brought together the largest group of ornithologists ever assembled on a control program. He reported no apparent impact on birds and mammals and minimal impact on aquatic organisms.

Mr. P.A. Pearce reported on monitoring by the Canadian Wildlife Service which he said was modest and confined to New Brunswick. Where possible, field activities were integrated with those of the Chemical Control Research Institute so as to benefit from pooled resources and to permit comparison of different appraisal techniques. The study was conducted in areas which were sprayed once with fenitrothion in larviciding operations and subsequently re-sprayed twice with phosphamidon during a large-scale adulticiding program. In assessing the results of these studies (APPENDIX 4), Mr. Pearce reported the occurrence of considerable bird mortality from starvation linked with an unseasonably cold May with average temperatures four to fourteen degrees below normal. The tentative conclusions drawn from these monitoring studies are quoted below (APPENDIX 4):

"In light of the findings reported here and of previous experience with the two chemicals involved, emphasis being on identification of acute effects, the following tentative conclusions are drawn:

(a) birds of the New Brunswick forest suffered more from the elements in 1974 than from man in his attempts to protect that forest against other natural hazards;

(b) no widespread avian mortality is attributable to the influence of applied insecticides;

(c) fenitrothion approaches a threshold level toxic to birds when applied at 3 oz/acre;

(d) phosphamidon is near a threshold level toxic to birds when sprayed at 2 oz/acre;

(e) when those operational dosages of fenitrothion and phosphamidon are significantly, however inadvertently, exceeded, as in the case of oversprays, lethal effects are more readily discernable;

(f) summer applications of phosphamidon at 1 oz/acre are not toxic to adult birds, the influence on young birds has not been adequately assessed."

Dr. H.S. Thompson asked Dr. H.A. Hall of Halifax to present the report of the Environment Protection Service on environment monitoring activities connected with spruce budworm spraying in New Brunswick. Dr. Hall introduced his report by thanking Forest Protection Limited and the Canadian Forestry Service for continued substantial cooperation and assistance in 1974 as they had provided during the previous three years of the study.

Dr. Hall noted that the fenitrothior study area, which is located on Cove Stream, New Brunswick, has been used annually since 1971 to examine the short and long-term effects of fenitrothion application (APPENDIX 5). In discussing study methods, Dr. Hall stated that since the watershed was not scheduled to receive fenitrothion, and since the influence of aerial application of fenitrothion on insect drift has been well documented (See APPENDIX 5), it was decided to abandon the monitoring of insect drift during 1974. Emphasis was placed on the determination of the resident benthic population of invertebrates during the period early May to early June. Benthic sampling occurred during this same period of the year on all previous investigations of Cove Stream and was coincident with the operational forest spraying in the area. Stream conditions such as temperature, dissolved oxygen, chemical composition, water level, volume and current were routinely monitored. Water samples were regularly collected for analysis of fenitrothion and phosphamidon residue and the benthic invertebrate population using the Surber sampling method.

The concentration of fenitrothion and phosphamidon did not rise above the limit of detection (0.010 ppb for fenitrothion, and 0.050 ppb for phosphamidon) during the period of investigation (APPENDIX 5). The results of Surber samples showed that numbers of insects collected generally increased in late May or early June. To compare the benthic invertebrate population in Cove Stream in 1974 to that present in previous years, mean insect numbers per sampling effort were calculated for each year in which Surber samples had been collected in the stream. Statistical analysis are incomplete and it is not possible to say whether the benthic population is recovering after the "initial crash" between 1971 and 1972. It does appear, however, that a further decline in the benthic population has not occurred since 1972.

Dr. Thomas thanked Dr. Hall for his report and asked Mr. Rosemarin if he or any of his colleagues in Fisheries and Marine Service would care to comment at this point. Mr. Rosemarin deferred to Dr. D. Scarratt of the St. Andrew's Biological Station. Dr. Scarratt's report is quoted in full as follows:

"Fisheries and Marine Service Input to Forest Spray Program Assessment 1974

The Fisheries and Marine Service has a continuing interest in the productivity and diversity of the fauna in streams and rivers by reason of its concern for salmon and trout and other fish species of commercial and recreational value which may inhabit streams.

A consensus was reached by the "aquatic effects" section of the Pesticides Ecological Research Group in April 1974 that the effects of forest spraying of fenitrothion at 3 oz/acre, while causing measurable decreases in stream populations and productivity, were nevertheless within tolerable limits. The Fisheries and Marine Service was part of the group reaching this consensus and accordingly adopted the policy that experiments using forest pest control chemicals or simple monitoring would be discontinued pending any radical change in chemicals used, formulation, or method of application. A review of the documented effects of fenitrothion on aquatic systems is in preparation.

The experimental adulticide program in northeastern New Brunswick in 1974 included a stream where the St. Andrew's Biological Station has had a continuing program for some seven years. In cooperation with the New Brunswick Department of Natural Resources, this program was continued for one further year. Program termination date is November 30, 1974, and analysis will begin thereafter. A preliminary assessment is anticipated for the Pesticides Ecological Research Group meetings next spring."

Dr. Scarratt referred to a report presented by Dr. D.C. Eidt to an ad hoc meeting of the Pesticides Ecological Research Group in April 1974. This report (APPENDIX 6) discusses the monitoring in 1973 and 1974 of the three small headwater streams of the Nashwaak River, parts of the basins of which were sprayed with fenitrothion at 3 oz/acre in 1973 and 1974. He felt the findings of the study were pertinent and should be tabled at the meeting.

Dr. Scarratt referred also to a want of definition of the responsibility for monitoring in the aquatic field of non-target species and the lack of identification of funding of such work. He wondered if these questions should be addressed to a "court higher than this". Dr. Thomas assured him that the meeting would address itself to this problem under a later item.

Dr. Thomas called upon Dr. T.F. McCarthy, Medical Services Branch, Canada Department of Health and Welfare for any comments he may have. The full text of Dr. McCarthy's statement, which applies also to the Quebec operation, next on the agenda, is presented herewith:

"Health Monitoring - Dr. T.F. McCarthy

Consistent with your request for brevity in reporting, I will confine myself to a few general remarks regarding health monitoring.

(a) The interest of provincial health departments has increased and will no doubt be increased in the future. I would expect for large scale operations in New Brunswick and Quebec the respective responsible agencies would be more involved. The federal health function is being reduced to an observational and advisory status.

(b) The techniques for safe operations are well known and should continue to be well known unless techniques and formulations are radically changed.

(c) There are continuing reasons for health concern in that some incidents and near incidents have occurred that may have had an adverse effect on pilot reaction time for example.

(d) Recent medical literature has postulated a possible remote relationship between certain syndromes and forest spraying. This kind of information is being watched carefully but at the moment is not a reason for great concern.

With respect to my own observations on site both in Quebec and New Brunswick. As usual my presence was well accepted and any departures from recommended practise were easy to understand and in no case did any such observed departure constitute a real health hazard.

It would perhaps be worthwhile to mention that medical research is at present progressing and the hope is that a more reliable field test for measuring the effect of minimal doses on functions in humans can be developed. "

Dr. Thomas referred back to Dr. McCarthy's lead remarks concerning the increased interest in forest pesticide operations of provincial health agencies and asked about the advisability of inviting representatives of such agencies to the forum in the future. Dr. McCarthy felt this would be desirable.

Dr. Thomas stated that Dr. McCarthy's report constituted the last programmed presentation on the monitoring studies in New Brunswick and opened the session for a brief question period.

Mr. Pearce made a plea for standardization of terminology and said that, while we seem to have gotten over the confusion of the rash of names associated with fenitrothion, he felt that we are now encountering similar problems with phosphamidon. A lively discussion followed which lead to the erroneous ruling that the common name, and the acceptable one for our use, was Dimecron(R). Dr. Fettes subsequently contacted the secretary to make sure that this misunderstanding was corrected. <u>The common name, and the one we should use to avoid confusion with this pesticide, is phosphamidon</u>. He explained that this amounts to a generic designation and will not change. The same chemical might come out under various trade names, for example Dimecron (R), and is usually registered under a trade name.

In answer to a question by Dr. Neilson, Dr. Buckner explained that CCRI and CWS purposely used different methods to monitor birds in order to test and compare the two methods under the same conditions. Critical comparison has not been completed but the selection of the most effective method is the goal. Dr. Thomas expressed satisfaction that this positive and pre-negotiated collaboration occurred between the two agencies.

Mr. Flieger expressed concern over the different results that might be reported by two different agencies, citing the bird monitoring by CCRI and CWS as an example.

Mr. Pearce explained that the apparent difference stems from the fact that each agency will encounter some different conditions and will have different problems referred to them. Some cases of mortality are reported by the general public or outside agencies a week or more after the event and are difficult to analyse.

The Chairman stressed that it is incumbent on the various agencies charged with responsibility for monitoring to investigate the problems brought to their attention and to present the most accurate information they can muster. Some conflicting results are unavoidable when following up and analysing inadequately documented and tardily submitted reports.

Prospects and Plans - 1975

Mr. Kettela gave a brief rundown of the spruce budworm hazard for 1975 (APPENDIX 1). He indicated that 4.5 million acres of high and 2.3 million acres of high to extreme hazard were delineated in New Brunswick in 1974. This total of 6.8 million acres represents a significant increase over the 3.9 million acres recorded in these hazard classes the previous year.

In Nova Scotia, an aerial survey in July revealed that although there were some 380,000 acres of moderate and 87,000 acres of severe defoliation in Cumberland County, the forest near the coast of Cumberland Basin was more or less free of defoliation as compared to the previous two years. The amount and intensity of defoliation decreased again in Annapolis Valley, but significant acreages were mapped in Antigonish, Victoria and Inverness counties. Mr. Kettela said it was important to note that there was no recorded acreage of defoliation on Cape Breton Island in 1973 and that the damage noted in 1974 was the result of an invasion of moths in August 1973. Egg-mass surveys in August 1974, indicated significant increases in infestation only in five of the eight counties affected.

On Prince Edward Island there were patches of moderate defoliation all over the Island and patches of severe in the eastern half of the Island with about 42,000 acres of severe defoliation in all. Egg-mass surveys in August indicated, however, that the infestation had decreased significantly in intensity.

Replying to a question from the Chairman, Mr. Hoyt indicated he had little to add to Mr. Kettela's report except to say that obviously there was a severe problem. New Brunswick would be mounting as large a control operation as possible. He deferred to Mr. Flieger for further comment.

Mr. Flieger observed that while the picture of an agressive insect at over-powering populations is an interesting one, the reason for mounting chemical control operations in New Brunswick, right from the beginning, has been to save trees until they could be utilized. The assessment is that some 7 million acres of trees need protection in 1975. It appears Mr. Flieger said that there would be trees lost in a province that can ill afford to lose them. He observed that there was "very little slack in the system" and no one is in the mood to tolerate heavy damage. He noted that in over 20 years of spraying very few trees have been lost entirely. He stressed the determination of Forest Protection Limited, a provincial agency, to do all in its power to continue to protect the trees as much as possible.

The Chairman terminated debate on the question at this point by reviewing the pressures involved in the control operations in New Brunswick with massive and growing budworm populations, completely committed wood supplies threatened by destruction and severe constraints on the availability of suitable insecticides. He pointed out that Quebec is faced with the same problem and further debate on this phase may be profitably delayed until Quebec and Ontario have reported.

Mr. Brennan inquired about the situation in Nova Scotia. Mr. Kettela replied that the infestation in the western part of the province, adjacent to New Brunswick, has been up for 3 years now. Moths invaded Cape Breton Island a year ago and for the first time in 6 to 7 years there has been defoliation.

1.2 Quebec

Control Program - 1974

Operations - Mr. Paquet opened the discussion by giving a brief outline of the 1974 control operation in Quebec (APPENDIX 7). He reported that 6.35 million acres were sprayed from three bases of operation, Lac des Loups, La Macaza and Casey. Four different insecticides, fenitrothion, Matacil, Zectran and *Bacillus thuringiensis* were applied at a variety of dosage rates using four aircrafts including four DC-6Bs, three Super Constellations, one Constellation and two CL-215s (see detailed specifications in APPENDIX 7).

Technical Services and Assessments - The efficiency of the operation, estimated from 5-tree sample plots distributed throughout the treated areas, was described by Mr. Desaulniers. The insect populations were reduced by an average of 77.6% affording an average 89% protection. Relatively poor protection obtained with a single application of 3 oz of fenitrothion, in spite of the 84% population reduction, was attributed to lateness of the application. This anomoly was also experienced with the *Bacillus thuringiensis* spraying.

An aerial survey of the damage done by the insect in the treated areas indicated that it was light on 2.8 million acres, moderate on 2.1 million acres, severe on 1.1 million acres and the trees were dead on 300,000 acres. Accepting light to moderate damage as a criterion of success, the 1974 spraying operations would be considered successful on 78% of the treated areas.

Dr. Thomas called on Mr. Randall to give a brief rundown on technical developments in spray application techniques. Mr. Randall said the changes in technology in this field were too numerous and complex to deal with in a few minutes. It is the culmiration of 25 years of experimentation and operational experience both on this continent and elsewhere. He gave a brief summary of the various elements of spray and aircraft guidance technology which permits effective use of ultra-low-volume spray application.

Environmental Monitoring - Dr. Thomas invited Mr. Paquet to lead off the discussion on this topic. Mr. Paquet referred to the formation of an interdepartmental committee in January 1974 by the Quebec Department of Lands and Forests to study the effects of aerial spraying operations on the environment and human health. The committee is made up of 16 representatives of various provincial and federal departments. He said two complaints concerning bird mortality and 10 claims for houses, cottages or cars soiled by No. 4 fuel oil were received. Analysis proved that the spray was not responsible for bird kill. The claims for property damage, however, were rated justified. Specialists from the federal Department of Health and Welfare and relevant provincial agencies supervised the enforcement of safety measures and their reports indicated that in the aggregate safety measures were satisfactory. Mr. Paquet referred also to the joint surveillance effort by biologists of the Chemical Control Research Institute, and the Quebec Departments of Tourism, Fish and Game and Lands and Forests on the ecological consequences of the spray operations. Dr. Buckner summarized environmental monitoring studies carried on in Quebec by cooperative efforts of federal and provincial agencies (APPENDIX 8). He said that results of the studies indicate that bird and mammal components of the forest ecosystem treated were unaffected by any of the chemical applications. Some of the worker forces of the domestic bee colonies were killed, but he noted that this is not unexpected when a wide spectrum insecticide is used, and the damage bore no relevance to eventual honey production. Populations of certain components of the aquatic insect fauna were depressed by the treatments, but this mortality was minimal. He concluded that, in the present state of data analysis, no environmental damage of concern could be detected.

Prospects and Plans - 1975

Dr. Thomas reviewed briefly the background of difficulties facing the management of budworm control strategies in Quebec before asking Mr. Paquet to outline the prospects and plans for budworm control in Quebec.

Mr. Paquet reported that the spruce budworm infestation in Quebec at the end of 1974 extended over an area of 79.6 million acres compared to 28.2 million acres (APPENDIX 7) in 1974. On the basis of the 1974 egg surveys, it was estimated that the insect population will be sufficiently high to cause severe defoliation almost over the whole of Quebec. On the basis of aerial surveys of damage it was concluded that some 36.2 million acres should be treated in 1975. It was estimated that 22.4 million acres of timber is too far gone for successful protection and a further 21 million acres was deemed safe to schedule for treatment in 1976.

Mr. Paquet stated that shortage of insecticide experienced in 1974 is expected to continue in 1975 and control operations will not likely reach 10 million acres. Because of this shortage of insecticide, the Department of Lands and Forests has accepted the prospect of losing a considerable volume of wood in the coming years. In order to limit losses, a forest management program is under consideration which makes provision for salvage cuts of dead timber and pre-salvage cuts of threatened stands not possible to protect.

Forests placed on priority for protection against the infestation include the Gaspé, Lower St. Lawrence, Quebec and St. Maurice regions and Anticosti Island.

The insecticide shortage necessitates the use of a range of chemicals in the 1975 spray program including fenitrothion, Matacil, Zectran and Bacillus thuringiensis. Other chemicals are under consideration, the extent of their ultimate use depending on the availability of the foregoing insecticides. Mr. Paquet stated there was enough chemical to treat perhaps 5 million acres; the prospects of getting 10 million acres treated is most unlikely.

Mr. Martineau noted that the Province has accepted the necessity to sacrifice some timber, but stressed that, a decision to establish a particular pattern of priorization and attendant management procedures demands a commitment of sustained follow-through in the direction chosen. It is not possible to make appreciable modifications in the sequence of treatments without increasing losses.

Returning to the question of insecticide shortage, Mr. Rosemarin inquired what other chemicals might possibly be used in Quebec. Mr. Desaulniers suggested Dylox, dimethoate, phosphamidon and possibly DDT.

Dr. Thomas inquired if there could be prepared a "shopping list" of registered chemicals. Dr. Fettes pointed out that not all suggested chemicals are registered and to have them registered, it would be necessary to go through a time-consuming process of negotiation with the various agencies involved. Mr. Randall noted that many of the older discarded chemicals might be feasible to use at lower formulations, considering the greatly improved application techniques.

Mr. Paquet said that availability of chemicals may improve, citing the possible production of Matacil (R) by West Germany. In this connection, Dr. Thomas noted that Mr. Paquet had asked for the intervention of the federal government in the question and Madame Sauvé had agreed to intercede, but it was too early to tell if this will be helpful.

Dr. Thomas noted that there was no representative from the State of Maine present and enquired if Mr. Flieger could throw any light on developments in Maine. Mr. Flieger observed that Maine forestry authorities are in serious difficulties as Zectran is no longer going to be manufactured. They are very upset about the situation, he said, but one aspect is useful from our point of view - this situation will re-activate budworm research in the United States. Mr. Kettela added that Maine authorities are considering spraying 3.5 million acres of the 7 million acres infestation covering the northern 40% of the state. He went on to say that they sprayed 0.5 million acres with Zectran in 1974 with good results but that populations are rising elsewhere and reinfesting sprayed areas.

1.3 Ontario

Control Program - 1974

Outbreak Status and Control Operations - Mr. Turner made a few introductory remarks indicating that he would leave the details to Dr. Howse. He stressed that spruce budworm program in Ontario had two distinct, geographically separated parts; west of Lake Superior, where control strategy was to contain the limited infestations present and in the north and southeastern part of the province with very extensive infestations where the strategy involves the protection of limited areas of aesthetic values in designated parks. He noted that a serious fire hazard may be developing in areas of budworm mortality but there is no intention at present to undertake extensive control operations.

Dr. Howse reported that approximately 48,000 acres were sprayed by the Ministry of Natural Resources in Ontario against the spruce budworm in 1974 (APPENDIX 9). The Great Lakes Forest Research Centre provided the biological information required for the planning, execution, timing and assessment of these operations. The spraying was done by General Airspray Limited using Stearman and Agcat spray planes equipped with Micronair dispersal units. Zectran was applied at the rate of 1.2 oz in 0.15 U.S. gallons of spray mixture per acre. The spray mixture consisted of 1 part Zectran and 2 parts Arotex.

In northwestern Ontario, some 24,600 acres were sprayed in Quetico Provincial Park in the Atikokan District to prevent spread of budworm into susceptible forests to the east of Quetico. Pupal and egg counts from the sprayed areas indicated that budworm populations were reduced by more than 95%. A survey of the outbreak status indicated that, in addition to small pockets of defoliation noted at Prairie Portage in the sprayed area, a new 10,000 acre infestation was present at Bennett Lake in the eastern part of Fort Frances District and an infestation covering about 1,000 acres was found in the southeast corner of the district.

In northeastern Ontario a total of 21,900 acres were sprayed in two provincial parks. Assessment of the spraying in Lake Superior Park showed excellent results in some sections and not so good in others, such as Sand River corridor where defoliation reached 75%-80% in pockets. Surveys in northeastern Ontario delineated 18.5 million acres of moderate to severe defoliation as compared to 12.5 million acres in 1973 and some 200,000 acres of tree mortality. Egg-masses in 1974 increased by a factor of 2.6 over 1973 counts and are now at high levels over most of northeastern Ontario. It is expected that more than 20 million acres will be damaged in 1975 if only very modest extensions occur in the present boundaries of the infestation.

In southeastern Ontario, spray operations were confined to 1,860 acres in Algonquin Provincial Park in 1974 and were utilized primarily to protect foliage on trees in high value areas along Highway 60. It was evident that any treatment involving Zectran provided good to excellent foliage protection and that the level of treatment was enhanced when followed by B. t. from a mistblower (see APPENDIX 9 for details). Surveys indicated that the outbreak in southeastern Ontario diminished slightly in size from approximately 6.0 million acres in 1973 to 5.5 million acres in 1974. Larval population densities were particularly high in some parts of Algonquin Provincial Park, where control operations were conducted. Many pockets of tree mortality were evident throughout the Algonquin, Minden and Pembroke districts. Surveys showed that, on the average, egg-mass densities have declined by 37% in 1974. The decline in both the area defoliated and average egg-mass density may signal the start of the collapse of the outbreak in southeastern Ontario. It is evident, however, that moderate to severe defoliation will occur throughout 5 to 6 million acres in this part of Ontario in 1975.

Prospects and Plans - 1975

The approach to spruce budworm control will continue as in recent years, Mr. Turner said. He added that he did not feel it was justified to do any more than is being done. It is not expected that control operations will greatly exceed 50,000 acres in all of Ontario.

Mr. Prentice enquired about the situation in the adjacent Lake States of the United States and was told by Dr. Howse that budworm populations were declining there, hopefully indicative of trends in Ontario.

Replying to Mr. Brennan's question about mortality, Dr. Sippell said there were no compiled figures but some mortality has occurred. Mr. Turner added that much of the infestation is in relatively immature forests and he expects fair survival.

At this point, Mr. Keith turned the attention of the meeting back to an earlier comment by Mr. Flieger about problems concerning the dearth of insecticide and asked to hear the "bad news".

In answer, Mr. Flieger described the bad state of the pesticide industry and referred to extraordinary problems related to the rapidly esculating budworm outbreaks in New Brunswick. He referred also to a number of severe problems related to keeping enough aircraft on line and the shortage of the right kind of pilot.

Mr. Flieger went on to say that having safely gotten over a political crisis in New Brunswick (apparently referring to the previous day's election) Forest Protection Limited would proceed to inform New Brunswickens, not only those who have a direct stake in the trees but the general public, of the "situation" and about an inability to meet the problem unless some relaxations (of pesticide regulations) are allowed.

Referring to the "dirty word" (DDT) that "rolled on to the floor" during earlier discussions, he said Forest Protection Limited expected to prepare a DDT story, as complete as available facts will allow, and see how this is accepted in New Brunswick, and "of course only if it receives favourable consideration will it be taken any further, but if it does, it will be taken all the way". He indicated the rationale for the use of DDT will be based on a need for relaxation (of the ban on DDT) as the best way to close the gap in the shortfall of materials.

1.4 Newfoundland

Outbreak Status 1974, Prospect and Plans 1975 - Mr. Brennan deferred to Mr. Clark who described the developing spruce budworm situation in Newfoundland (APPENDIX 10). The insect had been in evidence since 1942 but no damage was recorded until 1971 when the outbreak covered several hundred acres. It increased rapidly in the next few years, from 1 million acres in 1972 to 7.2 million acres in 1974. About 2.1 million acres of the 1974 infestation were in the moderate to severe defoliation classes. On the basis of large-scale egg-mass surveys completed in October, it was estimated the area of moderate to severe defoliation will reach 4.5 million acres in 1975 and tree mortality will occur on 430,000 acres.

Mr. Brennan said there has been no decision taken to resort to chemical control, especially considering the cloudy situation with respect to the availability of insecticides. Spray operations are unlikely, he said, but options are being kept open to treat 450,000 to 500,000 acres. A joint salvage program with forest industry companies is under consideration. It is hoped to avoid catastrophic losses in 1975 and reach a better situation in 1976 for more direct alternatives.

1.5 Maine

(In the absence of any representatives from the State of Maine, a brief outline of the budworm situation in Maine was given by Mr. Flieger and Mr. Kettela earlier. See page 16)

1.6 Review of Research Underway and Planned

The Chairman asked Dr. Sanders, Chairman of the CFS Spruce Budworm Working Committee to introduce the topic and lead the discussion. Dr. Sanders presented a summary of the research activities of the Spruce Budworm Working Committee (APPENDIX 15). He referred to work aimed at developing new control agents and techniques and noted that up to now there have been no viable alternatives to chemicals. Potential alternatives being studied include microbial and biological agents, such as *B. t.*, growth regulators, pheromones and chemical-biological combinations.

Another approach involved the development of new strategies for control including the use of radar to monitor adult flights, computer simulation to develop more refined control strategies and the detection of budworm epicentres, a topic which remains somewhat controversial.

After completing his presentation Dr. Sanders interjected a few comments about the recent budworm symposium at Alexandria, Georgia. He said there had been about 100 people in attendance including six Canadians. He said the meeting portended more United States money in spruce budworm research and passed along pleas from U.S. officials for greater exchange of information on the problem. He indicated that the Americans were very sensitive to the fact that they have no registered chemicals for spruce budworm control.

Dr. Fettes discussed the insecticide screening studies at CCRI under Dr. P.C. Nigam (APPENDIX 16), and noted that this Institute had always felt the need to have as long a list of available chemicals as possible. He added, however, that it is necessary also to make the effort to get good chemicals registered. He said there were about 20 or 30 chemicals more promising than DDT, but 18 of them need to be carried through pilot and field tests and through the registration procedures.

In answer to a question from Dr. Thomas, Dr. Fettes reported that there are 6 or 7 insecticides registered for use. He added that pesticide companies are not prepared to go through the registration procedure unless a chemical is extremely promising economically.

Dr. Fettes gave a brief summary of the control methods research project underway at CCRI under Dr. J.A. Armstrong (APPENDIX 17). Studies under this project involve the aerial application of pesticides, effect of forest meteorological conditions on spray droplets and analysis of spray cloud, plantation pest control research, aerial application of *B. t.* and Orthene combinations and field tests of Orthene and Phoxim vs. fenitrothion when applied under simulated aircraft spray conditions.

Dr. Thomas felt it would be desirable to clarify thinking with respect to the CFS role regarding chemicals. He stressed that the CFS is not a forest protection agency.

In answer to a question from Dr. Angus as to why Zectran was not being produced, Mr. Flieger replied that Dow is losing money on it and they own the patent. To this, Dr. Fettes observed that this was all the more reason to keep a large number of chemical options open. Mr. Flieger returned that this does not help the current situation since none are available.

In regard to the slow process of registering chemicals, Mr. Houghton referred to discussions with the Environment Protection Agency (USA) and suggested that Canadian data would be acceptable in EPA evaluations.

Mr. Houghton indicated that the insecticide shortage problem was not confined to forestry and described the difficulties encountered by agriculture in trying to locate dimethoate for grasshopper control on the Prairies. Most pesticide manufacturing plants are located in the U.S. and Europe and little has been done to encourage the industry in Canada. He said the Department of Industry, Trade and Commerce is very much interested in the question and expressed the opinion that the climate is right to bring to bear the concern not only of one department but of several departments, on this problem and take steps to encourage Canadian industry.

In answer to a question from the Chairman, Dr. Sanders suggested that the next topic discussed should be biological agents, starting with research at IPRI.

Dr. Angus outlined the research underway at IPRI (APPENDIX 18). He referred to field tests conducted during the summer on Manitoulin Island to test the efficacy of preparations of certain insect growth regulators, Bacillus thuringiensis and a combination of both in controlling infestations of spruce budworm. The growth regulator PH 60-40 at 5 oz/acre on balsam fir had the best effect, reducing budworm populations by 92%. ZR-515 and RO-10-3108 did not work as well as expected and higher dosages seemed indicated. The Bacillus thuringiensis preparation at 6 BIU/acre was not very effective and it was felt that a more effective sticker was required.

In reply to Dr. Thomas' enquiry about the availability of growth regulators, Dr. Angus said that none were registered as yet but added that the manufacturers were optimistic and do not anticipate any difficulties in the safety testing.

In reply to a question from Dr. Thomas about future plans at IPRI in this area, Dr. Angus said there would be further trials with PH 60-40 to see if a better dosage picture could be obtained and field tests of a new Hoffman-La Roche analog, just recently received from Europe.

It was suggested that, before turning to the virus studies at IPRI, growth regulator work at MFRC should be reviewed. Mr. Kettela reported that MFRC and CIBA-GEIGY Canada Limited had participated jointly in an experiment to evaluate further the insect growth regulator CGA-13353, a CIBA-GEIGY product (APPENDIX 1). Six 100-acre spray blocks and one control area were established at Acadia Forest Experiment Station. Three dosage rates, 1.5, 3.0 and 6.0 oz/acre and two timings of application, at the peak of the 4th instar for one serie and the peak of the 6th instar in the other, were tested. Each spray block was treated once and the spray emulsion was applied at the rate of 0.5 gallons/acre with a Cessna Ag-wagon aircraft. Preliminary analysis of data indicates that up to 30% of the population was affected to the pupal stage. There appeared to be no discernable dosage-mortality-time of application response. Studies by Dr. Outram of "bonus" effects of this compound revealed that it does affect budworm emergence, fecundity and behavior. He demonstrated a clear dosage response in the early application series. The maximum effect was in the 6.0 oz/acre block where 82.7% of the insects reared had physiological malfunctions. Mr. Kettela observed that the chemical should not be considered for immediate foliage protection but does show some promise in terms of long-range population control. Dr. Angus supported this view of the use of growth regulators.

Dr. Thomas stressed that it should be kept in mind that these various approaches to budworm control being evaluated should not be looked upon as the final and one answer to deal with the problem but as part of an overall control strategy fulfilling part of the requirement not covered off by other approaches.

The discussion turned to virus spray studies underway at IPRI. Dr. John Cunningham reported on the progress of virus spray trials which have been conducted on Manitoulin Island for the past four years (APPENDIX 19). In 1974, two square miles of spruce budworm infested forest in which the predominant tree species was balsam fir were sprayed with nuclear polyhedrosis virus (NPV). A concentration of 100 x 10^9 polyhedra/acre at 1 gal/acre was applied when larvae were at the peak of the 4th instar and the buds were well expanded on balsam fir. The aqueous formulation contained 2.5% IMC "Shade"(R) and 0.13% Chevron(R) sticker. The level of virus infection recorded following the spray was 19% in larvae on balsam fir and 12% in larvae on white spruce. A white spruce plantation of 15 acres was sprayed at the same time but the insect development was more advanced, with about equal numbers of 4th and 5th instar larvae. A similar plantation was kept as a control. Virus infection was recorded in 15% of the larvae. Both these trials were performed to study the virus on a long term basis.

Virus was recovered from plots sprayed in 1971 and 1973 and it is still having some impact on the spruce budworm population.

Dr. Howse reported on cooperative studies with IPRI by GLFRC to follow up effects of virus spray trials. The GLFRC role was to carry out population and defoliation assessments similar to those used to evaluate operational and experimental spraying in Ontario over the past 6 years (APPENDIX 20). Results of follow-up studies of the 1971 virus spray trial at Petawawa, while difficult to assess, were encouraging. Carry over effects were much more pronounced on white spruce than on balsam fir. The follow-up of 1973 virus spray trials at Massey and Aubrey Falls indicated nuclear polyhedral virus (NPV) in all the original spray plots, population reduction and modest foliage protection occurred at Massey, most notably on white spruce. The 1974 virus spray trials by IPRI were assessed for population reduction and foliage protection. There was significant population reduction but little foliage protection in the year of application. Similar follow-up studies were carried out for the IPRI insect growth regulator and B. t. combination trials (see APPENDIX 19).

Dr. Angus noted that there have been questions in the past as to why IPRI is not conducting spray trials with Entomophthora disease. The problem, he said, has been that the fungus has been difficult to propogate in the laboratory. However, modest control trials against the spruce budworm are proposed with this pathogen in 1975.

In answer to Dr. Thomas' question concerning IPRI's supplies of virus material for spray trials, Dr. Angus replied that they are stretched to the limit at the moment, but he visualized treating four or five square miles and there is a commitment also to treat 2,000 acres against Douglas-fir tussock moth in British Columbia in 1975.

Dr. Angus reported Dr. Bird's opinion that the entomopox virus is the best IPRI has and he is convinced it is not being used properly in the field. IPRI may take a modest look at that question if resources permit.

Dr. Sanders suggested at this point that Bacillus thuringiensis be the next topic for consideration.

Dr. Smirnoff reported on his 1974 control trials with B. t. (APPENDIX 21). He said the aerial spray experiments with B. t. in 1971, 72 and 73 led to the last experimental step for the precommercial use of the bacillus, namely, evaluating definitively its efficiency for the control of spruce budworm and developing and using a concentrated and low-volume B. t. formulation in 1974. These last tests were carried out at La Macaza over 10,000 acres of severely budworm infested forest. The concentrated formulation was composed of 1 quart B. t. concentrate (6.8 B.I.U.) + 1 quart 70% sorbitol + 8 mg of chitinase + 1/1600 Chevron sticker. This was applied at 0.5 gal/acre. Aircraft used were CL-215 and DC-6B. Because of inadequate calibration, spray deposit was not uniform but where deposit was good, foliage protection was considered adequate. Dr. Smirnoff went on to say that the advantages of B. t. are that only one application is required a year and it is absolutely safe for the environment. The major obstacle is its cost which is about 2.5 times as high as chemical insecticides. Dr. Smirnoff said that costs may be reduced by using it over large areas thus promoting commercialization. He advised that, should this become impossible using B. t. produced in U.S.A., a decision should be taken towards Canadian production of Bacillus thuringiensis.

Dr. Thomas said by way of recapitulation that Dr. Smirnoff was quite justified in saying that amongst the alternatives in our arsenal, B. t. is definitely a front runner. He rightfully pinpointed the main constraint, which was cost and supply of material. He opened up the topic for further discussion.

Dr. Angus observed that during discussions with commercial houses there were no indications that large scale use of B. t. would bring with it economies of scale. They pointed out that it was being produced by a pretty good process and prices were pretty well at the level where they would remain and more than this, the materials that have to go into the fermentation tank, high protein compounds, are exactly the sort of things that are in short supply in all sorts of areas of endeavor.

Dr. Neilson suggested that with probable price increases for chemical pesticides as a result of their short supply, biological materials may become more competitive, assuming they hold the line in pricing.

Dr. Sanders reported that he had obtained an impression similar to Dr. Angus during a visit to a commercial pesticide house in the U.S.A. They were most emphatic in their contention that _B. t._ would never be able to compete price-wise with chemical insecticides. It was not intended to compete but rather it was expected to fulfill a special purpose in amenity areas, etc., where insecticides were not permitted.

Dr. Fettes pointed out that Dr. Smirnoff suggested that a material made by a fermentation process in Canada from fish meal might be a very cheap way of making _B. t._ He elaborated on some developments which at least left open some possibilities in this direction. Dr. Fettes also emphasized that we should not take for gospel statements by chemical companies.

On another angle of this same question, Mr. Randall reported that the industry is very interested in ultra low volume (ULV) application of thuricide products and pointed out that this development might also have a bearing on the economic feasibility of _B. t._

Dr. Thomas gave the assurance that _B. t._ would not be discarded, at least for the time being, because of the cost factor and encouraged the follow-up of promising avenues of development. He enquired if work was still proceeding in the dosage area. Dr. Angus replied that Dr. Smirnoff has this aspect in hand. Dr. Fettes gave further assurance that some very active work is going on with Dr. Smirnoff's group and CCRI involved.

Dr. Scarratt, going back to the question of cheap protein requirements for the _B. t._ fermentation process, referred to so-called "trash fish" and suggested sea cucumbers which are high in protein.

He made the second point that the discussions on costs around the table were concerned only with primary costs of producing and applying _B. t._ and stressed that dollars saved by using a product, such as _B. t._ which is not harmful to the environment might rightly be subtracted from the cost of producing and applying _B. t._

Dr. Sanders introduced the next research topic, that of insect sex attractants and indicated that they provided a tool for monitoring insect populations and for their management at endemic levels. They also serve as a means of disrupting mating behavior when the atmosphere is permeated with these compounds and the male budworm is prevented from finding the female (APPENDIX 22). The budworm attractant has now been microencapsulated.

In answer to a question from Mr. Rosemarin, Dr. Thomas replied that costing of the various other biological control methods, such as the virus and growth regulator approaches, has not been attempted because they are still in the experimental stage.

Dr. Sanders referred to the radar monitoring of adult spruce budworms and studies of adult dispersal and Dr. Neilson described the adult dispersal studies being carried out by Mr. Greenbank, MFRC, in cooperation with CCRI and GLFRC.

Mr. Kettela described the 1974 adult spray trials carried out on 2 million acres in northeastern New Brunswick (APPENDIX 1). Further evaluation of the data will be required before a clear picture of the results emerges. Mr. Kettela concluded by urging that full impetus be given to the development of this work.

Dr. Sanders directed attention to the final item of research; the modeling study at MFRC. He gave a brief background on the model which was originally started in cooperation with people at U.B.C. It is a four-part modeling program: the basic part is the model of the forest involving 256 component parts, the second is the budworm model which simulates the fluctuations of budworm populations, the third is a dispersal model, the one which proved itself to be the most important, and the fourth and last part is the model of control strategies. This latter part of the model requires the development of a lot more elements before it is ready for application.

Dr. Neilson observed that Mr. Greenbank, the leader of the modeling work was very excited about the results of the 1974 modeling and feels the dispersal model is now in shape.

2. Reports on 1974 Control Operations against Other Pests and Possible Operations in 1975.

Mr. J.M. Finnis reported the major insect problems in British Columbia on behalf of the British Columbia Forest Service as follows:

"Bark beetles are our biggest insect problem at present in B.C. Before Dr. Shepherd describes the current defoliation situation in B.C., I would like to mention the black army cutworm which is a threat to recently planted seedlings on fresh burns in part of the Interior of B.C. This insect appeared out of nowhere in 1973 and did considerable damage. The C.F.S. recommended we use Dylox but we ran into trouble with Fish and Wildlife Service. We suffered severe damage on the "Sue" burn near Golden and our Reforestation Division estimates rehabilitation and replanting will cost ¼ million dollars. Dr. Shepherd will now describe the current defoliation in B.C."

Dr. Shepherd described briefly test control operations against the false hemlock looper in British Columbia (APPENDIX 11). The treatments in two 40-acre plots included ½ lb of Dipel (B. t.) powder in 2 U.S. gallons of water per acre and the juvenile hormone, Altosid 5E at the rate of 3 fl. oz in 2 gallons of water per acre. A further 40-acre plot was set aside as untreated control. Using Abbott's formula a preliminary analysis of the data indicated a control of 77% in the B. t. plot and 30% in the Altosid plot. The latter was disappointing considering excellent laboratory results in B.C. and the results of field tests on Anticosti Island. Outbreaks of this insect spread and intensified in 1974 and egg surveys indicate a continuing problem in 1975. Further experiments and a control operation are contemplated for 1975.

Mr. Tripp gave a brief history and background to Douglas-fir tussock moth infestations in the West and described control trials with a nuclear polyhedral virus against the pest in British Columbia in 1974 (APPENDIX 12). The formulation put on a spray plot of 25 acres consisted of sufficient virus for a gallon of distilled water count of 50×10^9, 0.25 lbs I.M.C. sunlight protectant (R) and 0.01 pints of Chevron sticker(R). The formulation was applied at the rate of 2 gal. per acre. The deposit from the first run appeared poor and was repeated. It was estimated that most of the spray was lost through evaporation before reaching the ground but the effect on the target insect appeared adequate. Special effort to reduce evaporation appeared necessary for any future operations.

A report on a preliminary experiment for control of black army cutworm by Dr. S. Ilnytzky was tabled (APPENDIX 13). Also tabled was a report by V. Hildahl and G.A. Steneker describing aerial spraying with fenitrothion to control spruce and jack pine budworms in Manitoba in 1974.

3. Pest Control Products Act: New restrictions on the use of pesticide products in forest management.

Dr. Thomas asked Mr. Houghton, Plant Products Division, C.D.A., to bring to the attention of the group any new developments in the area of pesticide legislation.

Before discussing new developments in the area of pesticide legislation, Mr. Houghton turned the attention of the meeting back to the question of market information relative to the current pesticide shortage with the aim of corrective action. He said his agency had been instructed to compile marketing data on pesticide demand, shortages and potential alternative compounds and felt that while it was being done for agriculture, forestry could be taken into account at the same time. He noted that he was aware of only minimal overlap or competition for pest control products between the two departments, namely for dimethoate used for grasshopper control and lannate utilized recently for control of the army worm. He added that, while on the question of alternative compounds, due note should be taken of the toxicity rating of substitutes. He noted that there was a shortage not only of active ingredients of pesticide products but also of solvents, emulsifiers and other additives. As a result, some latitude in substitutions has been permitted manufacturers and he urged that particular attention be paid to formulations and that suppliers be asked to report substitutions, and that users become vigilant to possible adverse effects in performance or side effects.

Mr. Houghton reminded the meeting that at the last meeting, in 1973, he spoke of regulations in preparation concerning the use of pest control products in forestry. These regulations eventually came out in Trade Memorandum T 104 and were entitled "Restricted Status of Pest Control Products for the Use of Forest Management". This memorandum laid down the regulatory status of products that are to be used for pest control purposes in forest management. The nature of the restriction is that application must be made to regulatory authorities in the province where the proposed project is to take place and the regulatory authority would see that the proposals were vetted by the various interested disciplines. He went on to reiterate his comments at the previous year's meeting that the participants in the Forum involved in pest control operations were conducting them in the best possible way and that it was from this group that his agency drew information on how to conduct a forest pest control project. The memorandum has not yet been issued widely, for example, it has not yet gone to forest industry companies, although they are intended to receive them. What remains to be done to back up this memorandum, Mr. Houghton said, is to prepare an "I Memorandum" (Inspection Memorandum) which provides instructions to federal inspectors who may be participating where there is no provincial regulatory authority in force, relative to Trade Memorandum T 104. The inspection memorandum specifically instructs Inspectors to contact all of those disciplines in the province which have an interest in the conduct of a forest pest control project. Where necessary in the consideration of an application, it instructs inspectors to convene a meeting of interested parties and outline for them how the project is to be operated. The "I Memorandum" is nearly ready for distribution.

For the benefit of those working with viruses and other similar organisms, Mr. Houghton said that these organisms are also subject to the Pest Control Products Act. While the subject of research in government institutions they have no requirements to meet under the PCP Act, but should they be designated for commercial uses, they will be required to be registered under this Act. There are concerns about these agents similar to those with chemicals and perhaps some additional ones.

Dr. Neilson made the observation for Mr. Houghton's reaction that it was his impression that there were all sorts of regulations with respect to the approval of applications of pest control programs but wondered if there were any real provisions made for policing the operations once the application has been approved. Mr. Houghton took exception to the term "all sorts" with respect to regulations. From the federal standpoint, Mr. Houghton went over the review process involving various disciplines and noted that the approval notice that is finally granted to the applicant constitutes a regulatory document and if there are any unusual restrictions or requirements written therein, then it is subject to inspection to assure compliance with those particular parameters that have been decided upon or agreed upon.

Dr. Neilson pressed the point further saying that what he meant was "Are there any, what might be called provisions for routine inspection of forest control programs?"

Mr. Houghton replied that there was nothing routine but suggested that having gone through the review procedure, taking into account a wide range of pertinent factors and ending up with a regulatory document agreed to by all agencies taking part, this document and the agreed to conditions are part and parcel of the PCP Act. He emphasized that where there is no provincially legislated authority for the review procedure then the PCP Act applies, but where there are, the PCP Act considers that the provincial requirements serve the purpose.

The chairman indicated there was not time to pursue the topic further but said that the PCP Act had the jurisdiction and the capability, in effect, of monitoring. If,however, provincial legislation overtakes the PCP Act, then the province has the authority and presumably the muscle and manpower, to do the monitoring.

Mr. Richmond asked for clarification with respect to the applicability of the PCP Act in British Columbia. Mr. Houghton indicated that as far as he was aware British Columbia had its own procedure in operation.

4. Other Business

Dr. Thomas said that he wanted to take the opportunity in this section of the meeting to reintroduce the whole subject of monitoring of forest pest control operations. We have seen from the meeting today evidence of monitoring by various agencies, in many instances on their own initiative for purposes specific to their own resources, interests or human protection needs, he said, but we have not seen as much evidence of an acceptable form of overall leadership in the area of monitoring. He reminded those who were present at the meeting two years ago, the last meeting of the Interdepartmental Committee on Forest Spraying Operations, that he took time then to stress his personal view that the monitoring of pesticide operations was a deadly serious business and deserved a higher ranking than it received heretofore in the priorities of the agencies that have an obvious stake in the overall effects of pest control operations. He had, he said, encouraged at that time a greater activity on the part of these agencies to get into monitoring in a serious fashion and on a continuing basis. He noted that he had observed in the interim substantial evidence of a greater concern and greater activity in this area but he offered the view that it has not achieved the level of priority in the overall schedule of the various agencies that it deserves. To open up the subject of monitoring he posed the questions. Where are we going in this monitoring business? What direction should we take to bring about an acceptable level of monitoring? Whose responsibility is it? Who should give total direction, if indeed total direction is the way to go? Having been made aware of conditions as they exist today and having been forwarned of conditions as they will probably obtain tomorrow, Dr. Thomas expressed the view that this may be a good point on which to finish discussions.

Dr. Fettes observed that monitoring, other than of the target insect, has been no more than token over the years. He said that the Canadian Forestry Service, through CCRI, has been more active in the field than anyone but noted that we need monitoring for more than one reason; we need it not only to find out what is happening to the environment but also to protect ourselves in our official CFS role of making recommendations with respect to the use of chemical pesticides. We also have a responsibility to protect the managers of chemical control operations from becoming victims of untrue accusations, he said. He cited the example of the robin and blueberry controversy in New Brunswick where inadequate baseline information has made it difficult to deal with unsubstantiated charges of damage from insecticide application. He expressed the opinion that monitoring the wide range of possible effects of pesticide spraying should become an integral part of the spraying operation and a charge to the spraying operation. He felt that the CFS need not do all the monitoring nor to pay for it.

Dr. Fettes made the further point that while CCRI was not looking for the lead role in monitoring programs, it was commonly in the position of carrying out the initial field work with pesticides and therefore must maintain an expertise in monitoring techniques to cover off its own work.

Dr. Neilson reminded the meeting of the existence of PERG (Pesticide Ecology Research Group) which, he said, is a loosely knit group of people involved in monitoring the side effects of pesticide applications. He was not entirely sure of the specific objectives of the group, but said they do consider weaknesses in monitoring programs and have given expression to matters of environmental concern. For example at their last meeting in April 1974, general matters of concern were weaknesses in research, the ecological effects of phosphamidon on soil biology and pollinators and the question of unregistered, unmonitored aerial spraying in New Brunswick.

Dr. Neilson said he wanted to make the additional comment that in all branches, monitoring of side effects of chemical control operations operated on a shoestring.

Dr. Scarratt said he wanted to echo Dr. Neilson's comments, particularly the one about the shoestring. He described some of the difficulties experienced both by Dr. Hall's group and his own in developing and funding a monitoring program despite excellent support from Mr. Hoyt's department. He noted that a planned program at times may have to be reduced by one-half to comply with severe budget trimming. He pointed out that these were programs generated by the initiatives and from the budgets of individual investigators stimulated by the encouragement and approval of the forest resource people. But none-the-less there appeared to be inadequate "official seal or stamp of approval", he said, to help research managers to balance these requirements against other ones which are identified from other areas. "So it is not just the quality or quantity of work we would do if we could", he said, "it is also the question of the wherewithal with which to do it."

Dr. Thomas said that these words support one of his earlier comments that somehow this business of monitoring has not achieved the necessary priority in the individual programs of various agencies that obviously have a concern and responsibility in the whole area of forest pest control.

Mr. Flieger said he would like to make a few comments from the point of view of the operator and indicated that Forest Protection Limited had been monitored on every operation since their inception. He said they preferred to be monitored because "its the only safe way to be walking in a mine field". He wished to echo everything that had been said around the table about the need for improved monitoring. He did not agree with a previous comment that monitoring had been "token" but suggested rather that perhaps it lacked coordination. He went on to describe at some length the difficulties experienced by FPL through conflicting reports and inadequately answered questions concerning the effects of pesticide spraying.

The chairman expressed sympathy for FPL's past years problems and expressed the opinion that Mr. Flieger's comments lent support to the need for effective monitoring.

Dr. Watt introduced the idea of the environmental assessment review process and asked if it had been considered. He said there had been a lot of talk about short resources as one of the problems plaguing all agencies. "The cabinet decision on ERP calls for the supportive monitoring by the proponent. The proponent pays and I wonder if this would not be a consideration for this program which I feel could be considered as a candidate where there is federal money involved".

Dr. Thomas answered that the Environmental Review Process had predominantly a "before the event" thrust. It was a process whereby a proposed development, or in the present case a proposed project is examined for environmental consequences, other than the desired effect proposed. Inherent in the ERP is the possibility and, perhaps the desirability of requiring the proponent to carry out a monitoring program as well as a control program. Potentially the Environmental Review Process could indeed require FPL to do all the monitoring which the ERP requires or says it requires. Dr. Thomas said, however, that we are going beyond this in our discussion of monitoring. I think, he said, we are talking to the resource interests and those having responsibility for human health and who, for the very nature of their program,should be in the forefront of studying and monitoring what is happening. He indicated that it was not enough to invoke the Environmental Review Process and simply require the proponent in this case to carry out the depth of monitoring which was referred to. We include, he said, many cases which are well within the realm of data gathering and research in itself, which hopefully will produce useful guidelines for further projects, again in this case forest pest control projects. It would be a very short sighted policy and attitude to simply fall back on the ERP, thereby requiring a proponent to carry out the monitoring. Dr. Thomas felt the proper approach might be a combination of ERP and monitoring in a larger sense.

Dr. Thomas went on to say that agencies having a responsibility for resource management also have a responsibility to produce a bigger effort with respect to environmental monitoring. He urged representatives of agencies to convey the importance of this question to their groups. He said he would promote a motion from the meeting to produce a resolution giving recognition to the importance of this question.

Mr. Rosemarin expressed agreement with the importance attached to environmental monitoring and also with the feeling that there should be a lead agency. He asked the opinion of the meeting as to who should be the lead agency and of the manner in which funding might be earmarked for the work.

Dr. Thomas reiterated these questions for the group and indicated that the Minister of Environment Canada had asked the Canadian Forestry Service to take another look at the question of federal funding support for pest control operations. He indicated his intention of seeing that environmental monitoring received appropriate weight in this review.

Mr. Keith doubted that he could go along with an unqualified "more monitoring" and felt we should be very discriminating in what monitoring could be reasonably done. He cautioned against an open-ended format.

Dr. Thomas said there was no suggestion of an open-ended monitoring but there were obviously far too many gaps in our knowledge. He regretted that there was not time for further discussion on this important topic but said the meeting had been most helpful to him in clarifying many aspects of the problem.

The chairman adjourned the meeting with thanks to those present for their attendance and lively participation.

AERIAL SPRAYING AGAINST THE SPRUCE BUDWORM IN 1974 AND A FORECAST OF CONDITIONS IN THE MARITIMES REGION IN 1975.

E. G. Kettela

November, 1974

INTRODUCTION

The spruce budworm continued to be a pest of major concern in the Maritimes region in 1974 and caused severe defoliation over 6.8 million acres of forest, of which 6.3 were in New Brunswick. Large scale spray operations were carried out only in N. B. and some 3.9 million acres were sprayed to protect high hazard areas from spruce budworm larvae. An additional 2 million acres were sprayed in an experimental program against the budworm moth. Six hundred acres were sprayed in experimental trials with insect growth regulators (hormone type chemicals).

In keeping with instructions this report is only a brief account of the salient points arising from investigations in 1974. Analysis of operational and experimental data is underway and statements made herein may be altered in due course.

1. NEW BRUNSWICK

Spraying in 1974

General---In 1973 based on surveys of budworm damage and egg-mass infestations approximately 3.9 million acres of forest were deemed to be in a high to extreme hazard situation. As a result of this information Forest Protection Limited of Fredericton formulated and executed a larval spray program of 3.9 million acres (Fig. 1). A synopsis of acreages sprayed and insecticides used are presented in Table 1. An explanation for reasons why and how certain insecticides were used can be obtained from Forest Protection Limited. The standard three-plane formation of TBM aircraft was used however the configuration of spray blocks was changed. Two Grumman Ag-Cats were used to apply the Dylox spray.

The spring of N. B. was cold and wet and budworm emergence started two weeks later than usual and was a long drawn out process. At first it was thought that the spring weather had a deleterious effect on the budworm but this proved erroneous as 33% of the population generally survived to the adult stage. Late in the larval period conditions for survival actually did improve. Further, there was a large spread in the number of larval instars feeding in any one location at one time. Spray operations commenced on 18 May and ended on 20 June 1974.

Spray Results---The efficacy of the spray operation was determined from pre- and post-spray counts of budworms in treated and non-treated plots and from estimations of the quantity of new foliage saved. Fenitrothion (Table 2) at the dosages used gave better results than either Phosphamidon or Dylox and are consistent with results obtained with it over the past seven years. However its usage on the second instar stage appears to be marginal in terms of protection of foliage. Phosphamidon at 2 oz. per acre in a water solution gave poor results both in terms of insects killed and foliage saved. The results obtained with Dylox fall within the range of results obtained with fenitrothion, but are marginal when compared to the 9 oz. per acre dosage tested in 1973 which saved 65% of the foliage crop. The overall efficacy of the spray operation is lower than those obtained in previous operations (Table 3). This I feel is due to the poor performance of Phosphamidon which was used over a third of the sprayed area, to the fact that 37% of the spraying was done at the second instar stage of the budworm, and to the protracted larval development period.

Defoliation---In July the Canadian Forestry Service and Forest Protection Limited conducted a Province-wide aerial survey for defoliation. This survey mapped moderate to severe defoliation in almost every sector of the province (Fig. 2). The largest patch of more or less continuous moderate to severe defoliation extended from Bathurst in the east to Edmundston in the west, south to Fredericton and more or less northeast to Bathurst. In all approximately 2.0 million acres of moderate and 6.3 million acres of severe defoliation were delineated. With respect to severe defoliation this represents a substantial increase over 1973 (Table 4).

Egg-mass surveys---Counts of spruce budworm egg-masses at over 1,000 locations in N. B. show that the infestation has increased in area over that recorded in 1973 (Table 5). The largest increase was the area of high infestation which increased from 11.0 million acres in 1973 to 13.5 million acres in 1974. There are moderate to high infestations in virtually all the productive softwood forests in N. B. (Fig. 3). Further, the infestation increased in intensity as well as extent.

Hazard for 1974-75---Hazard to trees is computed from the surveys of budworm defoliation, egg-masses and tree condition. Weighted values are assigned to these measurements then the sum of the values is taken. In the past hazard has been divided into three categories, variable, high and high to extreme, however, this year I have presented only the latter two categories. The results of the hazard computation are shown in

Table 6 and Figure 4. The forecast for 1974-75 is 4.5 million acres of high and 2.3 million acres of high to extreme hazard. This total of 6.8 million acres of high and high to extreme hazard represents a significant increase over the 3.9 million acres delineated the previous year.

2. NOVA SCOTIA

Defoliation---In August 1973 surveys for spruce budworm egg-masses on the mainland of Nova Scotia showed that there was a significant increase in the infestation in Cumberland County and Antigonish County. Subsequently a survey for overwintering larvae of the spruce budworm in November indicated a dramatic upsurge of infestations on Cape Breton Island in Inverness and Victoria counties. In July an aerial survey for defoliation revealed that although there were some 380,000 acres of moderate and 87,000 acres of severe (Fig. 5) defoliation in Cumberland County that the forest near the coast of Cumberland Bay was more or less free of defoliation as compared to the previous 2 years. The amount and intensity of defoliation decreased again in the Annapolis Valley, however significant acreages of defoliation were mapped in Antigonish, Victoria and Inverness Counties. It is important to note that there was no recorded acreage of defoliation on Cape Breton Island in 1973 and that the damage noted in 1974 was the result of an invasion of moths in August 1973. Further, on Cape Breton Island two other insects, the Hemlock Looper and the Black-headed budworm in concert with the spruce budworm seriously damaged 12,000 acres on the plateau.

Egg-mass Surveys---In August 1974, 129 locations in Nova Scotia were sampled for spruce budworm egg-masses to aid in forecasting infestation levels for 1975. The results of this survey are shown in Table 7 and compared to surveys conducted in 1972 and 1973. Infestation levels increased in the Counties of Cumberland, Colchester, Hants, Annapolis, Antigonish, Richmond, Victoria and Inverness. However, from the forecast of defoliation point of view increases are significant only in the counties of Cumberland, Antigonish, Inverness, Victoria and Richmond. In general, increase in infestations in Nova Scotia is similar to that experienced in New Brunswick.

3. PRINCE EDWARD ISLAND

In 1973 surveys for egg-masses on P.E.I. showed that a very uniform moderate to high infestation of the spruce budworm covered the island. As a result in 1974 defoliation caused by the budworm was noticeable on virtually all fir and spruce trees on the island. Generally there were patches of moderate defoliation over the entire Island, and patches of severe in the eastern one-half of the Island (Fig. 5). In all the survey delineated 42,000 acres of severe defoliation.

Egg-mass survey---In August a survey of budworm egg-masses at 45 locations showed that the infestation decreased significantly. The level of infestation for 1974 compared to 1973 and 1972 is:

County	Mean egg-masses per 100 ft.^{2} foliage		
	1972	1973	1974
Prince	211	477	293
Queens	39	587	211
Kings	103	564	207

(counts over 240 egg-masses per 100 ft^2 are high)

Thus on P.E.I. in 1975 there should be patches of moderate to severe defoliation again but to a lesser degree than in 1974.

EXPERIMENTAL SPRAYING

Spraying Adult Budworms -- An adult spray program was carried out on two million acres (40 x 80 mile rectangle) in northeastern New Brunswick in 1974. The area was divided into 43 spray blocks. TBM's were used to treat 32 blocks, and a DC-6 for the remainder. All but two blocks were treated twice with 1 oz. of phosphamidon; the two exceptions were treated three times.

There were two major problems in spray application: (a) Owing to retarded budworm development in 1974, the first spray was not applied until July 13 which was about one week later than expected, (b) Owing to topographical variations there was a 12-day difference in adult emergence between the 'warmest' and 'coldest' plots within the spray area. The outcome of these two conditions was that spraying may have been too early in some blocks to hit the bulk of the female population.

The effects of the treatment were evaluated from counts of; living males in two types of traps, dead adults in collecting trays and mats, and living adults at observation towers. Adult abundance was also checked by onsite radar. Finally, egg counts were obtained on many plots within and outside the spray area.

The counts of living males in treated versus check plots suggested that over 80% of the males were killed within the spray area.

Counts of dead adults in trays and on large mats suggested a high rate of kill (over 70%) of adults. Male and female mortalities were about equal. However, because we lacked good information on the natural fall-out of dead adults, we were unable to define the rate of mortality caused solely by the treatment.

A broad-scale egg survey suggested 38% fewer eggs in the TBM sprayed area and 29% fewer in the DC-6 area than in the check plots. As a comparison, the most effective adult treatment in 1973 resulted in 56% fewer eggs while in 1972 egg density was reduced by about 40% over an 8,000 acre block. Although the application rate was heavier in 1972 and '73, (2 oz. applied twice) our data to date suggest a 40 to 50% reduction in egg density as a result of the present type of adult spray program. With reference to the 1974 program we await radar observations to determine whether the egg-masses in the treated area resulted from failure to kill resident females before oviposition, or from invasion, or both.

Insect growth regulators --- The Maritimes Forest Research Centre and CIBA-GEIGY Canada Ltd. participated jointly in an experiment to further evaluate the insect growth regulator CGA-13353, a CIBA-GEIGY product. Six 100 acre spray blocks and one control area were established in the Acadia Forest Experiment Station. Three dosage rates, 1.5, 3.0 and 6.0 oz. per acre, and two timings of application, peak of 4th instar for one series and peak of 6th instar in the other, were tested. Each spray block was treated once. The spray emulsion was applied at the rate of 0.5 gallons per acre with a Cessna Ag-wagon aircraft.

Preliminary analysis of the data indicates that up to 30% of the population was affected to the pupal stage. However, there appears to be no discernable dosage-mortality-time of application response. Studies by Dr. Outram of "bonus" effects of this compound did reveal that this compound does affect budworm emergence, fecundity and behaviour. He has demonstrated a clear dosage response in the early application series. The maximum effect was in the 6.0 oz/acre block where 82.7% of the insects reared had some physiological malfunctions. The results of the late series of sprays, however, did not show this dosage response and it is suggested that this is due to forest cover type and spray deposit. These trials indicate that CGA 13353 does have a measurable effect on budworm survival and fecundity.

Table 1 Synopsis of Spraying Against the Spruce Budworm in New Brunswick in 1974[a]

Insecticide	Dosage (oz.) and application rate (U.S. gal/acre)	Formulation	Applications	Acreage
	Operational Larval Spray Program[(b)]			
Fenitrothion	3 oz in 0.15 U.S. gal/acre	emulsion	IX	2,415,000
Phosphamidon	2 oz in 0.15 U.S. gal/acre	water solution	IX	1,458,000
Dylox	6.4 oz in 0.15 U.S. gal/acre	0.1 solution	IX	33,000
			Sub total	3,906,000
	Experimental Larval Spray Program[(c)]			
CGA 13353	6 oz in 0.5 gal/acre	emulsion	IX	200
	3 oz in 0.5 gal/acre	emulsion	IX	200
	1.5 oz in 0.5 gal/acre	emulsion	IX	200
			Sub total	600
	Experimental Adult Spray Program[(d)]			
Phosphamidon	1 oz in 0.09 U.S. gal/acre	water solution	2X	2,017,000
			Grand total	5,925,600

a - Does not include operational spraying by other agencies.
b & d - Sprayed by Forest Protection
c - Sprayed by C.I.B.A. GEIGY Ltd.

Table 2   Synopsis of larva spray results in New Brunswick, 1974

Insecticide & Dosage	Insect instar at spraying	Blocks sampled	Pre-Spray larvae per 18" br. tip	Pest-Spray pupae per 18" br. tip	Survival % Pupae/larvae x 100	Percentage new foliage crop saved
			BALSAM FIR			
Fenitrothion (3 oz./acre)	L2	6	25	5.8	22	15
	L3	5	35	5.1	14	34
	L4	1	20	5.4	27	60
Phosphamidon (2 oz./acre)	L2	1	20	6.3	32	5
	L3	3	31	10.4	33	5
(1 oz./acre)	L5	1	27	7.0	25	5
Dylox (6.4 oz./acre)	L4-L5	2	13	3.0	23	25
Unsprayed Controls			32	10.6	33	0
			SPRUCE			
Fenitrothion (3 oz./acre)	L2	7	23	3.3	14	-
	L3	5	18	2.4	13	-
	L4	1	69	6.3	9	-
Phosphamidon (2 oz./acre)	L2	2	25	4.7	18	-
Dylox (6.4 oz./acre)	L3-L4	2	12.5	2.3	18	-
Unsprayed Control			22	3.7	16	-

Table 3 Percentage reduction in survival of population, and percentage of balsam fir foliage saved by spraying, 1952-1973

Year	% reduction of survival of population		% balsam fir foliage saved
	Balsam fir	Spruce	
1952[a]	99	-[b]	7
1953	96	-	41
1954	-	-	52
1955	83	-	41
1956	89	-	25
1957	85	-	35
1958	80	-	34
1960[c]	81	42	-
1961	85	82	-
1962	82	70	-
1963	81	79	-
1964	83	65	-
1965	85	62	-
1966	88	73	-
1967	84	63	-
1968	79	70	-
1969	90	80	35
1970	76	72	65
1971	85	75	40
1972	78	65	35
1973	81	47	45
1974	70	55	25

a. Data for 1952-58 (Webb *et al.* 1961).
b. - denotes no data.
c. Data for 1960-67 (Macdonald *et al.* 1963, 1968).

Table 4 Moderate and severe defoliation (millions of acres) in New Brunswick, 1972 to 1974

Year	Defoliation category Moderate	Severe	Total	Ratio (74/73, 73/72)
1974	2.0	6.3	8.3	
				1.06
1973	4.3	3.5	7.8	
				1.81
1972	2.4	1.9	4.3	

Table 5 Areas (million acres) by categories of spruce budworm egg-mass infestations in New Brunswick, 1960-1973

Year	Infestation category: Light	Moderate	High	Total
1974	0.8	0.7	13.5	15.0
1973	2.5	1.5	11.0	15.0
1972	5.8	2.7	4.8	13.3
1971	4.9	.9	9.0	14.8
1970	4.2	.7	7.9	12.8
1969	3.0	2.0	5.0	10.0
1968	5.6	1.0	3.6	10.2
1967	4.3	.7	.8	5.8
1966	4.9	.5	1.4	6.8
1965	4.6	2.4	1.5	8.5
1964	4.4	.3	1.7	6.4
1963	3.2	.4	1.3	4.9
1962	2.7	.2	.2	3.1
1961	3.6	.8	.6	5.0
1960	3.1	.3	2.0	5.4

Table 6 Area (thousands of acres) of forest in New Brunswick in high and high to extreme hazard due to the spruce Budworm (1971 to 1974)

Year	hazard	Category[a]	
	high	high to extreme	Total
1974	4,541	2,265	6,806
1973	2,038	1,886	3,924
1972	1,857	2,856	4,713
1971	4,120	575	4,695

a. High to extreme - tree mortality and top-killing is expected.

High - tree vigor will be reduced and top-killing is expected.

Table 7 - Spruce budworm egg-mass densities by County in Nova Scotia in 1972, 1973 and 1974

County	Egg-masses per 100 ft.^{2} foliage[b.] 1972	1973	1974	Ratio 1974/1973
Cumberland	133	264	314	1.18
Colchester	51	40	60	1.50
Hants	18	9	29	3.22
Kings	67	26	15	0.57
Annapolis	34	23	30	1.30
Digby	7	12	12	1.00
Yarmouth	0	0	0	1.00
Shelburne	0	0	0	1.00
Queens	3	9	0	0.00
Halifax	0	0	0	1.00
Lunenburg	4	8	0	0.00
Guysborough	0	5	0	0.00
Pictou	5	15	--	--
Antigonish	16	134	204	1.52
Richmond	0	--[a.]	125	--
Victoria	0	--	330	--
Inverness	0	--	500	--
Cape Breton	0	--	---	--

a. --- No information

b. Egg-masses per 100 ft.^{2} foliage

E.M/100 ft.^{2}	Infestation level
0	nil
1 - 99	low
100 - 239	medium
240 - 399	high
400 +	very high

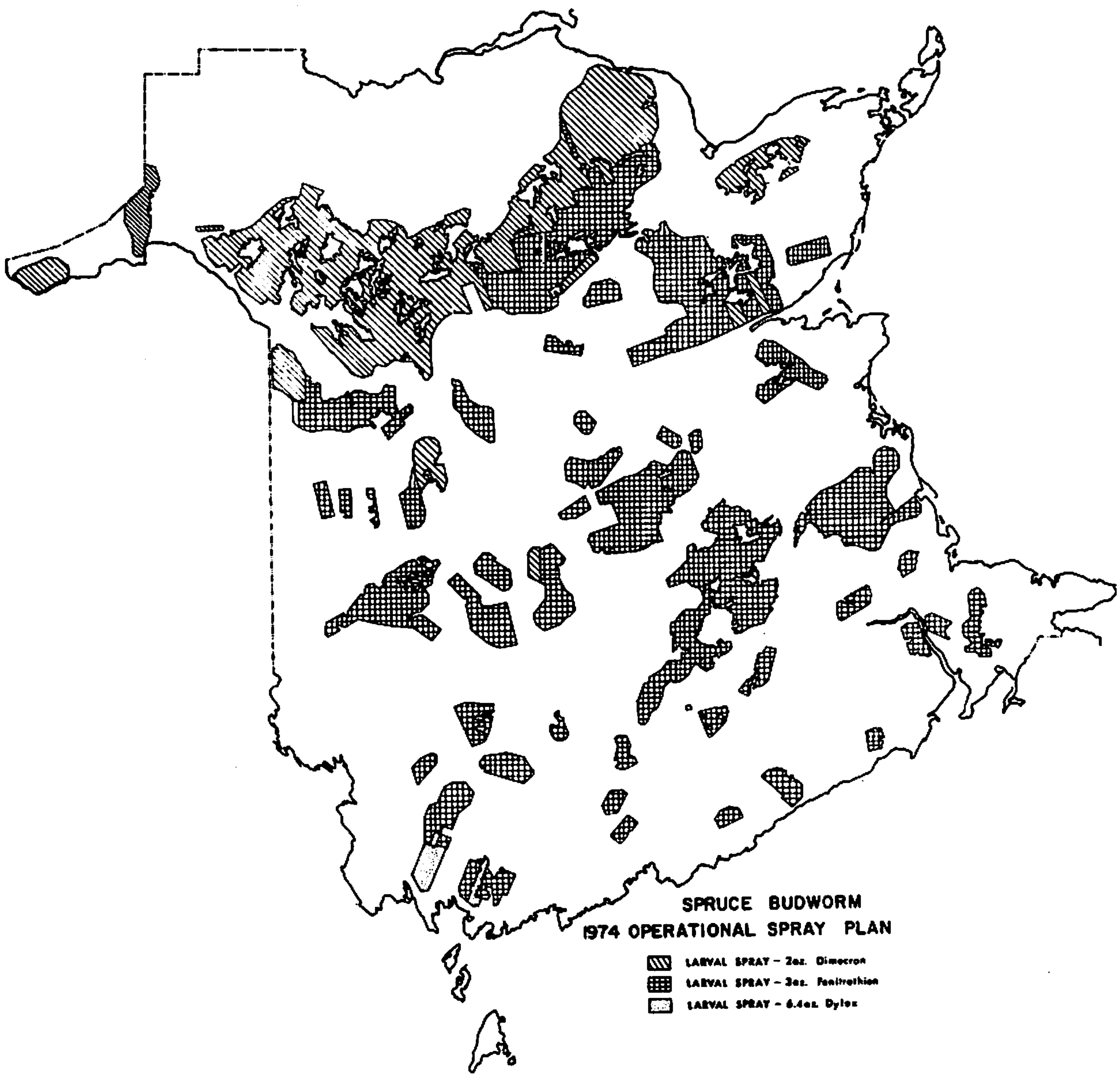

Fig. 1. Area sprayed in New Brunswick in 1974 to prevent massive tree mobtality due to the spruce budworm.

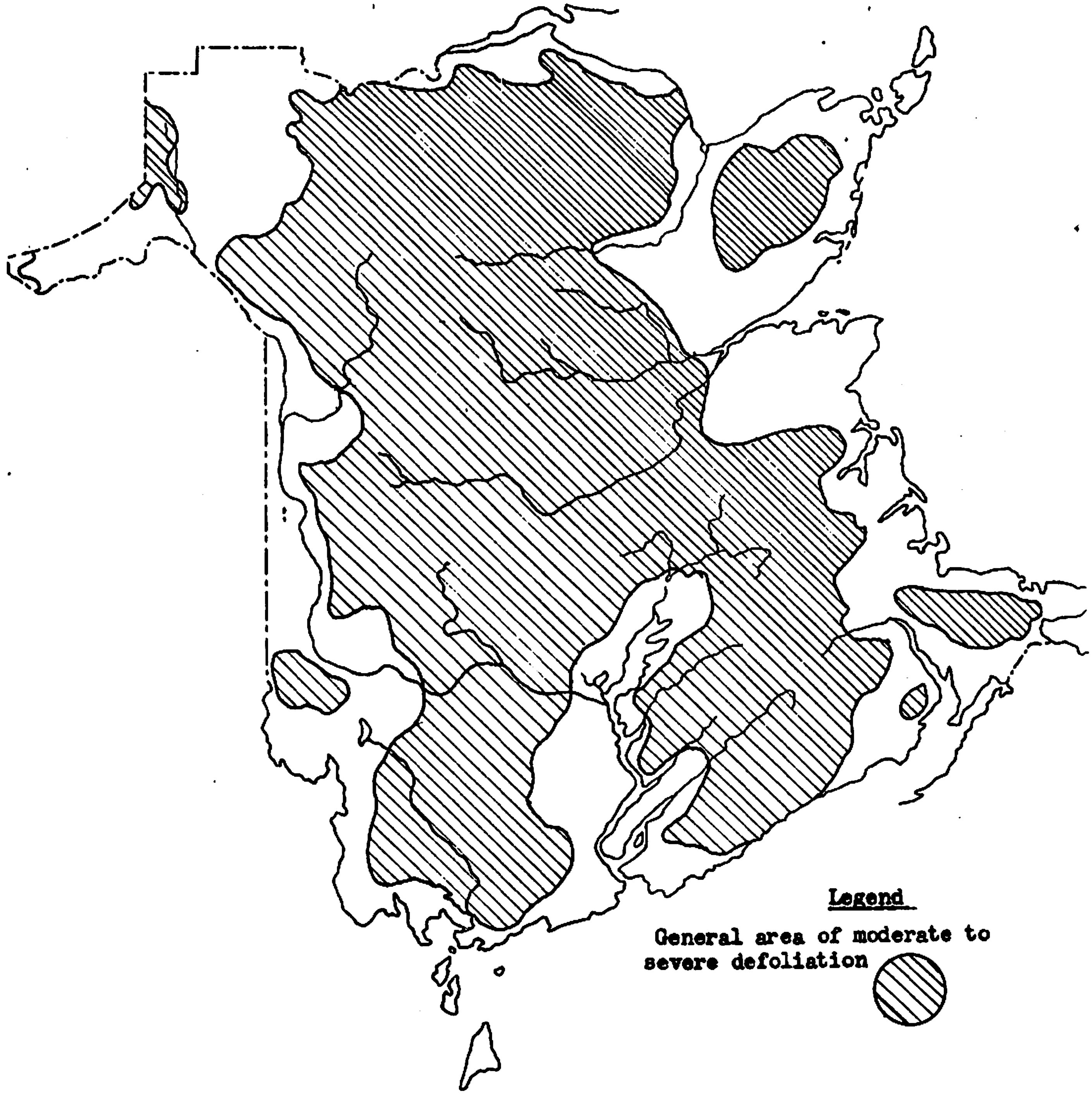

Fig. 2. Results of aerial surveys in New Brunswick showing areas inside which there is moderate to severe defoliation.

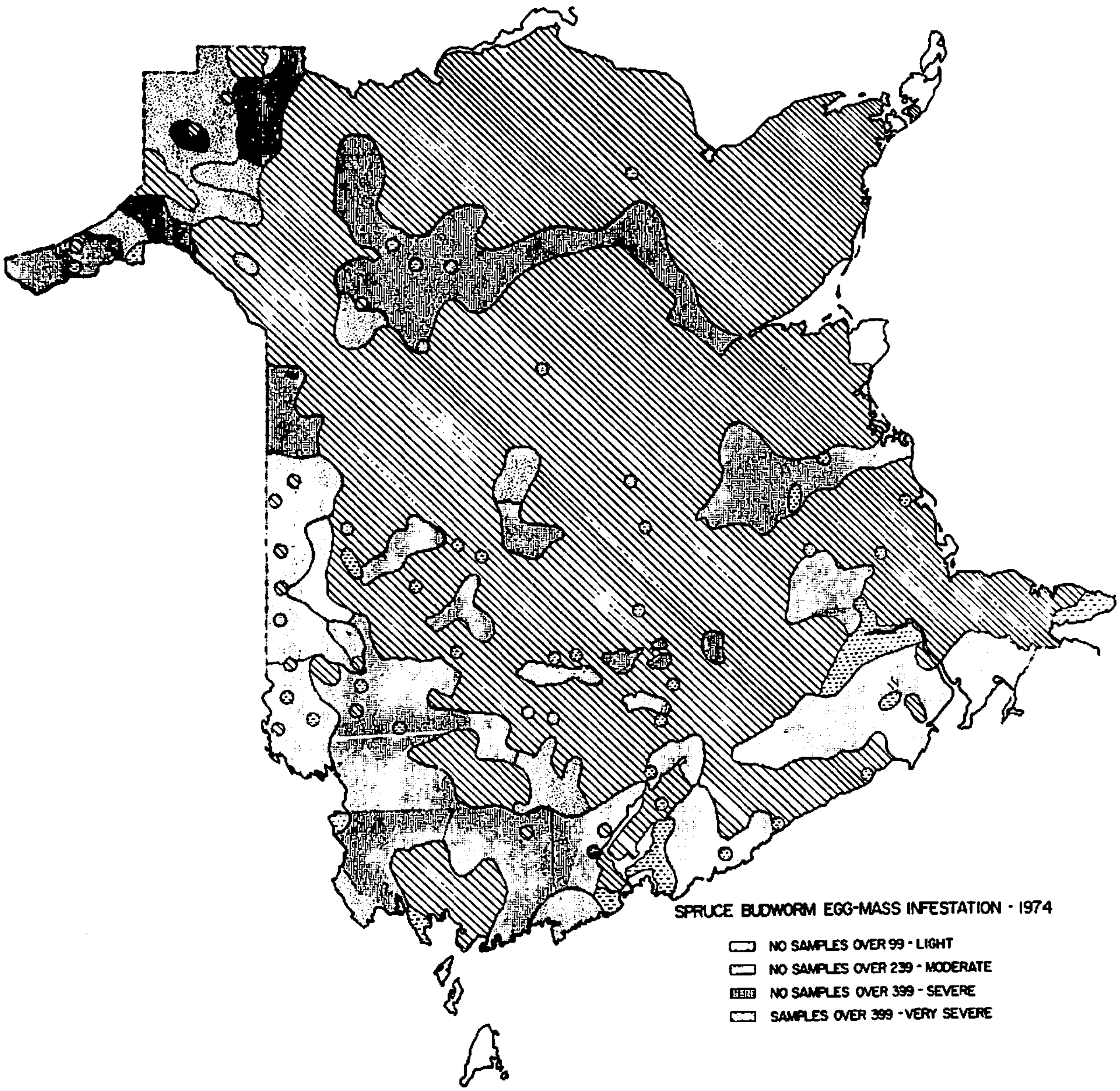

Fig. 3. Spruce budworm egg-mass infestations in New Brunswick in 1974.

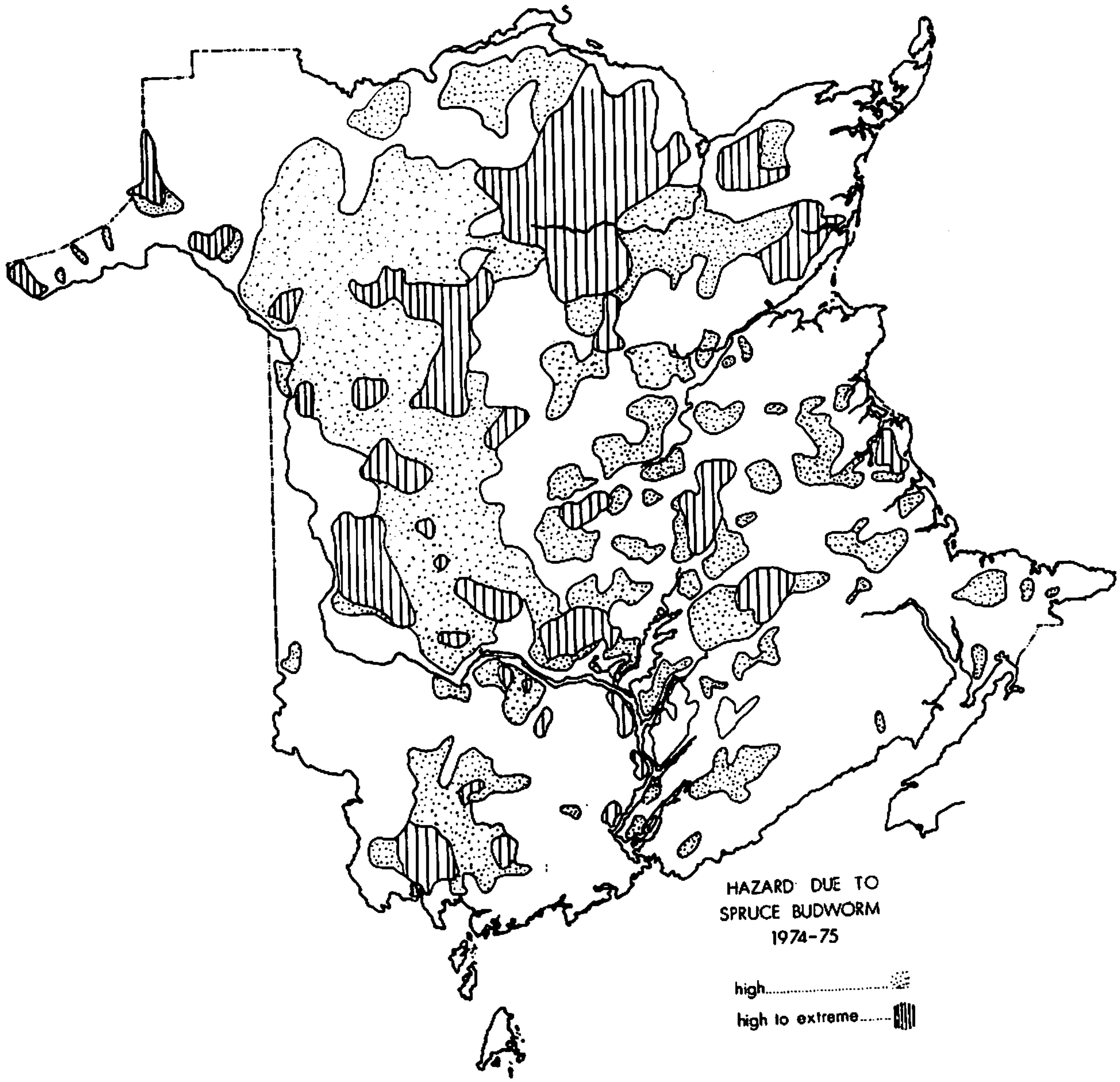

Fig. 4. Areas of high and high to extreme hazard due to damage caused by the spruce budworm, for the year 1975.

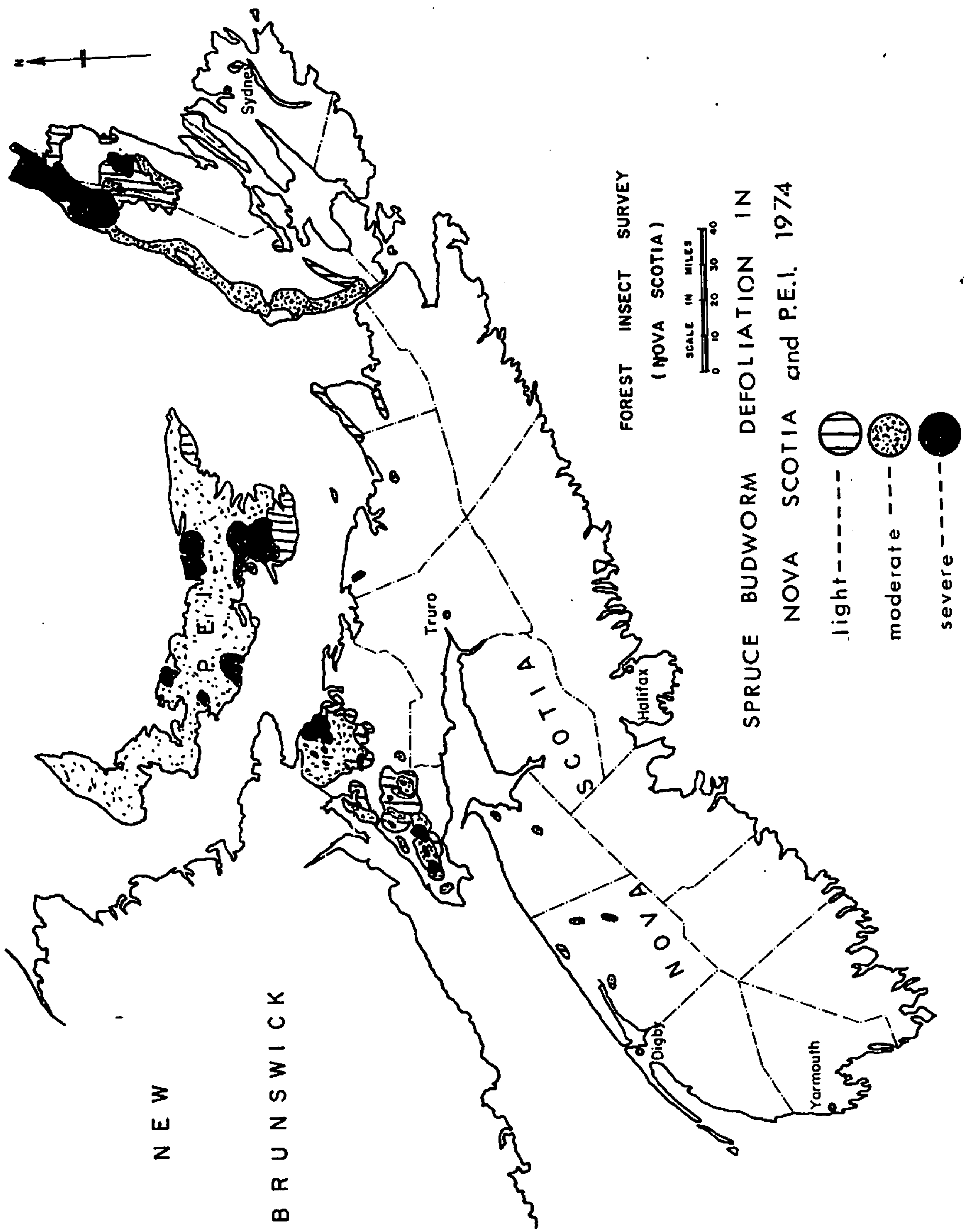

Fig. 5. Defoliation caused by the spruce budworm in Nova Scotia and Prince Edward Island in 1974.

APPENDIX 2

Environmental Effects

Project CC-3

Report to the Canadian Insect Pest Control Forum

by

C.H. Buckner

Chemical Control Research Institute
Canadian Forestry Service
Environment Canada

November 1974

CC-03 Environmental Impact Project

Chemical analyses have provided data on the occurrence, persistence and concentration levels of many of the insecticides in current use against forest pests. This forms a necessary step in the surveillance of pesticides in the various components of the environment. Emphasis has been placed on fenitrothion and matacil, with particular attention placed on the uptake, distribution and persistence of fenitrothion in various tree species. The ecological and population consequences on selected forest fauna of most of the insecticides in use indicated that if applied as recommended, no serious disruption of forest ecosystems, either terrestrial or aquatic are to be expected.

Summary Report

Research on Persistence and Fate of Insecticides in the Forest

Study CC-3-009

By

W.N. Yule

Chemical Control Research Institute
Canadian Forestry Service
Environment Canada

November 1974

Field studies of persistence and fate of fenitrothion in the forest environment have been continued in New Brunswick, where some areas of forest have been sprayed for up to six consecutive years for spruce budworm control. Fenitrothion deposits and residues have been found to weather rapidly to become undetectable in water and forest soil within several hours to days, and in tree foliage such as red maple and black, white and red spruces within months. Further work at Priceville, N.B. in 1974, has confirmed that residues of fenitrothion had accumulated in older foliage of balsam fir to levels of approximately 1 ppm, however, while persisting at a very low level (> 0.01 ppm) in white spruce foliage from the same plots. A study of penetration, translocation and metabolism of C_{14} - labelled fenitrothion in potted spruce and balsam trees was begun last winter to help elucidate field situations.

DDT residues persisting at Priceville were measured in 1974. While only occasional traces of DDT were found in tree-foliage and aquatic environments, levels of approximately 0.5 ppm persisted in forest soils. These soil residues appear to be declining at a steady slow rate, with increased proportions of breakdown products such as DDE appearing in some soils.

Studies of the persistence and fate of phosphamidon and aminocarb in the forest environment, and development of analytical methods for each of these insecticides, were begun in 1974.

Summary Report

Physiological Relationships

of Insecticides in Forest

Trees

Study CC-3-013

By

R. Prasad

Chemical Control Research Institute
Canadian Forestry Service
Environment Canada

November 1974

Penetration, Transport and Fate of Insecticides
(Fenitrothion) in Forest Trees

by R. Prasad (Study #CC-3-013)

During aerial sprayings of vast tracts of forests, considerable drift of insecticides takes place and some of these residues are likely to persist on and penetrate into the vegetative components of the forest ecosystems. Although much of the residues of fenitrothion are biodegradable, some toxic metabolites (fenitro-oxon) have been detected from the forest trees. The purpose of this study is twofold: (a) to monitor the systemic activity of insecticide residues in the forest trees with a view to control the economic insect pests and (b) to investigate the fate and environmental effects that these residues might produce on the vegetative components of the forest ecosystem, since many forest trees (bark, buds, seeds and cones, roots and foliage) constitute food sources for the wildlife.

(a) Penetration of Fenitrothion-C^{14} in Balsam fir and White Spruce.

Using greenhouse and laboratory experiments it was found that fenitrothion-C^{14} persisted largely on the cuticle of balsam fir and white spruce but under certain conditions it did penetrate the epidermis and hypodermis of the needles and moved towards the vascular system (xylem vessels). A modified histoautoradiographic technique employing 10% glycerol, Tissue-Tek and cryostat was developed to study persistence and penetration at cellular and tissue level. Movement of fenitrothion-C^{14}

was faster in balsam fir than in white spruce and thus suggesting a clue to greater toxicity of the spruce budworm on the balsam fir than on the spruce needles. Further laboratory experiments on seedlings trees indicated that fenitrothion-C^{14} breaks down into metabolites both in the spruce as well as in the balsam fir.

(b) Fate of Fenitrothion in Forest Trees.

The metabolism of fenitrothion and effects of the metabolites on seeds and seedlings growth (regeneration) of white pine and birch was studied under the laboratory conditions. Seeds and seedlings sprayed with the field concentration (4 oz./acre A.I.) and a tenfold higher concentration showed deleterious effects on stratification and general functioning of important enzymes (succinic dehydrogenase, esterases and oxidases) and caused dwarfing of the young forest seedlings. However, at field concentration, the recovery from the phytotoxicity was rapid and once the seedlings established themselves, the initial adverse effects of the pesticide treatment were subsequently nullified. At higher concentrations, fenitrothion was extremely phytotoxic to birch seedlings and completely decimated its regeneration and re-establishment. Clearly, the insecticide sprays affect deciduous tree species differentially and this is important from the ecological point of view.

Residues of fenitrothion and metabolites were detected from seeds and seedlings by development of sophisticated chemical methodology. Several toxic metabolites of fenitrothion - fenitro-oxon, amino fenitrothion, amino fenitro-oxon and S-methyl fenitrothion were chemically synthesized and their structure characterized by gas, thin layer chromatography and mass spectroscopy. Uptake and accumulation of fenitrothion, fenitro-oxon and S-methyl fenitrothion was demonstrated in the perisperm and embryos of the germinated seeds and seedlings but neither the parent compound nor its metabolites adversely affected the later growth of white pine seedlings. Studies are underway to monitor their accumulation pattern and phytotoxicity in seeds and seedlings of birch trees.

Summary Report

Ecological Effects of Pesticides in Forest Ecosystems

Study CC-3-014

By

C.H. Buckner

Chemical Control Research Institute
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Environment Canada

November 1974

ECOLOGICAL EFFECTS OF PESTICIDES

The ecological impact team continued its program of monitoring and research during 1974. In New Brunswick, the ecological side effects of fenitrothion and phosphamidon were studied under operational conditions. In the larvicide program, the effects of fenitrothion at 2 oz per acre applied twice and phosphamidon at 2 and 3 oz per acre applied once were examined. There was a slight impact upon birds in these treatment areas, amounting to somewhat less than 5%. There was no impact on mammals, the other component of the ecosystem studied. Extensive monitoring operations in the 2 million acre adulticide program using phosphamidon at the rate of 1 oz per acre applied twice had no detectable impact on birds and mammals and only a slight impact on aquatic organisms.

Extensive monitoring programs in Quebec concentrated on the effects of fenitrothion, zectran and matacil on various components of the forest. Fenitrothion at the application rate of 2 oz per acre, and Matacil and zectran at 3/4 oz per acre, all applied twice, had no detectable effects on bird and mammal populations and very minimal impact upon aquatic ecosystems. Colonies of domestic bees in areas treated with fenitrothion and zectran lost a small portion of their worker force immediately after the treatments, but the colonies all recovered quickly with no loss of productivity.

Continuing research in the LaRose Forest in Ontario concentrated on the possible prolonged effects of repeated treatments using fenitrothion at the rate of 4 oz per acre. After four annual treatments at this dosage no ecological disruption could be detected in birds, mammals and aquatic systems. A single application of matacil at the rate of 1 oz per acre was also examined. No adverse effects on birds, mammals, honey bees or aquatic ecosystems could be found. In central Ontario,plantation treatments using methoxychlor at the rate of 1 lb per acre were examined. No serious ecological disruption occurred and honey bee colonies survived the treatment with minimal damage.

The Environmental Emergency Team investigated two reports of suspected insecticide poisoning of birds in Quebec. In both cases, causes other than insecticides were responsible for the mortality: in one case starvation associated with unusual phenological conditions and in the other ingestion of calcium chloride used in road maintenance was the cause of death.

It was concluded that, under the conditions of application, no serious deleterious environmental effects resulted from areal insecticide applications during 1974.

SUMMARY REPORT TO THE ANALYTICAL CHEMISTRY SERVICE SECTION AND METHODOLOGY RESEARCH FOR INSECTICIDE RESIDUES IN THE FOREST ENVIRONMENT

(Study Ref. No. CC-3-018)

A REPORT TO THE ANNUAL FOREST PEST CONTROL FORUM

By

K.M.S. SUNDARAM

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October, 1974

REPORT BY THE ANALYTICAL SERVICES SECTION OF C.C.R.I. TO THE ANNUAL FOREST PEST CONTROL FORUM

The Analytical Services Section of the Institute has played an increasingly active role during the 1974 spray operations by providing analytical data on various pesticide residues found in formulations, water, air, soil, foliage, birds, mammals, insects and fish samples numbering ca 800 collected from sprayed forest areas of Canada from coast to coast.

The insecticide residues analysed were fenitrothion, phosphamidon, Gardona®, Sevin®, D.D.T. and methoxychlor. New methodologies and techniques have been developed for the extraction and analysis of those insecticides and their metabolites from various substrates of the forest environment. In addition to providing the analytical service, the Section has collaborated actively in various research projects carried out at the Institute, and other Forestry establishments such as MFRC, PFRC and LFRC, on the effective use of pesticides in forest protection and studied intensively the distribution, persistence and fate of some of the insecticides currently used in spray programs and their overall impact produced on the forest ecosystem.

Environmental impact of aerial spraying on stability of arthropod communities in forest ecosystems, 1974 (I.W. Varty)

Background. Because chemical insecticides kill beneficial insects and other indispensable components of forest arthropod communities, some concern has grown that recurrent large-scale spray operations would ultimately produce imbalance in the trophic linkages in forest ecosystems, and that this perturbation would ultimately manifest itself in (a) more vigorous development of budworm outbreaks, (b) irruptions of minor pests released from biocontrol restraints, threatening multiple pest problems in various tree crops, (c) long-term interference with other processes such as nutrient turn-over and pollination, leading to quite unpredictable consequences to resource conservation. For whatever reason, budworm outbreaks have become larger and more threatening, and prospects of large-scale, perennial insecticide spray programmes in eastern Canada are real.

The MFRC is attempting to develop monitoring techniques for surveillance of arthropod communities, and to make spot-checks of short-term and long-term responses of indicator species populations involved in such functions as parasitism, predation and pollination. It is research; no survey is conducted.

In 1974, MFRC environmental studies were aimed at (1) monitoring the effect of larvicide (May-June) sprays (fenitrothion) on parasitism in spruce budworm populations with various spray histories; (2) monitoring short-term effects of adulticide (July) sprays (Phosphamidon) on predators and parasitoids; (3) monitoring the short-term effect of growth regulator chemicals (JH) on non-target insects; (4) establishing methodology whereby insecticidal stress on the arthropod community on red maple could be measured; (5) investigating the environmental persistence of Phosphamidon applied aerially; (6) measuring the effect of insecticide drift on the activity of pollinators and its significance to the blueberry crop.

RESULTS

Spruce budworm parasitism. Parasitism is a very difficult function to quantify due to variation in the timing of samples, the sampling universe, and habitat characteristics. Our research is largely aimed at the methodology of measuring parasite abundance so that deviations from the norms may be detected. The evidence of several successive seasons, including 1974, is that parasitism as a function has not been substantially disturbed by intervention with larvicide sprays of fenitrothion.

Adulticide sprays with Phosphamidon hit parasitoids at a far more vulnerable stage than larvicidal sprays. Dramatic kills of *Apanteles* and *Glypta* adults, often in excess of 100,000 per acre, have been recorded in three experimental years. However, our limited evidence indicates that the recuperation of parasitoid populations is rapid, even in stands where mortality of parasitoid adults was almost total. This research is continuing (F.I.D.S. collaboration).

Predaceous arthropods in fir crowns. Predatory insects are at low population ebb in fir-spruce forests in New Brunswick, probably in response to the cycle of prey abundance, and independent of insecticides. Monitoring of predator abundance in an area subject to recurrent larvicide spray of fenitrothion has shown immediate mortality but no long-term decline over several years, with some specific exceptions. Thus the function of predation in the ecosystem does not appear to be endangered.

Adulticide operations may pose a more severe hazard because in July, peak populations of adults are exposed. Phosphamidon produced a high percentage kill of major predaceous insects (not spiders and mites), but the rate of recuperation is unknown.

Growth regulator chemicals. (Collab. CIBA-Geigy). These J.H.-like compounds affect a much narrower spectrum of susceptible insects than conventional insecticides. Data from 1974 have not yet been analysed but will probably show that parasitism in spruce budworm populations was not substantially affected by the dosages/timings tested in New Brunswicks fir stands. Predators and other groups of non-target insects were not drastically affected, but methodology for the type of monitoring is underdeveloped.

Red maple arthropod community (contract study). Red maple is the most abundant non-target tree in New Brunswick's sprayed forests; red maple stands were severely defoliated in 1974 by the lesser maple spanworm and two other defoliator species, suggesting a relationship between irruption and spray stress. Methods of sampling the arthropod community are being established, and data are being gathered to determine the sensitivity of a species diversity index re insecticide usage. The study also researched the use of a fluorescent tracer dye for measurement of insecticide deposit.

Insecticide persistence. A collaborative study (CCRI) is expected to establish the field persistence of Phosphamidon in foliage of fir, spruce, maple, and in soil and in water, over a 6 month monitoring period. A similar study on the environmental persistence of fenitrothion, conducted in 1973, is not in press.

Pollinators (contract study: collab. Agric. Canada). Blueberry growers in New Brunswick have complained that drift and overhead sprays from forest operations have caused such mortality of wild bees that blueberry yields have severely declined. MFRC established a second year contract in 1974 to research the relationship between drift and bee activity and crop yield. The results confirm that drift can be heavy and distant from the spray block but the evidence of correlation between drift and bee activity (= survival) is conflicting; the problem has not been resolved, but some pertinent data were collected.

OTHER

Pesticide Ecology Problem Appraisal. Dr . Buckner and I are consulting with other departmental and university specialists to review the problem of the side effects from insecticide usage in forests, and to suggest a comprehensive approach to long-term research. The report is expected to be produced in winter 1974-75.

Pesticide Ecology Research Group. PERG met on April 4/74 at Fredericton, and minutes are available (Chmn. I.W. Varty). General matters of concern were weaknesses in research on ecological effects of Phosphamidon, on soil biology, and on pollination; and the problem of unregistered unmonitored aerial spraying in New Brunswick. In all branches, monitoring of side effects operates on a shoestring.

Bird responses to forest sprays in New Brunswick, 1974

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Canadian Forest Pest Control Forum
November 19, 1974
Hull, P.Q.

Introduction

An investigation was undertaken in northeastern New Brunswick in 1974 by N. Garrity for the Canadian Wildlife Service to assess the influence of forest spraying on resident birds. Where possible, his field activities were integrated with those of the Chemical Control Research Institute so as to benefit from the advantages of pooled resources and to permit a comparison of different appraisal techniques. The study was conducted in areas which were sprayed once with fenitrothion in larviciding operations and which were subsequently re-sprayed twice with phosphamidon during a large-scale budworm adulticiding program.

This report in part briefly reviews the salient features and conclusions of that study and also attempts to set it in a broader context by presenting other information of relevance.

Bird mortality from natural causes

Because it took place at a time when fenitrothion larviciding operations against spruce budworm were in full swing in New Brunswick, a natural event which caused considerable bird mortality deserves some comment.

It was unseasonably cold in the province throughout much of May, light falls of snow being reported three times. Average temperatures were four to ten degrees below normal during the third week and up to 14 degrees below normal in the last week of the month. Seasonable conditions prevailed from early June onward. The prolonged cold weather deprived many birds of their natural food sources at a time when their migratory flights had left them without body fat reserves, and resulted in grounding and a subsequent major die off. Under those conditions, increased vulnerability to predation undoubtedly was a contributing mortality factor. The phenomenon was widespread, being noteworthy throughout much of New England and the Maritime Provinces. The event went unnoticed in northern New Brunswick, perhaps because the major migratory thrust had not then penetrated that far. It is not possible to estimate total mortality, although "hundreds of thousands" of casualties were reported from Maine. Casualties were reported from many southern localities in New Brunswick, from the middle of May through to the end of the month. Of those specimens examined, all of which were emaciated, most were insectivorous birds such as swallows, flycatchers and warblers. Omnivorous and granivorous species appeared to be relatively little affected. About three dozen species representing ten families were identified.

Forest spraying began on May 18 in the early phenological zones, and by the end of that month one quarter of the total provincial larviciding program had been completed. The early spraying took place precisely in the region where forest birds were under the severest stress from inclement weather. In that region, however, treatment blocks were widely scattered and in relatively small aggregations. In such fairly restricted areas, insecticide application may possibly have compounded the problem of bird starvation and lessened the likelihood of survival. The matter may be clarified after examination of the presently-unavailable results of analysis for residual fenitrothion in representative bird carcasses recovered from some of those areas.

Monitoring program

Bird census transects were established in three spray blocks, 197, 195 and 193 (Figure 3) near Newcastle which were sprayed in early June by TBM aircraft with fenitrothion at 3 oz/acre. A control route was set up in a nearby zone which remained unsprayed. All four areas were subsequently sprayed twice with phosphamidon at 1 oz/acre in mid-July. At that time, as a result of block re-designation, routes 197 and 195 were in block 12 and routes 193 and control were in block 13. Phosphamidon was applied by TBM rather than by DC-6, as had been hoped.

Bird censuses were made almost daily from late May to late July. Indices to species abundance, based largely on counts of singing males, were derived in a manner previously explained at this forum. Fourteen captive birds were exposed in phosphamidon-treated zones, and breeding success was determined by following activity at thirteen nests. Population indices are shown in Figure 1. Warblers constituted the largest avifaunal component in the areas studied: total numbers noted along each transect are given in Figure 2.

(a) Fenitrothion larviciding

Block 193 was sprayed on June 5, and blocks 197 and 195 on June 7. At that time, because of the preceding cold weather, most locally breeding birds had just established on territory. However, it was felt that an adequate pre-spray population "fix" was obtained. Census data did not indicate any depression of local bird populations that could be attributed to exposure to fenitrothion, day-to-day apparent fluctuations being related to the influence of wind and other factors on bird activity. Three birds - a Tennessee, a Magnolia, and a Bay-breasted Warbler - exhibited typical symptoms of organophosphate poisoning. Those individuals were sacrificed and are currently being analysed.

One report came to hand concerning avian mortality in a fenitrothion spray zone elsewhere.. That was at Breau Creek, near Sackville, in a locality precisely on the border between two contiguous spray blocks both of which were sprayed on the same morning by the same team of spray aircraft. A "considerable" number of dead and dying birds were found, a few of which were obtained for chemical analysis. It seems most probable that they were victims of an overspray.

In Appendix 1 are shown some representative levels of residual fenitrothion which proved lethal to some birds and which caused no observable effects in others. Samples were taken in 1970-73.

(b) Phosphamidon larviciding

Extensive tracts of forest in northern and northwestern New Brunswick were sprayed with phosphamidon at a dosage of 2 oz/acre during budworm larviciding operations. No monitoring activities were conducted there by CWS but several isolated reports came to hand, mostly from field staff of the New Brunswick Department of Natural Resources, concerning the finding of dead birds during mid-June. Those reports were received too late after the event for on-the-spot investigations to have been very fruitful. Apparently "hundreds" of carcasses were found along the Benjamin River and small numbers of dead and dying birds were noted in the vicinity of the Jacquet and Serpentine Rivers and at Riley Brook. Another report of bird deaths from the watershed of the Southeast Upsalquitch River may have been at or near the crash site of a spray aircraft. A later examination of spray schedules suggested quite strongly that those events were related to spraying activity. If errors in formulation can be discounted, it seems likely that oversprays may have been the causal factor.

(c) Phosphamidon adulticiding

Censusing was continued throughout the summer in spray blocks 197, 195, 193 and in the control area, subsequently re-designated, respectively as blocks 12, 12, 13 and 13. By mid-July singing activity by birds had begun to decline noticeably, as reflected in Figures 1 and 2. Two applications of phosphamidon were made - at an interval of seven days in block 12, and at an interval of four days in block 13. Census data, of the kind admittedly of limited value at that time of year, indicated no untoward effects. Thorough post-spray searches revealed no obvious casualties. All but one of 14 captive adult birds (Evening Grosbeaks, Purple Finches, Brown-headed Cowbird), exposed to the sprays in block 13, survived without displaying symptoms of poisoning and were released a week later. Of thirteen nests located only a few were active at the time of spraying. They were mostly of ground-nesting Swainson's Thrushes and White-throated Sparrows, whose breeding success did not appear to be jeopardized by the sprays. That little evidence notwithstanding, a major initial objective of the study - to determine the influence of phosphamidon on nestling and fledgeling survival - was for various reasons most inadequately met. Possibly very young birds would come into less contact with contaminated surfaces than adults, being less mobile. It remains undetermined whether they would be seriously vulnerable to secondary poisoning through ingestion of contaminated food.

<u>Other activities</u>

Monitoring of DDT levels in breast muscle of woodcock has continued in New Brunswick. Concentrations of that chemical in fall-shot birds from two areas with similar spray histories are shown for general interest in Appendix 2. A gradual decline of contamination is indicated, the apparent reversal of the trend in the Bettsburg samples in 1973 being attributed to one or two extremely "hot" birds. In order that those levels of contamination may be appraised in a wider context a five-year program, terminating in 1975, is being conducted to determine DDT concentration in the wings of woodcock from New Brunswick and from other parts of that species' range in Canada.

Conclusions

In light of the findings reported here and of previous experience with the two chemicals involved, emphasis being on identification of acute effects, the following tentative conclusions are drawn:

(a) birds of the New Brunswick forest suffered more from the elements in 1974 than from man in his attempts to protect that forest against other natural hazards;

(b) no widespread avian mortality is attributable to the influence of applied insecticides;

(c) fenitrothion approaches a threshold level toxic to birds when applied at 3 oz/acre;

(d) phosphamidon is near a threshold level toxic to birds when sprayed at 2 oz/acre;

(e) when those operational dosages of fenitrothion and phosphamidon are significantly, however inadvertently, exceeded, as in the case of oversprays, lethal effects are more readily discernible;

(f) summer applications of phosphamidon at 1 oz/acre are not toxic to adult birds, the influence on young birds not being adequately assessed.

Figure 1. Bar chart showing total birds noted per minute along census lines in spray zones.

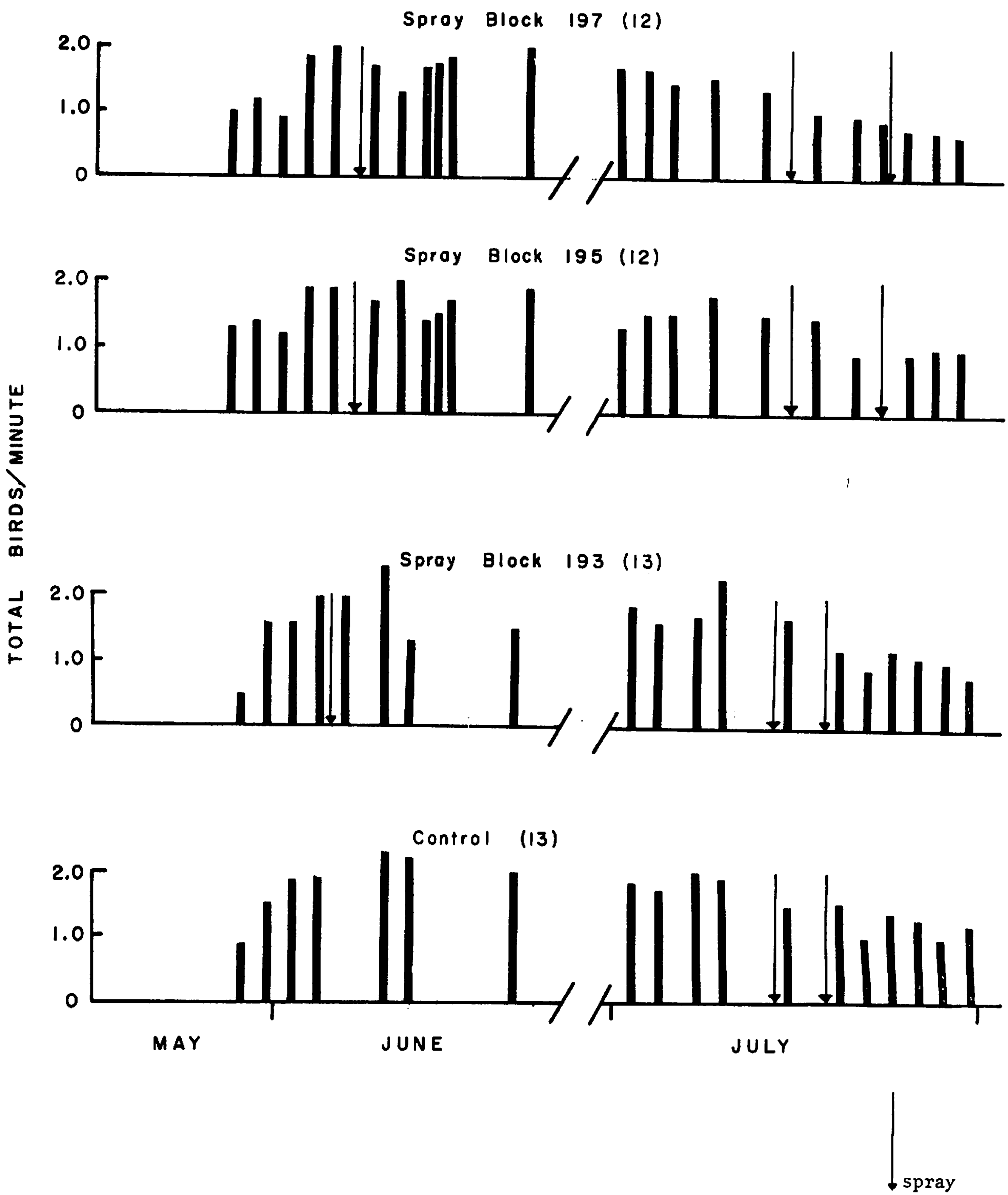


Figure 2. Bar chart showing number of warblers noted along census lines in spray zones.

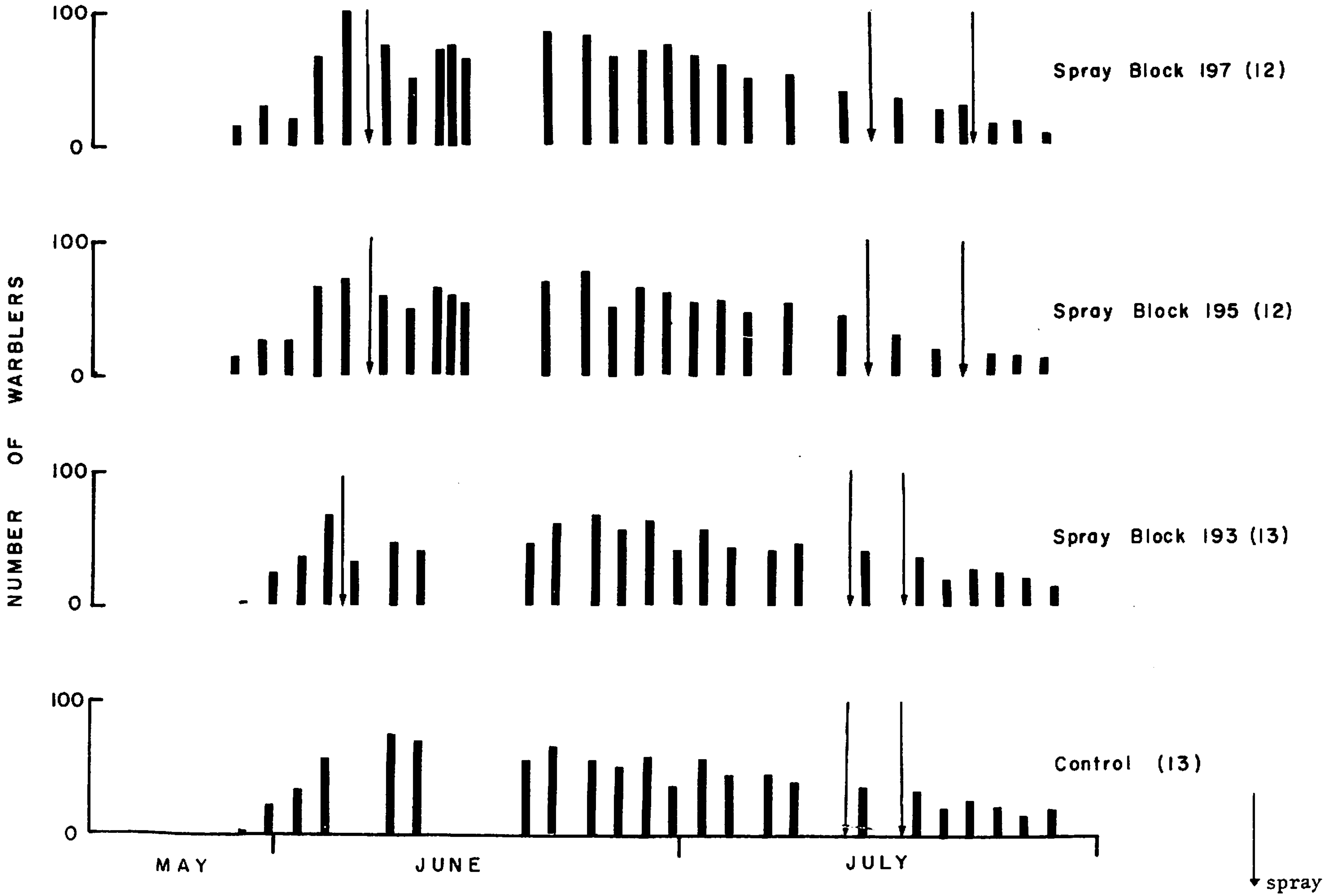
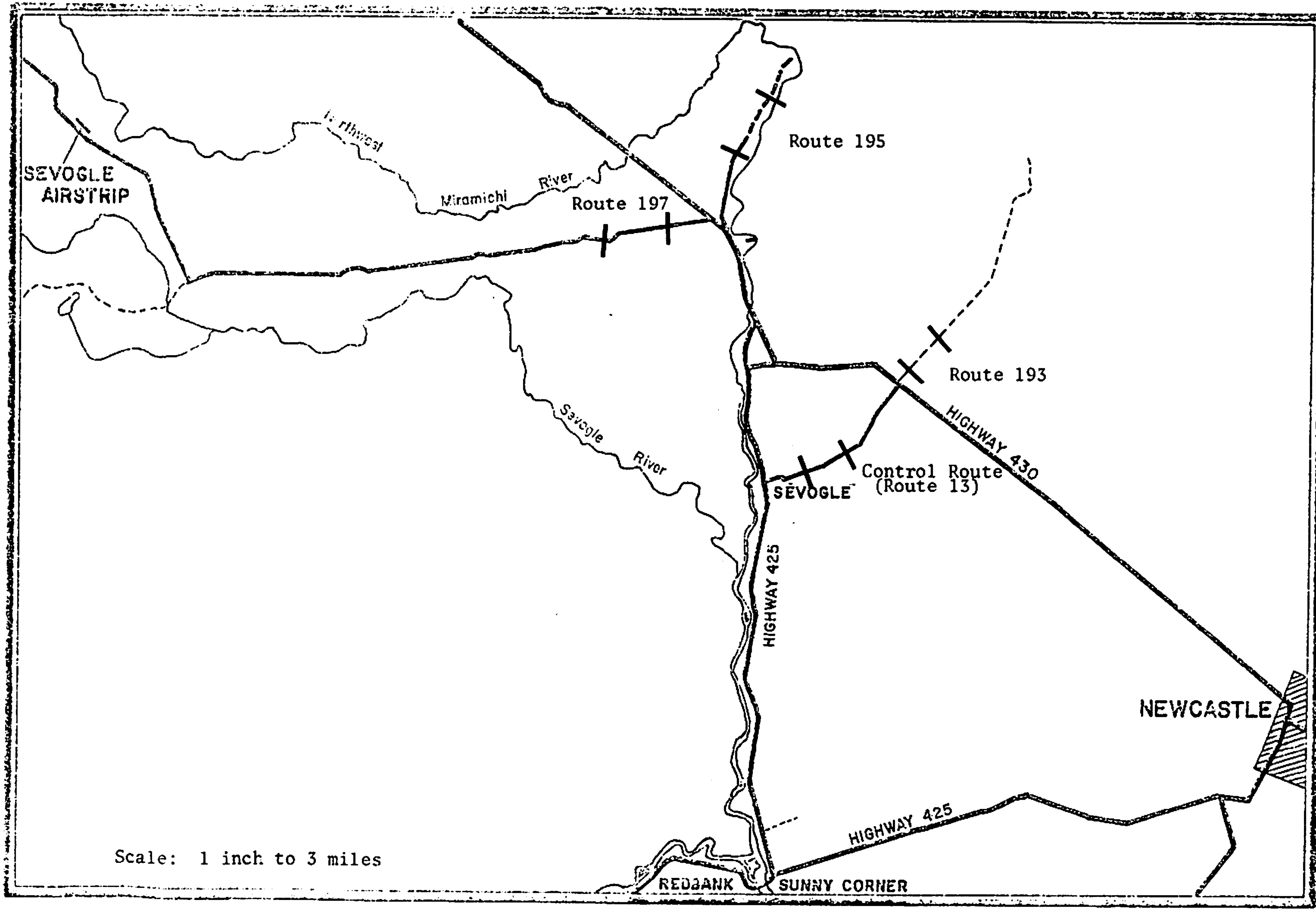


Figure 3. Location of Fenitrothion and Phosphamidon Census Routes.



Appendix 1. Fenitrothion levels in representative samples of forest birds exposed to operational spraying.

Species	Fenitrothion (ppm fresh weight - whole body less head)
Magnolia Warbler *	1.98
" " *	2.07
" " *	3.48
Blackburnian Warbler *	2.31
" " *	4.42
" " *	5.22
American Redstart *	1.11
" " *	1.48
" " *	2.54
Bay-breasted Warbler **	0.047
" " **	0.150
" " **	0.192
White-throated Sparrow **	0.028
" " **	0.033
" " **	0.183

* birds found dead in spray zone

** apparently normally-behaving birds in spray zone

Appendix 2. DDT levels in breast muscle of New Brunswick woodcock.

Year	Number of analyses	Number of birds	Total DDT* (ppm lipid weight)
		Bettsburg	
1970	14	45	75
1971	21	80	58
1972	3	22	40
1973	7	18	74
		Zionville	
1970	8	8	72
1971	5	34	50
1972	4	21	40
1973	5	10	37

* Weighted arithmetic mean

SUMMARY

INVESTIGATIONS CONDUCTED BY THE ENVIRONMENTAL PROTECTION SERVICE DURING 1974 CONCERNING THE EFFECTS OF FENITROTHION ON AQUATIC INVERTEBRATES IN NEW BRUNSWICK

prepared for

FOREST PEST CONTROL FORUM

November, 1974

by

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INTRODUCTION

Since 1971 the Environmental Protection Service has been involved in the investigation of the influence of aerially applied insecticides on stream dwelling invertebrates. Most of our emphasis has been directed toward investigating the influence of the use of fenitrothion, however, in 1973 some effort was made to describe the effects of phosphamidon on stream invertebrates in Northwestern New Brunswick.

During 1974, fenitrothion related work continued in New Brunswick. This report deals with the findings of that work and compares the data gathered in 1974 to that gathered since 1971.

STUDY AREA

The fenitrothion study area is located on Cove Stream, New Brunswick (see Figure 1). This stream has been used annually since 1971 to examine the short-term and long-term effects of fenitrothion applications. The watershed of Cove Stream has received applications of fenitrothion in each of 1971, 1972, and 1973, however, the watershed was not sprayed during 1974.

METHODS

Since the watershed was not scheduled to receive fenitrothion, and since the influence of the aerial application of fenitrothion on insect drift has been well documented by Banks (1973) and Eidt (1974, in press), it was decided to abandon the monitoring of insect drift during 1974. Emphasis was placed on the determination of the resident benthic population of invertebrates during the period early May to early June. Benthic sampling had

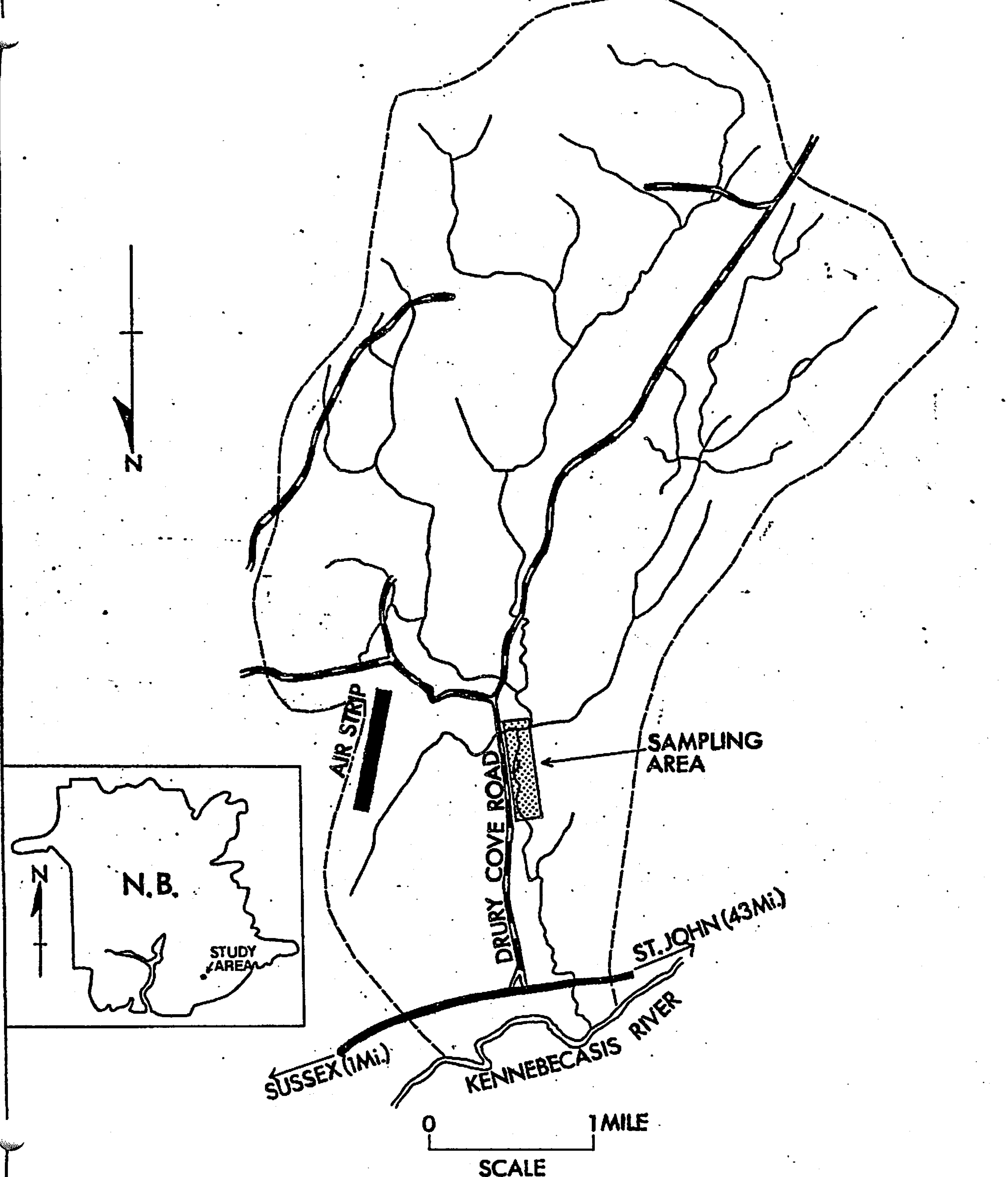

FIGURE 1. MAP OF THE COVE STREAM DRAINAGE BASIN SHOWING THE LOCATION OF BENTHIC SAMPLING.

occurred during this same period of the year in all previous investigations at Cove Stream and was coincident with the operational forest spraying in the area.

Stream conditions such as temperature, dissolved oxygen, chemical composition, water level, volume and current were routinely monitored in the manner of Banks (1973). Water samples were regularly collected for analysis of phosphamidon and fenitrothion residue. Analysis was done at the Water Quality Laboratory of the Environmental Management Service, Moncton, N.B.

The benthic invertebrate population was sampled using the Surber sampling method. Nine samples were collected twice weekly during the study period. The extensive riffle area used in all previous years was the site of sampling in 1974.

At Cove Stream sampling began on May 6 and continued until June 6.

RESULTS

Water levels in Cove Stream during the study period experienced a rapid increase (Figure 2) in early May associated with one heavy rainfall. The stream has been shown in previous years to react rapidly to rainfall.

The concentration of fenitrothion and phosphamidon did not rise above the limit of detection (0.010 ppb for fenitrothion, and 0.050 ppb for phosphamidon) during the period of investigation (see Table 1).

The results of Surber samples are presented in Figure 2 for the four main insect Orders resident in Cove Stream. Numbers of insects collected generally increased in late May and early June. A slight decrease in numbers of Diptera between samples on May 9 and May 16 is evident from these data. This decrease in

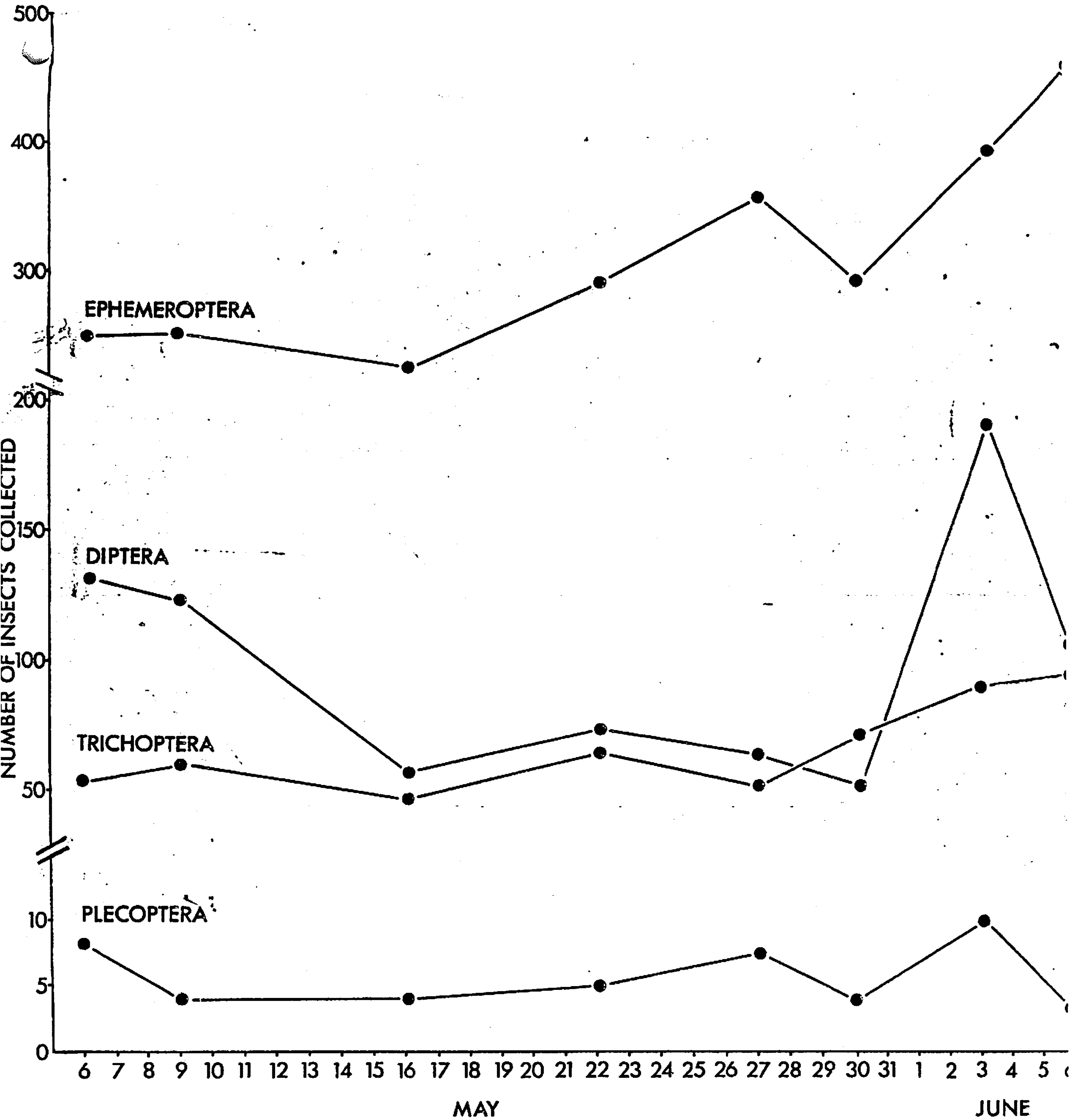

FIGURE 2. NUMBER OF INSECTS COLLECTED FROM COVE STREAM DURING 1974.

number may have been the result of a spate during that time (see Figure 3) which could have washed many larvae from the surface of the benthos. The number of Simulidae in samples taken May 16 was 60% fewer than in samples taken May 9.

To compare the benthic invertebrate population in Cove Stream in 1974 to that present in the stream in previous years, mean insect numbers per sampling effort were calculated for each year in which Surber samples had been collected in Cove Stream. These data are presented in Table 2. Statistical analysis of the means has not been completed at this time, therefore, it is not possible to say whether these data indicate that the benthic population is recovering after the initial crash between 1971 and 1972. It does appear, however, that a further decline in the benthic population has not occurred since 1972. Annual monitoring of the benthos will be necessary to determine whether receovery to the 1971 population will occur in future years.

In an attempt to investigate the changes in the diversity of the benthos, all benthic samples collected since 1972 have been re-identified to Family. Initial use of these samples in Banks (1973) was at the Order level of classification. Using the Shannon-Weiner method of diversity index calculation described by Saunders (1968) and Fager (1972), these benthic samples have been examined to determine whether benthic diversity has changed during the past three years. Results of the calculations are shown in Table 3. Although the number of Families has changed slightly, those Families abundant in the benthos in 1972 were evident in comparable numbers in both 1973 and 1974. Unfortunately, the original samples from 1971 are not available for further examination.

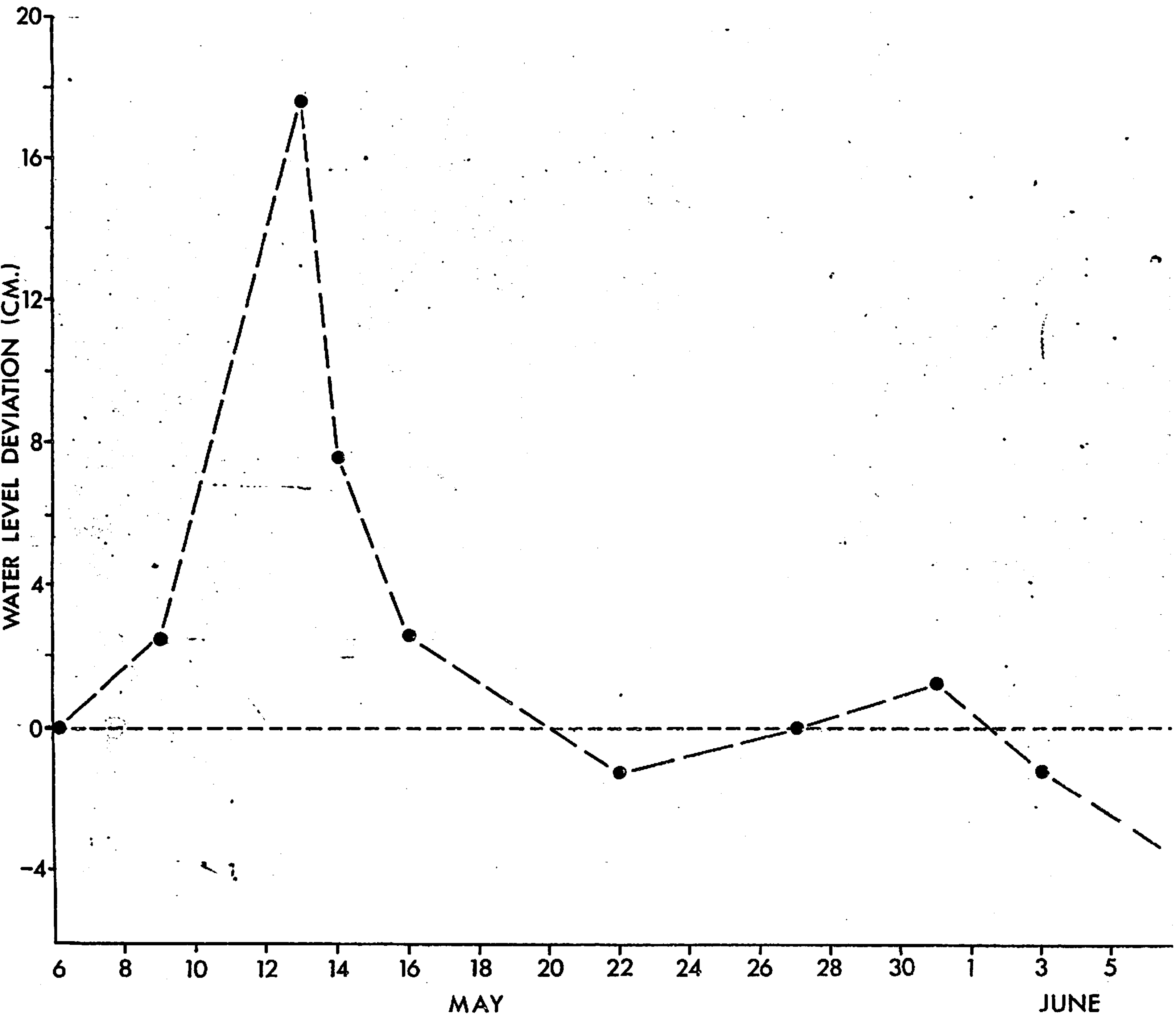

FIGURE 3. DEVIATION IN WATER LEVEL OF COVE STREAM.

Table 4 presents a summary of fenitrothion residues detected in the water of Cove Stream since 1971. When these fenitrothion concentrations are examined in relation to the data presented in Table 2 concerning the benthic invertebrate population over the same period of time, it may suggest that Cove Stream benthos is still recovering from the effects of the 57.0 ppb fenitrothion maximum recorded during the spring of 1971. Compounding this recovery could be the double application of fenitrothion received by the stream in 1972 and 1973. It is not possible to prove these possibilities at this time but it is hoped that in future years monitoring of the benthos will shed light on the question of benthic recovery.

ACKNOWLEDGEMENTS

I would like to thank Forest Protection Limited, the Water Quality Laboratory of the Environmental Management Service, Moncton, N.B. and the Canadian Forestry Service for their cooperation and assistance during the 1974 field work for this project.

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Table 1

Insecticide residues in water samples from Cove Stream during 1974.

DATE	FENITROTHION (ppb)	PHOSPHAMIDON (ppb)
May 6	<0.010	<0.050
May 9	<0.010	<0.050
May 13	<0.010	<0.050
May 16	<0.010	<0.050
May 22	<0.010	<0.050
May 27	<0.010	<0.050
May 30	<0.010	<0.050
June 3	<0.010	<0.050
June 6	<0.010	<0.050

Table 2

Mean Number of Insects Collected in Benthos per Sampling Effort

YEAR	EPHEMEROPTERA	TRICHOPTERA	PLECOPTERA	DIPTERA	TOTAL
1971	92.1	11.2	2.1	83.2	188.6
1972	34.5	5.6	0.4	10.1	50.6
1973	32.2	10.8	0.2	2.0	45.2
1974	35.4	7.5	0.6	11.1	54.6

Table 3

Diversity Indices for Benthic Samples from Cove Stream 1972-1974

YEAR	NUMBER OF FAMILIES	DIVERSITY INDEX
1972	22	1.6857
1973	17	1.4788
1974	24	1.7655

Table 4

Maximum Concentrations and Range of Detectable Concentrations of Fenitrothion in Cove Stream 1971-1974

YEAR	MAXIMUM (ppb)	RANGE (ppb)
1971	57.0	4.0 - 57.0
1972	14.3	3.0 - 14.3
1973	11.2	2.4 - 11.2
1974	<0.01	<0.01

Fenitrothion in New Brunswick Headwaters Streams

D. C. Eidt

Three small headwaters streams of the Nashwaak River were monitored in 1973 and 1974. Parts of all three basins were sprayed with fenitrothion at 3 oz/ac (210 g/ha) in 1973 and part of one basin at the same rate in 1974.

Fenitrothion residues were sampled with the assistance of Dr. K.M.S. Sundaram, according to his sequential scheme, and kill was assessed through the use of drift nets.

A substantial kill of insects was found in one stream in 1973 where a peak concentration of 5.25 ppb occurred. It was the production (in numbers) of 3 m^2 of stream bottom for three consecutive days, but it made no difference to benthos quantitatively or qualitatively as measured with two types of artificial substrates. Another stream had a peak fenitrothion concentration of 6.38 ppb, but it coincided with a spate, declined rapidly, and no kill occurred.

In another stream, H. A. Hall and P. Eaton (E.P.S. Halifax) recorded a peak concentration of 11.2 ppb. They described a reduction of up to 10% of Ephemeroptera, Plecoptera and Trichoptera in survey samples following successive sprays at 2 oz/ac (140 g/ha) with rapid recovery except of Trichoptera. There was a more open stream with a wider shallower cross section.

In 1974, a peak fenitrothion concentration of 3.80 ppb was recorded in the sprayed stream but no kill occurred. Both unsprayed streams had small amounts. The remotest stream had a peak fenitrothion concentration of 3.00 ppb even though the basin was more than 1 km from the nearest sprayed area and not downwind.

Several basic observations were made:

1. Spray was found in streams as far as 4 km from the nearest sprayed area.

2. At 210 g/ha, if all the spray reached the water surface and coverage were perfect, a well mixed stream of 10 cm average depth would have a peak concentration of 210 ppb.

3. The peak concentration in a stream where mixing is thorough depends on, in addition to spray rates, coverage and weather, the screening effect of trees and the water depth.

4. The change in concentration of fenitrothion at a given point in a stream following spraying, approximates a negative exponential curve which is an expression of fenitrothion decomposition, all inputs, all outputs and change in dilution through changes in stream discharge.

/.38/acre.

5. At 210 g/ha, most peak concentrations of fenitrothion in streams will not exceed 15 ppb and will be extremely variable from stream to stream.

6. It is not enough to measure drift because changes in stream discharge strongly affect drift rates. The dead component must be measured.

7. Drift catches must be held long enough for fatally poisoned animals to die (24 hours in the stream where it was collected was adequate).

8. Kills had diurnal peaks like normal drift, suggesting animals were killed as they entered drift, and that the fenitrothion did not permeate the substrate in fatal amounts. That species normally inhabiting the upper layers of the substrate and common in drift were most affected, supports this.

– 12 mile spray drift has been documented.

9. Differences in sensitivity occurred within genera and it was concluded that effective monitoring must be at the species level. Monitoring at the family level is not adequate and at the order level is virtually useless.

AERIAL SPRAYING AGAINST THE SPRUCE BUDWORM IN QUEBEC IN 1974 AND FORECAST FOR 1975

by

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Report presented at the meeting of the
Canadian Forest Pest Control Forum
held in Hull on November 19, 1974

AERIAL SPRAYING AGAINST THE SPRUCE BUDWORM

IN QUEBEC IN 1974 AND FORECAST FOR 1975

1 – History of the epidemic

1.1 – The present epidemic of the Spruce Budworm in Quebec was discovered in 1967. Since then, the infested areas have developed as follows:

1968			375,000 acres
1969			2,000,000 "
1970			6,000,000 "
1971			13,000,000 "
1972			25,700,000 "
1973			28,200,000 "
	Light	9,000,000 acres	
	Moderate	8,000,000 "	
	Severe	10,600,000 "	
	Mortality	600,000 "	
1974			79,600,000 "
	Light	23,800,000 "	
	Moderate	18,600,000 "	
	Severe	34,400,000 "	
	Mortality	2,800,000 "	

53.0

1.2 - Each year since 1970, aerial spraying operations have been carried out as follows:

1970	28,800 acres
1971	2,146,780 "
1972	1,879,342 "
1973	9,727,030 "
1974	6,350,000 "

2 - <u>The 1974 spraying program</u>

2.1 - Area sprayed 6,350,000 acres (see fig. 1)

2.2 - Bases of operations

a) Lac des Loups	1,614,700 acres
b) La Macaza	1,722,000 "
c) Casey	3,013,300 "

2.3 - Pest control products used

a) Fenitrothion	4,140,000 acres
b) Matacil	1,200,000 "
c) Zectran	1,000,000 "
d) Bacillus thuringiensis	10,000 "

2.4 - Type of treatment

2.4.1 - Fenitrothion

a) Two oil-base applications of 2 oz. in 16 oz. of mixture per acre 3,840,000 acres

b) Two oil-base applications of 2 oz. in 12 oz. of mixture per acre 120,000 acres

c) One oil-base application
of 3 oz. in 16 oz. of
mixture per acre 180,000 acres

2.4.2. - Matacil

Two oil-base applications
of 3/4 oz. in 16 oz. of
mixture per acre 1,200,000 acres

2.4.3 - Zectran

Two oil-base applications
of 3/4 oz. in 16 oz. of
mixture per acre 1,000,000 acres

2.4.4 - Bacillus thuringiensis

a) One application of 16 oz.
of 3.25 B.I.U. in 32 oz. of
mixture (including Chitinase)
per acre 5,000 acres

b) One application of 32 oz.
of 6.5 B.I.U. in 64 oz. of
mixture (including Chitinase)
per acre 5,000 acres

2.5 - Aircraft used

a) 4 DC-6B

b) 3 Super Constellation (L-1049)

c) 1 Constellation (L-749)

d) 2 CL-215

2.6 - Aircraft operators

a) Conair Aviation Ltd., Abbotsford, British Columbia — 4 DC-6B

b) Aviation Specialties Trade Corporation, Mesa, Arizona, U.S.A. — 3 Super Constellation, 1 Constellation

c) Aerial Service, Quebec Department of Transport — 2 CL-215

2.7 - Aircraft characteristics

a) DC-6B

Payload	3,600 USG
Swath width	3,000 feet
Speed	230 MPH

b) Super Constellation (L-1049)

Payload	4,400 USG
Swath width	3,000 feet
Speed	230 MPH

c) Constellation (L-749)

Payload	3,600 USG
Swath width	3,000 feet
Speed	230 MPH

d) CL-215

Payload	1,320 USG
Swath width	1,500 feet
Speed	150 MPH

3 - Results of the 1974 spraying program

The efficiency of the spraying operations was estimated from sample plots composed of five trees each and distributed throughout the treated areas.

3.1 - Reduction of the insect population

The original population of the insect, in the 259 sample plots established in the treated areas, averaged 25.7 specimens per 18-inch branch. After treatment, it was reduced by 77.6% to an average of 5.8 individuals. Table 1 indicates the pertinent data for each type of treatment.

3.2 - Protection of the forest

A glimpse of the protection afforded to the forest by the various types of treatment may be found in table 2. In the aggregate of the 297 sample plots established in the treated areas (except those treated with Bacillus thuringiensis), the various types of treatment have enabled to protect the forest at the rate of 89%, considering the fact that the vitality of the trees was reduced by only 5% in the treated areas as compared with 48% in the untreated areas. In the areas treated by means of a single application of 3 oz. of fenitrothion per acre, the trees have suffered a loss of vitality running to 46% although the insect population has been reduced by as much as 84% (see table 1). This result can be explained by the fact that this treatment (like those made with Bacillus thuringiensis) was carried out later than the others in the insect development period.

The aerial survey of the damage done by the insect in the treated areas indicates that the damage was light on 2.8 million acres, moderate on 2.1 million acres and severe on 1.1 million acres and that the trees were dead on 300,000 acres. If light or moderate damage is considered as a criterion of success, the 1974 spraying operations would have been successful on 78% of treated areas.

3.3 - Effects of the spraying operations on the environment

An interdepartmental committee has been formed in January 1974 by the Department of Lands and Forests to study the effects of the aerial spraying operations on the environment and human health. This committee is made up of 16 representatives from various provincial and federal departments.

Biologists for the Chemical Control Research Institute and the Quebec Departments of Tourism, Fish and Game and Lands and Forests have been jointly engaged in the surveillance of the ecological consequences of the spraying operations on aquatic life, bees, birds and mammals. A preliminary analysis of their data leads to conclude that no important damage to the environment has been detected.

Two complaints pertaining to bird mortality and ten claims for houses, cottages or cars soiled by fuel oil No. 4 were received. The analysis of the dead birds has proved that their mortality could not be imputed to the spraying operations. On the other hand, the claims for damage to property have proved to be justified.

For their part, specialists from the federal Department of National Health and Welfare and the provincial departments responsible for health and the quality of the environment have supervised the enforcement of safety measures directed to the employees assigned to the handling of insecticides. Their reports indicate that in the aggregate they were satisfied with the enforced safety measures.

4 - The epidemic at the end of 1974

4.1 - Infested areas

The Spruce Budworm infestation at the end of 1974 extends over an area of 79.6 million acres (see fig. 1 and 2) distributed as follows:

Infestation	Infested area (in million acres)		
	In the treated areas	In the untreated areas	Total
Light	2.8	21.0	23.8
Moderate	2.1	16.3	18.4
Severe	1.1	33.4	34.5
Mortality	0.3	2.6	2.6
Total	6.3	73.3	79.6

4.2 - Insect population forecasted for 1975

On the basis of the survey of the eggs laid in 1974 by the Spruce Budworm, the insect population forecasted for 1975 will be high enough to cause severe defoliation almost over the whole Quebec territory (see fig. 3 and 4). The results of the egg-mass survey may be summarized as follows, the number of sample plots being given in parenthesis:

	Number of egg masses per 10 square meter of foliage		1974/1973
	1973	1974	
In the treated areas	666 (613)	2,179 (288)	3.27
In the untreated areas	401 (1,000)	1,630 (1,347)	4.06

This table indicates that the Spruce Budworm population in the treated areas will be 3.27 times heavier in 1975 than in 1974 and that, in the untreated areas, it will be 4.06 times heavier than in 1974.

5 - <u>Spraying project for 1975</u>

5.1 - Areas to be treated

Of the 79.6 million acres infested in 1974 by the Spruce Budworm according to the aerial survey of the damage caused in 1974, some 36.2 million acres should be treated in 1975, i.e., those areas treated in 1974 which have suffered light or moderate defoliation (4.9 million acres), the 16.3 millions acres which have suffered moderate defoliation in the areas untreated in 1974 and some 15 million acres which have suffered severe defoliation for the first time in 1974 in the areas untreated in 1974.

This implies that 22.4 million acres of forested lands already are hurted to such an extent that they could not be protected by treatment, whereas 21 million acres could wait till 1976 to be treated because of the fact that they have suffered but light defoliation in 1974.

We must however considerthe fact that the scarcity of insecticide which has prevailed in 1974 will continue in 1975 and, as a result, we will have to limit ourselves to a program which will hardly reach a maximum of ten million acres.

Owing to this shortage of insecticide, the Department of Lands and Forests has reconciled itself to the idea of losing a considerable volume of wood in the coming years. In order to cut down the losses, a forest management program is under consideration, which makes prevision for salvage cuts of the dead trees and presalvage cuts of the balsam or spruce stands which are not likely to be protected by spraying operations.

Priorities have also been set for the protection of the forests against this epidemic. The Gaspe, Lower St. Lawrence, Quebec and St. Maurice regions will thus have to be treated in priority, as well as the Anticosti Island. The Saguenay-Lake St. John region will come next, followed by the Ottawa region.

5.2 - Pest control products to be used

Several insecticides will be used for the 1975 spraying program, namely: a) Fenitrothion; b) Matacil; c) Zectran; d) Bacillus thuringiensis. Other chemical insecticides are also considered proportionately to the availability of the afore-mentioned insecticides and of the other insecticides under consideration. We plan to use Bacillus thuringiensis for the spraying of some 250,000 acres. As in 1974, Fenitrothion will be used at the rate of 2 oz. per acre in two applications, whereas Matacil and Zectran will be used at the rate of 3/4 oz. per acre also in two applications. These three insecticides will be used in oil-solution at the rate of 12 oz. of mixture per acre, as compared to 16 oz. in 1974.

5.3 - Bases of operations to be used

In addition to Anticosti Island, five bases of operations are foreseen for the 1975 spraying program, namely: a) La Macaza; b) Casey; c) St. Honoré (Chicoutimi); d) Riviere du Loup; e) Bonaventure.

5.4 - Aircraft to be used

The aircraft to be used for the 1975 spraying program will be four-engine machines such as the DC-6B, the Constellation (L-749) and the Super Constallation (L-1049). Their respective number will depend on the size of the operations.

We plan to use Sikorski helicopters S-55T for the spraying operations on Anticosti Island.

Table 1

INSECT MORTALITY DEPENDING ON THE TREATMENT

Treatment	Number of sample plots	Population Pre-spraying	Population Post-spraying	Mortality
Fenitrothion				
a) (2 oz./16 oz./acre) x 2	162	26.6	6.0	77.4%
b) (2 oz./12 oz./acre) x 2	4	21.0	4.4	79.3%
c) (3 oz./16 oz./acre) x 1	10	45.8	7.3	84.0%
Matacil				
(3/4 oz./16 oz./acre) x 2	9	27.5	7.0	74.4%
Zectran				
(3/4 oz./16 oz./acre) x 2	70	20.6	4.9	77.1%
Bacillus thuringiensis				
a) (16 oz./3.25 B.I.U./32 oz.) x 1	1	41.6	4.0	90.4%
b) (32 oz./6.5 B.I.U./64 oz.) x 1	3	77.7	8.3	89.3%
Average (Treated areas)	259	25.7	5.8	77.6%
Average (Untreated areas)	72	22.4	7.0	68.8%

Table 2

PROTECTION OF THE FOREST DEPENDING ON THE TREATMENT

Treatment	Number of sample plots	Loss of new foliage	Loss of vitality	Protection afforded
Fenitrothion				
a) (2 oz./16 oz./acre) x 2	194	60%	14%	71%
b) (2 oz./12 oz./acre) x 2	15	43%	Nil	100%
c) (3 oz./16 oz./acre) x 1	10	86%	46%	4%
Matacil				
(3/4 oz./16 oz./acre) x 2	12	62%	Nil	100%
Zectran				
(3/4 oz./16 oz./acre) x 2	66	56%	Nil	100%
Bacillus thuringiensis				
a) (16 oz./3.25 B.I.U./32 oz.) x 1	2	34%	17%	64%
b) (32 oz./6.5 B.I.U./64 oz.) x 1	10	84%	75%	Nil
Average (Treated areas excluding Bacillus thuringiensis)	297	59%	5%	89%
Average (Untreated areas)	61	68%	48%	Nil

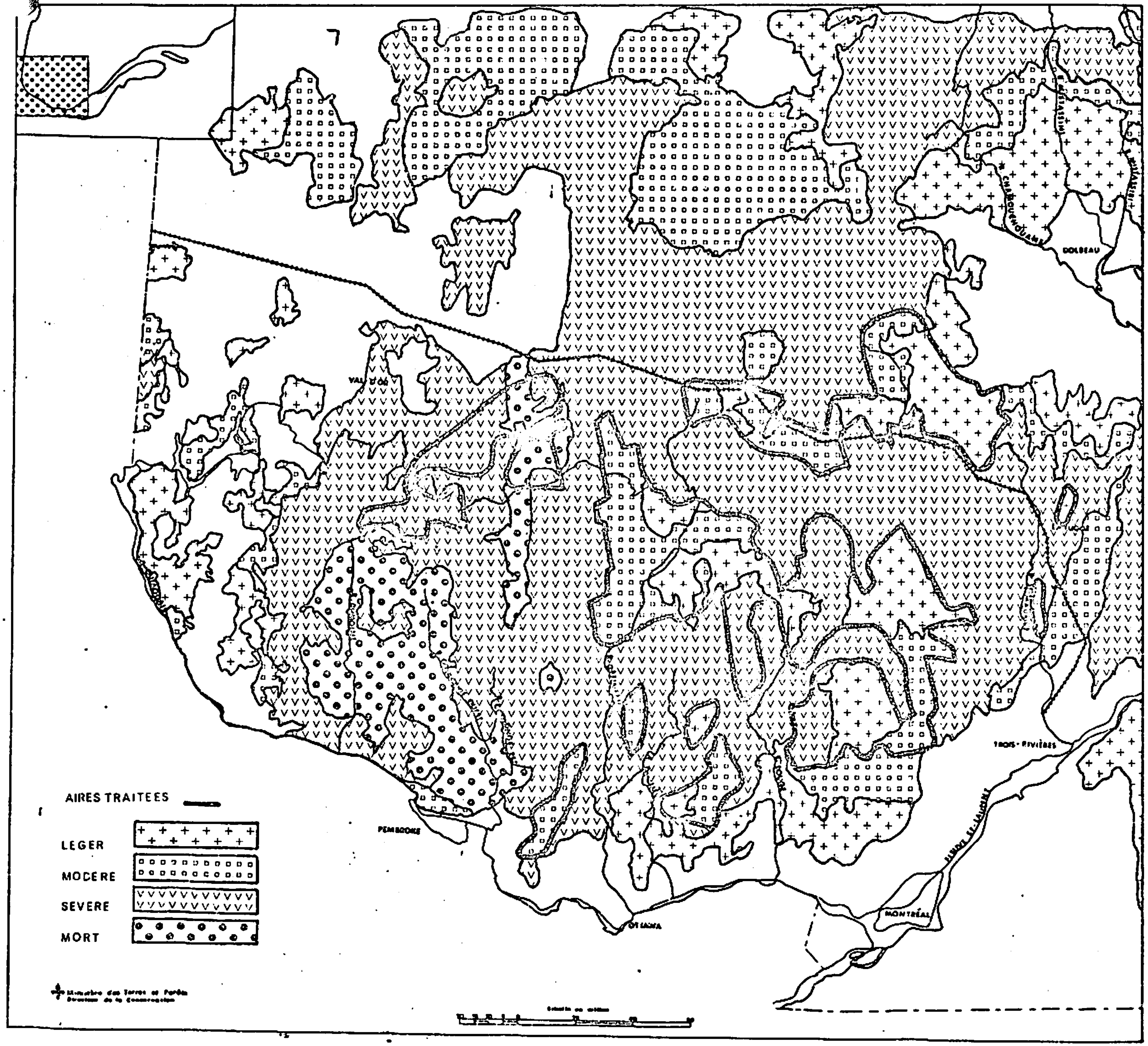

Fig. 1 - Tordeuse des bourgeons de l'épinette - Dommages 1974

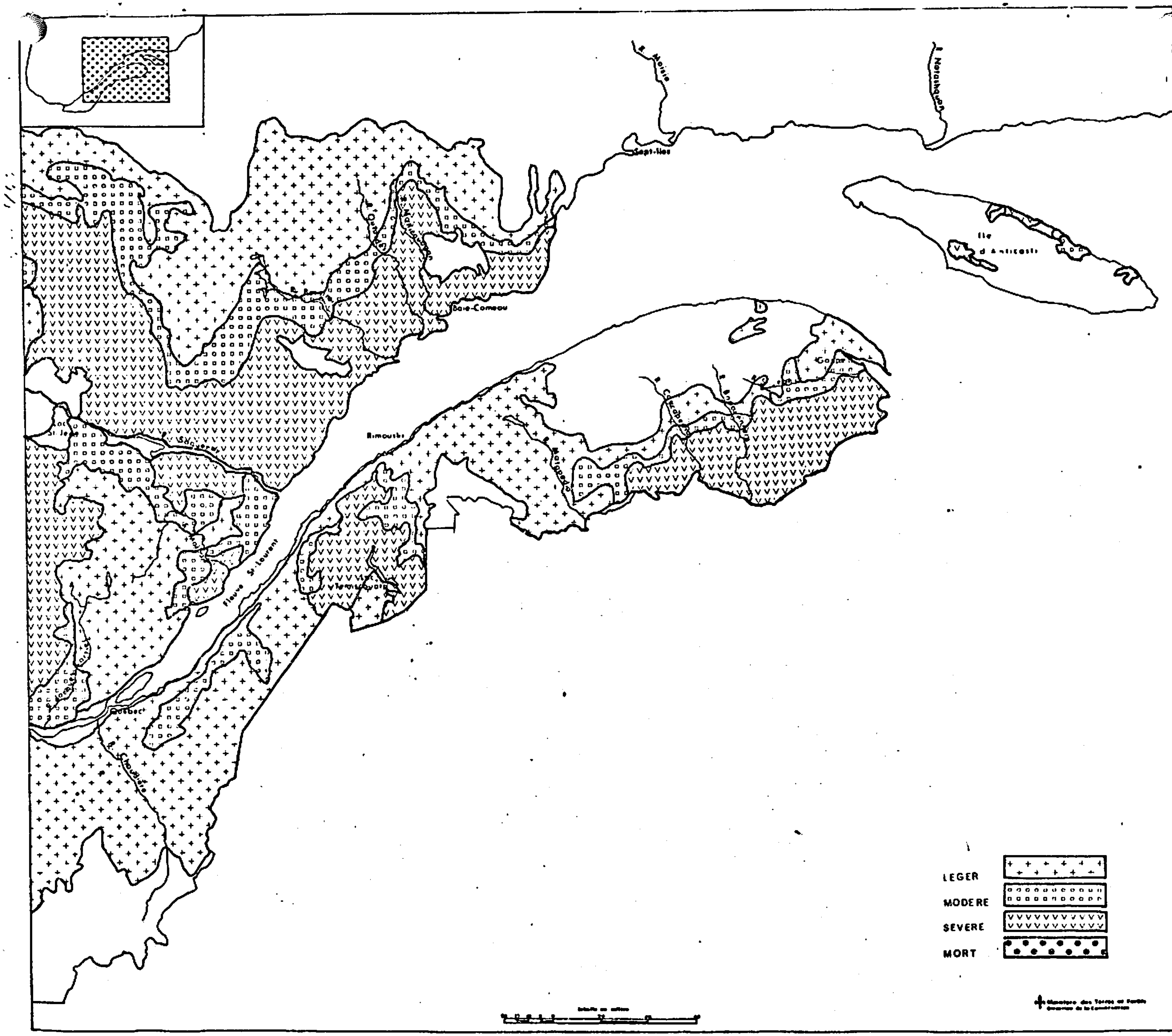

Fig. 2 - Tordeuse des bourgeons de l'épinette - Dommages 1974

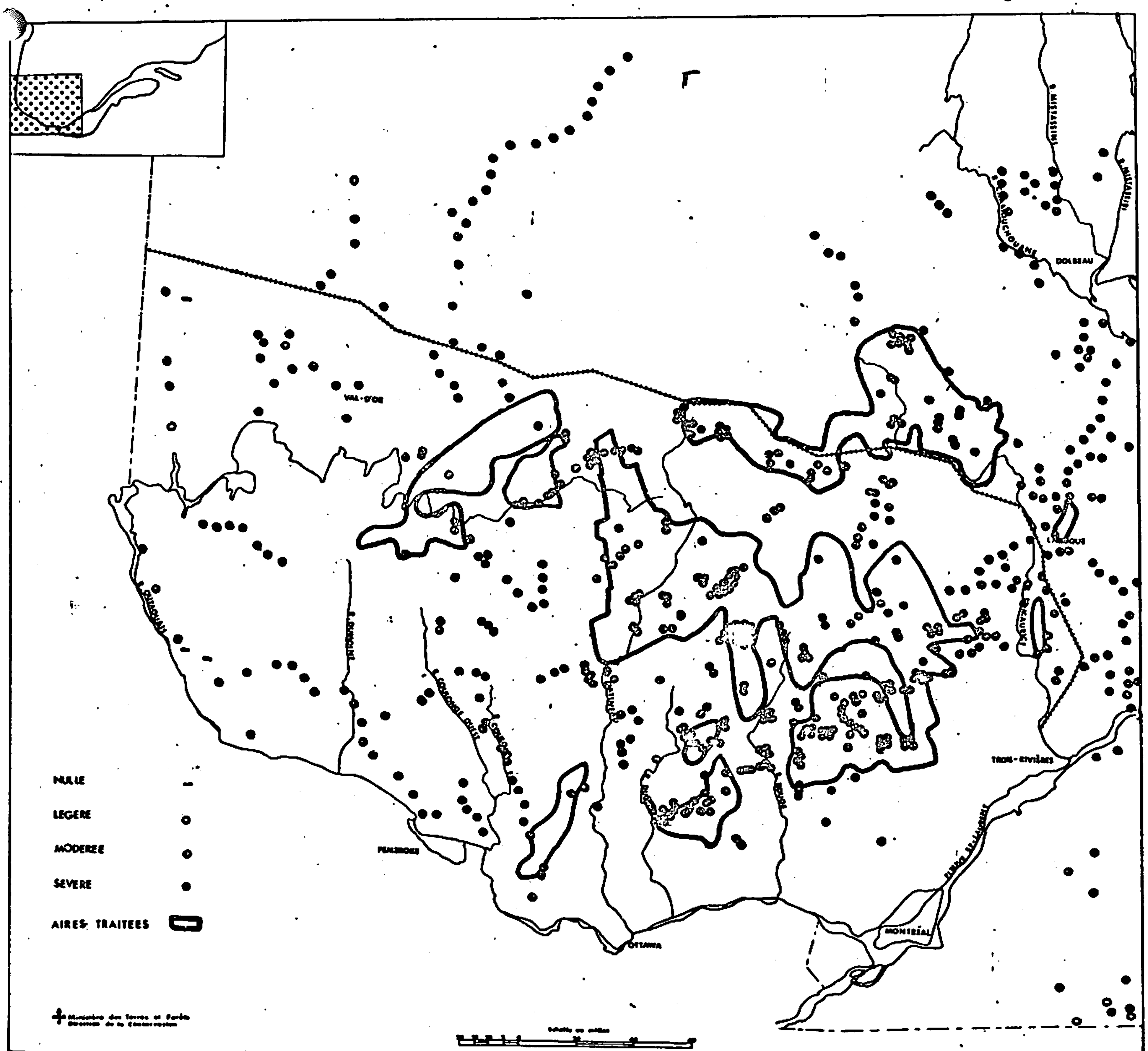

Fig. 3 - Tordeuse des bourgeons de l'épinette - Population prévue pour 1975

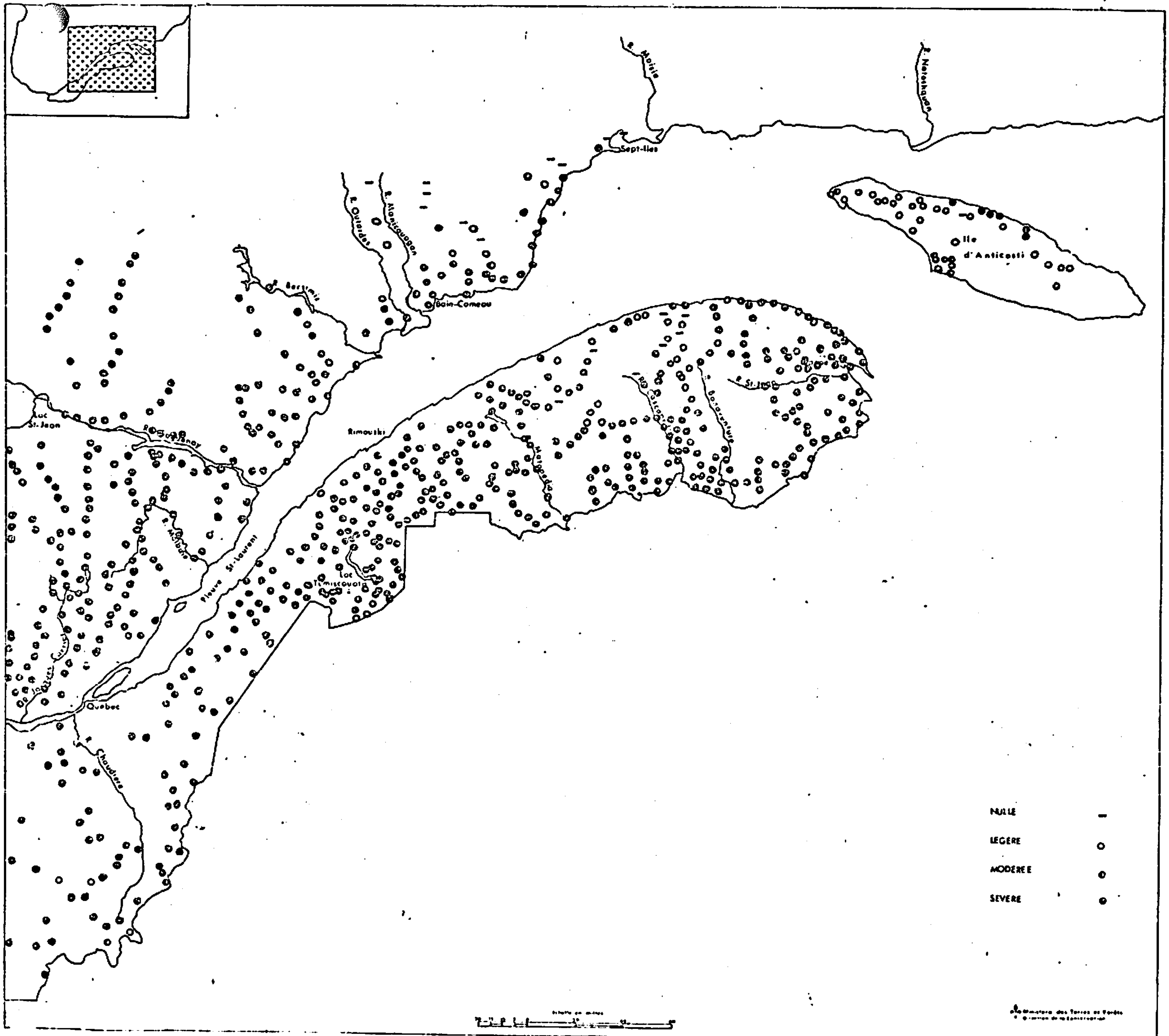

Fig. 4 – Tordeuse des bourgeons de l'épinette – Population prévue pour 197[illegible]

ARROSAGES AERIENS CONTRE LA TORDEUSE DES BOURGEONS DE L'EPINETTE AU QUEBEC EN 1974 ET PREVISIONS POUR 1975

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Ministère des Terres et Forêts

Rapport présenté à la réunion du
Colloque canadien sur la lutte
contre les organismes forestiers nuisibles
tenue à Hull le 19 novembre 1974

ARROSAGES AERIENS
CONTRE LA TORDEUSE DES BOURGEONS DE L'EPINETTE
AU QUEBEC EN 1974 ET PREVISIONS POUR 1975

1 - Historique de l'épidémie

1.1 - La présente épidémie de la tordeuse des bourgeons de l'épinette a été détectée en 1967. Depuis lors, les superficies infestées ce sont développées comme suit:

1968		375,000 acres
1969		2,000,000 "
1970		6,000,000 "
1971		13,000,000 "
1972		25,700,000 "
1973		28,200,000 "
Léger	9,000,000 acres	
Modéré	8,000,000 "	
Sévère	10,600,000 "	
Mortalité	600,000 "	
1974		79,600,000 "
Léger	23,800,000 "	
Modéré	18,600,000 "	
Sévère	34,400,000 "	
Mortalité	2,800,000 "	

1.2 - Chaque année depuis 1970, des arrosages aériens ont été effectués comme suit:

1970	28,800 acres
1971	2,146,780 "
1972	1,879,342 "
1973	9,727,030 "
1974	6,350,000 "

2 - Le programme d'arrosage de 1974

2.1 - Superficie traitée — 6,350,000 acres (voir fig. 1)

2.2 - Bases d'opération

a) Lac des Loups	1,614,700 acres
b) La Macaza	1,722,000 "
c) Casey	3,013,300 "

2.3 - Insecticides utilisés

a) Fénitrothion	4,140,000 acres
b) Matacil	1,200,000 "
c) Zectran	1,000,000 "
d) Bacillus thuringiensis	10,000 "

2.4 - Modes de traitement

2.4.1 - Fénitrothion

a) Deux applications à base d'huile, de 2 onces dans 16 onces de mélange l'acre	3,840,000 acres

b) Deux applications à base d'huile, de 2 onces dans 12 onces de mélange l'acre — 120,000 acres

c) Une application à base d'huile, de 3 onces dans 16 onces de mélange l'acre — 180,000 acres

2.4.2 - Matacil

Deux applications à base d'huile, de 3/4 once dans 16 onces de mélange l'acre — 1,200,000 acres

2.4.3 - Zectran

Deux applications à base d'huile, de 3/4 once dans 16 onces de mélange l'acre — 1,000,000 acres

2.4.4 - Bacillus thuringiensis

a) Une application de 16 onces de 3.25 B.I.U. dans 32 onces de mélange (y compris Chitinase) l'acre — ~~500,000~~ 5,000 acres

b) Une application de 32 onces de 6.5 B.I.U. dans 64 onces de mélange (y compris Chitinase) l'acre — ~~500,000~~ 5,000 acres

2.5 - Avions utilisés

a) 4 DC-6B

b) 3 Super Constellation (L-1049)

c) 1 Constellation (L-749)

d) 2 CL-215

2.6 - Opérateurs aériens

a) Conair Aviation Ltd., Abbotsford, Colombie-Britanique	4 DC-6B
b) Aviation Specialties Trade Corporation, Mesa, Arizona, U.S.A.	3 Super Constellation 1 Constellation
c) Service aérien, Ministère des Transports du Québec	2 CL-215

2.7 - Caractéristiques des avions

a) DC-6B

Charge payante	3,600 USG
Largeur d'application	3,000 pieds
Vitesse	230 MPH

b) Super Constellation (L-1049)

Charge payante	4,400 USG
Largeur d'application	3,000 pieds
Vitesse	230 MPH

c) Constellation (L-749)

Charge payante	3,600 USG
Largeur d'application	3,000 pieds
Vitesse	230 MPH

d) CL-215

Charge payante	1,320 USG
Largeur d'application	1,500 pieds
Vitesse	150 MPH

3 - <u>Résultats du programme d'arrosage de 1974</u>

L'efficacité des arrosages a été estimée à partir de places d'étude constituées de cinq arbres chacune et distribuées sur tout le territoire traité.

3.1 - Réduction de la population de l'insecte

La population de l'insecte, dans les 259 places d'étude établies dans les aires traitées, s'élevait à une moyenne de 25.7 spécimens par branche de 18 pouces. Après le traitement, elle a diminué de 77.6% pour s'établir à 5.8 individus. Le tableau 1 montre les données pertinentes pour chaque mode de traitement.

3.2 - Protection de la forêt

On trouvera dans le tableau 2 un aperçu de la protection assurée à la forêt selon les différents modes de traitement. Dans l'ensemble des 297 places d'études établies dans les aires traitées (sauf celles traitées au Bacillus thuringiensis), les différents traitements à l'insecticide ont permis de protéger la forêt dans une proportion de 89%, si l'on considère le fait que la vitalité des arbres n'a été réduite que de 5% dans les aires traitées comparativement à 48% dans les aires non traitées. Dans les aires traitées par une seule application de 3 onces de Fénitrothion l'acre, les arbres ont subi une perte de vitalité de 46% bien que la population de l'insecte y ait été réduite de 84% (voir tableau 1). Ce résultat s'explique par le fait que ce traitement (comme ceux faits avec Bacillus thuringiensis) a été réalisé plus tard que les autres dans la période de développement de l'insecte.

L'inventaire aérien des dommages causés par l'insecte dans les aires traitées indique que les dommages ont été légers sur 2.8 millions d'acres, modérés sur 2.1 millions d'acres et sévères sur 1.1 million d'acres et que les arbres sont morts sur 300,000 acres. Si des dommages légers ou modérés sont assumés comme critères de succès, les opérations de 1974 auraient été réussies sur 78% du territoire traité.

3.3 - Effets des opérations d'arrosage sur l'environnement

Un comité interministériel a été formé en janvier 1974 pour étudier les effets des opérations d'arrosage aérien sur l'environnement et la santé. Ce comité est composé de 16 représentants de différents ministères tant provinciaux que fédéraux.

Des biologistes de l'Institut de Recherche en Répression chimique et des ministères provinciaux du Tourisme, de la Chasse et de la Pêche et des Terres et Forêts ont travaillé conjointement à surveiller les conséquences écologiques des opérations d'arrosage sur les organismes aquatiques, les abeilles, les oiseaux et les mammifères. Une analyse préliminaire des données recueillies permet de conclure qu'aucun dommage important n'a pu être décelé sur l'environnement. Deux plaintes relatives à des mortalités d'oiseaux et dix réclamations concernant des maisons, des chalets ou des automobiles tachetés d'huile à chauffage No 4 ont été reçues. L'analyse des oiseaux morts a démontré que leur mortalité ne pouvait pas être attribuée aux opérations d'arrosage. Par contre, les réclamations pour dommages matériels se sont avérées justifiées.

De leur côté, des spécialistes du ministère fédéral de la Santé et du Bien-être social et de ministères provinciaux responsables de la santé et de la qualité de l'environnement ont surveillé l'application des mesures de précaution à l'adresse des employés préposés à la manutention des insecticides. Leurs rapports indiquent que dans l'ensemble ils étaient satisfaits des mesures de précaution qui avaient été mises en application.

4 - L'épidémie à la fin de 1974

4.1 - Aires infestées

L'infestation de la tordeuse des bourgeons de l'épinette à la fin de 1974 couvre une superficie globale de 79.6 millions d'acres (voir fig. 1 et 2) réparties comme suit:

Infestation	Superficie infestée (en millions d'acres)		
	Dans les aires traitées	Dans les aires non traitées	Total
Légère	2.8	21.0	23.8
Modérée	2.1	16.3	18.4
Sévère	1.1	33.4	34.5
Mortalité	0.3	2.6	79.6
Total	6.3	73.3	79.6

4.2 - Population de l'insecte prévue pour 1975

D'après l'inventaire des oeufs déposés en 1974 par la tordeuse des bourgeons de l'épinette, la population de l'insecte prévue pour 1975 sera suffisamment élevée pour causer des défoliations sévères sur presque la totalité du territoire québécois (voir fig. 3 et 4). Les résultats de l'inventaire des masses d'oeufs de l'insecte peuvent se résumer comme suit, le nombre de places d'étude étant indiqué entre parenthèses:

	Nombre de masses d'oeufs par 10 mètres carrés de feuillage		1974/1973
	1973	1974	
Dans les aires traitées	666 (613)	2,179 (288)	3.27
Dans les aires non traitées	401 (1,000)	1,630 (1,347)	4.06

Ce tableau indique que la population de la tordeuse des bourgeons de l'épinette dans les aires traitées en 1974 sera 3.27 fois plus élevée en 1975 qu'en 1974 et qu'à l'extérieur de ces aires, elle sera 4.06 fois supérieure à celle de 1974.

5 - Projet d'arrosage pour 1975

5.1 - Aires à traiter

Des 79.6 millions d'acres infestées en 1974 par la tordeuse des bourgeons de l'épinette selon l'inventaire aérien des dommages causés en 1974, quelque 36.2 millions d'acres devraient être traitées en 1975, soit les aires traitées en 1974 ayant subi une défoliation légère ou modérée (4.9 millions d'acres), les forêts à défoliation modérée dans les aires non traitées en 1974 (16.3 millions d'acres) et environ 15 millions d'acres qui ont été défoliées sévèrement pour la première fois en 1974 dans les aires non traitées en 1974. Cette proposition implique que 22.4 millions d'acres de forêt sont déjà trop endommagées pour penser à les protéger par des arrosages, tandis que 21 millions d'acres pourraient attendre pour être traitées en 1976 en raison du fait qu'elles n'ont subi que des défoliations légère en 1974. Nous devons toutefois considérer que la pénurie d'insecticide qui a existé en 1974 persistera en 1975 et nous devrons en conséquence nous limiter à un programme qui atteindra avec beaucoup de difficulté un maximum de dix millions d'acres. Par suite de cette pénurie d'insecticide, le ministère des Terres et Forêts s'est résigné à l'idée de perdre un volume considérable de bois au cours des prochaines années. Pour limiter les pertes, un programme d'aménagement forestier est à l'étude, lequel prévoit des coupes de récupération des arbres morts et de prérécupération des peuplements de sapin ou d'épinette qui ne pourront être protégés par des arrosages. Des priorités ont également été établies pour la protection des forêts contre cette épidémie. C'est ainsi que les régions de la Gaspésie, du Bas St-Laurent, de Québec et de la Mauricie ainsi que l'Ile d'Anticosti devront être traitées en priorité. La région du Saguenay-Lac St-Jean vient ensuite, suivie de l'Outaouais.

5.2 - Insecticides devant être utilisés

Plusieurs insecticides seront utilisés pour le programme d'arrosage de 1975, à savoir: a) Fénitrothion; b) Matacil; c) Zectran; d) Bacillus thuringiensis. D'autres insecticides chimiques sont également considérés, suivant la disponibilité des insecticides précités et des autres insecticides à l'étude.

Nous prévoyons utiliser le Bacillus thuringiensis pour l'arrosage de quelque 250,000 acres. Comme en 1974, le Fénitrothion sera utilisé à raison de 2 onces l'acre en deux applications, tandis que le Matacil et le Zectran seront utilisés à raison de 3/4 d'once l'acre également en deux applications. Ces trois insecticides seront utilisés en solution dans l'huile à raison de 12 onces de mélange l'acre, comparativement à 16 onces en 1974.

5.3 - Bases d'opérations prévues

En plus de l'Ile d'Anticosti, cinq bases d'opérations sont prévues pour le programme d'arrosage de 1975, à savoir: a) La Macaza; b) Casey; c) St-Honoré (Chicoutimi); d) Rivière-du-Loup; e) Bonaventure.

5.4 - Avions devant être utilisés

Les avions devant être utilisés pour le programme d'arrosage de 1975 seront des appareils quadrimoteurs tels que le DC-6B, le Constellation (L-749) et le Super Constellation (L-1049). Leur nombre respectif dépendra de l'envergure des opérations.

Nous prévoyons l'utilisation d'hélicoptères Sikorski S-55T pour les opérations d'arrosage sur l'Ile d'Anticosti.

Tableau 1

MORTALITE DE L'INSECTE SELON LE TRAITEMENT

Traitement	Nombre de places d'étude	Population Pré-arrosage	Population Post-arrosage	Mortalité
Fenitrothion				
a) (2 oz/16 oz/acre) x 2	162	26.6	6.0	77.4%
b) (2 oz/12 oz/acre) x 2	4	21.0	4.4	79.3%
c) (3 oz/16 oz/acre) x 1	10	45.8	7.3	84.0%
Matacil				
(3/4 oz/16 oz/acre) x 2	9	27.5	7.0	74.4%
Zectran				
(3/4 oz/16 oz/acre) x 2	70	20.6	4.9	77.1%
Bacillus thuringiensis				
a) (16 oz/3.25 B.I.U./32 oz) x 1	1	41.6	4.0	90.4%
b) (32 oz/6.5 B.I.U./64 oz) x 1	3	77.7	8.3	89.3%
Moyenne (Aires traitées)	259	25.7	5.8	77.6%
Moyenne (Aires non traitées)	72	22.4	7.0	68.8%

Tableau 2

PROTECTION DE LA FORET SELON LE TRAITEMENT

Traitement	Nombre de places d'étude	Perte de nouveau feuillage	Perte de vitalité	Protection assurée
Fenitrothion				
a) (2 oz/16 oz/acre) x 2	194	60%	14%	71%
b) (2 oz/12 oz/acre) x 2	15	43%	Nulle	100%
c) (3 oz/16 oz/acre) x 1	10	86%	46%	4%
Matacil				
(3/4 oz/16 oz/acre) x 2	12	62%	Nulle	100%
Zectran				
(3/4 oz/16 oz/acre) x 2	66	56%	Nulle	100%
Bacillus thuringiensis				
a) (16 oz/3.25 B.I.U./32 oz) x 1	2	34%	17%	64%
b) (32 oz/6.5 B.I.U./64.oz) x 1	10	84%	75%	Nulle
Moyenne (Aires traitées sauf Bacillus thuringiensis)	297	59%	5%	89%
Moyenne (Aires non traitées)	61	68%	48%	Nulle

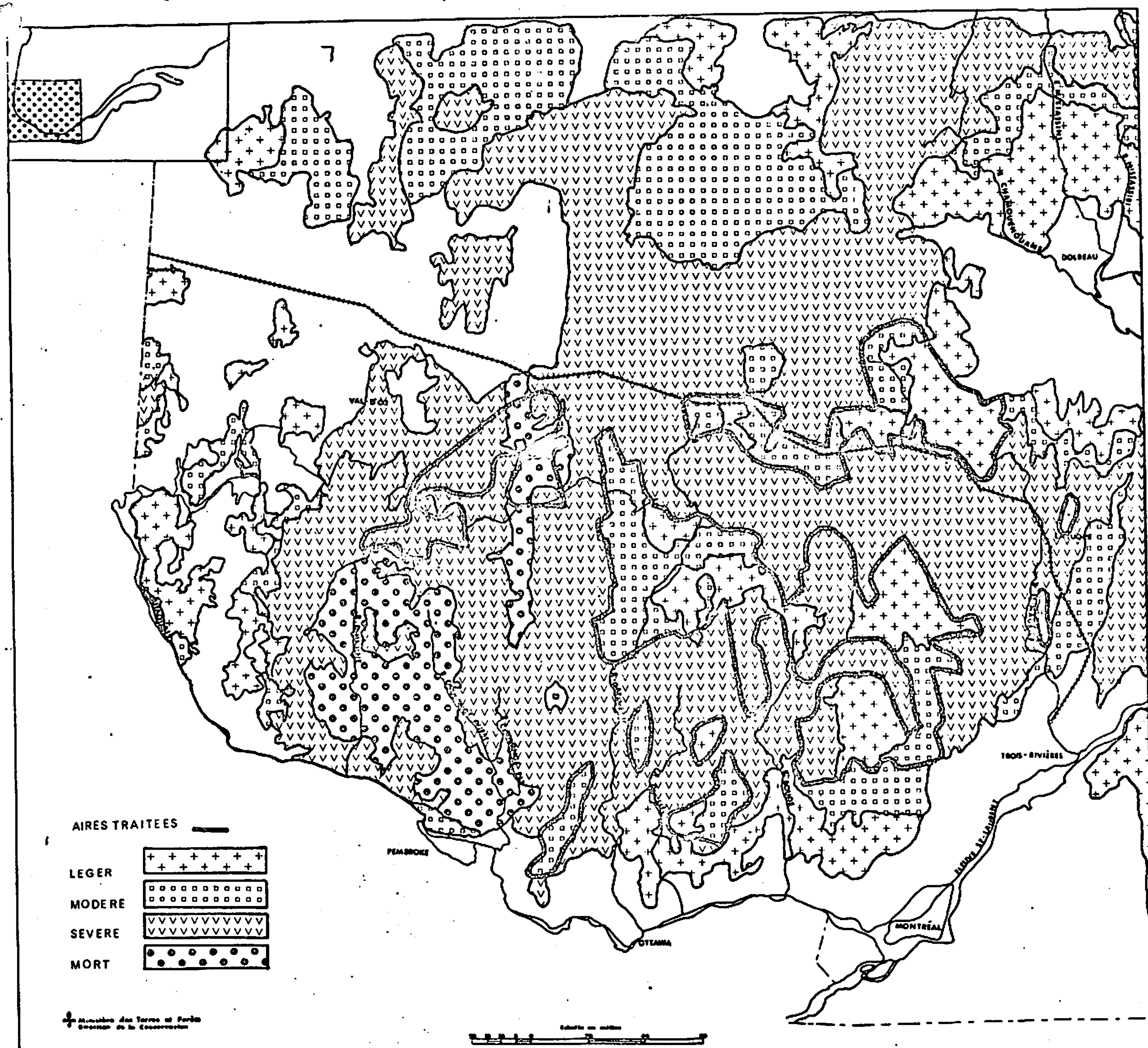

Fig. 1 - Tordeuse des bourgeons de l'épinette - Dommages 1974

APPENDIX 8

THE ECOLOGICAL IMPACT OF FOREST INSECT CONTROL OPERATIONS IN QUEBEC DURING 1974

Edited by C. Buckner and R. Sarrazin

INTRODUCTION

Ecological monitoring teams comprised of members of the staff of the Chemical Control Research Institute (Environmental Management Services, Forestry Directorate, Canada Department of the Environment) and the Research Branch of the Department of Tourism, Fish and Game of the Province of Quebec were established in each of the Fenitrothion, Matacil and Zectran treatment areas. The areas of responsibility varied: in some cases members of the two groups worked simultaneously in the same area; in other cases the work force was distributed over extensive areas. The former allowed for checking of uniformity of results from team to team, the latter provided expansive coverage.

This control operation has been one of the most extensive ever launched against a forest insect pest. Companion monitoring operations, which being of major scope both within the area and temporal frames, examined only a small fraction of the treated areas. Because of difficulties in obtaining and analysing samples, the aquatic monitoring was the least extensive. Despite the dilution of monitoring effort, strong documentary evidence of the environmental impact of the program was obtained.

In addition to the monitoring teams, the CCRI emergency investigation group was also placed at the disposal of the Quebec program. Only three reports of unusual circumstances were forwarded and all were found to be unrelated to the control programs.

AQUATIC ORGANISMS

P.D. Kingsbury and R. Sarrazin

Bottom fauna populations were examined in streams within the fenitrothion, matacil, zectran, fenitrothion-zectran and B.t. spray blocks. Preliminary perusal of the data indicates that no substantial reductions of aquatic insect or other benthic invertebrate populations occurred. Data which has been analysed from streams in the matacil treatment block indicate a reduction of stoneflies (Plecoptera) and blackfly larva (Diptera:Simuliidae) attributable to the application of this insecticide. Despite the decreases in these two groups, total numbers of aquatic insects in these streams increased over the treatment period commencerate with changes in phenology.

BIRDS

B. McLeod, R. Sarrazin, R. Ouellet, J. Bergeron and G. Gaboray

Small forest songbird populations were monitored on 20 acre plots in treatment areas and in non treated areas. Adverse weather conditions delayed migration of many species, especially the warbler group. Many of the small insect eating birds arrived before natural food was available and numerous reports of mortality due to starvation were received.

The first applications of fenitrothion and matacil were deposited before most of the migrating birds had arrived to set up breeding territories. The second application of these chemicals and the application of Zectran in Mont Tremblant Park took place after the majority of the migrants had settled into breeding territories.

Several blocks were treated with the first application of Fenitrothion between May 11-18th. Many species of warblers had not as yet returned but species such as the white-throated sparrow, purple finch and slate-colored junco were present in numbers but did not suffer any adverse side effects of the chemical application despite the fact that these birds occupied niches fully exposed to the spray. The second application took place June 6-7th when the majority of birds were in breeding territories. Plot searches after treatment failed to establish any immediate impact and preliminary analysis of the data indicate no impact.

The first application of Matacil took place on June 4th and the second on June 15th. Very few birds had reached the treatment area by the time of the first application. Several species of sparrows and slate-colored juncos were not affected. The majority of the species were in breeding territories by the time of the second application but again preliminary analysis does not indicate an adverse impact.

The application of Zectran also took place when most migrants had arrived. The treatment plots were searched after application but no evidence of sick or dead birds being found. Preliminary analysis of the data also indicates that the songbird complex did not suffer any adverse side effects.

SMALL MAMMALS

R. Sarrazin and B. McLeod

Populations of small mammals were censused in the treatment blocks at the time of application and approximately six weeks afterwards. Standard small mammal trap lines were employed. Specimens collected were used to determine the species complex, age structure, breeding condition and impact upon the young of the year. Preliminary analysis of the data show a large proportion of the adult small mammal population in breeding conditions.

Data compiled from the second trapping period confirm the absence of impact upon the small mammal complex. A significant portion of the population was made up of juveniles, sub-adults and pregnant females demonstrating no disruption in the breeding cycle.

SUMMARY

Results of the environmental monitoring studies indicate that bird and mammal components of the forest ecosystem treated were uneffected by any of the chemical applications. Some of the worker forces of the domestic bee colonies were killed, but this is not unexpected when a wide spectrum insecticide is used, and the damage bore no relevance to eventual honey production. Certain components of the aquatic insect fauna were depressed in population by the treatments, but this mortality was minimal.

It is concluded that, in the present state of data analysis, no environmental damage of concern could be detected.

SPRUCE BUDWORM IN ONTARIO, 1974

- AERIAL SPRAYING OPERATIONS
- OUTBREAK STATUS AND FORECASTS
- PLANS FOR 1975

By

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Report prepared for the Canadian Forest Pest Control Forum
Ottawa, November 19, 1974

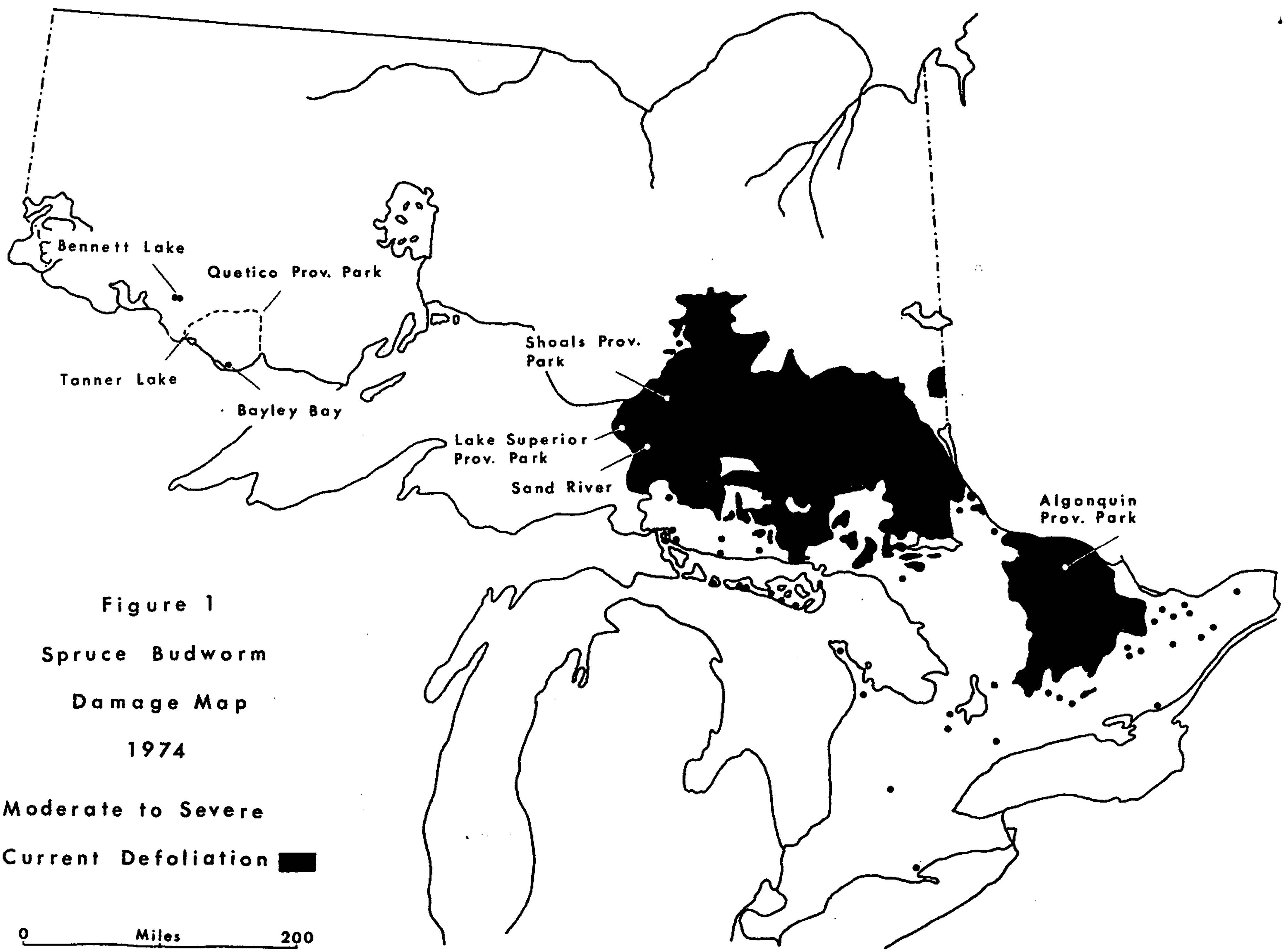

Figure 1
Spruce Budworm
Damage Map
1974

INTRODUCTION

Approximately 48,000 acres were sprayed by the Ministry of Natural Resources in Ontario against the spruce budworm in 1974. The Great Lakes Forest Research Centre cooperated with OMNR by obtaining the biological information required for the planning, execution, timing and assessment of these operations. GLFRC also conducted province-wide surveys for spruce budworm defoliation and egg-mass counts in order to determine the current overall situation and provide forecasts for 1975.

The spraying was done by General Airspray Ltd., St. Thomas, Ontario using Stearman (2) and Agcat (1) spray planes equipped with Micronair dispersal units. Zectran was applied at a rate of 1.2 ounces in .15 U.S. gallons of spray mixture per acre. The spray mixture consisted of 1 part Zectran : 2 parts Arotex.

NORTHWESTERN ONTARIO

1974 Operations

In 1974, some 24,600 acres were sprayed in Quetico Provincial Park in the Atikokan District. The purpose of this operation was the same as the past three years, i.e. to prevent the spread of budworm into susceptible forests to the east of Quetico. Cool weather delayed budworm emergence till the latter part of May. A single Stearman, working from Atikokan, started spraying June 13 and finished July 2.

Two areas were sprayed in Quetico. One block of 21,600 acres extended from the west end of Poohbah Lake westward to the International Boundary at Martin Bay. The second block sprayed consisted of 3000 acres at Prairie Portage on Basswood Lake, which is also located on the Ontario-Minnesota border.

Based on aerial defoliation surveys, pupal counts and egg-mass counts, the results appear to be good. Several small pockets of defoliation totalling about 700 acres were mapped in the Prairie Portage spray block. No defoliation was evident in the larger Poohbah Lake-Tanner Lake spray block. Pupal counts and egg-mass counts from the sprayed areas compared with 1973 show that budworm populations are reduced by more than 95%.

Outbreak Status 1974 and Forecasts 1975

In addition to the small pockets of defoliation noted in the Prairie Portage spray block, a new 10,000 acre infestation was detected at Bennett Lake in the eastern part of Fort Frances District and an infestation covering about 1000 acres was found between Eva Lake and Namakan River in the southeast corner of Fort Frances District. Elsewhere, throughout northwestern Ontario, larval populations were generally very low. Low population levels are also reflected in the counts from an extensive egg-mass survey conducted in August and September, 1974. For example, more than 70% of the foliage samples were free of egg-masses. The average egg-mass density based on 175 locations is 4.3 egg-masses per 100 square feet of foliage. Thus, the forecast for 1975 is that infestations are likely to occur only at Bennett Lake and Prairie Portage and populations should remain very low elsewhere.

Plans for 1975

It is planned that OMNR will spray the infestation at Bennett Lake and the remnants of the Prairie Portage infestation. Total acreage is not likely to exceed 15,000.

NORTHEASTERN ONTARIO

1974 Operations

A total of 21,900 acres were sprayed in two provincial parks in northeastern Ontario, 20,200 in Lake Superior Park in the Wawa District and 1700 acres in the Shoals Park, Chapleau District. The primary purpose of this spraying, as in past years, was to minimize the intensity of damage caused by budworm within selected areas that have recreational or aesthetic values.

Budworm emergence occurred during late May. Spraying was carried out from June 15 to June 24 in Lake Superior Provincial Park and June 21-23 for the Shoals. Two aircraft, a Stearman (LSPP) and an Agcat (Shoals) carried out the spraying but due to other commitments the Agcat arrived in Chapleau well past the optimum time to achieve maximum protection. In Lake Superior Park the spray plane flew from a gravel road in the middle of the park instead of the Wawa airport which considerably reduced ferry time.

Assessments of the spraying along HW 17 and Mijin Lake Road in Lake Superior Park showed excellent results (see Table 1). However, spraying results from elsewhere in Lake Superior Provincial Park, specifically the Sand River corridor, and in Shoals Park were not as good. The Sand River corridor was virtually completely defoliated despite the spraying and defoliation reached 75% - 80% in various pockets in the Shoals.

Outbreak Status 1974 and Forecasts 1975

In 1974, the total area within which moderate to severe defoliation occurred to balsam fir and white spruce in northeastern Ontario was 18.5 million acres, compared to 12.5 million acres in 1973. In addition to the 200,000 acres of tree mortality caused by budworm in the Onaping Lake area in the Sudbury and Gogama districts, many more reports of mortality have been received from most districts in northeastern Ontario.

Egg-mass densities in 1974 have increased by a factor of 2.6 over 1973 counts from 330 to 842 per 100 ft^2 of foliage and are now at record high levels for most of northeastern Ontario. It is expected that more than 20 million acres will be damaged in 1975 if only very modest expansion occurs to present boundaries.

Plans for 1975

It is planned that 20,000 acres will be sprayed in Lake Superior Provincial Park, 5000 - 8000 acres in various parks in the Chapleau District and some 4000 acres in two parks in the Sudbury District.

SOUTHEASTERN ONTARIO

1974 Operations

A total of 1860 acres were sprayed in Algonquin Provincial Park in 1974. The purpose of spraying was to protect foliage on host trees in high value areas along HW 60. Many major camping or recreational areas and environ such as Mew Lake, Lake of Two Rivers, Killarney Lodge, Pog Lake, Whitefish Lake and Opeongo Lake were sprayed.

Zectran and *B.t.* were applied from an aircraft. *B.t.* was also sprayed from the ground using a John Bean Roto-Mist blower. Following are the treatments and acreages:

1. Zectran - 1 application of 1.2 oz - 1350 acres
2. Zectran - 1 application of 1.2 oz + 1 mistblower application of *B.t.* - 20 acres
3. Zectran - 2 applications of 1.2 oz each - 200 acres
4. Zectran - 2 applications of 1.2 oz each + 1 mistblower application of *B.t.* - 125 acres
5. *B.t.* - 2 applications by aircraft of 4 B.I.U. each, both applications at .5 gal. U.S. per acre - 100 acres
6. *B.t.* - 1 mistblower application - 65 acres

The basic approach was to spray 1 application of Zectran at 1.2 oz per acre. Some areas, such as campgrounds, where a high level of protection was required received a second application of Zectran and in addition *B.t.* was applied to accessible trees from a mistblower. Thuricide applied from the mistblower was diluted 7:1 with water. The 100 acres sprayed with B.t. from the air was located at the south end of Opeongo Lake where the Harkness Fisheries Laboratory and a campground are located.

Budworm emergence occurred about the third week of May. Zectran spraying was carried out June 6 and 7 and the aerial applications of B.t. were made on the morning of June 8. Mistblower spraying with B.t. started June 5 and finished June 10.

All treatments with the exception of #3 (2 applications of Zectran) were assessed. Results are presented in Table 2. It is evident that any treatment involving Zectran provides good or excellent foliage protection and that the level of treatment is enhanced when followed by B.t. from a mistblower. Differences between results of aerial applications, aerial and mistblower and mistblower only on the two host species indicate that the better results on wS are probably due to improved coverage by the mistblower. The mistblower overcomes the problem of coverage on white spruce. The aerial application of B.t. provided moderate foliage protection although the data did not show a population reduction on white spruce. Treatment #6, mistblower application of B.t., would probably have been more effective, in terms of foliage protection, if applied a few days earlier.

Overall Situation 1974 and Forecasts 1975

The outbreak in southeastern Ontario diminished slightly in size from approximately 6.0 million acres in 1973 to 5.5 million acres in 1974. Larval population densities were extremely high, particularly in some parts of Algonquin Provincial Park, where control operations were conducted (see Table 2). Many pockets of tree mortality are evident throughout Algonquin, Minden and Pembroke districts.

Surveys show, that, on the average, egg-mass densities have declined by 37% in 1974 to 420 from 670 per 100 ft^2 of foliage in 1973. The decline in both area defoliated and average egg-mass density may signal the start of the collapse of the outbreak in southeastern Ontario. However, it is evident that moderate-severe defoliation will occur throughout 5-6 million acres in this part of Ontario in 1975.

Plans for 1975

Protection is planned for some 4000 acres of Algonquin Provincial Park in 1975.

Table 1. Population reduction and foliage protection attributable to Zectran on balsam fir and white spruce in Lake Superior Provincial Park, 1974. Budworm Development (instar) at time of spraying was L4-L5. Data from 20 plots (14 spray, 6 check).

	Prespray Larvae/18" Branch tip	Surviving Pupae/18" Branch tip	% Population Reduction due to Treatment	% 1974 Defoliation
		Balsam Fir - 1 application of 1.2 oz		
Spray	28.1	.6	94	26
Check	19.7	7.0	-	66
		White Spruce - 1 application of 1.2 oz		
Spray	51.7	2.8	87	24
Check	41.3	17.1	-	55

Table 2. Population reduction and foliage protection attributable to spraying on balsam fir and white spruce in Algonquin Provincial Park, 1974. Budworm development (instar) at time of spraying was L4. Data from 14 plots (10 spray, 4 check).

	Prespray larvae/18" branch tip		Surviving pupae/18" branch tip		% Population reduction due to treatment		% 1974 Defoliation	
	bF	wS	bF	wS	bF	wS	bF	wS
Zectran 1 application of 1.2 oz - L4 - 1350 acres								
Spray	57.6	122.6	.8	4.4	92	36	28	38
Check	50.3	113.3	8.9	6.3	-	-	95	88
Zectran 1 application of 1.2 oz + 1 mistblower application of *B.t.* - L4 - 20 acres								
Spray	144.9	137.1	.2	1.3	99	83	13	16
Check	82.5	113.3	6.9	6.3	-		100	88
Zectran 2 applications of 1.2 oz each + 1 mistblower application of *B.t.* - L4 - 125 acres								
Spray	67.4	108.1	0	1.3	100	79	11	18
Check	50.3	113.3	8.9	6.3	-	-	95	88
B.t. 2 applications of 4 B.I.U. each, both .5 gal. U.S. per acre - L4-5 - 100 acres								
Spray	29.1	136.9	3.2	15.0	64	0	44	42
Check	34.5	113.3	10.4	6.3	-	-	99	88
B.t. 1 mistblower application - L4-5 - 65 acres								
Spray	-	-	1.3	.1	78	86	44	57
Check	-	-	5.8	.7	-	-	98	94

THE SPRUCE BUDWORM IN THE NEWFOUNDLAND REGION - 1974

(Report prepared for presentation to a meeting of the Canadian Pest Control Forum in Ottawa, November 19, 1974).

R.C. Clark

In Newfoundland scattered outbreaks of the spruce budworm, Choristoneura fumiferana (Clem.) have been recorded periodically since 1942 but they were relatively small and did not cause any appreciable damage. However, the most recent outbreak which began on the west coast of the Island in 1971, is the largest and most severe ever recorded.

Budworm infestations reported in 1971 expanded in 1972 and defoliation was recorded over an estimated one million acres of spruce-fir forest extending from the Codroy Valley north to Ten Mile Lake on the Northern Peninsula, in western Newfoundland, and to Badger in central Newfoundland. About 600,000 acres of this area were in the moderate and severe defoliation classes (Fig. 1).

In 1973 the size of the outbreak increased and ground and aerial surveys delineated a defoliated area of about 3.5 million acres of which about 230,000 acres were recorded in the moderate and severe classes (Fig. 2). The reason for the decrease in the area of moderate and severe defoliation from 1972 to 1973 is unknown but may be explained by the aerial survey being conducted after some of the dead needles had been washed away by heavy rains.

In 1974 the outbreak again increased in both size and intensity and now covers approximately 7.2 million acres of which 2.1 million acres are in the moderate and severe defoliation classes (Fig. 3). These acreages of defoliation have been delineated on standard topographic map sheets for use by forest managers, (see Table).

The reasons for the rapid build-up and expansion of the present outbreak on the Island are not thoroughly understood. However, it appears that extensive areas of mature and overmature balsam fir, some of which were weakened earlier by the hemlock looper and the balsam woolly aphid, combined with 2-3 consecutive years of warm and dry weather during the spring and early summer, have been the major contributing factors.

A large scale spruce budworm egg-mass survey was undertaken in September 1974 in the susceptible spruce-fir forests of the Island. The survey was conducted by the Forest Insect and Disease Survey of the Newfoundland Forest Research Centre in cooperation with the Newfoundland and Labrador Forest Service, the forest industry and the National Parks Service. Assistance from these agencies included provision of aircraft for sampling remote areas and manpower for counting egg-massses.

The survey was completed early in October and a total of 750 locations were sampled. Egg-masses per 100 square feet of foliage ranged from none at some locations to as high as 2,700 at others. Based on these results, and on the premise that weather will continue to be favorable for spruce budworm survival, it is forecast that the area of moderate and severe defoliation will be 4,500,000 acres in 1975 (Fig. 4).

On the basis of knowledge of forest conditions in this area, e.g. occurrence of prior damage by spruce budworm, hemlock looper and balsam woolly aphid, it is estimated that some tree mortality will occur in 430,000 acres (Fig. 5).

1974 SPRUCE BUDWORM INFESTATIONS BY DEFOLIATION CLASSES

Map locations 1:250,000 scale	Inventory region	Acres of defoliation			
		Light	Moderate	Severe	Total
Blanc Sablon	1	242,752	43,200	-	285,952
Port aux Basques	6	8,576	-	-	8,576
Port aux Basques	2	33,792	-	-	33,792
St. Anthony	1	73,920	-	-	73,920
Sandy Lake	1	378,688	21,248	187,136	587,072
Sandy Lake	2	501,696	107,776	188,544	798,016
Sandy Lake	3	190,464	-	213,440	403,904
Sandy Lake	3	134,464	79,360	33,280	247,104
Port Saunders	1	250,432	15,104	261,952	527,488
Port Saunders	2	1,280	-	38,336	39,616
Bay of Islands	2	7,680	2,688	31,744	42,112
Stephenville	2	569,856	24,192	183,936	777,984
Red Indian Lake	2	110,848	116,544	141,824	369,216
Red Indian Lake	4	62,720	12,352	11,776	86,848
Red Indian Lake	4	501,312	149,312	49,216	699,840
Botwood	3	762,752	32,384	16,832	811,968
Botwood	3	1,984	24,576	50,624	77,184
Gander Lake	5	778,176	54,912	-	833,088
Gander Lake	5	320,320	-	-	320,320
Belleoram	5	55,808	19,008	-	74,816
TOTAL		4,987,520	702,656	1,408,640	6,998,816

Expected 1975 severe defoliation - 4,500,000 acres

Areas severely defoliated by the spruce budworm more than once - 320,755 acres (green on map)

Total area within spruce budworm infestation severely defoliated by hemlock looper in the 1968 to 1971 infestation - 430,000 acres.

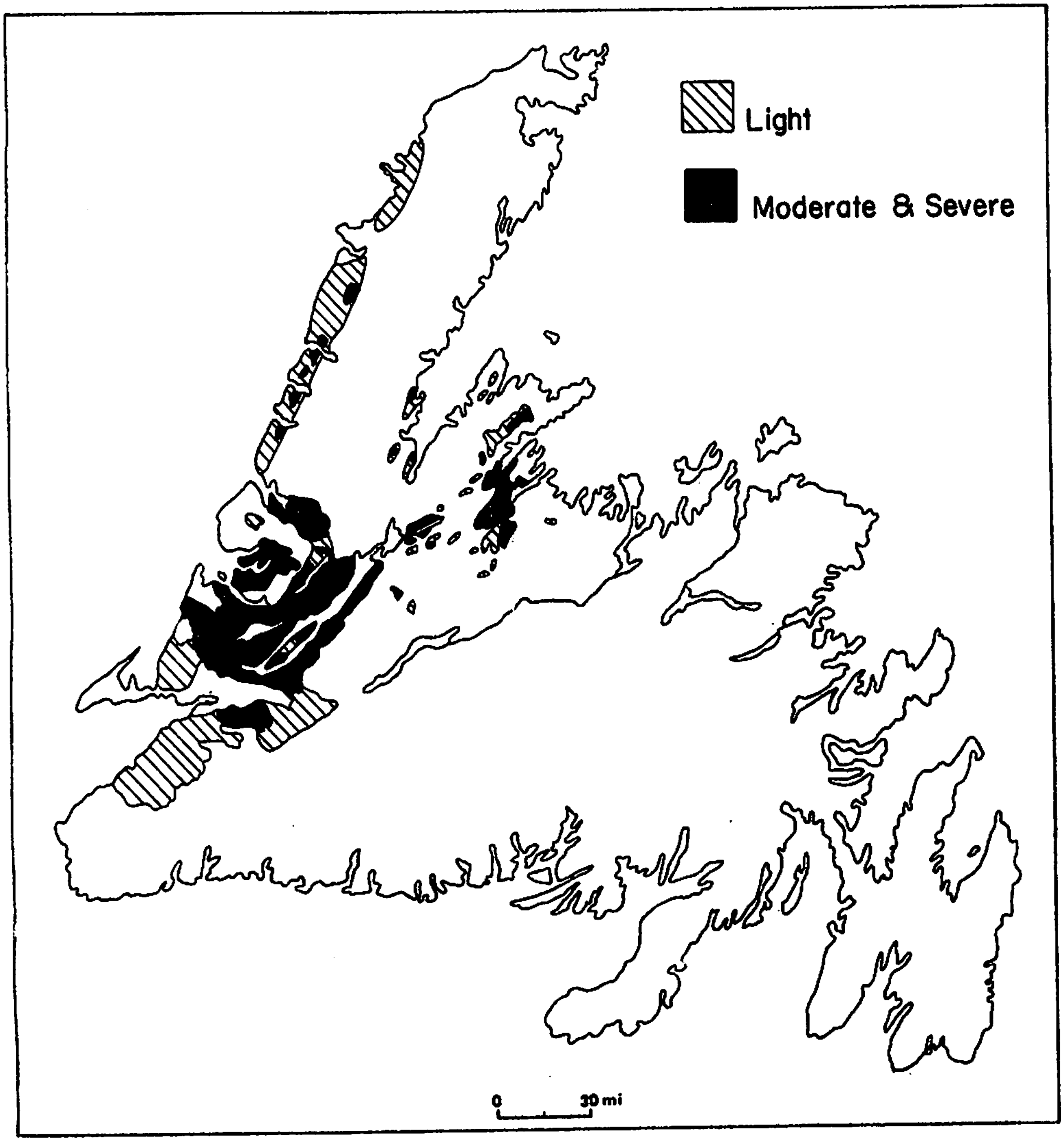

Fig. 1. Areas of spruce budworm defoliation - 1972.

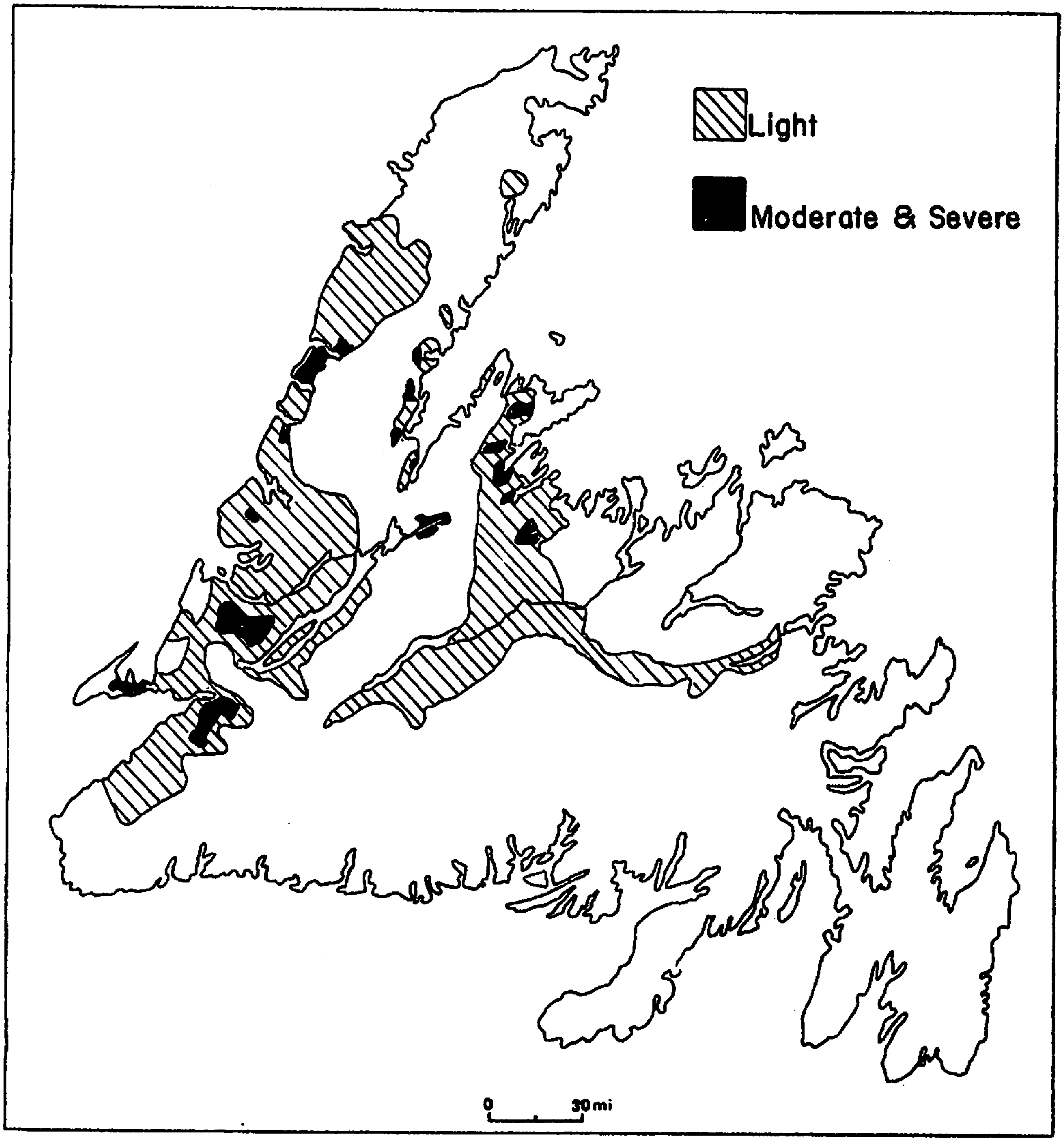

Fig. 2. Areas of spruce budworm defoliation - 1973.

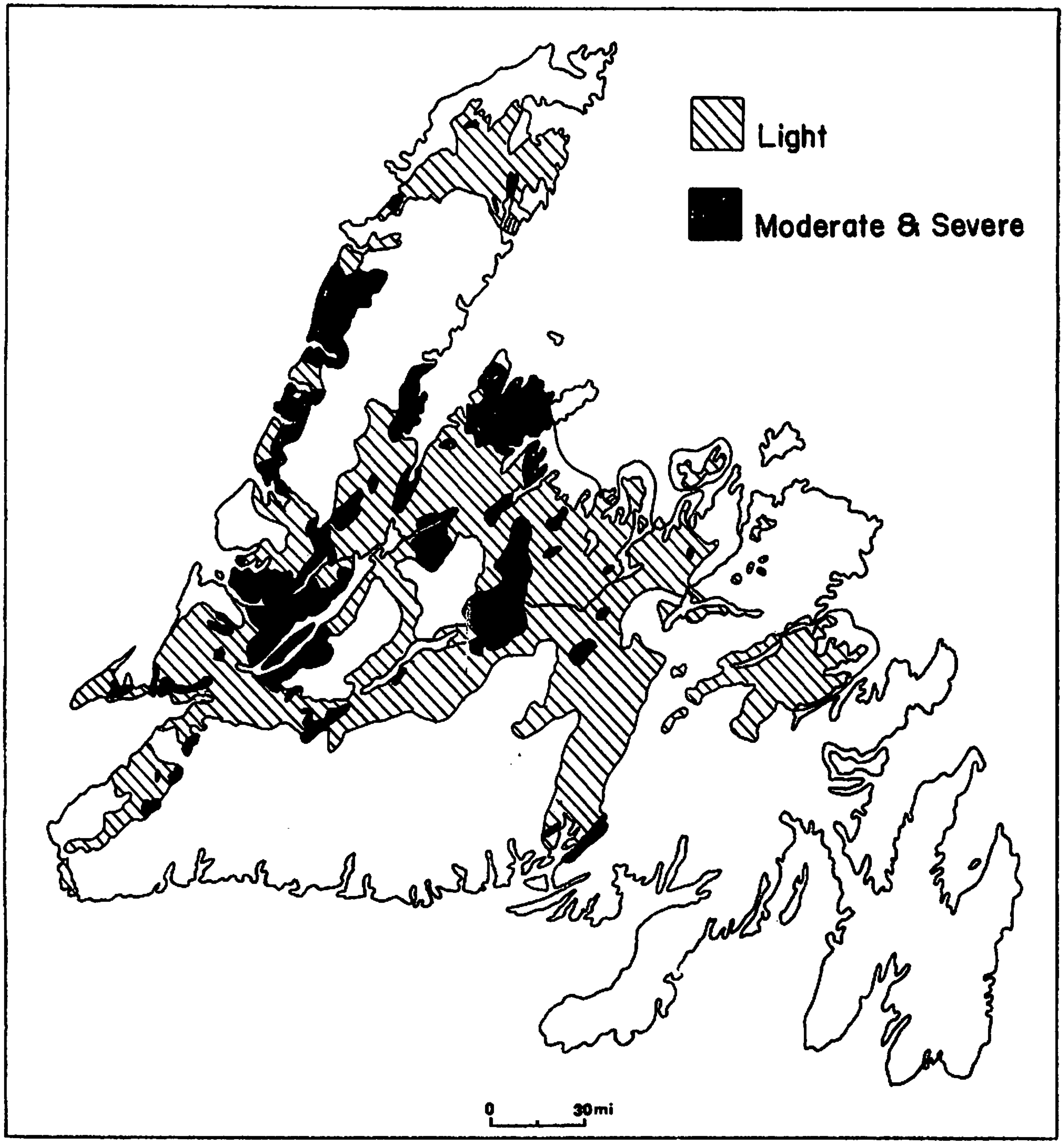

Fig. 3. Areas of spruce budworm defoliation - 1974.

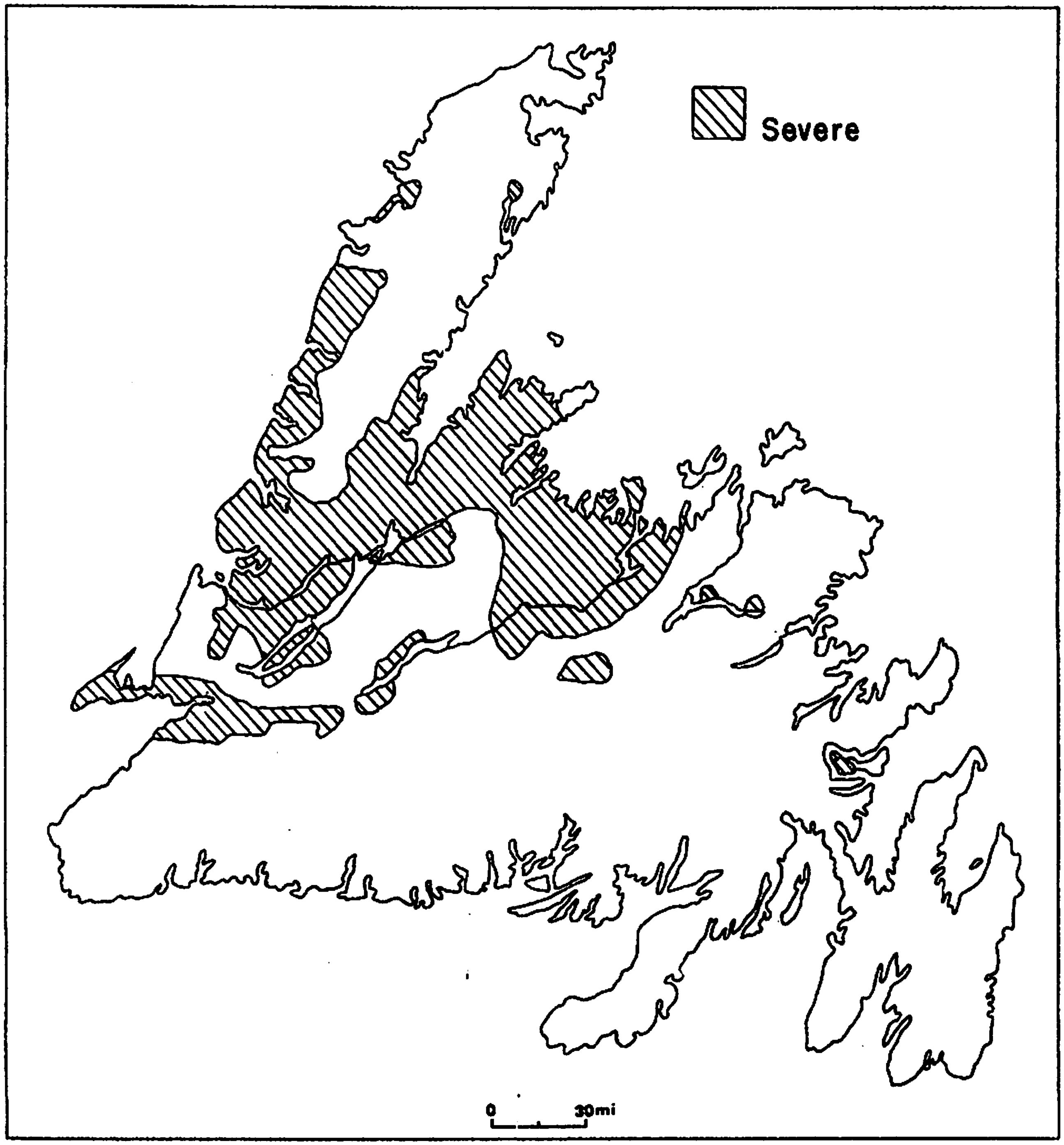

Fig. 4. Predicted areas of severe spruce budworm defoliation - 1975.

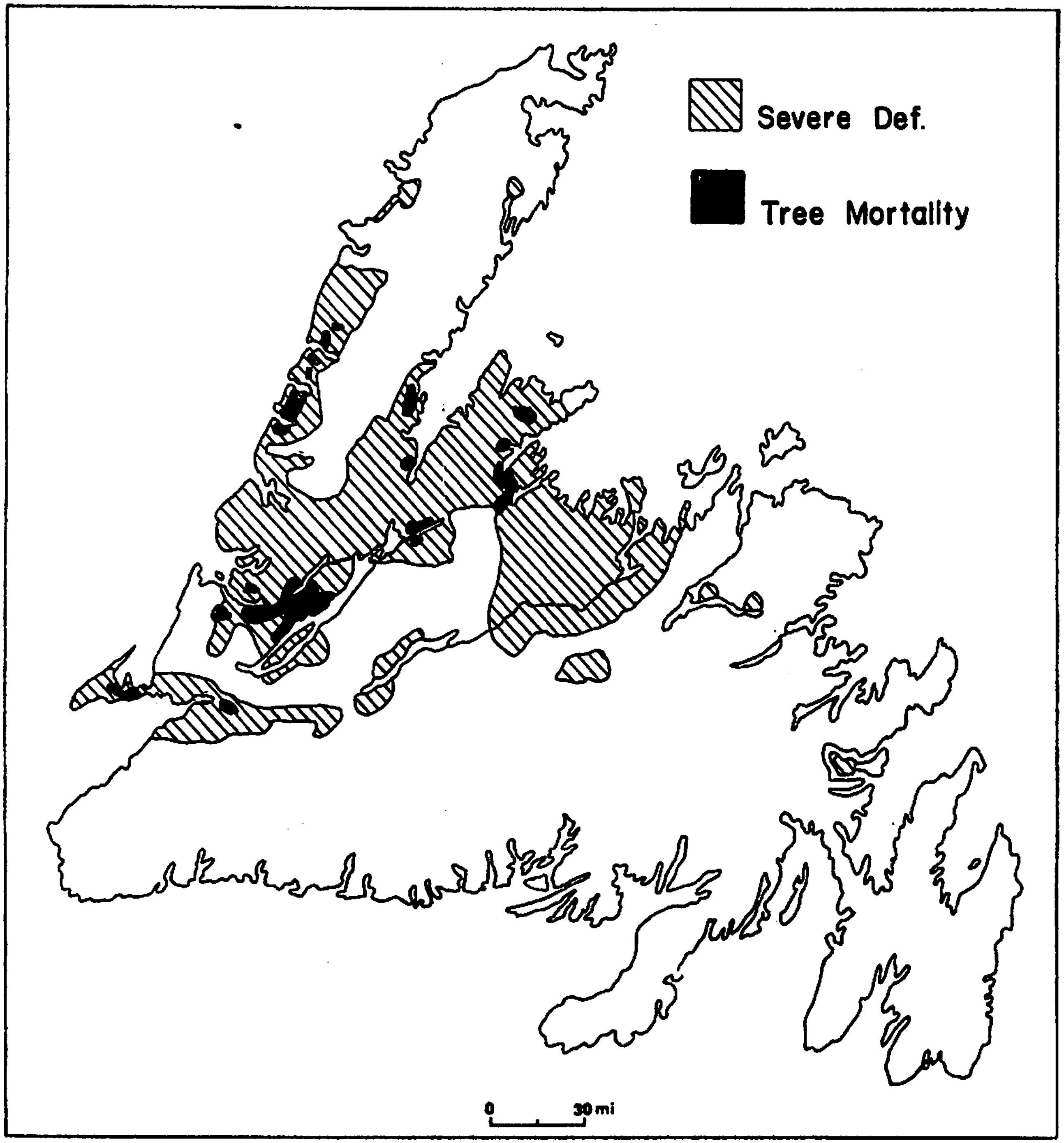

Fig. 5. Areas where severe defoliation and tree mortality are expected in 1975.

FALSE HEMLOCK LOOPER (*Nepytia freemani* Munroe)

AERIAL SPRAY TRIALS,

Chase, B. C. 1974.

SUMMARY REPORT

by

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Prepared for
Canadian Forest Pest Control Forum
1974 Meeting
Place Vincent Massey
Hull, Quebec
November 19, 1974.

False Hemlock Looper Spray Trials

Plans for a replicated test of three materials on hemlock looper (Lambdina fiscellaria) near Revelstoke, B.C., had to be abandoned in mid-season because of collapsing populations. A much smaller test was arranged for false hemlock looper (Nepytia freemani) on Douglas-fir near Chase, B.C. The latter insect was in the third year of an outbreak on Douglas-fir. Some mortality had already occurred and tests with Dipel the previous year had been only partially successful (Ilnytzky, Forum Report 1973). The problem forest represented high amenity values as well as production forests. It is further complicated by including residents, farms and recreation and grazing areas as well as encompassing streams with large breeding stocks of salmon - One of the most ecologically sensitive forests in the country. The B.C. Forest Service cooperated in the trial by supplying finances and staff.

Three 40-acre plots were layed out and larval-sampled, one was sprayed with Bacillis thuringiensis, one with juvenile hormone, and one was left non-treated as a check. Samples consisted of two whole branches from each of three crown levels of thirty trees per plot. Post-spray sampling was carried out during the pupal stage and again during the egg stage. Spraying took place on July 23 and 24 when about half the larvae were in the last instar and half were in the penultimate instar. Hot dry conditions prevailed thereafter with no rain for at least two weeks.

Two passes were made over the plot with an 'Agtruck' spraying ½ lb of Dipel powder (Abbott Laboratories) in 2 U.S. gallons of water per acre on each pass; Biofilm at the rate of 16 oz/100 gals and 0.1% by volume of Rhodamine B were added. The juvenile hormone, Altosid 5 E (previously called Zoecon 515), was used at 3 fl. oz. per 2 gallons water per acre with 0.1% by volume of Rhodamine B added. The Altosid contained 65% active ingredient.

Two environmental monitoring plots originally laid out at Revelstoke were retained. One contained a stream and one a pond; both were sprayed with Altosid at the same rate as above to test the influence on aquatic fauna. It was monitored by the Environmental Protection Service; results are not yet available.

Using Abbott's formula a preliminary analysis of the data, expressed as average number of insects per branch, based on survival of larvae to adult, indicated a control of 77% in the B.T. plot, and 30% in the Altosid plot. The latter was disappointing in view of the previous excellent laboratory results completed in B.C. and the field test in 1973 on Anacosti Island; no reason has been found.

Nepytia larvae were reared in cages at the field site to determine the amount of natural mortality in the population as well as the pattern of mortality following spraying. Larvae were fed on unsprayed foliage, Dipel-sprayed foliage or Altosid-sprayed foliage and checked every second day. Mortality from the larva to adult was 25% on Altosid foliage, about the same as on unsprayed foliage (28%)(Table 1). On Dipel foliage, mortality averaged 46%. Within the Dipel treatment, some larvae were exposed to sprayed foliage continuously until pupation (Treatment 1; Table 1), others were given one feeding on freshly-sprayed foliage then fed on unsprayed foliage (Treatment 2), whereas others were fed on sprayed foliage starting 48 hours after spraying, i.e. the B.t. was exposed to ultra-violet radiation for 2 days prior to feeding (Treatment 3). Survival to the adult stage in these 3 treatments was similar, but in Treatments 2 and 3, much of the mortality was delayed to the pupal stage. In Treatment 1, in which larvae were fed continuously on sprayed foliage, most mortality occurred during the larval stage.

Table 1. Mortality of false hemlock looper reared in cages on sprayed foliage. (150 larvae were used in treatments 1 to 3, and 300 larvae in treatments 4 & 5)

Treatment	% Parasitism	% Non-emerged pupae	% Larval mortality	Total mortality (%)
1. Dipel	12.7	6.0	28.0	46.7
2. Dipel + unsprayed	5.3	19.3	20.1	44.7
3. Unsprayed + Dipel	3.3	17.3	24.1	44.7
4. Altosid	6.7	10.0	8.0	24.7
5. Unsprayed	6.0	12.0	10.0	28.0

Special weather problems were found when spraying in mountainous terrain. In one situation inversion conditions were rare and a morning lee-wind had to be utilized. In another location, we used an evening cross-valley circulation to obtain a good deposit. Under both situations low humidities probably resulted in large evaporation losses.

Outbreaks of this insect spread and intensified in 1974. Egg samples indicate a continuing problem in 1975 and further tree mortality. In much of the area Douglas fir tussock moth is mixed with the looper. Further experiments and a control operation are being contemplated for 1975.

DOUGLAS-FIR TUSSOCK MOTH, *Orgyia pseudotsugata* (McD.), AERIAL SPRAY TRIAL WITH VIRUS INSECTICIDE, Kamloops Lake, B. C., 1974.

SUMMARY REPORT

by

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Prepared for
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1974 Meeting
Place Vincent Massey
Hull, Quebec
November 19, 1974.

Outbreak Histories

Epidemic levels of Douglas-fir tussock moth in British Columbia seldom continue in a particular stand beyond three years but through the initiation of new spot infestations outbreaks have continued for six and seven years. Commencing in 1916, seven outbreaks were recorded at intervals of about five years; all occurred in the semi-arid regions of the B.C. Interior, primarily in the Okanagan - Shuswap - Kamloops areas which are characterized by stands of Douglas-fir - ponderosa pine.

The current outbreak began in 1971 in the Okanagan Valley and although most of the original infestations have already collapsed, new infestations in the Kamloops vicinity cover over 5,000 acres. Based on past trends it is expected that this outbreak will continue through 1975 and collapse in 1976. Each collapse of tussock moth has been associated with a high incidence of virus disease (NPV) but this has not been demonstrated to be the only or even primary factor involved.

The feeding behavior of the insect is such that Douglas-fir may be completely defoliated and some tree mortality is evident after a single year. Through aerial reconnaissance it was estimated that tree mortality amounted to about 40%, or 1,000 acres out of 2,500 acres under attack, during the three-year period of 1971-73 in the south Okanagan Valley.

Since female Douglas-fir tussock moths are wingless, dispersion is by airborne early instar larvae during May and June. Hence, it is virtually impossible to detect infestations during the initial year in time to effect control before extensive defoliation. Control measures enacted early the second year, however, should prevent most tree mortality and also limit further dispersion.

Purpose of Trial

A small quantity of Douglas-fir tussock moth nuclear polyhedrosis virus (NPV) sufficient to treat a few hundred acres was available in 1974 from the Insect Pathology Research Institute, Sault Ste. Marie. This stock originated from Douglas-fir tussock moth larvae from an infestation in Oregon but was propagated at Sault Ste. Marie on the white marked tussock moth.

The lethal nature of this virus to early instar Douglas-fir tussock moth larvae was established in the laboratory, but an aerial field trial was required to confirm the timing and gain experience when faced with unique problems associated with the insect, the terrain, and the weather. During the spray period (early June) the insect is being dispersed which introduces extreme variations in population counts. The host trees are situated on very steep slopes and in gorges. Strong air movement is prevalent and the relative humidity seldom exceeds 50%. Precipitation, however, at that time of the year is unlikely.

Experimental Area

Two small infestations which first appeared in 1973 were selected near Kamloops. Larvae forced reared from a few of the egg masses were found to be free of virus disease. The spray plot consisted of 25 acres. The control area was located only about 1/4 mile distant but separated by a higher land mass.

Formulation and Application

The spray formulation per U.S. gallon consisted of virus to give a polyhedral count of 50×10^9, 0.25 lbs. I.M.C. sunlight protectant®, and 0.01 pints Chevron sticker®, all mixed in distilled water. The use of distilled water was a precautionary measure because a sample from a local lake had an alkalinity of 9.1 and city water was treated with chlorine.

The formulation was applied in the early morning of June 11 from a Cessna Ag Wagon equipped with 38 T jet nozzles at a rate of 2 gals. per acre. Preliminary examination of spray cards revealed a very poor ground deposit. For this reason, the spray was repeated during the evening of June 12. This amounted to a total of 4 gals. of spray (200×10^9 polyhedra) per acre but the total ground deposit as registered by spray cards was less than one drop per square cm. The mean drop diameter was about 400 microns. Cards have not been analysed with respect to gals. per acre but the amount was certainly less than that considered normal for the quantity emitted. It is believed that most of the spray was lost through evaporation before reaching the ground but considering the apparent effect on the target insect, the quantity reaching the tree crowns must have been adequate.

Assessment

A total of 50 sample trees were pre-selected in each of the spray and control plots prior to application. Two pre-spray population samples consisting of single 18" branches from the mid crowns of each tree were taken -- the first, 5 days prior to application on June 6, and the second, one day before on June 10. The latter sample revealed 81% of the larvae in the second instar. A single post-spray population sample was taken about three weeks after application on July 3. In addition, surviving larvae were examined for the presence of virus at about weekly intervals until pupation. Results of the population sampling are shown in Table 1.

Table 1. Populations of Douglas-fir tussock moth larvae per 18" branch tip before and after treatment with NPV on June 11 and 12, and calculated mortality from treatment.

Plot	Pre-spray			Post-spray		Mortality from treatment
	June 6	June 10		July 3		
	larvae	larvae	reduction	larvae	reduction	
Sprayed	71.1	46.3	35%	1.1	97.6%	96.8%
Unsprayed	21.2	15.0	29%	11.1	26.0%	

The initial pre-spray population sample produced a mean of 71 larvae per 18" branch from the spray plot as compared to 21 from the control area. The second pre-spray sample revealed 46 and 15, respectively, for reductions of 35 and 29%. Hence, although the spray plot had apparently over three times the population of the control, the percent reductions immediately prior to spraying were about the same. Post-spray sampling on July 3 revealed means of 1 and 11 larvae per branch in the sprayed and control plot, respectively. This amounted to population reductions of 98% and 26%, respectively, or an effective control (Abbott's formula) of 97%.

The mean virus infectivity in the surviving larvae (Table 2) was found to be 27% in the sprayed plot as compared to 3% in the control. The virus in the control plot could have resulted from drift or the presence of wild virus. In any event, the infectivity differences as recorded in the survivors is further evidence of an effective treatment.

Table 2. Infectivity of surviving larvae following treatment with NPV on June 11-12, 1974.

Date	Spray plot			Control		
	Larvae examined	Number infected	Percent infected	Larvae examined	Number infected	Percent infected
June 24	62	11	18%	100	0	0
July 1	100	26	26%	50	5	10%
July 3	20	4	20%	17	1	6%
July 8	200	54	27%	100	5	5%
July 9	50	24	48%	32	2	6%
July 15	100	18	18%	50	0	0
July 22	100	31	31%	100	1	1%
Totals	632	168	27%	449	14	3%

Conclusions

Data from population reductions and infectivity of surviving larvae indicate that the nuclear polyhedral virus is an effective material when applied during the second instar.

The experience gained during this trial strongly suggests that evaporation and drift could be major problems. Hence any attempt to produce spray droplets of smaller diameter such as that achieved by Micronair equipment would likely compound the problems. It is suggested that aqueous formulations require a good anti evaporant material and that conventional boom and nozzle equipment is adequate when spraying this particular forested area of B.C.

Preliminary Experiment for Control of Black Army Cutworm *Actebia fennica* Tauscher

Golden, B.C. 1974

SUMMARY REPORT

by

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INTRODUCTION

In 1974, preliminary control experiments were made for the black army cutworm (Actebia fennica Tauscher), which was severely damaging Douglas-fir [Pseudotsuga menziesii (Mirb.) Franco] and white spruce [Picea glauca (Moench) Voss.] natural and planted (B.C. Forest Service) seedlings on a 52,000-acre burn, about 25 miles north of Golden, British Columbia.

MATERIALS AND METHODS

The plots were located in a 3-acre area within the burn. The insecticides used and their application rates were: (i) Diazinon at 1, 2 and 3 lb per acre in 4.4 Imperial gallons of water, (ii) Dylox at 1, 2 and 4 lb per acre in 4.4 Imperial gallons, (iii) Cordyceps militaris (L) at 4.2×10^6 mycelial particles plus conidia per ml^2 in 4.4 Imperial gals. of water per acre, (iv) Bacillus thuringiensis (Berliner) "Dipel" one 1 lb[1/] in 5.4 U.S. gallons of water per acre, and (v) the Nuclear Polyhedrosis Virus, (N.P.V.) at 4×10^{10} polyhedra per U.S. gallon mixed in 16 U.S. gallons of water per acre.

Each concentration of each insecticide, except B.t., was applied to three 0.1-acre plots (replicates) in a randomized complete block design. The B.t. treatment was applied to only one 0.1-acre plot. To avoid cross-contamination, the N.P.V. plots were located about 1 mile away from the others. All test materials were applied by a mist blower, on May 30 and 31, between 08:00 and 10:30 hr at 2 to 10°C (35.6-50.0°F) and 40 to 50% relative humidity. It was clear and sunny and, as the temperature rose, a slight breeze developed. Pre- and post-spray examinations, consisting of checking 22 one-square foot samples per plot, were taken between 08:00 to 12:00 hr, when larvae were quiet.

1/ Equivalent to 7.26 billion international units of potency per pound of product.

RESULTS AND DISCUSSION

Table 1 shows the results obtained with the chemical insecticides. In the table, survival was calculated using the difference between pre-spray and subsequent counts in control (untreated) plots, and this was converted to percentage control using Abbott's formula[1/]. In these plots, reduction in the number of larvae occurred sooner and lasted longer at the highest rate of Diazinon and were next best in the plots receiving 2 lb/acre of Dylox. Larval control was poorest in the 4 lb/acre Dylox plots. This probably could be attributed to the high consistency of the spray mixture which, even with constant agitation, tended to clog the intake tube of the sprayer, causing uneven distribution of the insecticide.

Fourteen days after spraying, a microscopic examination of larvae showed no infected larvae in the N.P.V. plots. Samples taken from the Bacillus thurigiensis and Cordyceps sprayed areas also showed no reduction of larvae.

These tests show that Diazinon and Dylox have potential use for cutworm control, e.g. 79% of the larvae were killed by these two insecticides within 5 days after spraying (Table 1). Further tests should be made under more controlled conditions, especially since the high mobility and cannibalistic behavior of the insect under field conditions hinders estimation of larval mortality.

1/ J. Econ. Entomol. 18:265-267.

Table 1. Percentage control of Black Army Cutworm by Diazinon and Dylox plots.

Material	Rate in lb/acre	On Days 1, 3 and 5 following treatment and percentage cutworm control		
		1	3	5
Diazinon	1	19	59	79
	2	45	67	71
	3	57	76	76
Dylox	1	18	61	67
	2	43	71	77
	4	44	72	64

AERIAL SPRAYING WITH FENITROTHION TO CONTROL BUDWORMS IN MANITOBA IN 1974

The spruce budworm, _Choristoneura_ _fumiferana_ and jack pine budworm, _C. pinus pinus_ are important pests of native white spruce and planted pines in the Spruce Woods Provincial Forest and Park in Manitoba. Several heavy outbreaks of the spruce budworm have been recorded since 1938, but until recently serious tree injury has been negligible. The current outbreak, involving about 115 square miles, developed in 1967, and heavy defoliation since 1970 has resulted in extremely severe damage to both regeneration and mature white spruce. Two damaging outbreaks of the jack pine budworm have been recorded in the area in recent years (one from 1956-58 and the other from 1965-67), both of which caused extensive top-killing and tree mortality in jack- and Scots pine plantings. Notable increases in resident jack pine budworm populations in 1972-73 indicated that another general outbreak was imminent.

1974 Spray Program

In June 1974 approximately 1,850 acres of white spruce forest and 150 acres of pine plantations were sprayed by the Manitoba Parks Branch for budworm control with the chemical fenitrothion; the spray program having previously been approved and licensed under the Clean Environment Act of Manitoba. Canadian Forestry Service personnel from Winnipeg assisted in an advisory capacity. The fenitrothion was applied as one treatment in an oil-in-water emulsion spray at the rate of 4 oz. active ingredient in 1 U.S. gallon of water per acre. Spraying was carried out with a Piper Pawnee 235B aircraft equipped with conventional boom and nozzle apparatus. The aircraft, using No. 8003 nozzles, covered a swath width of 50 ft flying about 8-15 ft above the treetops, and was guided upwind along successive flight paths by flagmen with helium-filled weather balloons or white flags on aluminum poles. Applications against the spruce budworm were made on June 13 and 17 and against the jack pine budworm on June 27, during the early morning hours (0430-1100) to take advantage of the cooler temperatures, higher humidities, and low wind speeds (less than 5 mph). Treatments were timed to coincide with the periods when the majority of the larvae of each species were in the 4th instar.

Control Assessment

Control was assessed by C.F.S. personnel using the standard branch-sampling technique; the sample unit consisted of two 18-inch tips collected from the mid-crown regions of 10 sample trees selected at right angles to the spray paths. Larval counts were commenced 12 days before and continued to date of spray application to determine pre-spray population levels and natural mortality trends. Larval control achieved was based on the number of surviving larvae per 18-inch branch on the sprayed plots five days after treatment compared with adjacent untreated stands. Counts taken in the spray plots prior to treatment ranged from 15 to 193 per 18-inch branch for the spruce budworm and from 22 to 97 for the jack pine budworm.

Results and Discussion

Favorable weather during the spray period in 1974 allowed the timely application of the insecticide. Less than 5% of the larvae had reached the 5th instar at the time of spraying, thus preventing serious feeding injury to the foliage in the treated areas. Because of the open growing and scattered nature of white spruce stands in the Spruce Woods Provincial Forest and Park, control was less effective against the spruce budworm than it was against the jack pine budworm in the pine plantations with their dense crown covers. It is assumed that the more open spruce stands caused more air movement which resulted in poorer settling of spray droplets among the spruce than the pine.

The chemical, however, substantially reduced budworm populations from 78.0% to about 88% in three plots sprayed for spruce budworm control, and about 95% in one plot sprayed for jack pine budworm control. These data are presented in the following table.

TABLE 1

Summary of Larval Reductions Achieved on Four Plots Sprayed With Fenitrothion in the Spruce Woods Provincial Park and Forest in 1974

Plot #	Size ac.	Average No. Larvae/18-Branch(1) Treated	Untreated	% Larval(2) reduction
1	350	4.7	38.3	87.7
2	780	5.9	41.3	85.7
3	640	12.2	55.4	78.0
4	150	1.7	33.4	94.9

(1) Based on examination of twenty 18-inch branch samples from each plot.

(2) Figures not corrected by Abbott's formula.

At this time an assessment of foliage protection and egg-masses has not been made.

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October 15, 1974

Canadian Forest Pest Control Forum
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Summary of Research Activities of Spruce Budworm Working Committee

Introduction

All research on the spruce budworm in eastern Canada is coordinated through an integrated project of the CFS, whose personnel meet together once a year for presentation of results and for the discussion and planning of future research.

The long term aim of this project is to devise and recommend environmentally and economically acceptable techniques for protecting the forests of eastern Canada from the spruce budworm. One immediate objective is to develop, test and evaluate new and improved control agents and methods for their application. Under this heading are included the experimental use of *Bacillus thuringiensis*, viruses, insect growth regulators, sex pheromones and sterilants, as well as new approaches in the use of conventional insecticides.

B.t.

Research on B.t. has been conducted by V. Smirnoff of LFRC and by IPRI, with additional field evaluation by CCRI. A working group comprised of those active in research and development of B.t. is agreed that B.t. is effective for the regulation of budworm numbers, the only outstanding problem is a technical one of effective application. Operational planes of the future in Quebec will be DC-6B's. Trials for 1975 therefore will be an attempt to demonstrate the effectiveness of B.t. applied by DC-6B under operational conditions.

Viruses

Virus research is being conducted by J.C. Cunningham of IPRI, with additional field testing by O.N. Morris of CCRI. Of the available viruses, NPV continues to show promise, with significant carryover and infection 3 years after application. Experiments in 1974 & 75 are aimed at providing a treated area sufficiently large, and so located, that the risk of moth invasion is reduced, allowing a full appraisal of the effects of carryover.

Insect growth regulators

All research on IGR's is now being conducted by A. Retnakaran of IPRI, with additional field evaluation of candidate compounds in the Maritimes. Compounds having juvenile hormone properties have been field tested, but have not lived up to expectations from lab tests. However, a compound inhibiting the biosynthesis of chitin has shown considerable promise and it will be further evaluated together with J.H. type compounds in 1975.

Chemical/Biological Combinations

Field testing of sublethal dosages of chemical and biological insecticides has been conducted by O.N. Morris of CCRI. Results are promising, but the number of possible combinations is considerable and further testing is required.

Sex Pheromone

The use of the sex pheromone in population survey and control is being conducted by C.J. Sanders of GLFRC with support from I. Weatherston, chemist of IPRI. Field results have demonstrated that many males are prevented from locating females in air permeated with synthetic attractant, and trials of aerial application are planned for 1975. Sex attractant traps are now available and can be recommended for monitoring fluctuations of low density populations.

Sterilants

A. Retnakaran has demonstrated the feasibility of sterilizing male budworm, however the logistics of mounting an effective control program are impractical.

Adult Spraying

One of the more ambitious developments of the past few years is the investigation into the effectiveness of spraying adult budworm, involving MFRC, FPL and contractors utilizing radar to monitor adult dispersal. Adults are apparently very vulnerable to low concentrations of insecticide, however the timing of application is extremely critical and even large areas of treated forests are subject to re-invasion. Possibly this problem may be solved by air-air spraying of the re-invading insects.

Epidemiology

The prediction of outbreaks and their early detection and suppression is still the only viable alternative to large scale spraying, at least until more intensive forest management becomes a reality. We are therefore planning to increase our research efforts in this direction. The work necessarily will be carried out in northwestern Ontario, the only extensive area of endemic budworm populations in eastern Canada.

APPENDIX 16

SUMMARY OF LABORATORY EVALUATIONS OF INSECTICIDES AGAINST VARIOUS SPECIES OF FOREST INSECT PESTS DURING 1974

(Study Ref. No. CC-2-006)

A REPORT TO THE ANNUAL FOREST PEST CONTROL FORUM

By

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Ottawa, Ontario.

October, 1974

SUMMARY OF LABORATORY EVALUATION OF INSECTICIDES AGAINST VARIOUS SPECIES OF FOREST INSECT PESTS DURING 1974

By

P.C. NIGAM

Thirty-seven insecticides were tested for contact, stomach, and residual toxicity using modified Potter towers. Thirteen of these were new insecticides and formulations. The results are summarized under contact, stomach, and residual toxicity studies. Unless otherwise specified mortality counts were made at 72 hours after treatment.

CONTACT TOXICITY

Insecticides were tested for contact toxicity against insects from British Columbia, Ontario, and Quebec. The results are summarized by area of origin and by species. Insect collections were provided by the staff of the Forest Insect and Disease Survey and personnel of the Insect Toxicology Section, Chemical Control Research Institute. Insecticides are arranged in descending order of toxicity.

BRITISH COLUMBIA

Black Cutworm - *Agrotis ipsilon* (Hufnagel)

Six insecticides were tested in 1974 against fifth instar larvae of black cutworm. The corrected percentage mortality ranged from 79% to 100%.

Methomyl > fenitrothion > carbaryl > Dylox > malathion > Orthene

Douglas Fir Tussock Moth - *Hemerocampa pseudotsugata* McDunnough

Four insecticides were tested in 1974 against fourth instar larvae of Douglas fir tussock moth. The corrected percentage mortality ranged from 48% to 100%.

Phoxim > MATACIL > fenitrothion > Orthene

Sitka Spruce Weevil - *Pissodes sitchensis* Hopkins

Seven insecticides were tested against Sitka spruce weevil adults which emerged in 1973. The corrected percentage mortality ranged from 74% to 100%.

Methyltrithion > Gardona > Dursban > Dowco 214 > lindane > Trithion > DDT

Jack Pine Sawfly - _Neodiprion pratti banksianae_ Rohwer

Eight insecticides were tested against fifth instar larvae of black-headed jack pine sawfly. The corrected percentage mortality ranged from 11% to 100%.

Supracide > methomyl > NRDC-119 > SBP-1382 > RH 218 > Trithion > Orthene > Bay Meb 6046

ONTARIO

Larch Sawfly - _Pristiphora erichsonii_ (Hartig)

Eight insecticides were tested against fourth instar larvae of larch sawfly. The corrected percentage mortality ranged from 78% to 100%.

RU-11679 > SBP-1382 = Supracide > RH-218 > Chlorophoxim > Fyfanon > allethrin > Orthene

Four insecticides were tested against fifth instar larvae of larch sawfly. The corrected percentage mortality in each case was 100%.

RU-11679 > Supracide > RH 218 > Orthene

Spruce Budworm - _Choristoneura fumiferana_ (Clemens)

Field Collected Larvae

Thirteen insecticides were tested against fifth instar larvae of spruce budworm. The corrected percentage mortality ranged from 38% to 100%.

RU-11679 > NRDC-119 > RH-218 = RU 11483 > SBP-1382 > phoxim > F-6957 > Pyrocide = Supracide > PP484 > PH60/40 > Chlorophoxim > Bay 6046.

Thirteen insecticides were tested against sixth instar larvae of spruce budworm. The corrected percentage mortality ranged from 25% to 100%.

RU-11679 > NRDC-119 = RU 11483 > SBP-1382 > RH-218 > Pyrocide > Supracide > F-6957 > PP484 > Fyfanon > Orthene > Isopropyl/parathion > Bay Meb 6046

Laboratory Reared Larvae

Three insecticides were tested in late 1973 and 1974 against fifth instar larvae of laboratory reared spruce budworm. The corrected percentages mortality ranged from 26% to 99%.

Dylox > fenitrothion > Orthene

Sixteen insecticides were tested against pupae of laboratory reared spruce budworm. The corrected percentage mortality ranged from 23% to 100% at 72 hours.

Imidan = methomyl > Supracide > Dowco 214 > Orthene = Phosphamidon = Zectran > dimethoate > fenitrothion = Matacil > Trithion > phoxim > Dylox > Phosvel > Dimetilan DDT.

Orthene was tested against sixth instar larvae of laboratory reared spruce budworm. The corrected percentage mortality was 97% at 3.0% concentration and .8 gpa (2.69 $\mu g/cm^2$).

White Pine Weevil - Pissodes strobi (Peck)

Fourteen insecticides were tested against white pine weevil adults. The corrected percentage mortality ranged from 3% to 100%.

Gardona > Methyl Trithion > phoxim > Dursban > Supracide > Dowco 214 > Imidan > Phosvel > lindane > Trithion > MATACIL > DDT > Chlorophoxim > Dimetilan.

QUEBEC

Redheaded Pine Sawfly - Neodiprion lecontei (Fitch)

Eleven insecticides were tested against fifth instar larvae of redheaded pine sawfly. The corrected percentage mortality ranged from 28% to 100%.

NRDC-119 > Supracide > methomyl > Gardona > Fyfanon > SBP 1382 > Chlorophoxim > RH-218 > Trithion > Orthene > Bay Meb 6046.

Seven insecticides were tested against fourth instar larvae of redheaded pine sawfly. The corrected percentage mortality ranged from 16% to 100%.

RU-11679 > Supracide > Gardona > SBP-1382 > Chlorophoxim > RH218 > Bay Meb 6046.

Swaine Jack Pine Sawfly - Neodiprion swainei Middleton

Nine insecticides were tested against fourth instar larvae of Swaine jack pine sawfly. The corrected percentage mortality ranged from 82% to 99%.

Supracide > Gardona > NRDC-119 > Fyfanon > phoxim > SBP-1382 > Chlorophoxim > RH-218 > Orthene

STOMACH TOXICITY

Orthene, fenitrothion and PH 60-40 were tested for stomach toxicity against 5th instar laboratory reared spruce budworm. The foliage was sprayed with various concentrations of these materials at six rates of application. The toxicity of fenitrothion and Orthene was evaluated after 72 hrs. The stomach toxicity of fenitrothion and Orthene was approximately same as both of them gave 97% mortality at 0.22 $\mu g/cm^2$. PH 60-40 gave 100% mortality after 7 days at 1.79 $\mu g/cm^2$ although there was high control mortality.

STOMACH AND CONTACT TOXICITY TOGETHER

Orthene and fenitrothion were tested against laboratory reared and field collected spruce budworm and larch sawfly. Orthene gave 100% mortality against 4th instar larch sawfly at 0.179 $\mu g/cm^2$ and against laboratory reared and field collected 5th instar spruce budworm at 0.224 $\mu g/cm^2$ and 0.448 $\mu g/cm^2$, respectively. Fenitrothion gave 99% mortality against 5th instar laboratory reared spruce budworm at 0.112 $\mu g/cm^2$.

RESIDUAL TOXICITY

The insecticides were tested for residual toxicity by spraying potted trees in the spraying chamber. The sprayed host plants were then exposed to weathering conditions for up to 10 days for jack pine, balsam fir, white spruce, and for up to 40 days for larch. The insects used for bioassay of residues were collected in the field and maintained in the laboratory until their release on the insecticide treated foliage. The residue of the insecticides bioassayed on the same day of spraying (i.e. 4 ± 2 hours after spraying) are referred to as 0 day and these host trees were not exposed to weathering. The insecticides are arranged in descending order of residual toxicity at 0 and 10 days of residual life. The corrected percentage of mortality is given in brackets and is that observed 72 hours after releasing of insects, except in the case of PH 60-40 where it is ten days after insect addition.

Spruce Budworm - *Choristoneura fumiferana* (Clemens)

Residual toxicity of twelve insecticides was tested against fifth instar larvae of spruce budworm. Two percent phoxim, Zectran, Volaton-A, Volaton-B, Volaton-D (these are various formulations of phoxim), and five percent DDT and Orthene at the rate of 1 GPA were tested using white spruce and balsam fir as hosts (series I). The Volaton formulations were tested for the first time whereas the rest of the insecticides is a repeat test from previous year, although phoxim and Orthene were tested for the first time on balsam fir. Eight percent carbaryl, Imidan, five percent resmethrin, PH 60-40, and two percent fenitrothion, at the rate of 1 GPA, except PH 60-40 which, tested for the first time, was applied by hand for complete coverage of foliage, were also repeated from previous year using white spruce as host (Series II).

Series I

White Spruce 0 day-Volaton-A, Volaton-B (100) > Orthene (98) > phoxim (96) > DDT (95) > Volaton-D
10 day-Orthene (42) > DDT (2)

Balsam Fir 0 day-Orthene (100) > phoxim (92) > DDT (90) > Zectran (86)
10 day-Orthene (69) > Zectran (57) > DDT (27)

Series II

White Spruce 0 day-Imidan (89) > fenitrothion (76) > resmethrin (75) > carbaryl (28) >
10 day-Imidan (39) > carbaryl (33) > fenitrothion and resmethrin (0)
0 and 10 day values for PH 60-40 ten days after insect addition were 90 and 59%, respectively.

Jack Pine Sawfly - _Neodiprion pratti banksianae_ Rohwer

Four insecticides were tested against fourth instar larvae of jack pine sawfly. One percent aminocarb, Zectran, and two percent phoxim and propoxur, at the rate of 1 GPA were repeated from previous year using jack pine as hosts.

0 day-Zectran = aminocarb = propoxur = phoxim = all 100%
10 day-Zectran (65) > aminocarb (61) > propoxur (52) > phoxim (0)

Larch Sawfly - _Pristiphora erichsonii_ (Hartig)

One percent concentration of three insecticides: dimethoate, Gardona and propoxur, at the rate of 1 GPA were tested against fourth instar larvae of larch sawfly using European larch and tamarack as hosts. This was a repeat of previous year's test.

0 day-dimethoate = Gardona = propoxur = all 100%
10 day-propoxur (93) > dimethoate (74) > Gardona (44)

Acknowledgment

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List of Insecticides Used in 1974

No.	Insecticide	Formulation Stock	Type	Source
1	Allethrin	90%	Botanical derivative	McLaughlin, Gormley, King, Co.
2	Bay Meb 6046	98%		Chemagro
3	Carbaryl	12.5% & 49%	Carbamate	Union Carbide
4	Chlorophoxim	23%	Organophosphate	Chemagro
5	DDT	100%	Chlorinated Hydrocarbon contact	Math. Col. & Bell
6	Dimethoate	43.5%	Organophosphate	Cyanamide
7	Dimetilan®	25% E.C.	Carbamate contact	Geigy
8	Dowco® 214	60.6%	Organophosphate contact	Dow
9	Dursban®	28.8%	Organophosphate contact	Dow
10	Dylox®	39% E.C.	Organophosphate contact	Chemagro
11	F-6957	2.4%	Pyrethroid	McLaughlin, Gormley, King, Co.
12	Fenitrothion	98% & 98.7%	Organophosphate contact	Sumitomo
13	Fyfanon	95%	Organophosphate	Cheminova
14	Gardona®	94%	Organophosphate contact	Shell
15	Imidan®	12.5% & 11.92 %	Organophosphate contact	(Stauffer) Chipman
16	Isopropylparathion	50%	Organophosphate	Pharacaps Can. Ltd.
17	Lannate®	100%	Carbamate	Dupont

No.	Insecticide	Formulation Stock	Type	Source
18	Lindane	99%	Chlorinated Ayrl hydro-carbon	Hooker
19	Malathion	50%	Aliphatic derivative of phosphorus compounds	
20	Matacil ® (Aminocarb)	34% & 99%	Carbamate	Chemagro
21	Methyl Trithion ®	40%	Aryl derivatives of phosphorus compounds	Stauffer
22	NRDC-119	100%	Pyrethroid	Procida
23	Orthene ®	94%	Organophosphate contact	Chevron
24	PH 60/40	25%	Urea	Philips Duphar
25	Phosphamidon	90%	Aliphatic derivatives of phosphorus compounds	CIBA
26	Phosvel	27%	Organophosphate contact	Velsicol
27	Phoxim	47% & 73%	Organophosphate contact	Chemagro
28	PP484	95%		Chipman Chemicals
29	Propoxur (Baygon)	98%	Organophosphate	Chemagro
30	Pyrocide	20%	Pyrethroid	McLaughlin Gormley, King Co.
31	RH218	88%	Organophosphate	Rohm & Haas
32	RU-11483	100%	Pyrethroid contact	McLaughlin, Gormley, King Co.
33	RU-11679	100%	Pyrethroid contact	McLaughlin, Gormley, King Co.
34	SBP-1382 (Resmethrin)	84.5%	Botanical derivative contact	SB Penick

No.	Insecticide	Formulation Stock	Type	Source
35	Supracide®	40%	Organophosphate contact	Geigy
36	Trithion® 8E	95.4%	Organophosphate	Stauffer
37	Zectran®	93.3 & 90%	Carbamate	Dow

LIST OF INSECTS USED IN 1974

Insect	Area of Origin	Instar Stage	Number Used
	CONTACT TOXICITY		
Black Cutworm	B.C.	V	3360
Blackheaded budworm	B.C.	V	210
Douglas Fir Tussock Moth	B.C.	IV	840
Sitka Spruce Weevil	B.C.	Adult	1470
Blackheaded Jack pine Sawfly	Sault Ste Marie Ontario	V	1680
Larch Sawfly	Ottawa Ontario	IV	3360
Larch Sawfly	Ottawa Ontario	V	840
Spruce Budworm	Laboratory reared	V	3780
Spruce Budworm	Laboratory reared	VI	210
Spruce Budworm	Laboratory reared	Pupae	6090
Spruce Budworm	Ottawa Ontario	V	3780
Spruce Budworm	Ottawa Ontario	VI	3780
White Pine Weevil	Sault Ste Marie Ontario	Adult	3150
Redheaded Pine Sawfly	Que.	IV	1890
Redheaded Pine Sawfly	Que.	V	2730
Swaine Jack Pine Sawfly	Que	V	5460
	STOMACH TOXICITY		
Larch Sawfly	Ottawa Ontario	IV	210
Larch Sawfly	Ottawa Ontario	V	210
Spruce Budworm	Laboratory reared	V	1680
Spruce Budworm	Laboratory reared	VI	420
Spruce Budworm	Ottawa Ontario	V	210
Spruce Budworm	Ottawa Ontario	VI	210

Insect	Area of Origin	Instar Stage	Number Used
COMBINATION CONTACT AND STOMACH TOXICITY			
Larch Sawfly	Ottawa Ontario	IV	210
Larch Sawfly	Ottawa Ontario	V	210
Spruce Budworm	Laboratory reared	V	3360
Spruce Budworm	Laboratory reared	VI	210
Spruce Budworm	Ottawa Ontario	V	630
Spruce Budworm	Ottawa Ontario	VI	420
RESIDUAL TOXICITY			
Spruce Budworm	Ottawa Ontario	V	5400
Blackheaded Jack Pine Sawfly	Ottawa Ontario	IV	1380
Larch Sawfly	Ottawa Ontario	IV	2640

APPENDIX 17

Control Methods Research

Project CC-1

Report to the Canadian Insect Pest Control Forum

by

J. A. Armstrong

Chemical Control Research Institute
Canadian Forestry Service
Environment Canada
Ottawa, Ontario

November 1974

Control Methods Research

Project CC-1

The aerial application of insecticides at night for the control of the spruce budworm using multi-engined aircraft was shown to be feasible. Preliminary analysis of a formulation emitted at a lower than standard volume suggests that the efficiency of the spray operation can be improved in this way.

Orthene applied at 9 ounces per acre in 0.5 gpa was shown to be effective for control of the spruce budworm at PFES.

A mixture of a biological material (B.t.) plus a sublethal amount of Orthene was also shown to be effective for control of the spruce budworm on white spruce.

Ground and aerial application of insecticides for the control of the spruce budworm and white pine weevil in plantations indicated the success of new candidate insecticides and the feasibility of using spray adjuvants to improve the deposit characteristics of the various formulations.

The use of specialized equipment to produce a simulated aerial deposit on individual trees continued to be useful in the screening of candidate insecticides which appeared of promise for the control of forest insect pests.

Studies on the control of the spruce budworm by aerial application of chemicals

(Study ref. No. CC-1-001)

Report to the Canadian Insect Pest Control Forum

by

A. P. Randall

Chemical Control Research Institute
Canadian Forestry Service
Environment Canada
Ottawa, Ontario

November 1974

SUMMARY

(Study Ref. CC-1-001)

Trials were carried out with a DC-6B fitted with a Litton Inertial Guidance system to investigate the possibility of night application of insecticides for control of the spruce budworm. Assessment of the deposit on the target area showed that with an aircraft flying at night at a greater altitude to meet safety requirements a deposit required for budworm control appeared possible. Concurrent with the need to fly at the higher altitude is the need for better observations of meteorological conditions up to spray emission height.

Fenitrothion was applied in oil formulations at an emission rate of 12 fluid ounces per acre. The aircraft was a DC-6B. Preliminary analysis of the data indicates that, providing the spray is applied under suitable meteorological conditions an adequate deposit can be achieved which will provide protection to the trees.

Trials with mixtures of No. 2 and No. 4 fuel oil as the solvent in the fenitrothion: arotex solution were completed which showed that oil solvents other than No. 2 fuel oil could be used. A mixture of No. 2 and No. 4 fuel oil resulted in droplet formation required to meet the needs for budworm control.

Studies on the control of the spruce budworm

by aerial application of chemicals

(Study ref. No. CC-1-001)

by

A. P. Randall

Spray trials to assess new techniques for more efficient application of insecticides were carried out in the Lac des Loups and La Macaza areas of Quebec. All trials were completed with the cooperation of LFRC and the Province of Quebec and Conair Ltd.

1. Night trials

With the aim of extending the number of hours available for spraying the possibility of a night application of insecticide was investigated. The aircraft used was a DC-6B fitted with a Litton Inertial Guidance System. The aircraft flew about 800 feet above ground level at swath intervals of 0.5 miles. Emission rate was 16 fluid ounces per acre of a fenitrothion: arotex: No. 4 fuel oil formulation with the fenitrothion being emitted at 2 ounces AI per acre.

A deposit was recorded for approximately 5.5 miles downwind of the emission run. Analysis of the spray cards by NAE indicated a D max. of 147.5 μ, NMD of 36 μ and MMD of 62 μ. The deposit ranged from 0.2 to 6.9 drops per square centimetre. An observation of meteorological conditions at the time of the spray indicates the need to have good meteorological data from ground height up to the spray height.

Further experimentation is required to check the results of this single trial.

2. Twelve ounce per acre trial

The aim of this series of trials was to determine if the efficiency of a spray operation could be improved by emitting less formulated material (12 ounces/acre rather than 16 oz/acre) yet keeping the amount of insecticide the same (2 oz AI/acre). The criterion of success was to be assessed in terms of population reduction and foliage protection.

Two applications were made again using DC-6B aircraft. The spray formulations were fenitrothion: arotex; No. 2 fuel oil and fenitrothion: arotex; and No. 4 fuel oil. The decision to use No. 4 fuel oil only on one of the trials was necessitated by a shortage of No. 2 oil. The swath interval on both trials was 1/2 mile. The aircraft that emitted the No. 4 oil was not properly calibrated and as a result a coarse spray was produced (No. 4 fuel oil being more dense than No. 2 fuel oil).

The deposit on the No. 2 fuel oil block ranged from 43 to 2 drops per square centimetre while that on the No. 4 fuel oil block was less in terms of drops per square centimetre but with the coarser spray a greater volume of material was applied.

At present only partial analysis of the data has been completed but the data obtained indicate that emission of 12 fluid ounces per acre will provide adequate protection to the forest. Further experimentation is required to confirm this observation.

3. Formulation assessment

Applications were made to assess the possibility of using an oil formulation other than the standard fenitrothion: arotex; No. 2 fuel oil. With availability and lower cost of No. 4 fuel oil a formulation consisting of fenitrothion: arotex; No. 2 fuel oil and No. 4 fuel oil was developed. Two DC-6Bs were used each emitting at 16 fluid ounces per acre. Again the formulations contained 2 ounces AI fenitrothion per acre. Due to assessment problems only partial assessment of the data was possible, however, the use of No. 2 and No. 4 fuel oils together resulted in a good deposit (up to 60 drops per square centimetre) compared with 39 drops per square centimetre for the No. 2 fuel oil formulation. The drop spectrum analysis of the No. 2 + No. 4 fuel oil indicated a D. max of 147 μ NMD of 28 μ and MMD of 57 μ. These values are comparable to those obtained with the No. 2 fuel oil formulation.

This study indicates that a cost saving with no change in spray characteristics can be achieved by the use of No. 2 and No. 4 fuel oil in the fenitrothion: arotex formulation.

A Study of the effect of forest meteorological conditions on spray droplets and an analysis of the spray cloud

(Study ref. No. CC-1-011)

Report to the Canadian Insect Pest Control Forum

by

J. A. Armstrong

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Environment Canada
Ottawa, Ontario

November 1974

SUMMARY

(Study Ref. CC-1-011)

Members of project CC-1-011 were involved in projects to:

A. Assess the efficacy of insecticides for control of the spruce budworm;

B. Assess the effect of insecticides on non-target organisms;

C. Correlate weather conditions with adult budworm flight behaviour and

D. Correlate weather conditions with spray deposit.

These studies were carried out at Petawawa Forest Experiment Station (PFES), LaRose Forest and in New Brunswick.

Results

A. 1 - The results of the Orthene applications at PFES showed that effective control of the spruce budworm on white spruce was possible with the application of a total of 9 oz AI/acre of Orthene® at an emission rate of 0.5 gallons (US) per acre.

2 - The application of Bacillus thuringiensis plus a sublethal amount of Orthene provided good control of the spruce budworm on white spruce (see report by Morris, CC-1-019).

B. - Fenitrothion and Matacil applications at LaRose Forest were applied under good weather conditions (see report by Buckner, CC-3-014).

C. - During the course of the adult budworm study in N.B. observations were made on the effect of weather systems on flying budworm adults to produce concentrations of insects.

D. - The correlation of meteorological conditions with spray deposit is producing data to enable limits to be set on the suitability of spray conditions when different solvent systems are used.

A Study of the effect of forest meteorological conditions on spray droplets and an analysis of the spray cloud

(Study ref. No. CC-1-011)

by

J. A. Armstrong

This section was involved in a project to assess the efficacy of a new insecticide, Orthene®, which had been shown in laboratory and small scale field applications to have promise as a good material for the control of the spruce budworm. Assistance was given to studies on the aerial application of Bacillus thuringiensis alone and Bacillus thuringiensis plus sub-lethal amounts of Orthene at Petawawa Forest Experiment Station in the formulation of material and control of the applications. The members of the section were also involved in the formulation and control of the aerial applications of fenitrothion and Matacil on study blocks in the LaRose Forest. Adult budworm flight studies were continued in New Brunswick in cooperation with MFRC, CIBA-Geigy Ltd., and AES with CCRI providing meteorological equipment to measure climatological conditions in and just above the forest canopy. Studies on the effect of meteorological conditions on spray drift and deposit were continued in LaRose Forest with the CCRI aircraft being used to apply the sprays.

A. The efficacy of insecticides for control of the spruce budworm.

Two main projects were carried out using chemical and biological insecticides in an attempt to solve the recurrent problem of spruce budworm infestations on white spruce and balsam fir.

I. Orthene® trials

Studies by Nigam (CC-2-006), Hopewell (CC-1-022) and DeBoo (CC-1-012) showed that Orthene was effective against the spruce budworm. At PFES Orthene was applied, using aircraft fitted with Micronairs, to plantations at emitted dosages of 3, 6, 9 oz AI/acre. The insecticide was formulated in a 10% glycol:water preparation and applied at rates of 0.25, 0.5 and 1.0 gallons (US) per acre. The sprays were assessed in terms of population reduction and percentage defoliation of the host trees. Spray deposit analysis was completed by W.W. Hopewell (CCRI) and E. Slack (NAE). The results of the sprays are shown in Table I.

The studies showed that good protection can be provided to white spruce with the application of a water formulation of Orthene in 0.5 gallons per acre to give total deposits of 4 - 6 ounces of Orthene per acre. Emission rates of less than 0.5 gallons per acre per application, even with the higher amount of insecticide, did not provide protection to white spruce.

II. Bacillus thuringiensis applications.

These applications were completed in cooperation with O.N. Morris (report CC-1-019). *Bacillus thuringiensis* plus a sublethal amount of Orthene was applied to three plots at emission rates of 0.75 gallons (US) per acre to give emitted concentrations of 4, 8, and 12 BIU/acre. All sprays were carried out under good to very good spray conditions [stability ratios from + 0.12 (neutral) to + 23.6 (very stable)]. A short rain shower at the time of the last application resulted in a poor deposit. A detailed report of this application is given by Morris. B.t. alone was also applied to a plot at PFES.

B. The effect of insecticides on non-target organisms

This project is under the direction of C.H. Buckner (project CC-3-014); the role of project CC-1-011 was to check calibration of the spray aircraft, determine suitability of spray conditions, monitor weather conditions during the time of spray application, and formulate the spray preparations. Matacil and fenitrothion were applied to spray blocks in LaRose forest. Sprays were applied under conditions ranging from neutral to very stable.

C. Correlation of weather conditions with adult budworm flight behaviour.

The meteorological sensing and recording equipment was set up in the study area near Chipman New Brunswick. Data was collected for the time period 5-18 July with analysis completed at the site using an on-line computer. This project is under the direction of MFRC with general compilation and correlation being their responsibility. The CCRI aircraft CF-BZA also took an active role in the 1974 project collecting flying moths.

D. Studies to correlate weather conditions with spray deposit.

In 1973 a study was initiated in LaRose forest to assess the effect of meteorological conditions within and above the forest canopy on spray deposit. The non-insecticidal formulations were applied by the institute aircraft. Analysis of the deposit was completed by members of CCRI (chemical and colorimetric) and NAE (droplet analysis). The studies completed in 1973 showed that with an oil spray a good deposit can be achieved under stable weather conditions with winds less than 8 mph and a relative humidity of at least 60-70 per cent. Examination of the deposits on sample cards showed the effect of trees near the cards and the necessity of the cards being placed in a large clearing. Work with the chemistry section (project CC-3-009) provided information on the spray coverage of white spruce and penetration of the spray cloud within the tree crown. This work is being continued with water and water plus glycol sprays. Information is being collected which indicates the percentage of an anti-evaporant which must be added to a water-base spray to ensure adequate deposit under operational and experimental conditions. Colorimetric analysis of the deposits correlated with a deposit calculated from the volumes of droplets on the sample cards was found to give misleading results. As the water evaporated the relative concentration of the dye increased and if this change was not taken into account the colorimetric analysis suggested a greater deposit than actually occurred.

Plot.	Spray emitted per Application		No. of Appl'ns	Total emitted	Actual Deposit	Spray Dep. Drops/cm^2	Corrected % Population reduction		% Defoliation	
	oz AI/ac.	gpa		oz AI/ac.	oz AI/ac.	(Total)	Bf	Ws	Bf	Ws
A	3	1.0	1	3.0	2.13	> 100*	71	0	8.2	43.8
B	3	1.0	2	6.0	1.56	> 86.3	0	0	26.6	55.9
D	3	1.0	3	9.0	3.76	> 135.4	100	55	7.3	16.7
E	3	0.50	1	3.0	3.0	52.8	87	70	28.4	32.8
F	3	0.50	2	6.0	3.22	42.5	85	41	25.9	62.4
G	3	0.50	3	9.0	5.96	> 76.1	100	75	2.7	4.1
H	3	0.25	1	3.0	0.40	> 25.6	0	0	32.8	58.9
J	3	0.25	2	6.0	0.68	> 38.8	89	0	31.2	65.5
K	3	0.25	3	9.0	2.76	55.6	69	0	28.1	48.6
42	9	0.50	1	9.0	0.48	14.1	-	27	-	-
126	9	1.0	1	9.0	0.36	3.8	-	30	-	-
101	6	0.5	1	6.0	0.25	13.0	-	0	-	-
Untreated	0	0	0	0	0	0	-	-	32.9	65.4

* Where more than the number of drops is indicated (i.e. > 100) some of the spray cards in the sample had a deposit such that it was impossible to count the number of drops / cm^2; in these cases the drops density was determined from the cards that could be counted and the deposit was then indicated as more than this number.

Plantation Pest Control Research

(Study Ref. CC-1-012)

Report to the Canadian Insect Pest Control Forum

by

R.F. DeBoo

Chemical Control Research Institute
Canadian Forestry Service
Environment Canada
Ottawa, Ontario.

November 1974

Plantation Pest Control Research: Spruce Budworm

(Study Ref. CC-1-012)

by R.F. DeBoo

I. Experimental Mistblower Applications of *Bacillus thuringiensis*, B.t. + chemical combinations, and chemical insecticides, Grand'Mère Plantations, Quebec.

A total of 15 spray treatments were applied by mistblower (John Bean Rotomist 100) to white spruce trees (25 to 70 ft. tall) during the period June 4-12. The spray study was designed to evaluate the effectiveness of insecticides for potential registration against spruce budworm (Study CC-1-025).

Results of larval population sampling and estimates of foliage protection indicated that all chemical sprays (Orthene®, carbaryl, methomyl, phoxim) applied at aircraft dosages (a.i.) were highly effective in preventing budworm damage. Very similar protection levels were attained when small quantities of chemical insecticides were added to commercial preparations of B.t. (Dipel®, Thuricide 16B® @ 4 BIU/acre, each). Applications of B.t. alone vs. L_3 (at dosages to 8 BIU/acre), however, did not induce foliage protection levels much different from defoliation levels observed in the untreated check areas.

The major implication of the Grand'Mère sprays confirms previous results of B.t. spray experimentation (CFS Inf. Rept. CC-X-59): a spray additive appears necessary to enhance efficacy of this microbial insecticide for operational use. The addition of sublethal dosages of conventional chemical insecticides to stress larval populations is apparent to us as the most practical avenue to the successful recommendation of B.t. for control of spruce budworm in Canada.

II. Experimental Aerial Applications of Carbaryl (Sevin-4-Oil®), Shawville, Quebec.

Two white spruce plantation blocks (25 ft. trees) totalling 34 acres in size having moderate infestations of the budworm were sprayed with Sevin-4-Oil on June 3 (a.m.) as follow-up replication of the trial in Manitoba during 1973. Applications were made by CCRI's Cessna 185 equipped with 4 Micronair AU3000 spray atomizers at 7.8 oz. a.i. carbaryl/acre, a dosage lower than that recommended for gypsy moth control. Spray emission rate, however, was at 20 oz./acre (16 oz. Sevin-4-Oil, 4 oz. no. 2 fuel oil) vs the 40 oz. (containing 16 oz. a.i.)/acre used in Manitoba. Spruce budworm population density at Shawville was estimated at 30/18 in. branch tip one day prior to treatment. Larval development on June 3 was 60% L_4 and 35% L_3.

Results of the Shawville trial indicated, once again, that carbaryl is an effective insecticide for control of spruce budworm larvae. Corrected larval mortality five days after spray was 25-67%, with defoliation limited to 11% of the new growth vs. 34% in the untreated check areas. Higher volume sprays containing approximately 8 oz. a.i. of carbaryl undoubtedly would have provided greater penetration of tree crowns resulting in higher larval mortality and foliage protection. Similarly, sprays applied 3 to 5 days later (vs peak L_4 larvae) most probably would have provided superior control levels.

Experimental Applications of Insecticides for Control of Spruce Budworm on White Spruce, Grand'Mère Plantations, Quebec, 1974. (Roadside sprays by mistblower, approx. 15 gal. aqueous spray mix/acre, 16 ac./treatment = 1 mile of roadside; 6 larval population samples -2 prespray, 4 postspray; defoliation estimates based on 1000 shoot samples randomly selected from 20 mid-crown branches/treatment plot).

Treatment	Amount a.i./Acre	Date Sprayed (JUNE)	Larval Development at Spray Date	Larval Population Density 1 Day Prespray (No./18 in. branch)	Larval Mortality 10 Days Postspray (%)	Percent Defoliation
Dipel WP	4BIU	6	63% L_3	50	0	49
Dipel WP	6BIU	6	63% L_3	67	21	20
Dipel WP	8BIU	6	63% L_3	56	14	40
Thuricide 16B	4BIU	5	68% L_3	50	8	47
Thuricide 16B	6BIU	5	68% L_3	73	31	64
Thuricide 16B	8BIU	4	68% L_3	88	50	35
Thuricide + carbaryl	4BIU + 2 oz.	7	50% L_3; 40% L_4	51	56	25
Thuricide + methomyl	4BIU + 1.5 oz.	7	" "	42	45	23
Thuricide + Orthene	4BIU + 2 oz.	7	" "	27	43	12
ABC 6007	Confidential	7	" "	33	34	25
Dipel + Fundal	4BIU + 4 oz.	6	63% L_3	40	29	20
Orthene 90WP	8 oz.	12	83% L_4	47	98	6
Carbaryl (Sevin 80S)	10 oz.	9	76% L_4	37	89	13
Methomyl (Lannate 20L)	4 oz.	10	75% L_4	42	85	11
Phoxim (Volaton 47SC)	4 oz.	10	75% L_4	55	79	8
Untreated check 1	-	-	-	-	-	61
Untreated check 2	-	-	-	-	-	42
Untreated check 3	-	-	-	-	-	60
Untreated check 4 (water)	-	-	-	-	-	57
Untreated check 5 (water)	-	8	-	-	-	29

R.F. DeBoo, CCRI
Sept./74

Plantation Pest Control Research

(Study ref. No. CC-1-012)

Report to the Canadian Insect Pest Control Forum

by

R. F. DeBoo

Chemical Control Research Institute
Canadian Forestry Service
Environment Canada
Ottawa, Ontario

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Plantation Pest Control Research: White Pine Weevil

(Study Ref. CC-1-012)

by R.F. DeBoo

Experimental aerial applications of insecticides for control of white pine weevil (Pissodes strobi) infesting pine plantations were conducted for the third consecutive year in Ontario during 1974. The project was sponsored jointly by the CFS and the Ontario Ministry of Natural Resources to determine effective treatments for preventing weevil injury in valuable white pine stands.

Areas selected for treatment were located within the Simcoe County Forest north of Barrie, within the National Capital Commission Greenbelt Forest and the Torbolton Township Forest near Ottawa, and at the Kirkwood Forest Management Unit north of Thessalon. A total of 1394 acres were sprayed using a variety of aircraft (AgCat, Agtruck, Cessna 185, Stearman) equipped with Micronair AU2000 and AU3000 atomizers. Treatments were primarily methoxychlor at 2 or 2.5 lb. a.i. in either 2 or 4 U.S. gal. No. 2 fuel oil per acre. Two plantations (108 acres) were sprayed with carbaryl (Sevin-4-Oil®) at 1 lb. a.i. in 1 U.S. gal. oil per acre. All sprays were timed to prevent adult oviposition: April 28 to May 3 in Simcoe Co., April 28 to 30 in the Ottawa Valley, and on May 8 and 9 at Kirkwood.

Results have not yet been completely analysed due partly to a breakdown of NRC's computerized flying spot scanner used for spray deposit data computation this year. Similarly, reports of low potency of the methoxychlor formulations have not been verified by appropriate bioassay. Accordingly, the unsatisfactory protection levels achieved after treatments cannot be explained at this time. Timing of sprays was similar to other years although a very significant weevil population increase (ranging from 5 to 267% over levels in 1973) was observed in all untreated areas visited. This increase in density might have accounted for the deviations in results from previous years (CFS Inf. Repts. CC-X-25, CC-X-68). Although weeviled-leader incidence was reduced to 6% or less after treatment with methoxychlor in 13 of 19 plantations, the reduction in leader attack from 1973 to 1974 averaged only 54%. Results for the lower volume carbaryl sprays were quite similar. A detailed report is in preparation.

Summary of Results of Aerial Application of Insecticides for Control of White Pine Weevil in Ontario, 1974

Treatment	Location	No. Acres	Leader Injury by White Pine Weevil: 1973 No.Weeviled/No.Examined	1973 %	1974 No.Weeviled/No.Examined	1974 %	Change Between Years(%)
Methoxychlor 2 lb @ 4 gpa	Simcoe Co.	685	1683/13526	12	759/15273	5	-58
Methoxychlor 2.5lb @ 4gpa	Ottawa Valley	161	827/6524	13	396/5839	7	-46
Methoxychlor 2 lb @ 2 gpa	Kirkwood	440	394/2979	14	464/6705	7	-50
Methoxychlor	All	1286	2904/23039	13	1619/27817	6	-54 [a]
Carbaryl 1 lb in 1 gpa	Simcoe Co.	90	336/1550	22	149/1551	10	-55
Carbaryl 1 lb in 1 gpa	Ottawa Valley	18	405/1303	31	189/1087	17	-45
Carbaryl	All	108	741/2853	26	338/2638	13	-50
Untreated Check	Simcoe Co.	75	541/3057	18	801/3110	26	+44
Untreated Check	Ottawa Valley	183	87/5123	2	133/4753	3	+50
Untreated Check	Kirkwood	209	209/2100	10	340/2413	14	+40
Untreated Check	All	467	837/10280	8	1274/10276	12	+50 [b]

a - Range = 0 to 87% reduction due to treatment.

b - Range = 5 to 267% increase in leader injury 1973 to 1974

Aerial Application of *Bacillus thuringiensis* Orthene Combinations against the Spruce Budworm, *Choristoneura fumiferana* (Clem.) at Petawawa Forest Experiment Station

(Study Ref. CC-1-019)

Report to the Canadian Insect Pest Control Forum

by

O.N. Morris and J.A. Armstrong

Chemical Control Research Institute
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Environment Canada
Ottawa, Ontario.

November 1974

SUMMARY

(Study Ref. CC-1-019)

A mixture of Dipel WP and a sublethal dosage of Orthene® was applied to plantations at PFES. Three treatments, at the rates of 12 BIU B.t. + 0.9 oz Orthene, 8 BIU B.t. + 0.6 oz Orthene and 4 BIU + 0.3 oz Orthene per acre were made. A separate plot was treated with 8 BIU B.t. alone and studies of the effects of Orthene alone were made on the plots treated with this material (see report CC-1-011 by Armstrong). The materials were applied when the larvae were in the L_2 and L_3 stage of development.

The spray treatments were assessed in terms of population reduction, protection against defoliation, moth emergence, oviposition and the effects on the parasitism of the target insect.

The results indicate that effective protection in terms of population reduction can be provided for balsam fir, but not white spruce with the application of 8 BIU B.t. + 0.6 oz Orthene. This treatment provided effective protection on both host tree types in terms of decreased defoliation. Orthene at 0.9 oz per acre affected larval parasites. The other treatments did not affect the larval, pupal or egg parasites.

Reassessment of the plots treated with B.t. - fenitrothion in 1973 showed a significant reduction in defoliation on both tree types compared with the untreated check or B.t.-alone treatments indicating a carryover effect of the combination treatment.

Aerial Application of *Bacillus thuringiensis* Orthene Combinations against the Spruce Budworm, *Choristoneura fumiferana* (Clem.) at Petawawa Forest Experiment Station.

(Study Ref. CC-1-019)

by O.N. Morris and J.A. Armstrong

Prepared for the Canadian Forest Pest Control Forum

In 1974, mixtures of a commercial formulation of *Bacillus thuringiensis* (B.t.) + low concentrations of Orthene®, an organophosphate insecticide, were aerially applied to white spruce and balsam fir trees infested with 2nd to 4th instar spruce budworm. Pre-spray population densities ranged from 10.4 to 28.3 on treated white spruce and from 5.5 to 10.5 larvae per 18" branch tip on treated balsam fir. White spruce and balsam fir on the check plot had 11.8 and 34.4 larvae per branch tip, respectively.

Twenty-five white spruce (Ws) or 25 Ws and 25 balsam fir (Bf) were selected in each plot for periodic assessment of the efficacy of the treatments. The suitability of spray conditions was determined using wind speed and wind direction sensors mounted on a 97 ft. tower and temperature differential sensors were mounted on the Branstead tower at the station. Dry bulb temperatures and relative humidities were recorded with standard recording units at the Branstead site. The criteria for suitability of spray conditions were wind speed less than 8 mph and temperature differentials indicating inversion conditions to give a positive stability ratio. Weather conditions were measured for a period of 40 min. after applications to give an indication of the conditions during the time that the spray cloud was settling.

The sprays were applied during the mornings and evenings of May 25 to June 3 using a Cessna Agtruck aircraft fitted with 4 AU 3000 Micronair emission units calibrated to deliver droplets in the 50 to 100 micron range. The swaths were about 200 ft. with the planes flying 200 ft. above the tree tops. Larvae were mainly L_2 (second instar) at the start and mainly L_3 at the end of the spray period.

The commercial B.t. used was Dipel WP (Abbott Laboratories, North Chicago, Illinois) with a potency of 16000 International Units (IU) of activity/mg and 25 billion viable spores/gm. Deposits were assessed using Kromekote cards, glass plates and Millipore filter membranes.

Deposit units were collected 20-30 min. after spray. The Kromekote cards were analysed for droplet size and density. Volume deposits on the glass slides were estimated by fluorometric analysis of the tracer dye (Erio Acid Red) and deposits of the viable spores were estimated by counting the number of bacterial colonies developing on the Millipore filter membranes which had been placed on typticase soy agar media for 24 hours at 29°C.

Two 18 inch branch tips were collected from the top third of each sample tree on May 17-20 (pre-spray), June 17-18 and June 25-26. The number of dead and live insects taken from the foliage were recorded for each sample period to determine the effects of the treatments on larval survival and parasitism. Dead insects were diagnosed for the presence of *B. thuringiensis* and other pathogens using phase contrast optics or stained smears.

At the completion of pupation in the field, 200 male and 200 female pupae were collected from each plot for moth emergence and parasitism studies. Defoliation and oviposition assessments were conducted at the end of the field season.

The results summarized in Table 1 indicated that the 8 BIU B.t. + 0.6 oz Orthene treatment was effective in reducing budworm population on balsam fir but not on white spruce. However, this treatment afforded acceptable protection of both tree species from excessive defoliation. Both the 8 BIU and 12 BIU treatments caused substantial reductions in pupal weight and rate of moth emergence. The Orthene applied at 0.9 oz per acre apparently caused substantial mortality among larval parasites but none of the other treatments affected larval, pupal or egg parasitism.

A reassessment of the plots treated with B.t. - fenitrothion combination in 1973 showed that defoliation of current growth on both white spruce and balsam fir was significantly lower than on the untreated check plot or on B.t. alone plot. This indicates a prolonged effect of the combination treatment, an important consideration in the use of the integrated control approach to pest management.

Table 1

Summary of Results of *Bacillus thuringiensis* - Orthene Aerial Trials
Against Spruce Budworm, PFES 1974

Treatments Applied/A	Plot Size (Acres)	International Units of B.t./A Deposited (Billions)	Drops/cm^2	No. Viable Spores/A Deposited X 10^9	Corrected[1] % Population Reduction		% Current Growth Defoliation		Average Pupal Wts (mg)	%[2] Moth Emergence	No. Viable[3] Egg Mass/ 100 sq.ft. Foliage	% Parasitism		
					Ws	Bf	Ws	Bf				Larvae	Pupae	Eggs
12 BIU + 0.9 oz Orthene	230	3.67	12.4	3.04	13.6	-	62.6	-	88±1	31	163	0.6	3.3	50.8
8 BIU + 0.6 oz Orthene	267	2.29	15.9	4.09	0	78.0	45.1[ab]	18.8[ab]	104±6	49	132	3.1	4.3	69.4
8 BIU alone	100	1.0	11.7	2.90	0	27.9	52.4[ab]	27.7[ab]	108±2	71	204	2.2	4.8	49.7
4 BIU + 0.3 oz Orthene	260	0.75	20.0	1.41	0	-	54.5[b]	-	99±8	80	237	2.8	4.5	46.2
Untreated Check	100	-	-	-	(58.7)	(40.7)	65.4	32.9	107±1	78	262	1.5	4.5	51.1

[1]Corrected by Abbott's formula

[2]Based on 200 males and 200 females reared in the laboratory

[3]Egg mass survey at end of test

[a]indicates significant differences at 99% level of confidence between B.t. treatments - with and without orthene; [b]indicates significant differences at 99% level of confidence between treated and untreated check (t-test).

Field tests of Orthene and Phoxim vs. Fenitrothion for Spruce budworm control when applied as simulated aircraft spray - Shawville - 1974

(Study Ref. CC-1-022)

Report to the Canadian Insect Pest Control Forum

by

W.W. Hopewell

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November 1974

SUMMARY

(Study Ref. CC-1-022)

Laboratory tests by Nigam (1972) and field testing by Nigam and Hopewell (1973), Hopewell and Nigam (1974), using simulated aerial spray deposit on individual spruce trees with a natural infestation of spruce budworm have shown Orthene® to have high potential for large scale use in budworm control. Preliminary field testing in 1973 showed Orthene to be at least as effective as fenitrothion: more intensive testing in 1974 confirmed these results and showed its many desirable properties for large scale use. Orthene is water soluble; fast acting in effect on all instar stages of the budworm; of low toxicity to birds, mammals and fish; non-persistent; registered for use in control of many common agricultural pests.

Field tests of Orthene and Phoxim vs. Fenitrothion

for Spruce budworm control when applied as simulated

aircraft spray - Shawville - 1974

(Study Ref. CC-1-022)

by

W.W. Hopewell

Ten spray treatments each replicated 6 times, were applied to individual spruce trees 8 to 10 ft. in height, in the form of a simulated aerial spray deposit. Applications were made on 5, 6 and 7 June when larval development was predominantly L_4 and L_5. All materials were made up to contain 10% active ingredient; there were 3 treatments using Orthene, i.e., nominal application rates of 4, 6 and 9 oz a.i./acre; 4 treatments using Phoxim (1) in summer oil (2) corn oil, (3) oil + 1% ultraviolet inhibitor, (4) oil + 5% μv inhibitor; 3 treatments using fenitrothion (1) emulsion (2) oil solution and (3) oil + 1% spreader-sticker. Samples of deposit were taken at 4 points for each test. Larval counts were taken 7 days postspray and check of defoliation on all test trees in October, 1974.

Results are summarized in Table 1. Orthene gave greatest population reductions of 87 and 96% at average deposits of 4.4 and 5.9 oz a.i./acre resp., and the best foliage protection with ca 4% defoliation compared with 24% on check trees and 9% on fenitrothion treatments. Phoxim gave some protection but did not surpass fenitrothion. Addition of ultra violet inhibitor appeared to reduce effectiveness of Phoxim. Addition of a sticker-spreader to fenitrothion oil formulation showed no significant improvement.

TABLE 1

Summary of Results of Simulated Aerial Spray

Applied to White Spruce for Budworm Control - Shawville 1974

(Ave. for 6 trees each treatment - 15 check trees)

Treatment	Deposit		Population Reduction* (% Control)	% Defoliation	% in stage**		
	Fl oz/ac	drops/cm^2			L_4	L_5	L_6
Phoxim (oil)	57	43	50	6	10	45	45
Phoxim (corn oil)	53	46	56	9	10	49	41
Phoxim (oil + 1% UVI)	54	35	22	18	6	37	57
Phoxim (oil + 5% UVI)	50	40	39	12	8	38	54
Fenitrothion (emulsion)	26	51	67	9	8	48	44
Fenitrothion (oil)	49	37	57	8	5	50	45
Fenitrothion (oil + 526)	40	37	59	10	4	37	59
Orthene (light) 4 oz	44	27	87	5	4	48	48
Orthene Med. (6 oz.)	59	33	96	3	0	67	33
Orthene (9 oz.) Heavy	90	35	95	5	0	89	11
Checks	0	0	0	24	5	31	64

** Development class of survivors at spray + 7 days.

* Calculated from average number of larvae per 45 cm branch on treated trees compared with 7.8 per branch on checks.

Experimental field trials using *Bacillus thuringiensis* and some insect growth regulators against the spruce budworm [Manitoulin Island in July, 1974].

A series of field tests were conducted during the summer of 1974 at Manitoulin Island to evaluate the efficacy of preparations of certain insect growth regulators, *Bacillus thuringiensis* and a combination of both in controlling infestations of the spruce budworm, *Choristoneura fumiferana*.

Two types of insect growth regulators were tested against the spruce budworm. (1) Juvenile hormone analogs application of which at the last larval instar results in larval-pupal mosaics that for the most part fail to complete their metamorphosis. Two analogs, RO-10-3108 (Hoffmann La Roche, Basle, Switzerland) and ZR-515 (Zoecon Corporation, California, U.S.A.) were used in the field testing.

(2) PH 60-40 (Philips Duphar, Amsterdam, Netherlands) which when ingested interferes with the normal development of the endocuticle by inhibiting chitin biosynthesis.

The potential use of a combination of *Bacillus thuringiensis* and a growth regulator was investigated. Preliminary testing indicated a low dose of each in combination to be more effective than a low dose of each by itself. An application of Thuricide 16B especially formulated for forestry use was also applied principally for comparative purposes.

Experimental Plan

All materials were available as emulsifiable formulations excepting PH 60-40 which came as a wettable powder. Rhodamine-B solution (DuPont) was added to give a final concentration of 0.1% in the spray mixture. A Grumman AgCat equipped with two micronaire systems was used for the spray operation. The aircraft was calibrated to deliver approximately 1 gallon (U.S.)/acre.

The instar distribution of spruce budworm was monitored to find the right stage for spraying. When peak 5ths were reached the materials were sprayed. B.t. (6 B.I.U.) was sprayed when most of the larvae were at 4th instar stages. Five controls plots in different areas were selected for comparison.

Pre-spray sampling was done a day before spraying by cutting 18" branch tips at mid-crown level and counting the larvae. Post-spray sampling was done when about 10% of the insects reached pupal stage. Additional samples were collected 5, 12, 17 and 22 days after spraying and reared in the laboratory to determine the effects of the growth regulator tested.

Results

The results are summarized in Table 1.

TABLE 1

Compound	Plot	Host	% Population Reduction	% 1974 Defoliation	% Successful Emergence
Bacillus thuringiensis 6 B.I.U.	I	bf**	55	23	51
	Check	bf		27	59
	I	ws**	0	42	67
	Check	ws		51	82
ZR-515/3 oz. with *B.t.*/3 B.I.U.	K	bf	33	52	63
	Check	bf		49	85
	K	ws	0	61	93
	Check	ws		56	88
Bacillus thuringiensis 3 B.I.U.	L	bf	44	76	46
	Check	bf		66	62
	L	ws	0	86	64
	Check	ws		69	68
ZR-515 5 oz.	M	bf	0	83	84
	Check	bf		49	85
	M	ws	0	46	87
	Check	ws		60	86
PH 60-40 5 oz.	N	bf	92	59	19
	Check	bf		32	73
	N	ws	23	55	59
	Check	ws		67	80
RO-10-3108 5 oz.	O	bf	19	90	80
	Check	bf		49	82
	O	ws		83	93
	Check	ws		83	91
RO-10-3108 3 oz.	P	bf	0	75	88
	Check	bf		49	82
	P	ws	0	80	97
	Check	ws		60	86
ZR-515 3 oz.	R	bf	20	67	86
	Check	bf		49	82
	R	ws	0	65	93
	Check	ws		51	92

* - bf - balsam fir
** - ws - white spruce

Conclusions

1. PH 60-40 at 5 oz./acre on balsam fir had the best effect. A population reduction of 92% was obtained.
2. Bacillus thuringiensis (6 B.I.U.) was not very effective presumably because of a heavy rain 12 hours after spraying. Greenhouse tests have shown that a better sticker may be necessary.
3. The survival rates on white spruce controls were very low for reasons that are not obvious. Therefore the results on white spruce are deemed inconclusive.
4. ZR-515 and RO-10-3108 did not work as well as expected. A higher dose is warranted.

Recommendations

Additional field trials should be carried out in the summer of 1975.

1. Two plots, 200 acres each for the testing of PH 60-40 at doses of 5 oz. and 3 oz./gal.
2. One plot of 200 acres to test a new analog that is presently being greenhouse tested.

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Prepared for Canadian
Insect Pest Forum - 1974.

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Experimental field trials using *Bacillus thuringiensis* and some insect growth regulators against the spruce budworm [Manitoulin Island in July, 1974]

Summary

A series of field tests were conducted during the summer of 1974 at Manitoulin Island to evaluate the efficacy of preparations of certain insect growth regulators, *Bacillus thuringiensis* and a combination of both in controlling infestations of the spruce budworm, *Choristoneura fumiferana*.

Various insect growth regulators were tested against the spruce budworm and these included: RO-10-3108 (Hoffmann LaRoche, Basle, Switzerland); ZR-515 (Zoecon Corp. Calif. U.S.A.); and PH-60-40 (Phillips Duphar, Amsterdam, Netherlands). A *Bacillus thuringiensis* preparation (Sandoz-WAnder Corp., Homestead, Florida U.S.A.) was also tested, alone and with ZR-515.

PH 60-40 at 5 oz/acre on balsam fir reduced population by 92%. ZR-515 and RO-10-3108 did not work as well as expected and higher dosages seem indicated.

The *Bacillus thuringiensis* preparation at 6 BIU/acre was not very effective. It felt that a more effective sticker should be included in the preparation tested.

Experimental spraying of spruce budworm
with nuclear polyhedrosis virus (NPV)
1974

Virus spray trials have now been conducted for four consecutive years. The Insect Pathology Research Institute has been responsible for the production of virus and, with the exception of the 1971 trials, with its dissemination and an evaluation of the level of infection in the population. Staff of the Great Lakes Forest Research Centre have been responsible for estimates of population reduction due to the virus treatment and estimates of foliage protection. Methods of virus production and dosages have now been well established but the optimal timing of the application has not yet been established for balsam fir. In mixed stands where both white spruce and balsam fir are represented, early applications of virus on second and third instar larvae give a good level of virus infection in larvae on white spruce but poor on balsam fir. Later applications on fourth and fifth instar are moderately effective on larvae feeding on both species of trees but higher levels of infection still occur in larvae on the white spruce.

It has been established that NPV is transmitted from one year to the next and gives biological control in the true sense of the word. It is suggested that the mode of transmission is by foliage contamination. Virus-killed larvae, webbed-up in nests, remain over the winter months on the trees and infectious virus is probably washed over the foliage by rain in the spring and summer.

Small plots were sprayed in 1971 and 1973. In 1972 large areas were sprayed but the operation was nullified due to a late frost which killed many budworm larvae and the current year's foliage. When studying virus epizootics over several years after the initial application it is desirable to have as large a plot as is practicable so as to avoid "fill in" of moths from nearby unsprayed areas.

Trials on Manitoulin Island, Ontario, 1974

A two-square mile block was selected on Manitoulin Island in Robinson Twp. The stand was composed of about 60% balsam fir (30-40 ft.), 20% poplar (30-40 ft) 10% white spruce, 5% white birch and a variety of species in the remaining 5%. The hardwoods did not form an overstory. Budworm feeding on balsam fir were the principal target because of the composition of the stand. The development of the buds was closely watched and spraying commenced when the balsam fir buds were fully expanded and starting to flush open. The white spruce buds were still capped and the budworm larvae were mainly in the fourth instar.

Virus was suspended in water and 2.5% IMC "Shade"® added to act as a marker and protect the virus from UV inactivation. Chevon® sticker was also added at a concentration of 1 pint per 100 gallons. A Gruman Agcat fitted with Micronair spray equipment was used for the application, the emission rate was 1 U.S. gal/acre and the dosage 100×10^9 polyhedra/acre. Spraying commenced in the evening of June 12th and finished on the morning of June 14th.

On June 14th, a 15 acre white spruce plantation in Dawson Twp. was also sprayed with the same virus formulation. A similar 15 acre plantation was left unsprayed as a control; bud development and insect development were further advanced than on the large plot. The spruce buds had all shed their caps and there were about equal numbers of fourth and fifth instar larvae.

The resulting levels of virus infection reached 19% in larvae on balsam fir and 12% on the white spruce in the large plot. In the white spruce plantation 15% of the larvae were infected. Mortality and defoliation data is reported by Dr. G. M. Howse of GLFRC. It has been accepted that virus spray trials must be evaluated on a long term basis and these levels of infection are considered satisfactory for an initial introduction. These plots will be studied for the next few years.

Follow up of trials conducted in 1971 and 1973

NPV was found in two white spruce plots near Petawawa, Ontario sprayed in 1971 with 6% virus-infected budworm larvae in each. In plots sprayed with entomopoxvirus (EPV) in 1971 in the same general area, very low levels of virus (up to 2% infected larvae) were found except in one plot. It was sprayed when larva were in the fourth instar with an EPV suspension which had an NPV contaminant. Here 2.5% NPV infected larvae were found on balsam fir and 10.5% on white spruce. The level of virus in the white spruce plantations has gradually declined since 1971 but these plots have not been as seriously defoliated as nearby control areas.

In 1973 a series of small plots were sprayed near Massey, Ontario and another series near Mashigama Lake and Aubrey Falls, Ontario. Generally, levels of virus infection were low in 1974 and it is possible that there was "fill in" from surrounding unsprayed areas heavily infested with spruce budworm. At Massey levels of NPV-infection ranged from 1.5% infected larvae on balsam fir to 3.5% on white spruce. At Aubrey Falls two plots were examined and 2% and 3% NPV infected larvae were found on balsam fir and 3% and 6% on white spruce. Similar levels of infection were recorded in a control between the two plots and this may be due to spray drift, spread of the virus or natural virus in the population.

Plans for 1975

In 1975, it is intended to continue spray operations with NPV on Manitoulin Island, Ontario in the same area as in 1974 and extend the size of the two sq. mile test plot by a further 2 to 3 sq. miles. Virus is currently being produced for this operation.

Monitoring of the impact of the virus will continue in several of the plots sprayed in the last four years.

Prepared for Canadian
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October 31, 1974.

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Experimental spraying of spruce budworm
with nuclear polyhedrosis virus (NPV)
1974

Summary

Two square miles of spruce budworm infested forest on Manitoulin Island, Ontario in which the predominant tree species was balsam fir were sprayed with NPV. A concentration of 100×10^9 polyhedra/acre at 1 g.p.a. was sprayed when larvae were at the peak of the fourth instar and the buds were well expanded on balsam fir. The aqueous formulation contained 2.5% IMC "Shade"® and 0.13% Chevon® sticker. The level of virus infection recorded following the spray was 19% in larvae on balsam fir and 12% in larvae on white spruce. A white spruce plantation of 15 acres was sprayed at the same time but the larvae were more advanced, with about equal numbers of fourth and fifth instar. A similar plantation was kept as a control. The level of virus infection was recorded as 15% of the larvae. Both these trials were performed to study the virus on a long term basis.

Virus was recovered from plots sprayed in 1971 and 1973 and it is still having some impact on the spruce budworm population.

APPENDIX 20

Assessment of Experimental Aerial Spraying for Control of Spruce Budworm in Ontario, 1974

by

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Report prepared for the Canadian Forest Pest Control Forum
Ottawa, November 19, 1974

INTRODUCTION

During 1974, the Great Lakes Forest Research Centre cooperated with the Insect Pathology Research Institute in several studies involving the aerial application and assessment of biological insecticides against the spruce budworm. Basically, the GLFRC involvement was to carry out population reduction and defoliation assessments similar to those used to evaluate operational and experimental spraying as carried out in Ontario over the past six years. All of the studies described were also assessed by other researchers using different evaluation techniques (see 1974 reports to the Forest Pest Control Forum by J.C. Cunningham, IPRI and A. Retnakaran, IPRI).

A. Virus Carry-over -- Follow-up of 1971 Virus Spray Trials

Areas on the Canadian Forces Base Petawawa (Deluthier Road) and in Algonquin Park (near Achray) were sprayed with NPV and entomopoxvirus in 1971. In 1972, it was learned that NPV carried over in all areas sprayed, probably as a foliage contaminant in sufficient quantity on both balsam fir and white spruce to cause considerable infection, larval mortality and foliage protection. Similar results were reported for 1973 although the incidence of virus decreased.

These areas were re-examined in 1974. IPRI determined that NPV was again present in the budworm populations in all but one of the original spray plots sampled in 1974. GLFRC studies determined the degree of population reduction and defoliation that occurred (see Table 1).

At the present time, the significance of virus carry-over for three years is difficult to assess. However, such results are encouraging. Budworm populations have steadily declined in the presence of the virus and foliage has been saved. Carry-over effect is much more pronounced on white spruce than balsam fir but, where white spruce is a prominent component of the stand, the overall long-term result should be a decline in population throughout the sprayed area, provided there is no significant moth immigration

B. Virus Carry-over -- Follow-up of 1973 Virus Spray Trials

Plots near Massey and Aubrey Falls sprayed with NPV in 1973 were examined in 1974 by GLFRC and IPRI for presence and effects of virus carry-over.

NPV was present in the budworm populations in all of the original spray plots sampled in 1974. GLFRC studies determined the degree of population reduction and defoliation that occurred (see Table 2).

Population reduction and modest foliage protection occurred at Massey, most notably on white spruce. There was no foliage protection evident at Aubrey Falls but this is not surprising in view of the extremely high larval populations that were present. NPV was present in the check plot, in fact, at a higher level than was found in either of the two sprayed plots. Consequently, the population reduction data for Aubrey Falls are not reliable.

C. Virus Trials, 1974 -- Manitoulin Island

In 1974, IPRI conducted aerial applications of NPV on Manitoulin Island. GLFRC carried out population reduction and defoliation studies of these trials. Results are reported in Table 3. As has been found previously, there is significant population reduction but little foliage protection in the year of application. Two similar white spruce plantations with low but almost identical budworm populations were located less than a mile apart. One was sprayed with NPV, the other left unsprayed. Long-term effects of NPV will be studied in these plantations.

D. Insect Growth Regulators, *B.t.* and mixtures of *B.t.* and IGR's -- 1974, Manitoulin Island

IPRI carried out aerial applications of insect growth regulators, *B.t.* and combinations of IGR's and *B.t.* on Manitoulin Island in 1974. GLFRC cooperated in assessing these sprays by determining population reductions and foliage protection attributable to each treatment. Results of these trials are presented in IPRI reports to the Forest Pest Control Forum.

PLANS FOR 1975

1. Re-examine areas sprayed with virus in 1971, 1973 and 1974 for virus incidence and impact in 1975.

2. Conduct immediate and long-term studies of the effects of virus, IGR and *B.t.* sprays if such tests are continued by IPRI in 1975.

Table 1. Population reduction (adjusted for natural mortality) and current defoliation in two plots on Deluthier Road, PFES and four plots at Achray in the third year following application of virus sprays.

Plot	Pre-spray larvae/18" branch tip		Surviving pupae/18" branch tip		% Population reduction due to NPV carry-over		% 1974 Defoliation	
	bF	wS	bF	wS	bF	wS	bF	wS
Deluthier Road - G		36.8		1.8		56		46
H		23.5		1.0		62		35
Check		39.5		4.4		-		63
Achray - A	13.5	48.0	6.0	3.5	0	48	41	46
B	12.2	41.3	5.4	3.9	0	34	59	38
Check	12.4	47.8	3.4	6.8	-	-	55	84
Achray - C	11.0	36.8	6.6	3.9	0	5	39	32
D	11.0	23.6	3.7	2.7	0	0	28	32
Check	12.4	39.5	3.4	4.4	-	-	55	63

Table 2. Population reduction (adjusted for natural mortality) and current defoliation in three plots at Massey and two plots at Aubrey Falls in the year following application of NPV sprays.

Plot	Pre-spray larvae/18" branch tip		Surviving pupae/18" branch tip		% Population reduction due to NPV carry-over		% 1974 Defoliation	
	bF	wS	bF	wS	bF	wS	bF	wS
Massey - 1	18.6	47.4	7.0	3.8	0	48	45	30
2	11.1	54.2	3.9	3.2	7	62	40	30
Check	16.2	32.2	6.1	5.0	-	-	47	44
Massey - 3	14.5	12.8	5.2	3.2	4	26	48	17
Check	16.2	28.2	6.1	9.4	-	-	47	33
Aubrey Falls - 6	66.4	92.0	6.1	3.8	0	0	100	96
7	99.6	159.1	4.4	3.8	42	37	100	97
Check*	75.2	181.0	5.7	6.8	-	-	100	99

* Contaminated with NPV - probably drift from 1973 spray and carry-over.

Table 3. Population reduction (adjusted for natural mortality) and current defoliation in two plots on Manitoulin Island in the year of application of NPV sprays.

Plot	Pre-spray larvae/18" branch tip		Surviving pupae/18" branch tip		% Population reduction due to NPV spray		% 1974 Defoliation	
	bF	wS	bF	wS	bF	wS	bF	wS
Virus - 100 x 10^9 PIB/ac.	26.8	36.8	3.7	3.6	58	5	71	64
Check	33.8	37.6	11.1	3.9	-	-	71	67
Plantation - 100 x 10^9 PIB/ac.		5.5		1.6		46		20
Check		4.5		2.5		-		24

CANADIAN INSECT PEST CONTROL FORUM

OTTAWA, November 19, 1974

EXPERIMENTS WITH BACILLUS THURINGIENSIS IN QUEBEC

Work conducted with the cooperation of:

Laurentian Forest Research Centre,

Canadian Forestry Service,

Department of the Environment,

Ste.Foy, Quebec.

Conservation Branch,

Department of Lands and Forests,

Quebec.

The results of aerial spraying experiments with *Bacillus thuringiensis* in 1971-72-73 (Table I) led to the last experimental step for a pre-commercial use of the bacillus, evaluating definitively the bacillus efficiency for the control of *C. fumiferana* and developing and using a concentrate and low-volume *B. thuringiensis* formulation in 1974. The pre-commercial treatment with the concentrated formulation was made in 1974 at La Macaza, north of Montreal, over 10,000 acres of forest severely infested by *C. fumiferana*. Prior to spraying, the average number of larvae per 18-in. branch tip, was 46 on fir and 69 on spruce.

The concentrated formulation per acre was composed of 1 quart *B. thuringiensis* concentrate (6.8 B.I.U.) + 1 quart 70% sorbitol + 8 mg of chitinase + 1/1600 Chevron sticker. Rate of application was 0.5 gal/acre; the use of 70% sorbitol along with the elimination of water in the formulation increased specific gravity thus reducing evaporation (Table I). For the first time in the history of application of this bacillus, the twin-engine CL-215 (1875 gallon capacity) and the four engine DC-6B (3500 gallon capacity) were used. Because the preliminary calibration of aircraft for the application of the B. thuringiensis formulation was not realized in 1974 due to a lack of funds and material, deposit was not uniform. However, where deposit was relatively good, foliage protection was considered acceptable by members of the spruce budworm committee who visited the area of the experiment. Also, operations in 1974 confirmed that B. thuringiensis is more efficient when insect populations do not exceed 30 larvae per 18-in branch tip.

The advantages of B. thuringiensis treatments are that it requires only one application a year and is absolutely safe for the environment. However, the major obstacle to the use of B. thuringiensis over vast territories is its price which is still 2.5 times higher than that of chemical insecticides. One way of reducing the cost of B. thuringiensis is by using it over large areas thus promoting its commercialization. Should this prove to be impossible using B.t. produced in USA, a decision should be taken towards Canadian production of B. thuringiensis.

Our plan for 1975 is: Calibration of different aircrafts so they can be ready for commercial application of B. thuringiensis in regions that meet criteria for a successful operation, and particularly in regions where the use of chemical insecticides should be avoided because of unfavourable effects on the environment. The Quebec Department of Lands and Forests proposes to treat with *B. thuringiensis* a 225,000 acre area in the region of Rivière-du-Loup, or other regions of Québec in 1975.

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November 12, 1974.

RESULTS OF AERIAL SPRAYINGS WITH BACILLUS THURINGIE

TEMISCOUATA, QUEBEC, 1971, 1972, 1973, AND LA M

FORMULATIONS USED (QUANTITY PER ACRE)		RATE OF APPLICATION GAL/ACRE	NUMBER OF DROPLETS PER SQ.CM. AT GROUND LEVEL	SPRAY SYSTEM USED	DEPOSIT GAL/ACRE
STEARMAN					
Thuricide HPC	0.5 gal				
Polyglycol 400	0.5 gal	2.0	105	Micronair	0.31
Nu-Film-BT	0.05 gal	7.8 billion			
Water	1.0 gal	B.I.U./acre			
Chitinase	5.5 mg				
TBM AVENGER					
Thuricide HPC	0.5 gal				
Polyglycol 400	0.5 gal	2.0	32.5	BOOM	0.37
Chevron sticker	0.16 oz	7.8 billion		and	
Water	1.0 gal	B.I.U./acre		NOZZLES	
Chitinase	10.0 mg				
CL-215					
B. thuringiensis					
(concentrated)	0.25 gal				
Carrier: Sorbitol 70%	0.25 gal	0.5	23.2	BOOM	0.17
Chevron sticker	0.04 oz	6.8 billion		and	
Chitinase	5.0 mg	B.I.U./acre		NOZZLES	
DC-6B & CL-215					
B. thuringiensis					
(concentrated)	0.25 gal				
Sorbitol 70%	0.25 gal	0.5	-	BOOM	0.29
Chevron sticker	0.04 oz	6.8 billion		and	(Preliminary
Chitinase	5.0 mg	B.I.U./acre		NOZZLES	estimation)

Canadian Forest Pest Control Forum
1974

Sex attractants of the spruce budworm

Sex attractants, compounds mimicking females by attracting males, are known for 4 of the 5 budworms feeding on spruce-fir. C. fumiferana, C. occidentalis and C. biennis are all attracted to trans-11-tetradecenal (tdal), C. viridis to trans-11-tetradecenyl acetate. Both compounds are commercially available. The sex pheromone communication system of C. fumiferana definitely contains one or more secondary compounds, and it is probable that secondary compounds occur in the other species, making the pheromones more species-specific. The correct 'blend' is essential for optimum attraction, and work on the identification of these compounds is underway. However, the cis-isomer has a synergistic effect on male C. fumiferana, and a mixture of 99 trans : 1 cis, made up in a solid plastic formulation, gives good catches, quite adequate for survey monitoring in low density populations.

Four types of trap are commercially available. Their effectiveness in low population densities and their ability to withstand exposure for use as a 'once-a-year' trap is currently under investigation.

The presence of tdal in the atmosphere disrupts the ability of male C. fumiferana to find a female. One of 2 known inhibitors, trans-11-tetradecenyl acetate, however, has so far failed to disrupt behaviour, the other, the equivalent alcohol, is under investigation. trans-11-Tetradecenal has been encapsulated, in similar fashion to disparlure (Cameron et al, Science 183: 972-973, 1974) and information on the release rate of the tdal is currently being gathered, in preparation for field trials from a helicopter in 1975. Disruption of mating behaviour will probably be most effective at low population densities, possibly it may be of use in dampening incipient population increases, but in any event, operational use is still several years away.

C. J. Sanders
November 7, 1974