REPORT OF MEETING OF THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

West Memorial Building, Wellington Street, Ottawa.
November 22, 1971.

In Attendance:

Nova Scotia Department of Lands and Forests

R. G. Robertson, Truro.

New Brunswick Department of Natural Resources

H. H. Hoyt, Fredericton.

Quebec Department of Lands and Forests

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

Ontario Department of Lands and Forests

K. B. Turner, Toronto.

Forest Protection Limited

K. B. Brown, Fredericton.
B. W. Flieger, Fredericton.

Council of Forest Industries of British Columbia

H. A. Richmond, Victoria.

Canada Department of Agriculture

Research Branch: D. G. Peterson, Ottawa.
Plant Products Division: E. R. Houghton, Ottawa.

Department of National Health and Welfare

T. F. McCarthy, Ottawa.

Department of Indian Affairs and Northern Development

R. Kroll, Ottawa.

Department of the Environment

Fisheries Service: H. H. Watson, Ottawa.
Canadian Wildlife Service: J. A. Keith, Ottawa.
P. A. Pearce, Fredericton.
A. M. Rick, Ottawa.

Canadian Forestry Service:

R. M. Belyea, Ottawa (Chairman)
R. M. Prentice, Ottawa (Secretary)
F. E. Webb, Fredericton.
M. M. Neilson, Fredericton.
E. G. Kettela, Quebec.
J. R. Blais, Quebec.
R. Martineau, Quebec.
J. J. Fettes, Ottawa.
J. M. Cameron, Sault Ste. Marie.
J. B. Thomas, Sault Ste. Marie.
G. M. Howse, Sault Ste. Marie.
R. W. Reid, Edmonton.
D. R. Macdonald, Victoria.

The Chairman welcomed representatives from various agencies and referred briefly to the agenda that had been drawn up primarily to encourage orderly discussion of programs involving chemical control operations in 1971, research and trials over the past year, and operations planned or anticipated for 1972.

1. SPRUCE BUDWORM AERIAL SPRAYING OPERATIONS

Mr. Flieger gave a brief synopsis of operational programs in New Brunswick and Quebec. Roughly 1,650,000 lbs. of Fenitrothion were used in the two operations. Dosages were the same as those used in 1970, that is, one application of 3 ozs. of Fenitrothion per acre. Forty-five aircraft, namely TBM's, were utilized and the operations were marred by several accidents, three involving spray planes and one Cessna lost on the guidance system.

1.1 NEW BRUNSWICK

Operations 1971 - An attempt was made to advance the spray dates in New Brunswick but plans were disrupted due to weather. Some early spraying was carried out with an oil emulsion in late May but most of it was with water-base emulsion during June. During the latter part of June, aircraft were grounded for several days and as a result feeding damage was well advanced at the time of spraying over roughly one quarter of the area, and there was considerable discoloration of foliage. An additional airfield was utilized at Sussex, for a total of five operational bases for the New Brunswick spray program. (Appendix 1).

Surveys and Services 1971 - Mr. Kettela, reporting on surveys and services by the Canadian Forestry Service, noted that 6,000,000 acres had been treated in New Brunswick in 1971. This included 400,000 acres that had been added to the initial spray plan following assessment of larval populations in the spring. Post-spray population counts indicated about 85% larval mortality on balsam fir and 75% on white spruce. Current foliage saved over the total area averaged approximimately 40%. (Appendix 2).

Environmental Monitoring 1971 - Mr. Pearce gave a brief synopsis of environmental monitoring carried out in New Brunswick by the Canadian Wildlife Service. Pre-and post-spray census based on carcass counts and nest survival counts indicated no significant mortality of birds in the Matacil trial areas in New Brunswick. In the operational areas with Fenitrothion there was a low order of mortality of three species of warblers, but this had little effect on overall bird populations. (Appendix 3).

In the absence of a report from Fisheries Service Dr. Neilson gave a brief summary of a meeting at Fredericton with Fisheries representatives when monitoring programs were discussed. Some mortality of aquatic insects had been recorded in the New Brunswick spray areas. Also, there was a reduction in trout populations in some areas but this could be related to the effects of chemical sprays. Work going on at the St. Andrews' research station again suggests changes in fish behaviour. Mr. Watson representing Fisheries Service expressed his apologies for the lack of a report on their research programs but indicated a report would be forthcoming. This is attached as Appendix 4.

With reference to human health in sprayed areas, Dr. McCarthy stated that operations in 1971 had been carried out without illness or accidents directly attributable to the toxic effects of insecticides. He again stressed the need for timely notification of where and when spray operations will be carried out and he reminded the Committee of obligations to develop procedures to be followed in the event of major spills, particularly in the vicinity of water reservoirs. Dr. McCarthy also suggested that one of the conditions of employment of spray aircraft should be that pilots be equipped with respirators with an outside air supply. There was some discussion of what department would be responsible for a contingency plan in the event of a major spill. Dr. Houghton indicated that the new Pest Control Products Act has been passed and we are now awaiting regulations that will flow from the Act. It is expected that the regulations will set out minimum operational conditions that are considered to be safe, and some of the elements of concern expressed by Dr. McCarthy will be taken care of through the regulations and registration process. Dr. Houghton expects that the new regulations will be in force by 1973. Representatives from provincial governments referred to provincial legislation that is being drafted for the use of pesticides and it was agreed that provincial laws will probably be in line with the federal act. (Appendix 5).

The Maritimes Forest Research Centre reported on monitoring toxicity of Fenitrothion to non-target insects, namely predators and parasites of the spruce budworm. Population trends over the past three years show a general decrease in the predators (syrphids, elaterids, and lacewings) but spider populations are stable and mites have increased. Egg and small larval parasites have remained fairly steady but parasites of large larvae and pupae have diminished drastically. It was pointed out that while parasites and predators are not expected to perform an important regulatory function in the current epidemic populations of the budworm, their destruction could reduce the rate of any future budworm collapse or endanger the stability of re-established endemic populations. (Appendix 6).

Forecast of Insect and Forest Conditions 1972 - Counts of egg masses at 1,000 locations in New Brunswick indicate an increase in the area of high infestation from 7.9 million acres in 1970 to 9.0 million acres in 1971. A comparable increase is evident in the areas of light-to-moderate infestation. In general, egg mass densities were lower in the areas sprayed in 1971. The major extensions in the areas of high infestation were through Madawaska, Victoria, Restigouche, and Gloucester counties in the north. In Nova Scotia counts showed an increase in egg mass numbers in western Cumberland County and in Kings and Annapolis Counties. Increases were also recorded in the western quarter of Prince Edward Island. Hazard to trees in 1972 (based on egg mass counts and defoliation histories) are high-to-extreme over approximately 4.7 million acres in New Brunswick and about 0.5 million acres in Nova Scotia. (Appendix 2).

Proposed Aerial Spray Operations 1972 - Mr. Flieger reported that Forest Protection Limited recently considered spray plans for 1972 involving something in excess of 4 million acres. Fenitrothion will be used at the same application rates as in 1971. A serious effort will be made to advance the spray dates in the hope that most of the operation can be completed by the end of May.

Research 1971 and Proposed 1972 - Mr. Kettela reported on experimental field trials in New Brunswick with formulations of Zectran and Matacil. Two dosages of Zectran at 0.25 and 0.5 ozs. per acre gave poor results in terms of both percent mortality of larvae and foliage protection. Trials with Matacil at 0.5 and 1.5 ozs. per acre in Panasol, and at 1.5 ozs. per acre in summer oil gave equally disappointing results. On the basis of this work it appears that in terms of both cost and effectiveness Fenitrothion is still the superior insecticide for control of budworm. (Appendix 2).

Miss A. M. Rick of the Canadian Wildlife Service reported on amphibian monitoring during the 1971 Matacil trials in New Brunswick. Matacil applied at the rate of 1.5 ozs. (in 0.15 USG Panasol or summer oil) per acre had a negligible effect on frogs and tadpoles. The techniques applied in this study attempted to assess only the immediate post-spray hazard; long-term effects are unknown. (Appendix 7).

With reference to environmental monitoring in 1972 both Wildlife and Fisheries Service stated that their programs would continue. Dr. Webb referred briefly to Dr. Varty's program involving ecological consequences of large-scale spraying of Fenitrothion in New Brunswick and stated that the Maritimes Forest Research Centre would like to see this program expanded in 1972. Mr. Brown supported this proposal and stated that they would like to see the federal government step up its activities in environmental monitoring. Dr. Neilson referred to observations by G. W. Wood of the Canada Department of Agriculture, Fredericton, concerning the effects of aerial spraying on blueberry pollinators. (Appendix 8). Preliminary studies suggest that Fenitrothion may cause a significant reduction of native pollinators but further work is required before valid conclusions can be drawn. Dr. Peterson confirmed that in view of the importance of pollinators to the blueberry industry in New Brunswick a somewhat more elaborate monitoring program will be conducted by Wood in 1972. Dr. Fettes reported on the Chemical Control Research Institute's work with Fenitrothion in Larose Forest in 1971. Some 22 colonies of domestic bees were placed in the spray blocks and they could find no apparent damage even at dosages as high as 11 ozs. per acre. These trials will be repeated in 1972 in cooperation with the Department of Agriculture. Also, the program for monitoring small mammal populations will be expanded. (Appendix 9).

1.2 QUEBEC

Operations 1971 - A total of 2,030,000 acres were sprayed in western Quebec in 1971. The operations were conducted by Forest Protection Limited and the dosage was 3 ozs. of Fenitrothion per acre applied between June 11 and June 25. The operations were conducted from airfields at Maniwaki, Lac de Loups and Nilgaut, and biological assessments were carried out by personnel from the Quebec Department of Lands and Forests and the Canadian Forestry Service. Reduction of populations due to spraying varied considerably between areas but averaged roughly 50% for the whole area. It was pointed out by Dr. Blais that these calculations were based on limited data and must be considered as estimates. Although tree mortality was negligible, most of the current foliage was lost in the areas treated in 1971, and back-feeding on old foliage was observed in some areas.

Approximately 120,000 acres were treated in the Temiscouata area with 3 ozs. of Fenitrothion per acre. Results here were variable with an average population reduction of only 65%. Mr. Paquet expressed some concern over the rather poor results of spray operations in Quebec in 1971. This was attributed mainly to conditions that delayed spray operations until most of the larvae were in the fifth instar and the extremely high populations that resulted in most of the terminal buds being destroyed before spray operations were underway. (Appendix 10).

Environmental Monitoring 1971 - Mr. Pearce reported on environmental monitoring programs in Quebec that were carried out in cooperation with M. R. Ouellet of the Quebec Wildlife Service. Bird population surveys in the Gatineau River and Temiscouata area failed to indicate any significant post-spray bird population depressions but a few casualties, mostly warblers, were found. With reference to monitoring in 1972, the Canadian Wildlife Service was not prepared to make any advance commitments. (Appendix 3).

Forecast of Insect and Forest Conditions 1972 - The outbreak in western Quebec now covers approximately 13,000,000 acres. High egg populations persist through most of the area treated in 1971 and an additional 1,170,000 acres will require treatment in 1972 for a total of 3,200,000 acres. Quebec will be aiming for an earlier starting date for spray operations with a recommended dosage of 3 ozs. per acre with a second application of 2 ozs. where necessary.

High egg populations have been recorded over an area of 500,000 acres in the Temiscouataarea outbreak but there has been no decision on spraying for 1972. (Appendix 10).

Research 1971 and Proposed 1972 - Dr. Blais reported on experimental trials for control of spruce budworm with commercial preparations of *Bacillus thuringiensis* with the enzyme chitinase as an additive. The assumption was that chitinase would aid in breaking down the cell walls of the gut and accelerate the penetration and action of B.T. spores. The results of these trials were encouraging but not conclusive. Mortality ranged as high as 88% with B.T. plus chitinase and larval mortality occurred somewhat earlier thus offering better protection of foliage. One of the drawbacks to the use of chitinase is the cost. This has been partially overcome by cheaper production methods that are now being worked out and the B.T. trials will be expanded in 1972. (Appendix 11).

1.3 ONTARIO

Operations 1971 - Mr. Howse reported on aerial spray operations against the spruce budworm that covered 80,000 acres in Ontario in 1971. Three hundred and seventy-five acres of research forest at the Petawawa Forest Experiment Station were sprayed by helicopter, with 3 applications of 3 ozs. of Fenitrothion per acre. Overall levels of foliage protection were not satisfactory (35% on white spruce as compared to 57% on balsam fir). Spraying for foliage protection was carried out in three provincial parks in northeastern Ontario (6,000 acres in Missinaibi, 1,620 acres in Shoals, and 1,000 acres in Lake Superior provincial parks). Areas treated received a single application of 5.3 ozs. per acre of Fenitrothion. Once again the larval mortality and foliage protection was better on balsam fir than on white spruce. Approximately 64,800 acres in Quetico Provincial Park and 7,600 acres in the southwest corner of the Thunder Bay District were sprayed to prevent the spread of infestations in this part of the Province that threatened high value stands around the Burchell Lake and Lac des Mille Lacs. These areas received one application of 4 ozs. of Fenitrothion per acre applied when larvae were in the early instars. No significant spread of the infestation has been recorded and populations are now somewhat lower in sprayed areas. (Appendix 12).

Forecast of Insect and Forest Conditions 1972 - Egg mass surveys in southeastern and northeastern Ontario indicated further expansions of the budworm outbreak in this part of the Province in 1972. Aerial spray programs in 1972 will again be restricted to high value recreational areas and experimental forests as follows:

Southeastern Ontario	-	Petawawa F.E.S.
	-	Recreational areas
Northeastern Ontario	-	Provincial Parks
Northwestern Ontario	-	Quetico Park

The Ontario representatives expressed some concern over the lack of effective control of budworm using recommended dosages of Fenitrothion. The problem in Ontario appears to be linked to ineffective equipment and application methods. Representatives from the Canadian Wildlife Service questioned the use of dosages in excess of the registration limits for Fenitrothion (6 ozs. per acre) and they expressed some concern that side effects of operations in Ontario were not being monitored. Dr. McCarthy did note that health authorities had been involved in checking out pilots and insecticide ground crews. With reference to operations in 1972 Dr. Fettes indicated that the Chemical Control Research Institute would be demonstrating improved application techniques in the Petawawa area and probably one provincial park in 1972.

Research 1971 and Proposed 1972 - Dr. Fettes gave a brief summary of ongoing experimental spray studies being conducted by the Chemical Control Research Institute and mentioned some of the main highlights as follows:

(a) Early spring applications of ULV sprays were tested using various concentrations of Matacil, Fenitrothion and Zectran. With Fenitrothion as a standard, their order of effectiveness was Fenitrothion, Matacil, and Zectran. The results indicated that with proper spray conditions and with Micronair nozzle equipment, spraying with Fenitrothion can start immediately following 2nd instar larval emergence. (Appendices 13 and 14).

(b) An experimental spray program was carried out in the Larose Provincial Forest to test the effects of Fenitrothion on birds, small mammals, and domestic bees. At application rates of 4 ozs. of Fenitrothion per acre certain species of young birds (particularly the open nesting warblers) experienced some mortality. Losses were estimated to be about 50%. Populations of shrews were also slightly depressed. In cooperation with the Canada Department of Agriculture a special study was carried out to determine the effects of the insecticide on domestic bees. Some adult bees were killed but broods recovered quickly following spray operations and in the opinion of the apiculturist, no serious damage could be attributed to the spray program. (Appendices 8 and 15).

(c) Environmental contamination studies were continued by Dr. Yule. The fate of an operational dose of 4 ozs. per acre of Fenitrothion has been followed over the past year. Spruce and balsam fir foliage collected 2-to-4 ppm of Fenitrothion but only traces were found in forest soils. It has been postulated that the initial large losses were of external deposits and were due to physical factors such as rain, air, and sun. Further work on the fate of Fenitrothion is being undertaken using radiolabelled pesticides in potted conifers. Measurements of the uptake of DDT from contaminated soils, and translocation of DDT from sprayed foliage are in process, together with a residue survey of DDT in lumber from sprayed forests in New Brunswick. (Appendix 16).

(d) Dr. Fettes spoke briefly about the plans for an experimental spray aircraft for the Chemical Control Research Institute. Definite plans have not been drawn up for use of the aircraft in 1972 but one of their early objectives will be to set up a field demonstration program that will make forest managers aware of the advantage of ULV spray equipment.

Dr. Cameron gave a brief resume of NPV and Y-virus aerial application trials for control of spruce budworm in the Petawawa Forest Experimental area in 1971. The NPV virus had been subject to laboratory and small field trials for two years but the Y-virus was a newly discovered pox-virus isolated from 2-year cycle budworm in British Columbia. There was a significant larval population reduction from both viruses and mating success and egg production of survivors have been reduced indicating some debilitating effects of the viruses. Complete results of these trials will not be confirmed until mid-winter but results to date have been encouraging and the Insect Pathology Research Institute has laid plans for mass production of virus materials that will allow expanded trials in 1972. (Appendix 17).

2. OTHER INSECT PROBLEMS

2.1 AMBROSIA BEETLE CONTROL - EXPERIMENTAL TRIALS IN BRITISH COLUMBIA

D. R. Macdonald reported on trials of water sprays on stored logs to prevent attack by ambrosia beetle in British Columbia. The trials were carried out in cooperation with the Council of Forest Industries. A continuous spray of decked unsorted logs, mostly Douglas-fir and hemlock, gave 100% protection from ambrosia beetle attack. Mr. Macdonald pointed out that the success of these trials indicates that water sprays will provide an alternative to the treatment of stored logs with insecticide. (Appendix 18).

2.2 BLACK-HEADED BUDWORM INFESTATION ON VANCOUVER ISLAND

Populations of black-headed budworm have shown a sharp increase over the past two years on lower Vancouver Island. Roughly 160,000 acres of hemlock and amabilis fir have been defoliated in the Cowichan and Nanaimo lakes area, and fall egg surveys indicate further increases in degree and extent of infestations in 1972.

Mr. Macdonald stated that the problem had been recently discussed by the Pest Control Committee but there was still no decision on a spray program for next year. If they do spray, Fenitrothion would be used except for one area involving the Nanaimo water district where Bacillus thuringiensis may be tried as a safe alternative. (Appendix 19).

2.3 EXPERIMENTAL SPRAYING OF SEED PRODUCTION AREAS IN BRITISH COLUMBIA

Mr. Macdonald reported on control trials aimed at protecting seed cones from attack by a species of cone moth and midges. Dimethoate applied by helicopter at rates ranging from 4-to-12 ozs. per acre (approved by B.C. Interdepartmental Committee on Pesticides) had little, if any, effect on insect populations. In view of the increasing demands to protect seed production trees from attack by seed and cone insects, more work is required to determine the best insecticides and dosages for this type of an operation. (Appendix 20).

2.4 EXPERIMENTAL TRIALS FOR CONTROLLING WHITE-PINE WEEVIL

Dr. Fettes reviewed the results of control trials against the white-pine weevil in Ontario aimed at determining the efficacy of

Methoxychlor and two new materials, Dursban and Gardona. Ground applications with Methoxychlor with hydraulic equipment at a rate of 2 lbs. per acre gave up to 90% population reduction when applied prior to adult feeding and oviposition (late April and early May). Applications of Gardona and Dursban applied at a rate of 0.5 lb. per acre also gave good control. Both of these materials show promise and they will be field tested in 1972 at somewhat higher dosage and with a spreader-sticker additive. (Appendices 21 and 22).

2.5 THE JACK-PINE BUDWORM SITUATION IN ONTARIO

Mr. Howse reported that an aerial spray operation planned for a 7,500 acre stand of jack pine in the Parry Sound District in 1971 had been cancelled when winter surveys revealed a low damage potential. However, populations of the jack-pine budworm remained high in parts of the Pembroke District and the Parry Sound District in 1971, and the Department of Lands and Forests is considering aerial spraying for 1972 in a limited number of high value jack-pine stands. (Appendix 23).

2.6 THE EASTERN HEMLOCK LOOPER PROBLEM IN QUEBEC

Dr. Blais reported on an outbreak of the eastern hemlock looper covering roughly 500,000 acres on Anticosti Island and the north shore of the St. Lawrence River. Trees have been heavily damaged and the Quebec Department of Lands and Forests has confirmed that an aerial control program will be carried out in 1972 covering areas of approximately 400,000 acres. The program will be carried out in cooperation with workers from the Canadian Forestry Service in Quebec and in Newfoundland. (Appendix 24).

The Chairman expressed his thanks to members of the Interdepartmental Committee for their participation in the meeting and indicated that a report would be distributed on the basis of a revised mailing list within the next month.

R. M. Prentice,
Secretary.

R. M. Belyea,
Chairman.

APPENDIX I

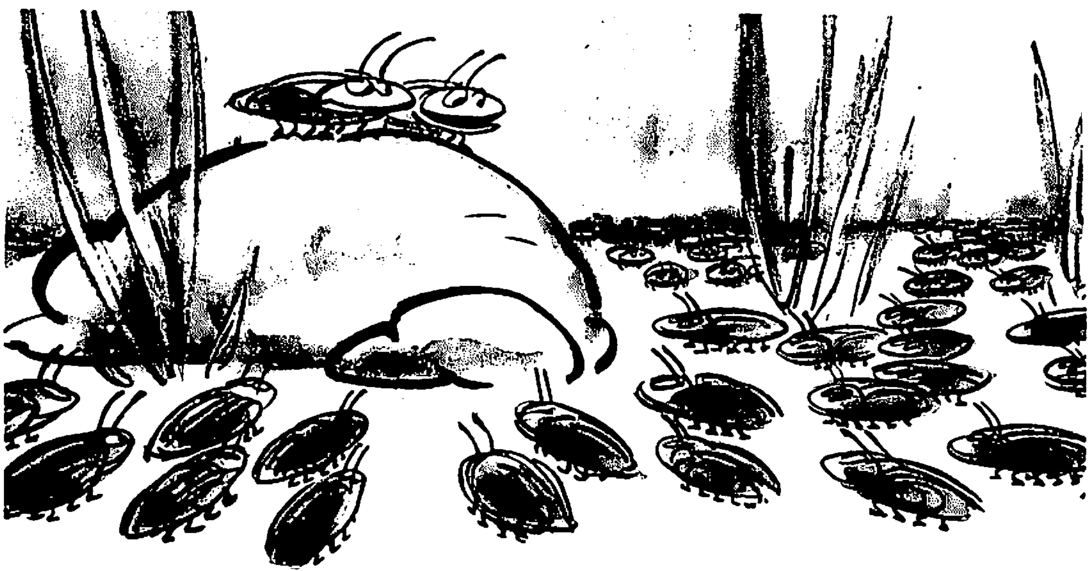
OPERATIONS OF

FOREST PROTECTION LTD.

1971

B.W.Flieger
November 1971

In the belief that a picture is sometimes worth a thousand dollars this brief report of F.P.Ltd. 1971 work is liberally sprinkled with environmental humor in cartoon form. The first has to do with the current budworm situation.



"We've got enough for an infestation, but we're still shy of a blight."

PLANS FOR SPRAYING OPERATIONS

The Directors of Forest Protection Ltd. in the fall of 1970 agreed that spraying in New Brunswick to prevent damage from spruce budworm be undertaken in 1971 by the Company on a scale of 5,200,000 ac. approximately, and that the Company would act in the capacity of agent for the Department of Lands and Forests, P.Q., undertake to do spraying of a further 2,000,000 acres approximately in Quebec.

In the planning stage it was decided to use the same insecticide, aircraft type, and spraying techniques in both Provinces.

CONSTRUCTION

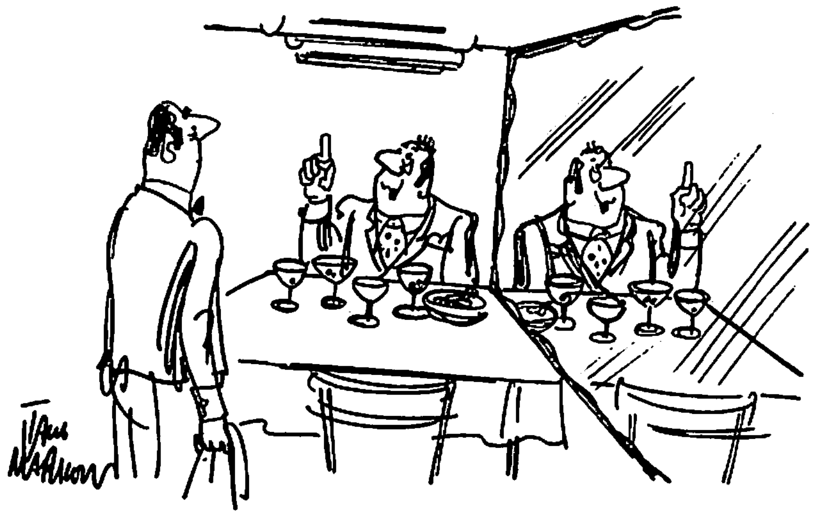
To facilitate the covering of such substantial acreages five bases were required in N.B. necessitating the construction of an airstrip near Sussex (at the usual northerly limit of the Fundy fog belt) and three bases were needed in P.Q. also calling for construction of an airstrip near Lac Nilgaut about 60 miles west of Maniwaki, P.Q. Both were built in the fall of 1970 and brought into operational condition in the spring of this year.

PROCUREMENT OF CHEMICALS

Fenitrothion (Technical) in the amount of 1,650,000 pounds was purchased from three suppliers, approximately 1,200,000 pounds for the N.B. programme and approximately 450,000 for P.Q. The necessary quantities of solvents and emulsifiers for the formulation of insecticide were also purchased.

A small quantity from these stocks was supplied to Lands and Forests, Ontario (approx. 12,000 lbs.) and J.D. Irving Co., N.B. (approx. 4,000 lbs.).

Most of this material was used up in the spraying operations. Current N.B. inventory is zero lbs., P.Q. inventory approximately 11,000 lbs.



"Separate checks, please."

CHANGES IN PLANS

During the late winter some 400,000 acres were added to the N.B. plan.

During spraying in N.B. another (approx.) 400,000 acres were added.

In P.Q. no changes were made until immediately before spraying when in the Temiscouata region adjustment to plan area was made and the number of applications was changed from 2 to 1. In Western P.Q. about 50,000 acres were added during spraying.

PROCUREMENT OF SPRAYER AIRCRAFT

It was decided to use T.B.M. sprayer aircraft for the combined operations and Cessna aircraft for the Company's guidance system.

Some difficulty was experienced in fielding the exact number of each in all cases due mostly to the tactics of minor Canadian operators. As a result the Company has now for the first time, the support of the

National Aviation Authorities in dealing with operators who fall short in supply and performance relative to their committments and promises.

At one time or other 20 Canadian and 25 U.S. TBM's a/c worked the two projects. Average power N.B. 33 - P.Q. 9 + . The fleet was marshalled in New Brunswick prior to spray time:-

a) In order to facilitate Customs, etc., clearance for U.S. aircraft.

b) For the calibration of the entire fleet.

c) For removal of operational snags before dispatching a/c to Quebec.

Some difficulty was encountered in getting enough aircraft of the designated type for the guidance system. Twenty-five of these were provided from the usual supplier. Another dozen were hired from private owners.

Facilities for loading out aircraft were supplied by the Company for N.B. and P.Q. projects. Accommodation and board is also a part of project planning and in P.Q. these were provided by two Industry sponsors (E.B. Eddy Co. and C.I.P.Co.).

OPERATIONS*

Spraying began in late May in N.B. and came to a stop on June 28. In P.Q. the first spraying was on June 5 and the last on June 27. All of the P.Q. plan was completed and almost all of that in N.B. (A very limited area which became overripe was left in the Sussex, N.B. area).

* A log of operations is available if required.

The relative size of the two operations not adjusting for differences in average haul distance is approximately 3.8 - 3.9: 1 NB : PQ.

FLYING INCIDENTS

During Ferry:-

One T.B.M. and pilot lost enroute East from California.

One T.B.M. down in Canadian prairies. Crew O.K. This aircraft is now back in B.C. and is ready to fly again.

During Operations:-

N.B. - One T.B.M. forced to land in swampy land near Jemseg - now back in California - pilot unhurt.

P.Q. - One T.B. forced to land in lake, later salvaged, repaired and ferried to B.C. It will fly again - pilot unhurt.

N.B. - A first for Cessna. Plane missing and down in bush. Crew of 2 rescued hours later, alive but hurt. Both pilot and navigator worked again. A lucky ending.

P.Q. - Much Helicopter trouble for entomologists. A project stand-by Hughes 500 washed out - but not on project duty.

WEATHER

In N.B. there was very ordinary but steady spraying progress until about mid June when the weather produced what has come to be a regular off color week for sprayers. Unfortunately, this is of the kind which causes the pest to feed with increased fury and several days of this can completely change the tree picture and cause the operation to run out of needle saving days. This is what transpired on about 25% of the plan area - this fraction lost its new foliage and reddened. When spraying resumed a sharp reduction of feeding population was obtained - back feeding was limited and tops are for the most part still alive.

The poor weather extended over all of Eastern Canada and was felt even more strongly on the P.Q. project.

Results - see Kettela for N.B., Desaulniers, Martineau and Benoit for P.Q.

SIDE EFFECTS OF SPRAYING N.B. - BIRDS AND BEES

"What bird would you like to see become our national bird when and if the bald eagle becomes extinct?"

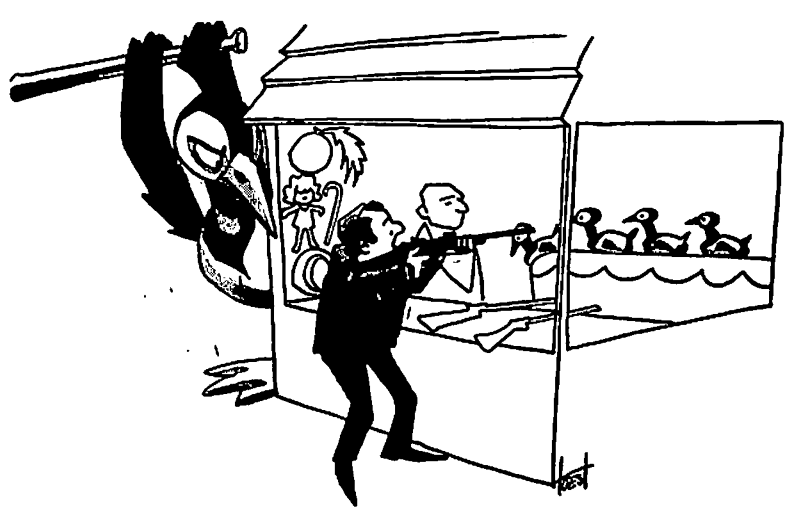
1) The Company sprayed this year within the constraints laid down by an injunction obtained by a firm of blueberry growers. In addition this firm has taken action against F.P.Ltd. for alleged damage sustained from the operations of the Company in 1970. It is expected that this lawsuit may take some considerable time to settle. (The lawyers may have a field day)

2) Honey Bees - production of honey affected by spraying insecticide.

3) Birds - Because of no increase in dosages in 1971 the Company did not expect much from the C.W.S. different from 1970, nor has it heard anything to the contrary.

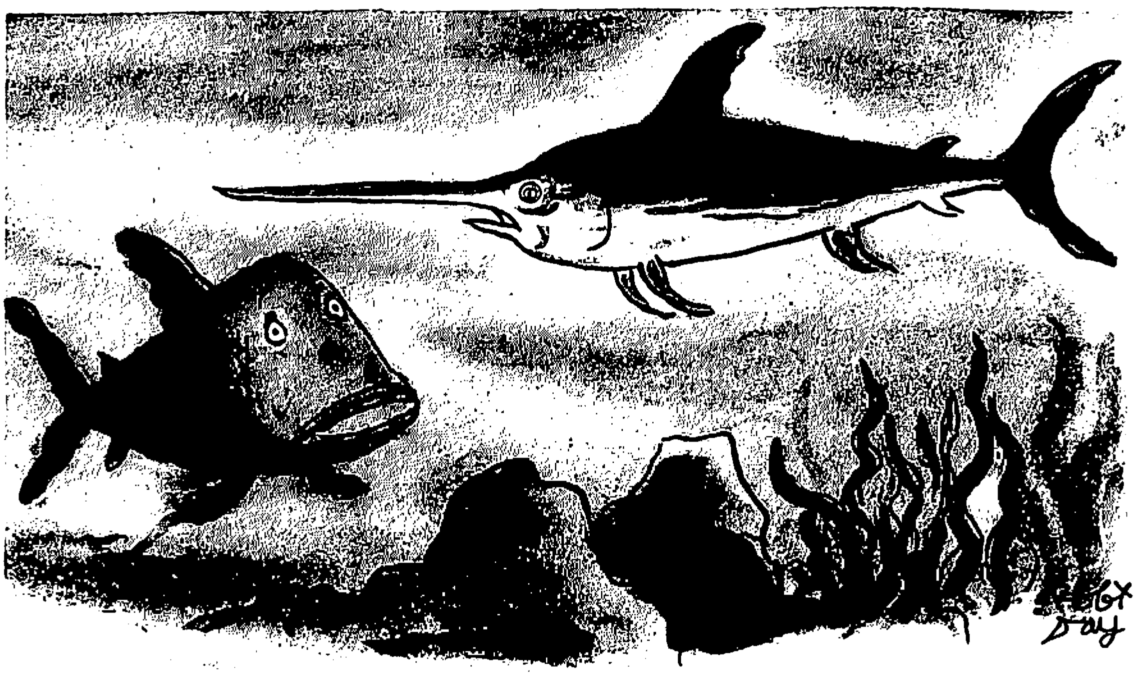
There are two interesting developments in the man-bird world worth mentioning here:-

a) Nobody has come forward to explain why it is that the woodcock, about which B.S. Wright said some 8 years ago - "O.K. for human consumption but in danger perhaps of extinction locally because of use of pesticides" - have gradually become so plentiful and at the same time so contaminated that Food and Drug say "not fit to eat" - in fact for one year (1970) too dangerous to be hunted!



b) It is rumoured that the blueberry grower above mentioned is considering further action against sprayers because the robins and perhaps starlings have been deprived of their rightful diet and are driven to consume large quantities of ripening blueberries and that to save the crop in 1971 the growers have had to shoot (again a very 2nd hand rumour) some 30,000 birds - a third rumour is that this course of action against birds is quite legal if permission is granted after the proper application forms have been filed which step in this case may have not been regularized.

FISH AND AQUATIC LIFE



"They keep pulling me out and throwing me back, pulling me out and throwing me back. Frankly, I've just about had it."

The same may be said about new discoveries relating to the effect of spraying on fish life. That is not to say that all is well but only to say that all is tolerably well for the moment.

Since I wrote five years ago about the Atlantic Salmon in a way that did not find favour with the scientific fraternity I detect very little change in the policy of not letting the people know how confusing the Salmon situation really is.

I list here some pertinent statistics for the period 1962 - 1971* which show a steady wasting of the resource as measured by catches (always the way increase and decrease has been measured). And now (in 1971) when fishing (leaving out tinkering with the fishing dates) has fallen to less than half the low of 10-15 years ago - there are no goats in sight. Unlike B.S. Wright who now incorrectly says about the woodcock - I told you so - there is not sound except from the fishermen who blame the rules makers. I wish that the St. Andrews Society (Dr. P. Elson in particular, who talks about salmon as if he were William Buckley addressing the Oxford Union) had taken my idea a little less seriously and tried it out 5 years ago!

Year	Angling Catch of grilse and salmon, numbers of fish	Commercial Catch salmon only, in pounds of fish
1961	16,600	267,000
1962	19,800	365,000
1963	58,200	369,000
1964	31,100	596,000
1965	43,000	597,000
1966	57,500	651,000
1967	51,900	869,000
1968	18,872	420,578
1969	27,496	354,300
1970	19,088	320,313
1971	9,670	163,293

* Miramichi System

PESTICIDE RESIDUES

The Company is monitored from time to time by Canada Health and Welfare and vice-versa. We have no idea what Dr. McCarthy will say about us this year.

1) On the projects we have taken precautions to protect all personnel exposed to pesticides.
2) Last year the Company cleaned all drum containers and disposed of them to a drum dealer who was told about the drum history.
3) Testing of spraying equipment when loaded with insecticide formulation was banned in 1971.
4) Pressure (flow regulator) adjustable by pilot in flight (on report of plugged nozzles via guidance system ratio) was used for the first time.

OPERATIONAL TESTS OF INSECTICIDES

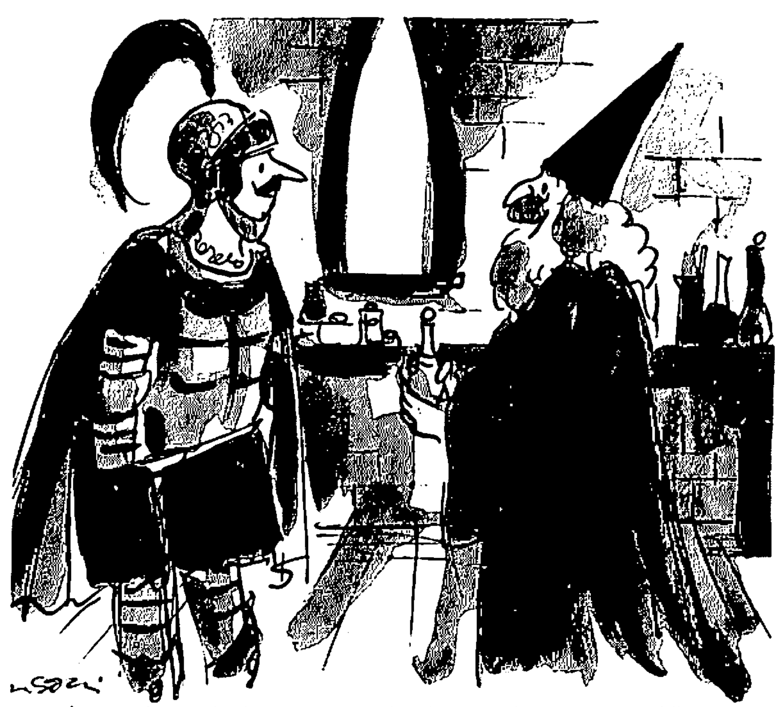
Though it turned out to be fairly expensive the Company found out that formulations of Zectran and Matacil as used did not give acceptable results and did not begin to match Fenitrothion on a dollar for dollar basis, in fact, the formulations less the toxicant sometimes cost more than the regular spray. This means that neither of these pesticides as recommended for use at the present time constitutes an attractive alternative to Fenitrothion. The tests were initiated and paid for by the Company.

FORMULATIONS

In all of the spraying in P.Q. and almost all of that in N.B. the Company used the same formulations of Fenitrothion (emulsions) as in 1970.

On a small fraction of the N.B. project an oil solution of the chemical was used.

The feasibility of using an oil solution of Fenitrothion was worked out in 1971. It is expected that more will be used in 1972 not only in N.B., but elsewhere. Suddenly there is much talk of oil solutions of Fenitrothion. Moving in this direction is more expensive but there may be some offsetting gains. For effect compared with emulsion see Kettela's report N.B. Spraying 1971. He has the only valid comparison to date albeit not so extensive as one would like to have it.



"Not only is it a great deodorant; it's rust-proof."

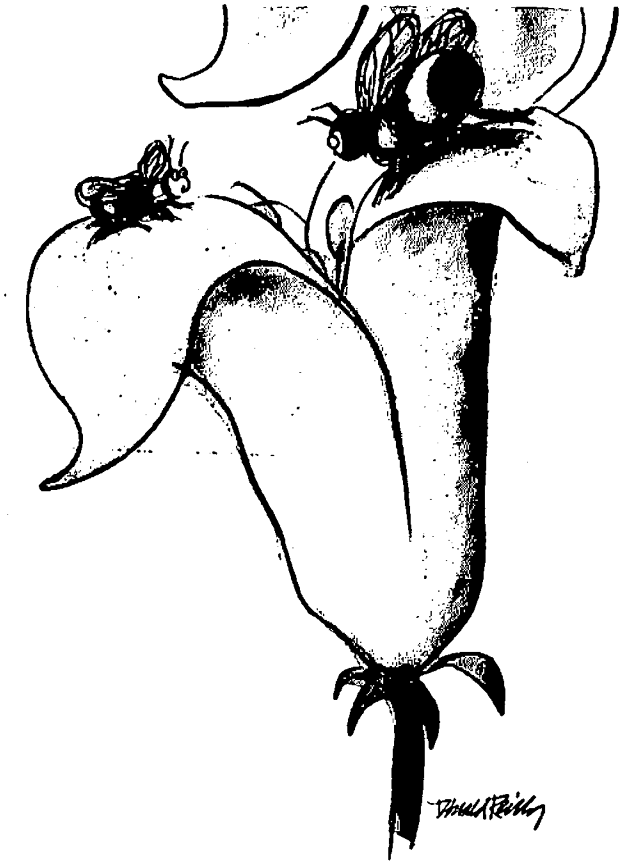
The Company encountered some embarrassment from solvents much too powerful for the aircraft plumbing. It is rather odd we think that manufacturers, operators, formulators and others alike, did not warn the Company about the super activity of panasol.

COOPERATIVE ASSISTANCE

Apart from assistance to N.B.F.S. and to Canada Forestry Service which is of an annual nature, the Company provided:-

1) Accommodation and board at its own active bases for all who needed it.
2) As planned the local programme of C.C.R.I. under A.P. Randall was serviced pretty much as in 1970. We understand that this long and bitter friendship has now come to an end and that finally this service after twenty years of mastering the art of the scrounge is to get its own air service - we say thanks and good luck!
3) The Regional Lab. -F.P.Ltd. plan for joint action produced a new and interesting finding about adult budworm movements and the arrangement worked we believe to our mutual satisfaction.*
4) Assistance to Dr. Elson, - the Company found two field workers for the season at the request of Dr. Elson.
5) The Company helped itself by engaging the services of a person who had some knowledge of pollinators. We were fortunate to find him through the good work of Dr. Varty.

* See Greenbank

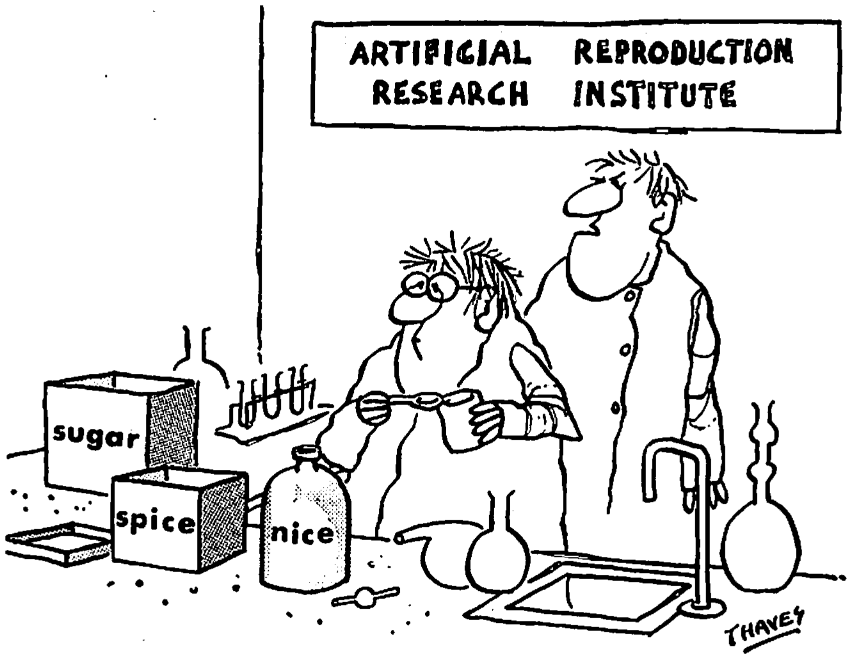


"Now, let's have it again, Pop. Which are the pistils and which are the stamens?"

6) Dr. N.R. Brown assisted the work of checking the effect of spray on pollinators for 1½ months.

7) R.W. Nash state entomologist, Maine, spent a month on the P.Q. project assisting Mr. W.D. Brown, who was in charge of operations for the Company.

PUBLICITY



"Knock it off, Jenkins."

The tempo of press releases concerning spruce budworm, which of course can come from a very limited number of sources, has increased, I believe, in 1971. The articles have, in the main, consisted of the usual garble. Outside of making filler in the newspaper I have had the impression that the accounts of numerous ways of controlling budworm populations which we are not using contributed at least to a confusion of mind. I should have known better. At worst these turn out to be a waste of time - in New Blovia at least, if you can place any credence in a hurry up test of opinion which we undertook this fall.
(See attached letter)

1 9 7 2

N.B. will continue forest spraying on a scale of 4.5 - 5.0 million acres.

1) Insecticide will be Fenitrothion.

2) Dosage - variable according to priority, in any case probably not more than 4 oz. a.i./ac.

3) T.B.M. a/c and F.P.Ltd. guide system will be used.

4) As in 1971 - 5 bases but not same 5 will be needed.

5) Plan to begin work X days after emergence and not at a calculated point in larval development.

6) Hope to get a substantial area treated in May including blueberry culture areas and tame bee locations and to complete if possible by the bad (third) week in June.

Costs - In 1971 per acre cost of spraying reached a 20 year minimum - not likely to be duplicated in 1972.

P.Q. - ? according to the noises we hear from our suppliers P.Q. will probably have some spraying done some way by somebody. We do not put too much reliance on the sounds but they are always the first kind we hear, which is one hell of a note, but after all, as you so well know, our outhouse is a one holer and it's occupied!

Maine is considering the spraying of perhaps 500,000 acres in 1972 - this we shall watch with interest.

SPRAYING CLOUDS ON THE HORIZON

1) Sounds from De Varty. Is his negative more important than his positive? Time will tell!

2) Pollination problems. Must be given more attention!

3) Red Spruce - reaction to spraying. (see Kettela)

4) The many resistances of Balsam Fir. These are not well known.

5) New ways to apply chemicals to forest from the air.

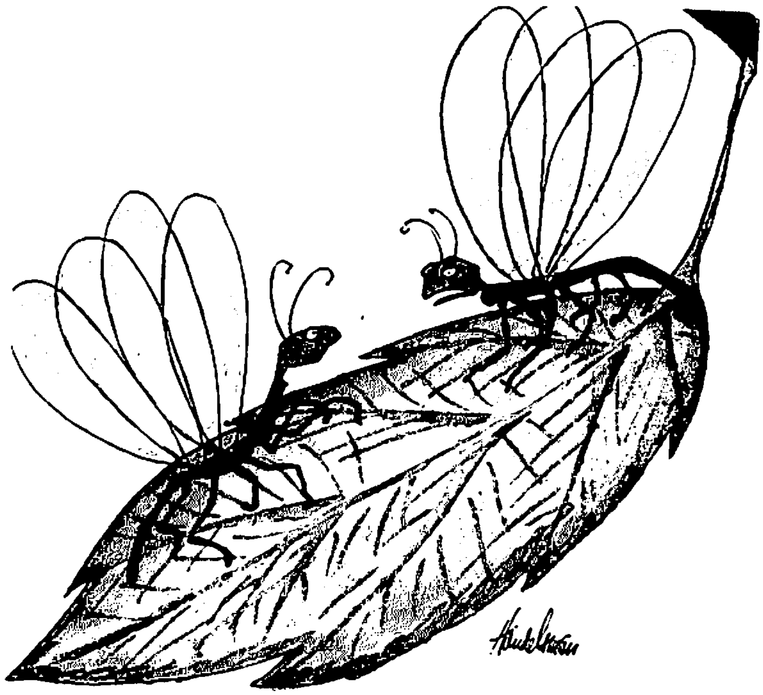
Once early in our spraying years we suggested that a person interested in the life processes of trees was necessarily a part of a task force whose function it is to contend with such an emergency as we have been engaged with in N.B. for the past 20 years.

This notion fell upon deaf ears and we are now paying for it and have been for some time. All of the records compiled on the insect pest can be thrown away for all they have to do with the reaction of trees to pest and protective treatment. Had we known it would be this way we might have stirred up more dust by doing something about it without benefit of entrenched science.

We have also suggested more than once to you in this meeting that the force (technical personnel) you make available to the investigation of the tug of war between trees and insects in N.B., where we have been working, is ridiculously small in terms of the total Spectrum of scientific activity (in the forest).

We would still like to see these above two items given some further consideration (although it is now almost as late as was the d.d.t. residue hunt starting gun). Remember Ross MacDonald made noises 5 years ago about epicentres. That boat was missed by 2-3 years. We should pay some attention to "future shock"!

ANYWAY A "MERRY XMAS" AND FULL EMPLOYMENT IN THE NEW YEAR.



"What do kids like you know of life? Wait till you've lived four hours, like me."

APPENDIX 2

AERIAL SPRAYING AGAINST THE SPRUCE BUDWORM IN NEW BRUNSWICK IN 1971, AND A FORECAST FOR CONDITIONS IN THE MARITIMES REGION IN 1972

(E. G. Kettela)

Synopsis

Based on surveys of defoliation, egg masses and hazard conducted in 1970, Forest Protection Limited of New Brunswick embarked on a proposed spray program of approximately 5.2 million acres in 1971. As new survey data came to light in the winter of 1970-71 and in the spring of 1971, approximately 800,000 acres were added to the plan. In all, 6,003,477 acres were treated; 4,284,727 acres receiving one application of 3 oz. per acre and 1,718,750 acres receiving two applications of 2 oz. per acre each of fenitrothion. In addition, 24,000 acres were treated with Zectran and 48,000 acres were treated with Matacil in an attempt to explore their operational capabilities.

The spring of 1971 was warm and favored the development and survival of budworm larvae. Emergent budworms were detected on 26 April in the Fredericton area. Spray operations commenced on 18 May and ceased on 26 June, 1971.

Results of Spraying

(a) Operational Spraying.--An aerial survey for defoliation conducted in July by F.P.L. and the C.F.S. delineated 1.1, 1.9 and 1.6 million acres of light, moderate, and severe defoliation, respectively, for a total of 4.6 million acres. This represents an increase of 0.6 million acres of all categories of defoliation over 1970. Generally throughout the sprayed area, there was fair success in protecting foliage. The largest single area of severe defoliation in the sprayed area was in the northern 1/4 of the spray plan. This area was sprayed late mainly because of weather conditions not favorable to spraying. Based on ground observations, the percentage of new balsam fir foliage saved was 40%. The per cent reduction in survival of budworms was 85% on fir and 75% on spruce. These figures of foliage saved and reduction in survival are comparable to the results of past spraying programs.

In addition to spraying with an emulsion formulation, a number of spray blocks were treated early in insect development with fenitrothion in oil. In terms of reduction in survival, the results were mediocre (fir - 72%, spruce - 26%); however, protection to foliage was fair (35% of new foliage saved).

(b) Trials with Zectran and Matacil

Zectran.--Two dosages of Zectran (0.25 and 0.5 oz./acre) were tried on 12,000-acre blocks. The results on balsam fir indicate poor success at 0.25 oz./acre (8% foliage saved, 44% reduction in survival), but better success at 0.50 oz./acre (25% foliage saved and 57% reduction in survival). However, on spruce there was virtually no reduction in insect populations.

Matacil.--Two dosages and two formulations of Matacil were tried on four, 12,000-acre blocks: (1) 0.5 oz./acre in Panasol; (2) 1.5 oz./acre in Panasol; and (3) 2 blocks at 1.5 oz./acre of wettable powder in summer oil. The results obtained were by and large inconclusive because of the many problems encountered in application of the poison. However, the results in terms of per cent reduction in survival on balsam fir was better on both wettable powder blocks than on either of the oil blocks. There was virtually no effect on budworm populations on spruce on all four blocks. Per cent of new fir foliage saved averaged 20% on all four blocks. Compared to fenitrothion, the Matacil tests gave poorer results both in terms of foliage saved and effect on budworm populations.

Results of Egg-mass Surveys and a Forecast for the Maritimes Region in 1972

(a) In New Brunswick, counts of budworm egg masses at 1,000 locations indicate an increase in the area of high infestation from 7.9 million acres in 1970 to 9.0 million acres in 1971, and an increase of low to moderate infestation from 4.9 million acres in 1970 to 5.8 million acres in 1971. However, the area of high infestation in 1971 has a lower population density than in 1970. In general, egg densities were lower in sprayed areas. There were major extensions and increases of budworm populations in Madawaska, Victoria, Restigouche and Gloucester counties in the north and in Charlotte County in the southwest corner of New Brunswick.

In Nova Scotia, egg-mass counts at 30 locations showed an intensification of the outbreaks in western Cumberland County and on the north and south mountains in Kings and Annapolis counties. The infestation appears not to have increased in area. However, this might change, pending the results of a survey for overwintering larvae.

In Prince Edward Island, counts of egg masses at eight locations indicate a moderate to high infestation in the western 1/4 of the Province.

(b) Hazard to Trees in 1972

Hazard is determined from the results of egg-mass and defoliation surveys. In New Brunswick, the acreages of high and extreme hazard are 4.1 and 0.6 million acres, respectively. Another 4.0 million acres (approximately) fall in a variable hazard category. The acreage of 4.7 million acres of high and extreme hazard represents an increase of 2.1 million acres over 1970.

In Nova Scotia, hazard is high to extreme in balsam fir stands located in the infestation areas of Cumberland, Kings and Annapolis counties.

In Prince Edward Island, hazard is generally low to moderate because of the newness of the infestation.

Introduction

The 1971 aerial spraying operation was the nineteenth to protect the forests of New Brunswick from massive budworm damage. A summary of the results of operational and experimental spraying and a forecast of conditions for 1972 are presented. Analyses of data are still underway and, although conclusions in the report are thought to be valid, they are subject to change. In 1971, as in previous years, there were a number of operational trials with other poisons. The results of these trials are discussed under (B) of "Efficacy of the Spray Operation".

Assessment of the 1971 Aerial Spraying Program

General.--Surveys for budworm egg masses in 1970 delineated 7.9 million acres of high, and 0.7 million acres of moderate infestation (Table III). Hazard to trees was extreme on 370,000 acres, high on 2,160,000 acres, and variable on 5,370,000 acres (Table V). Based on this information, the basic spray plan proposed for 1971 included 5.2 million acres. Provision was made for the addition of areas if further surveys in 1971 indicated protection was needed.

The operational insecticide used was fenitrothion. The basic formulation was an emulsion consisting of water, solvent oil (Aerotex), emulsifier, and fenitrothion. In addition, 9 spray blocks were treated with a solution of fenitrothion and Aerotex. The spray formulations were applied on spray blocks of 12,600 acres each, with teams of 3 T.B.M. aircraft. A summary of acreages sprayed with fenitrothion and other poisons is shown in Table I and is depicted in Figure 1.

The warm spring of 1971 was generally conducive to budworm larval survival. Emerging budworm larvae were detected on 26 April in the Fredericton area, the same date as in 1970. Spray operations commenced on 18 May, 1971, on a number of spray blocks slated for very early application of poison. Budworm larvae were, by and large, in the second instar at this date. Through May and June, insect and host-tree development progressed at an average rate, and larval populations reached the peak of the sixth instar on 20 June in central New Brunswick. Spraying operations ceased on 26 June, 1971.

As a result of overwintering larval surveys conducted in February and March of 1971, and prespray third-instar and tree condition surveys conducted in May, 1971, approximately 800,000 acres were added to the spray plan. The added acres received 3 oz. of fenitrothion per acre.

(A) Efficacy of the Spray Operation.--The efficacy of spraying on budworm populations was estimated from pre-spray and post-spray counts on 25 plots in each of 23 spray blocks, and from a similar set of counts from 144 unsprayed plots. In all, 13, 1-application and 10, 2-application spray blocks were monitored. The data were grouped by insect development at time of spraying (Tables VII, VIII). Protection to trees was estimated from ground surveys of defoliation in the sampled spray blocks and at unsprayed plots. The nature and extent of damage (defoliation) were determined from an aerial survey conducted by Forest Protection Limited and the Canadian Forestry Service.

Per Cent Reduction in Survival and Per Cent Foliage Saved

For the 1971 operation, the average weighted per cent reduction in survival was 85% on balsam fir and 75% on spruce (red/black). Table VI shows the relationship of these results with previous spraying programs. The mean per cent reduction in survival for blocks receiving one and two applications follows:

	Balsam fir	Spruce
One application	82	65
Two applications	88	77

The per cent foliage saved, as determined from ground defoliation estimates, was 40% (balsam fir) (Table VI). However, per cent foliage saved was higher in blocks receiving one application (45%) and lower in those having two applications (35%). Summaries of population counts, per cent reduction in survival and per cent foliage saved are shown in Tables VII and VIII. These tables suggest that:

(1) early application of fenitrothion in oil yields poor results in terms of per cent reduction in survival and fair success in terms of protection of balsam fir foliage;

(2) at one application of 3 oz., the best results in terms of per cent reduction in survival are achieved at peak L_4, but that good foliage protection is achieved at peak L_3 and L_5; late spraying (L_6) provides little foliage protection;

(3) at one application on spruce, the best results in terms of per cent reduction in survival are obtained at peak L_3 and L_6;

(4) at two applications, results in terms of per cent reduction in survival were more uniform on balsam fir than one application, and the best results in terms of per cent foliage saved were achieved when the first application was applied at the peak of L_3 and L_4. There appears to be no real advantage in treating blocks with 3 oz. + 2 oz. over 2 oz. + 2 oz.

Damage to Foliage.--An aerial survey for defoliation, conducted in July by Forest Protection Limited and the Canadian Forestry Service, delineated 1.1, 1.9 and 1.6 million acres of light, moderate and severe defoliation respectively, for a total of 4.6 million acres (Fig. 2). This represents an increase of 0.6 million acres for all categories of defoliation combined over 1970 (Table II). A summary of the various categories of defoliation by county is presented in Table II. Generally, throughout the plan there was fair success in protecting foliage. Exceptions to this were in the northern 1/4 of the spray plan, where two bands of severe defoliation, 126,000 acres near Heath Steele Mines, and 400,000 acres from McGraw Brook in the east, to Plaster Rock in the west, were detected. Both these areas were sprayed late in terms of insect development. The late spraying was a result of four days of weather in June conducive to budworm development but unfavorable for spraying.

(B) Results of Operational Trials with Zectran and Matacil

(1) Zectran.--Two dosages of Zectran (0.25 and 0.5 oz./acre) were tried on 12,000-acre spray blocks. The results of population counts, per cent reduction in survival and per cent foliage saved are shown in Table IX. The results on balsam fir indicate poor success both in per cent reduction in survival and per cent foliage saved at 0.25 oz./acre. The results on the block treated at 0.50 oz./acre were slightly better in terms of per cent reduction in survival, but three times better in terms of per cent foliage saved. However, the per cent foliage saved is less than that attained with fenitrothion. On spruce, the per cent reduction in survival was nil. In 1969, when Zectran was tried at 2.4 oz./acre, reduction in survival on spruce was low (71%) and high on balsam fir (99%). This apparent lack of ability to affect budworm larvae on spruce may be due to the short field life of Zectran and/or the habits of the budworm on red/black spruce.

(2) Matacil.--The efficacy of Matacil was monitored on 4, 12,000-acre blocks. The dosages and formulations used were:

(i) 0.5 oz./acre in Panasol;

(ii) 1.5 oz./acre in Panasol;

(iii) 2 blocks at 1.5 oz./acre of wettable powder in summer oil (Table I and Table IX).

The results obtained were, by and large, inconclusive because of the many problems encountered in application of the poison, particularly the Matacil-Panasol blocks. However, from the data that were gathered, the results in terms of per cent reduction in survival on balsam fir were better on both wettable powder blocks than on either of the Matacil-Panasol blocks. Percentage foliage saved was similar on the Matacil oil block at 1.5 oz./acre sprayed at peak L_3 and the Matacil wettable powder block sprayed at peak L_5 of insect development (Table IX). Both these blocks yielded better results in terms of foliage saved than the other two Matacil blocks, but all four blocks fell short of the performance record of fenitrothion. On all four Matacil blocks, there was no apparent effect on the budworm populations on red/black spruce.

Results of Egg-mass Surveys and a
Forecast for the Maritimes Region in 1972

(a) Results of Egg-mass Surveys.--In New Brunswick, counts of budworm egg masses at 1,000 locations indicate an increase in the area of high infestation from 7.9 million acres in 1970 to 9.0 million acres in 1971, and an increase of low to moderate infestation from 4.9 million acres in 1970 to 5.8 million acres in 1971 (Table III) (Fig. 3). This increase of infestation area is in keeping with the trend set over the past four years. However, the area of high infestation in 1971 has a lower average population density than in 1970, and the areas of extreme infestation (400 + egg masses/100 ft.^{2} of foliage), are decidedly smaller than in 1970. In general, egg densities were lower in sprayed areas in 1971 (Table IV), particularly in areas sprayed twice. A 7.5-fold increase in egg densities was detected in northwest New Brunswick in Madawaska and Restigouche counties and, particularly, in Victoria County (Table IV). Also, egg-mass densities showed an increase in the northeast, central-west, and southwest portions of New Brunswick. An exception is the east coast area of New Brunswick where populations decreased slightly (Table IV). The largest areas of extreme egg-mass populations (400+ egg masses/100 ft.^{2} of foliage) are listed below:

(1) a wide band from Bathurst in the east to Grand Falls in the west - 1.3 million acres;

(2) in the McGivney, Stanley and Durham Bridge area - 115,000 acres;

(3) a patch south of Fredericton to the Bay of Fundy and east to the St. John River - 937,000 acres;

(4) the Kingston Peninsula and Stewarton area - 188,000 acres;

(5) from Coles Island southeast to the Petitcodiac River and Bay of Fundy - 889,000 acres;

(6) from the north end of Grand Lake northeast to the Cains River - 250,000 acres; and

(7) a band along the east coast from Dorchester, north to Chatham - 789,000 acres.

In Nova Scotia, egg-mass counts at 30 locations showed an intensification of the outbreaks in western Cumberland County and on the North and South Mountains in Kings and Annapolis counties. Elsewhere, populations were generally low and the infestation appears not to have increased in area from 1970. The average egg-mass count for Nova Scotia is 242 and ranges from 28 to 970 egg masses per 100 sq. ft. of balsam fir foliage. The indicated trend of the infestation in Nova Scotia might change, pending the results of a survey for overwintering larvae.

In Prince Edward Island, counts of egg masses at eight locations indicate a moderate to high infestation in the western 1/4 of the Province. A survey for overwintering larvae in Prince Edward Island has been completed and supports the results of the egg-mass survey. Elsewhere in the Province, populations are low to moderate. However, there has been an over-all increase from 1970 in the area and intensity of the infestation on Prince Edward Island.

(b) Hazard to Trees in 1972.--Hazard to trees for 1972 is based on:

(1) estimates of tree condition, current defoliation, previous defoliation, and egg-mass populations at each egg-mass sample location;

(2) a composite map of areas that received two years of defoliation (1970-71) as determined from aerial surveys;

(3) observations made by E. G. Kettela of forest conditions from a low-flying aircraft and from the ground.

Hazard is classified into three categories and the areas on the map are general locations inside which this hazard condition is prevalent, particularly on balsam fir.

These categories are:

(1) Extreme - tree mortality and extensive top-killing is expected in 1972;

(2) High - tree vigor will be reduced and top-killing is expected in 1972;

(3) Hazard variable - low to moderate - trees more or less in fair to good condition. A high insect population is present. In 1972, tree vigor will be reduced and there may be top-killing in some scattered locations.

In New Brunswick, the acreages of high, extreme and variable hazard for 1971 and 1972 are shown in Table V and Figure 4. The acreage of 4.7 million acres of high and extreme hazard represents an increase of 2.1 million acres over 1970-71.

In Nova Scotia, hazard is high to extreme in balsam fir stands located in the infestation areas of Cumberland, Kings and Annapolis counties. The approximate acreage inside which there are stands in a high to extreme rating are: Cumberland County - 100,000 acres, Kings and Annapolis counties - 165,000 acres.

In Prince Edward Island, hazard is generally low to moderate. This is due to the newness of the infestation in that Province.

Table I

Synopsis of the 1971 Operational Spray Program in New Brunswick to Minimize Damage by the Spruce Budworm

Insecticide and treatment	Acres
<u>Fenitrothion</u> - 1 application of 3 oz. of poison in 0.15 U.S. gal. of formulation per acre	4,212,727
- 2 applications of 2 oz. of poison, each in 0.15 U.S. gal. of formulation per acre	1,427,750
- 2 applications, one of 3 oz., the other of 2 oz. of poison, each in 0.15 U.S. gal. of formulation per acre	291,000
Sub-total	5,931,477
<u>Operational Experiments</u>	
<u>Zectran</u> - 1 application of 0.25 oz. of poison in 0.15 U.S. gal. of emulsion per acre	12,000
- 1 application of 0.50 oz. of poison in 0.15 U.S. gal. of emulsion per acre	12,000
<u>Matacil</u> - 1 application of 0.50 oz. of poison in 0.15 U.S. gal. of solution per acre (Solvent - panasol)	12,000
- 1 application of 1.50 oz. of poison in 0.15 U.S. gal. of solution per acre (Solvent - panasol)	12,000
- 1 application of 1.50 oz. of wettable powder poison in 0.15 U.S. gal. of suspension per acre (Carrier - Summer Oil)	24,000
Sub total	72,000
Total	6,003,477

Table II

Acreages of Light, Moderate, and Severe Current Defoliation by the Spruce Budworm in New Brunswick by County for 1970 and 1971

County	1970			1971		
	Light	Moderate	Severe	Light	Moderate	Severe
St. John	38,800	41,800	8,000	127,500	42,800	70,700
Albert	72,700	42,800	2,000	40,800	44,800	93,600
Westmorland	101,600	37,900	5,000	58,800	145,400	52,800
Kings	57,800	276,900	90,600	105,600	150,400	115,500
Queens	164,300	100,600	19,900	51,800	136,500	44,800
Charlotte	130,400	56,800	4,000	53,800	110,600	102,600
Sunbury	72,700	116,500	65,700	30,900	112,500	52,800
Kent	154,400	25,900	4,900	31,900	190,200	101,600
York	387,400	145,400	38,800	51,800	210,300	314,700
Northumberland	539,800	22,700	122,500	256,000	454,200	344,600
Carleton	68,700	61,700	8,900	19,900	55,800	90,600
Victoria	134,500	82,800	8,000	82,700	196,200	181,200
Madawaska	18,900	11,000	1,000	46,800	4,000	--
Restigouche	--	--	--	5,000	--	--
Gloucester	46,800	17,900	--	83,700	91,600	3,000
Totals	1,988,800	1,040,700	379,300	1,047,000	1,945,300	1,568,600

Total acreage showing some degree of defoliation - 1969 - 3,395,500

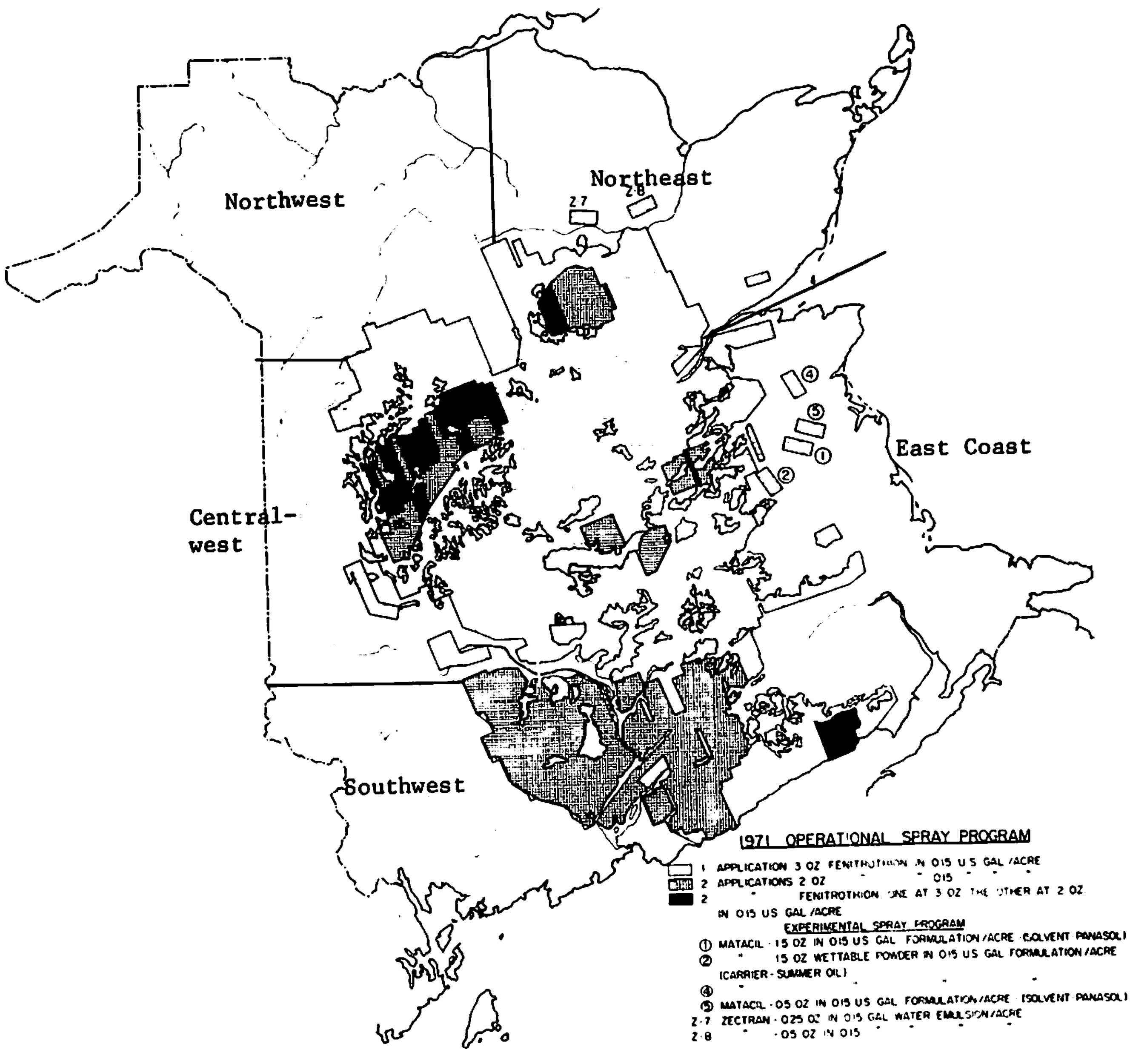
1970 - 4,016,300

1971 - 4,560,900

Table III

Acreages of Light, Moderate and High Spruce Budworm Egg-mass Infestations in New Brunswick - 1960-1971

Year	Infestation category Light	(millions of acres) Moderate	High	Total
1971	4.9	0.9	9.0	14.8
1970	4.2	0.7	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	0.7	0.8	5.8
1966	4.9	0.5	1.4	6.8
1965	4.6	2.4	1.5	8.5
1964	4.4	0.3	1.7	6.4
1963	3.2	0.4	1.3	4.9
1962	2.7	0.2	0.2	3.1
1961	3.6	0.8	0.6	5.0
1960	3.1	0.3	2.0	5.4



Sprayed and unsprayed sectors of New Brunswick

Table IV

Trends in Spruce Budworm Populations by Sector from 1967 to 1971
(Number of sample points in brackets.) (Refer to map on opposite page.)

Area	Mean egg masses per 100 ft.^{2} of foliage					Egg-mass ratios			
	1967	1968	1969	1970	1971	68/67	69/68	70/69	71/70
Sprayed in 1971									
Sprayed once	130(281)	470(288)	462(313)	517(340)	392(346)	3.61	0.98	1.12	0.76
Sprayed twice	117(86)	215(94)	652(106)	718(107)	430(120)	1.84	3.03	1.10	0.60
Unsprayed in 1971									
North - West	4(111)	4(113)	5(121)	22(152)	165(169)	1.00	1.25	4.40	7.50
- East	13(54)	28(56)	50(70)	250(84)	425(90)	2.15	1.78	5.00	1.70
Central - West	24(94)	85(99)	121(104)	136(115)	161(118)	3.54	1.42	1.12	1.18
South - West	3(36)	25(41)	47(43)	136(56)	234(63)	8.33	1.88	2.89	1.72
East coast	30(70)	107(70)	304(70)	620(82)	500(86)	3.56	2.84	2.04	0.81

Table V

Acreage of Forest in Extreme, High and Variable Hazard Categories in New Brunswick - 1970 and 1971

Category	Year 1970	Year 1971
Extreme[1]	370,000	575,000
High[2]	2,160,000	4,120,000
Variable[3]	5,370,000	4,000,000
Total	7,900,000	8,695,000

[1]Extreme hazard - tree mortality and top-killing is expected.

[2]High hazard - tree vigor will be reduced and top-killing is to be expected.

[3]Variable hazard - trees more or less in fair condition; a high insect population is present; there will be reduction in tree vigor plus some scattered top-killing; areas of high and extreme hazard are too small to be delineated.

Table VI

Per Cent Reduction in Survival or Population, and Percentage of Balsam Fir Foliage Saved by Spraying - 1952-1971

Year	% reduction of survival of population: Balsam fir	% reduction of survival of population: Spruce	% balsam fir foliage saved
1952[1]	99	-[3]	7
1953	96	-	41
1954	-	-	52
1955	83	-	41
1956	89	-	25
1957	85	-	35
1958	80	-	34
1960[2]	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

[1]Data from 1952-58 - from paper by F. E. Webb.

[2]Data from 1960-67 - from reports by D. R. Macdonald.

[3]- indicates no data.

Table VII

Results of Spraying in Terms of Budworm Survival, Per Cent Reduction in Survival and Per Cent Foliage Saved. One Application of 3 Oz. of Fenitrothion - Oil and Emulsion Sprays.

	Peak instar of insect development	Number blocks sampled	Budworm per 18" branch tip Pre-spray	Budworm per 18" branch tip Post-spray	Survival (pre-spray)/(post-spray)	Per cent reduction in survival	Per cent new foliage saved
				Balsam Fir			
Oil	L2	3	43.3	3.5	0.08	72	35
Emulsion	L3	1	13.3	1.1	0.08	72	67
	L4	5	54.5	1.7	0.03	90	30
	L5	3	17.5	1.0	0.06	80	52
	L6 - P	1	40.5	2.3	0.06	80	3
Unsprayed control			14.6	4.2	0.29		
				Spruce			
Oil	L2	3	13.2	1.7	0.13	26	
Emulsion	L3	1	11.4	0.2	0.02	88	
	L4	5	22.3	1.1	0.05	71	
	L5	3	21.9	3.1	0.14	20	
	L6	1	28.3	0.4	0.02	88	
Unsprayed control			14.8	2.6	0.18		

Table VIII

Results of Spraying in Terms of Budworm Survival, Per Cent Reduction in Survival and Per Cent Foliage Saved. Two Applications of Fenitrothion.

Insecticide treatment	Number blocks	Insect development: One applic.	Insect development: Two applic.	Budworm per 18" branch tip: Pre-spray	Budworm per 18" branch tip: Post-spray	Survival (pre-spray)/(post-spray)	Per cent reduction in survival	Per cent new foliage saved
				Balsam Fir				
2 oz. + 2 oz.	1	L3	L5	20.3	0.6	0.03	90	40
	2	L4	L6	20.6	0.3	0.01	97	69
	2	L5	L6	33.1	1.8	0.05	83	20
	2	L6	L6	29.2	0.7	0.02	93	26
	1	L6	Pupae	16.3	2.6	0.16	45	10
				Spruce				
	1	L3	L5	37.7	1.1	0.03	83	
	2	L4	L6	11.5	0.7	0.06	67	
	2	L5	L6	16.4	1.9	0.12	33	
	2	L6	L6	16.2	0.7	0.04	78	
	1	L6	Pupae	17.2	2.4	0.14	22	
				Balsam Fir				
3 oz. + 2 oz.	2	L4	L6	38.5	1.2	0.03	90	40
				Spruce				
		L4	L6	34.6	0.9	0.03	83	
				Balsam Fir				
Unsprayed control				14.6	4.2	0.29		
				Spruce				
				14.8	2.6	0.18		

Table IX

Synopsis of Results of Operational Trials with Various Dosages and Formulations of Matacil and Zectran

Poison	Dosage oz./acre	Formulation	Spray block	Insect development instar	Budworm per 18" branch tip: Pre-spray	Budworm per 18" branch tip: Post-spray	Survival (pre-spray)/(post-spray)	Per cent reduction in survival	Per cent new foliage saved
					Balsam Fir				
Matacil	1.5	oil[1]	1	L3	39.0	5.1	0.13	48	25
	0.5	oil	5	L5	21.6	2.9	0.13	57	15
	1.5	w.p.[2]	2	L5	39.1	2.3	0.06	76	30
	1.5	w.p.	4	L6	24.0	1.2	0.05	82	6
					Spruce				
	1.5	oil	1	L3	42.9	6.6	0.16	0	
	0.5	oil	5	L3	19.0	7.1	0.38	0	
	1.5	w.p.	2	L5	15.1	4.0	0.27	0	
	1.5	w.p.	4	L4	24.4	3.6	0.15	3	
					Balsam Fir				
Zectran	0.25	emul.[3]	7	L4	16.7	3.7	0.22	44	8
	0.50	emul.	8	L5	18.5	2.8	0.15	57	25
					Spruce				
	0.25	emul.	7	L3	12.1	1.1	0.09	0	
	0.50	emul.	8	L4	15.2	1.5	0.10	0	

[1] oil - Matacil formulated in Panasol.

[2] w.p. - Matacil wettable powder formulated as a suspension in summer oil.

[3] emul. - Zectran 2E emulsion formulated in water.

Table X

Extent of Spruce Budworm Infestation and
Percentage of Infestation Sprayed in New Brunswick, 1949-1972

	Infested area (millions of acres)		Sprayed area		
Year	Total infestation	High infestation	Acres treated (millions)	% of total infestation	% of high infestation
1972	14.8	9.0	--	--	--
1971	12.8	7.9	6.00	47	73
1970	10.0	5.0	4.24	42	85
1969	10.2	3.6	3.09	30	86
1968	5.8	0.5	0.49	8	98
1967	6.8	1.4	1.04	15	74
1966	8.5	1.5	1.97	24	100
1965	6.4	1.7	2.12	33	100
1964	4.9	1.3	1.98	40	100
1963	3.1	0.2	0.67	22	100
1962	5.0	0.6	1.37	27	100
1961	5.4	2.0	2.19	41	100
1960	6.9	1.9	2.96	43	100
1959	8.9	0.3	0.00	0	0
		(moderate to high)			
1958	13.9	3.1	2.60	19	84
1957	17.7	13.5	5.69	32	42
1956	17.7	11.4	1.97	11	17
1955	17.2	9.1	1.12	7	12
1954	10.4	8.2	1.14	11	14
1953	9.2	8.7	1.81	20	21
1952	11.5	2.9	0.19	2	7
1951	8.8	1.8	--	--	--
1950	6.9	0.7	--	--	--
1949	6.9	0.6	--	--	--

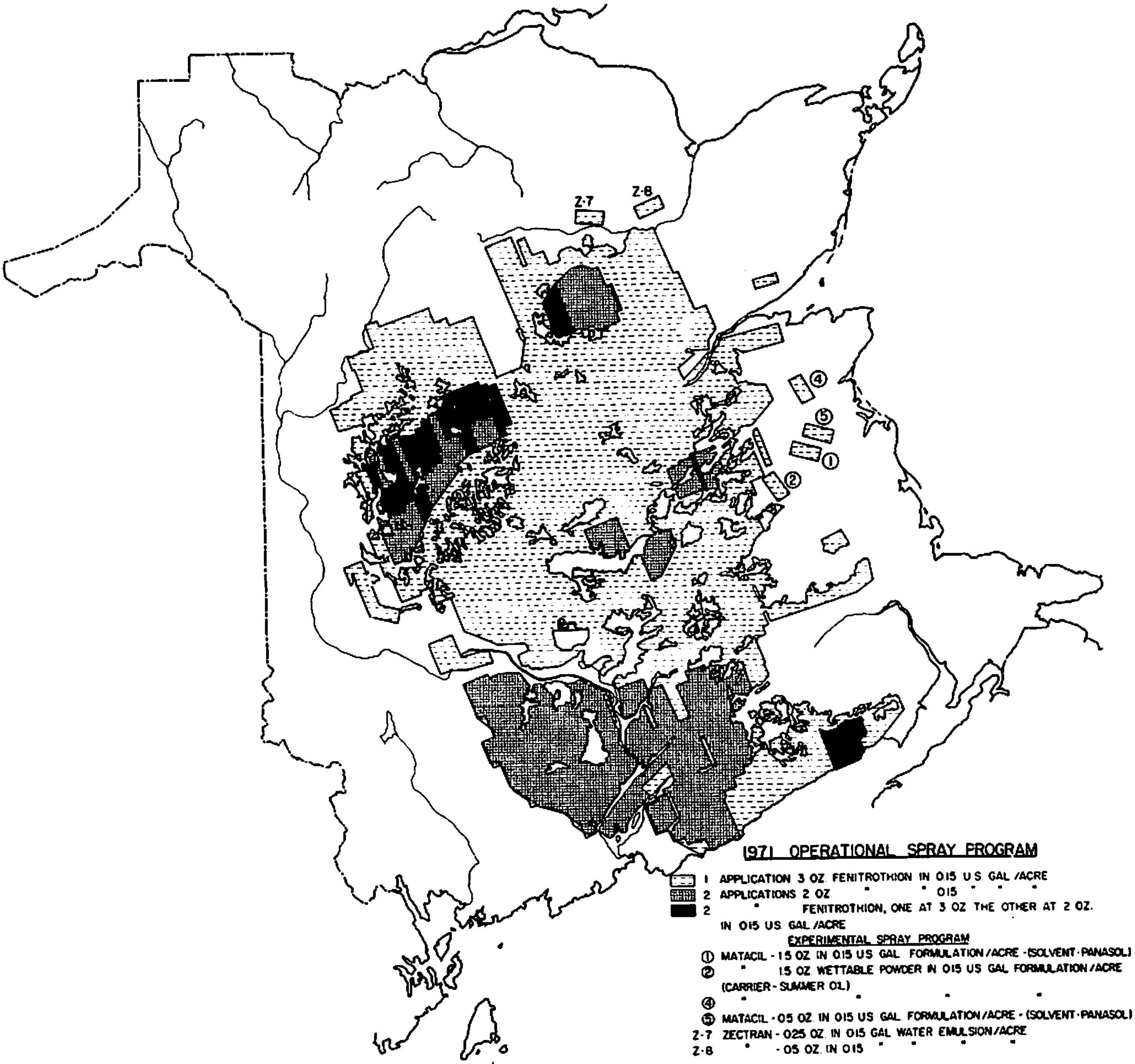

Z-7
Z-8
1971 OPERATIONAL SPRAY PROGRAM
1 APPLICATION 3 OZ FENITROTHION IN 015 US GAL /ACRE
2 APPLICATIONS 2 OZ " " 015 " " "
2 " FENITROTHION, ONE AT 3 OZ THE OTHER AT 2 OZ.
IN 015 US GAL /ACRE
EXPERIMENTAL SPRAY PROGRAM
① MATACIL - 15 OZ IN 015 US GAL FORMULATION /ACRE - (SOLVENT - PANASOL)
② " 15 OZ WETTABLE POWDER IN 015 US GAL FORMULATION /ACRE
(CARRIER - SUMMER OIL)
④ " " " "
⑤ MATACIL - 05 OZ IN 015 US GAL FORMULATION /ACRE - (SOLVENT - PANASOL)
Z-7 ZECTRAN - 025 OZ IN 015 GAL WATER EMULSION /ACRE
Z-8 " - 05 OZ IN 015 " " " "

Figure 1

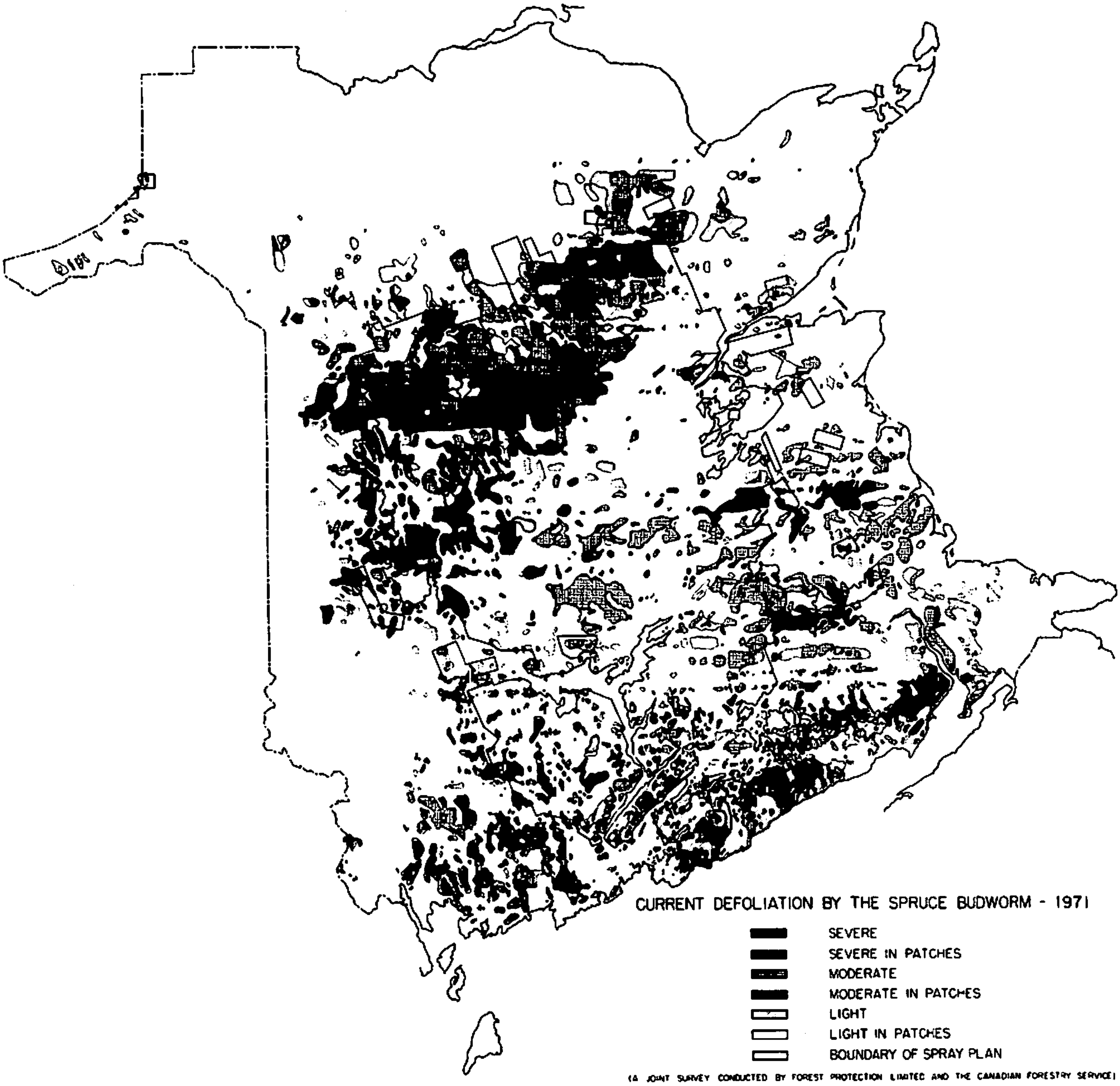

CURRENT DEFOLIATION BY THE SPRUCE BUDWORM - 1971
SEVERE
SEVERE IN PATCHES
MODERATE
MODERATE IN PATCHES
LIGHT
LIGHT IN PATCHES
BOUNDARY OF SPRAY PLAN
(A JOINT SURVEY CONDUCTED BY FOREST PROTECTION LIMITED AND THE CANADIAN FORESTRY SERVICE)

Figure 2

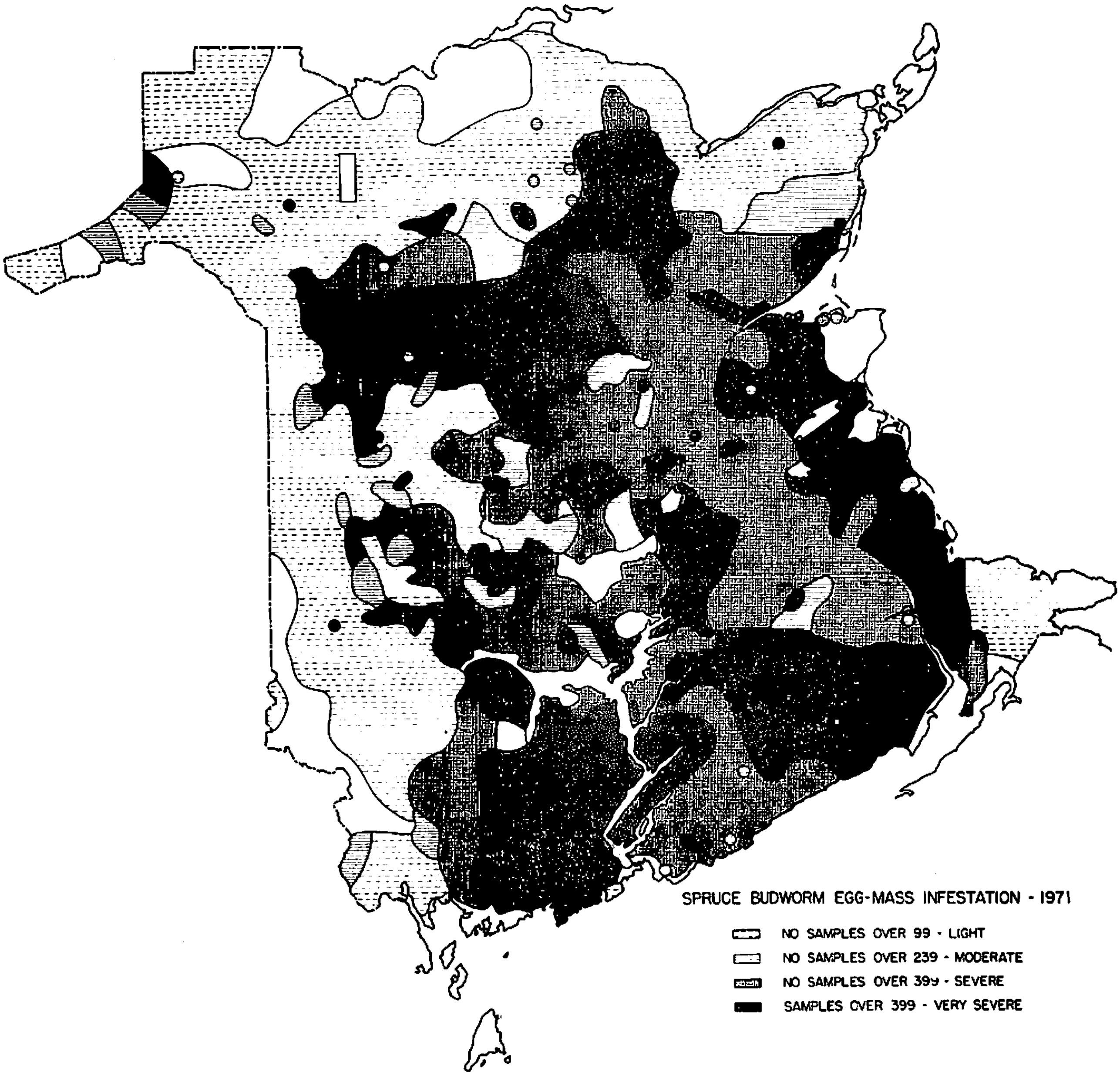

SPRUCE BUDWORM EGG-MASS INFESTATION - 1971
NO SAMPLES OVER 99 - LIGHT
NO SAMPLES OVER 239 - MODERATE
NO SAMPLES OVER 399 - SEVERE
SAMPLES OVER 399 - VERY SEVERE

Figure 3

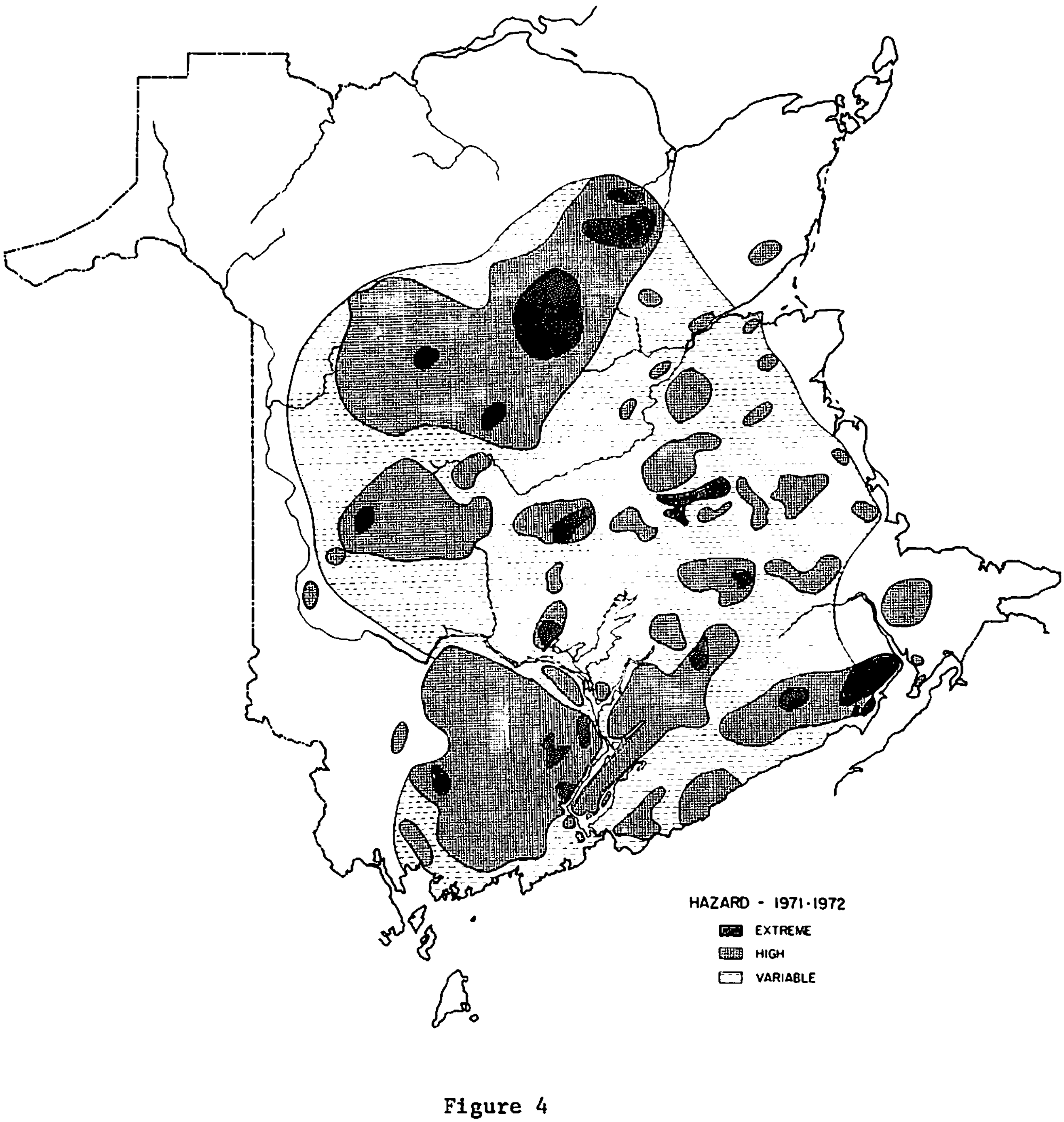


Figure 4

APPENDIX 3

Effects of Matacil and fenitrothion spraying on birds
New Brunswick and Quebec, 1971

P.A. Pearce
Canadian Wildlife Service
Department of the Environment
Fredericton, N.B.

For Interdepartmental Committee on Forest Spraying Operations, November 1971

Abstract

An appraisal of the effects of Matacil and fenitrothion spraying on populations of forest birds was made by the Canadian Wildlife Service during spruce budworm control programs, experimental and operational, conducted in New Brunswick and Quebec in 1971.

Matacil was employed in a duplicated trial at an emitted dosage of 1.5 ounces of wettable powder in 0.15 US gallons of summer oil per acre. In a third trial, insecticide was applied at an emitted dosage of 1.5 ounces in 0.15 US gallons of Panasol per acre. Matacil was apparently not acutely toxic to birds at those rates of application under the conditions of exposure prevailing at the time of spraying.

The effects of fenitrothion spraying at an emitted dosage of 3 ounces in 0.15 US gallons of oil-in-water emulsion were assessed in the Gatineau River and Lac Temiscouata regions of Quebec and in Fundy National Park, New Brunswick. Bird trend counts failed to indicate any significant post-spray bird population depressions but a few casualities, mostly warblers, were found in some treated areas.

Canadian Wildlife Service interest in the impact on birds of current forest insect pest control programs and in the hazard to birds presented by newer insecticides, with the potential for wide-scale use, continued in 1971. Matacil spraying was monitored during trials conducted in New Brunswick, and operational fenitrothion spray programs were monitored in that province and in two regions of Quebec (Table 1).

The field techniques used, already described to this committee, consisted of pre- and post-spray bird "censuses" or "trend counts" in treated and control areas, intensive searches of spray zones for evidence of bird intoxication, and observation of post-spray activity at nest sites. Bird identification was based essentially on voice recognition.

For the sake of brevity our findings are presented, with little comment, in a tabular and graphic manner. A species by species comparison of the day-to-day numbers of birds noted in treated and untreated areas in most cases showed no variability that could not be attributed to factors other than the spray. For this reason the census data have been condensed and species grouped into the most abundantly represented passerine families.

Experimental Matacil spraying

Co-operative monitoring of large-block experimental spraying of Matacil, begun in 1970, continued this year because of further interest in the potential of that insecticide for budworm control. The development of unforeseen solvent/spray equipment incompatibilities resulted in mid-course changes in the spray plan and the introduction of wettable powder applications. Our field program was sufficiently flexible to allow us to adjust to those changes. The choice of spray block locations was necessarily a compromise reflecting the requirements of the co-operating monitoring agencies - the Maritimes Forest Research Centre, the Chemical Control Research Institute, the Resource Development Branch of Fisheries, and ourselves.

We were able to monitor the three treatments indicated in Table 1 in spray blocks located as shown in Figure 6. Bird counts were made along 2.5 mile routes in the treatment areas and along a route of the same length in a control (unsprayed) area in Kouchibouguac National Park. The counts are summarized in Tables 2, 3, and 4 and population indices are presented in Figures 1, 2, and 3. There were no apparent population depressions that could be attributed to the spray. Birds were noted to be behaving normally during intensive post-spray searches of treated areas. There was no evidence that nestling survival was adversely affected by the spray (Table 8).

If we consider only emitted dosage as the most important factor in predicting hazard to birds, our failure to demonstrate any damage reflects our findings during the 1970 Matacil trials. The available acute oral toxicity information suggests that Matacil is slightly more toxic to birds than fenitrothion. All other factors being equal, it is probable that adverse effects on birds would begin to manifest themselves in areas treated with Matacil at about twice the rates used in 1971.

Operational fenitrothion spraying

1. Lac Temiscouata operation

Control action against budworm in the Lac Temiscouata region was apparently, in some quarters, initially envisaged as a "knock-out" attempt. Fenitrothion in two applications at a total dosage of 6 ounces per acre was to have been used. Our concern was in the possibility that bird casualties could result if the time interval between the two treatments was very short. A late-hour revision of the spray plan resulted in the elimination of some blocks (in which we had begun bird counts), the redrawing of the boundaries of others, and the adoption of a single application rate of 3 ounces per acre.

We conducted pre- and post-spray bird counts, summarized in Table 5 and Figure 4, in block 4 located as shown in Figure 7. There was no indication that birds were adversely affected by the spray and we were unable to find any casualties during two days searching of the treated area. On the afternoon of June 14 we found an intoxicated myrtle warbler and a sick American redstart in block 5, which had been sprayed that morning. The redstart was held in captivity for a short while, then sacrificed so that it could be analysed later. Most of the few nests we were able to find remained active until at least nine days after spraying, though their final outcome is unknown because observations were not continued.

We gratefully acknowledge the assistance of M. Réginald Ouellet, of the Quebec Wildlife Service, during the monitoring of this operation.

2. Western Quebec operation

About two million acres of mixedwood forest in the Gatineau River region was sprayed in 1971. Fenitrothion was applied at 3 ounces per acre throughout. Because of its proximity to Ottawa we selected block 232, located as shown in Figure 8, for study. All of the area traversed by the 1.9 mile census route was sprayed on the morning of June 7. The westernmost portion of the block was not sprayed until June 16. A summary of bird counts in treated and control areas is given in Table 6, and day-to-day variation in population indices is shown in Figure 5. Apart from an apparent decrease in the activity of Nashville warblers, ovenbirds, and American redstarts in the treated area for two days after spray application, the census data indicated no marked depression of the number of resident birds. No casualties were seen during searches of the spray zone.

3. Fundy National Park operation

Fundy National Park was scheduled for one spray application, but a late change in plan resulted in two treatments being made. The first application, at the rate of 3 ounces per acre, took place during the period June 7 to 13. No bird trend counts were made but personnel of the park's interpretive and warden services conducted post-spray searches for carcasses and incapacitated birds. Eight were found, details of which are given in Table 7. Park Naturalist John MacFarlane noted that "Other sightings of abnormally behaving birds were reported after the initial spray operation by casual observers such as tourists who were unable to provide adequate detail to make the sightings meaningful." It is expected that determinations of acetylcholinesterase activity in the brain tissue of some of the casualties, as well as control birds, will be made. Carcasses will also be analysed for residual fenitrothion.

A second application at the rate of 2 ounces per acre was made on the morning of June 25, after a minimum time lapse of 12 days. Commencing on the afternoon of that day we spent about 50 man-hours walking about 40 miles of woodland roads and trails throughout the treated area in a search for evidence that the spray had adversely affected birds. None was found. Pending pathological examination of the specimens, passing reference is made to the finding of a moribund snowshoe hare in the vicinity of the main campground about an hour after spraying, and to the finding of a dead woodland jumping mouse on the day following the spray.

In conclusion, we note that experience with fenitrothion during the last few years shows that a few birds, particularly males of some warbler species, may be acutely poisoned at emitted rates as low as 2 or 3 ounces per acre during operational spraying. Casualties may occur in areas where inadvertent or unavoidable overdosing may take place. The hazard could possibly be reduced by formulating the insecticide in a different manner and by spraying much earlier in the season.

Table 1. Summary of treatments monitored.

Spray block designation	Location	Insecticide	Dosage, formulation and application rate	Date sprayed	Conditions
M-1	Kent Co. N. B.	Matacil	1.5 oz in Panasol at 0.15 USG/acre	June 5 am	Foliage dry. Wind speed 10-20 mph
M-2	Kent Co. N. B.	Matacil	1.5 oz wettable powder in summer oil at 0.15 USG/acre	June 10 pm	Calm. Foliage wet, shower immediately after spray.
M-4	Kent Co. N. B.	Matacil	1.5 oz wettable powder in summer oil at 0.15 USG/acre	June 11 am	Wind up to 10 mph
4	Lac Temiscouata Que.	fenitrothion	3.0 oz in Aerotex + Atlox in water emulsion at 0.15 USG/acre	June 14 pm	Foliage dry. Calm.
232	Kazabazua R. Western Que.	fenitrothion	3.0 oz in Aerotex + Atlox in water emulsion at 0.15 USG/acre	June 7 am	?
562-568	Fundy National Park, N. B.	fenitrothion	3.0 oz in Aerotex + Atlox in water emulsion at 0.15 USG/acre	June 7-13	?
940-943	Fundy National Park, N. B.	fenitrothion (re-spray)	2.0 oz in Aerotex + Atlox in water emulsion at 0.15 USG/acre	June 25 am	Calm, some coastal fog.

Table 2. Summary of census data for selected passerine families - Matacil experimental spray block M-1.

Treatment

Family	May 25	28	30	June 1	4	5		6	8	10	13	16
Tyrannidae	22	16	18	16	20	21	sprayed on June 5	23	21	19	21	21
Turdidae	15	25	23	29	26	23		31	30	30	35	32
Sylviidae	10	12	11	10	9	9		11	11	12	14	10
Vireonidae	5	5	4	6	12	10		10	8	10	13	9
Parulidae	153	162	167	168	138	120		164	186	157	164	144
Fringillidae	47	39	28	34	26	40		41	36	33	31	26

Control

Family	May 25	28	30	June 1	4	5		6	8	10	13	16
Tyrannidae	2	2	3	3	3	12	unsprayed	9	18	2	14	17
Turdidae	25	18	21	35	14	18		16	20	20	13	23
Sylviidae	27	37	21	20	14	19		25	24	30	23	22
Vireonidae	4	6	5	7	4	4		1	5	3	4	5
Parulidae	162	156	165	176	138	145		153	175	160	164	164
Fringillidae	90	92	69	65	45	58		56	61	54	42	60

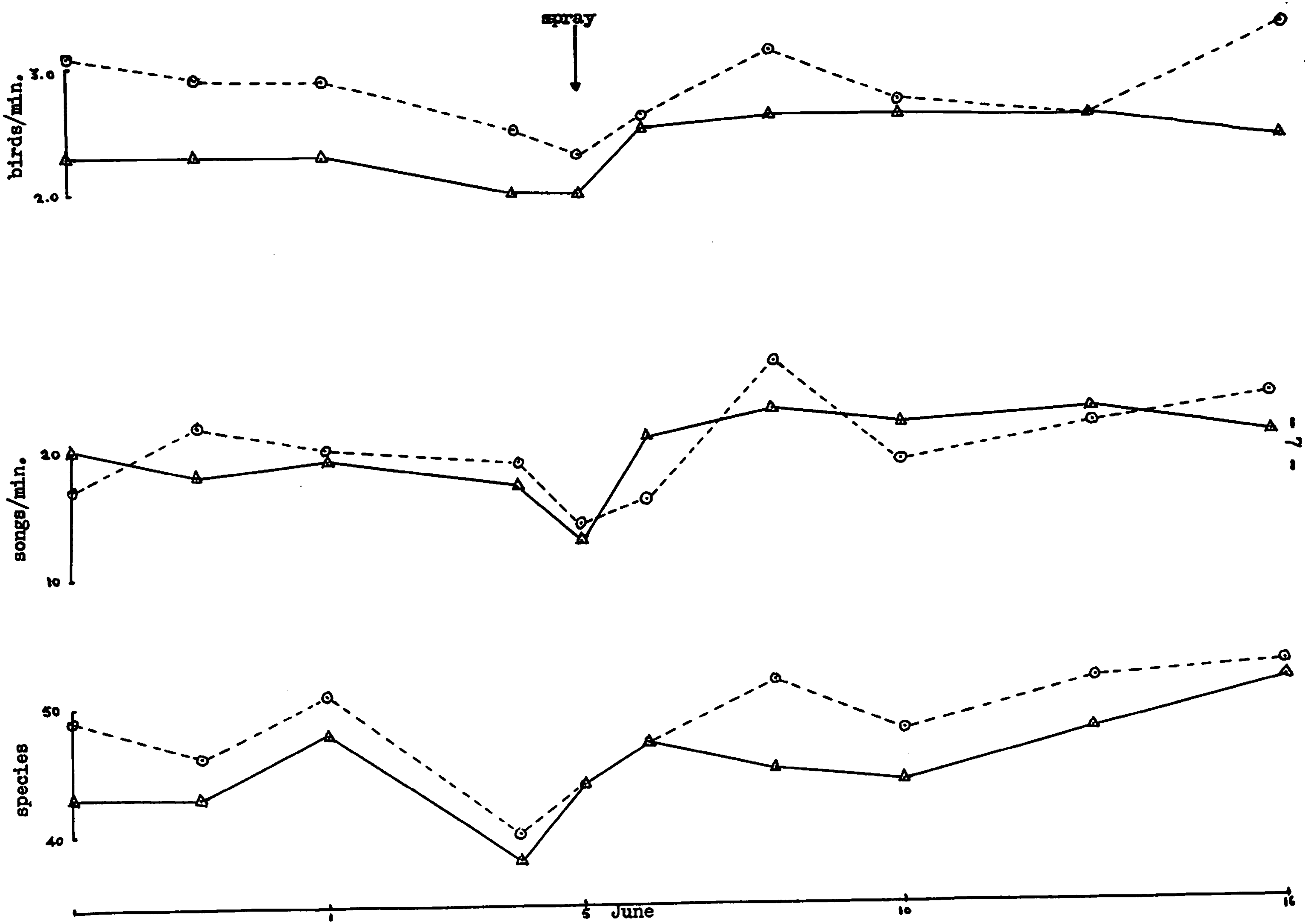


Figure 1. Bird population indices - Matacil block M-1. (treatment △——△ , control ⊙- - -⊙)

Table 3. Summary of census data for selected passerine families - Matacil experimental spray block M-2.

Treatment

Family	Number of birds recorded on June 4	5	6	7	8	10		11	12	13	14	17
Tyrannidae	9	12	21	20	20	17	sprayed on June 10	16	17	17	22	20
Turdidae	28	33	41	48	39	42		36	44	49	47	37
Sylviidae	17	19	22	18	21	22		18	18	21	25	18
Vireonidae	5	9	8	9	9	13		13	11	10	9	10
Parulidae	145	132	165	172	179	170		173	197	175	172	168
Fringillidae	30	36	52	52	39	38		45	48	58	39	43

Control

Family	June 4	5	6	7	8	10		11	12	13	14	17
Tyrannidae	3	12	9	19	18	2	unsprayed	10	15	14		12
Turdidae	13	18	16	19	20	20		10	23	13		31
Sylviidae	14	19	25	29	24	30		22	23	23		15
Vireonidae	4	4	1	6	5	3		2	2	4		5
Parulidae	138	145	153	194	175	160		165	152	164		151
Fringillidae	45	58	57	80	61	56		55	48	42		41

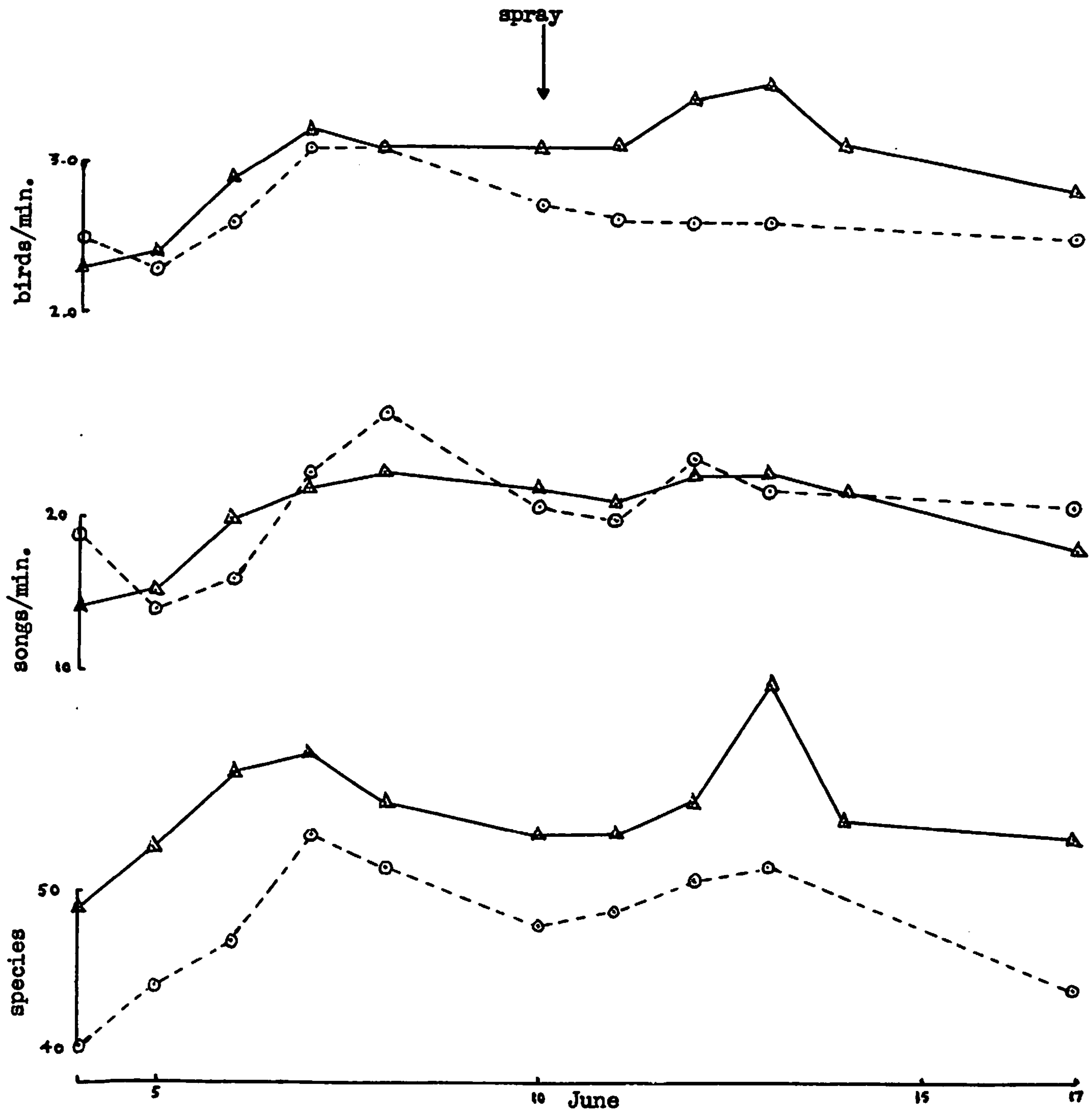


Figure 2. Bird population indices - Matacil block M-2. (treatment △——△ , control ⊙---⊙)

Table 4. Summary of census data for selected passerine families - Matacil experimental spray block M-4.

Treatment

Number of birds recorded on

(sprayed on June 11)

Family	May 27	29	31	June 2	7	9	11	12	15	17	18
Tyrannidae	8	15	10	9	19	12	17	24	12	15	19
Turdidae	15	24	13	22	27	27	22	43	33	35	33
Sylviidae	10	10	6	10	11	8	6	9	7	3	4
Vireonidae	1	3	6	10	13	6	12	12	12	11	10
Parulidae	118	163	154	144	151	111	120	134	158	133	128
Fringillidae	42	51	29	43	51	31	33	37	38	29	31

Control

(unsprayed)

Family	May 27	29	31	June 2	7	9	11	12	15	17	18
Tyrannidae	2	8	3	8	19	0	10	15	17	12	11
Turdidae	23	20	25	18	19	8	10	23	21	31	22
Sylviidae	38	33	16	20	29	13	22	23	20	15	12
Vireonidae	4	6	6	4	6	0	2	2	4	5	2
Parulidae	141	170	174	162	194	165	165	152	150	151	131
Fringillidae	100	113	70	73	80	40	55	48	52	41	46

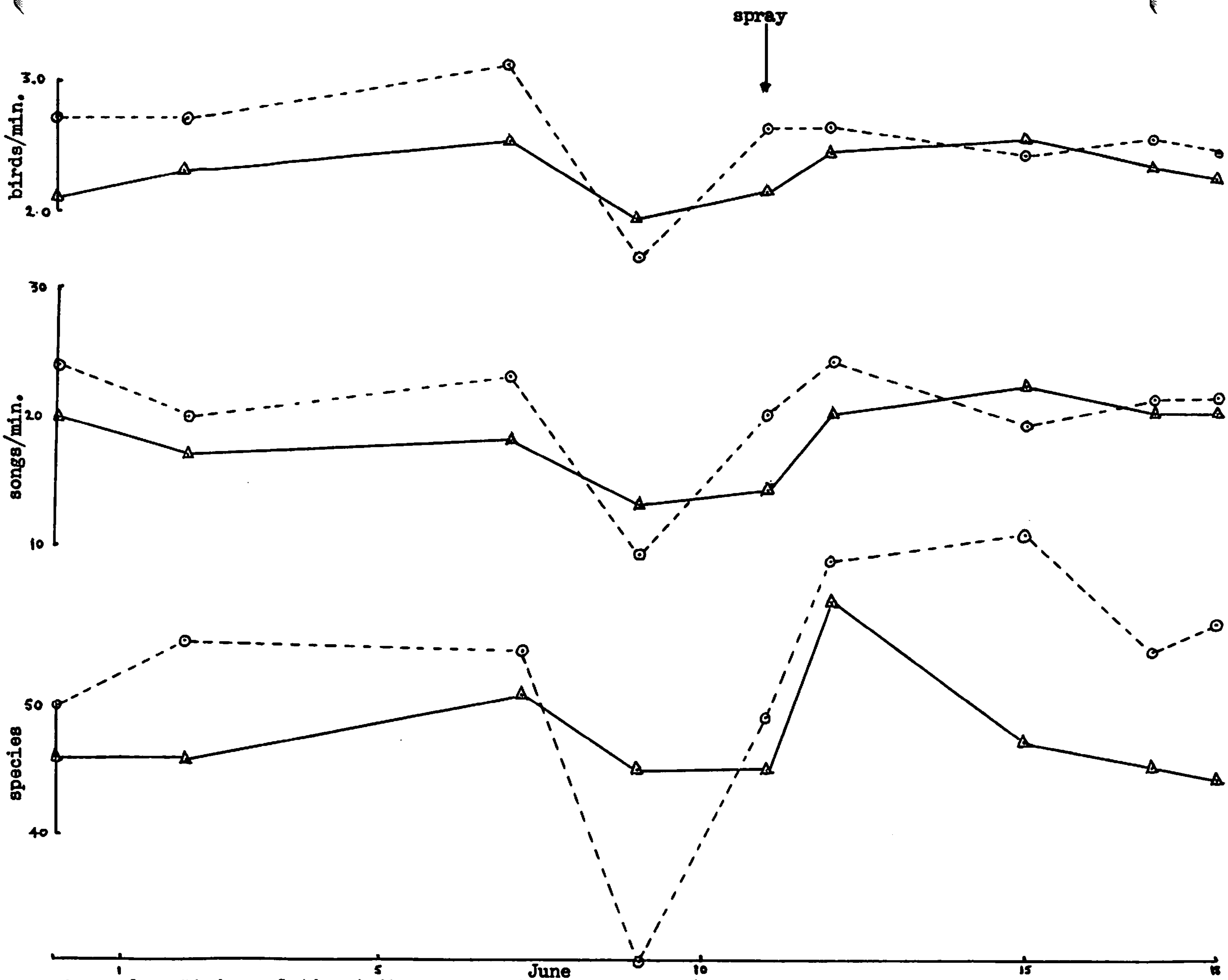


Figure 3. Bird population indices - Matacil block M-4. (treatment △——△, control ⊙---⊙)

Table 5. Summary of census data for selected passerine families - fenitrothion operational spray block 4 (Temiscouata, Que.)

Treatment

Family	May 29	June 1	3	5	7	10	11	12	14		15	16	17	18
Tyrannidae	2	5	8	5	13	12	7	10	13	sprayed on June 14	11	9	9	8
Turdidae	66	82	70	34	56	53	73	74	66		69	77	67	75
Sylviidae	26	31	22	20	13	15	16	17	12		12	12	15	8
Vireonidae	7	13	11	9	10	19	19	15	26		22	15	21	20
Parulidae	216	201	170	122	101	147	158	160	144		157	130	156	135
Fringillidae	224	231	213	141	133	194	193	241	187		191	163	159	167

Control

Family	May 29	June 1	3	5	7	10	11	12	14		15	16	17	18
Tyrannidae	5	17	30	16	14	20	24	23	21	unsprayed	24	25	27	30
Turdidae	73	74	93	60	71	72	84	82	81		85	74	70	71
Sylviidae	3	6	3	3	3	4	4	5	3		4	5	4	4
Vireonidae	5	0	0	0	1	6	4	7	5		5	6	5	7
Parulidae	102	93	109	88	105	93	116	94	95		106	102	101	90
Fringillidae	117	133	98	106	121	100	115	132	101		110	119	101	101

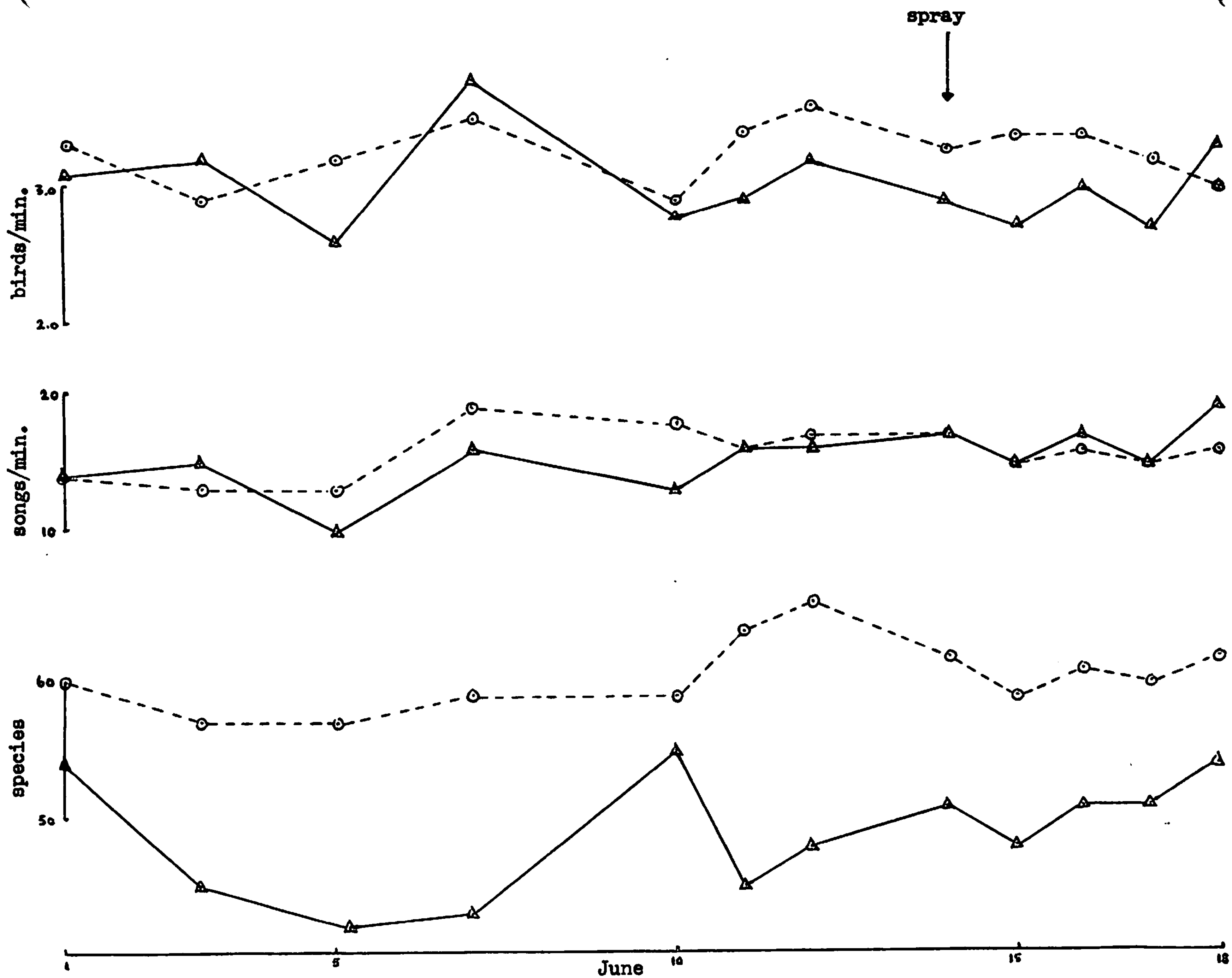


Figure 4. Bird population indices - fenitrothion block 4. (treatment △——△ , control ⊙- - -⊙)

Table 6. Summary of census data for selected passerine families - fenitrothion operational spray block 232 (western Que.)

Treatment

Family	May 28	29	30	June 1	2	3	4	5	6		8	9	10	14
	Number of birds recorded on													
Tyrannidae	5	9	4	7	8	8	10	6	9	sprayed on June 7	9	5	8	8
Turdidae	7	14	15	12	13	18	14	15	23		15	16	29	24
Vireonidae	4	8	8	7	10	9	9	6	9		9	11	11	10
Parulidae	87	88	109	85	83	93	89	88	88		57	72	81	83
Fringillidae	25	29	20	14	20	11	15	16	19		13	11	16	21

Control

Family	May 28	29	30	June 1	2	3	4	5	6		8	9	10	14
Tyrannidae	9	6	10	12	11	12	11	11	13	unsprayed	12	11	8	8
Turdidae	9	14	16	13	22	15	13	14	19		18	14	21	13
Vireonidae	4	3	10	7	9	10	7	5	6		3	6	5	5
Parulidae	40	49	45	55	54	49	34	36	39		47	43	44	34
Fringillidae	20	20	31	22	23	13	17	15	27		16	19	31	11

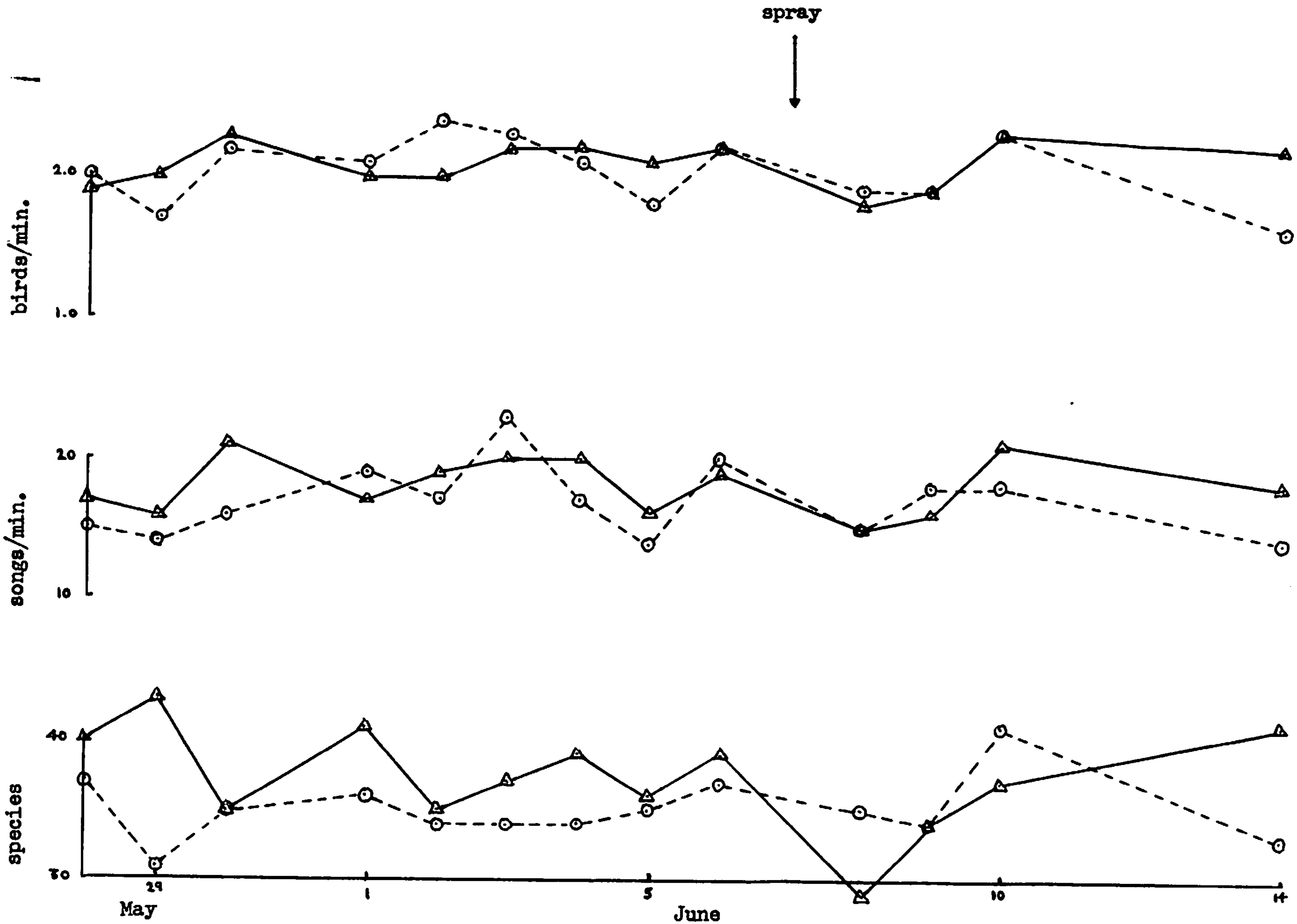


Figure 5. Bird population indices - fenitrothion block 232. (treatment △——△, control ⊙- - - -⊙)

Table 7. Possible spray casualties reported by interpretive and warden personnel after first fenitrothion application (3 oz/acre) at Fundy National Park.

Spray block designation	Date sprayed	Casualties	Comment
562	June 7	1 magnolia warbler*	Found dead at Marven Lake (centre of block) on June 9.
563	June 7	1 purple finch*	Found in convulsions in Wolfe Lake vicinity (centre of block) on June 8. Died in captivity following day.
		1 Tennessee warbler 1 yellow warbler 2 American redstarts	All exhibiting symptoms of acute poisoning at Wolfe Lake on June 8.
564	June 11	1 Blackburnian warbler	Exhibiting symptoms of acute poisoning, between Bennett Lake and Tracey Lake on June 12.
566	June 11	1 magnolia warbler* 1 myrtle warbler*	Both found dead at Chignecto campground on June 12.

*Carcasses preserved for analysis and brain cholinesterase determination.

Table 8. History of nests in spray areas.

Spray block	Nests found	Species represented	Nests active at spray time	Nests active (n) days post-spray	Nests abandoned post-spray	Nests in which young believed fledged	Outcome unknown*
M-1	19	11	13	(16) 5	4	4	5
M-2	8	6	6	(12) 6	1	2	3
M-4	4	4	4	(10) 3	0	1	3
4	10	8	7	(9) 6	1	0	6
Fundy Nat. Park	3	3	3**	(2) 3	0	0	3

*because observations were not continued
**second spray

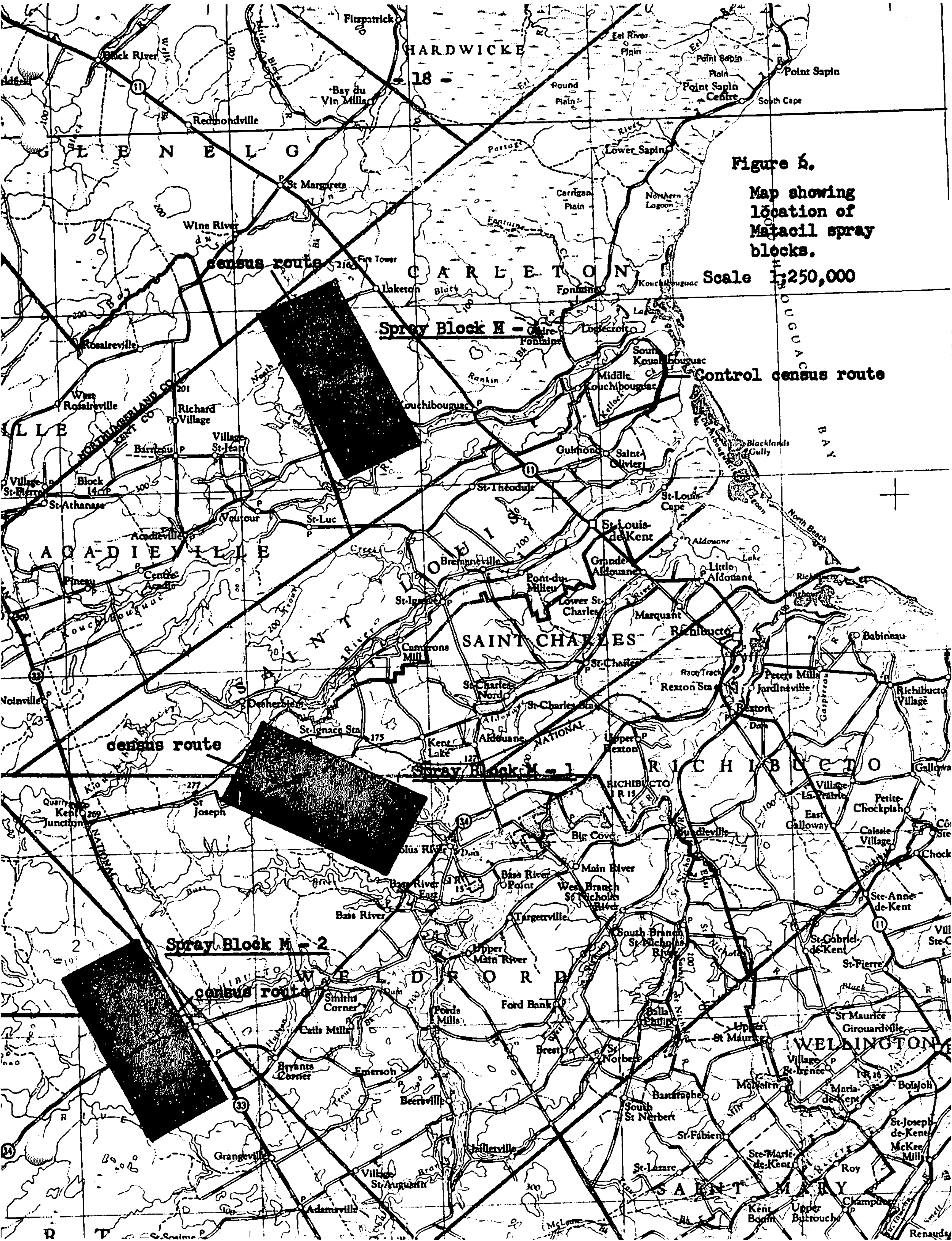


Figure 6.

Map showing location of Matacil spray blocks.

Scale 1:250,000

Figure 7. Map showing location of fenitrothion spray block 4.

Figure 8. Map showing location of fenitrothion spray block 23

Scale 1:250,000

APPENDIX 4

SUMMARY REPORT ON THE EFFECTS OF FOREST SPRAYING IN NEW BRUNSWICK IN 1971, ON JUVENILE ATLANTIC SALMON AND AQUATIC INSECTS

prepared for

THE INTERDEPARTMENTAL COMMITTEE ON
FOREST SPRAYING OPERATIONS

G. H. Penney
Department of the Environment
Canadian Fisheries Service
Resource Development Branch
Pollution Abatement Section
Halifax, N.S., November, 1971.

INTRODUCTION

In 1971, approximately six million acres of New Brunswick forests were operationally sprayed with the organophosphate insecticide known as Fenitrothion, for control of the spruce budworm. Several operational-experimental spray blocks of approximately 12,000 acres each were located apart from the main operational spray area, and were sprayed with various concentrations of the carbamate insecticides, Matacil and Zectran.

This is a preliminary summary of the effects of Fenitrothion spraying on juvenile Atlantic salmon and aquatic insects, and of matacil spraying on aquatic insects, as indicated by Resource Development Branch field monitoring in 1971.

STUDIES

Effects of the Fenitrothion and Matacil spraying were evaluated by:

(a) Population density determinations of juvenile Atlantic salmon in streams located in the Fenitrothion spray area.

(b) Sampling of aquatic insect populations in two streams that were sprayed twice with Fenitrothion, and by having pre-spray and post-spray samples of water and aquatic insects analyzed for Fenitrothion residues.

(c) Sampling of aquatic insect populations in a stream that was sprayed with Matacil.

RESULTS

(a) Population Densities of Juvenile Atlantic Salmon

Juvenile salmon populations were determined by electrofishing at 29 stations in spray area streams, by biological staff operating from the Newcastle District office of the Salmon Management Section of Resource Development Branch. 14 stations were located on the Southwest Miramichi River and 15 stations on various tributary streams to the Southwest Miramichi River. Mean numbers of salmon fry, small parr, and large parr, per 100 square yards found at stations in the Southwest Miramichi River and at stations in tributary streams are tabled below. Juvenile salmon populations were determined at the same stations over approximately the same time period in 1970, so comparative figures are presented.

	Fry		Small Parr		Large Parr	
	1970	1971	1970	1971	1970	1971
Southwest Miramichi River	13.9	13.9	1.7	2.7	2.5	0.8
Tributary Streams	16.4	11.2	2.4	8.0	5.3	2.5

Table 1 Mean numbers of juvenile salmon per 100 square yards in the Southwest Miramichi River and tributaries.

(b) Aquatic Insect Populations and Fenitrothion Residues

(i) Double Fenitrothion Spray (1 x 3/16 lb./acre + 1 x 1/8 lb./acre

A stream located in Fundy National Park and sprayed with the above application rates was sampled by the "Surber" sampling method to determine populations of aquatic insects. Five one square-foot samples were taken once each week for three weeks before the first spray application, five samples once each week for two weeks between the first and second spray applications, and five samples on each of three sampling dates over a three and one-half week period following spraying. Insects were identified to the four major orders that are utilized as food by young salmon and counted. Total biomass of all orders of insects was determined for the composite five one-square foot samples taken on each sampling date.

Preliminary analysis of the data collected by the "Surber" sampling technique, indicates that numbers of caddisflies, dipterans and mayflies were not affected by the double Fenitrothion spraying. Average numbers of stoneflies found following spraying, were however, only one-third the average numbers found before spraying.

The average biomass, which consists of all orders of stream insects, was slightly higher following spraying, than it was before spraying.

Mayflies were collected and analyzed for Fenitrothion residues. One pre-spray sample, three samples between the first and second spray applications, and four samples following the second spray application were analyzed. The last sample was taken 14 days after the second spray application. No Fenitrothion or its breakdown product was detected in any of the mayfly samples analyzed.

(ii) Double Fenitrothion Spray (1x1/8 lb/acre + 1x1/8 lb/acre)

A stream located near the Sussex airfield, and sprayed with the above application rates was sampled to determine Fenitrothion spray effects on aquatic insect populations. Methods included the "Surber" sampling technique, stone counts, drift sampling, and analyses of water samples and aquatic insect samples (mayflies) for Fenitrothion residues.

Surber Sampling

Nine one-square foot "Surber" samples were taken on each sample date, twice a week beginning in the third week in May, and continuing until nearly the end of June. Insects were identified to the four major orders that are utilized as food by young salmon and counted. Total biomass of all orders of insects was determined for the composite nine one-square foot samples taken on each sampling date.

Preliminary analysis of the data collected indicates that numbers of caddisflies were reduced by one-fifth following spraying; and stoneflies were reduced by a significant 83% or by about 5/6 following spraying. Numbers of dipterans and mayflies as determined by "Surber" sampling were not reduced following spraying.

The average biomass, consisting of all orders of stream insects collected by "Surber" sampling, showed a noticeable decrease immediately following both the first and second spray applications. The biomass determined following spraying was 27% less than the biomass determined before spraying.

20 Stone Counts

Stone counts were made at two stations, twice each week, beginning about one week before spray and continuing on a bi-weekly basis for one week following the second or final spray application. Numbers of caddisflies and mayflies were recorded for each stone on each sampling date. This data has not yet been analyzed.

Drift Sampling

Drift sampling was carried out at two stations by using modified "Surber" samplers. Four drift nets, each with a one-foot square opening were used at one station, and two drift nets at the second station. Drift nets were placed in the stream for 15 minutes every third hour, over a 24 hour period. Drift sampling was done at intervals ranging from immediately before and after spray to a few days before and after spray. Drift samples have not yet been processed.

Fenitrothion Analyses

Five separate water samples were collected and analyzed for Fenitrothion and its breakdown product. No Fenitrothion was detected in water before spray. A high of 0.057 ppm of Fenitrothion was found in water after the second spray application was partially completed over the watershed of the test stream. 0.001 ppm of Fenitrothion was detected in water one week following the second spray application. No water samples were analyzed beyond the date.

Three pre-spray samples of aquatic insects (mayflies), eight samples between the first and second spray applications, and two samples after the second spray application, were collected and analyzed for Fenitrothion and its breakdown product. 0.15 ppm of Fenitrothion was found in mayflies a few days before any spraying was supposed to have taken place over the watershed area of the test stream. The highest level of Fenitrothion detected in mayflies; 3.19 ppm, was found one week following the first spray application, and no Fenitrothion was detected in mayflies beyond this date.

No breakdown product of Fenitrothion was detected in water or aquatic insect samples.

(c) Matacil Spray

A stream in an area sprayed once with 1.5 oz/acre of Matacil in an oil formulation, was sampled to determine the effects of Matacil spraying on aquatic insects.

Five one-square foot "Surber" samples were taken on each sampling date. Samples were taken twice a week, beginning the third week in May and continuing until the second week in August.

Preliminary analysis of the data collected shows that numbers of caddisflies found per square-foot following spraying were 16% less than numbers found per square-foot before spraying; numbers of mayflies 22% less and numbers of stoneflies 75% less. Numbers of dipterans were not reduced.

The average biomass, consisting of all orders of stream insects collected by "Surber" sampling that was determined following spraying was 40% less than the average biomass determined before spraying.

SUMMARY

Population density determinations of juvenile Atlantic salmon found in Fenitrothion sprayed streams in 1970 and 1971, do not indicate any short term effects of spraying on numbers of juvenile salmon.

Sampling of aquatic insects by the "Surber" sampling method in two streams that received double applications of Fenitrothion at slightly different rates, shows different results of spray effects on aquatic insects in these two streams.

(i) In the stream receiving (1x3 oz/acre + 1x2 oz/acre), numbers of caddisflies, dipterans and mayflies were not affected. Numbers of stoneflies per square-foot found following spraying were only 1/3 the numbers found before spraying. The average biomass per square-foot of aquatic insects was not reduced following spraying. No Fenitrothion or its breakdown product was detected in mayflies collected from this stream.

(ii) In the stream receiving (1x2 oz/acre + 1x2 oz/acre), results show that average numbers of caddisflies found per square-foot in the period following spraying were reduced by 20% of the numbers found before spraying; stoneflies were reduced by 83%. Numbers of dipterans and mayflies were not reduced. The average biomass per square-foot of aquatic insects determined following spraying was reduced by 27% from the biomass per square-foot determined before spraying. Fenitrothion was detected in varying amounts in both water and mayflies collected from this stream.

There could be several factors contributing to finding different results of the effects of the double Fenitrothion spray on aquatic insects in two different streams. It should be noted, however, that the stream showing the least effects has a relatively small and unbranched watershed, and the entire watershed was on both the first and second spray applications, sprayed on one date each time. The stream showing the greatest effects on aquatic insects as well as Fenitrothion residues on water and aquatic insects, has in comparison, a large watershed with many branches, and different parts of this watershed was sprayed on three consecutive days for both the first and second spray applications, thus exposing the watershed to Fenitrothion over a period of 3 days on two occasions.

Spraying of 1.5 oz/acre of Matacil in an oil formulation reduced numbers of caddisflies 16%, mayflies 22% and stoneflies 75%. Numbers of dipterans were not reduced. The biomass per-square-foot determined following matacil spraying was 40% less than that found before spraying.

DISCUSSION

Monitoring of the short-term effects of Fenitrothion (Accothion, Folithion, Novathion, or Sumithion), spraying on aquatic stream invertebrates in Maine, Newfoundland and New Brunswick has been carried out by various agencies from 1968-1970. The location of spraying, year, and application rates monitored each year, ranging from 3 to 8 ounces per acre are listed below.

Location	Year	Application Rates Monitored
Maine	1968	1x6 oz/acre
Maine	1970	2x2 oz/acre
Newfoundland	1968	2x2 oz/acre
Newfoundland	1969	2x2 oz/acre
New Brunswick	1966	1x8 oz/acre
" "	1967	1x8 oz/acre
" "	1968	1x4 oz/acre and 1x6 oz/acre
" "	1969	2x2 oz/acre and 3x2 oz/acre
" "	1970	2x2 oz/acre and 1x3 oz/acre

A general summary of results reported by various investigators in their respective localities is presented.

MAINE

Investigators monitoring the effects on aquatic insects of spraying in Maine in 1968, report that total numbers of insects in a sprayed stream were reduced after spraying in excess of what could be expected from natural variation and that this reduction may have been partially caused by Fenitrothion spray. Spray deposit assessment cards, however, show no penetration of the spray into the forest, and the quantity of spray reaching the test stream could not be determined.

It was reported that Fenitrothion as applied to Maine forests in 1970, resulted in significant reductions in Chironomid populations, but not in other stream organisms examined. Total numbers of different taxa in sprayed streams were unaffected.

NEWFOUNDLAND

Monitoring of the effects of the 1968 spray in Newfoundland, on aquatic insects, was carried out by staff of the Resource Development Branch of the Canadian Fisheries Service-Newfoundland Region. They concluded that aquatic insects were reduced over a period of time after spraying.

Monitoring of the 1969 spray in Newfoundland revealed no noticeable reduction in aquatic insects as a result of spraying.

NEW BRUNSWICK

Staff of the Resource Development Branch of the Canadian Fisheries Service-Maritimes Region, monitored the effects of Fenitrothion spraying in New Brunswick, on aquatic insects from 1966-1970. Results of sampling in streams sprayed with 1/2 lb/acre of Fenitrothion in 1966 and 1967, show significant reductions in numbers and total biomass of aquatic insects following spraying. The reduction found in the 1967 study had fully recovered as shown by 1968 sampling. Results of studies in 1968, 1969 and 1970, on the effects of Fenitrothion spraying at total application rates varying from 3 to 6 oz/acre, on aquatic insects are reasonably consistent and any decrease shown in numbers and biomass of aquatic insects were not significant enough to be definitely attributed to spraying.

The Fisheries Research Board of Canada, in their 1969-1970 Review, report that following Fenitrothion spraying in 1969 and 1970, on two watersheds that are being studied by Fisheries Research Board staff, stream invertebrates were reduced to levels below those recorded following DDT spraying, and levels did not recover during the usual period of summer high population densities.

Results or conclusions that have been presented on the effects of Fenitrothion spraying on aquatic insects, show differences between the two years of study conducted in Maine, between the two years of study conducted in Newfoundland, and between studies conducted in New Brunswick by Resource Development Branch and the Fisheries Research Board of Canada.

A brief review of available publications and other reports on methods of study and results of the effects of Fenitrothion spraying in Maine, Newfoundland and New Brunswick, on aquatic insects, show a variety of similarities and differences. These differences are not clearly understood, although several logical theories could be presented that would probably account for some of the differences. To more accurately determine the precise short-term and perhaps longer-term effects of Fenitrothion spraying on aquatic insects, more thorough studies and a satisfactory degree of co-ordination, co-operation, and standardization of monitoring and reporting of results, should be arranged among those conducting such studies.

ENVIRONMENT CANADA - FISHERIES SERVICE

BIOLOGICAL STATION

ST. ANDREWS, N. B.

REPORT ON ACTIVITIES TO INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

1. Toxicity of Organophosphate Insecticides: There was no significant difference in acute toxicity of fenitrothion to Atlantic salmon alaevins, fry, and parr. Exposure to fenitrothion in 7-day tests caused malformation of the posterior body and head swelling in some fish at lethal and sublethal concentrations. The 24-hr LC50 to salmon alaevins and fry is 13.0, 7.4, 3.2, and 0.8 mg/l for methyl parathion, fenitrothion, parathion, and malathion, respectively.

   \- D. J. Wildish

2. Effect of fenitrothion on the temperature selection of Atlantic salmon fingerlings: The effects of 24-hr exposure to four concentrations of fenitrothion (50, 100, 500, 1000 ppb) on the behaviour of Atlantic salmon fingerlings in a horizontal temperature gradient were investigated. The control fish were spread out through the gradient (4-24°C) with a modal temperature of 14°C. The fish exposed to the three higher concentrations of fenitrothion occupied the 4-8°C portion of the gradient most of the time, forming a cluster in the cold end. The fish exposed to 50 ppb were intermediate between the controls and those fish exposed to higher concentrations.

   \- R. Peterson and J. M. Anderson

3. Behaviour of juvenile Atlantic salmon in artificial streams after exposure to fenitrothion: Exposure of fish to 0.1 and 1.0 mg/l of fenitrothion for 15-16 hr had no quantitatively detectable effects on movement or territorial behaviour of juvenile Atlantic salmon. However, after the exposure to 1.0 mg/l of fenitrothion, some fish ceased feeding, swam abnormally and deserted their territories. The effects disappeared after a few days.

   Force-feeding of 2,3,5, and 20 μl of fenitrothion daily for a week caused fish by the third or fourth day to flex convulsively at sudden stimuli, but never caused death. After the force-feeding, fish however frequently regurgitated.

   \- P. E. K. Symons

4. Trout Brook and Nashwaaksis ecological studies: Forest spraying of the Trout Brook basin for three consecutive years has been followed by decrease in underyearling speckled trout to one-third of pre-spray abundance. Recruitment thus has become too low to maintain local populations except by immigration of Northwest Miramichi migratory stocks. Production of salmon smolts has been good in the spray years. Invertebrate fauna used by trout and young salmon as food also continued to show decrease to one-third pre-spray abundance.

In Nashwaaksis stream, which was also sprayed, stocks of underyearling trout are below those in Trout Brook. Post-spray production of invertebrates was similar to the pattern in Trout Brook.

- J. W. Saunders

5. Effects of nonionic surfactants on the olfactory epithelium of Atlantic salmon: Pesticide formulations usually contain nonionic or nonionic and anionic surfactants. Of the 200 nonionic surfactants tested at 1 ppm on the olfactory epithelium of Atlantic salmon, none were stimulatory at 1 ppm indicating that salmon probably do not detect the compounds as odours at low concentrations. Unlike some anionic and cationic surfactants, none of the nonionics blocked the sense of smell of salmon to other known odours (amino acids).

- A. Sutterlin

6. Levels of chlorinated hydrocarbons in aquatic animals: With only a few exceptions, polychlorinated biphenyls (PCB) were found in highest concentrations, ranging from 0.1 to 1 μg/g in fish and from 5 to 40 μg/g in eggs of aquatic birds. The toxicological significance of the observed levels of PCB cannot be evaluated at the moment. Polychlorinated terphenyls (PCT) were detected only in eggs and fatty tissues of herring gulls at levels of 0.1 and 1.4 μg/g, respectively. Chlorinated dibenzodioxins and dibenzofurans were not detectable at the detection limit of the technique used (0.01-0.04 μg/g).

Of the chlorinated hydrocarbon pesticides, p,p'-DDE was found in highest concentrations from about 0.2 μg/g in fish to 30 μg/g in eggs of aquatic birds. Most samples also contained low levels of p,p'-DDT, p,p'-DDD, and dieldrin.

- V. Zitko

Compiled by: V. Zitko
December 9, 1971.

DEPARTMENT OF
NATIONAL HEALTH AND WELFARE

CANADA

MINISTÈRE DE LA
SANTÉ NATIONALE ET DU BIEN-ÊTRE SOCIAL

APPENDIX 5

Environmental Health Centre,
Tunney's Pasture,
Ottawa, Ont. K1A 0K9

November 17, 1971.

Dr. R.M. Belyea,
Acting Director General,
Canadian Forestry Service,
Environment Canada,
Ottawa, Ont.

Dear Dr. Belyea:

Subject: Meeting - Interdepartmental Committee on Forest Spraying Operations, Board Room, 5176 West Memorial Building, 344 Wellington Street, 9:00 a.m., November 22, 1971.

In answer to your letter of November 2nd the attached items are suggested for consideration.

Yours truly,

T.F. McCarthy

T.F. McCarthy, M.D.,
Clinical Consultant.

ENCL.

The following items are submitted as topics for consideration by the Interdepartmental Committee on Forest Spraying.

I In order to protect the health of federal government employees, any plans a federal government department or agency have to conduct forest spraying operations should be made known to the Department of National Health and Welfare. This notification should be given well in advance of the planned operation. Such notification would permit health workers to conduct examination on the employees before the beginning of the operation and to become familiar with the toxicology of the pesticide proposed for use in the operation. If a new or experimental pesticide is to be used or a new use of a registered pesticide is proposed notification becomes more urgent.

II If a federal government operation is to be conducted in a province it is essential that the health department of that province be given an opportunity to study the plan and consider any possible public health effects that such operation may have. The suggestions already made with respect to available time for study apply.

III Contingency Plan - A plan for dealing with major spills or accidents should be available prior to beginning operation. These should include the probable health consequences of exposure of people and contamination of the environment. In addition some one should be available to answer questions regarding the length of time the spilled pesticide will constitute a health hazard and the approved methods of decontamination.

IV Federal forest spraying programs should not proceed without a plan approved by an appropriate agency or perhaps a committee such as this for disposing of unwanted pesticides and pesticide residues, and for disposal of containers.

V Consideration should be given to insisting that the wearing of adequate respirators be a condition of employment for pilots.

APPENDIX 6

ECOLOGICAL CONSEQUENCES OF INSECTICIDE USAGE AGAINST THE SPRUCE BUDWORM IN NEW BRUNSWICK

(I. W. Varty)

Synopsis

The Balsam Fir Community

Studies have been conducted since 1966 to determine how side effects of insecticides applied to budworm-infested stands may influence the long-term prospects for natural regulation of spruce budworm, and whether they may affect the stability of minor pests normally kept at sparse densities by biocontrol mechanisms. Populations of minor-pest species, scavengers and epiphyte browsers, predaceous arthropods, and budworm parasites have been monitored both in sprayed and unsprayed areas on balsam fir.

Both defoliation and insecticides influence the arthropod community on fir. The plotting of population densities in sprayed plots since the introduction of fenitrothion shows the following trends, but does not specify the cause:

Pests: Spruce budworm - high density maintained, more or less.
Minor defoliator pests (e.g. Evagora) - low density maintained.
Twig aphids - increasing to high density.
Scale insects - stable.
Thrips - greatly diminished.
Spider mites - stable.

Non-pests: Scavenger insects - spp. stable or diminished.
Algivorous insects and mites - stable.
Fungivorous mites - density vastly increased (abundance of fungal browse on damaged foliage).

Predators: At least one ladybeetle species drastically reduced.
Other groups (mirids, syrphids, pentatomids, lacewings) moderately reduced.
Spiders - strikingly stable.
Predatory mites - striking increase in some species.

Parasitism Per Cent: Egg parasites - stable or reduced.
Parasites of small budworm larvae - stable.
Parasites of large larvae and pupae - drastic reduction.

These trends suggest that (1) the biocontrol complex operating against the budworm has been weakened. While predators and parasites may not have much influence on the population dynamics of epidemic budworm, it is desirable to maintain high populations of beneficial insects so that they may help to regulate budworm when endemic status is eventually resumed. Spraying may lead to higher general equilibrium levels of budworm, so that resurgence becomes more probable. (2) So far no minor pest is opportunistically approaching epidemic status. However, spray-induced interference with biocontrol forces leaves this possibility open.

Mortality in the Arthropod Community

Drop cloth studies in 1971 in two sample plots showed that the greater part of the mortality of all species occurred in the first four days post-spray. The spruce budworm was the prime victim; however, its mortality continued for two weeks post-spray, even though chemical analysis failed to detect fenitrothion or metabolites in newly dead larvae after the fourth day. Other victims included large numbers of lepidopterous and sawfly larvae and enormous numbers of fir twig aphids. Large numbers of perching flies (nematocerous Dipterans, etc.) were killed.

Parasite adults were killed in modest numbers; 40 spp. of ichneumonoids and 5 spp. of tachinids. In addition, some 30 spp. of muscoid flies were poisoned, and some of these could have a parasitic function in the ecosystem. Among the predators, the main victims were syrphid-fly larvae, plus considerable numbers of elaterid beetle adults, lacewing larvae and others. The rarity of ladybeetles and pupal parasites of the budworm is believed to be due to near-extirpation in the spray programmes of 1969-1970. Spiders and mirids survived abundantly on the foliage; presumably they are not much susceptible to fenitrothion. Syrphid-larvae collected on the fourth day post-spray had a level of fenitrothion higher than that in spruce budworm.

These results demonstrate that fenitrothion is indeed toxic across a broad range of insect species, and that it has the potential to strike particularly hard on actively flying insects.

DDT

The forest canopy is now shedding its residues of DDT, and henceforth biological cycling may be more and more restricted to the soil community. Evidence of residue magnification is being sought in fungi, slime moulds, and in invertebrate and vertebrate animals.

Proposals for 1972

(1) To monitor the faunal community on balsam fir including predators and parasites.
(2) To initiate similar studies in red spruce and one hardwood species.
(3) To relate acute toxicity to the fate of the spray cloud in research plots.
(4) To investigate the relationship of fenitrothion residues to insect mortality.
(5) To improve surveillance over other ecosystems.

(6) To investigate adult parasite behaviour relative to sampling and insecticide responses.

(This will be a new project proposal, but scope is more suited to a small team than to one researcher.)

Comment

These results suggest that ecological hazards are real, but not matured. The problem arises not from the dosage but from the varying susceptibilities within the complex of arthropod species, from the huge area of spray operations and from the recurrent applications. The reinvasion or population resurgence of beneficial insects may be too slow to counter the rapid reproduction of pest insects. We need to plan in anticipation of a decade of spraying.

Background

Although the primary object of spray operations against the budworm is to preserve foliage of spruce and fir trees, homeostatic mechanisms in a mosaic of non-target ecosystems including forest, shrub, aquatic and even agricultural are unavoidably influenced. Since fenitrothion is a wide-spectrum insecticide recurrent spraying will probably cause drastic adjustments in species population distributions over the course of years; not only in the spruce-fir ecosystem, but also in those dominated by hardwoods or minor conifers. This stress may ultimately result in irruptions of minor-pests released from biocontrol mechanisms. Our efforts to solve one problem by insecticides may spawn other problems in forest protection.

Current research in side effects is concentrated on the spruce-fir ecosystem because it is the most important and because such studies will indicate the nature of the response of an arthropod community to repeated low dosages of a potent insecticide. The project has been operating since 1966--the DDT era--and the first objective has been to obtain an inventory of insects, mites and spiders on balsam fir, and to document their population levels in various environmental circumstances. The effort to measure population change has met with varying success; the densities of common insects like budworm and twig aphids have been measured with reasonable precision. However, most insect species occur at considerably lower densities and population estimates are less reliable. Sampling methods have been designed to provide three groups of data: (1) population densities of the arthropod fauna on balsam fir foliage - 20 species of minor pests and prey insects; (2) densities of predaceous forms - 30 insect and 20 arachnid species; and (3) per cent parasitism in budworm populations - a tally on about 20 species of wasps and flies.

Although study plots have been located both inside and outside the spray area, differences in species counts cannot be unreservedly ascribed to intercession with spray. Each plot is unique with its own set of environmental parameters, and the establishment of 'control' plots in the rigorous experimental sense is impossible. Therefore, conclusions from the collected data must be inferred and tentative rather than cut-and-dried fact.

Biomass as a Measure of Community Status

Of the various criteria of insect importance, numbers are the easiest to measure, but biomass is a better index of community impact. In budworm-infested firs, the spruce budworm typically outnumbers most species populations and easily dominates the biomass inventory; for example in June, the budworm biomass may outweigh the combined biomass of all other arthropods by 1,000-fold. The next most important species in terms of biomass is the balsam twig aphid, and this species, with 10 or 20 million individuals per acre, is the staple diet of a large number of invertebrate predators. Next in biomass are the various minor lepidopterous pests such as Evagora. Still lower are other assorted pests and non-pests such as mites, scales, psocids, springtails and thrips.

The biomass of all predatory arthropods on fir approximates the combined biomass of all prey insects excluding the spruce budworm. Biomass measurements list species in rather different order from measurements of numbers. Mirids, cecidomyiids and ladybeetles are relatively high in the list, but mites and spiders are relatively low in spite of their enormous numbers. These various predators help to reduce populations of budworm in the early stages (eggs, first and second instars) but it is obvious that, in general, predators have little significance in regulating epidemic populations at any time in the season. An exception to this general statement may have been discovered in studies at Fundy Park this year. A small cecidomyiid was found to kill 80% of the third-instar budworm population in the research plot samples. In biomass terms, this predator is extremely efficient; although it is much smaller than its host, it feeds on the host blood and attacks several individuals.

Population Trends in Key Species

Since every species has its own characteristic seasonal curve, a single population fix for each species will not provide seasonal and perennial trends. Thus populations have been estimated from samples of the branch-dwelling community taken at one- to two-week intervals during May, June and July of each year 1966-1970. These results are being summarized as a series of species graphs but are not included here.

In summary, the following trends have been observed in five research plots, from the late 1960's to 1971:

Phytophagous Arthropods:

Spruce budworm: In infested and repeatedly sprayed plots, densities remain perennially high. In unsprayed plots, the trend is upward.

Other lepidopterous pests: Sampling is not sufficiently sensitive to determine density changes of most species, but there does not appear to be much difference in densities between sprayed and unsprayed plots. _Evagora_ sp. and _Dioryctria_ sp. have generally a tendency to increase.

Balsam twig aphid: Population trends have been accurately plotted. This species appears to have an oscillation of about five years which is largely independent of fenitrothion spray. Currently in New Brunswick, populations are close to the perennial peak.

Thrips (2 spp.): Population densities are somewhat lower in unsprayed areas but dramatically lower in sprayed plots since fenitrothion was used.

Scales (_Abgrallaspis_): Remarkably steady and similar in sprayed and unsprayed plots.

Spider mites (2 spp.): Steady and similar in both sprayed and unsprayed plots.

Oribatid mites (30 spp.): A few species have attained spectacular densities in infested sprayed forest. This is a response to the availability of fungal browse on the defoliated foliage, although fenitrothion kill of some predators may contribute.

Springtails (2 spp.): _Entomobrya_ sp. has steady low densities in both sprayed and unsprayed plots. _Sminthurus_ sp. has become very scarce in sprayed plots since the introduction of fenitrothion, but has remained steady in unsprayed plots.

Predatory Arthropods:

Spiders (10 spp.): Populations remarkably stable in unsprayed plots. In one sprayed plot, normal density has been resumed under the fenitrothion regime from a very low density under the former DDT regime.

Mites (many spp.): Densities high and stable in unsprayed plots; apparently erratic but sometimes very high in sprayed plots.

Mirids (10 spp.): Moderately stable densities in unsprayed plots; less stable but common in sprayed plots.

Ladybeetles (2 main spp.): Moderate density related to abundance of aphid prey in unsprayed plots. Sharp reduction (near extirpation) in sprayed plots.

Nabids (1 sp.): Low density in all plots, but apparently unaffected by spray regime.

Pentatomids (2 spp.): Low density in all plots, but especially rare in sprayed plots.

Lacewings (5 spp.): Low density in all plots; still lower in sprayed plots.

Syrphids: Moderate density; a difficult sampling problem; somewhat reduced in spray plots.

At this stage, after only three years of fenitrothion spraying, and only four to six years of population sampling, I am reluctant to ascribe changes in density to spray effects. Obviously one would have to know the population dynamics of each species in detail to specify interactions. Changes in density involve the expected oscillation of a population around a mean, plus the susceptibility of that species to the spray, plus any reduction in biocontrol forces (parasites, predators), plus other food-chain effects (competition for food). Nevertheless, the evidence of near extirpation of the ladybeetle, Mulsantina hudsonica, plus evidence of population instability in other organisms, suggests to me that major changes in the faunal community can be expected if the spray programme is extended in space and time.

Spruce Budworm Parasites

A survey of budworm parasitism was conducted in New Brunswick in 1970 and 1971 because of the suspicion that hymenopterous and dipterous adults might be especially susceptible to the spray cloud. Pole-stage, fir-spruce sample plots were selected for differences in climatic zone, insecticide history and budworm density, and sampled at intervals across the spring. The data are currently being examined, but first impressions are: (1) the parasites of small larvae (Glypta and Apanteles spp.) have maintained the same level of parasitism (about 20%) in sprayed and unsprayed areas. These parasites are killed by the insecticide in about the same proportion as their hosts when sprays are applied to fourth-instar budworm. It is possible that late sprays could cause reduction in survival of Apanteles adults; (2) parasitism of large budworm larvae and pupae is greatly reduced (<1%) in the plots sprayed with fenitrothion. These ichneumonoids (Meteorus, Apecthis, Itoplectis, Phaeogenes sp., etc.) and tachinids (Actia, Eumea, Winthemia sp., etc.) ordinarily provide around 10% parasitism in epidemic budworm populations; (3) egg parasite (Trichogramma sp.) densities have been measured, but no gross difference between sprayed and unsprayed plots has been detected. Of the parasite species that have been reduced, many are flying adults at spray time, so it is suspected that they have fallen victim to fenitrothion.

Parasitism is important, but by no means a key factor in the dynamics of epidemic budworm populations. Nevertheless, it is desirable that the parasite complex be sustained at high density so that it may exert an influence on the eventually collapsing budworm populations. If parasites become very sparse under a spray regime, they may need several years in which to re-build populations to an influential position. In the meantime, budworm populations would tend to fluctuate around a higher equilibrium level and resumption of outbreak conditions might be more easily triggered.

Spray-induced Mortality in the Arthropod Community

To determine the range and intensity of acute toxicity of the spray to insects, drop cloths were erected in two plots to collect the bodies of poisoned insects under fir trees. These cloths were examined at two-day intervals and the species were identified. Table I exemplifies the results from one plot.

It is believed that the scarcity of ladybeetles and of adult parasites of the budworm in this plot is due to extensive reductions in their numbers in spray seasons 1969 and 1970. Small numbers of apparently healthy, large, larval parasites (Eumea sp.) were recovered as puparia from the drop cloths, indicating again that some species are less susceptible than others.

The above mortality values confirm that fenitrothion is indeed a wide-spectrum insecticide. The large number of predator and parasite species among the victims indicates a pronounced weakening of biocontrol mechanisms; but this will remain hypothesis until life-table studies of individual species can be conducted.

Persistence of Insecticide in Insects

Dr. Yule's studies have shown that fenitrothion is rapidly broken down by photo-exposure, but is longer lived when absorbed in foliage. To check whether the fenitrothion persisted in the bodies of its victims, freshly dead insects were collected in the field at intervals after spray application, and analysed by Dr. Duffy (U.P.E.I.) for fenitrothion and its toxic metabolite fenioxon. Fenitrothion was detected in budworm in a descending gradient until the fourth day post-spray but not thereafter. Fenioxon was not detected. This suggests that dead or dying insects may provide an oral pathway for ingestion of poison by predators (arthropods, birds, fish, amphibia, etc.) during only a few days post-spray.

It was interesting also that insecticide disappeared from victims within four days of spray, although budworm mortality continued at a high rate for 2-3 weeks post-spray. This suggests that a delayed lethal factor is involved.

Fenitrothion was also detected in aphids and syrphids. The high level in the syrphids may indicate that the mode of locomotion or of predation is important in the vulnerability of individual species.

Some studies on DDT residues are continuing. The evidence is that the forest canopy is now shedding its residues by the process of annual leaf-fall, and biological cycling may be more and more confined to the soil community. The significance of these residues in soil fertility and nutrient cycling is unknown. Further evidence of residue cycling and concentration is being sought by analysis of fungi, slime moulds, vertebrate and invertebrate animals.

Proposals for 1972

I personally feel that if insecticide usage is to be a forest management technique for the foreseeable future, then we must be prepared to go much further with side-effects studies. Ideally, we should have simulation studies of ecosystem interactions (pest - competitors - biocontrols - chemical agents); biocontrol mechanisms in the absence of spray; life-table or key-factor studies of indicator species to compare survival in spray regimes and natural circumstances; life-table studies of pest mortalities relative to spray chemical candidates, dosages, formulations and timings; and the impact of insecticides on non-target organisms. Some components of these studies could be contracted to universities as graduate studies; others would be preferable inside the C.F.S. We must aim at minimizing defoliation, minimizing ecosystem disruption, and maximizing target pest kill. Since our present insecticides, although highly potent, are broad-spectrum, our progress toward the ideal may be slow.

Pending initiation of a comprehensive side-effects programme, I propose in 1972 to make the following studies:

(1) to monitor the faunal community on balsam fir foliage (including predators and parasites);

(2) to initiate similar studies in red spruce and one hardwood species;

(3) to relate acute toxicity to the fate of the spray cloud in research plots;

(4) to investigate the relationship of fenitrothion residues to insect mortality;

(5) to improve surveillance of other ecosystems;

(6) to investigate adult parasite behaviour relative to sampling and insecticide responses.

The above proposal is more suited to a small team than to a single researcher.

Table I

Estimates, from Drop Cloth Counts, of
Numbers per Acre of Various Arthropod Groups Killed
on Balsam Fir by Aerial Application of 2 Oz. of Fenitrothion per Acre

Group	No. of insects killed (thousands per acre)	No. of species	Peak of kill (days post-spray)
Pests			
Spruce budworm	525	1	4
Other lepid. larvae	14	13	4
Sawfly larvae	21	3	4
Balsam twig aphid	2,000	1	4-6
Cinara aphids	16	2	2-4
Parasites			
Ichneumonoid adults	5	30	2
Tachinid adult	0.2	2	2
Predators			
Syrphid-fly larvae	70	10	4
Elaterid beetle adults	9	3	4
Lacewing larvae	5	3	2-4
Hemiptera	0.2	3	4
Spiders	1.5	9	4
Non-pests			
Muscoid flies	4	20+	2
Nematocerous flies	16	Many	2
Brachycerous flies	6	Many	2
Various orders	2	Many	2

APPENDIX 7

AMPHIBIAN MONITORING DURING 1971 MATACIL TRIALS IN NEW BRUNSWICK

Anne M. Rick and Iola M. Gruchy
Canadian Wildlife Service
Department of the Environment
Ottawa, Ontario

For Interdepartmental Committee on Forest Spraying Operations, November 22, 1971

We monitored frogs and tadpoles from May 29 to June 11, 1971, near Richibucto, New Brunswick, in an attempt to assess the immediate effects of experimental aerial Matacil spraying on these amphibians. Frogs and their larvae are abundant vertebrates in New Brunswick forest ponds and ditches during the period in spring when forest insecticides are applied to control the spruce budworm; these amphibians are therefore exposed to toxic chemicals during their critical reproductive period. Frogs and tadpoles are important links in both terrestrial and aquatic food chains, where they are eaten by many other vertebrates.

STUDY AREA AND METHODS

This study was carried out in Block M1 (between Kent Junction and Richibucto) and Block M2 (just west of Mortimer and Harcourt). Block M1 was sprayed with an emitted dosage of 1.5 oz. Matacil in 0.15 USG Panasol per acre on the morning of June 5, and Block M2 received 1.5 oz. Matacil wettable powder in 0.15 USG summer oil per acre on the evening of June 10. Both were operational-size blocks of approximately 12,500 acres each. Three census sites were located in Block M1 and four in Block M2; there were two control sites, both located between Block M1 and Richibucto. In addition, experimental sites of one block served as controls when the other site was sprayed. Experimental census sites received a good dosage of spray as evidenced by spray cards set out at each site just prior to spraying.

The methods used in 1971 are essentially those of our 1969 and 1970 New Brunswick spray monitoring studies. We gathered four principal types of data for our assessment of immediate pesticide effect: (1) actual counts of numbers of frogs of each species found at selected census sites during specified times of day and night; (2) post-spray observations on caged and free-living frogs and searches for dead individuals; (3) post-spray observations on caged and free-living tadpoles; and (4) information on frog calling activity during the nights of the study.

A total of 2509 individual observations was made on frogs and toads during census counts, by species as follows: green frog (Rana clamitans), 1237; leopard frog (Rana pipiens), 934; American toad (Bufo americanus), 6; unknown, 332. Census areas were selected at roadside ditches and ponds and their boundaries clearly marked. Frogs were enumerated in the afternoons and again at night by walking around and/or through each census area and counting numbers of each species seen. Individuals which moved too rapidly to be specifically identified were counted as "unknown". Night counts were made using 6-volt flashlights. This technique allowed rapid identification and counting with very little disturbance of the census areas, and enabled us to make one complete circuit of the nine sites in about four hours.

Post-spray searches for dead or abnormally-acting frogs and tadpoles were made at and near the census sites in Block M1 soon after the morning spraying on June 5 and again during the census that afternoon. The census sites and nearby areas in Block M2 were searched after the June 10 evening spray and also the next morning. Control sites were also searched after each spraying.

Cages made from plastic trays covered with aluminium screening were filled with known numbers of tadpoles prior to spraying at each site where tadpoles could be caught, and the caged tadpoles were then returned to the water. Post-spray observations were made on these caged specimens.

This year only one frog, a Rana pipiens, was caged during spraying, in contrast with previous years when attempts were made to expose a large variety of caged reptiles and amphibians to the aerial spray.

Notes were made of frog vocal activity during nights when censuses were made. These notes are sketchy but serve to indicate the presence in the area of the species involved. Numbers of individuals calling could rarely be determined.

RESULTS

Numbers of green frogs at control and experimental census sites remained approximately the same or increased slightly during the course of our study. Day-to-day fluctuations in number could have resulted from variable factors such as temperature, rainfall, wind and migrations of several kinds. There were no changes in numbers after spraying which could definitely be attributed to the effects of Matacil. Counts of leopard frogs were more variable than those of green frogs; no changes in the numbers of this species could be traced to Matacil. Observations on other frog and toad species were too few to allow interpretation.

No abnormal post-spray behavior of free-living frogs was noted in the vicinity of the census sites, nor did the caged Rana pipiens show any untoward effects of its exposure to the spray. Only one dead frog, a Rana clamitans, was found during the entire study; it died before the first block was sprayed.

Prior to the June 5 spray, thirty small tadpoles were caged at site 4 within Block M1 and thirty at control site 1. At approximately three hours after spraying three of the tadpoles at site 4 were dead; there was no further mortality when the cages were checked again two-and-a-half hours later. All tadpoles at site 1 survived.

Only large tadpoles were found in Block M2; sixteen were caged at site 7 and three at site 8 prior to spraying. Forty small tadpoles at site 1 were used as controls. There was no mortality at the experimental sites or the control site fourteen to sixteen hours after spraying.

Small choruses of the spring peeper (Hyla crucifer), were heard each night throughout the study areas. The American toad was also heard almost every night at scattered sites. A few green frog calls were noted. No correlation could be made between chorus activity and Matacil spraying.

CONCLUSIONS

Aerial forest spraying of Matacil in June, 1971, at an emitted dosage rate of 1.5 oz. in 0.15 USG Panasol or summer oil per acre had a negligible effect on frogs and tadpoles in the two spray blocks studied. Future spray programs carried out at similar rates and under similar conditions should pose no immediate hazard to frogs, although a few tadpoles in shallow-water areas may be killed. The techniques employed in this study attempted to assess only the immediate post-spray hazard to amphibians; long-term effects of spraying at this dosage are unknown.

APPENDIX 8

SOME OBSERVATIONS ON THE EFFECTS OF AERIAL SPRAYING FOR SPRUCE BUDWORM CONTROL ON BLUEBERRY POLLINATORS

The following report is a summary of the information obtained by the entomological staff of the Fredericton Research Station on the effects of aerial spraying for spruce budworm control on the 1971 lowbush blueberry crop. Involvement by Canada Department of Agriculture (C.D.A.) came about because of a request for assistance by Bridges Bros. Ltd. of Calais, Maine and Oak Bay, New Brunswick. Their company is the largest producer of lowbush blueberry in New Brunswick. Their normal production is about 1,000,000 pounds annually, but in 1970 it plunged to 400,000 pounds. The sudden drop was blamed on lack of pollination in the King's County area where the fields were allegedly sprayed with fenitrothion by Forest Protection Ltd. This company holds a contract with the provincial government for aerial spraying of New Brunswick forests for spruce budworm control.

In April, 1971, a meeting was convened by Mr. S.R. Colpitts of the Plant Industry Branch of the New Brunswick Department of Agriculture. Attending this meeting were representatives of Forest Protection Ltd., N.B. Dept. of Agriculture and C.D.A. Research Station, Fredericton. The problem of budworm spraying and its effects on honeybees and native pollinating insects was discussed, and some recommendations were made regarding the 1971 operation. It was agreed that Forest Protection Ltd. would attempt to avoid spraying blueberry fields where possible, and that they should try to limit those flights which would be made over blueberry fields to periods of the day when the temperature was below 45°F. Forest Protection Ltd. also agreed to employ an entomologist to study the problem. G.W. Wood of the Fredericton Research Station agreed to assist in this study. Two entomologists were subsequently employed by Forest Protection Ltd. They were Professor N.R. Brown, professor of entomology at U.N.B. and Mr. Brian Rice, a graduate biologist with experience in forest entomology and blueberry entomology.

The outline of study was based on techniques used in previous studies on blueberry pollination carried out by the Fredericton Research Station. It required a census of pollinating insects in a series of blueberry fields in Kings County, Albert County, and Saint John County. Three fields were included in the designated spray area while a fourth served as a control. Ten 2-square-yard plots were established in each field, and 25 half-minute counts of pollinators were taken in each plot on each of three days during the bloom period. Counts were taken during favourable conditions for bee activity at early, mid and full bloom. Data were also obtained on fruit set in these fields by counting blossoms and berries on ten randomly selected clones. Since it required one man to do the counting in each field, and the counts ran concurrently, C.D.A. supplied two men and Forest Protection supplied two men. The input was shared and the data were to be shared.

Shortly after the study plans were made, Bridges Bros; brought a $230,000 lawsuit against Forest Protection Ltd. and obtained an injunction preventing them from spraying over their blueberry land.

Forest Protection Ltd. reacted to this situation by advising their staff not to release any information they obtained on pollinator counts. Consequently this report contains the results of only the two fields in which our staff did the counting. It is hoped that a complete report will be possible at the conclusion of the court hearings.

The two fields from which counts are available at this time were both located in Kings County and both were sprayed with the organophosphate fenitrothion. Field A is known locally as "Hamilton Field" and is located along highway 695. Field B is known as "Pidgeon Hill" and is located along a dirt road running south of highway 850. Field A was sprayed on May 25 when less than 5% of the blueberry blossoms were open. It was sprayed at approximately 6:15 A.M. at a temperature of 41°F. Field B was sprayed on June 22 when blueberry was going out of bloom. G.W. Wood observed Field A being sprayed and was told of the spray date for field B by Mr. Brian Rice.

In field A the density of solitary bees (mostly Andrenidae and Holictidae) was determined as 0.144 bees per square yard and the density of bumblebees was determined as 0.011 bees per square yard. In field B the density of solitary bees was 0.129 bees per square yard, and the density of bumblebees was 0.014 bees per square yard. These estimates of pollinator density fall within the range obtained in previous studies (see Table 1). Data on fruit set are being held by Forest Protection Ltd.

Table 1. Data on native bee density in blueberry fields not treated with organophosphate insecticides*

Pollinator densities (bees per square yard)			
Solitary bees	Bumblebees	Year	Location
0.035	0.028	1957	Cumberland County, N.S.
0.042	0.016	1968	Charlotte County, N.B.
0.075	0.012	1954	Charlotte County, N.B.
0.096	0.015	1955	Charlotte County, N.B.
0.106	0.024	1968	Charlotte County, N.B.
0.119	0.006	1956	Charlotte County, N.B.
0.124	0.022	1956	Charlotte County, N.B.
0.133	0.007	1955	Charlotte County, N.B.
0.134	0.000	1969	Gloucester County, N.B.
0.151	0.013	1956	Charlotte County, N.B.
0.181	0.005	1955	Charlotte County, N.B.
0.206	0.000	1961	Washington County, Maine
0.209	0.021	1968	Charlotte County, N.B.
0.226	0.000	1961	York County, Maine
0.276	0.004	1971	Gloucester County, N.B.
0.330	0.000	1970	Gloucester County, N.B.
0.340	0.059	1971	Albert County, N.B.
0.386	0.015	1968	Charlotte County, N.B.

*All fields, except those in Gloucester and Albert Counties, N.B., were treated with calcium arsenate for blueberry maggot control.

In addition to the two fields agreed upon in the original plan, our staff at C.D.A. was able to carry out further observations in two other fields. This seemed advisable when we were told that the counts in the control field were not going to be released by Forest Protection Ltd. It was our intention that both fields would be controls but one of them was sprayed after we began our counts.

Field C was located at Lisson Settlement, Kings County, along a dirt road running easterly from Highway 111. Field D is referred to as "Jonah Mountain" by its owners and is located along Highway 910 in Albert County. Field C was reported as sprayed with fenitrothion on June 7 (at mid bloom) while Field D was not sprayed. Pollinator counts were taken as in the previous fields except that they were limited to two days. The counts obtained were as follows:

Field C.	Before spraying (June 4)	250 observations
	solitary bees	0.138 per sq. yd.
	bumblebees	0.032 per sq. yd.
	After spraying (June 11)	250 observations
	solitary bees	0.012 per sq. yd.
	bumblebees	0.002 per sq. yd.
Field D.	June 8	250 observations
	solitary bees	0.294 bees per sq. yd.
	bumblebees	0.042 bees per sq. yd.
	June 11	250 observations
	solitary bees	0.386 bees per sq. yd.
	bumblebees	0.076 bees per sq. yd.

These data show a reduction of over 90% of the bee population in field C following the spray applications, while in field D the bee count was higher on the second date.

Following the obvious loss of bees in field C, the owner (Bridges Bros.) moved in a large supply of honeybees. This move did not appear to compensate for the lack of native pollinators (see Table 2). Yield data are not available at this time.

Table 2. Effect of fenitrothion spraying on fruit set of blueberry

Field	Treatment	Blossom count	Berry count	Percent fruit set
C	sprayed	7,267	1,187	16.3
D	unsprayed	12,104	4,391	36.3

Conclusions

The 1971 study was limited because of lack of staff and a previous commitment to other work in the small fruit program. All data obtained on the effect of the 1971 budworm spray on blueberry pollinators are not included in this report because of the decision of Forest Protection Ltd. to withhold their information. In spite of the inadequate amount of data obtained, some points will be obvious to the reader.

1. The density of native pollinating insects in blueberry fields is highly variable between fields and between years.

2. The 1971 budworm spray operation had no measurable effect on native bee densities in fields A and B.

3. The effect of any excessive pollinator mortality which may have occurred in 1970 because of spraying operations is not apparent in the 1971 estimates of pollinator density.

4. There was a significant reduction in number of native bees in field C following the fenitrothion spraying.

Further study is definitely necessary before valid conclusions can be drawn. Our data on native bee density in the Kings-Albert area is very scarce, and their numbers may normally be much higher than in Charlotte County where most of our studies were previously carried out. It must be noted that fields in Charlotte County have a long history of arsenic usage whereas the Kings and Albert County areas have not been subjected to pesticides previous to the aerial spraying.

The long term effect of a high kill such as appeared to occur at Lisson Settlement (field C) should be followed. Will the population recovery rate be more rapid in areas where blueberry fields are continuous as opposed to areas where the fields are surrounded by forests? How does the lack of spring forage plants during the burn year affect nesting and reproduction in isolated blueberry fields? These are just some of the points which need clarification before the full effect of mass poisoning can be understood.

We have no information on the effect of fenitrothion on honeybees. It is listed as highly toxic and we are aware of some reports of mortality during 1970 and 1971. If honeybees are necessary for pollination in some of the sprayed areas, their use will add significantly to the cost of production. Until 1970 very good yields were obtained without them.

In summary, it can be stated that bees are vital to lowbush blueberry production. In New Brunswick we have relied very heavily on native bees as blueberry pollinators and any threat to their population level is extremely important to the blueberry industry.

G. W. Wood

Research Station

Canada Department of Agriculture

Fredericton, N. B.

APPENDIX 9

THE ECOLOGICAL EFFECTS OF TREATING FORESTS WITH INSECTICIDES, WITH PARTICULAR REFERENCE TO SMALL FOREST VERTEBRATES

By

C. H. Buckner and B. B. McLeod

Chemical Control Research Institute
Canadian Forestry Service
Department of the Environment

The Ecological Effects of Treating Forests with Insecticides, with Particular Reference to Small Forest Vertebrates

C. H. Buckner and B. B. McLeod

Laboratory and field studies were initiated in 1971 to assess the short - and long - term ecological consequences of treating forests with insecticides for the control of forest insect pests. Major emphasis was placed on the effect of insecticides on small forest vertebrates, particularly mammals and birds, but certain components of the ocosystem impinging either directly or indirectly' upon their ecology were also examined.

The impact of four insecticides on small forest vertebrates was measured: (1) "pox" virus for the control of spruce budworm in Algonquin Park, Ontario in cooperation with the Insect Pathology Research Institute and the Regional Laboratory at Sault Ste. Marie; (2) Matacil for the control of spruce budworm near Harcourt, N.B. in cooperation with Forest Protection Limited and the Regional Laboratory at Fredericton; (3) DDT used in the past to combat spruce budworm in northern New Brunswick in cooperation with the Chemical Analysis Section of the Chemical Control Research Institute; and (4) Fenitrothion for use against various forest insects including spruce budworm in the Larose Forest near Ottawa, Ontario.

POX VIRUS STUDIES

A pox virus identified, isolated and propagated by F. T. Bird, Insect Pathology Research Institute, was disseminated in an aerial spray against spruce budworm on experimental plots near Achray, Algonquin Park in May and June 1971. Virus material was sprayed at the rates of 0.2g, 2g and 20g per acre in an early application (15 May) and again at the same concentrations later in budworm development (1 June). Small mammals of four species (Clethrionomys gapperi, Microtus pennsylvanicus, Peromyscus maniculatus and Mus musculus) exposed in cages to the heaviest concentration of virus material did not exhibit any evidence of virus infection. Population densities, fecundity, six ratios and age structure of three species of small mammals resident on the treated areas (Sorex cinereus, Clethrionomys gapperi and Peromyscus maniculatus) remained unchanged after treatment. Breeding bird populations, nesting and fledging success also remained unaffected by the treatments. A general and widespread mortality of evening grosbeaks (Hesperophona vespertina) due to a disease organism the aetiology of which could not be established, was obviously unrelated to the effects of the virus material. It is concluded that, from the standpoint of homoiothermic vertebrates, the virus is a safe insecticide.

THE EFFECTS OF MATACIL ON SMALL MAMMALS

Small mammal populations were censused on the large Matacil block near Harcourt, N. B. receiving 1.5 oz active ingredient per acre. Five standard snap-back lines were operated one month after the insecticide application in habitats ranging from open meadow to dense forest. Populations, age structure, sex ratios and fecundity for three species of shrews (Sorex cinereus, Sorex fumeus and Blarina brevicauda) and four species of rodents (Clethrionomys gapperi, Microtus pennsylvanicus, Peromyscus maniculatus and Napeozapus insignis) were normal in all respects. Shrews made up a substantial portion (ca 10%) of the catch. In view of the fact that small mammals and particularly the highly insectivorous shrews appeared unaffected by the treatment it is concluded that under the conditions of this trial matacil could be used without fear of immediate damage to small mammals.

SMALL MAMMALS IN A GRADIENT OF RESIDUAL DDT

Small mammal populations were censused in nine areas in northern New Brunswick that had been analyzed for residual DDT and its metabolites in the soil (Yule, 1971, unpubl.rpt.). Concentrations on these areas in September, 1970 ranged from 0.066 oz. per acre residual DDT's near Cambeltown to 9.431 near Bathurst. Four species of insectivores (Sorex cinereus, S. fumeus, Microsorex hoyi and Blarina brevicauda) and five species of rodents (Clethrionomys gapperi, Microtus pennsylvanicus, Peromyscus maniculatus, Zapus hudsonicus and Napeozapus insignis) were taken on the study plots, with S. cinereus, C. gapperi and P. maniculatus forming the preponderance. Species composition, population densities, age structures, sex ratios, breeding conditions, and fecundities bore no relationship to the insecticide gradient. It is concluded that although the environment may still be contaminated heavily by DDT and its metabolites, the contamination load at this point in time does not influence small mammals. Specimens preserved for chemical examination have not yet been analyzed.

SOME ECOLOGICAL EFFECTS OF SPRAYING FORESTS WITH FENITROTHION

The first experiments of a proposed long-term study of the immediate and prolonged effects of the insecticide fenitrothion on forest ecosystems were initiated in the spring and early summer of 1971 in the Larose Provincial Forest near Ottawa. Because these experiments were to a large measure exploratory, the results should be considered indicative rather than conclusive.

On July 1 a 40 - acre block of spruce forest was treated with an operational dosage of 4 oz. of fenitrothion per acre. Populations of small mammals and small forest birds were censused prior to and following the spray application and in an unsprayed control area of similar area. Two species of small mammals predominated (Sorex cinereus and Clethrionomys gapperi). Populations of both were suppressed somewhat following the treatment; most noticeable was a reduction in juvenile shrews. Fledglings and some adults of certain species of small birds also experienced some mortality, noticeably the open nesting warbler complex (i.e. the yellow warbler, Dendroica petechia, the myrtle warbler, D. coronata, and the yellowthroat, Geothlypis trichas) and the chipping sparrow (Spizella passerina).

A special study was made on the effects of this insecticide on colonies of domestic bees, in co-operation with Dr. T.A. Gochnauer (Can. Dept. Agric.). Twelve of seventeen experimental hives were located on the spray plot three weeks prior to treatment: the remainder were located on the unsprayed area and served as controls. Some adult bees were killed by the spray and some brood was lost, but in both cases losses were estimated conservatively at less than 5%. All sprayed hives gained strength in the two weeks after the treatment, and one swarmed. It was the opinion of the apiculturist that no serious damage attributable to fenitrothion poison was incurred by any of the treated colonies.

RAPPORT PRELIMINAIRE DES OPERATIONS CONTRE LA TORDEUSE DES BOURGEONS DE L'EPINETTE DU QUEBEC EN 1971

par

P. Benoît — Centre de Recherche forestière des Laurentides
Ministère canadien de l'Environnement

R. Desaulniers — Direction générale de la Conservation
Ministère des Terres et Forêts

Y. Hardy — Faculté de Foresterie et de Géodésie
Université Laval

R. Martineau — Centre de Recherche forestière des Laurentides
Ministère canadien de l'Environnement

Québec

1971

ENGLISH SUMMARY

In 1971, an area of 2 million acres was sprayed with insecticide against the spruce budworm in western Quebec. The insecticide used was Fenitrothion and was applied once at a rate of 3 ounces in 0.15 gallon of water emulsion per acre. Spraying was done from the 4th to the 25th of June. Insect development was faster than had been expected and was synchronized at the peak of the 5th instar over the whole region due to a long spell of warm and dry weather.

The treatment had been scheduled for the time the insect would reach 50% of the 4th instar. Spraying started a few days later in two areas, and a few days earlier in the third.

Total mortality averaged 85% at pupal time. However, mortality due to the insecticide alone, 10 days after spraying, was estimated at an average of 42% on two-thirds of the region and 69% in the area where insect development was the slowest. According to aerial and ground surveys, defoliation of current year growth was complete except for some small areas around Low and in Gatineau Park where up to 50% of current year foliage was saved.

Sequential sampling of egg masses in 101 localities in sprayed areas gave an average of 847 masses per 100 square feet of balsam foliage. That number is more than enough to cause a severe defoliation in 1972, but it is about 50% less than the average number of egg masses for the same areas in the previous year.

In Temiscouata, ~~11,376~~ 116,376 acres were sprayed in 1971 with the same insecticide and at the same rate as in western Quebec. Spraying was done from the 12th to the 15th of June inclusive. The late start was due to a delay in the arrival of the planes. Total mortality at pupal time averaged 80%, however, mortality due to the insecticide alone was estimated at 53%. Results of aerial and ground surveys indicate that defoliation of the current year's growth was patchy and generally higher than 50% except for a small area around Dole lake where the foliage protection was very good.

The same egg sampling method was used as in western Quebec and the data revealed that 25% of the sprayed area can be expected to suffer severe defoliation in 1972.

The results of the operation in 1971 indicate that in western Quebec: 1) spraying should have started about five days earlier, and 2) the period of application should have been shortened by one half. Whereas, in Temiscouata, according to Dr. Y. Hardy, in charge of the biological investigation, failure was mostly due to poor operation.

The entomological surveys suggest that aerial spraying should be considered for an area of 3.2 millions acres in western Quebec. The objective of bringing to an end the Temiscouata's infestation is eliminated and non-operational project of aerial spraying is forecast for 1972 in the Temiscouata region.

TABLE DES MATIERES

RAPPORT PRELIMINAIRE DES OPERATIONS CONTRE LA TORDEUSE DES BOURGEONS DE L'EPINETTE DANS L'OUEST DU QUEBEC

par

Desaulniers, R., R. Martineau et P. Benoît

INTRODUCTION

L'invasion de la tordeuse des bourgeons de l'épinette détectée en 1967 à Low, comté de Gatineau, s'est accrue en intensité et en étendue et affectait une superficie de 5.9 millions d'acres à l'automne de 1970. Un premier arrosage effectué en 1970 dans cette région couvrit 24,000 acres et fit l'objet d'un rapport.

Le ministère des Terres et Forêts du Québec en collaboration avec six des concessionnaires intéressés et avec le ministère fédéral de l'Environnement a élaboré un projet de répression (carte 1) s'étendant à 2 millions d'acres comportant des terrains de 10 tenants distincts (tableau 1).

GENERALITES

Les superficies à traiter à l'insecticide avaient été déterminées à l'automne 1970 et devaient remplir les trois conditions suivantes:

1 - Etre des peuplements résineux et/ou mélangés à prédominance de sapin beaumier et d'épinette blanche d'après les cartes forestières

du Service de l'inventaire forestier, ministère des Terres et Forêts.

2 - Avoir deux années ou plus de défoliation sévère (50 pour cent du feuillage détruit par année) d'après l'inventaire aérien et après vérification au sol.

3 - Présence à l'automne 1970 d'une population d'oeufs de l'insecte permettant de prévoir des dommages sévères pour 1971.

L'exécution de ce projet d'arrosage a nécessité la construction d'une piste d'atterrissage aux environs du lac Nilgaut sur les concessions forestières de E. B. Eddy Company, dans le bassin de la rivière Noire, ainsi que des aménagements spéciaux aux aéroports de Maniwaki et du lac des Loups.

L'application de l'insecticide au taux de 3 onces de Fénitrothion en émulsion dans l'eau à raison de 0.15 gallon d'émulsion par acre a été confiée à Forest Protection Limited. Cette organisation utilisa à chaque aéroport une formation de trois avions T.B.M. Avenger pouvant traiter un bloc de 12,600 acres de forêt à chaque envol. Les arrosages eurent lieu du 4 au 17 juin inclusivement à Maniwaki, et du 5 au 25 juin inclusivement au lac Nilgaut et au lac des Loups. Un total de six et de quatre jours dans les secteurs lac Nilgaut et lac des Loups respectivement ne purent être utilisés pour fins d'arrosage principalement à cause de la visibilité insuffisante. D'après les données du Service de l'Environnement atmosphérique du Canada, la température des mois de mai et juin fut normale; de même la précipitation fut normale en mai, mais ne fut qu'environ 60 pour cent de la normale en juin, ce qui a pu contribuer au développement rapide de l'insecte.

EXPERTISE BIOLOGIQUE

A - Places d'étude

Pour connaître les effets de l'insecticide sur le niveau de population de la tordeuse, 107 places d'étude furent établies dans les territoires à arroser, soit 29 dans le secteur de Maniwaki, 42 dans celui du lac Nilgaut, et 36 dans celui du lac des Loups. Chaque place d'étude consistait généralement en un peuplement de sapin et/ou d'épinette blanche dans lequel on avait choisi cinq arbres-échantillon, généralement des sapins, co-dominants et espacés d'environ une chaîne les uns des autres et au moins à une chaîne de la bordure des routes. Les échantillons prélevés dans ces places d'étude à peine quelques jours avant l'arrosage de chacune d'elles, comprenaient 10 bouts de branches de 18 pouces de longueur prises à mi-cime à raison de deux branches par arbre-échantillon. Au pourtour des trois secteurs arrosés, 20 places-témoins furent établies de façon semblable, dont huit à Maniwaki, six au lac Nilgaut et sux au lac des Loups, afin de connaître les changements de niveau de population sous l'effet des facteurs écologiques (naturels) seulement. Malheureusement, près des deux-tiers des places témoins, soit l'ensemble de ces dernières des secteurs lac Nilgaut et lac des Loups, ne sont pas représentatives de ces secteurs traités principalement à cause de leurs populations moyennes de larves beaucoup plus faibles. Pour cette raison, on ne pourra utiliser les données de ces dernières places témoins pour calculer la mortalité attribuable à l'insecticide.

B - <u>Développement de l'insecte</u>

Pour suivre le développement de l'insecte, lequel aide à déterminer le premier jour des arrosages, des échantillons furent prélevés tous les jours dans diverses places d'étude. La plus grande partie du développement (i.e. pic du troisième âge au pic du sixième âge) s'est effectuée en 10, 12 et 21 jours dans les secteurs Maniwaki, lac Wilgaut et lac des Loups respectivement (voir figures 1, 2 et 3). Ce dernier secteur étant plus au nord et d'une altitude un peu plus élevée que les deux autres, il est normal d'y avoir un développement plus lent. Cependant, le pic du cinquième âge fut atteint presque simultanément dans les trois secteurs, soit le 9, le 11 et le 12 juin respectivement.

Les arrosages devaient normalement débuter lorsque 50 pour cent des larves avaient atteint le quatrième âge. Les raisons qui militaient pour l'adoption de ce critère sont les suivantes: 1) le Fénitrothion était reconnu pour se désagréger après quatre jours, ses éléments n'étant plus actifs après cette période, 2) cette période devait coincider avec le moment où la larve devenait plus exposée au contact de l'insecticide, 3) il est reconnu que l'on peut obtenir une plus forte mortalité des larves au quatrième âge que plus jeune, alors qu'elles n'ont fait encore que peu de dommage, 4) que les dommages les plus importants sont surtout occasionnés par le sixième âge, et 5) qu'une seule application d'insecticide était prévue. En pratique, les arrosages se sont écartés quelque peu de cette norme, ils ont commencé trois jours plus tard à Maniwaki, deux jours plus tôt au lac Nilgaut, et deux jours plus tard au lac des Loups.

C - Population pré-arrosage de l'insecte

Les populations moyennes par branche de 18 pouces avant les arrosages étaient de 17.7, 19.6 et 22.1 (voir tableau 2, 3 et 4) dans les secteurs Maniwaki, lac Nilgaut et lac des Loups respectivement. Les populations moyennes des places témoins étaient dans ce même ordre, 16.8, 9.5 et 10.4 larves (tableau 5). On remarque dans ce tableau que les populations des places témoins des secteurs Nilgaut et des Loups sont environ deux fois moindresque celles des places d'études. Pour cette raison, les données des places-témoins de Maniwaki ne seront utilisées qu'avec réserve pour estimer approximativement l'efficacité de l'insecticide, 10 jours après les arrosages dans les secteurs du lac Nilgaut et du lac des Loups.

D - Population post-arrosage de l'insecte

Deux séries d'échantillons des populations résiduelles furent prélevées selon la même méthode et sur les mêmes arbres que pour les populations pré-arrosage. La première série fut prise environ 10 jours après l'arrosage de chaque place d'étude et les données furent utilisées pour estimer l'efficacité de l'insecticide. La deuxième série eut lieu au temps de la chrysalide, et les données indiquent la mortalité totale due à l'action combinée de l'insecticide et des facteurs naturels. Les populations résiduelles moyennes par branche de 18 pouces, au temps de la chrysalide, étaient de 2.6 à Maniwaki, 3.6 au lac Nilgaut, et 2.4 au lac des Loups, équivalant à une mortalité moyenne totale de 85,82 et 89 pour cent dans les secteurs respectifs. Cependant, l'efficacité de l'insecticide seul, estimé à l'aide de la formule Abbott[1] donne pour Maniwaki une mortalité de 40 pour cent 10 jours après l'arrosage. Quant aux secteurs du lac Nilgaut et du lac des Loups, cette mortalité, calculée avec les données des places-témoins de Maniwaki, est de 44 et 69 pour cent respectivement.

E - Défoliation dans les territoires arrosés

La défoliation dans les territoires arrosés fut déterminée grâce à l'inventaire aérien exécuté dans les territoires infestés du Québec, du 12 juillet au 7 août. Les informations alors recueillies furent en partie vérifiées par des observations sur le terrain, lors de l'inventaire des oeufs fait au cours du mois d'août. Les données révèlent que la destruction du feuillage de l'année courante fut presque complète sur la majorité du territoire arrosé. Toutefois certaines localités furent répérées aux environs de Low et dans le Parc de la Gatineau, arrosées pour une deuxième année consécutive, où jusqu'à 50 pour cent du feuillage de l'année courante fut sauvé sur le sapin.

Quant au feuillage des années précédentes il n'a généralement pas été attaqué au cours de cette saison (back feeding) sur le territoire arrosé.

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1 $\frac{x - y}{x} \times 100$ ou x = % moyen survie dans les places témoins

ou y = % survie dans les places d'étude traitées

F - Population de masses d'oeufs dans les superficies arrosées

Un total de 101 localités furent échantillonnées par la méthode adoptée au cours des années passées consistant en des comptages séquentiels des masses d'oeufs par 100 pieds carrés de feuillage de sapin. Une moyenne de 847 masses par 100 pieds carrés fut trouvée, moyenne qui excède de beaucoup la quantité de 200 requise pour causer une défoliation sévère en 1972. Ainsi, on peut s'attendre à des dégâts sérieux dans les mêmes superficies l'an prochain, si aucun traitement à l'insecticide n'est appliqué. Cette population est toutefois inférieure dans une proportion de 53 pour cent à celle enregistrée dans les mêmes territoires en 1970.

G - Discussion

Les arrosages à l'insecticide Fénitrothion exécutés contre la tordeuse des bourgeons de l'épinette dans l'ouest du Québec en 1971, n'ont pas produit tous les résultats attendus. Donc, le but premier des arrosages était de prévenir la mortalité du sapin en protégeant le feuillage de l'année courante ainsi que celui des années antérieures. Malheureusement, le feuillage de l'année courante a été presque totalement détruit, mais le vieux feuillage fut préservé et relativement peu de sapins sont morts. Par ailleurs, une certaine quantité du vieux feuillage fut détruit dans des peuplements à population élevée situés en périphérie des aires arrosées. Il semblerait donc que les arrosages auraient empêché la destruction d'une partie du vieux feuillage dans les aires arrosées.

Vu le demi-succès des opérations de 1971, certains sont tentés de conclure à un départ tardif. De fait, l'opération aurait pu commencer cinq jours plus tôt (pic du troisième âge), mesure qui aurait permis d'atteindre l'insecte d'autant plus tôt dans son développement. Cependant, ce changement n'aurait pas contribué à raccourcir la période d'arrosage, mais aurait contribué à protéger environ 20 pour cent du territoire arrosé à une période plus propice.

Le retard enregistré au départ n'a malheureusement pu être rattrapé par la suite en raison du développement accéléré de l'insecte favorisé par des conditions de climat extrêmement avantageuses à travers la majorité du territoire. De fait, on comptait sur un développement plus lent et plus étalé, alors qu'il fut complété en un temps relativement court et que dans les trois secteurs l'insecte atteignit le cinquième âge à peu près à la même date.

On sait de plus que la population de l'insecte existait à un niveau très élevé dans ce territoire. Les conditions de climat étant devenues soudainement, et pour une période prolongée, favorables au développement de l'insecte au début de la saison, il est possible que les jeunes larves se soient attaquées au feuillage au tout début de l'éclosion des bourgeons, les détruisant relativement tôt dans la saison.

D'après les considérations précédentes, on est tenté de conclure qu'il aurait fallu commencer les arrosages plus tôt et aussi raccourcir la période d'arrosage de moitié en modifiant les méthodes d'opération.

RAPPORT PRELIMINAIRE DES OPERATIONS CONTRE
LA TORDEUSE DES BOURGEONS DE L'EPINETTE
DANS LA REGION DU TEMISCOUATA

par

Desaulniers, R. et Y. Hardy

INTRODUCTION

Les premiers signes d'une augmentation de la population de la tordeuse des bourgeons de l'épinette devinrent évidents dans la région du Bas St-Laurent en 1968. La population augmenta au cours des deux années suivantes, si bien qu'à l'automne de 1970 l'infestation en majorité légère couvrait 42,500 acres. Seule une superficie de 2,800 acres avait subi des défoliations modérées.

Les représentants de la Direction générale de la Conservation au ministère des Terres et Forêts du Québec et ceux du Centre de Recherche forestière des Laurentides du ministère fédéral de l'Environnement décidèrent de tenter de contrôler en 1971 ces foyers d'infestation qui pouvaient donner naissance à une nouvelle épidémie dans l'est du Québec. Ce projet de répression s'est étendu à 116,376 acres (carte 2).

GENERALITES

Les superficies à traiter devaient remplir les deux conditions suivantes:

1 - Etre des peuplements résineux et/ou mélangés à prédominance de sa-

pin beaumier et d'épinette blanche d'après les cartes forestières du Service de l'inventaire forestier, ministère des Terres et Forêts.

2 - Présence à l'automne de 1970 d'une population d'oeufs de l'insecte permettant de prévoir des dommages pour 1971.

Puisque l'on devait tenter de contrôler une épidémie naissante, le projet prévoyait, selon les avis de l'Institut de recherche en répression chimique du ministère fédéral de l'Environnement, une double application de 3 onces de Fénitrothion dans 0.15 gallon d'émulsion aqueuse par acre. L'application de l'insecticide a été confiée à Forest Protection Limited qui a utilisé trois avions T.B.M. Avenger volant en formation et pouvant traiter un bloc de 12,600 acres de forêt à chaque envol. L'insecticide fut formulé au Nouveau-Brunswick d'où il était expédié par camion à l'aéroport municipal d'Edmunston, la base d'opération. L'émulsion finale de l'insecticide dans l'eau était faite quelques minutes seulement avant le chargement à bord des avions.

A la suite de représentations de Forest Protection Limited, le projet a été modifié et une seule application de 3 onces d'insecticide à l'acre a eu lieu. Les opérations d'arrosage débutèrent le 12 juin pour se terminer le 15 mais elles furent interrompues le 13 à cause de conditions climatiques défavorables. D'après les données du Service de l'environnement atmosphérique, la température des mois de mai et juin fut selon la normale; la précipitation fut également normale en mai mais ne fut qu'environ 25 pour cent de la normale en juin.

EXPERTISE BIOLOGIQUE

A - Places d'étude

En vue de déterminer le rythme du développement de l'insecte et l'amplitude des populations avant et après le traitement, 10 places d'étude furent établies dans les aires à traiter. Chaque place d'étude consistait généralement en un peuplement de sapin et/ou d'épinette blanche dans lequel on avait choisi cinq arbres-échantillon, généralement des sapins, co-dominants et espacés d'environ une chaîne les uns des autres et au moins à une chaîne de la bordure de la route. Un total de quatre places témoins furent établies de façon semblable à l'extérieur des aires traitées. L'échantillon de base était constitué des 18 pouces apicaux de deux branches de chacun des cinq arbres-échantillon. Ces branches étaient prélevées dans le tiers médian de la cime de l'arbre à l'aide d'un sécateur muni d'un panier en canevas de 18 pouces de diamètre. Les branches, identifiées et enveloppées individuellement dans un sac de polyéthylène fermé hermétiquement, étaient apportées au laboratoire et examinées le jour même de leur prélèvement ou au plus tard le lendemain.

B - Développement de l'insecte

L'échantillonnage a débuté le 25 mai et il s'est poursuivi jusqu'à ce que l'insecte ait atteint le stage de chrysalide. Chacune des places d'étude fut visitée à intervalles d'environ quatre jours. La largeur de la capsule cranienne de chaque larve fut mesurée et comparée à l'échelle de McGugan (1) afin de déterminer le stade larvaire de l'insecte. En cumulant les données journalières, il fut ensuite possible de tracer la courbe de développement de l'insecte (figure 4). On constate, à l'analyse de cette courbe, que les arrosages ont eu lieu lorsque la majorité des larves étaient au cinquième âge et qu'ils se sont terminés 10 jours avant que l'insecte atteigne le pic du sixième âge.

C - <u>Population pré-arrosage de l'insecte</u>

Le dénombrement des larves, au début de l'échantillonnage, s'est fait manuellement sur chacune des branches après une localisation visuelle des larves. Lorsque le quatrième âge larvaire fut atteint, les larves étaient délogées des branches en secouant celles-ci vigoureusement contre un grillage monté à l'intérieur d'un baril. Cet appareil, une modification apportée par Martineau à celui décrit par DeBoo et Campbell (2), s'avéra très précis et fut responsable d'une économie de temps appréciable.

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(1) McGugan, B. M. 1954. Needle-mining habits and larval instars of the spruce budworm. Can. Ent. 86: 439-454.

(2) DeBoo, R. M., and Campbell, L. M. 1971. 1970 evaluation of a new sampling technique for estimating numerical trends in larval populations of insect defoliators on conifers. Chemical Control Research Institute. Canadian Forestry Service.

La population moyenne de l'insecte par branche de 18 pouces deux jours avant l'arrosage s'élevait à 12.1 dans les aires traitées et à 10.6 dans les places témoins (tableau 6).

D - Population post-arrosage de l'insecte

Pour estimer le niveau de la population après le traitement, on procéda à trois échantillonnages selon la même méthode et sur les mêmes arbres que pour les populations pré-arrosage. Ces échantillonnages furent faits 6 et 10 jours après le traitement et au pic du stade de chrysalide soit environ 22 jours après le traitement. La population résiduelle moyenne par branche de 18 pouces dans les aires traitées s'élevait à 4.8 spécimens après 6 jours, à 2.8 après 10 jours et à 2.4 au temps de la chrysalide, équivalant à une mortalité moyenne totale de 60, 77 et de 80 pour cent à chacune des phases de l'échantillonnage. Cependant, la mortalité attribuable à l'insecticide, estimée à l'aide de la formule Abbott[1], s'élève à 55 pour cent 6 jours après l'arrosage, à 61 pour cent après 10 jours et à 58 pour cent au temps de la chrysalide.

E - Défoliation dans les territoires arrosés

De multiples observations de la défoliation dans les divers peuplements traités indiquent qu'en général moins de la moitié du feuillage a échappé à la défoliation. Toutefois, la protection du feuillage d'une parcelle de forêt, située à proximité du lac Dole, a été très efficace.

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1 $\frac{x - y}{x} \times 100$ ou x = % moyen survie dans les places-témoins
ou y = % survie dans les places d'étude traitées

F - Population des masses d'oeufs dans les superficies arrosées

Un total de 21 localités furent échantillonnées par la méthode consistant en des comptages séquentiels de masses d'oeufs par 100 pieds carrés de feuillage de sapin. Une moyenne de 15.8 masses d'oeufs par 100 pieds carrés fut trouvée en 1971 comparativement à 11.4 en 1970.

G - Discussion

L'objectif fixé, c'est-à-dire contrôler une épidémie de tordeuse des bourgeons de l'épinette à ses débuts, n'a pas été atteint. Il serait présomptueux de définir avec exactitude des causes du bas rendement des opérations. Cependant, le fait qu'une seule application de 3 onces d'insecticide à l'acre a été réalisée, alors que le projet initial en prévoyait deux, en plus du retard avec lequel l'opération a débuté, à cause du manque de disponibilité d'avions, doivent être considérés parmi les facteurs ayant contribué à laisser une population résiduelle s'élevant à 2.4 spécimens de l'insecte par branche de 18 pouces. Les résultats obtenus au lac Dole, le seul endroit où la mortalité larvaire et la protection du feuillage ont atteint un niveau acceptable, au cours de l'opération qui n'a duré que quatre jours, laissent supposer qu'il aurait été possible d'obtenir de meilleurs résultats que ceux obtenus dans les autres aires traitées. A une occasion, il nous a été permis de vérifier si les lignes de vol se succédaient à un intervalle de un quart de mille tel qu'il se devait. Or il a été constaté que cette distance variait entre un demi mille à moins de un quart de mille, ce qui porte à croire qu'un problème se situe au niveau de la distribution aérienne de l'insecticide.

Il ne faudra pas conclure pour cela que l'opération a été un échec complet. Le traitement de l'infestation à ses débuts a eu pour effet de ralentir les progrès de l'insecte qui aurait eu tôt fait de dévaster la région présentement infestée et de s'étendre aux régions avoisinantes. D'autre part, le feuillage qui a été protégé permettra aux arbres de résister plus longtemps aux attaques à venir. Il y a donc des chances qu'en considération de son coût, l'opération du Témiscouata ait été rentable.

DEFOLIATION DANS LA PROVINCE EN GENERAL

par

R. Desaulniers

Comme depuis 1968, un inventaire aérien de la défoliation causée par la tordeuse des bourgeons de l'épinette a été réalisé en 1971. Les résultats de cet inventaire indiquent que la défoliation était sévère sur une superficie de 4.1 millions d'acres, modérée sur une superficie de 4.3 millions d'acres et légère sur une superficie de 5.1 millions d'acres. C'est donc dire que 13.5 millions d'acres de forêts de sapin et d'épinette blanche sont actuellement affectées par l'insecte.

A - Région ouest du Québec

L'inventaire aérien de 70,000 milles carrés de forêts à l'ouest de la rivière St-Maurice a contribué à délimiter plusieurs foyers d'infestation nouveaux ou demeurés imprécis l'an dernier. Les résultats de cet inventaire indiquent que des défoliations ont été enregistrées sur une superficie totale de 13.0 millions d'acres en 1971 comparativement à 6.0 millions d'acres en 1970. La défoliation a été sévère sur une superficie de 4.7 millions d'acres, modérée sur une superficie de 4.2 millions d'acres et légère sur une superficie de 4.1 millions d'acres (carte 3).

En plus du foyer principal s'étendant de la rivière Dumoine à la rivière du Lièvre, des aires d'infestation ont été observées

1) entre la frontière de l'Ontario et le lac Opasatica; 2) aux environs du lac Simard; 3) dans le parc du Mont-Tremblant; 4) aux environs de St-Michel-des-Saints; 5) dans les plantations d'épinette blanche près de Grand'Mère et 6) sur le territoire s'étendant entre Sanmaur à l'ouest jusqu'à La Tuque à l'est.

Notons que les forêts du foyer principal couvrant une superficie de 3.726 millions d'acres ont subi deux ans et plus de défoliations modérées et sévères soit 4 ans sur une superficie de 24,700 acres, 3 ans sur une superficie de 538,600 acres et 2 ans sur une superficie de 3.163 millions d'acres.

B - Région centre du Québec

L'inventaire aérien de cette région a couvert une superficie de 4,000 milles carrés sur le territoire s'étendant de la rivière Montmorency vers l'est jusqu'à la rivière Saguenay. Cet inventaire a permis de constater, aux environs de la rivière Malbaie, que l'insecte a causé des défoliations en majorité légères sur une superficie de 23,372 acres. Seule une superficie de 461 acres a subi des défoliations modérées (carte 4).

C - Région de l'est du Québec

L'inventaire aérien de cette région a couvert une superficie de 1,100 milles carrés sur la rive nord du St-Laurent depuis la rivière Saguenay jusqu'à Forestville à l'est et de 10,000 milles carrés sur le territoire s'étendant du comté de Kamouraska vers l'est jusqu'aux environs de Matane ainsi que la partie sud de la péninsule gaspésienne. Cet inventaire a révélé que les forêts du Témiscouata ont été les seules à montrer des signes de défoliation (carte 5). Cette infestation, qui affectait une superficie de 42,600 acres en 1970, s'est substantiellement étendue en 1971 pour couvrir une superficie de 471,436 acres dont 2,767 acres de défoliation sévère, 33,520 acres de défoliation modérée et 435,149 acres de défoliation légère.

POPULATION DES OEUFS DANS LA PROVINCE EN GENERAL

par

R. Martineau

Comme en 1970, un inventaire des œufs de la tordeuse des bourgeons de l'épinette a été fait dans la province de Québec en 1971. La méthode adoptée a été la même que par les années passées et a consisté dans des comptages séquentiels de masses d'oeufs par 100 pieds carrés de feuillage de sapin. Le travail fut exécuté par les techniciens du Laboratoire de Recherche forestière des Laurentides en coopération avec ceux du Ministère des Terres et Forêts. L'échantillonnage a été distribué en prenant comme base la carte d'infestation préparée par le même ministère lors d'un inventaire aérien fait en juillet 1971. Le grand foyer de l'ouest du Québec fut l'objet d'une attention particulière en raison de l'importance de l'aire d'infestation et de l'intensité des dégâts. Il importe de souligner ici que dans certaines des localités de ce secteur les opérateurs avaient peu de choix pour localiser des arbres-échantillon, particulièrement dans les terrains visités par la coupe. Pour cette raison la population d'oeufs pourrait, dans ces cas spécifiques, ne pas être représentative des conditions rencontrées dans les forêts non exploitées avoisinantes.

A – Région ouest du Québec

Un total de 414 localités furent échantillonnées au cours du mois d'août dans et à la périphérie du secteur principal d'infestation tel que déterminé par l'inventaire aérien, afin d'y établir la population d'oeufs. La distribution des localités échantillonnées en 1971 est montrée sur la carte 6 et le synopsis suivant montre leur répartition d'après la population d'oeufs enregistrée comparativement à celle de 1970.

Année	0-99 (légère)	100-199 (modérée)	200 + (sévère)
1971	12.8	2.7	84.5
1970	29.2	2.1	68.7

Il importe d'ajouter que 26 pour cent des localités avaient une population supérieure à 1,000 masses d'oeufs par 100 pieds carrés de feuillage, le maximum atteignant 5,800. On peut donc s'attendre à une défoliation sévère sur la plus grande partie de ce territoire en 1972.

Le tableau 7 a été préparé pour montrer les tendances de la population d'oeufs de 1970 à 1971 et donne les populations moyennes enregistrées dans les divers secteurs au cours des deux dernières années. Un premier examen des chiffres représentant le rapport de la population d'oeufs 1971/1970 révèle 1) une réduction de la population d'oeufs d'environ 50 pour cent dans les superficies arrosées, lesquelles ont été considérées dans la première section du rapport et 2) une variation importante (0.39 à 37.7) dans les superficies non arrosées. Une étude plus attentive des chiffres présentés pour les superficies non-arrosées montre que tous les nombres inférieurs à 1 concernent les secteurs sud-ouest et sud de l'infestation, alors que les autres se rapportent au secteurs nord et est. Cette constatation nous laisse croire que l'infestation commence à décliner dans la zone adjacente à la rivière Ottawa alors qu'elle progresse vers le nord et l'est.

D'après les chiffres de population d'oeufs enregistrés cette année, les secteurs Pomponne-Joncas, Gatineau Centrale et Baskatong-Cabonga nous apparaissent comme les plus exposés à une défoliation sévère en 1972 et il est à craindre que dans ces secteurs le feuillage soit éliminé assez tôt dans la saison, en raison de la surpopulation.

B - Région centre du Québec

Un total de 185 localités furent échantillonnées pour les oeufs dans le centre du Québec qui couvre toute la région comprise depuis le bassin du St-Maurice à l'ouest, jusqu'à l'embouchure du Saguenay à l'est. Leur distribution dans les diverses catégories d'infestation est présentée dans le synopsis suivant:

0 (nulle)	1-100 (légère)	101-200 (modérée)	200 + (sévère)	Total
70	73	4	38	185

Ces chiffres montrent que la population de l'insecte est faible dans la majorité des localités. Les populations les plus élevées furent notées dans les localités du bassin du St-Maurice, plus spécialement dans les environs de St-Michel-des-Saints, dans les plantations d'épinette blanche de Grand'Mère, au sud de Sanmaur et au nord du barrage Gouin. Quelques autres points comportant une population élevée furent relevés dans deux localités du comté de Charlevoix (carte 7).

C - Région est du Québec

Un total de 180 localités furent échantillonnées pour les oeufs dans la région de l'est du Québec. Cette région comprend tout le secteur situé à l'est du Saguenay et du comté de Kamouraska. La distribution des localités suivant la population d'oeufs enregistrée est présentée dans le synopsis suivant pour l'ensemble du territoire.

Endroit	0 (nulle)	1-100 (légère)	101-200 (modérée)	201 + (sévère)	Total
Sud du St-Laurent	70	74	6	22	162
Nord du St-Laurent	14	4	-	-	18

Ces chiffres indiquent que la population est toujours faible au nord du St-Laurent alors qu'au sud plusieurs localités laissent voir une population élevée. La très grande majorité des localités classées sévères furent repérées dans la région du Témiscouata où l'infestation est active depuis une couple d'années (carte 8). Pour cette raison, l'échantillonnage y avait été intensifié en 1971. Des 97 localités échantillonnées, 23 contenaient plus de 200 masses d'oeufs et une seule au dessus de 1000. D'après les chiffres recueillis, il y a lieu de s'attendre à une défoliation modérée à sévère sur environ 30 pour cent du territoire.

Le tableau 8 donne une idée de la tendance de la population d'oeufs pour les différents secteurs de ce territoire. Dans la superficie arrosée, la population d'oeufs augmenta quelque peu en 1971, alors qu'ailleurs elle est généralement beaucoup plus élevée.

RECOMMANDATIONS POUR 1972

Les recommandations pour 1972 sont basées sur les aires ayant subi deux années ou plus de défoliations modérées et sévères ainsi que sur la population des masses d'oeufs de l'insecte. Les peuplements résineux et mélangés à prédominance de sapin et d'épinette blanche selon les cartes forestières ont également été considérés au moment de l'élaboration de ces recommandations.

Quelque 3.2 millions d'acres de forêts du principal foyer d'infestation de la région ouest du Québec sont présentement à l'étude en vue de réaliser une opération d'arrosage aérien d'insecticide en 1972. Ces aires d'infestation sont composées de 1.7 millions d'acres de forêts résineuses et de 1.5 millions d'acres de forêts mélangées. Les territoires à l'étude ont été délimités selon les données entomologiques mais les aspects forestiers et économiques pourront éventuellement apporter des modifications à ce projet.

Aucune opération d'envergure concernant des arrosages aériens d'insecticide n'est prévue pour 1972 dans les aires d'infestation des régions centre et est du Québec. Toutefois, des travaux de recherche pourront y être réalisés.

Tableau 1 - SUPERFICIE (ACRES) DES ARROSAGES

CONTRE LA TORDEUSE DES BOURGEONS DE L'EPINETTE EN 1971

SELON LA TENURE DES TERRES

Tenure	Superficie (acres)
025 Booth Veneer Limitée	48,891
068 Compagnie Internationale de Papier du Canada	1,085,225
071 Consolidated-Bathurst Limitée	86,989
132 The E. B. Eddy Company	566,015
148 Forêt Coulonge Inc.	8,972
168 Gillies Bros. & Company Limited	93,751
Terrains vacants	68,395
Réserve cantonale	520
Terrains privés	63,324
Parc de la Gatineau	8,322
Total	2,030,404

Tableau 2 - MORTALITE DES LARVES PAR PLACE D'ETUDE SUIVANT LE TRAITEMENT AU FENITROTHION

DE LA TORDEUSE DES BOURGEONS DE L'EPINETTE DANS LA GATINEAU EN 1971

SECTEUR MANIWAKI

No place étude	Date de l'examen des larves	Date de l'arrosage	No bloc d'arrosage	Pourcentage de chaque âge à la date de l'examen des larves						Population moyenne d'insectes/branche 18"			Pourcentage total de survie		Pourcentage de mortalité totale		Pourcentage de mortalité dû à l'insecticide après 10 jours (selon Abbott)
										pré-arrosage	post-arrosage						
				II	III	IV	V	VI	chrys.		après 10 jours	à la chrysalide	après 10 jours	à la chrysalide	après 10 jours	à la chrysalide	avec survie moyenne des témoins de Maniwaki
1	12-6	17-6	201			23	26	51		20.5	7.8	4.7	38.0	26.9	62.0	73.1	10
5	12-6	15-6	204			22	48	30		13.8	7.6	5.8	55.0	42.0	45.0	58.0	0
8	8-6	15-6	209			40	43	16		32.5	1.5	1.4	4.6	4.3	95.4	95.7	89
10	12-6	15-6	210			9	57	34		10.7	2.3	4.5	21.5	42.0	78.5	58.0	49
11	9-6	14-6	211		5	32	55	8		45.9	6.1	7.3	13.3	15.9	86.7	84.1	68
12	9-6	12-6	213		1	46	44	9		28.2	2.9	1.1	10.3	3.9	89.7	96.1	75
13	9-6	11-6	214			47	49	4		19.3	1.9	4.5	9.8	23.3	90.2	76.7	77
14	9-6	11-6	215			16	75	9		28.6	5.4	2.4	18.9	8.4	81.1	91.7	55
15	8-6	11-6	216							3.8	5.0	3.5	130.2	92.1	0.0	7.9	0
16	9-6	11-6	216							20.6	3.0	3.0	14.5	14.5	85.5	85.5	66
17	8-6	11-6	217							4.9	0.7	1.1	14.3	22.4	85.7	77.6	66
19	3-6	5-6	219							6.9	6.6	1.1	95.6	16.7	4.4	83.3	0
20	3-6	5-6	219							9.5	5.7	3.1	60.0	32.6	40.0	67.4	0
21	6-6	6-6	222			51	45	4		39.0	4.0	2.0	10.2	5.1	89.8	94.9	76
22	7-6	6-6	222		36	50	4			13.0	2.6	0.9	20.0	6.9	80.0	93.1	52
23	6-6	6-6	224		2	49	47	2		32.0	5.8	4.5	18.1	14.0	81.9	86.0	57
24	9-6	10-6	226			14	59	27		10.6	5.1	4.0	48.1	37.7	51.9	62.3	0
25	9-6	10-6	226			56	36	8		19.8	6.4	1.5	32.1	7.6	67.9	92.4	24
26	11-6	13-6	229		6	54	34	6		14.1	5.0	3.6	35.5	25.5	64.5	74.5	15
27	6-6	8-6	230		5	30	53	12		5.8	0.3	0.3	5.1	5.1	94.9	94.9	88
28	7-6	7-6	231			28	64	8		2.6	0.8	0.3	30.8	11.5	69.2	88.5	93
28A	10-6	10-6	228			15	27	58		25.0	1.1	2.1	4.4	8.4	95.6	91.6	90
29	7-6	7,16-6	232			30	52	8		25.9	5.1	2.7	19.7	9.3	80.3	90.7	53
30	2-6	6-6	234							10.3	1.7	1.7	16.5	16.5	83.5	83.5	61
31	2-6	6-6	234							7.1	0.4	0.1	5.6	1.4	94.4	98.6	87
32	2-6	6-6	235							16.1	9.2	2.2	57.0	13.7	43.0	86.3	0
33	3-6	6-6	235					100		2.5	1.3	1.9	52.0	76.0	48.0	24.0	0
34	7-6	10-6	236			13	50	37		16.1	10.9	2.6	67.7	16.1	32.3	83.9	0
36	3-6	5-6	238			55	36	9		33.1	15.2	3.4	46.0	10.3	54.0	89.7	0
Moyenne										17.9	4.5	2.6	25.1	14.5	74.9	85.5	40

Tableau 3 - MORTALITÉ DES LARVES PAR PLACE D'ÉTUDE SUIVANT LE TRAITEMENT AU FENITROTHION
DE LA TORDEUSE DES BOURGEONS DE L'EPINETTE DANS LA GATINEAU EN 1971
SECTEUR LAC NILGAUT

No place étude	Date de l'examen des larves	Date de l'arrosage	No bloc d'arrosage	Pourcentage de chaque âge à la date de l'examen des larves						Population moyenne d'insectes/branche 18"			Pourcentage total de survie		Pourcentage de mortalité totale		Pourcentage de mortalité dû à l'insecticide après 10 jours (selon Abbott) avec survie moyenne des témoins de	
										pré-arrosage	post-arrosage							
				II	III	IV	V	VI	chrys.		après 10 jours	à la chrysalide	après 10 jours	à la chrysalide	après 10 jours	à la chrysalide	Nilgaut	Maniwaki
1	7-6	13-6	1		28	64	8			14.4	10.0	10.0	69.5	69.5	30.5	30.5	7	0
2	7-6	11-6	1			57	42	1		16.1	9.0	6.4	55.9	39.7	44.1	60.3	25	0
3	8-6	11,12-6	3			32	50	18		22.3	7.7	4.5	34.5	20.2	65.5	79.8	59	18
4	8-6	16-6	4		20	57	22	1		42.2	3.7	3.1	8.7	7.3	91.3	92.7	88	80
7	8-6	15-6	9			23	53	24		10.6	0.0	1.6	0.0	15.2	100.0	84.8	100	100
9	6-6	5-6	10		28	50	22			15.4	4.5	2.5	29.2	16.2	70.8	83.8	61	30
10	6-6	5-6	10		33	58	9			16.4	8.2	2.1	50.0	12.8	50.0	87.8	33	0
11	6-6	5-6	10		21	43	36			43.1	7.0	0.4	16.2	0.9	83.3	99.1	78	62
12	8-6	11-6	11			7	89	4		32.3	0.9	0.5	0.3	1.5	99.7	98.5	99	99
13	8-6	11-6	11			40	59	1		14.4	0.2	0.5	1.4	3.5	98.6	96.5	98	98
14	8-6	11-6	11		17	34	49			16.3	0.1	1.8	0.6	11.0	99.4	89.0	99	99
18	20-6	23-6	14			7	40	49	4	4.5	2.8	1.6	62.2	35.6	37.8	64.4	17	0
20	18-6	22-6	17			7	32	61		12.3	10.4	6.5	84.5	52.8	15.5	47.2	0	0
21	11-6	14,15-6	18			6	48	46		23.6	1.9	0.8	8.0	3.4	92.0	96.6	89	81
22	8-6	10,11-6	19							18.6	0.5	0.2	2.6	1.1	97.4	98.9	96	94
23	6-6	9-6	20		53	30	17			12.1	1.9	0.2	15.7	1.6	84.3	98.4	79	63
24	7-6	9-6	20		37	38	25			32.3	2.7	1.9	8.3	5.9	91.7	94.1	89	80
25	8-6	9,22-6	21		28	49	23			28.1	1.7	1.0	6.0	3.5	94.0	96.5	92	86
26	8-6	9-6	22		12	53	35			21.5	0.9	1.4	4.2	6.5	95.7	93.5	94	90
27	6-6	10-6	23		39	57	4			34.1	3.3	2.7	9.4	7.9	90.6	92.1	88	78
29	11-6	15-6	24			3	79	18		39.3	2.7	1.1	6.8	2.8	93.2	97.2	91	84
30	20-6	21-6	27				10	90		2.1	5.5	5.5	262.0	262.0	0.0	0.0	0	0
34	11-6	15-6	32			48	50	2		27.4	1.7	4.3	6.2	15.7	97.8	84.3	92	85
35	7-6	10-6	33			50	47	3		6.3	1.0	1.5	15.8	23.8	84.2	76.2	79	62
37	16-6	15-23-6	36			19	15	66		2.7	0.7	0.7	25.9	25.9	74.1	74.1	66	38
39	23-6	23-6	40			3	21	70	6	23.1	15.5	2.0	67.0	8.6	33.0	91.4	11	0
40	23-6	25-6	41				23	72	5	20.8	13.4	13.4	64.4	64.4	35.6	35.6	14	0
41	23-6	25-6	41					89	11	14.2	14.0	14.0	98.6	98.6	1.4	1.4	0	0
42	10-6	14-6	43			27	50	23		10.9	11.0	11.5	101.0	105.5	0.0	0.0	0	0
43	5-6	7-6	44		10	77	13			33.4	5.2	5.4	15.5	16.2	84.5	83.8	79	63
44	23-6	22-6	46				27	45	28	18.3	7.9	8.0	43.1	43.7	56.9	56.3	43	0
49	23-6	22-6	51				10	33	57	6.9	5.6	5.5	81.2	79.7	18.8	20.3	0	0
50	16-6	17-6	52			19	46	35		17.2	2.0	1.4	11.6	8.1	88.4	91.9	85	72
51	14-6	17-6	52		8	34	51	7		23.9	1.7	0.9	7.1	3.7	92.9	96.3	90	83
52	14-6	17-6	52			30	64	6		17.6	3.2	2.9	18.2	16.5	81.8	83.5	70	57
54	16-6	22-6	54			16	19	65		13.5	2.3	2.0	17.0	14.8	83.0	85.2	77	60
55	15-6	22-6	54			31	54	15		11.5	0.6	0.6	0.5	5.2	99.5	94.8	99	99
58	18-6	23-6	58			1	28	71		17.2	8.2	8.2	47.7	47.7	52.3	52.3	37	0
60	15-6	17-6	59				62	38		6.7	0.2	0.0	2.9	0.0	97.1	100.0	96	95
62	7-6	14-6	61		6	46	48			42.0	1.4	1.4	3.3	3.3	96.7	96.7	96	95
63	15-6	17-6	62				47	53		7.1	0.7	0.8	9.8	11.3	90.2	88.7	87	77
64	20-6	23-6	64			3	11	81	5	21.8	13.1	10.6	60.0	48.6	40.0	51.4	20	0
Moyenne										19.6	4.6	3.6	23.5	18.4	76.5	81.6	69	44

Tableau 4 - MORTALITE DES LARVES PAR PLACE D'ETUDE SUIVANT LE TRAITEMENT AU FENITROTHION

DE LA TORDEUSE DES BOURGEONS DE L'EPINETTE DANS LA GATINEAU EN 1971

SECTEUR LAC DES LOUPS

No place étude	Date de l'examen des larves	Date de l'arrosage	No bloc d'arrosage	Pourcentage de chaque âge à la date de l'examen des larves						Population moyenne d'insectes/branche 18"			Pourcentage total de survie		Pourcentage de mortalité totale		Pourcentage de mortalité dû à l'insecticide après 10 jours (selon Abbott) avec survie moyenne des témoins de	
				II	III	IV	V	VI	chrys.	pré-arrosage	post-arrosage après 10 jours	post-arrosage à la chrysalide	après 10 jours	à la chrysalide	après 10 jours	à la chrysalide	Loups	Maniwaki
1	13-6	22-6	101			47	49	4		15.4	3.2	3.0	20.8	19.5	79.2	80.5	65	50
2	13-6	22-6	102			36	58	6		12.4	5.0	4.3	40.3	34.7	59.7	65.3	49	4
3	13-6	22-6	103			74	26			10.1	1.4	1.3	13.9	12.9	86.1	87.1	83	67
4	13-6	22-6	104			33	63	4		13.0	0.7	0.7	5.3	5.4	94.7	94.6	93	87
5	13-6	22-6	104			29	67	4		13.0	2.2	1.1	16.8	8.5	83.2	91.5	79	60
6	13-6	22-6	105			60	36	4		11.9	2.2	2.2	18.5	18.5	81.5	81.5	77	56
7	23-6	22-6	106							31.5	2.5	2.2	7.9	7.0	92.1	93.0	90	81
8	23-6	22-6	106							9.6	2.1	2.2	21.8	21.1	78.2	78.9	72	48
11	13-6	15-6	109							16.3	1.1	1.1	6.7	6.7	93.3	93.3	92	84
13	19-6	22-6	111			16	16	68		14.5	2.5	2.5	17.2	17.2	82.8	82.8	78	59
14	22-6	23-6	112				20	80		2.5	0.4	0.5	16.0	20.0	84.0	80.0	80	62
16	22-6	23,24-6	114				15	85		9.4	0.0	0.0	0.0	0.0	100.0	100.0	100	100
18	22-6	24,25-6	115							20.6	14.0	14.0	68.0	68.0	32.0	32.0	14	0
20	12-6	12-6	117			9	74	17		12.4	0.6	0.6	4.8	4.8	95.2	95.2	94	89
21	12-6	12-6	117				44	56		26.0	4.1	2.2	15.6	8.5	84.4	91.5	80	63
26	13-6	17-6	122			33	52	15		21.6	2.2	2.1	10.2	9.7	89.8	90.3	86	76
29	10-6	12-6	125		14	42	43	1		39.8	1.3	1.3	3.2	3.2	96.8	96.8	96	93
30	10-6	13-6	126		7	56	37			16.0	1.1	1.1	6.9	6.9	93.1	93.1	91	84
34	10-6	10-6	134			20	60	20		71.6	6.0	3.3	8.4	4.6	91.6	95.4	90	80
35	10-6	10-6	135		9	41	50			20.7	1.8	1.0	8.7	4.8	91.3	95.2	89	79
36	10-6	11-6	135			36	57	7		9.4	1.7	2.5	19.1	26.6	81.9	73.4	77	57
37	10-6	11-6	137							30.1	0.2	0.8	0.6	2.6	99.4	97.4	99	99
40	5-6	6-6	140	1	76	23				23.1	8.0	11.3	34.6	49.0	65.4	51.0	56	18
41	5-6	6-6	140		64	36				29.5	4.0	1.6	13.5	5.4	86.5	94.6	83	68
42	5-6	5-6	143	5	55	38	2			52.2	3.0	0.9	5.7	1.7	94.3	98.3	93	86
43	5-6	5-6	143		44	55	21			48.0	12.1	6.6	25.2	13.7	74.8	86.3	68	40
44	9-6	11-6	144		21	58	21			13.9	0.4	0.9	2.8	6.5	97.2	93.5	97	94
45	9-6	11-6	145							12.7	0.1	1.3	0.8	11.2	99.2	88.8	99	99
46	9-6	11-6	146		13	62	25			8.9	0.2	0.8	2.1	9.0	97.9	91.0	97	94
47	9-6	12-6	147		51	38	11			15.3	2.7	1.2	17.6	7.8	82.4	92.2	78	58
48	6-6	6-6	151			11	75	15		24.5	3.7	1.0	15.1	4.1	84.9	95.9	81	64
49	6-6	7-6	152							25.3	8.8	2.4	34.8	9.5	65.2	90.5	56	17
50	6-6	7-6	153			61	38	1		40.9	2.9	2.7	7.1	6.6	92.9	95.4	91	83
51	6-6	7-6	153		16	71	13			17.1	5.8	4.2	33.9	24.5	66.1	75.5	57	19
52	6-6	7-6	153							45.1	1.0	0.7	2.2	1.5	97.8	98.5	97	94
53	6-6	7-6	154		4	66	30			12.5	1.2	1.2	9.6	9.6	90.4	90.4	88	77
Moyenne										22.1	3.0	2.4	13.6	10.9	86.4	89.1	83	68

Tableau 5 - SURVIE DES LARVES DE LA TORDEUSE DES BOURGEONS DE L'EPINETTE

DANS LES PLACES TEMOINS, REGION DE LA GATINEAU, EN 1971

No place témoin	Maniwaki		No place témoin	Lac Nilgaut		No place témoin	Lac des Loups	
	Nombre larves/branche 18"			Nombre larves/branche 18"			Nombre larves/branche 18"	
	pré-arrosage	post-arrosage		pré-arrosage	post-arrosage		pré-arrosage	post-arrosage
1	21.9	4.7	1	5.9	6.7	1	8.7	3.8
2	36.5	4.6	2	14.3	9.0	2	8.9	6.5
5	15.4	7.9	3	9.9	9.8	3	14.5	9.5
6	5.8	3.0	4	14.6	10.6	4	11.2	14.7
7	11.3	8.9	5	5.6	3.2	30	7.4	4.3
21	26.1	16.9	6	12.4	8.1	40	6.5	6.2
32	8.9	4.8						
36	8.8	5.4						
Total	134.7	56.2		62.7	47.4		57.2	45.0
Moyenne	16.8	7.0		10.4	7.9		9.5	7.5
Survie moyenne	42%			75%			79%	

Tableau 6 - MORTALITE DES LARVES PAR PLACE D'ETUDE SUIVANT LE TRAITEMENT AU FENITROTHION DE LA TORDEUSE DES BOURGEONS DE L'EPINETTE DANS LA REGION DU TEMISCOUATA EN 1971

No place	Population moyenne d'insectes/branche 18"				Pourcentage de mortalité totale			Pourcentage de mortalité dû à l'insecticide (selon Abbott)		
	pré-arrosage	post-arrosage								
		après 6 jours	après 10 jours	à la chrysalide	après 6 jours	après 10 jours	à la chrysalide	après 6 jours	après 10 jours	à la chrysalide
Places d'étude										
1	13.4	3.5	2.1	1.3	74	84	90	67	73	79
2	3.1	0.3	0.1	0.0	90	97	100	87	95	100
3	6.7	1.6	0.6	0.5	76	91	93	69	85	85
6	0.4	0.1	0.1	0.0	75	75	100	68	58	100
8	6.0	4.5	4.4	1.9	25	27	68	4	0	32
9	21.6	7.1	3.2	4.4	67	85	80	58	75	57
10	25.6	0.3	0.3	1.4	99	99	95	99	98	89
14	21.8	8.2	6.0	6.8	62	72	69	51	53	34
16	12.6	11.6	6.7	5.5	8	47	56	0	12	6
17	10.6	10.3	4.9	2.0	3	54	81	0	23	60
Moyenne pondérée	12.1	4.8	2.8	2.4	60	77	80	55	61	58
Places témoins										
3S	24.7	26.5	15.6	12.8	0	37	50			
5	1.8	0.9	0.9	0.4	50	50	78			
11	15.3	9.5	8.6	6.3	38	44	59			
12	0.7	0.7	0.4	0.5	0	43	29			
Moyenne pondérée	10.6	9.4	6.4	5.0	12	40	53			

Tableau 7 - TENDANCE DES POPULATIONS PAR SECTEUR

(Nombre de points échantillonnés entre parenthèse)

	Masses d'oeufs par 100 pieds carrés de feuillage			Rapport du nombre d'oeufs Année
	1970	1971		1971/1970
Territoires arrosés	1589.1 (101)	847 (101)		0.533
Territoires non arrosés	737 (375)	807 (313)		1.09
Pomponne-Joncas	1164 (36)	1894 (26)		1.64
Lac Nilgault	1110 (22)	807 (2)		0.73
Dumoine	869 (16)	719 (6)		0.83
Ottawa-Basse Noire	995 (21)	779 (19)		0.78
Coulonge	891 (24)	686 (14)		0.77
Basse Ottawa - Basse Gatineau	888 (29)	349 (16)		0.39
Gatineau Centrale	1099 (89)	1145 (31)		1.04
Baskatong Cabonga	646 (37)	1276 (33)		1.98
Basse Lièvre		227 (24)		
Lièvre Centrale	93 (59)	269 (17)	585 (79)	6.3
Haute Lièvre		954 (38)		
Gatineau Supérieure	-	666 (13)		
Ottawa Supérieure	-	944 (23)		
Mont-Tremblant-Rouge	8 (42)	302 (44)		37.7
Basse Rouge	-	9 (7)		

Tableau 8 - TENDANCE DES POPULATIONS PAR SECTEUR

(Nombre de points échantillonnés entre parenthèse)

Secteur	Masses d'oeufs par 100 pieds carrés de feuillage				Rapport du nombre d'oeufs Année 1971/1970
	1970		1971		
Territoires arrosés	11.4	(17)	15.8	(21)	1.38
Territoires non arrosés	3.5	(31)	78.2	(72)	34.2
Kamouraska	3.6	(5)	47.9	(10)	13.3
Rivière-du-Loup	-		125.9	(19)	-
Témiscouata-Ouest de la Seigneurie	0	(10)	88.0	(10)	-
Témiscouata-½ Nord de la Seigneurie	9.7	(4)	194.0	(17)	20.0
Témiscouata-½ Sud de la Seigneurie	10	(3)	86.4	(5)	8.6
Témiscouata-Est de la Seigneurie	2.3	(9)	93.9	(11)	40.8

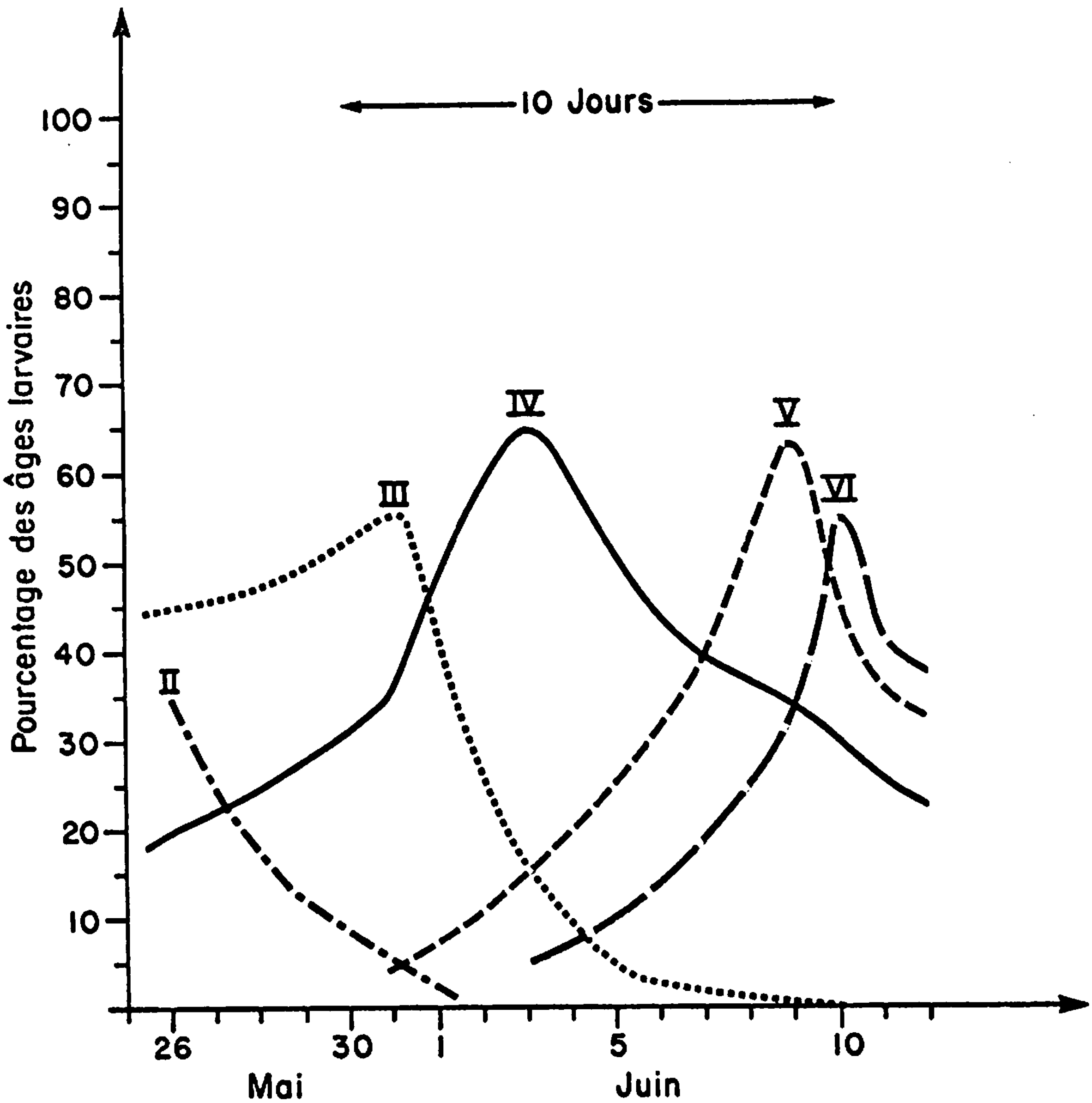


Fig. I — DÉVELOPPEMENT DE LA TORDEUSE DES BOURGEONS DE L'ÉPINETTE DANS LE SECTEUR DE MANIWAKI — 1971

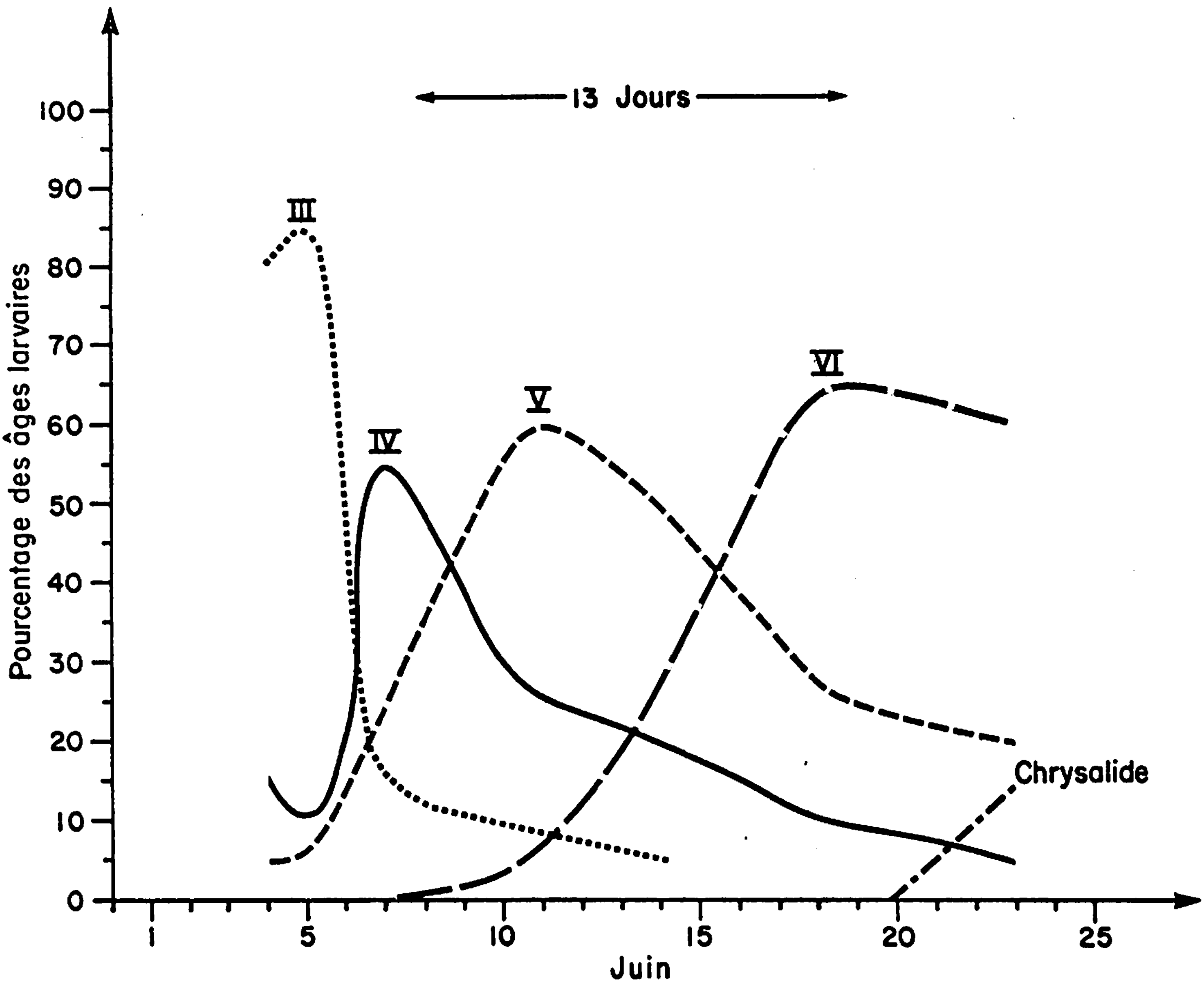


Fig. 2 _ DÉVELOPPEMENT DE LA TORDEUSE DES BOURGEONS DE L'ÉPINETTE DANS LE SECTEUR DU LAC NILGAUT _ 1971

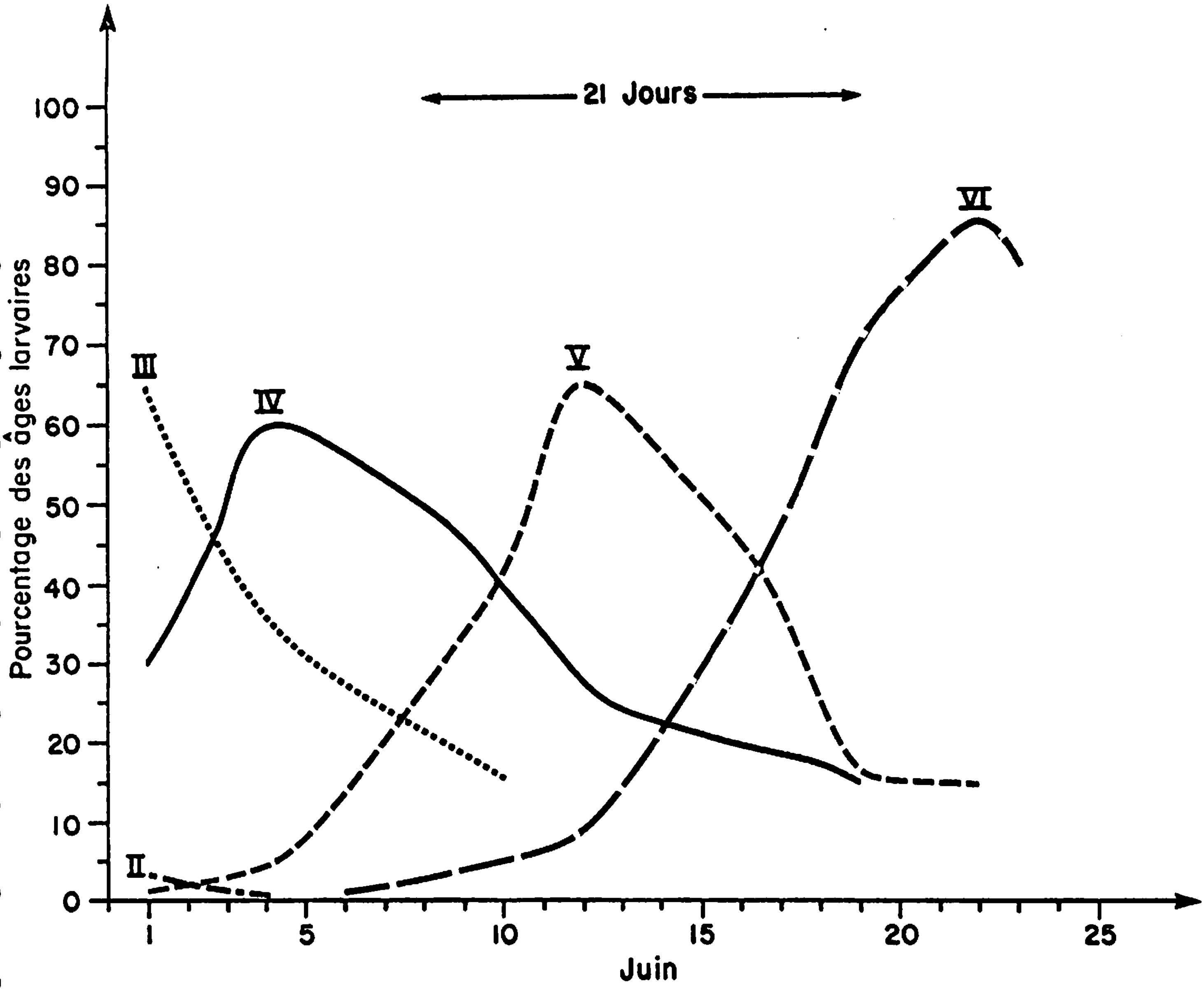


Fig. 3 _ DÉVELOPPEMENT DE LA TORDEUSE DES BOURGEONS DE L'ÉPINETTE DANS LE SECTEUR DU LAC DES LOUPS_1971

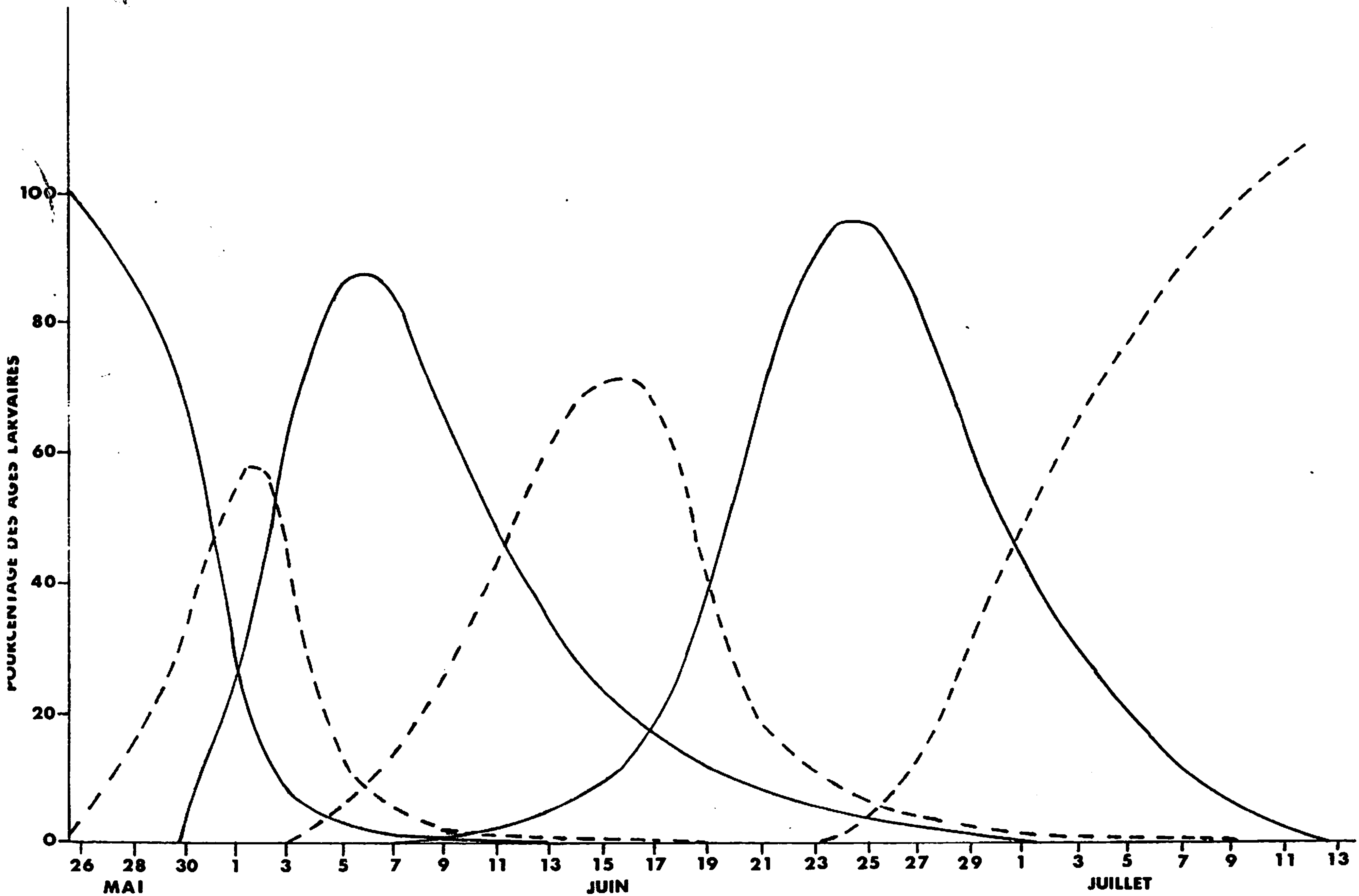
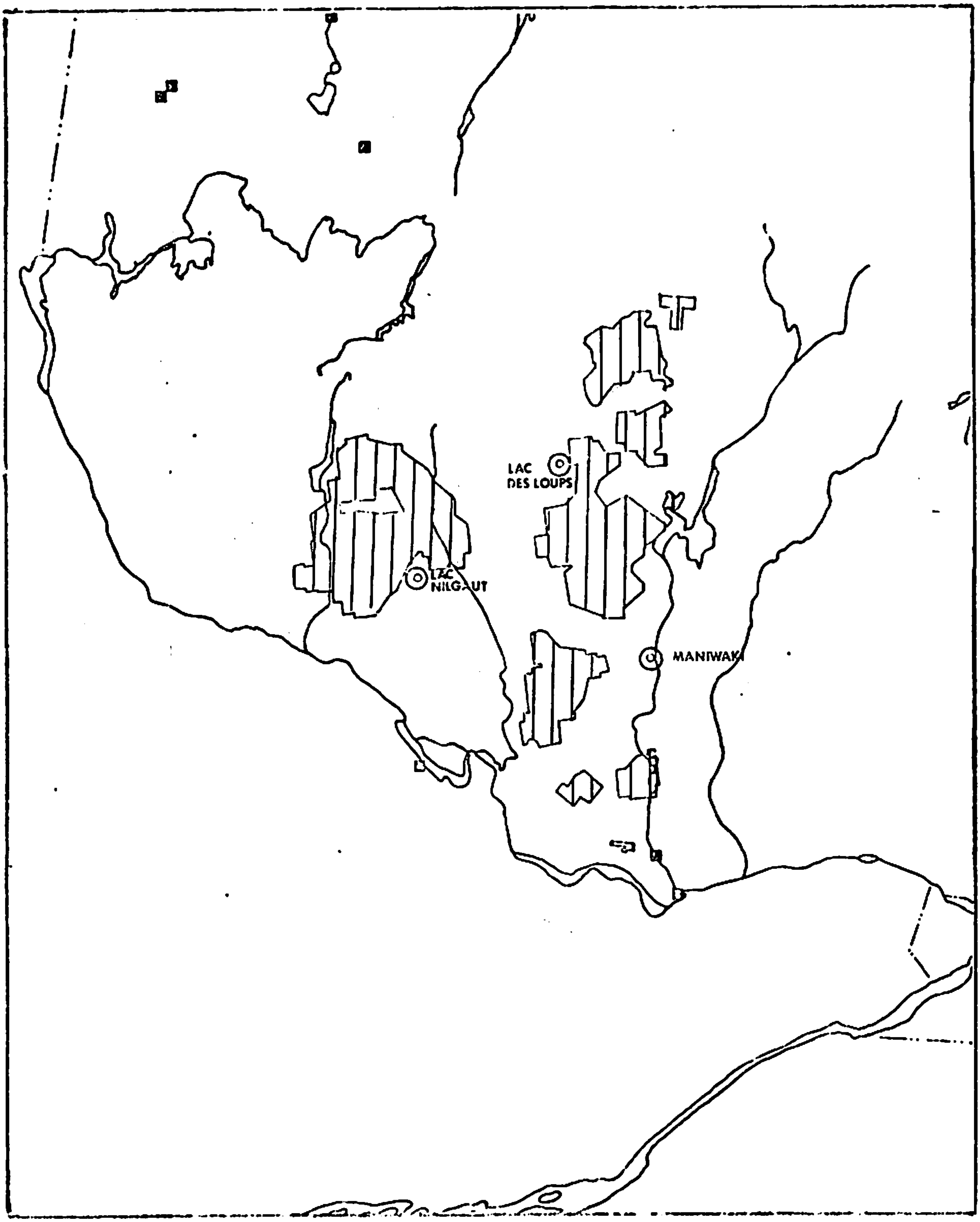
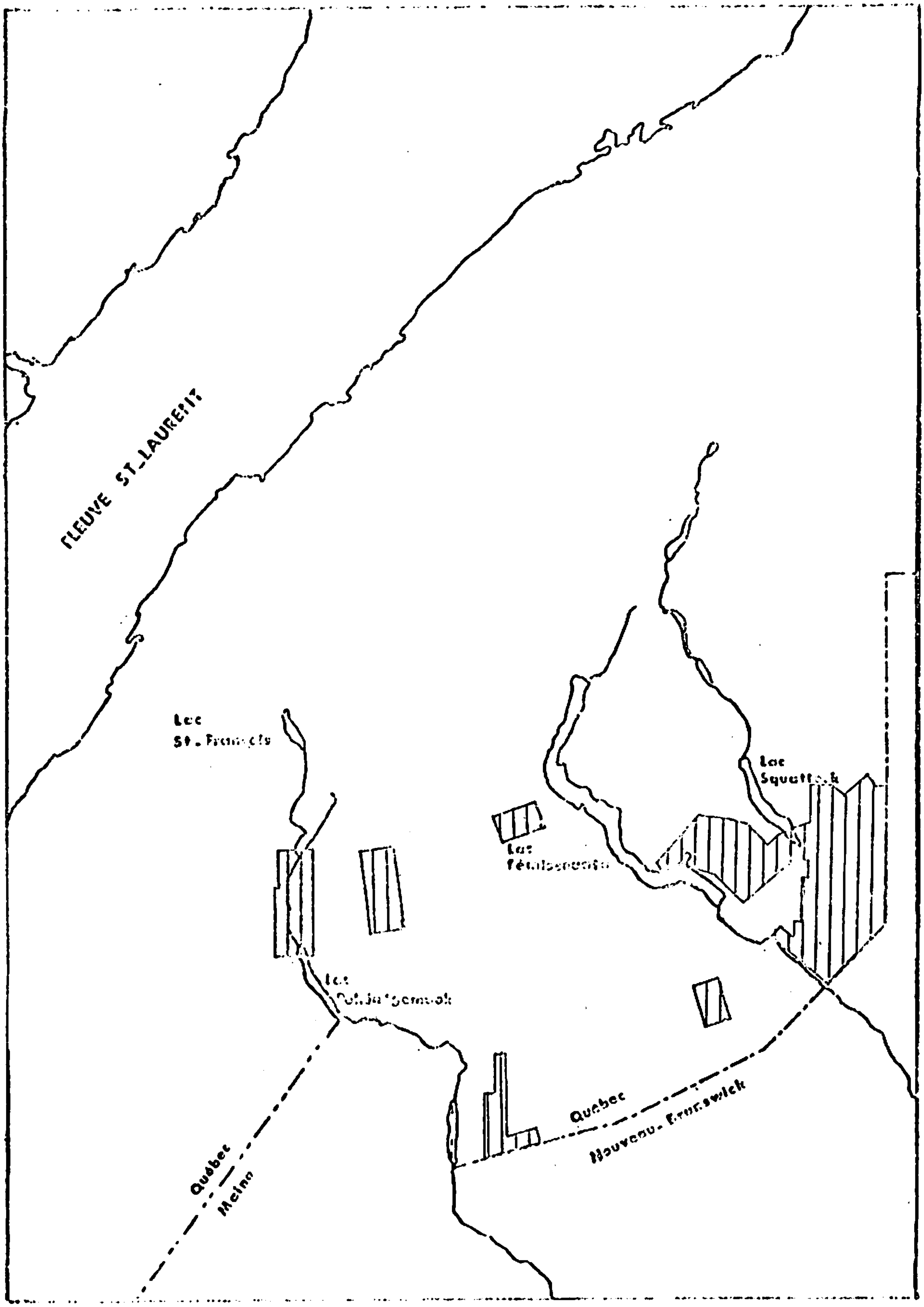


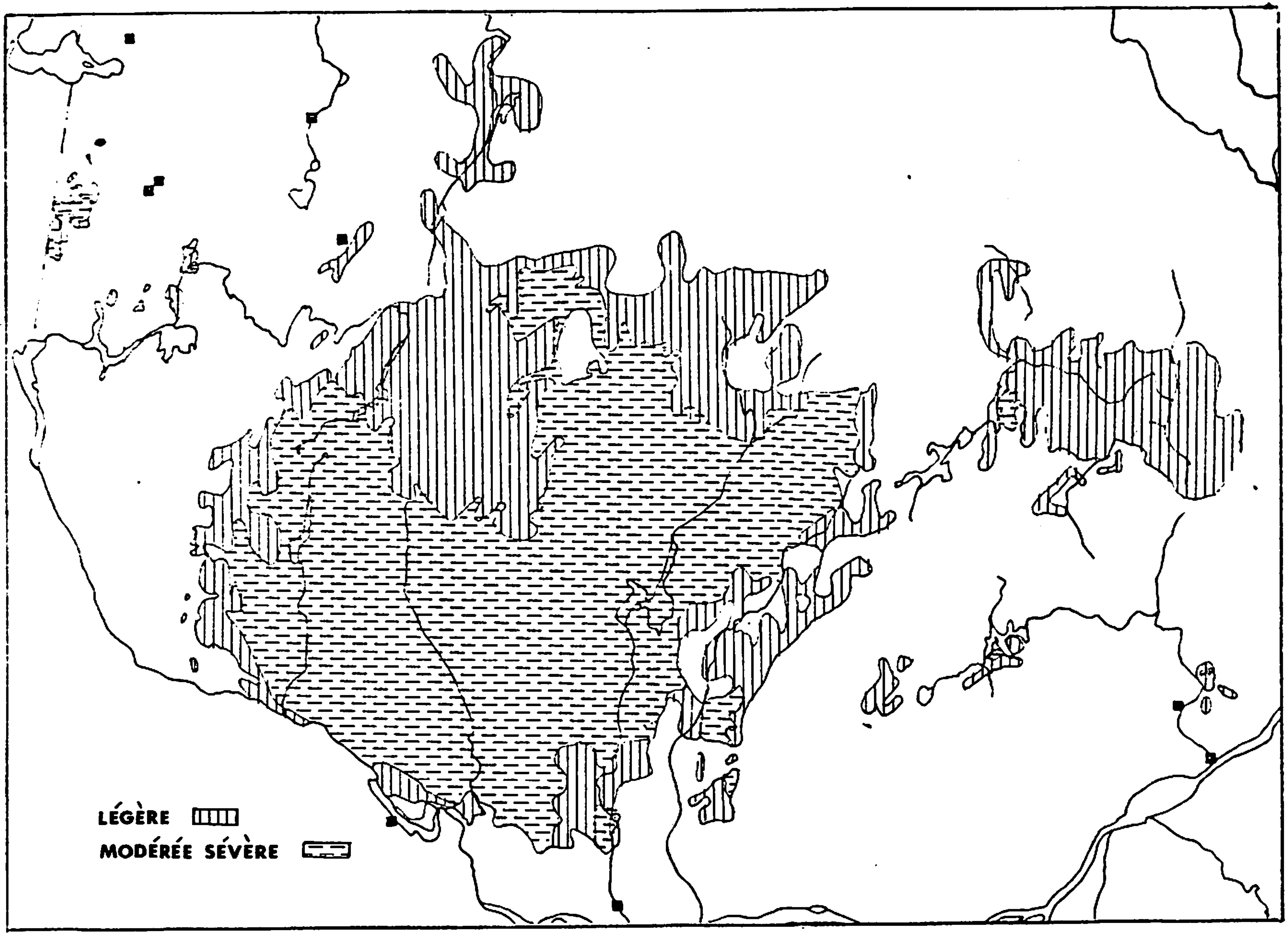
FIG. 4_ DÉVELOPPEMENT DE LA TORDEUSE DES BOURGEONS DE L'ÉPINETTE DANS LA RÉGION DU TÉMISCOUATA _ 1971



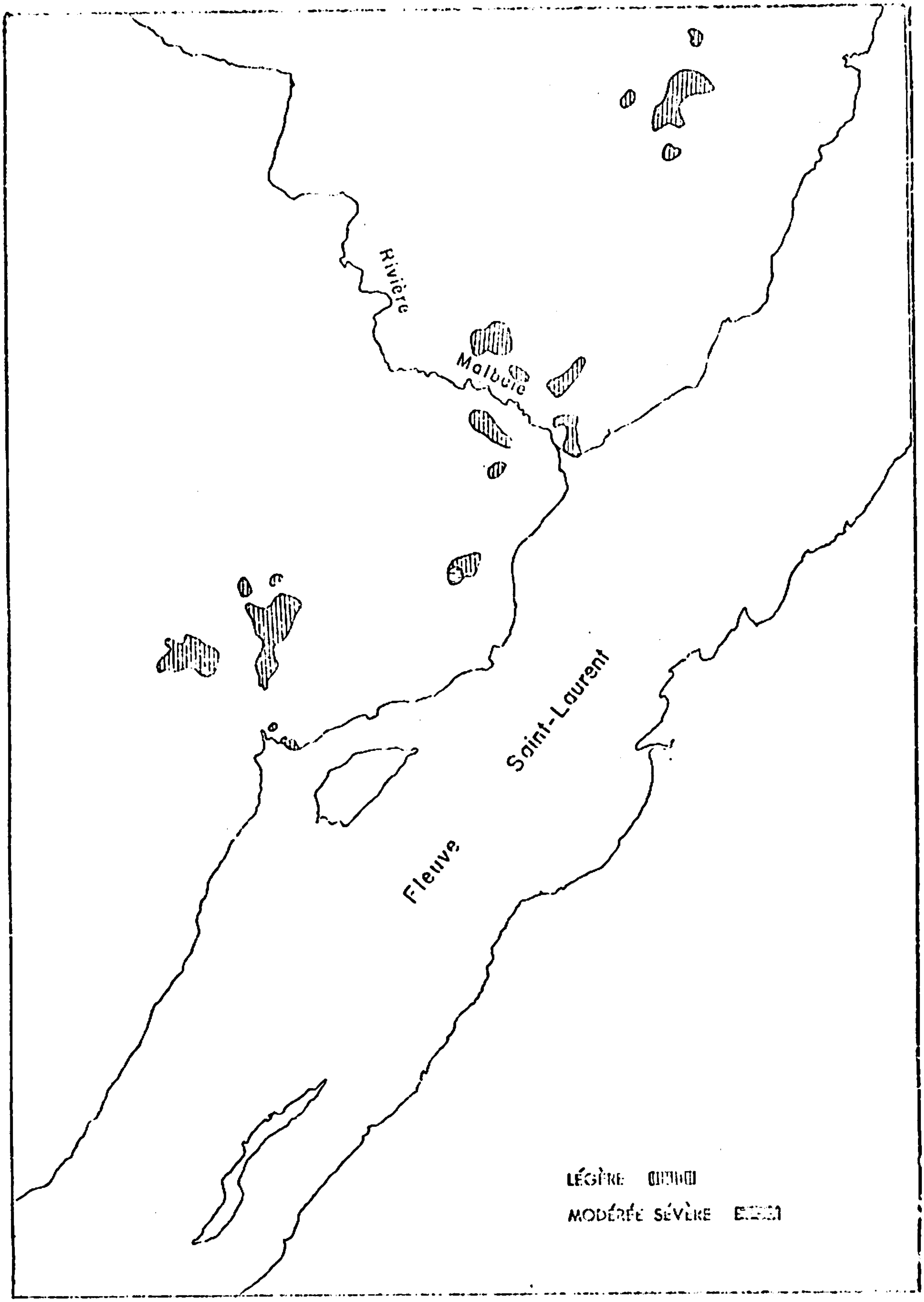
Carte 1 - Aires traitées contre la tordeuse des bourgeons de l'épinette dans l'ouest du Québec en 1971



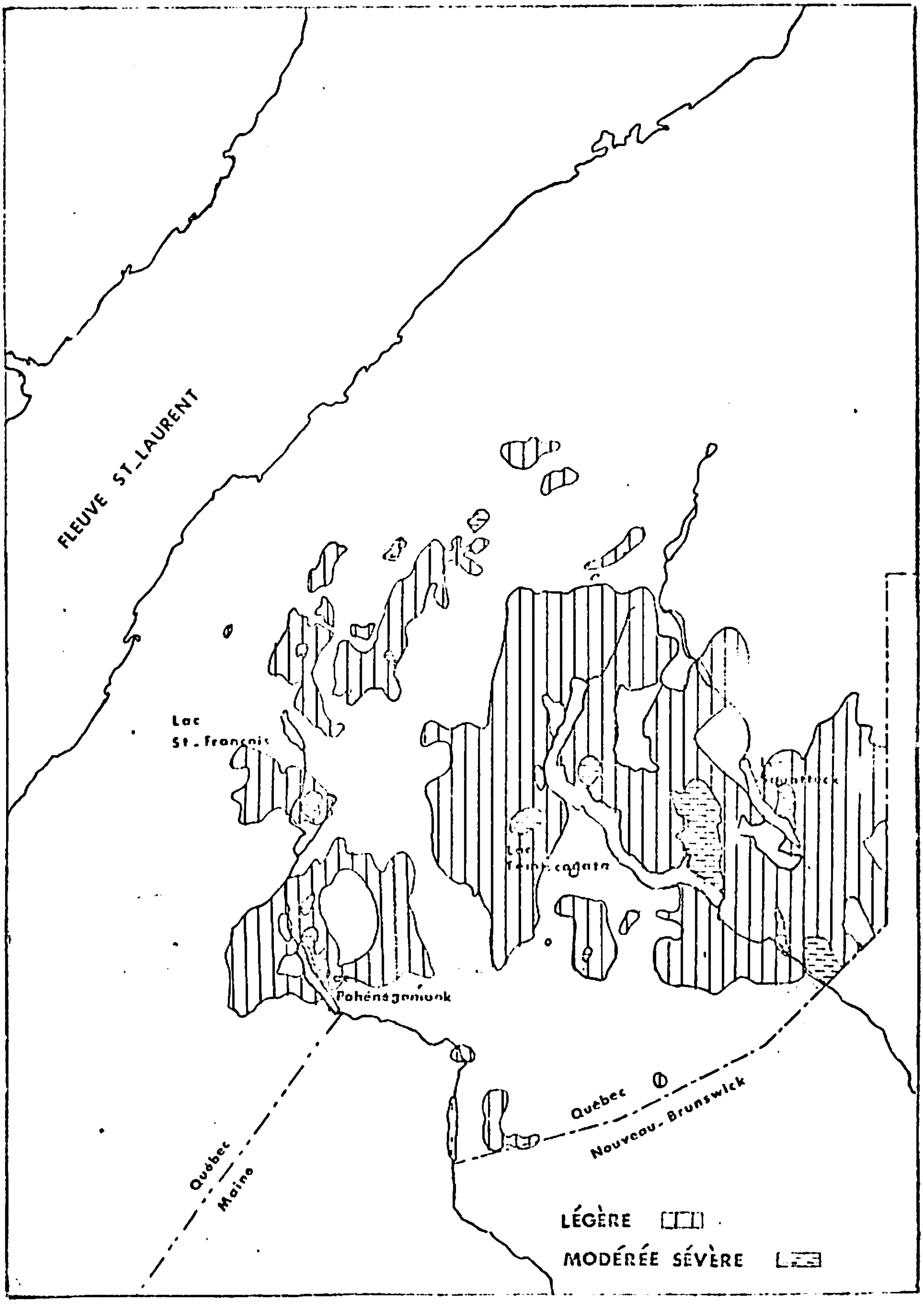
Carte 2 - Aires traitées contre la tordeuse des bourgeons de l'épinette dans la région du Témiscouata en 1971



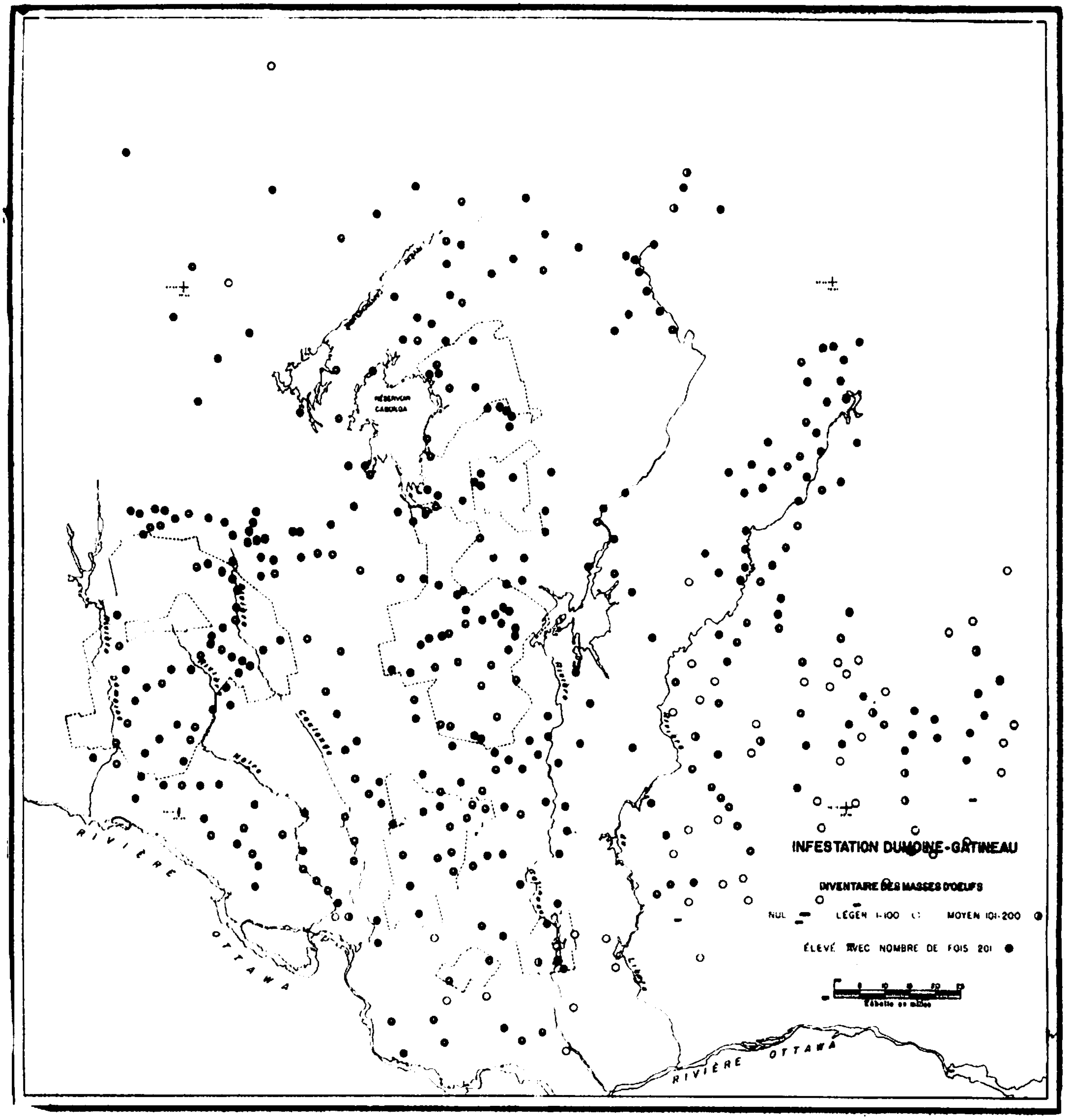
Carte 3 – Aires d'infestation de la tordeuse des bourgeons de l'épinette dans la région ouest du Québec en 1971



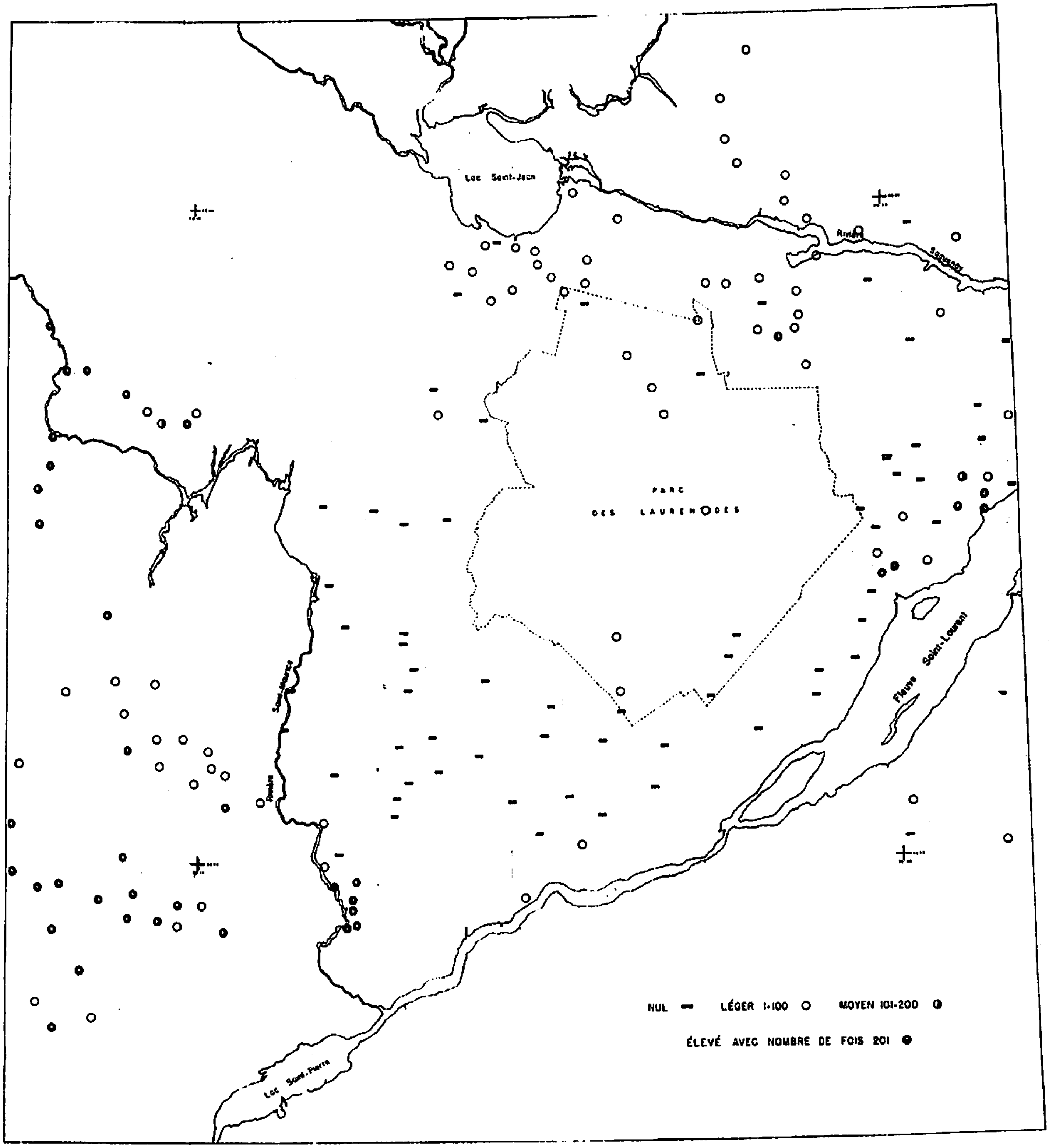
Carte 4 - Aires d'infestation de la tordeuse des bourgeons de l'épinette dans la région centre du Québec en 1971.



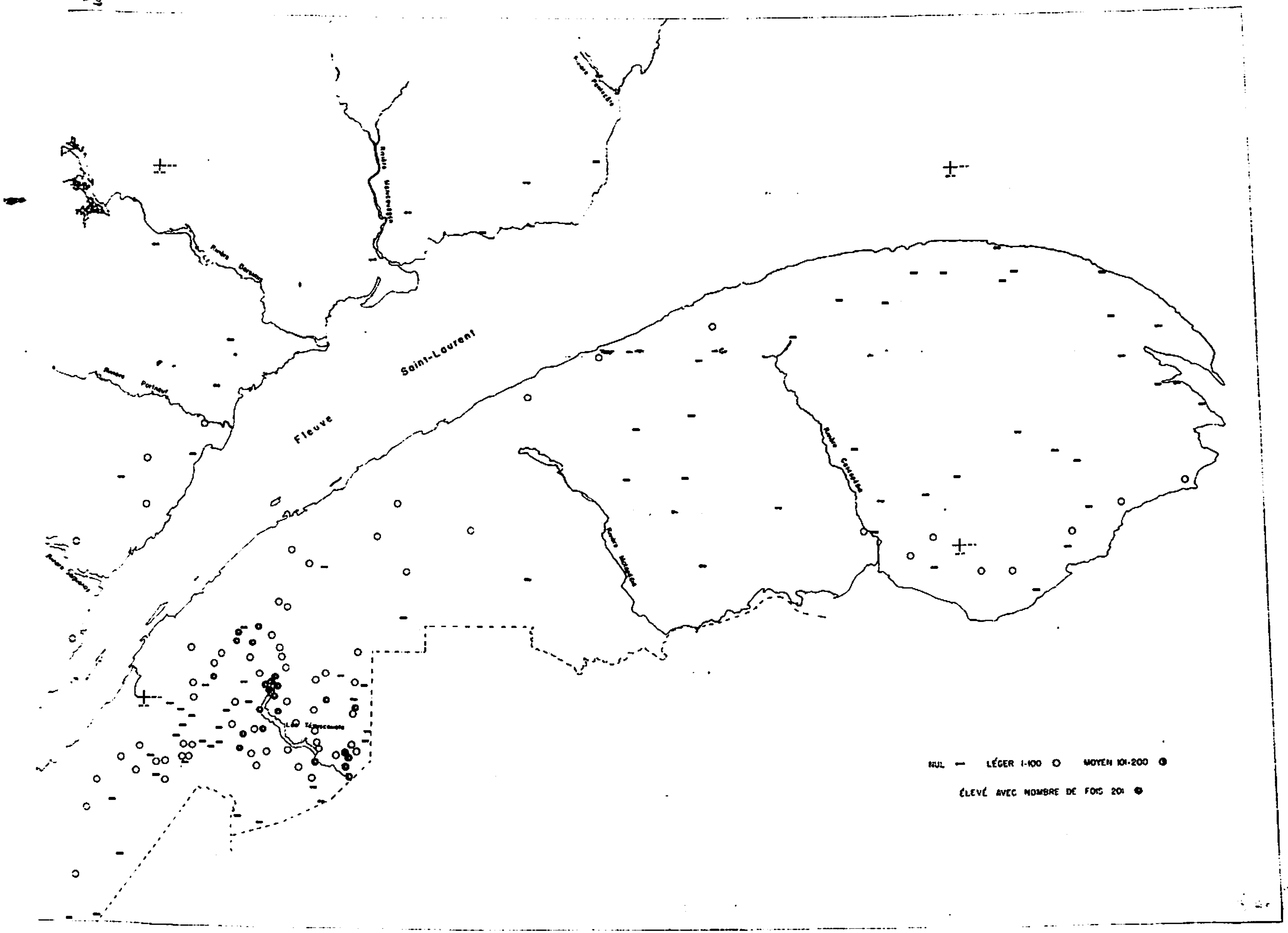
Carte 5 - Aires d'infestation de la tordeuse des bourgeons de l'épinette dans la région est du Québec en 1971



Carte [illegible] - Population des oeufs de la tordeuse des bourgeons de l'épinette dans la région ouest du Québec en 1971



Carte 7 - Population des oeufs de la tordeuse des bourgeons de l'épinette dans la région centre du Québec en 1971



Carte . – Population des oeufs de la tordeuse des bourgeons de l'épinette dans la région est du Québec en 1971

SUMMARY OF EXPERIMENTAL AERIAL SPRAYING OF *BACILLUS THURINGIENSIS* WITH ADDED CHITINASE AGAINST SPRUCE BUDWORM IN QUEBEC

Studies on the action of *Bacillus thuringiensis* on spruce budworm conducted by W. Smirnoff in Quebec in past years indicated that this action was a typical septicemia with secondary effects by toxic crystals. The efficacy of the *B.t.* was related to the ability of the spores to penetrate into the hemolymph of larvae. This led to the development of a new concept consisting in the addition of traces of enzyme chitinase to the *B.t.* preparation. This enzyme can hydrolyse the chitin layer of the insect gut, allowing spores of *B.t.* to penetrate more easily in the hemolymph.

During the spring of 1971 experimental sprayings with commercial preparations of *B.t.* alone and with added chitinase, were conducted in balsam fir stands in the Lac Temiscouata region in Quebec. Three 100-acre plots were established in mature balsam fir stands: Plot 1 was sprayed with Thuricide HPC* + chitinase, Plot 2 with Thuricide HPC alone, and Plot 3 served as control. Spraying was done by a Steerman plane equipped with micron-aire sprayers. The sprays were applied when larval development had reached 50% fourth instar and 50% fifth instar.

The following synopsis shows rate of mortality and total mortality for each treatment.

	Accumulated mortality/days after spraying			
	6 days	12 days	30 days	40 days
Plot 1 (*B.t.* + chitinase)	60%	78%	88%	93%
Plot 2 (*B.t.* alone)	54%	72%	73%	85%
Plot 3 (Control)	0	42%	47%	65%

This indicates that the rate of mortality and total mortality with the added chitinase was greater than *B.t.* alone. Also it is important to mention that mortality was close to 100% in the case of the earlier instars while the larger larvae survived better.

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* Product of International Minerals and Chemicals Corporation, North Chicago, Illinois, U.S.

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More foliage was saved in Plot 1 than in the two others. Eighteen-inch branch tips were cut during the pupal check and examined in the laboratory and counts were made of shoots completely destroyed, partially destroyed, and intact. Results are shown below.

	Per cent current year's shoots		
	Completely destroyed	Partially destroyed	Intact
Plot 1	24	37	39
Plot 2	64	32	4
Plot 3	86	13	1

These results indicate that the use of B.t. against spruce budworm shows promise with respect to foliage protection especially when chitinase is added.

It is generally concluded that the results obtained in 1971 warrant further investigations in the use of this living insecticide. It can be hoped that even better results would be obtained if the treatment were applied earlier with respect to insect development since the results of the 1971 experiment showed that the smaller larvae succumbed more easily to the treatment. Plans are being made for larger scale experiments in 1972 using a wider range of dosages.

J.R. Blais,
Associate Director,
Laurentian Forest Research Centre,
P.O. Box 3800, Ste. Foy,
Quebec 10, Que.

November 17, 1971.

SPRUCE BUDWORM AERIAL SPRAYING OPERATIONS

ONTARIO, 1971

by

G. M. Howse and W. L. Sippell

Great Lakes Forest Research Centre, Sault Ste. Marie

and

K. B. Turner*

Ontario Department of Lands and Forests, Toronto

Introduction

Aerial spraying operations, covering some 81,000 acres were conducted against the spruce budworm in Ontario in 1971. One operation was in southeastern Ontario at the Petawawa Forest Experiment Station (discussed under A); three operations in provincial parks in northeastern Ontario (B), Missinaibi, Shoals and Lake Superior Provincial Parks; and two operations in northwestern Ontario (C), one in southwest Thunder Bay District (Northern Light Lake, Granite Lake and Gunflint Lake) and one in Quetico Provincial Park of the Fort Frances District (Poohbah Lake, Metacryst Lake and Kawa Bay). The locations of these areas are shown in Figure 1. All operations, with the exception of the Petawawa Forest Experiment Station, were carried out by the Ontario Department of Lands and Forests with the advice and assistance of the Canadian Forestry Service. The PFES operation was solely the responsibility of the Canadian Forestry Service. This statement describes each operation and the results obtained, and outlines infestation forecasts for 1972, especially those pertaining to probable aerial spraying operations.

A. Southeastern Ontario Aerial Spraying Operations

Background

At the Petawawa Forest Experiment Station, a total of 400 acres of high value research forest, composed of some 23 white spruce plantations and 3 natural areas with high balsam fir and white spruce components, were sprayed to prevent or minimize damage from budworm feeding. The same areas had been sprayed in 1970 for the same purpose, with variable success. Egg-mass counts in the fall of 1970 forecast the presence of very high populations throughout the station in 1971.

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* This report was prepared by the Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario. K. B. Turner, who had final responsibility for all operational decisions concerning provincial operations, provided operational details for Sections B and C and consequently is included in the authorship.

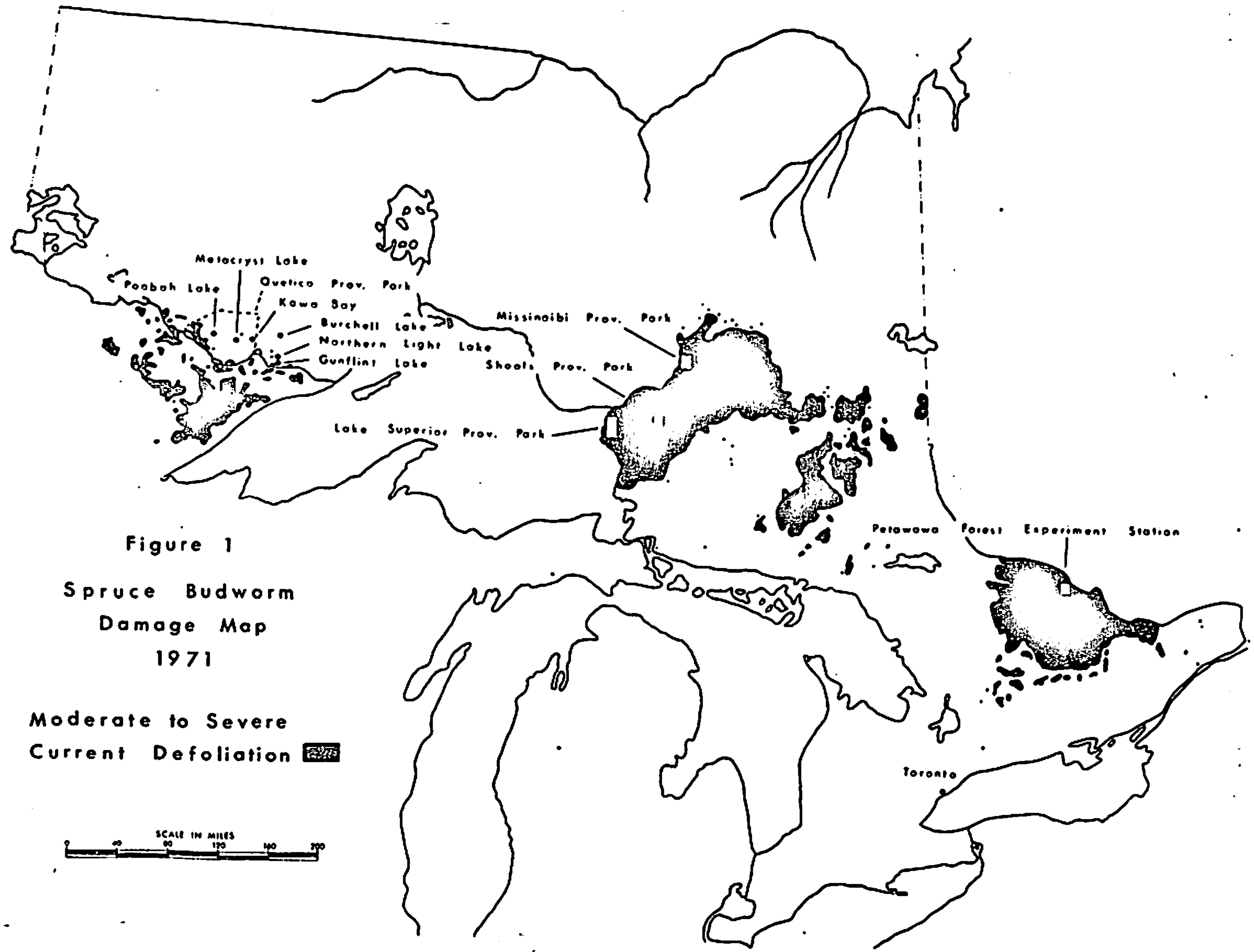

Figure 1
Spruce Budworm Damage Map 1971

Pre-spray Larval Surveys and Insect Development

Budworm emergence from overwintering hibernaculae started on May 7/71 and appeared to be complete by May 11/71. In April, prior to this emergence, foliage was collected from several locations on the station and incubated. Numbers of emerging larvae were considerable, exceeding 100 per branch in some cases. Natural emergence confirmed the establishment of a high population throughout the Station.

Plans called for at least two applications by helicopter of fenitrothion, each of 3 oz. per acre in fuel oil at a rate of one quart per acre. The first application was to be timed for the needle mining stage (second instar) and the second application for third and fourth instar. A third application of 3 oz. per acre was to be utilized, if necessary, two to four days following the second application. This strategy was based on recommendations of the Chemical Control Research Institute.

The timing of the spray applications was determined from observed insect development, host development and calculated accumulated heat units.

The Spraying Operations

A Hughes 269A helicopter equipped with a 32' boom and two spray tanks with a 55 gallon (U.S.) capacity, was contracted for the operation from Twinn Pest Control Aerial Ltd., Ottawa. The insecticide was formulated by Cyanamid of Canada and was Accothion dissolved in Aerotex 3134 at a concentration of 4 lbs active ingredient per gallon of Aerotex. The formulated insecticide was diluted to the desired concentration at the spray site with #2 fuel oil (diesel oil).

On the evening of May 17/71 and morning of May 18/71, 400 acres on the Station received the initial application of 3 oz. fenitrothion in 2 quarts of spray mixture (diesel oil plus Aerotex 3134). Insect development was 98% second instar and 2% third instar.

The second application was carried out on the evening of May 28/71 when the insects had reached the peak of third instar. The total area treated on May 28/71 was reduced to 325 acres because larval counts showed low population levels in two plantations of young trees totalling 75 acres. A third application was repeated over the 325 acres on the evening of May 31/71. The second and third applications were also at the rate of 3 oz. of fenitrothion per 2 quarts of diesel oil per acre. Generally speaking, weather conditions during all three applications were satisfactory.

Thus, in summary, 325 acres received 3 applications of 3 oz. per acre for a total of 9 oz. per acre and 75 acres received 1 application of 3 oz. per acre.

Entomological Assessment

A full entomological assessment of the effectiveness of the operation was carried out, i.e. population densities of the budworm were determined in sprayed plots and unsprayed check plots before and after spraying. The results of this assessment are contained in Table I.

TABLE I

% Population reduction due to treatment at PFES, 1971

Treatment	% Population wS	Reduction bF
Two applications of 3 oz. each per acre (6 oz.)	31.5	54.9
Three applications of 3 oz. each per acre (9 oz.)	35.2	56.6

% Defoliation at PFES, 1971

	wS	bF
Spray Plots	77.3	41.2
Controls	92.3	95.7

Post-spray Pupal Densities at PFES, 1971

	wS	bF
Spray Plots	10.0	2.5
Control Plots	15.1	9.4

Thus, as these data indicate, a poor level of protection was achieved on an overall basis.

The amount of defoliation and % population reduction varied considerably among plantations. In general, those plantations with initially high budworm levels eventually suffered the greatest damage. Aerial observation and ground work showed that one entire plantation was severely damaged, portions of 6 others were severely damaged and the remaining plantations received light or moderate damage. A fairly good degree of protection was afforded to the sprayed balsam fir in natural stands, at least as compared to white spruce.

A trace of damage was present in the two plantations that were sprayed only once during the second instar. However, population levels initially were not high enough to cause more than trace or light defoliation in any case.

The helicopter was calibrated to deliver 2 quarts per acre with pump pressure at 40 lbs p.s.i. and aircraft velocity of 60 m.p.h. This provided an effective swath width of approximately 80' when the helicopter's altitude was just above tree top level. Spray coverage, where it could be monitored, appeared to be satisfactory. For example, the average droplet density deposited on spray cards at ground level across one 80' spray swath flown at an altitude of 50' and 60 m.p.h. was 11.3 droplets per square cm. The majority of the droplets as recorded on spray cards ranged in size from 100 to 500 μ in diameter and averaged 250 μ.

Conclusions

It had been concluded in 1970 that the primary causes of the poor level of protection achieved that year at PFES, using a Stearman aircraft and higher rates of fenitrothion, were: "The unusually high initial levels of larval population, a delay in the arrival of the spray plane, a spell of poor flying weather, and the subsequent advanced stage of larval development beyond the fourth instar resulting from the lateness of spraying". The latter three of these four suggested causes were not involved as factors in the 1971 operation; i.e. the optimum timing was achieved and no delays were experienced due to weather or aircraft. As in 1970, larval population levels were generally very high. Population reduction figures show that not enough larvae were killed in order to provide a satisfactory degree of protection, which in turn, raises questions concerning the efficacy of fenitrothion and/or application techniques. It is interesting to note the marked difference between the results obtained on bF and wS.

Samples of the insecticide used were sent to CCRI. Bioassays were performed to compare the material used at PFES with laboratory stock. There appeared to be no difference in toxicity of the two batches of fenitrothion to spruce budworm larvae (personal communication from Dr. P.C. Nigam - CCRI).

The Spruce Budworm Situation in Southeastern Ontario and Forecasts for 1972

In 1971, moderate to severe defoliation was mapped as occurring within an area of approximately 4.5 million acres in southeastern Ontario. This represented a threefold increase in size of the infestation compared to 1970. Most of this increase occurred in the eastern half of the Pembroke District and northern part of the Tweed District. Egg-mass counts obtained from more than 70 locations throughout southeastern Ontario forecast a continuation of high damage levels in areas currently infested accompanied by some further enlargement of the outbreak in 1972.

Egg-mass counts from several locations throughout the Petawawa Forest Experiment Station support a forecast of severe defoliation on spruce and fir throughout the station in 1972. Therefore, a chemical control operation must again be considered to protect the experimental units on the station. Protection spraying of other high value areas, in southeastern Ontario (primarily for recreational use), are being considered by the Ontario Department of Lands and Forests. Definitive plans have not yet been arrived at.

B. Northeastern Ontario Aerial Spraying Operations

Background

Spraying was carried out in three provincial parks in northeastern

Ontario in 1971 - Missinaibi and Shoals in Chapleau District and Lake Superior Provincial Park in the White River District. The purpose of spraying in these parks was primarily to preserve foliage and keep balsam fir and white spruce trees as green as possible throughout various high use recreation areas and campgrounds.

The acreages sprayed in each park were; 6000 in Missinaibi (this was a repeat of the 1970 spraying), 1620 in the Shoals and 1000 in Lake Superior. These sprayed acreages represent only a small portion of the total size of each park since Missinaibi is 176 square miles, Shoals is about 50 square miles and Lake Superior is 576 square miles.

Pre-spray Larval Surveys and Insect Development

The Canadian Forestry Service was responsible for obtaining data on insect and host development and for following the accumulation of heat units in determining the start of spraying, which was to be at the peak of fourth instar.

Observations and foliage collections for larval samples in each of the proposed spray sites during third instar confirmed the presence of substantial numbers of larvae (Table II).

The Spraying Operations

Provincial personnel responsible for the operations were advised by the Canadian Forestry Service on June 7/71 (peak of third instar) that spraying should start about June 11-12/71. A single Stearman aircraft on floats arrived in Chapleau on June 13/71 and spraying started that evening. All areas treated received a single application of 5.3 oz. of fenitrothion in 1/5 gal. of water per acre.

The Shoals was sprayed on the evening of June 13 and morning of June 14, Missinaibi was started on the evening of June 14 and finished on the morning of June 17 and Lake Superior was completed on the evening of June 19.

Entomological Assessment

The following data (Table II) are pertinent to the assessment of these spraying operations.

TABLE II

Pre-spray and post-spray population densities and
% defoliation from sprayed areas in the three provincial parks

(Average no. of living budworm per 18" tip)

Location	Host	Pre-spray Larval density	Post-spray Pupal density	% Defoliation
Lake Superior	wS	27.2	9.8	60
		38.4	19.2	72
		15.0	1.0	2
	bF	21.0	1.5	7
		15.4	4.2	30
		8.0	.2	2
Shoals	bF	39.8	6.4	28
Missinaibi	wS	45.0	14.8	54
	bF	16.6	7.5	56
		9.0	2.8	50

Unsprayed control plots were not established in northeastern Ontario, however, if unsprayed survival curves for spruce budworm on wS and bF at PFES are used to calculate % population reduction for the above values, then a mean population reduction of 21% for sprayed wS and 36% for sprayed bF can be obtained. Defoliation of wS in sprayed areas was not appreciably different from that recorded for unsprayed wS in the Chapleau District whereas sprayed bF appeared to receive some protection compared to unsprayed bF (Table III). Pupal densities on sprayed bF were considerably less than unsprayed bF whereas pupal densities on sprayed wS were only slightly less than on unsprayed wS (Table III).

TABLE III

Pupal densities and defoliation for wS and bF
from sprayed and unsprayed areas

		Pupal Density (no. of living pupae per 18" tip)	% Defoliation
Sprayed	wS	11.2	47
Not sprayed	wS	10.7	52
Sprayed	bF	3.8	29
Not sprayed	bF	10.4	88

Spray deposit could not be measured because little, if any, dye was placed in the spray mixture. Weather conditions were considered to be good.

Conclusions

The results can only be considered as poor since very little of measurable value was accomplished. The contrasting results on wS and bF are similar to those noted for PFES. The weather conditions were suitable, no delays were experienced, the proper timing was achieved and larval populations were not excessively high. Therefore, the cause(s) of the poor results must be related to either the efficacy of the insecticide and/or application techniques.

The Spruce Budworm Situation in Northeastern Ontario and 1972 Forecasts

In 1971, 8.6 million acres of forest in northeastern Ontario was infested with spruce budworm to an extent that moderate to severe defoliation was recorded. This represented a sizeable increase over the comparable figure for 1970 of 5.2 million acres.

Egg-mass counts from more than 200 locations throughout northeastern Ontario forecast a continuation of high populations within the areas currently infested accompanied by further expansion of the outbreaks.

Anticipated spraying operations for 1972 include every provincial park within the infestation that has an appreciable volume of balsam fir and/or white spruce. There appears to be little interest by the province at the present time in protecting areas other than parks in this region.

C. Northwestern Ontario Aerial Spraying Operations

Background

In 1968 and 1969, aerial spraying operations were carried out in the Burchell Lake region of northwestern Ontario in an effort to eliminate a spruce budworm infestation that was threatening a nearby area of 4.5 million acres of susceptible spruce-fir forest around Lac des Mille Lacs. This area had not been severely damaged by budworm for over 40 years. These operations combined with cool, wet weather were successful in eliminating the Burchell Lake outbreak. Budworm population densities have remained very low from 1969 to the present throughout the Burchell Lake and Lac des Mille Lacs regions.

However, in the fall of 1969, two small discrete infestations were discovered near the International Border, about 25 miles south of Burchell Lake. These infestations were located at Northern Light Lake and Granite Lake and were 2800 and 1200 acres in size, respectively. These two areas plus an additional small infestation on Gunflint Lake, discovered in May 1970, were sprayed in June 1970 with the objective of eliminating these infestations before they could increase and spread, particularly into the Burchell Lake region.

The origin of these infestations near the International Border is not certain, but they could have resulted either from lingering populations that carried over from an earlier outbreak or from moth flights from an extensive, prolonged outbreak in northern Minnesota.

The 1970 spraying at Northern Light, Granite and Gunflint lakes which are all located in the Thunder Bay District, 25-30 miles south of Burchell Lake, was not completely successful, since these pockets of heavy infestation were not eliminated. Egg-mass counts in the fall of 1970 showed that infestation potential remained high for 1971.

Elsewhere, during the 1970 field season, a new infestation was found at Poohbah Lake in the south-central part of Quetico Provincial Park in the Fort Frances District. Poohbah Lake is located 50 miles to the southwest of Burchell Lake and 11 miles north of the International Border. Subsequent additional winter surveys in Fort Frances District revealed several infestations totalling 130,000 acres. These infestations extended from Namakan Lake in the west to Bayley Bay in the east, with most of the infested acreage located in Quetico Park along the International Border. Two corridors of budworm susceptible forest extended from the infestations in the south-central part of Quetico, in a northeast direction to the Burchell Lake-Lac des Mille Lacs region. It was believed that these corridors could provide avenues of access for the budworm in to the western part of the Thunder Bay District. High budworm populations were known to exist in at least two locations in these corridors; Kawa Bay on Kawnipi Lake and Metacryst Lake, 25 and 38 miles, respectively, S.W. of Burchell Lake.

A meeting was held in Sault Ste. Marie in early April 1971 between the Canadian Forestry Service and the Ontario Department of Lands and Forests to discuss the northwestern Ontario budworm situation. At this meeting, it was concluded

(i) that the knock-out spraying approach used successfully in earlier operations was now largely out of the question except in a few scattered areas

and

(ii) that the approach should become one of abatement spraying concentrating on populations detected in the two major corridors threatening the large area of susceptible forest to the north and east.

Thus, it was decided to spray, in 1971, all known pockets of infestation in the Thunder Bay District to again try to eliminate them and to start a program of abatement spraying in the Fort Frances District, starting with the easternmost infestations closest to Burchell Lake and working westward as far as resources would permit. Hopefully, this strategy would prevent the increase and spread of infestations threatening Burchell Lake. It was recognized that the procedure would have to be repeated perhaps annually until the infestations subsided naturally, even if the operation proved highly successful in 1971. The primary concern then was not protection, but to reduce the chances of the infestations along the border spreading to much larger susceptible areas containing uncut wood.

The operational plan for Quetico called for a single application (highest population areas to be sprayed twice) of 4 oz. of fenitrothion in 1/5 gal. of Aerotex per acre to be applied starting in the second instar or needle mining stage. This was recommended because much of the cover type in infested areas consisted of an aspen overstory that would prevent adequate spray deposit on understory balsam fir if spraying was carried out after leafing of the aspen overstory had occurred. The Thunder Bay District operations were to be carried out at peak of fourth instar and each area was to be sprayed twice.

Pre-spray Surveys and Insect Development

The areas recommended for spraying were selected on a priority basis using defoliation information, egg-mass sampling data, forest cover type information from type maps and aerial observations, a limited number of pre and post emergence larval counts and proximity to Burchell Lake.

In early May, 1971 it was recommended by the Canadian Forestry Service that 70,000 acres in Quetico Park be sprayed. This total acreage was composed of three separate blocks; the first block and closest to Burchell Lake (about 25 miles) was approximately 13,000 acres in size, located at Kawa Bay on Kawnipi Lake. The second block, which was about 9000 acres was located 13 miles west of Kawa Bay at Metacryst Lake. The third block was the eastern half of an 80,000 acre infestation surrounding Poohbah and Tanner lakes. Poohbah is about 12 miles west of Metacryst Lake.

Furthermore it was recommended that four blocks totalling 9500 acres in the Thunder Bay District be sprayed. These four blocks were located at Northern Light Lake (5000 acres), Granite Lake (2000 acres), Gunflint Lake (2000 acres), and 2 miles north of Granite Lake (500 acres).

Budworm emergence occurred on or before May 9 throughout Thunder Bay and Fort Frances districts and was generally complete by May 15, 1971. Field personnel of the Canadian Forestry Service followed insect development and host development and this information combined with accumulated heat units was used for the purpose of timing the various spray operations.

The Spraying Operations

It was recommended on May 13 that spraying should commence as soon as possible for the Quetico operations. Three Stearman aircraft (on wheels) and a Cessna guide plane arrived at Atikokan on May 14, 1971. Working from an airport at Atikokan and faced with an average 60 mile round trip, spraying commenced on the morning of May 21, 1971. The initial delay in starting was due to cool, turbulent weather. Spraying continued in Quetico until June 9, 1971 at which date 80% of the acreage had been covered. The aircraft then moved to an airstrip at Swallow Lake in the Thunder Bay District that had been especially constructed for the 1968 Burchell Lake operation. Spraying at Northern Light Lake started on June 11 and all four blocks were completed by June 15, 1971. Insect development during this time period had reached fourth and fifth instar. The aircraft returned to Atikokan on June 16 to resume the Quetico spraying which was completed by June 19, 1971. Insect development was advanced to fifth and sixth instar by this time.

Generally speaking, the northwestern Ontario operations were plagued with windy and turbulent weather conditions throughout the operation. This factor combined with the long hauls caused the spraying to extend over a longer period of time than was desirable.

All areas sprayed received a single application of 4 oz. of fenitrothion in 1/5 gal. of Aerotex per acre. There were no double applications as planned in Thunder Bay District. Table IV lists the location, dates and acreages sprayed.

Measurement of spray deposit for these operations was virtually impossible due to the inaccessibility of the sprayed areas. However, one series of cards placed along a bush road at Northern Light Lake showed the presence of spray droplets. Further analysis was not possible because no dye was present in the spray.

TABLE IV

Locations, Acreages and Dates Sprayed in Northwestern Ontario, 1971

Location	Acres	Date
Fort Frances - Quetico		
Block 1 - Kawa Bay	12,825	May 21, 22, 26, 27
" 2 - Metacryst Lake	9,450	May 21, 27, 28, 31
" 3 - Poohbah Lake-Tanner Lake	42,525	May 31, June 1, 2, 3, 4, 8, 9, 16, 17, 18, 19
Sub-total	64,800	
Thunder Bay		
Northern Light Lake	5,050	June 11, 14, 15
Granite Lake	1,680	June 15
Gunflint Lake	350	June 15
2 miles north of Granite Lake	500	June 15
Sub-total	7,580	
Grand Total	72,380	

Entomological Assessment

Owing to the general inaccessibility of the sprayed areas (except by water or aircraft), a conventional assessment involving pre- and post-spray population counts in sprayed and unsprayed areas was not attempted. However, it is possible to gain some general impressions of the effectiveness of the spraying through other ways such as pupal counts (Table V), aerial defoliation surveys and egg-mass counts.

TABLE V

Densities of Living Pupae in Sprayed and Unsprayed Areas on Balsam Fir in Thunder Bay and Fort Frances Districts

Location		No. of living budworm pupae per 18" tip
Thunder Bay	- Sprayed	.36
	- Unsprayed (uninfested)	.04
Fort Frances	- Sprayed	.35
	- Unsprayed (infested)	.78
	(uninfested)	.09

Aerial defoliation surveys showed that the sprayed areas were generally free of continuous defoliation but that they contained many, small, scattered pockets of moderate-severe damage.

Egg-mass counts indicate that all sprayed areas except the Metacryst Lake block have been reinfested to levels that will cause moderate or severe defoliation in 1972. The average egg-mass density however is about 1/3 lower this year than last year in the spray areas.

Conclusions

It is clear that pupal densities in sprayed areas were still quite high though not as high as they would have been without treatment. Egg mass counts indicate continuing infestations throughout most sprayed areas but at reduced levels compared to 1970. There is no evidence of any significant spread from infestation centers to uninfested areas to the north and east although a shift of population has been noted in the Poohbah Lake area. Populations are higher in the eastern part of this block and lower in the west compared with 1970. Forested areas near Burchell Lake and Lac des Mille Lacs are still uninfested by spruce budworm.

Thus, the situation is no worse now than it was one year ago. However, being able to maintain the status quo is a desirable objective all things considered in northwestern Ontario, and since this appeared to be achieved, the spraying can be considered a qualified success.

The Spruce Budworm Situation in Northwestern Ontario and Forecasts for 1972

Aerial defoliation surveys revealed 130,000 acres of moderate to severe defoliation, which for all but 2000 acres in Thunder Bay were located in the Fort Frances District. This represented very little change from the situation in 1970. In the Fort Frances District, the 1971 defoliation extended from Namakan Lake to Bayley Bay along the International Border. Small, scattered pockets of defoliation were found around sprayed areas at Kawa Bay and Poohbah Lake.

In the Thunder Bay District, about 2000 acres of current defoliation was recorded, most of which occurred in a new infestation found near Mountain Lake along the border. Small pockets of defoliation occurred in sprayed areas at Northern Light Lake, Granite Lake and Gunflint Lake and adjacent unsprayed areas of Gunflint Lake. These infestations in Thunder Bay and Fort Frances Districts represent the northern edge of an extensive outbreak that occurs throughout central and northern Minnesota.

An egg-mass survey (185 locations) for northwestern Ontario confirms the defoliation picture. Population levels are again high within areas that were sprayed or defoliated in 1971. With the exception of Mountain Lake, no new major infestations were detected in 1971 and population levels have remained quite low outside of the known infested areas. Thus it is reasonable to expect moderate-severe defoliation over an area of some 125,000 to 150,000 acres in 1972.

The need for aerial spraying operations in this region in 1972 remains similar to that of 1971, however, no pertinent decisions have, as yet, been made.

D. The Problem of Unsatisfactory Operational Results with Fenitrothion in Ontario

Fenitrothion has been employed as the chief chemical weapon for operational control projects in Ontario against spruce budworm for the past four years, i.e., 1968-1971. This insecticide has been applied in several different ways under a variety of conditions in several formulations and many different dosages in order to try to accomplish specific goals. It has provided a variety of results.

Following is a summary of results (Table VI) from all operations in Ontario that have been critically assessed over the last four years.

TABLE VI

Results of Spruce Budworm Control Operations using Fenitrothion in Ontario, 1968-1971

Operation		Host	oz. of fenitrothion per acre (operational)	% Population reduction	% Defoliation
N.E. Ontario	- 1971	wS	5.3	21	47
PFES	- 1971	wS	6.0	32	77
PFES	- 1971	wS	9.0	35	77
PFES	- 1970	wS	10.2	36	94
PFES	- 1970	wS	14.5	61	74
N.E. Ontario	- 1971	bF	5.3	36	29
PFES	- 1971	bF	6.0	55	41
Burchell Lake	- 1968	bF	6.0	45	—
PFES	- 1971	bF	9.0	57	41
PFES	- 1970	bF	10.2	51	67
Burchell Lake	- 1968	bF	12.0	89	—
PFES	- 1970	bF	14.5	98	40

Graphing these results (Figure 2) illustrates the close relationship between the dosage of fenitrothion (oz. per acre) and the resulting population reduction. The difference in results on white spruce (wS) and balsam fir (bF) is striking.

Linear regressions were calculated for each group of data. The fit of each regression line to the corresponding data was tested and found to be significant at the .05 level for sW and at the .01 level for bF. A further test showed that there was a significant difference at the .01 level between the two groups of data (regressions).

Conclusions

1. Population reduction is lower on wS than on bF when using the same dosage of fenitrothion. For example, where the two species are

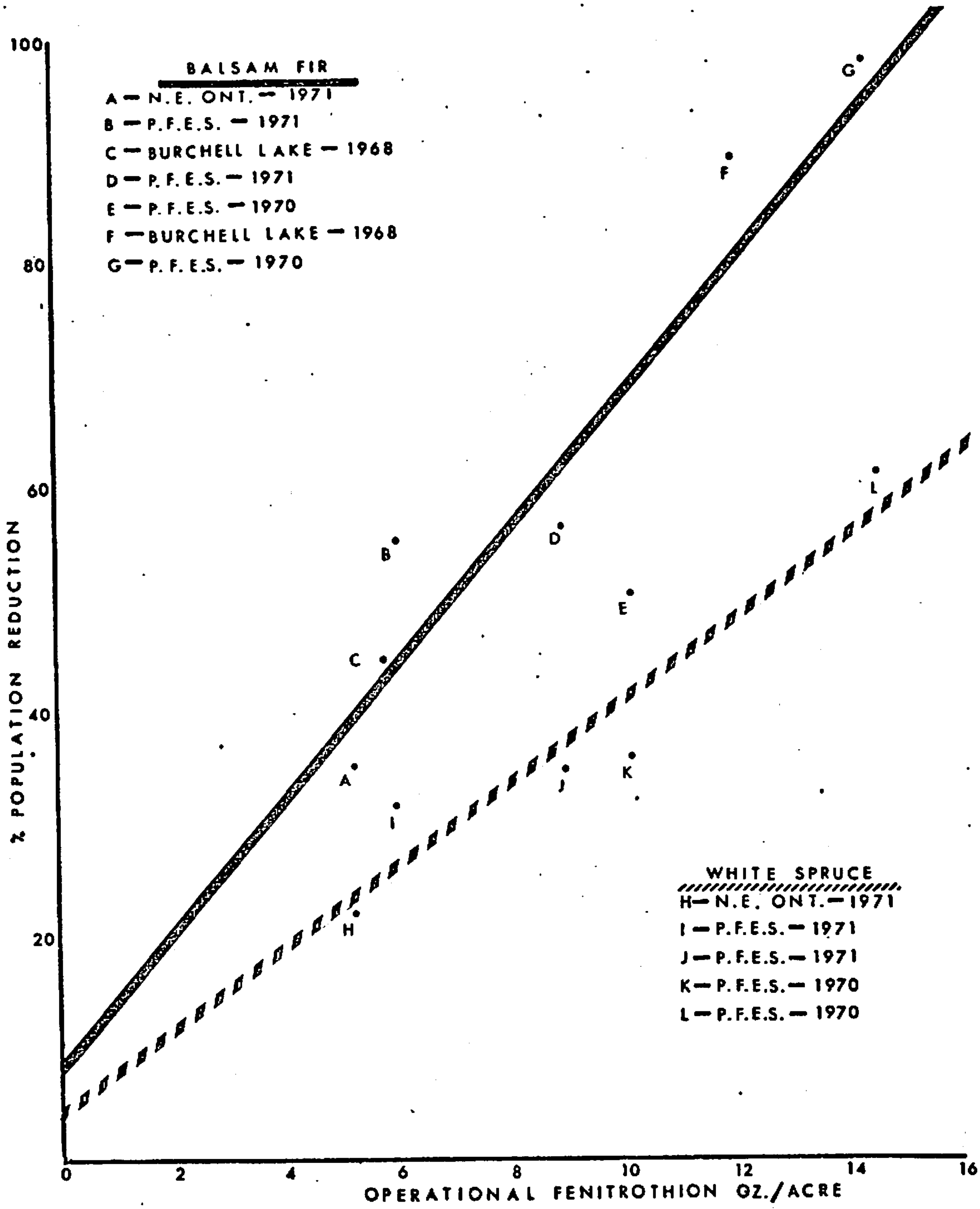

Figure 2. Different relationships on balsam fir and white spruce between population reduction and dosage using fenitrothion operationally against the spruce budworm in Ontario.

growing together, the population reduction is significantly lower on wS than on bF but under these conditions, it is reasonable to assume that both species must, overall, receive exactly the same treatment.

2. It has not been possible to obtain a level of population reduction affording a satisfactory degree of foliage protection on wS in Ontario using less than 15 oz. of fenitrothion per acre.

Proposals for 1972

In mid-October, a meeting was held in Ottawa by the Canadian Forestry Service to review spruce budworm control operations that took place in eastern Canada in 1971. The majority of opinions among those present at this meeting was that the problem of poor protection of white spruce in Ontario was mainly a result of ineffective application of the insecticide.

Dr. J. J. Fettes, Director of the Chemical Control Research Institute, offered to conduct a demonstration of budworm control in 1972 in Ontario using ULV application techniques that would hopefully provide satisfactory results. The Great Lakes Forest Research Centre welcomed this offer and suggested that the most suitable location for such a demonstration would be the Petawawa Forest Experiment Station. In addition, it was suggested that a second demonstration by CCRI might be conducted in an Ontario provincial park, heavily infested with budworm, for the purpose of demonstrating to the Ontario Department of Lands and Forests and others interested, the operational feasibility and superiority of using Micronair equipment.

Statement prepared for the Interdepartmental
Committee on Forest Spraying Operations

November 10, 1971

STUDIES ON THE CONTROL OF THE SPRUCE BUDWORM *Choristoneura fumiferana* (Clem.) BY AERIAL APPLICATION OF THE CHEMICALS

Reference CCRI Project CC-001

by

A.P. Randall, W.W. Hopewell, W. Haliburton & B. Zylstra

Chemical Control Research Institute
Canadian Forestry Service
Department of the Environment

Studies on the Control of the Spruce Budworm
Choristoneura fumiferana (Clem.)
by Aerial Application of the Chemicals

A.P. Randall, W.W. Hopewell, W. Haliburton & B. Zylstra

Reference CCRI Project CC-001

Introduction: The 1971 spruce budworm field trials are the seventh in a series of investigations carried out by the Chemical Control Research Institute to study means of controlling the spruce budworm Choristoneura fumiferana (Clem.) by aerial application of ultra low volumes of systemic and botanical insecticides. The project has been supported in part by personnel and equipment from Forest Protection Ltd., New Brunswick, Canada, the use of airport and facilities by the New Brunswick Development Corporation, and the campsite facilities of the New Brunswick Forestry Service. Donations of insecticides and solvents were made by the following companies: Ciba Co. Ltd., Chemagro Corporation, Dow Chemical of Canada, Dupont of Canada, McLaughlin Gormly & King Co. Ltd. (USA), and S.B. Penick & Co. (USA). The project consisted of two series of spray trials:

(a) pre-emergence 2nd instar budworm trials
(b) post emergence 2nd instar budworm trials

These trials were undertaken in a mixed spruce-fir-hardwood stand in Westmorland County near Scoudouc, New Brunswick. Application of the sprays was made by using a Stearman aircraft (CF-EQS) equipped with four AU-3000 Micronair units operating with 15" experimental curved fans set a maximum rotation. The insecticide formulations were applied using cross wind emission lines of decreasing swath widths to provide incremental dosage deposit patterns across each experimental plot.

A study of the three control plots selected in light,medium, and heavy spruce budworm larvae population density areas yielded the following defoliation results:

Control	Tree Species	Ave. No. buds/18" br.	Ave. Larval pop./18"/Br.	Percentage Defoliation
A	Fir	160	74	75
	Spruce	235	71	75
B	Fir	155	53	50
	Spruce	198	60	40
C	Fir	145	106	98
	Spruce	260	94	90

The above data was used as a base line or datum line to interpret the effects of each insecticide treatment on the pre-emergent 2nd instar larvae by classifying each individual spray plot to the appropriate control plot. The basis of classification was determined by insect and bud population densities on an 18" branch sample and subsequent tree defoliation. Emergence of 2nd instar larvae May 1, 1971.

Part (a): The effect of early spring application of ULV aerial sprays of Matacil, Sumithion, and Zectran on pre-emergence spruce budworm larval population and subsequent host tree defoliation.

Preliminary Results of the Pre-emergence 2nd Instar Budworm Trials

The summarized results of the ULV spray trial conducted against the pre-emergence 2nd instar stage of the spruce budworm are presented in Table I for balsam fir and spruce host trees. A résumé of results for each of the spray plots are listed below.

Plot 12 - Sumithion (fenitrothion) (2/5/71)

Biological assessment of the effects of ULV application of fenitrothion indicated relatively low population reduction of the budworm larvae even at the higher deposit densities (30 drops/cm^2). These results were corroborated by the high degree of defoliation within the plot and the lack of significant larval mortality on field collected foliage. Above results applicable to fir and spruce are shown in Table I.

Plot 5 - Zectran (4/5/71)

Biological assessment of budworm populations within the plot showed that a slight decrease in larval counts occurred with increase in spray deposits above the 10 drops/cm^2 deposit density in both spruce and fir. These results were confirmed by a decrease in the percentage defoliation of the trees in the higher spray deposit categories as shown in Table I.

Plot 3 - Matacil ULV (Panasol.)(5/5/71)

Biological assessment of post spray budworm populations within the plot indicated that a positive reduction of larvae occurred with increase in spray deposits above 5 drops/cm^2. These results were strengthened by the defoliation studies which showed a progressive decrease in defoliation with increased deposition of spray (Table I). Further evidence of efficacy was shown by the field laboratory studies of high larval mortalities on field foliage from heavy deposit areas.

Plot 6 - Matacil (Micronized Matacil in summer oil) (7/5/71)

Biological assessment of the post spray budworm population showed that very little reduction of budworm population occurred at the lower deposit dosage levels, but, a positive reduction occurred at 30^+ drops/cm^2 in fir and 20-30 drops/cm^2 in spruce (Table I). These latter results were confirmed by both the defoliation data and the field laboratory toxicity trials.

Conclusions: Application of systemic insecticides prior to the emergence of 2nd instar budworm larvae appears to have very little effect on subsequent development of larval population. However, when the application date is delayed to coincide with the peak emergence of the 2nd instar, a progressive decrease in population establishment occurs within the plots treated with the systemic insecticide. Whether the decrease is due to systemic action or a combination of systemic and residual action must be resolved by further studies. The results appear to be applicable to all three systemic insecticides tested.

TABLE I

Summarized Data of Aerial Spray Trials Against
Field Populations of Pre-emergent Budworm Larvae 1971

Host Trees - Fir

Spray Date	Treatment Plot No.	Drops/ cm^2	Deposit oz./ac.		No. of Samples	Population Reduction		Days After Treatment		Defoliation Percent	
			Liquid	Active		1st count	2nd count	1st	2nd	Plot	Control
2/5/71	Sumithion P-12	1-10 10-20 20+	1.43 2.06 5.05	0.37 0.56 1.33	4 10 9	41.7 25.5 58.7	32.4 0.0 43.1	15	31	50-65 60-80 70-80	C-C 98
4/5/71	Zectran P-5	1-10 10-20 20+	0.78 1.16 2.50	0.14 0.20 0.45	14 5 1	25.3 45.5 67.9	5.0 0.0 58.6	14	30	60-70 40-55 50-70	C-A 75
7/5/71	Matacil P-3	1-10 10-20 20+	1.69 3.78 5.45	0.31 0.65 0.92	10 6 5	28.8 56.5 63.2	47.8 41.5 53.2	13	29	40-50 35-55 20-30	C-B 50
7/5/71	Matacil W.P. P-6	1-10 10-20 20+	- - -	0.18 0.55 1.43	21 8 12	14.0 10.0 30.0	0 0 59	14	35	40-50 40-50 20-30	C-A 75
					Host Trees - Spruce						
2/5/71	Sumithion P-12	1-10 10-20 20-30	1.32 2.26 4.29	0.35 0.61 1.13	9 17 10	23.0 22.4 54.7	24.0 13.1 34.7	15	31	35-60 50-80 50-75	C-C 90
4/5/71	Zectran P-5	1-10 10-20 20+	0.59 1.32 3.40	0.10 0.23 0.61	39 6 2	16.8 44.9 50.8	0.0 48.1 55.4	14	30	60-75 25-50 25-30	C-A 75
7/5/71	Matacil P-3	1-10 10-20 20+	2.38 3.0 5.90	0.37 0.53 1.06	14 9 2	50.1 49.8 76.0	33.8 33.6 61.0	13	29	50-75 35-50 40-50	C-B 40
7/5/71	Matacil W.P. P-6	1-10 10-20 20+	- - -	0.19 0.46 0.82	8 15 5	0.0 0.0 60.0	0.0 0.0 22.5	14	35	50-60 40-50 20-40	C-A 75

Part (b): The effect of aerial application of ultra low volume sprays on field populations of 2nd and 3rd instar spruce budworm larvae.

Preliminary Results

Results of the 1970 aerial spray trials on the pyrethrins and pyrethroid insecticides, indicated that these compounds were very effective at low dosages when applied against the later stages of the spruce budworm larvae. The present series of trials were undertaken to ascertain the efficacy of these materials on 2nd and 3rd instar larvae under field conditions and to observe the subsequent effects of these sprays on host tree defoliation. Sumithion was used as a standard of comparison of field performance. All field data was corrected for natural mortality and interpreted on the bases of control observations. The summarized results of the 1971 ULV spray trials are presented in Table II for balsam fir and spruce host trees. A résumé of results for each plot are listed below.

Plot 4 - Sumithion and Aerotex (26/5/71)

Biological assessment of the efficacy of ULV application of aerotex formulated fenitrothion indicated a progressive trend of larval population reduction with increasing deposition of spray deposits beyond the 5 drops/cm^2 on both fir and spruce host trees. These results were strengthened by the high degree of foliage protection provided by spray deposits above 10 drops/cm^2 and by the positive evidence of larval mortality on plot collected foliage from the moderate and heavy deposit density sample positions as shown in Table II.

Plot 9 - Pyrethrins (29/5/71)

Biological assessment of the efficacy of early ULV application of pyrethrin indicated that a very slight reduction of budworm population occurred at the higher dosage levels on fir and spruce host trees. Some foliage protection (particularly spruce) was afforded by spray deposit densities above 10 drops/cm^2 as shown in Table II. Results of laboratory toxicity test on field collected foliage four days after treatment failed to show any signs of toxicity effects to 4th instar budworm larval.

Plot 10 - Sumithion and Pyrethroid (halfstrength) (2/6/71)

Biological assessment of the post-spray budworm population indicated that a positive reduction in larval population occurred within the plot on both fir and spruce host trees. A positive correlation occurred between drops/cm^2 and larval mortality. These results were strengthened by the defoliation studies that showed a positive decrease in defoliation of host trees (fir and spruce) with increasing drop deposits of spray as shown in Table II. Further evidence of tree protection and efficacy of the insecticide formulation was shown in the field-laboratory studies on foliage collected from various deposit density locations within the plot.

Plot 7 - Pyrethroid (SBP-1384) (5/6/71)

Biological assessment of post spray budworm populations within the plot indicated that a slight decrease in larval population occurred at dosage deposits levels above 15 drops/cm^2. These results are in agreement with the defoliation studies that indicate a progressive degree of foliage protection with increasing deposit densities above 15 drops/cm^2 (Table II). Results of toxicity studies of field contaminated foliage failed to show any residual or systemic activity of this compound 4 days after treatment.

Conclusions: ULV application of Pyrethrum insecticides at the dosages tested appear to have very little efficacy against the 2nd and 3rd instar spruce budworm larvae and subsequent foliage protection. Pyrethroid SBP-1382, Sumithion, and a mixed formulation of these two insecticides at half strength showed a positive correlation for efficacy of treatment and foliage protection with increasing spray deposit densities.

TABLE II

Summarized Data of Aerial Field Trials Against Field Populations of 2nd and 3rd Instar Budworm Larvae 1971

Spray Date	Treatment Plot No.	Drops/ cm^2	Deposit oz./ac.			No. of Samples	Population Reduction		Days After Treatment		Defoliation Percent	
			Liquid	Active			1st count	2nd count	1st	2nd	Plot	Control
Host Trees - Fir												
26/5/71	Sumithion P-4	1-10	0.96	0.28		19	6.0	16.4	6	9	40-60	C-B
		10-20	3.17	0.86		7	25.7	33.6			30-40	50
		20+	5.32	1.44		5	32.4	47.0			5-20	
29/5/71	Pyrethrum MGK 7063 P-9	1-10				21	0.0	0.0	6	10	25-35	C-B
		10-20				13	4.0	2.0			20-45	50
		20+				10	0.0	0.0			30-60	
			*S+P	*S	*P							
2/6/71	Sumithion+ Pyrethroid P-10	1-10	1.31	0.24	0.024	24	6	13	0	8	40-80	C-C
		10-20	3.58	0.65	0.057	9	48	25			20-40	98
		20+	6.30	1.13	0.10	3	33	16			35-60	
5/6/71	Pyrethroid SBP 1382 P-7	1-10	2.35	0.098		29	0	0	4	9	70-90	C-C
		10-20	4.70	0.19		8	0	23			20-80	98
		20+				-	-	-				
Host Trees - Spruce												
26/5/71	Sumithion P-4	1-10	1.21	0.33		23	30.8	42.0	6	9	35-50	C-B
		10-20	1.58	0.43		13	37.9	46.3			35-60	40
		20+	4.70	1.27		1	66.0	67.0			65-80	
29/5/71	Pyrethrum MGK 7063 P-9	1-10				12	46.9	8.3	6	10	20-40	C-B
		10-20				3	33.0	0.0			20-50	40
		20+				1	21.0	0.0			30-40	
			S+P	S	P							
2/6/71	Sumithion+ Pyrethroid P-10	1-10	0.92	0.16	0.01	20	15.0	16.1	0	8	60-75	C-C
		10-20	3.72	0.66	0.06	6	22.5	0.0			40-60	90
		20+	6.30	1.13	0.10	1	0.0	59.0			30-40	
5/6/71	Pyrethroid SBP 1382 P-7	1-10	2.02	0.08		27	0.0	0.0	4	9	80-90	C-C
		10-20	5.07	0.21		4	16.0	11.0			60-80	90
		20+	6.65	0.27		2	25.0	22.0			40-55	

* S = Sumithion
P = Pyrethroid SBP 1382

REPORT FOR MEETING OF THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

Evaluation of Insecticides and their Formulations Against Spruce Budworm and Other Insect Pests Under Laboratory Conditions - 1971

by

P. C. Nigam

Evaluation of Insecticides and their Formulations Against Spruce Budworm and Other Insect Pests Under Laboratory Conditions - 1971

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Thirty-five insecticides were tested against fourteen species of insects. The results are summarized under the following sub-headings.

(A) Studies on Spruce Budworm for 1971 Field Season

The following problems directly related to field operations were undertaken:

(a) Phytotoxicity of fenitrothion formulations:-

At the request of Mr. B.W. Flieger of Forest Protection Ltd. and Dr. J.A. Armstrong of this Institute the phytotoxicity of a fenitrothion solution in aerotex was evaluated. The aerotex solution of fenitrothion was proposed for early spring use in place of regular water emulsions which may freeze due to low temperatures.

The fenitrothion solution in aerotex was slightly phytotoxic to young foliage. The laboratory spraying was done on flushing potted balsam fir, white spruce and jackpine. The fenitrothion emulsion was not phytotoxic.

It appeared from these results that in mature trees during early spring, when buds are not flushed, the aerotex formulation may not cause phytotoxicity.

(b) Toxicity Studies of Matacil and Dylox Formulation for Control of Spruce Budworm:-

Ultra low volume and emulsifiable formulations of Matacil had been used experimentally against spruce budworm up to 1970. They were found very effective but are not as economical as the fenitrothion emulsion used in the field. In order to compete with fenitrothion (cost-wise) in large scale operations Chemagro Corporation developed 75% Matacil W.P. Air Mill formulation to be used in summer oil (as flowable material). It was suggested that efficiency of this formulation and of a similar Dylox formulation should be tested under laboratory conditions during the spring so that the results could be made available before the field season.

In residual toxicity tests the Matacil W.P. flowable formulation gave consistently higher mortalities than the ULV formulations up to 10 days and the same was true for the Dylox formulations. Two per cent active ingredient of each insecticide was applied at the rate of 1 gpa. So it appears from these studies, that flowable formulations (W.P.) are better than ULV in the laboratory toxicity tests.

(c) Residual Toxicity of Zectran Prepared by New & Old Process:-

The residual toxicity of new and old process Zectran was compared using fifth-instar spruce budworm. Two per cent concentrations of both types of Zectran were formulated in 80% ethylene glycol and 20% Dowanol and were sprayed at the rate of 1 gallon per acre on potted spruce trees. The insects were released on the foliage for toxicity observation, just after spraying and 1, 3, 5, and 10 days later. There was no significant difference in the corrected percentage mortality of new and old process Zectran, i.e. their toxicity appears to be the same.

(d) Studies on Spruce Budworm and Fenitrothion Received From Petawawa Spraying Operations:-

The fenitrothion received from Petawawa was tested using spruce budworm larvae from the Ottawa population and was found to be quite effective. The spruce budworm collected at Petawawa were tested using a laboratory formulation of fenitrothion prepared from technical grade. This collection proved to be quite susceptible to the laboratory formulation. Petawawa fenitrothion formulation and spruce budworm population both appear to be normal.

(e) Monitoring of Resistance Level of Spruce Budworm Field Populations Sprayed with Fenitrothion:-

Fifth instar spruce budworm from Quetico Park (unsprayed area) and Light Lake (sprayed area) were sprayed with fenitrothion using a modified Potter's tower. Results indicated no significant difference in susceptibility to fenitrothion between larvae from the sprayed and unsprayed areas.

(f) Residual Toxicity of Larch Foliage Collected From Fenitrothion Sprayed Plot at Larose Forest:-

Insecticide contaminated larch foliage was collected from a sprayed plot at periods of one and seven days after spraying. Larch sawfly larvae were used for the bioassay. There was a large variation in mortality between foliage samples. The average corrected percentage mortality was 22% one day after spraying and 6% seven days after spraying.

(B) Summary of Laboratory Screening of Insecticides Against Various Species of Forest Insect Pests

Insecticides were tested against insects from British Columbia, Ontario, Quebec and the Maritimes during 1971. The laboratory results are summarized by area of origin under each species. The insect collections were provided by the staff of the Forest Insect and Disease Survey with the exception of Gypsy Moth and native Elm Bark Beetle which were provided by the staff of the Department of Agriculture and National Capital Commission, respectively.

BRITISH COLUMBIA

Ambrosia Beetle - *Trypodendron lineatum* (Oliv.)

Nine insecticides were tested against ambrosia beetle adults. The corrected percentage mortality ranged from 100% to 19% for 72 hours after treatment. The insecticides are arranged in descending order of toxicity.

Phoxim > Methyl Trithion > BHC > Surecide >
Phosvel > Methoxychlor > Gardona > Hopcide >
Bassa

Sitka-spruce Weevil - *Pissodes sitchensis* (Hopk.)

The corrected percentage mortality for three insecticides tested against Sitka-spruce weevil adults ranged from 87% to 70%. Their order of toxicity is as follows:-

Methyl Trithion > Sumithion > Dursban

Filament Looper - *Nematocampa filamentaria* (Gn.)

The corrected percentage mortality for the fourth-instar larvae of the filament looper tested with 0.5% Sumithion applied at the rate of 1 gpa was 88% for 72 hours after treatment.

ONTARIO

White-pine Weevil - *Pissodes strobi* (Peck)

Fifteen insecticides were tested against white pine weevil adults. The corrected percentage mortality ranged from 100% to 50%. The insecticides are arranged in descending order of toxicity for 72 hours after treatment.

Methyl Trithion > Sumithion > Phoxim >
Dursban > Gardona > Zectran(new) >
Lindane > BHC = Zectran(old) = Methomyl >
C20132 = phosphamidon > DDT > Methoxychlor >
Chlordane

Jack-pine Budworm - *Choristoneura pinus* (Free.)

The corrected percentage mortality for fourth-instar jack-pine budworm larvae treated with 1% Sumithion at 0.8 gpa was 100% for 72 hours after treatment.

European Pine Sawfly - *Neodiprion sertifer* (Geoff.)

Six insecticides were tested against the fourth-instar larvae of European pine sawfly. The corrected percentage mortality ranged from 100% to 41%. The insecticides are arranged in descending order of toxicity for 72 hours after treatment.

Dupont 1642 > F6957 > Fitios > Pyrocide >
Allethrin > Pyrix

Black-headed Jack-pine Sawfly - *Neodiprion pratti banksianae* (Roh.)

Five insecticides were tested against the fourth-instar larvae of black-headed jack-pine sawfly. The corrected percentage mortality ranged from 100% to 80%. The insecticides are arranged in descending order of toxicity for 72 hours after treatment.

F6957 = Pyrocide > Surecide > Fitios > Pyrix

Larch Sawfly - *Pristiphora erichsonii* (Htg.)

The corrected percentage mortality for five insecticides tested against fourth-instar larvae of larch sawfly ranged from 100% to 59%. The insecticides are arranged in descending order of toxicity for 72 hours after treatment.

Surecide > Dylox > Cygon > C17974 > Allethrin

Native Elm Bark Beetle - *Hylurgopinus rufipes* (Eichh.)

Nine insecticides were tested against the adults of the native elm bark beetle. The corrected percentage mortality ranged from 100% to 87%. The insecticides are arranged in descending order for 72 hours after treatment.

Sumithion > Matacil > Dursban > DDT > Gardona =
Baygon > Diazinon > Methoxychlor = Chlordane

QUEBEC

Red-headed Pine Sawfly - Neodiprion lecontei (Fitch)

Fifteen insecticides were tested against fourth-instar of red-headed pine sawfly. The corrected percentage mortality ranged from 100% to 43.5% excluding Methoxychlor which gave 13%. The insecticides are arranged in descending order of toxicity for 72 hours after treatment.

Gardona > Baygon = Dibrom = Zectran = Phoxim > Sevin > Phosphamidon = Cygon > Stabilized pyrethrum > Phosvel > Galecron > Bassa > Monitor > Allethrin > Methoxychlor

Swaine Jack-pine Sawfly - Neodiprion Swainei (Midd.)

The corrected percentage mortality for eight insecticides tested against fourth-instar swaine jack-pine sawfly larvae ranged from 100% to 84%. The insecticides are arranged in descending order of toxicity for 72 hours after treatment.

Furadan > Matacil > Phoxim > Cygon > Dylox = C17974 > Cidial > Allethrin

Gypsy Moth - Porthetria dispar (L.)

The corrected percentage mortality was 100 with the six insecticides formulations tested against third-instar larvae of gypsy moth. They are listed in descending order of toxicity for 72 hours after treatment.

Matacil > Sevin 80S > Sevin ULV > Sevin 4 oil > Phosphamidon > Sumithion

MARITIMES

White-marked Tussock Moth - Hemerocampa leucostigma (J.E. Smith)

Twelve insecticides were tested against the fourth-instar larvae of white-marked tussock moth. The corrected percentage mortality ranged from 100% to 82.7% except Sevin ULV and Gardona where 33% and 20% mortality were observed. The insecticides are arranged in descending order of toxicity for 72 hours after treatment.

Phoxim > Pyrocide > Zectran > Matacil > Sumithion > Dylox > Sevin 4 oil > Sevin ULV > Phosvel > Phosphamidon > GS 13005 > Gardona

APPENDIX 13

THE APPLICATION OF COMPOUNDS
FOR THE CONTROL OF THE
SPRUCE BUDWORM (*Choristoneura fumiferana*)

by

J. A. Armstrong

Report on Project No. CC-011

Chemical Control Research Institute
Canadian Forestry Service
Department of the Environment

A Report to the Interdepartmental Committee on Forest Spraying Operations

The application of compounds for the control of the spruce budworm (*Choristoneura fumiferana*)

by

J.A. Armstrong

Report on project no. CC-011

A. Trials with chemical insecticides

Joint project with FPL, FRL, CWS, FRB and Chemagro Corp.

In 1970 Matacil, Dylox, and Lannate were applied operationally to a group of 2,500 acre blocks to assess their effectiveness against the spruce budworm and to determine what their effect would be against non-target organisms within the test area. The results showed that there were no deleterious effects, and that Matacil at 2.5 ounces active ingredient per acre gave excellent control of the spruce budworm. The 1970 trials were carried out using an expensive solvent. In 1971 it was therefore planned to apply Matacil to a series of full operational blocks (12,500 acres each) with the following aims:

(a) Determine the economics of applying Matacil at a dosage rated to give a level of control equal to that achieved with fenitrothion.

(b) Determine the minimum effective dosage of Matacil.

(c) Determine the effectiveness of a Matacil wettable powder formulation.

The experimental protocol was as follows:

Chemagro Corp. :- to supply insecticides, solvent and dye

FPL:- to apply the material, responsible for formulation

CFS, CWS, FRB:- monitor the spray application, and do pre- and post-spray checks in the spray blocks.

Results

(a) Determination of the economics of applying Matacil at a rate to give a level of control equal to that achieved with fenitrothion.

Two 12,500 acre blocks were selected to be treated with Matacil at 1.5 ounces active ingredient per acre in a total volume of 20 ounces of material. The solvent selected was Panasol. Slides, kromekote cards, cascade impactors and air samples were set out to measure the deposit. Meteorological conditions were also recorded within the plot.

The Panasol solvent caused a rapid and extensive swelling and distortion of the gaskets in the spray system of the aircraft. This resulted in a blocking of the lines and a reduction or cessation of the flow of insecticides. As a result of the blockage the aircraft attempted to continue spraying to deliver the total amount of material causing a greatly extended spray time. With no prior knowledge of the extended spray time the sampling systems were stopped at the normal time interval after the passage of the spray aircraft; Thus the planes continued to spray with no sampling systems functioning for the complete time period. As a result we have only partial information of the amount of material deposited, the calculations show that the block received an average of 6.69 ounces per acre of formulation, to equal to 0.49 ounces per acre of active ingredient. After the spray we learned that with the problems of blocked spray lines some of the aircraft returned with partial loads of insecticide, thus we have no knowledge of what volume was actually delivered and what the ratio of deposit to emitted insecticide was.

(b) <u>Determination of the minimum effective dosage of Matacil</u>

The 1970 trials showed that Matacil, at an emitted dosage of 2.5 ounces per acre gave virtually complete control of the spruce budworm. The 1971 trials were set up to determine what minimum amount of Matacil would give control equivalent to that provided by fenitrothion. Matacil was therefore applied at 1.0 and 0.5 ounces active ingredient per acre to pairs of 12,500 acre blocks. Again the solvent selected was Panasol.

A similar blockage occurred in these trials and there is no record of the amount emitted or deposited. To further complicate the picture insufficient dye was added and it was impossible to do any measurements on the droplet spectrum.

(c) <u>Determination of the effectiveness of a Matacil wettable powder formulation.</u>

A Matacil 75% wettable powder was formulated in a light summer oil and applied to two 12,500 acre blocks at the rate of 1.5 ounces of active ingredient per acre. As in the trials described in sections (a) and (b) the formulation was prepared for a total emitted volume of 20 ounces per acre. The first application was plagued with plugged lines; the second was applied with no problems.

The deposit in both applications was excellent, with a uniform coverage being obtained. The first block to be treated received 11.84 ounces of material, equal to 0.88 ounces per acre of active ingredient. The second block received an average of 20.45 ounces of material, the full effective dosage.

B. Experimental Application of Fenitrothion

In coordination with Dr. C.H. Buckner a joint project with various members of the Institute were involved in a study of the total effect of fenitrothion when applied to a 40 acre plot at a dosage and rate equal to that used by FPL. The meterological equipment was set up in a site between the experimental plots. The conditions at the time of spray application (1930 hours) were as follows:

wind speed	5.7 mph
wind direction	0 (N)
turbulence	Nil
stability ratio	0.23, very light inversion, neutral spray conditions
relative humidity	67% at 100 feet, 71% at 18 feet
temperature	21 C at 100 feet, 21.5 C at 18 feet

C. Virus Application

In coordination with IPRI and the Regional Laboratory at Sault Ste Marie CCRI provided Meterological equipment to monitor the weather conditions at the time of a virus application in the L. Achray area in Algonquin Park. The spray was applied the 15 May, 1971 starting at 1928 hours and finishing at 2010 hours. The meterological conditions were as follows:

wind speed	3.2 mph
wind direction	0 (N) mean wind direction
turbulence	Nil
stability ratio	average 18.283 and then infinitely large, indicating a very strong inversion and excellent spray conditions
relative humidity	36% at 40 feet, 51.5% at the forest floor
temperature	22.5 C at 40 feet, 19 C at the forest floor.

REPORT FOR MEETING OF THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

Summary of Environmental Contamination Project CC-009

by

W. N. Yule

Chemical Control Research Institute
Canadian Forestry Service
Department of the Environment

Summary of Environmental Contamination Project CC-009

by W. N. Yule

for ICFSO, November, 1971

Summaries are given here of sections of work which have been completed and reported in 1970-71. (Reprints are available from CCRI)

Atmosphere

DDT in air; drift from large spray operations; development of air-sampling apparatus. See Yule, W. N. and A.F.W. Cole, 1971, Proc. 4th Int. Agric. Aviat. Congr., Kingston, Ont., 1969, 346-353.

Fenitrothion in the atmosphere associated with the N.B. budworm operation of 1969. Small amounts (< 3 $\mu g/m^3$/day) phosphorus were collected in air-samplers situated in 5 towns around the spray operation. Even if all the phosphorus were derived from fenitrothion, and total absorption occurred, these daily amounts would not constitute a health hazard to the local human population, the criterion used as an indicator of ecological significance of spray loss and environmental contamination. Local air collections reflected down-wind drift and local application component factors. See Yule, W.N., A.F.W. Cole and I. Hoffman, 1971, Bull. Env. Contam. and Toxicol., 6, 289-296.

Soil

DDT. Intensive studies of DDT in forest soils have been continuing since 1967 at Priceville, N.B. Of the nominal 70 ounces/acre DDT applied operationally to the locality between 1956 and 1967, an average of approximately 11 ounces/acre persisted in the soil in 1968, and mostly in the surface organic horizons. Residue distributions were rather erratic, particularly in the vicinity of a creek valley, and comprised mainly the pp' DDT isomer. Soil residues have diminished slowly between 1968 and 1971, a half-life estimate of the present residue burden of soil is 10 years with no further DDT application. Isomer composition has changed slowly over the same period with pp' DDT decreasing (3-5%) and op' DDT and pp' DDE increasing (1-3%). See Yule, W.N., 1970, Bull. Env. Contam. and Toxicol. 5 (2); 139-144; and, Yule, W.N. and G.G. Smith, 1971, Canadian Forestry Service Information Report, CC-X-9, 21 pp.

Fenitrothion. The persistence and fate of an operational dose of 4 ounces/acre fenitrothion applied to the Priceville area in June 1970 has been followed over the past year in coniferous foliage and forest soil. Spruce and balsam fir foliage collected relatively large amounts of fenitrothion (2-4 ppm) from the aerial spraying, while only traces were found in surface forest soils. The parent compound decreased rapidly in foliage (50% loss in 4 days; 70-85% loss in 2 weeks), but the remaining 0.5 ppm. persisted for most of a year without further change. Since only traces of breakdown products (e.g. oxon or cresol $<$ 0.02 ppm.) were found during that time, it has been postulated that the initial large losses were of external deposits and were due to physical agencies (e.g. air, sun, rain), while the persistent residue may have been absorbed internally but apparently was not subject to rapid metabolic decomposition.

Further work on the fate of fenitrothion in a forest environment is being undertaken using radiolabelled pesticide and potted conifers, and above-operational dosages in forest soils. See Yule, W.N. and J.R. Duffy, 1971, Canadian Forestry Service Information Report, CC-X-10, 16 pp.

Water

DDT. Stream water was sampled from a creek draining the Priceville area of N.B. before, during, and up to 2 years after the final operational application of DDT to this area in 1967. Only during, and for a few hours after actual spray application, did the DDT concentration in stream water exceed a steady background level of 0.5 parts per billion pp' DDT ($<$17 ppb.), and this DDT flush occurred mainly as a surface film associated with the formulating oil. Bottom sediments showed a downstream dilution gradient of DDT residue from the same tributary to the estuary of the Miramichi River. Only 12.5% of the DDT concentration found in forest soils occcurred in the sediments of streams draining these lands (comparing averages), and much of the pp' DDT found in formulations and land residues had been decomposed to DDE and DDD in forest stream sediments. See Yule, W.N. and A.D. Tomlin, 1971, Bull. Env. Contam. and Toxicol., 5(6), 479-488.

Ecology

Having established some baseline quantities for DDT and fenitrothion in the physical environment of the forest, the project will be extended to measure passage to and cycling of pesticides within biological systems. A start has been made in this direction with insect-bioassay of forest soils and collection of soil invertebrates as simple measures of biological availability and ecological significance of DDT residues. Studies on the uptake of DDT from contaminated soil, and translocation of DDT from sprayed foliage are in process, together with a residue survey for DDT in lumber from sprayed forests in N.B. A survey of forest soils and coniferous foliage has been made in areas of Northern N.B. sprayed with DDT 1952-58, to include permutations of various environmental and chemical factors, to measure interactions that have occurred between them with a time variable. It is hoped to collaborate directly with other ecologists in the biological stage of this project, once facilities and methodology for chemical research are improved.

Dissemination of Poxvirus, Nuclear Polyhedrosis and Cytoplasmic Polyhedrosis Against the Spruce Budworm and Jack Pine Budworm

F.T. Bird, J.C. Cunningham and J.R. McPhee

Mass produced poxvirus contaminated with small amounts of nuclear polyhedrosis (NPV) and cytoplasmic polyhedrosis (CPV) was sprayed with hand-operated pressure sprayers and power-operated mist blowers on spruce trees infested with the spruce budworm and Scots pine infested with the Jack Pine budworm and by means of a helicopter on spruce and fir trees infested with the spruce budworm. NPV heavily contaminated with CPV was sprayed with helicopter on spruce and fir infested with the spruce budworm. Helicopter spraying was carried out at Pembroke, Ontario. Ground studies against the spruce budworm were carried out at Iron Bridge, Ont. and against the Jack Pine Budworm at Gore Bay, Ont. The virus material used in all studies was the freeze dried bodies of larvae infected with the viruses suspended in water.

I. Studies with Poxvirus Contaminated with CPV and NPV on Individual Trees at Iron Bridge, Ont.

Groups of small spruce (10'-20' high) infested with the spruce budworm were sprayed with the poxvirus on April 29 about 12 days before emergence of larvae from hibernacula and at about 4-day intervals thereafter similar groups of trees were sprayed. The object of this study was to determine the period of larval development most likely to come in contact with or feed on the virus. Some of the trees were sprayed with the virus material suspended in water and some were sprayed with the same virus suspension but with sunlight protectant added. The sunlight protectant, a dark powder of unknown constitution was obtained from I.M.C. (International Mineral and Chemical Corporation, Chicago). It was developed for use in spraying virus against <u>Heliothis</u> spp. A number of materials including India ink have been found to give some protection from solar radiation. The material from I.M.C. was used at the rate of 1 lb. in 5 gallons of water. The concentration of the freeze-dried poxvirus material was 0.5 gram (about 15 larvae) in 1 gallon of water. This was the equivalent of about $2x10^6$ virus inclusion bodies per ml of suspension. The virus suspensions were sprayed with a small pressure sprayer to obtain uniform coverage. Foliage samples were taken at weekly intervals and the tissues of at least 30 budworm from each sample were examined under the phase contrast light microscope for virus and other diseases. Percentages of budworm infected with poxvirus only are shown in Fig. 1.

There were 2 peaks of infection. The first from virus sprayed on May 14 when 80% of the larvae were in the second instar and 12% in the third instar; the second from virus sprayed on June 2 when 72% of the larvae were in the third and 25% in the fourth instar. High percentages of larvae were infected from virus sprayed on June 6 suggesting that the period of susceptibility or probably more correctly accessibility extended over a longer period at the later stage of larval development.

Incubation period of the disease (time from spraying until microscopic symptoms of infection) decreased as the season progressed, apparently as the result of increased temperatures, from a low of 32 days from virus sprayed on May 14 to 24 days from virus sprayed on June 6.

Most of the virus sprayed on April 29 (about 12 days before larvae emerged from hibernacula) was apparently inactivated by solar radiation. The small amount of virus that did persist until larvae picked it up, which apparently was very late in larval development, was probably that virus protected in sheltered niches.

Fig. 2 shows the results obtained when sunlight protectant was added to the virus suspension. In general, much higher percentages of infections were obtained among larvae on those trees sprayed with suspensions containing the sunlight protectant (all sprays were applied between 11 A.M. and 12 P.M.). Sunlight protectant did not protect virus sprayed on April 29 and was only mildly effective until larvae were actively mining needles. This is in agreement with studies on Heliothis virus where it has been found that the maximum effect is obtained during the first day (personal communication).

II. Studies with Poxvirus Contaminated with CPV and NPV Sprayed Over Rows of Scots Pine Infested with the Jack Pine Budworm.

Duplicate experiments were carried out at Gore Bay with and without sunlight protectant. The virus suspensions

(0.1 g; 1.0 g, and 10.0 g of freeze dried virus material in 4000 ml of water were sprayed with 2 mist blowers (1 for sunlight protectant and 1 without sunlight protectant) on the windward edge of rows of Scots pine from 6' to 8' high. Two gallons of the virus suspensions were sprayed over the rows of trees as the operator walked slowly a distance of about 400 ft. The most dilute suspension (0.1 g/4000 ml) was sprayed in a clear sunny day on June 14 at 5 P.M. The second suspension (1.0 g/4000 ml) was sprayed at 7 P.M. and the third at about 7:30 P.M.

The Jack Pine budworm population which was very high in 1970 was unfortunately very low in 1971 and the numbers of insects shown in Tables 1, 2, and 3 were all those found in the entire rows of trees sprayed. The virus, therefore, was tested against a very sparse population.

The virus concentration of 0.1 g/4000 ml (Table 1) caused 29% poxvirus infection in rows 1-3 and 3% in rows 5-7. Sunlight protectant apparently increased infection in rows 5-7 and some infection occurred in rows 17-19.

The virus concentration of 1.0 g/4000 ml. (Table II) caused 87% infection in rows 1-3 and 12% infection in rows 5-7. Sunlight protectant increased infection in rows 5-7 to 41% and diseased larvae were found in rows 9-11. For some reason (possibly because the spray was directed over too far over the tops of the trees) infection was less in rows 1-3 for sunlight protectant than without the protectant.

The virus concentration of 10. g/4000 ml (Table III) caused heavy infection (50%-80%) over 11 rows of trees with or without sunlight protectant. Without sunlight protectant from 11% to 45% of the larvae were diseased over a further 29 rows and infected larvae were found in rows 55-60, 65-70 and 85-90.

Besides the sunlight protectant, and virus dosages, another factor considered important was the time of spraying. Thus more virus would be inactivated by solar radiation at 5 P.M. than at 7:30 P.M. and it would appear probable that the best time to spray virus would be at dark. Perhaps at this time sunlight protectant would not be needed and conversely most virus sprayed during the morning would be inactivated with or without sunlight protectant.

NPV, a virus contaminant, infected very small numbers of larvae and only in the first 7 rows. CPV, the second virus contaminant caused higher percentages of infection but it too was limited to the first 23 rows apparently being diluted out as the spray drifted over further rows (Table III).

III. Studies of Poxvirus Contaminated with CPV and NPV and NPV contaminated with CPV Sprayed with Helicopter at Pembroke, Ont.

Poxvirus contaminated with small amounts of CPV and NPV and NPV heavily contaminated with CPV were sprayed by helicopter at the rate of 3 gallons per acre over 5 acre plots of spruce and fir. Three concentrations of poxvirus with sunlight protectant were used 0.1 g, 1.0 g, and 10.0 g per gallon. One concentration of NPV (25.0 g per gallon) without sunlight protectant were used. There were early and late sprays. The early spray period for poxvirus was between 7:30 P.M. and 8:10 P.M. on May 15 when 95% of the larvae were in the second instar and 5% in the third instar which according to ground studies discussed above was a period of larval development very susceptible to virus spray. It was also a favorable time of the day insofar as avoiding solar radiation was concerned. The second poxvirus spray was applied on May 31 at the peak of the fourth instar also a very favorable period insofar as larval development was concerned. However, spraying was carried out at about 7 A.M. of a bright sunny day, a most unfavorable time insofar as solar radiation was concerned. The NPV suspensions were both sprayed during the evening (about 8 P.M.) the first on May 16, the second on May 29.

Maximum percentages of budworm infected with the virus suspensions plus their contaminants are shown in Table IV. Percentages of infections varied with dosage. Samples from 4 selected trees from each plot sprayed with poxvirus on May 31 showed 10% infected with the lowest dosage and 37% infection at the highest dosage. Random samples taken throughout the plots showed 12% infection at the lowest dosages and 44% infection at the highest dosage. Very much less infection occurred from poxvirus sprayed during the morning of May 31. Samples from 4 selected trees in each plot showed 6% infection at the lowest dosage and 12% at the highest dosage. Random samples showed percentages infection of only 5% and 2%.

Percentages of infection in plots sprayed with NPV contaminated with CPV showed 31% infection from the early spray on May 16 and over double this (70%) from the late spray. One might expect therefore that if poxvirus had been sprayed during the evening rather than in the morning of May 30 a similar doubling of infection over that obtained on May 15 would have occurred.

Tables 5, 6, and 7 show the percentages of infection at successive weekly intervals after poxvirus was sprayed and Table 8 after NPV was sprayed. The incubation period for poxvirus was about 24 days for virus sprayed on May 15 and about 20 days for virus sprayed on May 31 somewhat shorter than that obtained in the cooler climate at Iron Bridge. The incubation period for NPV was not determined with certainty because of some natural infection in controls (Table 9). However, from laboratory studies and sprays applied from the ground the incubation period for NPV is considerably shorter than that for poxvirus.

Both CPV and NPV were found in unsprayed populations of the budworm at extremely low levels of infection (0.9% NPV and 2.7% CPV) from one area (Table 9) and no infection in another area (Table 7). There was no infection by poxvirus in any of the control areas.

NPV as a contaminant of poxvirus caused infections as high as 12%. This is considered very high considering the small amount of NPV present in the poxvirus suspension. There is the possibility of a synergistic relationship between poxvirus and NPV. CPV as a contaminant of poxvirus caused infection as high as 7%. This virus is difficult to diagnose in pupae and the prevalence of this virus might well be much higher. However, CPV as a contaminant of NPV caused percentages of infection of 28% among larvae sprayed on May 16 and 39% from virus sprayed on May 29. This virus interferes with and retards NPV development and infection by *NPV should* increase by removing CPV contaminant. Since NPV is a lethal virus and CPV mainly a dibilitating virus, there would be an advantage in eliminating CPV.

Much smaller percentages of budworm were infected with virus on balsam fir sprayed with the poxvirus suspension on May 15 than on spruce. Several factors may be involved but one simple explanation is related to solar radiation in that virus deposited on the flat needle of balsam would be more quickly inactivated than on the spruce needle. The difference in incidence of disease on balsam and spruce was not apparent on trees sprayed on May 29 when most virus on both trees was inactivated.

Sault Ste. Marie, Ontario,
October 13, 1971.

Virus Infection Resulting From the Dissemination of Poxvirus Contaminated with CPV and NPV Against the Jack Pine Budworm on Scots Pine, Gore Gay, Ontario, 1971.

Gram virus per 4000 ml of water	Date sprayed	Date sampled	Row no.	No sunlight protectant No. insects	% Pox	% CPV	% NPV	Total	With sunlight protectant No. insects	% Pox	% CPV	% NPV	% Total
			1-3	41	29	0	0	29	47	23	0	2	26
Table I			5-7	35	3	0	0	3	38	13	0	0	13
			9-11	29	0	0	0	0	57	0	0	0	0
			13-15	31	0	0	0	0	53	0	0	0	0
			17-19	13	0	0	0	0	24	4	0	0	4
0.1g.	June 14	July 12	21-23	28	0	0	0	0	20	0	0	0	0
		July 21	25-27	15	0	0	0	0	33	0	0	0	0
			29-31	18	0	0	0	0	21	0	0	0	0
			33-35	17	0	0	0	0	28	0	0	0	0
			37-39	16	0	0	0	0	25	0	0	0	0
			41-43	23	0	0	0	0	25	0	0	0	0
			45-47	16	0	0	0	0	15	0	0	0	0
			49-51	15	0	0	0	0	15	0	0	0	0

Gram virus per 4000 ml of water	Date sprayed	Date sampled	Row no.	No sunlight protectant No. insects	% Pox	% CPV	% NPV	Total	With sunlight protectant No. insects	% Pox	% CPV	% NPV	% Total
			1-3	30	83	13	3	87	24	42	0	0	42
Table II			5-7	26	12	0	0	12	29	38	0	3	41
			9-11	20	0	0	0	0	20	0	0	5	5
			13-15	18	0	0	0	0	18	0	0	0	0
			17-19	25	0	0	0	0	25	0	0	0	0
1.0g.	June 14	July 12	21-23	16	0	0	0	0	22	0	0	0	0
		-July 21	25-27	7	0	0	0	0	11	0	0	0	0
			28-31	11	0	0	0	0	13	0	0	0	0
			33-36	11	0	0	0	0	15	0	0	0	0
			37-49	11	0	0	0	0	15	0	0	0	0
			41-43	13	0	0	0	0	16	0	0	0	0
			45-47	12	0	0	0	0	16	0	0	0	0

Table III

Virus Infection Resulting From the Dissemination of Poxvirus Contaminated With CPV and NPV Against the Jack Pine Budworm On Scots Pine, Gore Bay, Ontario, 1971.

Gram virus per 4000 ml water	Date sprayed	Date sampled	Row no.	No sunlight protectant No. insects	% Pox	% CPV	% NPV	Total	With sunlight protectant No insects	% Pox	% CPV	% NPV	% Total
		July 6	1-3	108	34	27	4	46	171	32	32	0	51
			1-3	16	81	7	0	88					
			5-7	23	48	9	4	48	4	50		25	75
			9-11	15	47	13	0	53	25	44	56	4	64
10.0g.	June 14	July 12	13-15	20	10	0	0	10	24	13	8	0	21
		July 21	17-19	25	4	0	0	4	20	30	0	0	30
			21-23	12	9	0	0	9	11	36	9	0	45
			25-27	13	0	0	0	0	9	11	0	0	11
			29-31	17	12	0	0	12	14	21	0	0	21
			33-35	9	0	0	0	0	12	17	0	0	17
			35-40	12	0	0	0	0	13	15	0	0	15
			40-45	11	0	0	0	0	14	0	0	0	0
			45-50	7	0	0	0	0	8	0	0	0	0
			50-55	12	0	0	0	0	5	0	0	0	0
			55-60	13	0	0	0	0	15	7	0	0	7
			60-65	10	0	0	0	0	10	0	0	0	0
			65-70	5	0	0	0	0	20	10	0	0	10
			70-75	11	0	0	0	0	6	0	0	0	0
			75-80	11	0	0	0	0	16	0	0	0	0
			80-85	13	0	0	0	0	10	0	0	0	0
			85-90	9	0	0	0	0	17	6	0	0	6
			90-100	13	0	0	0	0	13	0	0	0	0

Table IV

Percentages of Infection Obtained When Spruce and Fir Were Sprayed With Poxvirus and Nuclear Polyhedrosis Virus

Virus	Grams virus per gal. water	Early spray: 4 trees	Early spray: Random samples spruce	Early spray: Random samples fir	Late spray: 4 trees	Late spray: Random samples spruce	Late spray: Random samples fir
Poxvirus	0.1	10	12	1	6	5	4
	1.0	26	19	3	2	2	2
	10.0	37	44	9	12	2	10
NPV	25.0		31			70	

Table V

Virus Infection Resulting From Dissemination of Poxvirus Contaminated with CPV and NPV Against the Spruce Budworm Achray, Ontario, 1971.

Gram virus per gallon of water	Time of spraying	Plot	Tree species	Time of diagnosis	No. of insects	% Pox	% CPV	% NPV	% Total
0.1	May 15	4 trees	spruce	June 21	324	7	0	2	9
				" 28	333	9	0	1	10
		Random samples	spruce	" 21	218	12	0	0	12
			spruce	" 28	329	0	0	0	0
			fir	" 28	435	1	0	0	1
0.1	May 30	4 trees	spruce	June 28	157	6	0	0	6
		Random samples	spruce	" 28	280	5	0	0	5
			fir	" 28	525	4	0	0	4

Table VI

Virus Infection Resulting From Dissemination of Poxvirus Contaminated with CPV and NPV Against the Spruce Budworm Achray, Ontario, 1971.

Gram virus per gallon of water	Time of spraying	Plot	Tree species	Time of diagnosis	No. of insects	% Pox	% CPV	% NPV	% Total
1.0	May 15	4 trees	spruce	May 30	123	0	0	0	0
				June 8	218	1	1	1	1
				June 14	429	8	3	1	11
				June 21	294	16	2	8	22
				June 28	292	16	4	12	26
		Random samples	spruce	June 21	185	15	1	4	19
				June 28	319	16	1	3	15
			fir	June 28	377	3	1	0	3
1.0	May 31	4 trees	spruce	June 28	358	2	0	0	2
		Random samples		June 28	317	1	0	1	2
			fir	June 28	275	2	0	0	2

Table VII

Virus Infection Resulting from Dissemination of Poxvirus Contaminated with CPV and NPV Against the Spruce Budworm, Achray, Ont., 1971.

Gram virus per gallon of water	Time of spraying	Plot	Tree species	Time of diagnosis	No. of insects	% Pox	% CPV	% NPV	% Total
10.0	May 15	4 trees	spruce	May 30	206	0	0	0	0
				June 8	205	0	1	1	1
				June 14	463	23	4	1	26
				June 21	479	26	7	10	37
				June 28	570	20	5	8	24
		Random samples	spruce	June 21	305	27	5	8	33
				June 28	660	38	0	6	44
			fir	June 28	381	9	0	1	9
Control			spruce	June 21	263	0	0	0	0
Control			spruce	June 28	1301	0	0	0	0
10.0	May 31	4 trees	spruce	June 21	99	5	1	7	12
				June 28	741	2	1	3	5
	May 31	Random samples	spruce	June 28	246	2	0	1	3
			fir	June 28	301	6	0	4	10
Control			spruce	June 28	1306	0	0	0	0

Table VIII

SUMMARY OF INFECTIVITY STUDIES
NPV PLOTS AT DELUTHIER RD.

Sample date	Number of days after spray	Number of insects sampled	% Total virus	% NPV	%CPV	% Healthy
	EARLY SPRAY					
May 30	14	286	4	3	1	85
June 7	22	250	10	2	8	68
June 14	29	187	34	8	28	66
June 21	36	542*	31	21	21	66
	LATE SPRAY					
June 14	16	200	71	46	35	25
June 21	23	116	59	41	22	23

*Only 212 pupae and larvae were examined microscopically. Due to the large number of pupae in the sample 94 were examined and the scores adjusted proportionately to maintain the balance of the sample.

Table IX

SUMMARY OF YOUNG CREEK RD.
CONTROL SAMPLES

Sample date	Number of insects examined	% Total virus	% NPV	% CPV	% Healthy
16 June	209	3	1	2	83
23 June	221	3	0	3	90

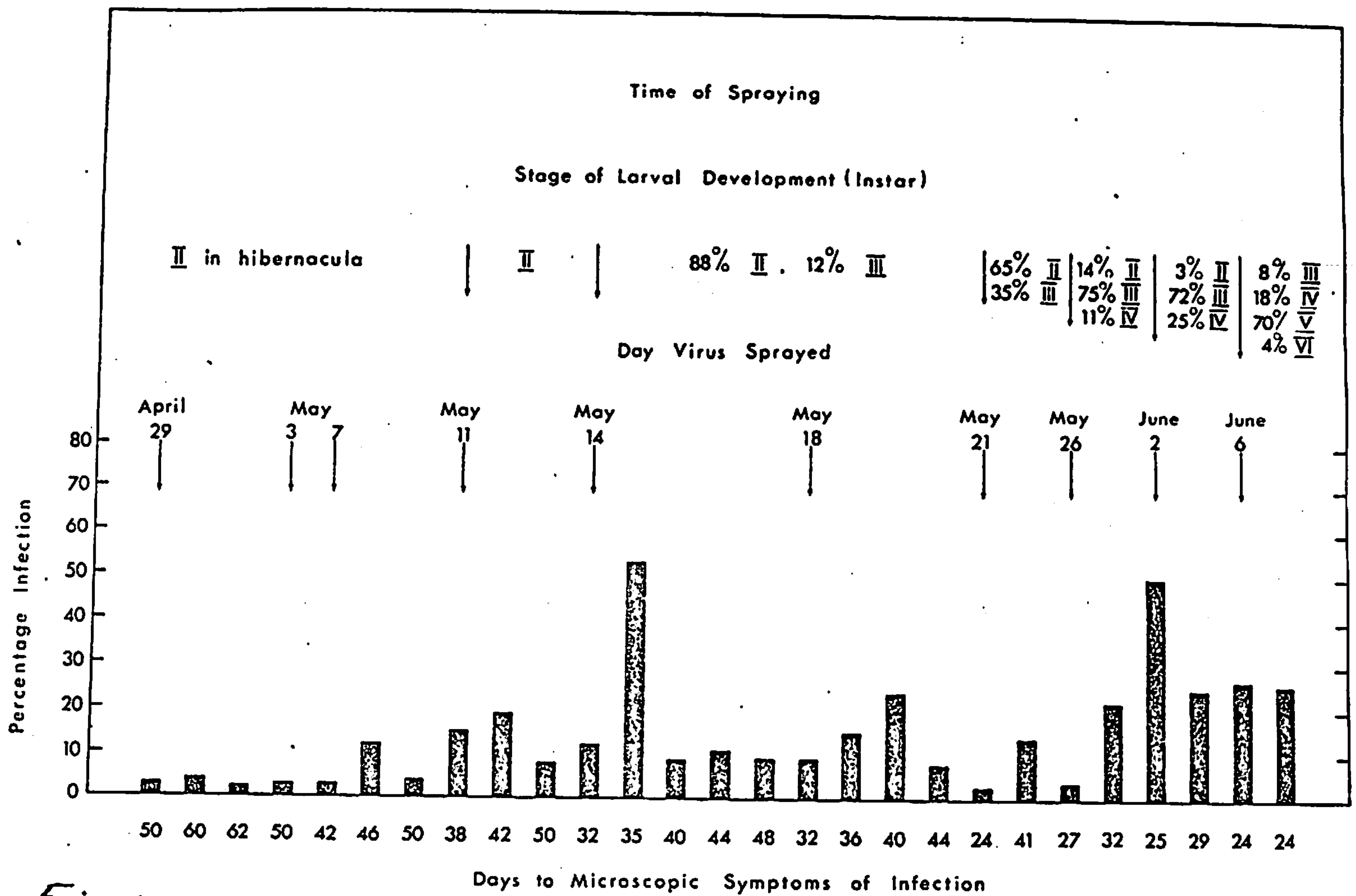
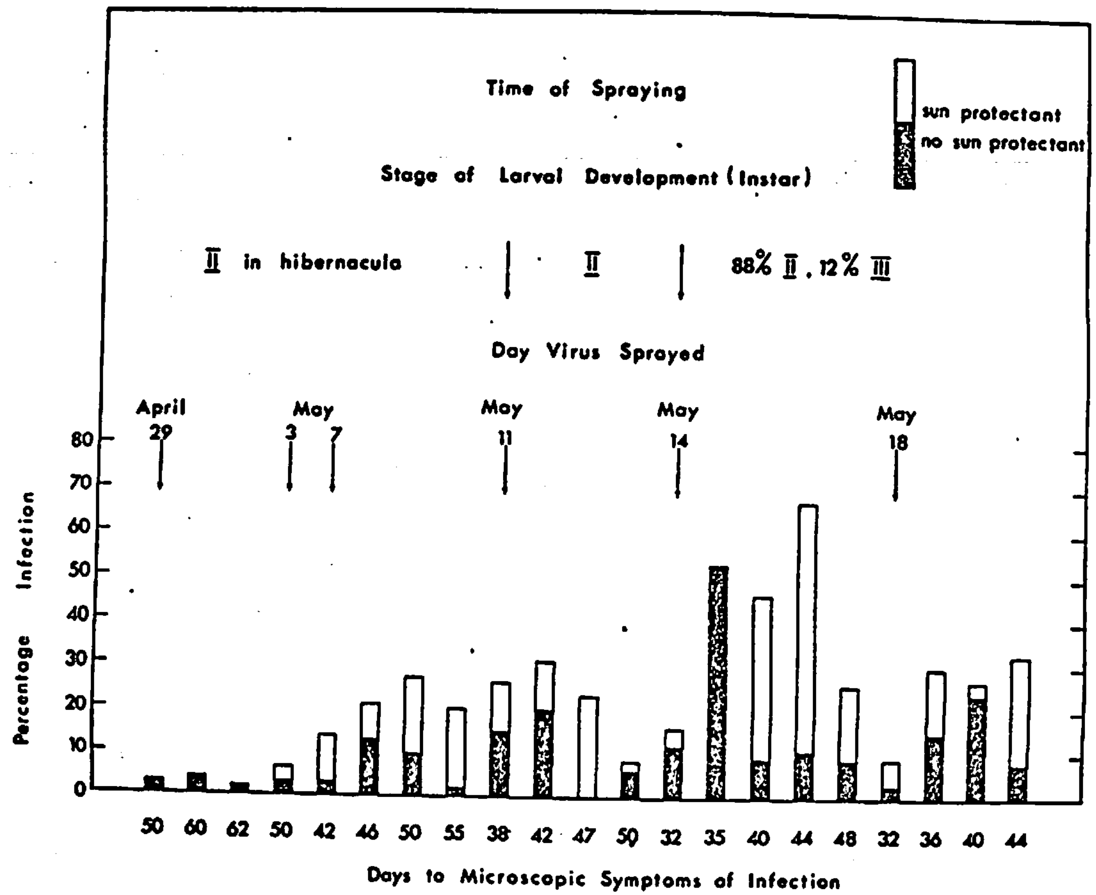

Time of Spraying
Stage of Larval Development (Instar)
II in hibernacula
II
88% II, 12% III
65% II 35% III
14% II 75% III 11% IV
3% II 72% III 25% IV
8% III 18% IV 70% V 4% VI
Day Virus Sprayed
April 29
May 3 7
May 11
May 14
May 18
May 21
May 26
June 2
June 6
Percentage Infection
80
70
60
50
40
30
20
10
0
50 60 62 50 42 46 50 38 42 50 32 35 40 44 48 32 36 40 44 24 41 27 32 25 29 24 24
Days to Microscopic Symptoms of Infection

Fig. 1.



Time of Spraying
sun protectant
no sun protectant
Stage of Larval Development (Instar)
II in hibernacula
II
88% II, 12% III
Day Virus Sprayed
April 29
May 3 7
May 11
May 14
May 18
Percentage Infection
0
10
20
30
40
50
60
70
80
50 60 62 50 42 46 50 55 38 42 47 50 32 35 40 44 48 32 36 40 44
Days to Microscopic Symptoms of Infection

Fig. 2.

AERIAL APPLICATION OF VIRUS AGAINST SPRUCE BUDWORM - 1971

MORTALITY STUDIES

Details of the experimental design of mortality studies carried out as part of the assessment of the effects of aerial applications of NPV and Y virus are described in the original proposal summarized by G. W. Green and T. A. Angus, January 22/71 and a subsequent memorandum by G. W. Green, May 11/71 that described changes in the original proposal.

Results, of analyses completed at the present time, are contained in Table I - Population Reduction, Table II - Defoliation and Table III - Pupal Survival. Population reduction percentages in Table I are based on emerged pupal counts and include any differential effects of virus treatments on pupal survival as evidenced in Table III.

The outstanding features of the data are:

1. Both NPV and Y virus, at the concentrations used, are capable of causing significant population reduction of spruce budworm on wS.

2. These population reductions on wS show a direct relationship to the concentration applied, with the exception of Plot C.

3. The general lack of population reduction on bF is both surprising and unexplainable.

4. There is little correlation between population reduction and infectivity for the second Y virus application but relatively good correlation exists for the first application of Y virus and the NPV applications (See reports by Dr. Bird and Dr. Cunningham).

5. It would appear that of the two application times tested, both viruses are more effective when applied to peak of IV instar.

6. There is no significant preservation of foliage by NPV on wS or Y virus on either wS (except perhaps in Plot C) or bF.

7. The pattern of pupal survival in the Y virus plots is related to the concentration of virus used.

Other analyses are being carried out. For example, an analysis examining the relationship between the per cent population reduction and spray coverage (in terms of droplets per $cm.^2$) shows that 5 drops of spray per $cm.^2$ are just as effective as more than 20 drops per $cm.^2$. Lower effective coverage permits economies in application rates and/or concentrations.

Another analysis that examined the relationship between % population reduction and prespray larval density showed that the effective kill increased in direct proportion with the larval density to a point where competition or starvation became the dominant factor and the effect due to virus declined.

This implies, however, that up to a certain level (about 80 or more V instar larvae per 18" tip on wS) the virus becomes an increasingly more effective killing agent. This increase in effectiveness occurs at population levels that most commonly occur in the field, i.e. from 20 to 80 V instar budworm larvae per 18" tip on wS.

CONCLUSIONS (on the basis of 1971 tests)

1. Significant numbers of budworm can be killed on wS by NPV and Y virus.

2. NPV cannot save wS foliage and Y virus cannot save wS or bF foliage.

Statement prepared for the
Interdepartmental Committee
on Forest Spraying Operations

November 9, 1971

G. M. Howse

Table 1

RESULTS OF MORTALITY STUDIES - Y-VIRUS - ACHRAY

Application date	Concentration	Application rate (theoretical)	Plot	Average number of droplets per cm² wS	bF	% population reduction due to treatment wS	bF
May 15/71 - pm (95% II instar 5% III instar)	10 gm/gal.	3 gal./ac	C	6.1	4.0	40	0
	1 gm/gal.	3 gal./ac.	D	5.0	3.3	61	0
	.1 gm/gal.	3 gal./ac.	E	5.5	4.1	25	0
May 31/71 - am (peak of IV instar - some III's and V's present)	10 gm/gal.	3 gal./ac.	A	12.3	13.6	79	30
	1 gm/gal.	3 gal./ac.	B	17.5	11.9	57	48
	.1 gm/gal.	3 gal./ac.	F	6.9	6.4	48	0

RESULTS OF MORTALITY STUDIES - NPV - DELUTHIER ROAD

Application date	Concentration	Application rate	Plot			% population reduction	
May 16/71 - pm	25 gm/gal.	3 gal./ac.	1			69	
May 29/71 - pm	25 gm/gal.	3 gal./ac.	2			80	

November 9, 1971

G. M. Howse

Table 2

DEFOLIATION

Achray - Y-virus		% defoliation of 1971 foliage wS	bF
Plot	C	59	87
	D	93	92
	E	87	96
	A	74	94
	B	88	99
	F	93	94
Controls	1	90	95
	2	72	94
	3	96	60

Deluthier Road - NPV		
Plot	1	99
	2	96
Controls	By-Pass	99
	Race Horse	86

November 9, 1971

G. M. Howse

Table 3

PUPAL SURVIVAL

		% successful pupal emergence[1]	
Achray - Y-virus		wS	bF
Plot	C	59.0	73.4
	D	72.2	70.8
	E	82.1	76.8
	A	72.6	64.6
	B	70.8	56.6
	F	83.6	66.1
Controls	1	82.2	76.8
	2	83.2	78.5
	3	79.9	70.0
Deluthier Road - NPV			
Plot	1	67.7	
	2	80.8	
Controls (PFES)			
By Pass Road		82.5	
Racehorse Road		84.0	

1 % successful pupal emergence = $\frac{\text{emerged budworm}}{\text{living budworm}} \times 100$

Living budworm - on date of sample collection

November 9, 1971

G. M. Howse

VIRUS FIELD APPLICATION - DEBILITATION STUDIES

1. General

A. Sampling

(i) Y-Virus White spruce foliage containing late-instar larvae was collected from Achray on June 11, 1971. The plots sampled were Plot C (1st application at highest rate), Plot A (2nd application at highest rate), Control 2, located between Plots B and C. All samples were of 18" branch tips collected in a basket mounted on a pole-pruner.

The foliage was taken to Sault Ste. Marie the following day in paper bags and kept at 42°F until examination and pick-off on June 14 and 15.

At the time of collection it was noted that the damage caused by the feeding budworm was less intensive near the tops of the trees. To document this, samples were taken from 4 crown levels. At each level (1 highest, 4 lowest) 2 branch-tips were taken, 4 trees were sampled in Plots A and C, 2 in the Control. This intensity of sampling was too low to detect possible differences among the plots, but collectively the pattern was as follows:

Crown Level	Budworm Distribution (%)	Damaged Buds (% Total Buds)
1	24	33
2	35	51
3	25	79
4	16	88

Thus, although most budworm were found in level 2, followed by 1 and 3, damage was highest at the lower levels, leaving the trees with green apices.

(ii) NPV Foliage was collected on June 12, using hand clippers from the 1st application NPV plot. It was taken direct to Sault Ste. Marie where it was stored at 42°F until pick-off on June 15 and 16. No collections were made from the 2nd application plot, nor from an unsprayed area in the vicinity.

2. Rearing

At the time of pick-off, 83% of the insects from Achray were VI-instar. Development in the NPV plot was slower, but many of the earlier instar larvae subsequently proved to be parasitised.

All living larvae were placed on artificial-medium, 3 larvae per creamer-cup. Cups were checked daily. The following information was recorded: Date of pupation, sex, pupal weight, date of emergence.

Dead larvae and pupae were kept, and parasites were identified as they emerged.

After successful emergence, adult male and female budworm from the same plot were placed together in pairs in 8 oz. jars, with balsam fir foliage for mating and oviposition. After 10 days the eggs were counted and placed in petri dishes with gauze for larval spin-up. The following data were recorded: female weight, number of eggs laid, success of mating (i.e., whether or not eggs hatched). II-instar larvae from successful matings will be kept at 32°F after spin-up to satisfy diapause requirements.

3. Results

A. Larval survival to pupation

The relevant data is summarised in the following table:

	Y-Virus Plots			
	Control	A	C	NPV
Total number collected	360	995	941	682
% pupating	75	68	64	30
% parasitised	10	7	8	51
% other mortality	15	25	28	19

(i) Parasitism Rates of parasitism among the 3 Y-virus plots were not significantly different, and of a total of 94 parasites reared, 76 were

Trial of Water Mist Protection of Logs from Ambrosia Beetle Attack

J. A. Chapman
Canadian Forestry Service
Victoria, B. C.

In 1971 the Council of Forest Industries of British Columbia carried out a test of water spray protection of stored logs from attack by the ambrosia beetle _Trypodendron lineatum_, as an alternative to treatment with insecticides. The experiment was conducted at B. C. Forest Products Ltd. dry land sorting and storage area, Port Renfrew, B. C. A hydraulic system was used to apply water as a fine mist to avoid problems associated with excessive water and heavy machinery, and to determine the feasibility of the system in areas with limited water supplies. A high pressure system was employed using nozzles designed for agricultural crop frost protection by misting. The operational trial was made to determine costs and reliability of the system and was conducted by H. A. Richmond and B. C. Forest Products Ltd. staff. The Canadian Forestry Service made the biological assessment.

Four large decks of unsorted logs, mostly Douglas-fir and hemlock, cut in winter and susceptible to spring attack were used, with two small unsprayed piles of similar logs as controls. In addition, small log billets were added to both wet and dry piles. An adjacent fifth deck of stored logs was wet along one edge, providing an unplanned but useful control situation in which individual logs were wet at one end and dry at the other.

Tidal water from a well screened intake was used. Water was applied from early April (before flights began) to August 27, when flights had ceased. The system was operated continually, night and day and through cool, rainy weather, to assure a good test of its functioning. The logs soon became thoroughly wet, from mist and drip, regardless of their position in the decks. Wind blew the mist readily but not long enough at any time to allow drying of the logs. Only occasional clogging of nozzles occurred, and other shut-downs were infrequent and brief.

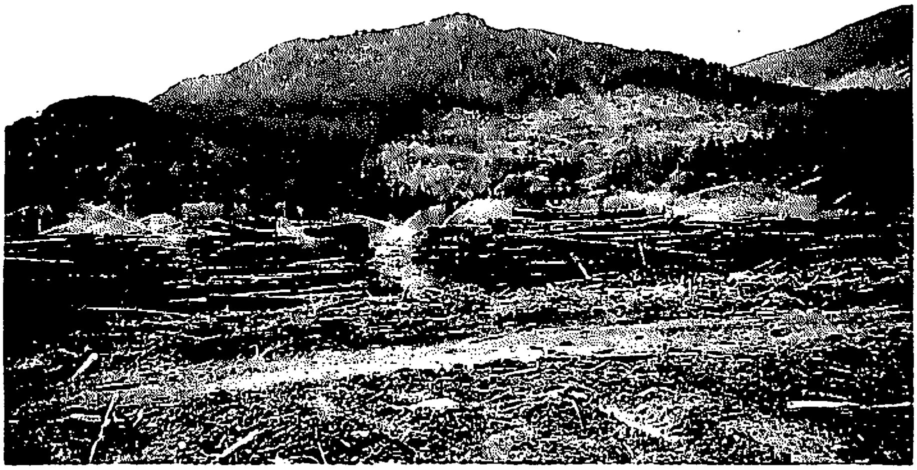
Attack flights of the beetles were monitored during the test, using traps and secondary attraction sources (screened logs plus female beetles). Three of these single log sources took a total of 11,167 beetles during the season, indicating the potential for a "dead-trap" system that could be set up around a log storage area if a synthetic attractant for _Trypodendron_ becomes available. Traps were also placed in wet and dry piles of logs. Careful observations were made in and around the wet and dry decks on several days of beetle flight. Beetles were seen flying into the decks and found crawling on the wet logs in numbers up to several per square foot, but none attacked the logs.

Prepared for Interdepartmental Committee on Forest Spraying Operations, November 22, 1971.

At the end of the test, logs from upper, mid and under portions of the wet decks, and from the control piles, were examined for beetle attacks (553 square-foot samples from wet logs and 159 from control logs). In addition, the small wet and dry billets were peeled and examined, and many square-foot samples were taken from wet and dry ends of logs from the partially wet deck, and along the axis of some of these logs.

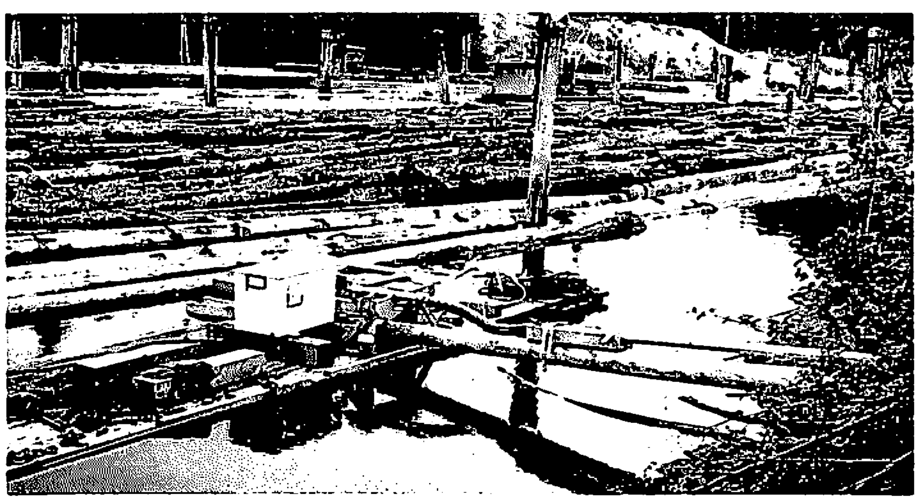
Control logs, and dry log ends and billets had appreciable numbers of attacks (to several per square foot), but the only holes found in wet logs were obviously (from gallery staining, lack of brood and general log appearance) the result of attacks on older logs before their transport to the storage area. There were no fresh attacks on wet logs, or wet ends of logs.

The water application resulted in complete protection of the logs from ambrosia beetle attack.



Four log decks (bays) being sprayed with water. Note nearby forest.

Spray nozzle array along one edge of test site.



Pump on raft, showing coupling to allow for tidal movement.

STATUS OF BLACK-HEADED BUDWORM INFESTATIONS ON VANCOUVER ISLAND, 1971[1]

A. C. Molnar
Canadian Forestry Service
Victoria, B.C.

The current black-headed budworm, Acleris gloverana (Walsingham), epidemic was initiated by a marked rise in population levels of the insect in 1969. By 1971 visible defoliation covered 2,500 acres, largely in the Green Mountain - Cottonwood Creek areas of Lower Vancouver Island. Aerial surveys in 1971 revealed a spectacular increase of defoliated hemlock and amabilis fir on 160,000 acres in three zones including the Jordan River, Cowichan - Nanaimo Lakes and Port Alice areas (see map). Of this total, 80,000 acres was classified as moderately to severely defoliated, within which further heavy defoliation could lead to severe growth loss and mortality.

Egg surveys in the fall indicated continued active budworm populations throughout the infestation although damage levels were projected to increase in some drainages and decrease in others. Based on a combination of current damage and projected population levels, three drainages, one in the Port Alice area and two in the Jordan River area, involving approximately 4,200 acres, are considered potentially subject to severe growth impact, and light mortality may occur. An additional seven drainages will sustain moderate growth loss and leader dieback if projected infestation levels materialize.

There was little indication in 1971 sampling that biological control factors will play an early role in controlling the epidemic, although up to 50% parasitism of pupae was noted in three samples from an older portion of the infestation. There was no indication of appreciable incidence of disease.

Large-scale infestations in the past have lasted up to five years but successive defoliation of specific areas has not been recorded beyond three years.

The outbreaks have usually collapsed rapidly in the third or fourth year of high population densities. The decline is usually attributed to weather, parasitism and occasionally a virus epizootic.

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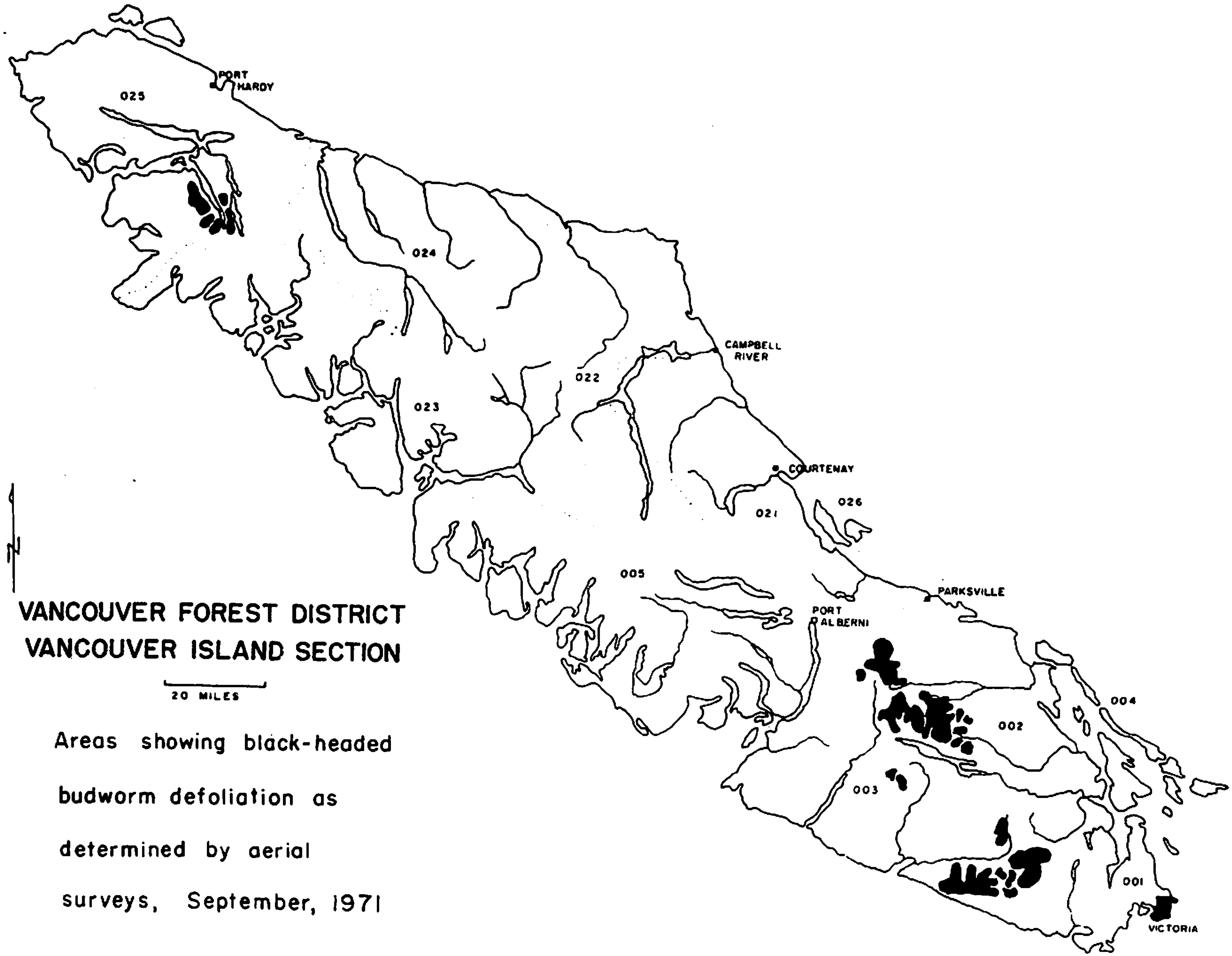
[1] Prepared for meeting of Interdepartmental Committee on Forest Spraying Operations, November 22, 1971.

Areas potentially subject to
severe growth impact and light tree mortality

	Acres
Clapp Creek	3,570
Loss Creek	115
S. Port Alice pulpmill	525
Total	4,211



VANCOUVER FOREST DISTRICT
VANCOUVER ISLAND SECTION

Areas showing black-headed budworm defoliation as determined by aerial surveys, September, 1971

Experimental Aerial Spraying of Seed Production Areas in British Columbia[1]

A. F. Hedlin
Canadian Forestry Service
Victoria, B. C.

MacMillan Bloedel Ltd. has established Douglas-fir seed production areas at different elevations on Vancouver Island to provide seed for reforestation purposes. In 1970, 8 areas (46 acres) were fertilized to stimulate cone production and in 1971 flowering was good. Examination of conelets immediately after pollination showed there was a moderate infestation of cone insects. The cone moth *Barbara colfaxiana* and the midge *Contarinia oregonensis* were the most common. The company decided to prevent or reduce losses to insects, and because of the rough terrain and difficult access they decided that application of insecticide would be most practical if done by helicopter.

It was proposed to apply recommended ground application rates[2] using a helicopter but the Chemical Control Research Institute, Ottawa, advised that dimethoate applied at a rate above 8 oz. active ingredient per acre would cause bird mortality. The proposed project was reviewed by the B. C. Interdepartmental Committee on Pesticides in consultation with the Canadian Forestry Service. The Committee approved a proposal that the operation be conducted on an experimental basis using dimethoate emulsifiable concentrate at a basic rate of 8 oz. per acre, including rates of 4 and 12 oz. per acre to portions of the area. Plots were divided and applications made from a minimum of 4 to a maximum of 148 oz. (approved by Committee on restricted area) per acre.

Sprays were applied on May 13, 14 and 15. The application for each plot was calculated on the basis of the number of trees per plot and the dosage of active ingredient per acre with the intention of treating each tree separately. In practice the plots were treated continuously and many trees probably received lighter than nominal dosages because of large distances between trees in some plots. Spray deposits were not monitored.

Prior to spraying, cones on one branch on each of 10 trees in each treatment area were isolated in a plastic bag. Bags were removed following treatment and the cones used as checks later in the season.

1/ Prepared for meeting of Interdepartmental Committee on Spraying Operations, November 22, 1971.

2/ Johnson, N. E. and A. F. Hedlin. 1967. Douglas-fir cone insects and their control. Canada Dept. Forestry and Rural Development, Forestry Branch, Publication No. 1168.

Cone samples were taken from 10 trees in each treatment area. Treated cones and cones isolated at time of spraying (checks) were examined for seed production and insect-caused losses. Infestation of cones ranged from light to fairly heavy. The Douglas-fir cone moth, Barbara colfaxiana was the most important seed-destroying insect but losses were not high. Insecticide applications had little, if any, effect at even the maximum dosage. Insects had fed normally throughout the summer and were living in August and September when cones were examined. Preliminary examination of data shows no difference between treatments in this experiment.

In view of the increasing demand to protect seed production areas from attack by seed and cone insects, further work should be conducted to determine appropriate application rates from a helicopter. It may be necessary to apply heavier dosages to these restricted areas than in conventional forest spraying operations.

WHITE PINE WEEVIL AERIAL SPRAYING OPERATIONS ONTARIO, 1971

by

G. M. Howse and W. L. Sippell
Canadian Forestry Service
Great Lakes Forest Research Centre
Sault Ste. Marie, Ontario

Introduction

In 1969 and 1970, aerial spraying operations were carried out in Ontario for the purpose of protecting white pine plantations from attack by the white pine weevil. Methoxychlor, applied at a rate of 2 pounds per acre in 1969 and 2-1/2 pounds per acre in 1970, provided limited protection achieving a maximum reduction of 74% in the incidence of weevilling in 1970. Based on the results of the 1969 and 1970 operations, it was concluded that Methoxychlor as presently formulated and applied was not capable of reducing weevil populations to a satisfactory level, unless application rates could be increased higher than 2-1/2 pounds per acre.

In 1971, the Canadian Forestry Service was asked by the Ontario Department of Lands and Forests to participate in an aerial spraying operation planned for the Sault Ste. Marie District. Our involvement was to be similar to that of 1969 and 1970, i.e., measuring weevil damage levels prior to spraying, timing of spraying and assessing the results. Two different areas were involved, namely, one plantation totalling 460 acres in the Kirkwood Management Unit located east of Sault Ste. Marie and 1,000 acres of plantation in Township 2A near Mount Lake north of Blind River.

It was decided to use Methoxychlor at 3 pounds per acre because: (1) There were no suitable alternative insecticides available and, (2) because it had been recommended that if Methoxychlor were used, then the dosage applied should be greater than 2-1/2 pounds per acre.

The 1971 Operation

Pre-Spray Infestation Levels

The incidence of weevilling in plantations to be sprayed in 1971 had been determined by special surveys conducted by Canadian Forestry Service personnel in August, 1970.

The Spraying Operation

The timing of the start of spraying was determined by observations of weevil emergence, abundance of weevil adults in the field and heat accumulation. The 460 acres in Rose Township were sprayed on May 10 and 11 and the 1,000 acres in Township 2A were sprayed on May 13 and 14. All applications were made by a S-Agcat aircraft supplied by General Airspray, St. Thomas, Ontario. All applications consisted of Methoxychlor at a rate of 3 pounds EC in 2.0 gallons of water per acre.

Spray card coverage showed that, in general, spray deposit was satisfactory. The effectiveness of the spraying was evaluated by determining the incidence of weevilling in the sprayed areas after spraying and comparing this with the population abundance before and after spraying in unsprayed areas. The results appear in Table I.

Table I

Incidence of weevilling in sprayed and unsprayed areas in the Kirkwood Management Unit and at Mount Lake before and after spraying

	Per cent of trees weevilled	
	Pre-spray (1970)	Post-spray (1971)
Sprayed areas, Kirkwood (460 acres)	11.9	5.7
Mount Lake (1000 acres)	27.5	11.5
Unsprayed areas collectively	37.3	37.0

Thus, the level of weevilling remained the same from 1970 to 1971 in unsprayed areas, but in sprayed areas was reduced from 11.9% to 5.7% in Kirkwood and 27.5% to 11.5% at Mount Lake. These reductions of 52 and 58% respectively, or 56% overall, are attributable to the spraying.

Forecasts for 1972

It is expected that white pine plantations not exceeding a total of 2,000 acres will require protection from white pine weevil in 1972 in the Sault Ste. Marie District.

Conclusions

A summary of results of white pine weevil spraying operations using Methoxychlor for the past three years in Ontario is presented in Table II.

Table II

Year	Rate of application	% Reduction in incidence of weevilling	Incidence of weevilling in sprayed areas after spraying
1969	2 pounds per acre	67	5.2%
1970	2½ " "	74	7.7%
1971	3 " "	56	8.6%

The reason for the reduced level of control in 1971 is not clear but may be related to the weather conditions that prevailed from May 10 - 20/71. Rain, in the form of drizzles, showers, steady downpours and thundershowers occurred commonly in this time period and could have been a factor in reducing the effectiveness of the spray applications by removing residual spray deposit from the leaders of white pine trees.

The overall incidence of weevilling after spraying in sprayed areas has continued to increase each year, in spite of spraying.

The 1971 results merely confirm earlier conclusions; that, Methoxychlor as presently formulated is not a satisfactory insecticide for white pine weevil control even at the rate of 3 pounds per acre.

Report Prepared for the Interdepartmental Committee on Forest Spraying Operations

November 3, 1971

APPENDIX 22

EXPERIMENTAL APPLICATIONS OF INSECTICIDES BY HYDRAULIC SPRAYER FOR CONTROL OF WHITE-PINE WEEVIL IN ONTARIO

Reference CCRI Project CC-012

by

R. F. DeBoo

Chemical Control Research Institute

Canadian Forestry Service

Department of the Environment

Experimental applications of insecticides by hydraulic sprayer for control of white-pine weevil in Ontario.

Chemical Control Research Institute - Project No. CC-012

by

R. F. DeBoo

Four insecticides and two spray adjuvants were applied experimentally in various combinations to young white-pine plantations to determine their efficacy in controlling severe infestations of the white-pine weevil (Pissodes strobi Peck.). The program was initiated after consultation with staff of the Great Lakes Forest Research Centre and the Ontario Department of Lands and Forests to:

(1) determine the efficacy of methoxychlor by ground sprayer applications using aircraft dosages (2 lb/acre) but conventional hydraulic sprayer volumes (approximately 100 gal/acre).

(2) determine the importance of timing and coverage of spring applications of short-residue insecticides.

(3) determine the efficacy of two insecticides, Dursban® and Gardona®, previously screened in laboratory toxicology studies at this Institute (Nigam, this report), but not used in field trials for control of adult weevils.

A total of 27 plots, each approximately 0.4 acre in size, were established in plantations near Orr Lake, 14 miles northwest of Barrie, Ontario. Applications were made May 8-14 (prior to the peak of adult activity), and again on May 27 (post-peak treatments) as outlined in Table I. The randomized complete block design was used for plot-treatment assignment; lindane was selected as the standard treatment. Assessments of pre- and post-treatment weevil populations were based on the occurrence of infested leaders.

More detailed information on materials, methods, treatment plots, meteorological conditions during applications, etc., is found in Canadian Forestry Service Information Report CC-X-11.

The results (Table I) indicate that ground applications of methoxychlor with hydraulic equipment will provide good control of the white-pine weevil when applied prior to adult feeding and oviposition during late April or early May. Not more than 2 lbs/acre is required to obtain population reduction levels in the range of 90-100%. Two applications, spaced at 10-14 day intervals provide better control than a single application, and good coverage of spray to the leader is a prerequisite to any successful application. Late applications will give only mediocre to poor control.

Very dilute hydraulic sprayer applications of Gardona® and Dursban® (0.5 lb/acre) provided good protection of leaders. Slightly more concentrated spray mixtures of either insecticide and/or the addition of a good extender-spreader-sticker should provide control at levels similar to those attained with methoxychlor treatments.

T A B L E III. Results of spray trials for control of the white-pine weevil at Orr Lake, 1971.

	Treatment	Total Dosage Act. ingr. (lb.) acre[1]	No. Applic.	No. Trees	1970 No. Weeviled	1970 %	1971 No. Weeviled	1971 %	Infestation Change (Reduction %)[2] Between years (70-71)	Infestation Change (Reduction %)[2] Between trtmts. +CK (71)
	EXPERIMENT 1									
I	Methoxychlor EC	2.0	1	666	169	25	17	3	90**	91**
II	Methoxychlor WP	2.0	1	732	143	20	15	2	90**	92**
III	Lindane WP	1.0	1	700	169	24	73	10	57**	63**
IV	Lindane WP/Target E	1.0	1	740	193	26	33	4	83**	83**
V	Gardona EC	0.5	1	695	152	22	45	6	70**	77**
VI	Gardona EC	1.0	2	672	162	24	7	1	96**	96**
VII	Dursban EC	0.5	1	733	210	29	81	11	61**	59**
VIII	Dursban EC/Target E	0.5	1	651	174	27	85	13	51**	57**
IX	Dursban EC/Pinolene	0.5	1	626	163	26	42	7	74**	79**
X	Untreated Check	-	-	680	193	28	198	29	(+)3 n.s.	-
	EXPERIMENT 2									
XI	Methoxychlor EC	2.0	1	100	48	48	2	2	96**	96**
XII	Methoxychlor EC	2.0	1(late)	100	40	40	9	9	78**	80**
XIII	Methoxychlor EC	4.0	2	100	59	59	0	0	100**	100**
XIV	Methoxychlor WP/ Target E	2.0	1	100	47	47	9	9	81**	80**
XV	Methoxychlor WP/ Target E	2.0	1(late)	100	45	45	20	20	56**	57**
XVI	Methoxychlor WP/ Target E	4.0	2	100	42	42	5	5	88**	89**
XVII	Untreated Check	-	-	100	62	62	46	46	26	-

1. Target E @ 4 gal.; Pinolene @ 0.2 gal.
2. As expressed by number of weeviled leaders (%)
   ** difference significant at 1% level
   n.s. difference not significant

THE JACK-PINE BUDWORM SITUATION IN ONTARIO IN 1971 RELATIVE TO FOREST SPRAYING IN 1972

by

G. M. Howse and W. L. Sippell
Canadian Forestry Service
Great Lakes Forest Research Centre
Sault Ste. Marie, Ontario

Introduction

No aerial spraying operations were carried out against the jack-pine budworm in 1971. This statement has been prepared to describe the infestation status of jack-pine budworm in central Ontario in 1971, to provide forecasts of infestation levels for 1972 and to point out situations which could call for chemical treatment in 1972.

The Situation in 1971

In the fall of 1970, a probable need for forest spraying was recognized in a 7,500-acre stand of jack pine which had been severely damaged for two years, near Illfed Lake in the Parry Sound District. However, in the fall of 1970, the infestation potential for 1971 was not well defined owing largely to the inaccessibility of the area. This situation was overcome by a special egg-mass survey in February, 1971 using snow machines to gain access to the area and to obtain foliage collections. The results of this special survey indicated a low damage potential for 1971 and no clearly defined need for spraying. Aerial and ground checks by FIDS personnel in July, 1971 revealed a shift of infestation with a few pockets of defoliation evident.

Elsewhere in the Parry Sound District, jack-pine budworm infestations failed to subside as they did in several other districts. Excellent survival conditions for the past two years and/or shifts of populations have resulted in a continuance of infestation in the northwestern part of the Parry Sound District. Most of the jack pine stands between Georgian Bay and Highway 69, within an area of about 300 square miles, have either been killed as the result of previous budworm attack, or were infested in 1971. The infestation crosses Highway 69, and extends eastward, and northward into the Sudbury District. Elsewhere in the Parry Sound, Sudbury, North Bay and Sault Ste. Marie districts where infestations have occurred over the past few years, feeding damage was not evident.

In the Pembroke District, pockets of moderate to severe defoliation were recorded at Lake Traverse, and infestations were detected in seven other townships. Salvage operations removing dead, dying and top-killed jack pine from the 1968-1969 infestation areas at Lake Traverse and the Petawawa Plains (CFB Petawawa) were started in June, 1971.

Forecasts for 1972

At the time of writing, egg-mass surveys were incomplete. However, from available counts, and numbers of unexpected infestations in 1971, it seems reasonable to forecast that damaging jack pine budworm infestations will persist in 1972.

Spraying Operations in 1972

Several spraying operations are being considered for 1972 in the Pembroke and Parry Sound districts.

(a) In the Pembroke District, an infestation in a 2,500-acre stand of semi-mature jack pine in the Montgomery Flats straddling the Algonquin Park-Petawawa Forest Experiment Station boundary is causing concern to both the Ontario Department of Lands and Forests and the Canadian Forestry Service. The western portion of the stand has had considerable stand improvement over the last two years. The eastern portion is being used by the Petawawa Forest Experiment Station for research purposes. Normally a stand of this type could withstand another year of defoliation without permanent injury. However, in view of extremely severe damage after only two years of heavy infestation in nearby jack pine stands at Lake Traverse and Petawawa Plains, we are recommending that the stand be treated next year. Based on egg-mass counts a potential now exists for damage ranging between moderate to severe in 1972.

(b) Young, previously undamaged stands of jack pine on the edge of the Lake Traverse outbreak in White Township were lightly or moderately infested in 1971. Improvement work in these stands has been delayed in face of the presence of the jack pine budworm. Protection spraying in 1972 is being considered.

(c) In the Parry Sound District, widespread damage throughout the northwest part of the district has prompted the provincial department to consider aerial spraying of only high value areas in 1972, particularly along Highway 69.

Discussions involving the G.L.F.R.C. and provincial officials are contemplated to develop appropriate strategies to deal with each situation.

Statement prepared for the Interdepartmental Committee on Forest Spraying Operations.

November 10, 1971

GOUVERNEMENT
DU QUÉBEC
MINISTÈRE
DES TERRES
ET FORÊTS
DIRECTION
GÉNÉRALE
DE LA
CONSERVATION
HÔTEL DU GOUVERNEMENT
QUÉBEC

RAPPORT PRELIMINAIRE DE LA SITUATION DE L'ARPENTEUSE DE LA PRUCHE DANS L'EST DU QUEBEC

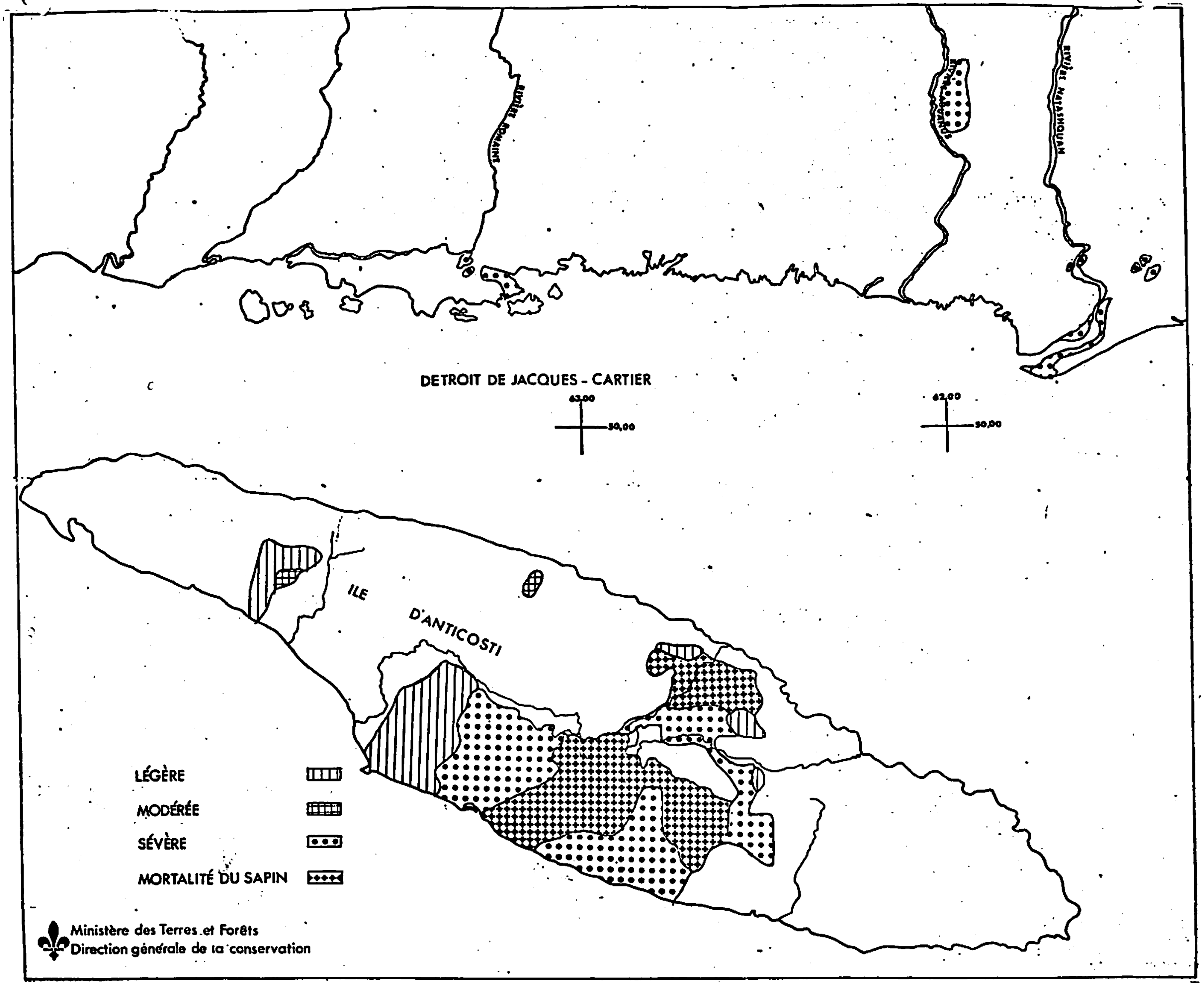
Réal Desaulniers, ing.f.

Une épidémie de l'arpenteuse de la pruche sévissant sur l'Ile d'Anticosti a été décelée vers la mi-juillet par le personnel affecté à la détection aérienne des incendies forestiers. Des inventaires aériens et terrestres ont été exécutés en août et septembre sur l'Ile d'Anticosti ainsi que sur la moyenne Côte-Nord du St-Laurent face à l'Ile.

L'inventaire aérien réalisé sur l'Ile d'Anticosti a permis de déceler des défoliations sur une superficie totale de 5~~9~~45,220 acres. La mortalité des arbres est apparue sur une superficie de 193,710 acres alors que la défoliation est sévère sur une superficie de 224,920 acres, modérée sur une superficie de 7,260 acres et légère sur une superficie de 114,330 acres. La carte ci-jointe indique également que des défoliations sévères ont été enregistrées sur une superficie de 39,800 acres sur la rive nord du St-Laurent aux environs de Havre St-Pierre et dans le bassin des rivières Aguanus et Natashquan.

Les résultats des inventaires terrestres indiquent que l'insecte était présent dans chacun des secteurs visités.

Des opérations d'arrosages aériens sont présentement à l'étude en vue de contrer la progression de cet insecte dans les deux secteurs infestés.



Infestation de l'arpenteuse de la pruche dans l'est du Québec en 1971