32798

REPORT OF MEETING OF THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

West Memorial Building, Wellington St., Ottawa

October 29, 1970.

In Attendance:

<u>Members of the Committee</u>

J.A. Keith	Canadian Wildlife Service, Ottawa
J.M. Anderson	Fisheries Research Board, St. Andrews, N.B. (Substituting for C.J. Kerswill)
M.L. Prebble (Chairman)	Canadian Forestry Service, Department of Fisheries and Forestry, Ottawa.

<u>Others</u>

G.L. Warren	Canadian Forestry Service, Dept. of Fisheries and Forestry, St. John's, Nfld.
R.C. Clark	Canadian Forestry Service, Dept. of Fisheries and Forestry, St. John's, Nfld.
S.G. Pond	Fisheries Service, Dept. of Fisheries and Forestry, St. John's, Nfld.
G.H. Penney	Fisheries Service, Dept. of Fisheries and Forestry, Halifax
J.R. MacDonald	Fisheries Service, Dept. of Fisheries and Forestry, Halifax
P.A. Pearce	Canadian Wildlife Service, Fredericton
M.M. Neilson	Canadian Forestry Service, Dept. of Fisheries and Forestry, Fredericton
E.G. Kettela	Canadian Forestry Service, Dept. of Fisheries and Forestry, Fredericton
B.W. Flieger	Forest Protection Limited, Campbellton
K.B. Brown	Forest Protection Limited, and Dept. of Natural Resources of N.B., Fredericton
J.R. Blais	Canadian Forestry Service, Dept. of Fisheries and Forestry, Quebec
R. Martineau	Canadian Forestry Service, Dept. of Fisheries and Forestry, Quebec
G. Paquet	Dept. of Lands and Forests, Quebec
R. Desaulniers	Dept. of Lands and Forests, Quebec
H.J. Irving	representing Dept. of Lands and Forests,Quebec
T. McCarthy	Dept. National Health and Welfare, Ottawa
W.A. Reeks	Canadian Forestry Service, Dept. of Fisheries and Forestry, Ottawa
J.J. Fettes	Canadian Forestry Service, Dept. of Fisheries and Forestry, Ottawa
J.M. Cameron	Canadian Forestry Service, Dept. of Fisheries and Forestry, Sault Ste. Marie

G.M. Howse	Canadian Forestry Service, Dept. of Fisheries and Forestry, Sault Ste. Marie
W.L. Sippell	Canadian Forestry Service, Dept. of Fisheries and Forestry, Sault Ste. Marie
K.B. Turner	Ontario Dept. of Lands and Forests, Toronto
H.A. Richmond	Council of Forest Industries, B.C., Vancouver
D.R. Macdonald	Canadian Forestry Service, Dept. of Fisheries and Forestry, Victoria
Mrs. M.K. Pearson	Canadian Forestry Service, Dept. of Fisheries and Forestry, Ottawa
Mrs. M.G. Bradley	Canadian Forestry Service, Dept. of Fisheries and Forestry, Ottawa

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1. The Chairman circulated copies of an agenda, as follows:

   1. Introduction
   2. Ambrosia beetles, B.C.
   3. Green-striped looper, B.C.
   4. Hemlock looper, Newfoundland
   5. White pine weevil, Ontario
   6. Leconte's sawfly, Quebec
   7. Balsam woolly aphid
   8. Jack pine budworm, Quebec
   9. Jack pine budworm, Ontario
   10. Spruce budworm, New Brunswick
   11. Spruce budworm, Quebec
   12. Spruce budworm, Ontario
   13. Other problems

The Chairman expressed the desirability of adhering to the following sequence of points for discussion under each problem area where relevant. The discussion on hazards to humans, relating to the New Brunswick spray program, was moved up to accommodate Dr. McCarthy.

Experimental studies with insecticides 1970
Experimental studies with pathogens 1970
Operational control projects 1970
Hazards to humans
Hazards to fish and other aquatic life
Hazards to wildlife
Studies of insecticide residues
Infestation status, fall of 1970, and areas of hazard for 1971
Proposals for definitive spray programs - 1971

2. Ambrosia Beetles, B.C.

Experimental Studies with Insecticides, 1970.- Fettes referred to experimental laboratory studies by Nigam using the most promising insecticides for controlling ambrosia beetles. Similar laboratory trials by C.C.R.I. in 1969 led to field trials by Ilnytzky at Cowichan Lake, B.C., in 1970. Reporting on this work, D.R. Macdonald stated that the insecticides tested were Methyl Trithion, Benzene Hexachloride, Methoxychlor, Monitor, Dursban, and Fenitrothion. The materials were applied to logs on open and shaded sites. Methyl Trithion was the most effective in shade, but it was inferior to Methoxychlor and Dursban in the open. In explaining Table 1 (Appendix 1), Macdonald stated that the treated logs were suspended by a method that permitted spraying the entire surface. The dosage was adjusted to pounds of active insecticide per 43560 sq. ft. or 1 acre of log surface.

Operational Control Projects, 1970.- Richmond noted that these operations were beset with new problems. First, in 1970 the spraying of logs in fresh water was prohibited for health reasons. It is unlikely that clearance to spray logs in fresh water will ever again be allowed. Indeed, even the floating of logs in fresh water may not be tolerated much longer. Early in the season, health and fisheries authorities agreed to the spraying of logs in salt water, but objections of the I.W.A. and tugboat operators' unions delayed operations. By the time these objections were satisfied, it was too late for effective spraying. However, 10 drums of Methyl Trithion were used in spraying operations at Kitimat despite objections of local citizens, but results were poor because of late application.

The objections of the labour unions to spraying seems to be largely emotional. On the other hand, it will not be possible to satisfy the Health Department re fresh-water control operations until we can identify the breakdown products of Methyl Trithion and produce evidence that they are not harmful.

Proposals for Definitive Programs, 1971.- Richmond forecast more land storage of logs, with log protection from beetle attack being provided by a water-fogging system. A similar system will likely be used for logs in water storage. Logistics of the system are now being developed for testing next year. Fogging will extend from dawn to sunset during the critical period. There is increasing recognition of the desirability of prompt manufacture of high-value logs, thereby shortening the period of log exposure to attack.

The Chairman expressed the need for comparing the effectiveness of insecticides and fogging. Because Ethanol is attractive to ambrosia beetles, Macdonald suggested fogging and concurrent use of Ethanol as an attractant on low value or cull logs to absorb some of the beetle population. Ethanol by itself is not sufficiently attractive to preclude the necessity of other forms of control.

3. Green-striped Looper, B.C.

Macdonald noted that this insect is a frequent pest of hemlock stands in British Columbia and the most recent infestation tended to follow the smoke plume from the Port Alice mill. Pupae of this pest are occasionally infected with an ascomycetous fungus (*Cordyceps militaris*). The fungus was artificially cultured in the spring for field testing against the looper outbreak (Appendix 2). It appears that 100% infection in the treated area at Port Alice was the result of artificially spreading the fungus and it is believed that it may have killed some larvae before the normal pupal period.

Discussion brought out the fact that we do not have a recommended available chemical insecticide for this insect, so it is fortunate that the outbreak collapsed in 1970 due to the combined effect of natural factors including avian and mammalian predators and *Cordyceps*. Fettes stated that Zectran will soon be available again and this is very satisfactory against the looper. Although Fenitrothion is reasonably effective, the volume required would be 10 times that of Zectran.

4. Hemlock Looper, Newfoundland

Experimental Studies with Pathogens, 1970.- Cameron reviewed Cunningham's field studies on a nuclear polyhedrosis virus in Newfoundland following small-scale production during the winter of 1969-70 (Appendix 3). Small-scale trials were made on 11 plots, and the approximate dosage emitted by a portable mist blower ranged from 151 to 646 gallons per acre. This dosage is not practicable, and the resulting larval infection of 10 to 45 percent, three weeks after application, is inadequate for control. Additional research is needed on: (a) two types of naturally occurring virus isolated as contaminants in the propagation program; and (b), development of protectants (e.g. India ink) to prevent inactivation of viruses by sunlight (Appendix 3, p.2). Small-scale trials with *Bacillus thuringiensis* were sufficiently promising to warrant additional trials in 1971, with emphasis on mortality in relation to dosage rate and comparative mortality resulting from single and multiple applications (Appendix 3, p.3). One or two species of entomophagous fungi apparently caused some mortality in 1969 and 1970 in western and central Newfoundland.

Cameron reported that a new *B.t.* product Dipel (Abbott Laboratories), is reported to be 5 to 10 times as effective as Thuricide and prices are almost identical.

Infestation Status, fall of 1970, and Areas of Hazard for 1971.- Infestation status of the looper in Newfoundland was discussed by Clark. The infestation started in 1966. About 2,000,000 acres were sprayed in 1969, but no spraying was done in 1970. An estimated 384,000 acres, of which 230,000 acres represent new infestations, were defoliated in 1970, some 136,000 acres less than predicted (Appendix 4, p.1). About 800,000 cords of wood have been harvested from dead stands aggregating some 170,000 acres. Dead trees on 180,000 acres remain to be salvaged, subject to accessibility and value of stands.

There has been no evidence of undesirable side effects of the 1969 operation. It did not perpetuate infestations, and the formulations of Fenitrothion and Phosphamidon used were not followed by any reports of deleterious effect on humans or other mammals. It is believed that deleterious effects on birds and fish were insignificant.

The outbreak will likely continue to weaken in 1971 in most regions. Clark forecast that 230,000 acres defoliated for the first time in 1970 may be severely attacked again in 1971. New outbreaks could conceivably appear in the Baie Verte area (Appendix 4, p.2). Total infestations in 1971 should not exceed 500,000 acres. Fairly high parasitism by native species the second year of looper attack strengthens the likelihood of a general outbreak decline next year (Appendix 4, p.3).

Discussion revealed that there is little evidence that Fenitrothion affected fish populations, although Pond stated that the 1969 operation possibly had some deleterious effects on fish. Fenitrothion was present in a few dead fish, but there is no proof that these were killed by the insecticide. Cameron suggested that death of looper larvae attributed to virus in Newfoundland during an earlier outbreak may actually have been caused by one or both of the two fungi reported in 1970, because external symptoms of virus-killed and fungus-killed larvae are similar.

Martineau reported an infestation of 300 acres near Riviere du Loup and Kettela reported a 100-acre infestation in P.E.I.

Proposals for Definitive Programs, 1971.- The C.F.S. in Newfoundland is not recommending spraying in 1971, but one of the companies may press for spraying part of the 500,000 acres of infestation forecast for next year. Paquet reported that decision regarding the Riviere du Loup infestation will be delayed until the spring of 1971.

5. White Pine Weevil, Ontario

Operational Control Projects, 1970.- Sippell reported on the spraying of 1,050 acres in the Kirkwood area and 1,200 acres north of Blind River in 1970. Methoxychlor was used at a rate of 2½ pounds EC in 2.0 gallons of water per acre. Counts indicated a reduction of 74.2% in new attacks compared with 67.3% in 1969 when a lower rate of application was used (Appendix 5). Methoxychlor is not an entirely satisfactory insecticide as formulated and applied in 1969 and 1970, although the treatments evidently prevented damage increases. The insecticide may be satisfactory at a higher rate of application.

Prebble questioned the wisdom of banning DDT in Ontario for use against the weevil when it is still permitted in tobacco fields. In Ontario, tobacco and rye are grown in rotation. Cutworm populations build up on the former crop and the present culture calls for treating fields with DDT after the rye is harvested and before the tobacco plants are set out. Therefore, as pointed out by Turner, DDT does not come in direct contact with tobacco, and dispersal of the insecticide is minimized by the downward emission of chemical from the nozzles of the sprayers.

In reply to Anderson, Fettes stated that the main differences in the performance of DDT and Methoxychlor are in toxicity and persistence. The latter insecticide is about one-eighth as toxic to insects and one-tenth as persistent. Fettes endorsed Gardona as a satisfactory weevil insecticide, and this was confirmed by Macdonald who stated that this was the best of six insecticides tested against the weevil in B.C.

Proposals for Definitive Programs, 1971.- It is likely that several hundred acres in the Kirkwood management unit will be sprayed in 1971.

6. Leconte's Sawfly, Quebec

Cameron referred to a cooperative demonstration of sawfly control in the St. Jovite area of Quebec. Among the principal cooperators were Paquet and Desaulnier of the Quebec Department of Lands and Forests, and Bird, DeBoo, and other staff of the Canadian Forestry Service. The material used was a nuclear polyhedrosis at four strengths of freeze-dried virus-killed larvae suspended in 1 gallon of water and applied as a mist directed over the young trees. A fifth plot was treated with more purified material (Appendix 6). Control of the insect was virtually complete with a dosage of one-eighth gram or more of virus-killed larvae per gallon. Because *Trichogramma* parasites were largely responsible for terminating infestations in many of the plantations, the demonstration area was much smaller than planned. Consequently, sufficient virus material to spray up to 4,000-5,000 acres is available for use in 1971.

Fettes stressed the need for working out details of concentration and dosage, noting an inverse relationship between larval mortality and distance of the treated trees from the mist blower. He also observed that delayed mortality up to 48 days permitted considerable defoliation and possibly tree mortality before larvae succumbed to treatment. In reply to Anderson, Flieger pointed out that as early as 1952 it was recognized that even 99.8% mortality in an area sprayed with insecticide could be nullified by invasion from surrounding untreated forest.

7. Balsam Woolly Aphid

The aphid in Newfoundland is still spreading, and the hemlock looper killed many balsam fir trees in the older aphid infestations. Thrre has been a resurgence of populations in eastern Nova Scotia because of recent mild winters. The pulp industry is concerned because thinning of stands as a silvicultural operation encourages aphid attack. A resurgence has also been noted in New Brunswick. Infestations in the Province of Quebec are still confined to the tip of the Gaspé. The distribution in B.C. has changed very little, although minor extensions in the southern part of Vancouver Island and the lower mainland are causing concern. The B.C. forest industry is calling a meeting in November (1970) to review the aphid situation.

Macdonald noted that nitrogenous fertilizers inhibit the settling of aphids on fir shoots. Fettes stated that experimental testing of insecticides has been transferred to Newfoundland where, in collaboration with Clark, 20 materials were tested this year, but the results have not been assessed. Baygon is still the most promising insecticide. Prebble posed the question of learning to live with the aphid if forest protection through the use of insecticides is not feasible, and expressed the need for effective controls of the aphid on high-value specimen and park-land trees. He also suggested that the C.F.S. establishment at Victoria and C.C.R.I. should examine the aphid problem in relation to their research priorities.

8. Jack Pine Budworm

Experimental Studies with Pathogens, 1970.- A small test conducted by Angus was described by Cameron (Appendix 7). Xmas trees were sprayed with Thuricide 90 TS and Dipel. Sprayed trees suffered little damage, whereas control trees were heavily damaged. Dipel did not show the five-fold superiority over Thuricide as claimed by the manufacturer. In reply to Richmond, Cameron said *B.t.* is better now than formerly because of improved selection of strains and manufacturing procedures.

Jack Pine Budworm Operational Control Project, Quebec, 1970.- Paquet reviewed Desaulnier's report on the spraying operation in Quebec (Appendix 8). This covered 2,700 acres on the Gatineau River Watershed. The material used was Fenitrothion at a dosage of 3 oz./ac. in 0.15 USG of formulation. A 68% reduction in population was noted four days after the operation, and the low level of 1970 egg populations indicated that additional spraying next year is not necessary.

9. Jack Pine Budworm, Ontario

There were no aerial spraying operations against the budworm in Ontario this year (Appendix 9). Next year it may be necessary to spray about 7,500 acres of jack pine near Illfed Lake in parts of Wilson, McKenzie, and Mills Townships south of Lake Nipissing. It is unlikely that spraying will be considered for older infestations near Lake Traverse (Algonquin Park), Petawawa, and Sault Ste. Marie.

Turner explained why the small Illfed Lake infestation is causing more concern than the much larger French River infestation. The former supports higher quality stands. Cameron expressed interest in B.t. trials in Algonquin Park, providing the material is proven to be satisfactory.

10. Spruce Budworm, New Brunswick

Experimental Studies with Insecticides, 1970.- The field evaluation of u.l.v. applications of insecticidal sprays (Appendix 10) yielded four points summarized by Fettes, as follows:

(1) Results of a single application of Matacil, Sumithion and Zectran indicated that a relatively high degree of budworm control and foliage protection can be obtained by a very early application of a systemic insecticide.

(2) The results confirm the effectiveness of Matacil and show that Lannate is relatively ineffective as an early spray insecticide at the dosages tested. Dylox shows moderate effectiveness at a dosage rate approximately five times that of Matacil.

(3) The results of a double application of Dylox, Lannate, and Matacil on 5th and 6th instar budworm larvae indicated that all three compounds are highly effective in controlling budworm on both fir and spruce trees at deposit densities of 15 to 20 drops/cm^2. The order of toxic efficacy appears to be (1) Matacil, (2) Lannate, (3) Dylox and (4) C.-17974.

(4) Preliminary field trials on the use of botanical insecticides (stabilized Pyrethrum and synthetic Pyrethroid SBP-1382) for the control of spruce budworm larvae show that both compounds are extremely effective

against the exposed larvae at a very low dosage. The order of effectiveness appears to be (1) Pyrethroid SBP-1382; (2) Pyrethrum 7014. The early application trials for Pyrethrum 7014 indicate that this material is non-systemic and thus ineffective as an early spray insecticide. Pyrethroid SBP-1384 on the other hand, in addition to being highly effective as a contact material, exhibits some systemic properties as evidenced by the reduction in foliage damage with increasing spray deposit.

Fettes also commented on the testing of insecticides on an operational scale (Appendix 11). Three insecticides, Lannate, Matacil, and Dylox were applied to 2,500 acre blocks by Forest Protection Limited according to standard operational procedures. The tests showed the following order of effectiveness from most to least effective: Matacil→ Dylox→Lannate. Results with Lannate were inconclusive. Matacil could be successful if applied at the rate of 2.5 oz. per acre (2 applications of 1.25). Dylox could be successful if applied at 12 oz. per acre (2 x 6 oz. with very short time interval).

Fettes further stated that the Americans did no testing with Pyrethroids this year. They asked the Chemical Control Research Institute to continue tests because of special problems in the U.S.A. The material is presently prohibited in the U.S., despite the fact that there is no evidence of Pyrethroids in the atmosphere six hours after application. Fettes also noted that experimental work in the laboratory shows that Zectran falls just below Matacil in toxicity to the budworm, and that Zectran is about 10 times more toxic than Fenitrothion.

Experimental Studies with Pathogens, 1970.- Cameron reviewed Bird's testing of a nuclear and a cytoplasmic virus (Appendix 12). Both are inactivated by solar radiation, and there was no infection when trees were sprayed prior to larval emergence from winter quarters. A suspension of nuclear virus using the equivalent of 40 diseased 6th-instar larvae in 1 gallon of water will initiate an epizootic that will destroy most of the larvae on the tree. In contrast, high infection was obtained with the cytoplasmic virus using as little as 5 diseased larvae in 1 gallon of water, but the high infection did not necessarily lead to high mortality in the laboratory or field. Encouraging results were obtained using both viruses, first applying the nuclear virus, followed by the cytoplasmic virus two weeks later. Mass propagation is in progress for larger scale trials in 1971. Neilson expressed the view that application of both viruses at more or less the same time may virtually duplicate the "normal" field condition since both viruses presumably occur naturally in wild budworm populations.

Reporting on Angus' work, Cameron referred to small-scale field trials in Algoma using Thuricide 90TS and Dipel (Appendix 13). Both formulations were effective and it was shown that wetters and stickers were beneficial. There seems to be some advantage to early spraying. This point will be investigated further, as will testing of new stickers.

Operational Control Projects, 1970.- In his review of operations (Appendix 14), Flieger noted that spraying with Fenitrothion was undertaken from May 28 to June 28. The total area sprayed covered 4,237,500 acres. Flieger stated that the guidance system worked well and the insecticide performed much as it did in 1969, but the operation was marred by several accidents, one of which was fatal. Flieger referred to an error in Appendix 14, page 2, line 4, where "625,000" should read "706,000 acres" to agree with Kettela's figure (See Appendix 16, p.2, line 7). It was stressed by Flieger that post spray surveys should be directed by one authority (Appendix 14, p.10), with another organization (C.F.S.?) paying for survey costs incurred outside the sprayed area.

Flieger referred to budworm spraying operations in Maine, where 210,000 acres of forest were sprayed in 1970 (Appendix 15). The assessment crews had a more complete monitoring program than adopted in Canada, and people in all disciplines will pool their findings in a single report.

In his synopsis of the 1970 spray program (Appendix 16), Kettela noted that 4,237,500 acres were treated as follows: (a) Fenitrothion - 1 application of 3/16 lb. in 0.15 U.S.G./ac. (1,880,500 ac.); (b) Fenitrothion - 2 applications, each consisting of 1/8 lb. in 0.15 U.S.G./ac. (1,983,000 ac.); (c) Fenitrothion - 3 applications, each of 1/8 lb. in 0.15 U.S.G./ac. of formulation per ac. (67,000 ac.); and (d) Dimecron 110 - 1 application of 3/16 lb. in 0.15 U.S.G./ac. (307,000 ac.). Percentages of reduction in survival on balsam fir were 69% and 70% for one application at 3/16 lb. and 2 applications of 1/8 lb. each, respectively. Corresponding figures for red spruce were 70% and 65%.

The Camp Gagetown area was not sprayed. Reference was made to the concern of Saint John authorities over the budworm situation involving over 20,000 acres of land surrounding the municipal water supply. Brown commented that if no action is taken the trees will be dead in two years, so applications of the best known insecticides are urgently required. Prebble pointed to the need for back-up action in case the use of chemical insecticides is rejected by the local authorities. As a step toward back-up action, Cameron was advised to make enquiries on the availability of B.t. in 1971, registration status of B.t. for use near municipal water reservoirs, and dosage required against budworm. We also require more information on the sub-lethal effects of Fenitrothion on humans.

In answer to Anderson's question on a cost-benefit study of spraying, Prebble commented that such a study in 1965 or 1966 showed that the benefits projected over a 35-year period far exceeded the costs. However, total costs and values may be different today. Brown also presented an impromptu statement on this point (summarized in Appendix 24), stating that spraying has permitted industry to expand and that there is need to spray in 1971 with the best known materials and methods.

Hazards to Humans.- McCarthy stated that the spraying operation was carried out without illness or accident directly attributable to the toxic effects of insecticides (Appendix 17). In preparing for Federal Government operations involving the use of pesticides, especially new ones, McCarthy felt his Department should be given the opportunity to express opinions regarding health effects on exposed workers. He also advocated developing procedures to be followed in the event of spills near sources of drinking water. The problem of disposal of pesticide containers is also difficult, and McCarthy suggested collecting drums for return to the supplier for decontamination.

Flieger doubted if container "1970-No. 2" in text table of Appendix 17, should have been included in the samples of residue in stored drums, the high residue indicating failure to decontaminate the container. He said it is not feasible to return drums to Japan. Forest Protection Limited does decontaminate drums to some degree before stacking with bungs removed. They are ultimately disposed of through a dealer. Flieger shared McCarthy's concern over the slow deterioration of residues in drums and felt this matter needs additional study.

Hazards to Fish and Other Aquatic Life.- J.R. MacDonald described Penney's investigations on the effect of selected new insecticides on juvenile salmon and aquatic insects (Appendix 18). Observations on caged fish showed no short term effects on juvenile salmon from the 1970 spraying with Dylox, Fenitrothion, Lannate, or Matacil, and average populations of under-yearling salmon in streams in the sprayed area were, on the average, four times greater than in 1969. Variations in numbers and bulk of aquatic insects subjected to treatments of the four abovementioned insecticides showed insignificant variations that are not necessarily attributed to spraying. However, it is known from earlier work that Fenitrothion at 1/2 lb./ac. causes serious depletion of aquatic insects.

Anderson summarized the composite report on studies undertaken by members of the St. Andrew's Biological Station, Fisheries

Research Board (Appendix 19). Investigations of fauna of Trout Brook and Nashwaaksis River, which run through areas sprayed with Fenitrothion in 1969 and 1970, indicated a further decline of invertebrate populations. There was no indication of fish mortality immediately after spraying, but summer electrofishing showed that trout stocks have remained low since 1966, possibly due to early spraying with DDT. Attention was also directed to the percentage of returns of grilse representing untreated and DDT-treated test populations. The untreated-treated ratio of return was 2:1, but a higher percentage of strays among the treated populations was reported. A 2% return of grilse is considered normal but may be as high as 5%. There is evidence that salmon parr are more vulnerable to predation by large brook trout after the former are exposed to Fenitrothion.

Discussion indicated that it has not been satisfactorily demonstrated that Fenitrothion is responsible for the depletion of insects (e.g. Diptera, stone flies, Mayflies, and caddis flies) despite the monitoring of streams in Ontario and Newfoundland. Pond stated that tank trials had not been used in Newfoundland. Anderson referred to an experimental (laboratory) salmon stream used to study the revival of parr after exposure to Fenitrothion. Parr were exposed to 1.0 ppm for 24 hours and they were affected to some degree, recovering soon after placing them in the artificial stream. Anderson felt that up to now we have not paid enough attention to sub-lethal effects of insecticides. One sub-lethal effect of DDT on fish is lack of sensitivity to low temperatures. Anderson was also concerned over finding mercury in streams that cannot be related to industrial pollution. Possibly mercury in some streams up to 2.0 ppm may be the indirect effect of air pollution.

Hazards to Wildlife.- Pearce reported on studies of birds on 2,500-acre blocks sprayed with Lannate (0.8 oz. in 0.15 U.S.G. Ethylene Glycol/acre x 2), Matacil (1.25 oz. in 0.15 U.S.G. Dowanol TPM/acre x 2), and Dylox (6 oz. in 0.15 U.S.G. Dowanol TPM/acre x 2). These operations presented no significant hazard to birds when sprayed in the manner and dosages used (Appendix 20). A monitoring study in Fundy National Park during forest spraying operations involving Fenitrothion (2 oz./ac.) indicated no discernible effect on the Park's amphibian fauna (Appendix 20, pp. 15,16). Pearce proposed better liaison between the investigators concerned with studies on the side effects of forest spraying. He noted that he and the Research Planning Branch had been invited to only one planning meeting leading to the 1970 spraying operation and at that time they were expected to outline their program without the benefit of knowledge of other aspects of the total program.

With respect to the last point, Flieger stated that only one planning meeting was actually held last year, and he solicited a letter from Pearce outlining his views on ways and means of better communication.

Studies of Insect Residues.- Fettes described Yule's work on the analysis of Phosphorus and Fenitrothion in the air, methodology for measuring Fenitrothion and its metabolites in the forest environment, and progress in the study of persistence of DDT in soils of the Priceville area (Appendix 21). This study is summarized as follows: (a) Fenitrothion- Most daily air samples contained Phosphorus at the nanogram ($1x10^{-9}$ g.)/cubic metre level, some of which was still in the form of parent Fenitrothion; (b) DDT- The analysis of Priceville soils for the 1968 intensive survey and for 1969 and 1970 persistence records have been completed, and a comprehensive report is in preparation.

Infestation Status, Fall of 1970, and Areas of Hazard for 1971.- The status of the budworm infestation in New Brunswick in the late summer of 1970 was described by Kettela (Appendix 16, pp.5-7). The total area of infestation based on egg counts in 1970 is 12.8 million acres, an increase of 2.8 million acres over 1969. Most of the acreage increase is in the light and severe categories as shown in the following synopsis:

	Light	Modereate	Severe
1970	4,200,000	700,000	7,900,000
1969	3,000,000	2,000,000	5,000,000

Ketella outlined the basis for identifying 3 categories of hazard, and estimated the acreage of each as follows:

(1) Extreme - 370,000 ac.
(2) High - 2,160,000 ac.
(3) Variable - 5,370,000 ac.

There are no definite plans for spraying in 1971, but remedial action should be taken for categories 1, 2, and part of 3. The hazard map may change after discussions next winter. Paquet and Martineau expressed the desirability of spraying near the Quebec border if Quebec authories decide to spray adjacent areas in 1971.

11. Spruce Budworm, Quebec

Operational Control Projects, 1970.- Paquet described the Quebec spraying operation over a total area of 24,300 acres in western Quebec (Appendix 22). Spraying was conducted in the Dumoine-Gatineau area (1,800 ac.) to protect foliage and in the lower Gatineau River watershed (22,500 ac.) to prevent tree mortality. Spraying extended from May 28 to June 8 but poor weather interruped operations from May 30 to June 4. The material, Fenitrothion, was formulated in New Brunswick and trucked to Carp, Ontario, for loading the three spray planes. The areas were treated with two applications, each at a dosage of 1/8 pound in 0.15 U.S.G./ac. The percentage of population reduction was extremely variable, ranging from zero to 98%. The best results were obtained where the size of the treated blocks exceeded 200 acres.

Another operation was carried out in the St. Maurice area, where 4,500 acres of white spruce plantations were sprayed. Fenitrothion at the rate of 3.5 oz. in 0.4 U.S.G./ac. of formulation was used. The weighted mean percentage reduction in budworm population was 89%, but surveys show that the infestation is increasing in size.

Paquet noted that aerial surveys and aerial spraying in 1970 were the responsibility of the Quebec Department of Lands and Forests, while the Canadian Forestry Service under Martineau was responsible for egg surveys. He commended this arrangement.

Infestation Status, Fall of 1970, and Areas of Hazard for 1971.- Extensive defoliation and egg counts were made in three regions, with additional egg surveys carried out at scattered points throughout the Province. In the Dumoine-Gatineau area egg counts were generally heavy, and 5,000,000 acres showed varying degrees of defoliation. Some 660,000 acres within the large region will likely be severely defoliated in 1971. In the St. Maurice area, 450 acres of plantations continued to show light defoliation, but the infestation has enlarged to about 2,590 acres accompanied by increases in egg counts. In the Temiscouta area, defoliation and egg counts as demonstrated by Martineau, were especially high southeast of the Lake.

Proposals for Definitive Programs, 1971.- Although spraying plans for 1971 have to be confirmed, Paquet forecast that spraying will be recommended for one million acres in the Dumoine-Gatineau area and 100,000 acres in the Temiscouta area.

In answer to a question by Keith, Turner suggested that the Temiscouta area would have to receive a higher dosage than used in New Brunswick, if the intent is to control an epicentre.

12. Spruce Budworm, Ontario

Operational Control Projects, 1970.- Spraying operations in Ontario, as reviewed by Howse, covered a number of blocks in three regions, i.e. southeastern, northeastern, and northwestern (Appendix 23).

A. SOUTHEASTERN REGION.- Late spraying and poor weather handicapped operations in the Larose and Petawawa Forest Experiment Station forests. At the former location, 80 acres received an estimated 21 oz./ac. and 720 acres received over 10 oz./ac. Turner had reservations about the Fenitrothion treatment of 21 oz./ac. in the Larose Forest and he intends to check the rate of application. At P.F.E.S., 450 acres were treated with two applications of 5.1 oz./ac. and 300 acres received one application of 4.3 oz./ac. (rained out). It is concluded that the Larose operation from the point of view of protecting white spruce foliage was satisfactory although the population per sample was reduced only from 11.4 to 4.0 (Appendix 23, p. 4). At P.F.E.S. the success of the operation was variable.

B. NORTHEASTERN REGION.- Here a total of 11,000 acres received one application of Fenitrothion at a rate of 4.3 oz./ac. It is questionable if this operation produced measurable value. The two Parks that were sprayed within this region lie within a massive infestation covering 4.5 million acres. The total area of moderate to severe infestation represents more than a three-fold increase over the total area defoliated in 1969. Five provincial parks in the Chapleau District are rated as "high hazard, 1971" over areas totalling 186,000 acres.

C. NORTHWESTERN REGION.- Fenitrothion was applied at the rate of 5.1 oz./ac. except for the first four loads when 4.3 oz./ac. was applied. Areas sprayed were 5,250 acres at Northern Light Lake (treated twice), 2,250 acres at Granite Lake (treated once), and 3,500 acres at Gunflint Lake (treated once). Since the primary objective of this operation was to eliminate two pockets of heavy infestation, the operation was not considered completely successful. Moderate to severe hazard is predicted for 1971 on areas totalling 937 acres. There are no firm decisions regarding spraying in 1971.

Turner considered that earlier attempts to control the budworm in the Burchill epicentre were fairly successful. There were many zero values in post-spray sampling, and treating a larger buffer zone contributed to the success. Turner also believed that small blocks of forests tend to give poor spraying success. If spraying is conducted in 1971, one application of Fenitrothion at 4.3 oz./ac. is likely to be used, but the application should be increased to 5.7 oz./ac. for late season spraying. Knock-out spraying should involve two applications of 5.7 oz./ac. each. Turner noted that future criteria in decisions on spraying large blocks,as in the northeast, will relate to recreational use and proportion of high value spruce and fir in the stands. There is also concern over the fire hazard created by the destruction of trees by the budworm.

13. Other Problems

A. The meeting did not review small operations, notably those relating to the gypsy moth and tussock moth.

B. Prebble referred to a November meeting of the Canadian Council of Resource Ministers in Winnipeg. A topic that will be discussed is mutual aid in forest protection. As a possible guide in developing policy, it would be helpful to know the feeling regarding the usefulness of meetings of the Interdepartmental Committee on Forest Spraying Operations. Views expressed were as follows:

Paquet: Very pleased to be invited to these meetings because the discussions are informative and it is highly desirable to obtain interprovincial as well as international points of view.

Turner: Firmly convinced that the meetings are becoming increasingly valuable.

Blais: The meetings are extremely valuable. It is enlightening to obtain the views of people in diverse disciplines.

Richmond: The meetings are a clearing-house of ideas. Would be reluctant to see termination of the Committee's activities.

Brown: The exchange of information is always valuable, but it would be highly desirable if the Committee would take a more positive role in leadership. In this connection, the Committee should inform the public as to all the facts of the situation and place these in their true perspective.

W. A. Reeks
Secretary.

M. L. Prebble
Chairman.

Ottawa, November 17, 1970.

Field Evaluation of Six Insecticides Against Ambrosia Beetles [1/]

by

S. Ilnytzky

Canadian Forestry Service
Victoria, B. C.

A field program to screen insecticides that may be used to protect logs from attack by the ambrosia beetle Trypodendron lineatum (Oliv.) was continued at Cowichan Lake, B. C. in 1970. Four insecticides, suggested by the Chemical Control Research Institute, were tested along with Methyl Trithion and Benzene Hexachloride.

Test material consisted of 30-inch log bolts (minimum diameter = 10 inches) taken at random from 12 Douglas fir trees cut in December, 1969. All bolts were suspended off the ground to allow the insects complete access to the bolts. The insecticides were applied with a six liter compressed air garden sprayer as shown in Table I. The tests were duplicated in a shaded forest stand and in an open area about 100 yards from the forest boundary.

The insecticides were applied in the open site on April 22 and in the shaded site on April 23. Three bolts were used for each insecticide concentration, and a control. The basic concentration (Table I) was diluted in diesel oil to give the desired concentration in lbs/acre which thoroughly saturated the bark. Cloth trays (18" x 18" x 4") were suspended under the middle of the 3 test logs 24 hours after treatment to collect dead insects. Insects were collected every second day until June 26.

Major beetle flights occurred on May 4, 17 and 27, activity was reduced to small flights thereafter until July 22 when flight activity ceased. The numbers of beetles collected from each concentration test are shown in Figure 1. The preliminary results reported herein refer only to the mortality of beetles. Additional data on log surface area and successful attack by the beetles are still being analysed.

[1/] Prepared for Interdepartmental Committee on Forest Spraying Operations Meeting, October 29, 1970.

The results showed that the most effective treatments were Methyl trithion at 10 lbs/acre in the shaded site, and Methoxychlor at 10 lbs/acre in the open site. The least effective were Monitor and Sumithion at 2 lbs/acre in the shade and open sites respectively. The observation that lower concentrations of certain insecticides were more effective may be because either the insecticide acted as a repellent at the higher concentration or because some logs were more attractive than others.

Contact mortality data for the different treatments were compared using the Friedman two-way analysis of variance by ranks (Siegel, 1956)[1/]. A comparison ranking the three observations for each treatment and computing X_r^2 from the total ranks for the three concentrations showed that there was a significant difference in the mortality of beetles between the various concentrations except for the BHC treatments on both sites and Methyl trithion in the open site.

The effects of the six insecticides were compared by the Friedman test by selecting for each insecticide the concentration giving the highest total mortality. The results showed that there were significant differences in mortality between each insecticide in both the shaded ($P < .001$) and the open ($P \ll .01$) sites. The order of effectiveness is:

shade MT-10 > MC-10 > BHC-10 > SUM-6 > DUR-6 > MON-6

open MC-10 > DUR-6 > MT-8 > SUM-6 > BHC-10 > MON-4

A significantly greater number of beetles were killed in the shaded site than in the open site. This may be because fewer ambrosia beetles were attracted to the logs in the open site and/or because the insecticides in the open were degraded more rapidly by sun and rain.

1/ Siegel, S. 1956. Nonparametric statistics for the behavioural sciences. McGraw-Hill, p. 166.

Table I

Insecticides used against ambrosia beetles

Insecticides	Type[1/]	Formula	Concentration[2/] inequivalent pounds of active insecticide per acre of log surface
Methyl Trithion (M.T.)	O-P Con.	S-(P-chlorophenylthio)= methyl) O,O-dimethylphos= phorodithioate	10% at 8, 10, 12
Methoxychlor (M.C.)	C-H Con.	88% 2,2-bis(P-methoxy-phenyl) -1,1,1-Tri-chloroectane and 12% other isomers	5% at 8, 10, 12
BHC (Lindane) (BHC)	C-H Con.	1,2,3,4,5,6-hexachloro= cyclohexone, 99% or more gamna isomer	5% at 8, 10, 12
Monitor (MON)	O-P Con.	O,S-Dimethyl phosphoro-midithioate	10% at 2, 4, 6
Dursban (DUR)	O-P Con.	O,O-diethyl O-(3,5,6,-Trichloro-2 pyridyl) phosphorothioate	10% at 2, 4, 6
Sumithion (SUM)	O-P Sys.	O,O-dimethyl O-(4 nitro-m-totyl) phosphorothioate	10% at 2, 4, 6

1/ O-P = organsphosphite

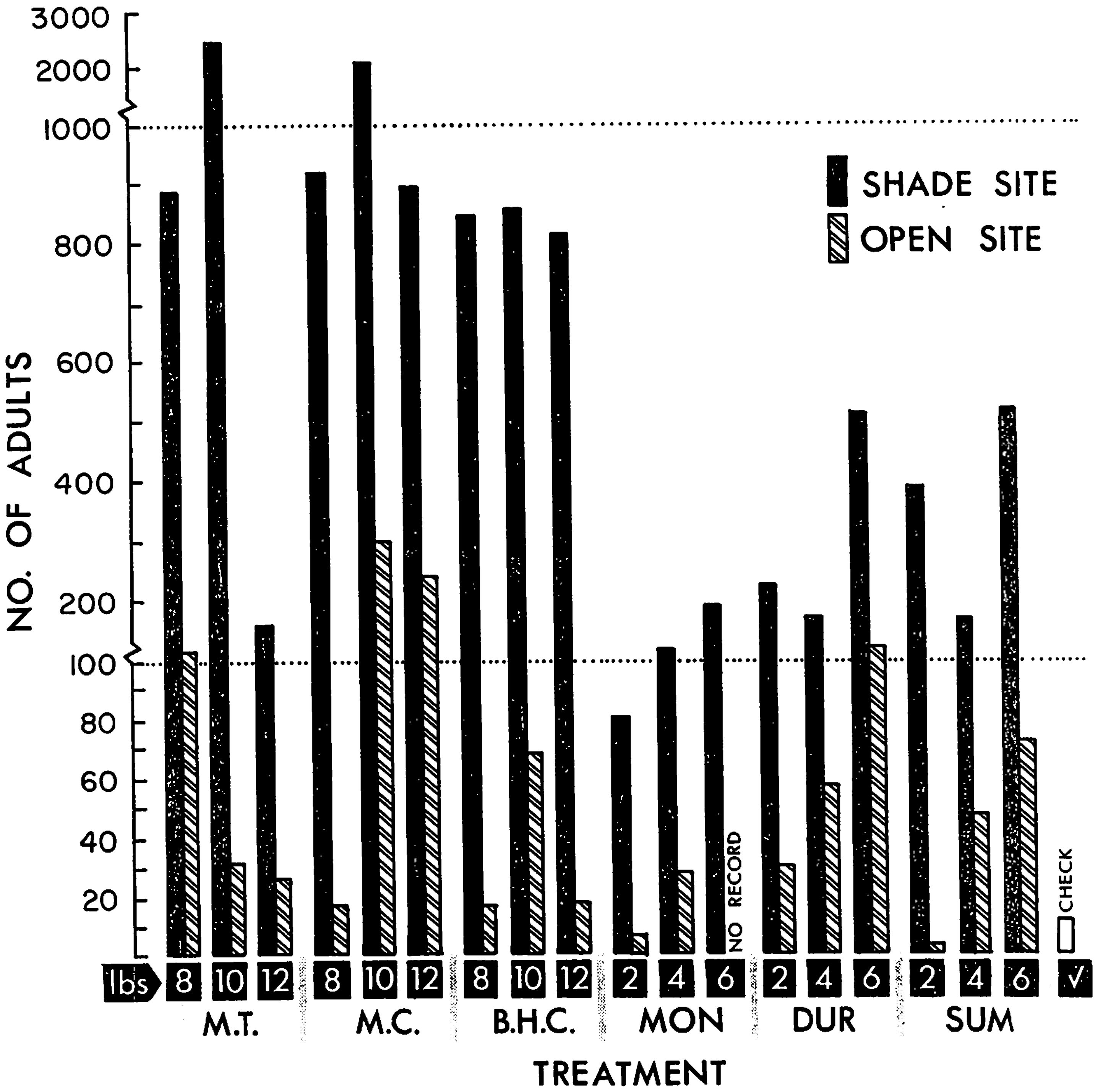
C-H = chlorinated hydrocarbon

Con. = contact

Sys. = systemic

2/ All insecticides were diluted in diesel oil.

FIG. I CONTACT MORTALITY OF AMBROSIA BEETLE WITH VARIOUS INSECTICIDES.



Field Test of *Cordyceps militaris* Against the Green-striped Forest Looper [1/]

by

A. Funk and S. Ilnytzky

Canadian Forestry Service
Victoria, B. C.

Introduction

The ascomycetous fungus, *Cordyceps militaris* is found occasionally as a natural parasite of the pupae of *Melanolophia imitata* in British Columbia. The possibility of artifically increasing its incidence was suggested in the spring of 1970, after it had been successfully cultured from ascospores. Several damaging outbreaks of the insect in the Quatsino Sound area were chosen for field testing, during the stage of larval feeding in the foliage of western hemlock trees.

Methods

Cordyceps was cultured on a liquid medium consisting of 3% malt extract in distilled water. Cultures were allowed to grow 5-6 weeks in 2-litre flasks containing 500 ml of medium. Immediately before spraying the fungus mat was blended for 5-7 seconds in 200 ml tapwater, then diluted to 2 litres for spraying. The concentration resulting had approximately 4.2 million fungus particles per ml., consisting of conidia and hyphal fragments. A mist blower with a range of approximately 58 ft was used to blow the suspension into the foliage (July 15, 1970).

Results

Observations were made at 4 weeks and 8 weeks after spraying.

Pt. Alice Area - After 4 weeks, all pupae found in the duff were parasitized and most had mature fruiting bodies of *Cordyceps* projecting above the ground surface. Some dead larvae found on surface of ground were covered with orange mycelium, believed to be *Cordyceps*.

After 8 weeks, pupal populations ranged from 1 to 4 per sq. ft. of duff sample and it was again observed that 100% of pupae were parasitized.

1/ Prepared for Interdepartmental Committee on Forest Spraying Operations Meeting, October 29, 1970.

Kokwino Cove Area - After 4 weeks there were no pupae of any kind in the duff, although living larvae were still feeding in the foliage. Some dead larvae, shaken from the trees, were shown to contain *Cordyceps* fungus in necrotic tissues, by cultural method.

After 8 weeks, it was again observed that no larvae had pupated in the duff.

Control Areas - Living, healthy pupae were found in the unsprayed areas, but not in heavy concentration (1-2/sq. ft.). Infected pupae in very small numbers were observed in one control area at 4 weeks.

Conclusions

Although this looper infestation was beginning to decline naturally, we feel that the 100% infection in the treated area at Pt. Alice indicates that there was an increase in fungal parasitism as a result of artificially spreading the parasite. Also, the occurrence of *Cordyceps* in and on dead larvae indicates that the fungus may have killed some before pupation. Complete absence of pupae in the Kokwino area is not explained otherwise.

Fruiting of *Cordyceps* has never before been observed in mid-summer on this species. Although a few pupae with fruiting bodies were found in the control area, the very high incidence of fruiting bodies (up to 15/sq. ft.) in the test area also provides evidence that the treatment increased the natural parasitism of the green-striped looper by *Cordyceps*.

Tests of Pathogens to Control the Eastern Hemlock Looper, *Lambdina fiscellaria fiscellaria*

J. C. Cunningham

Nuclear Polyhedrosis Virus

In order to continue the tests of nuclear polyhedrosis virus, the pathogen was produced in the Insect Pathology Research Institute during the winter of 1969-70, using the freeze-drying method to preserve the material. It was estimated that one larva killed by virus contained about 7.2×10^7 polyhedra. A standard concentration of about 10^6 polyhedra per ml has been used in experimental work, thus about 60 to 70 larvae are required to make one gallon of spray of this concentration. Some material was also produced in the Forestry Regional Laboratory in St. John's, Newfoundland, using the former method of allowing the larvae to decompose in water and recovering the polyhedra by differential centrifugation.

In all, 11 small plots were treated using a portable mist blower. Based on the numbers of trees treated and the volumes of material used, dosage rates were calculated following application and were found to range from 151 to 646 gallons per acre, figures that obviously do not mean a great deal in practical terms. Several different concentrations, both of the freeze-dried and of the purified preparations, were applied at a time when the insects were mostly in the second instar. Because of the variability of the infestation between plots it is felt that the best measure of the results was obtained by sampling at specific times after spraying and examining the larvae to determine the percentage of infection.

As in 1969, the results were rather disappointing. The population in some of the plots turned out to be so low that the results are of little significance. In the others virus infection ranged from about 10 to 45 per cent, not enough to be considered satisfactory for control, and no mortality was observed until about three weeks after application of the spray so that feeding and damage were extensive.

A somewhat more favourable picture is obtained if pupal mortality is taken into account. Pupal collections from five plots showed that virus killed more than two-thirds of them. Recognizing that the sampling methods were not satisfactory and that the numbers involved were very small, nevertheless there is a combined larval-pupal mortality due to virus of perhaps 80 per cent or better. The total effectiveness may be still further enhanced if evidence is found of transmission to the next generation.

Although the results were less promising than hoped for, further research is still warranted. There are a number of points to be investigated that might lead to better prospects. Two other types of naturally-occurring virus were found as contaminants in the propagation program, a cytoplasmic polyhedrosis and a non-occluded type. It is now known that in some other insects these different types of virus are antagonistic, and if the nuclear polyhedrosis virus can be freed of the contaminants it may be more effective. Virus is quite quickly inactivated by sunlight; some investigation of possible protectants is indicated. It is planned that these avenues will be followed.

Bacillus thuringiensis

Some small plots were sprayed with commercially-produced preparations of Bacillus thuringiensis. Although these tests were not extensive, they did indicate that the preparations are worth further examination. Mortality was obtained, but no attempt was made to estimate the dosage rate and this will be a prime consideration. Also, it will be necessary to compare results of a single spray with repeated applications; the long period during which larvae feed may mean that multiple applications will be the only way to get acceptable population reduction because of the weathering and inactivation of the spray.

The Eastern Hemlock Looper in Newfoundland - 1970

R.C. Clark
Annual Meeting Inderdepartmental
Committee on Forest Spraying Operations
October 29, 1970

THE EASTERN HEMLOCK LOOPER IN NEWFOUNDLAND - 1970

INTRODUCTION

The hemlock looper defoliated an estimated 700,000 acres of balsam fir forest in 1969 and forecasts indicated that 500,000 acres might be defoliated in the succeeding year. However, the forest agencies decided not to participate in a chemical control operation in 1970. The decision not to spray was based on results of surveys indicating that the outbreak was weakening and studies showing that the rate of deterioration of killed timber was slower than anticipated providing an extended salvage period.

This report provides a summary of the status of the outbreak in 1970, evaluation of spraying, forecasts for 1971 and information on biological control studies.

INFESTATION STATUS - 1970

Results of aerial surveys show that the looper has defoliated more than 1,750,000 acres of balsam fir forests throughout the Island since the outbreak began in 1966. An estimated 384,000 acres were defoliated in 1970 (Fig. 1), some 300,000 acres less than in 1969 (Fig. 2) and 136,000 acres less than predicted. However, approximately 280,000 acres of the defoliated areas were moderately to severely damaged as compared to a total of 217,000 acres in 1969.

Survey estimates show 180,000 acres of dead stands still to be harvested. An estimated 170,000 acres, yielding approximately 800,000 cords, have already been harvested and industry has indicated that they will be able to harvest the remaining accessible and most valuable dead and severely damaged stands.

EFFECT OF SPRAY OPERATION

The original aim of the spray operation was to minimize losses from looper damage. Although it is impossible to determine accurately if this goal was attained, it can be assumed that the operation was successful considering that less than 500,000 acres of fir forest have been killed out of an estimated total of 1,750,000 acres defoliated.

It is also impossible to determine precisely if spraying was responsible for the collapse of population levels in infested areas. However, results of aerial surveys indicate that, in the year following spraying, the size of defoliated areas was usually smaller or defoliation was negligible in treated stands. It should be noted that similar results were observed in some areas that were not treated. An outstanding example of this latter condition occurred in the Bay d'Espoir area where 80,000 acres of fir were defoliated in 1969 and showed traces of defoliation on new foliage in 1970 but no larvae or defoliation could be found later when population levels should have been highest. The reasons for the collapse of this outbreak are not known but disease is suspected because a high incidence of undetermined fungi was assumed to be responsible for the collapse of several smaller outbreaks in 1969 and 1970.

It should be noted that spraying to control the hemlock looper has had no obvious undesirable effects. It has not perpetuated infestations (defoliation has not occurred for more than 2 years in any one stand whether sprayed or unsprayed); and at the formulations used, fenitrothion and phosphamidon have not had any reported deleterious effect on humans or other mammals and if any, only very minimal effects on birds or fish.

FORECAST 1971

The history of outbreaks in Newfoundland and results of aerial surveys provide information indicating that the hemlock looper outbreak continues to weaken. Factors contributing to this conclusion are:

(1) The total area defoliated in 1970 was reduced by about 50% from 1969.

(2) About 2,000,000 acres have been heavily infested or defoliated for more than 2 years indicating that no further defoliation will occur in these areas during the present outbreak.

(3) The outbreak has virtually collapsed in western Newfoundland, south of the Northern Peninsula, and in the east and east-central areas of the Island.

(4) Disease appears to be more widespread; it was observed in western Newfoundland in 1969 and in western and central Newfoundland in 1970.

However, approximately 230,000 acres of new outbreak occurred in 1970 and most of these stands may be defoliated again in 1971. Stands in the Baie Verte area have the highest potential for additional new outbreaks. It has been estimated that not more than 500,000 acres should be defoliated in 1971.

The final decision for undertaking a chemical control program rests with the operating agencies. However, the predictions of the Canadian Forestry Service and the status of salvage cutting indicates that a spray operation would not be feasible in 1971. At the time of writing no firm decision has been made by the industry.

BIOLOGICAL CONTROL STUDIES

The study of biological control agents, notably parasites and disease organisms, continued in 1970. There appears to be five species of hymenopterous parasites attacking the hemlock looper, three of which have been tentatively identified as Aoplus velox, Apechthis ontario and Zele sp, and four unidentified dipterous species belonging to the family Tachinidae. Larval rearings indicate less than 1% parasitism by the hymenopterous species but up to 48% in western and 11% in central Newfoundland by dipterous parasites. Parasitism was highest in areas where looper outbreaks had persisted for 2 years.

Pathogens, notably viruses, have been credited with the collapse of earlier looper outbreaks. Dr. Cunningham of the Insect Pathology Research Institute, continued his field tests on the feasibility of using viruses to control the looper. His results will be reported elsewhere at this meeting.

Entomophagus fungi were observed killing looper larvae at several locations in western and central Newfoundland. According to Dr. McLeod of the Insect Pathology Research Institute two species may be involved.

The disease was first observed in three areas defoliated for the first year in 1969. These outbreaks collapsed in 1970 and the few remaining larvae were infested with fungus. Diseased larvae or pupae were found in all infested areas sampled in 1970 after larvae reached the third instar.

FIGURE 1

EASTERN HEMLOCK LOOPER

ACTIVE OUTBREAK 1970

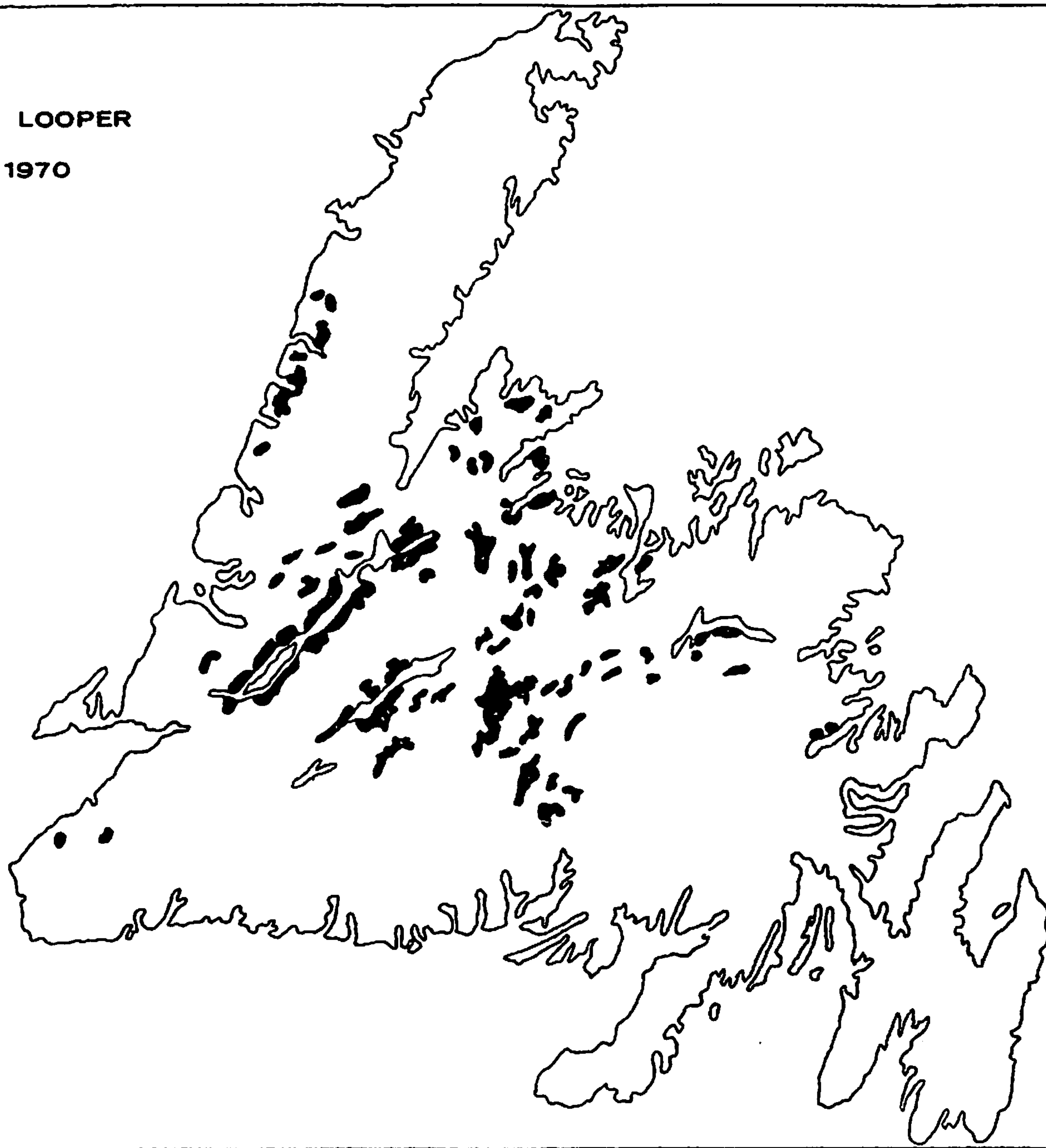
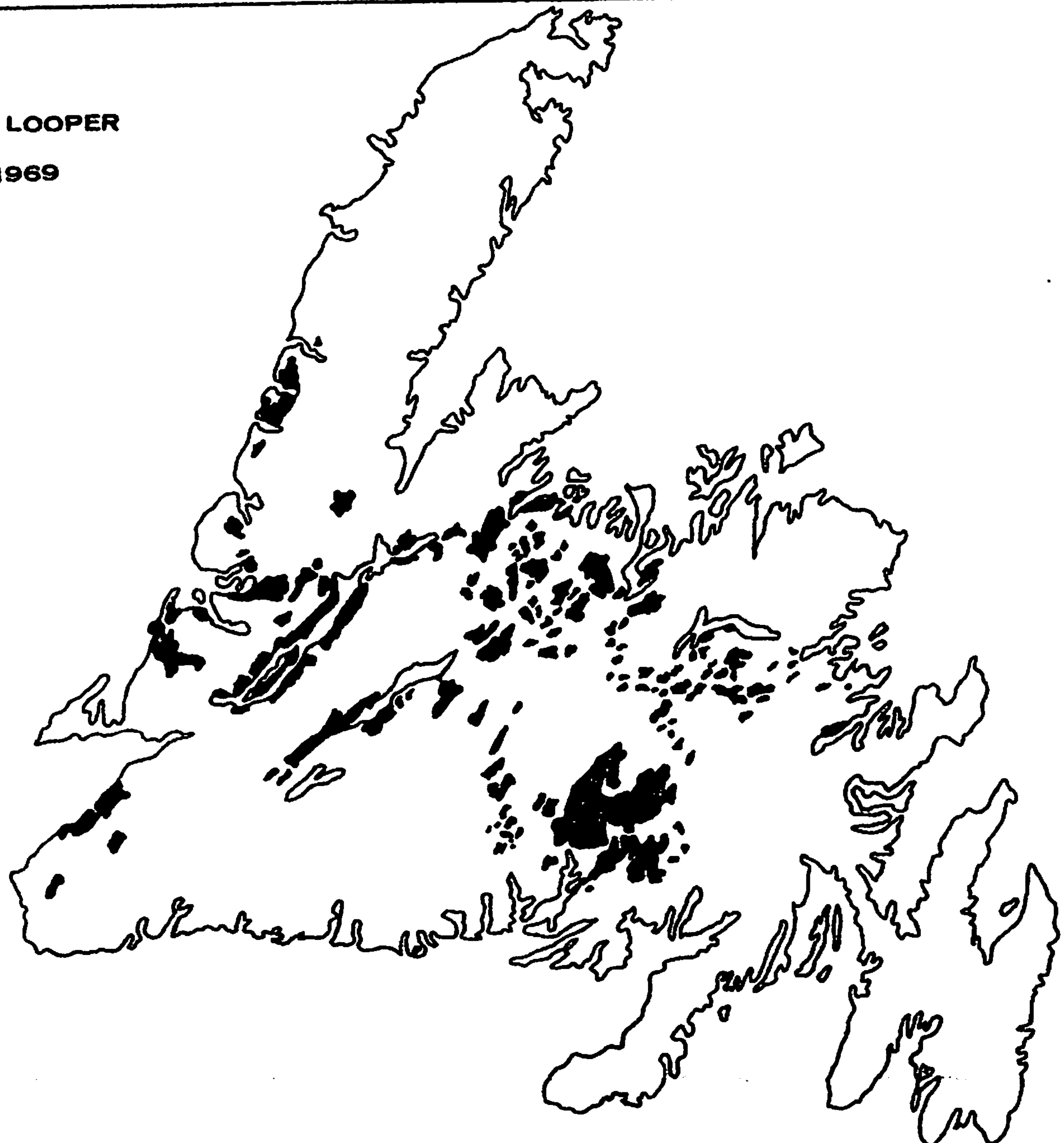


FIGURE 2

EASTERN HEMLOCK LOOPER

ACTIVE OUTBREAK 1969



Nuclear Polyhedrosis Virus to Control the Red-headed Pine Sawfly, *Neodiprion lecontei*

F. T. Bird

A demonstration on the use of a nuclear polyhedrosis virus as a control agent for the red-headed pine sawfly, *Neodiprion lecontei*, was made at St. Jovite, Quebec, at the request of forest entomologists in Quebec. A plantation of red pine trees about 4 to 5 feet high, heavily infected with the sawfly, was divided into plots each of which was sprayed with a different concentration of virus: 1/8, 1/4, 1/2 and 1 gm of freeze-dried larvae killed by virus suspended in 1 gallon of water, and a partially purified suspension of virus containing 10^6 polyhedra per ml of water.

The virus was sprayed with a mist blower, the operator holding the nozzle to direct the spray over the tops of the trees, allowing the virus spray to drift over the trees aided by a 4-5 mile per hr breeze. The first 10 rows of trees on the windward side of the plantation were left untreated as a control. The 11th row was sprayed with 1/8 gm of virus per gallon, the 18th with 1/4 gm of virus per gallon of water, the 25th row with 1/2 gm of virus per gallon, the 32nd row with 1 gm of virus per gallon, and 49th row with 10^6 polyhedra per ml of water. Larvae became sick and commenced dying about 10 days after spraying with the purified virus suspension, and a few days later with suspension of the unpurified freeze-dried material. There was a gradation in rates of mortality depending on the viral concentration, being more rapid at the higher concentration, and continuing for a period of about 48 days at the lowest concentration.

All larvae eventually died from virus except for a very few individuals in the rows of trees farthest from the spray source. Toward the end of the experiment some of the larvae on the control trees became infected with virus (transmitted possibly by parasites) and died. The lowest concentration prevented serious defoliation over 4 of the 7 rows. The next two more concentrated virus suspensions gave excellent protection over the seven rows in each plot, and the 16 rows sprayed with 1 gm of virus per gallon of water and the 19 rows sprayed with the purified polyhedra suspension were also fully protected. The demonstration therefore was completely successful and the results were similar to those obtained previously.

In carrying out these tests, valuable assistance was received from various sources. Officers of the Quebec Department of Lands and Forests and from the Quebec Forest Research Laboratory and the Chemical Control Research Institute of the Canadian Forestry Service located the plantations and assessed the population levels before spraying. The Chemical Control Research Institute also made a large contribution in examining the plots following treatment and assessing the development and extent of mortality. This assistance is gratefully acknowledged.

1970 Testing of Bacterial Microbial Insecticides against *Choristoneura pinus*

T. A. Angus

An isolated Christmas-tree planting of Scots pine at Gore Bay, Manitoulin Island heavily infested with the jack-pine budworm *Choristoneura pinus* was noted in 1969. A single spraying of 10 trees with the microbial insecticide 90TS gave promising results.

The infestation was still present in 1970 and a small number of trees were sprayed on June 9, 16 and 23 with two commercial formulations: Thuricide 90TS (International Minerals Corp., Skokie, Ill., U.S.A.) and Dipel (Amdal Division of Abbott Laboratories, North Chicago, Ill., U.S.A.).

These tests were only preliminary in nature since it had been forecast that the plantation was to be later custom-sprayed with a chemical insecticide. This however did not take place.

An inspection on June 29 indicated that sprayed trees had suffered little bud damage whereas control trees were heavily damaged. On Scots pine, this pest is sporadic and variable in intensity from year to year. It is difficult to forecast if further tests in 1971 will be possible or should be made since this is a private planting and the owners plans are uncertain.

APPENDIX 8

JACK-PINE BUDWORM AERIAL SPRAYING OPERATION

QUEBEC 1970

by

R. Desaulniers, Conservation Branch,
Quebec Department of Lands and Forests

Prepared for The Interdepartmental
Committee on Forest Spraying Operations

October 1970

JACK-PINE BUDWORM AERIAL SPRAYING OPERATION

QUEBEC 1970

I - INTRODUCTION

An infestation of the Jack-pine budworm was detected in the Gatineau River watershed in 1969. That year, populations on jack-pine reached such a high level that trees were virtually stripped of the current year's foliage. This infestation was the first important one for this insect in Quebec; the affected area covered 2,700 acres south of the Baskatong Reservoir and encompassed a valuable jack-pine seed orchard.

Meetings were held between Canadian International Paper Company, Provincial and Federal officials and spraying was considered warranted to bring this infestation to an end before it had a chance to spread to nearby large jack-pine stands.

II - PRE-SPRAY SURVEY AND INSECT DEVELOPMENT

A pre-spray survey was conducted in early June to measure insect development and to determine the population density in the area to be treated. Five sample plots measuring 10 square chains were monitored. The sample for each block consisted of one 18-inch branch from each of 10 trees, at a spacing of one chain. It was impossible to establish control plots because the entire infested area was sprayed.

III - SPRAYING OPERATION

The spraying operation was carried out by Forest Protection Limited with three Stearman spray aircraft and one Cessna as leader.

The insecticide had previously been formulated at a mixing plant in New-Brunswick and trucked in barrels to the Mont Laurier airport, where it was mixed with water and loaded into the aircraft. The operational plan called for two applications of Fenitrothion at a dosage of 3 ounces per acre in 0.15 U.S. gallon of formulation.

The first application was carried out on the evening of June 19 when 85 per cent of the population was in the third and fourth instars. The spraying operation was completed with the second application on the morning of June 22.

IV - POPULATION REDUCTION IN THE AREA SPRAYED

A post-spray survey was conducted at all sampling blocks where pre-spray insect density had been determined. At that time, 56 per cent of the larvae were still in the third and fourth instars. The effects of the spraying were not determined with Abbott's formula since no control points could be established. Pre- and post-spray surveys indicate that the weighted mean per cent reduction in budworm population was 68 per cent.

V - FORECAST FOR 1971

An egg-mass survey was carried out in early october in the five sample plots. Sampling was based on one 24-inch branch tip from each of 6 trees, at a spacing of one chain. Results of this survey indicate that populations can be expected to be low in 1971 since an average of 0.10 egg-mass per 24-inch branch tip was recorded. Current defoliation was rated at light for all sample plots.

VI - CONCLUSION

It seems reasonable to conclude that the objective of this operation was achieved. A relatively high degree of population reduction, almost 70%, was recorded 4 days after the aerial spraying was completed. The residual population is quite low at 0.10 egg-mass per 24-inch branch tip.

THE JACK-PINE BUDWORM SITUATION IN ONTARIO RELATIVE TO FOREST SPRAYING, 1970

by

G. M. Howse and W. L. Sippell

Canadian Forestry Service

Forest Research Laboratory

Sault Ste, Marie, Ontario

Introduction

No aerial spraying operations were directed against the jack-pine budworm, *Choristoneura pinus pinus* Free., in Ontario in 1970. This statement has been prepared to apprise the Interdepartmental Committee on Forest Spraying of information and events leading up to the cancellation of a 10,000-acre spraying operation, to describe the current status of the jack-pine budworm in areas that had been sprayed in 1969, and to point out a situation which could call for treatment in 1971. Locations of the areas involved are shown in Figure 1.

The Lake Traverse (Algonquin Park) Infestation

An early aerial spraying operation designed to protect about 5,000 acres of severely damaged stands of jack pine near Lake Traverse was cancelled in May, 1969 by the Ontario Department of Lands and Forests on the grounds of adverse public reaction to the use of insecticides in Algonquin Park.

During the summer of 1969, it became clear that this infestation had developed well beyond the intensities forecast and had expanded considerably in size. Extremely high larval, pupal, and egg-mass counts were made during the summer and fall of 1969, and based on the egg-mass counts, severe damage was again forecast for 1970. These forecasts coupled with serious previous and cumulative damage, which resulted from two consecutive years of severe infestation (1968 and 1969), dictated that consideration be given to the protection of at least part of the affected area by spraying in the spring of 1970. An operation to protect stands over about 10,000 acres was, therefore, planned for June, 1970.

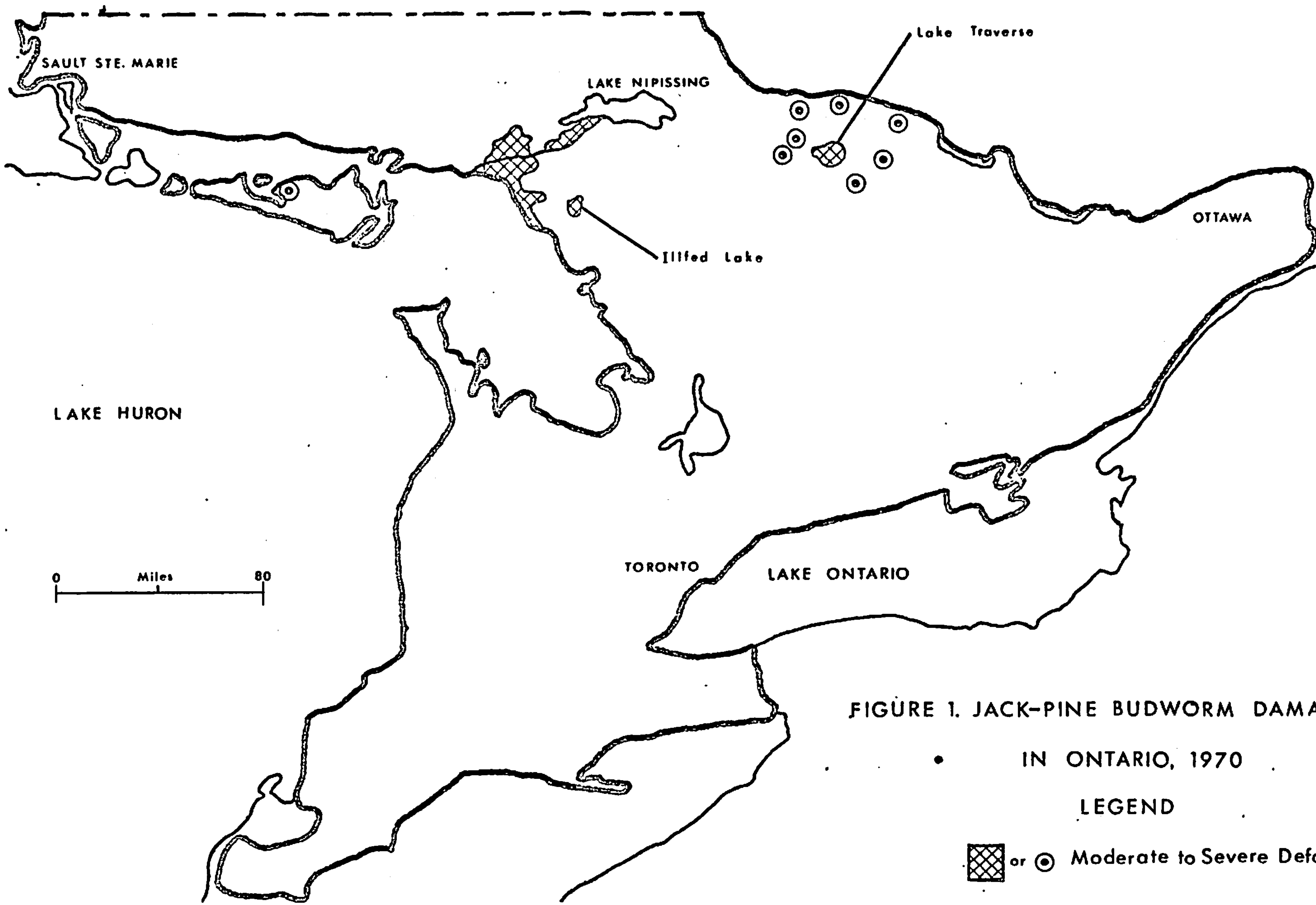


FIGURE 1. JACK-PINE BUDWORM DAMAGE IN ONTARIO, 1970

LEGEND

▩ or ⊙ Moderate to Severe Defoliation

An intensive pre-spray early-instar larval survey produced surprising results. Jack-pine budworm larvae were found everywhere in the Lake Traverse infestation, as anticipated, but in much lower numbers than expected. Counts were immediately repeated and the second set of values confirmed that populations of larvae were much lower than could have been expected from the previous year's measured egg populations. Larval population levels were capable of causing, at most, light defoliation and the urgency of control action had obviously lowered. The following comparison of populations measurements serve to illustrate this point.

In 1968, egg-mass numbers averaged 1.0 per 24" branch tip and ranged from 0 to 11 egg-masses per tip. In the spring of 1969, early-instar larval population densities of the same generation averaged 27 larvae per 24" tip and ranged from 1 to 125 larvae per tip. This resulted in widespread and severe defoliation. By comparison, egg-mass counts in the fall of 1969 averaged 2.9 egg-masses per 24" tip, almost three times that of 1968, and ranged from 0 to 24 egg-masses per tip. Such an increase in egg-mass numbers was sufficient to predict that larval populations in the spring of 1970 would be considerably higher than those of 1969. Instead, early-instar larval population densities as measured twice in 1970 averaged only 7.6 larvae per 24" tip and ranged from 0 to 36 larvae per tip.

All jack-pine budworm foliage samples, whether collected for larval or egg-mass counts, are normally taken from the mid-crown of dominant or codominant jack pine or red pine trees. Additional observations in the infested areas, however, showed unusually high budworm population on understory plantings and natural regeneration, including jack pine, white pine and red pine species. Apparently, either a downward redistribution of larvae occurred throughout most of the infested area or an unusually high degree of mortality among budworm populations occurred in the upper stand canopies--or both. From much fragmentary evidence it would appear most likely that the first possibility, namely a heavy dispersion of larvae which followed egg hatch in August, 1969, was responsible for this marked change. In any event, the number of larvae present on dominant and codominant trees was insufficient to cause consistently severe defoliation.

On June 17, an urgent meeting of those concerned was called at Pembroke, at which detailed entomological information was presented by the Canadian Forestry Service and at which forest management considerations were supplied by the Ontario Department of Lands and Forests. From the entomological viewpoint it was considered quite inappropriate to spray insect populations which had been declining through natural means, providing of course that the risk of additional damage to the stands could be tolerated. From the forest management point of view, plans had already been made to salvage much of the affected timber and some additional damage by the budworm was not likely to affect that operation appreciably. When these points were taken into consideration, it was decided to cancel the spraying operation. Although the final decision not to spray was necessarily that of the provincial department, the decision to cancel the operation was made with the concurrence of both working groups.

Defoliation surveys of late July, 1970 indicated that about 3300 acres of jack pine suffered moderate to severe defoliation compared to about 22,000 acres of severe damage in 1969. Light defoliation was evident on overstory pines throughout the remaining 18,700 acres but the defoliation of understory trees and regeneration of all species was moderate to severe.

Forecasts for 1971

Fall egg counts of 1970 averaged 0.3 egg-masses per 24" tip. This represents a 90% decrease in the density of egg-masses over 1969. Light defoliation interspersed with pockets of moderate to severe defoliation is forecast for 1971, and hence no chemical control is contemplated.

Petawawa-Deep River and Sault Ste. Marie Infestations

The general jack-pine budworm infestation picture is favourable in both areas where spraying against this pest was carried out in 1969. Defoliation of sufficient intensity to be detected by aerial reconnaissance was confined to two small pockets of infestation in the vicinity of Deep River and the forecast based on 1970 fall egg surveys calls for the virtual termination of both outbreaks in 1971.

Parry Sound District Infestation

The probable need for forest spraying is recognized in a 7500-acre stand of jack pine near Illfed Lake in parts of Wilson, McKenzie, and Mills townships, 25 miles south of Lake Nipissing. The stand lies some 30 miles east of where approximately 100 square miles of scrubby jack pine has suffered severe tree mortality (greater than 50%) by the jack-pine budworm over the past several years. The Illfed Lake stand was defoliated severely by the jack-pine budworm in 1969 and again in 1970, and in our opinion a recurrence of heavy feeding in 1971 would result in appreciable top-killing and some tree mortality. Ontario Department of Lands and Forests officials claim that further permanent damage in this area cannot be tolerated since the stand is scheduled for cutting in the foreseeable future.

Owing to the inaccessibility of the area and the scarcity of suitable lakes on which to land aircraft, sampling so far has been meagre and the infestation potential is still not known. The future course of action will largely be determined by the results of an egg survey made possible by the use of snow machines this winter.

Statement prepared for the Interdepartmental
Committee on Forest Spraying Operations.

October 22, 1970.

Field evaluation of the effectiveness of ultra-low-volume application of insecticidal sprays from aircraft for the control of the spruce budworm (Choristoneura fumiferana Clem) in New Brunswick 1970.

Chemical Control Research Institute
Project No. CC-001

by

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

Preface

The 1970 spruce budworm experimental spray project is the sixth in a series of investigations carried out be the Chemical Control Research Institute to study the control of the spruce budworm (Choristoneura fumiferana Clem) by means of ultra-low volume emission of non-chlorinated hydrocarbon type insecticides from aircraft. The project has been supported in part by personnel and equipment from Forest Protection Ltd., N.B., the use of aircraft facilities by the New Brunswick Development Corporation; and by the donation of insecticides and solvents from Chemagro Corp., Cyanamid of Canada, Ciba Co. Ltd., Dow Chemical of Canada, Dupont of Canada, McLaughlen Gormly King Co. Ltd., (U.S.A.), and SB Penick & Co., (USA).

The complete project consisted of thirteen experimental plots each of 400 acre size established within a moderately infested spruce budworm forest in Westmoreland County, N.B. The general area in which the plots were located, the base camp and the location of the airport is illustrated in Figure I.

To facilitate the handling of data and objectives, the experiments were grouped into five units (Parts 1, 2, 3, 4, and 5) to investigate the effectiveness of insecticides according to application date, larval instar and tree phenology. The subdivision of the project with summary of treatments and application dates are presented in Table I.

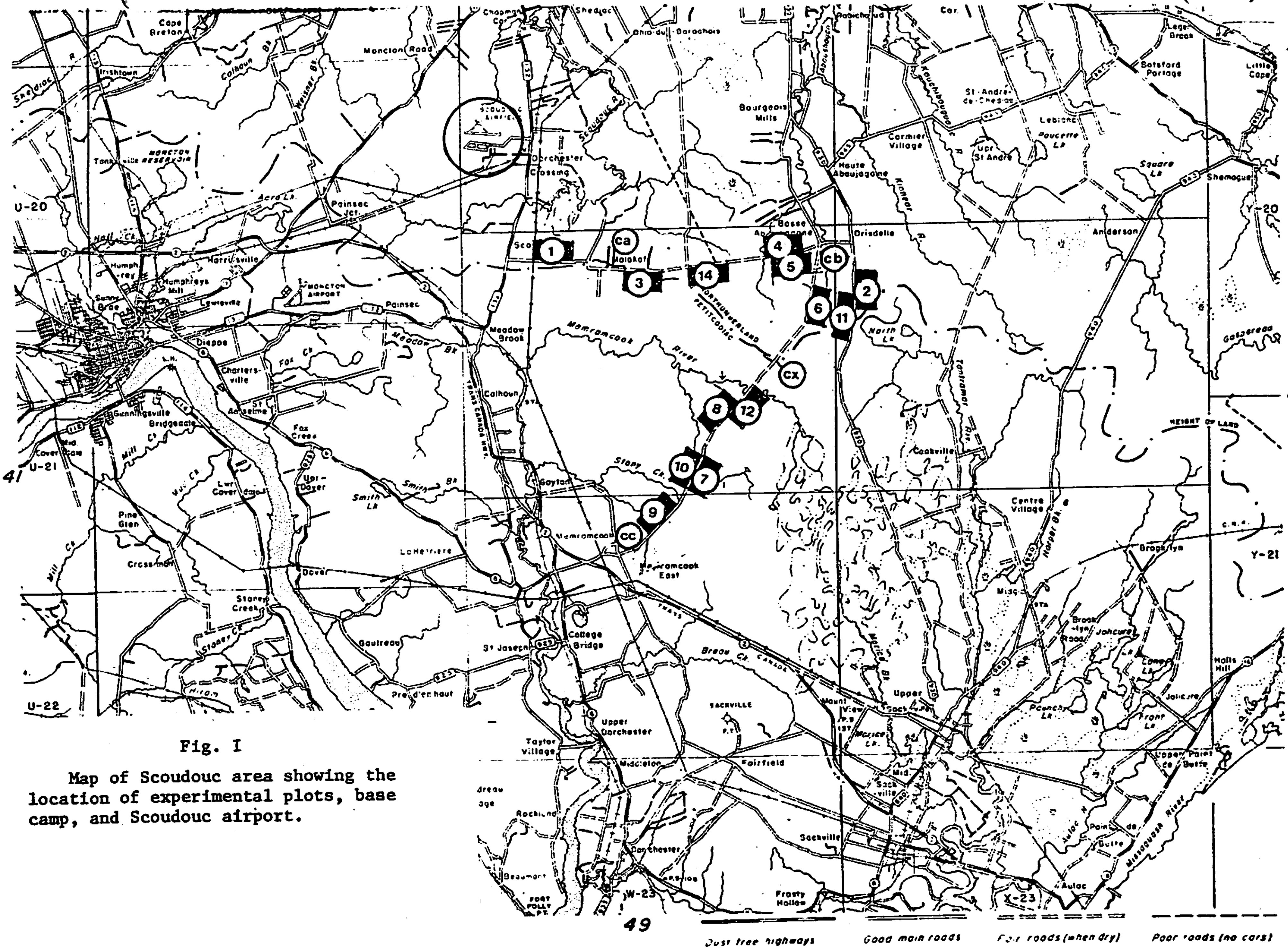


Fig. I

Map of Scoudouc area showing the location of experimental plots, base camp, and Scoudouc airport.

TABLE I

Summary of plot treatments and application dates

Project No.	Plot No.	Insecticide Treatment	Active Content/US gal.	Volume emitted gals/400 acres	Application date 1970	Larval Instar
CC-001 Part 1	3	Accothion *	4.2 lbs/gal	42.5	May 16	99%-2nd
	4	Matacil	2.6 lbs/ "	37.5	" 15	99%-2nd
	5	Zectran	0.15 lbs/"	75.0	" 15	99%-2nd
CC-001 Part 2	1	Dylox	4.0 lb/ "	35.0	May 29	63%-3rd
			4.0 lb/ "	35.0	June 4	
	2	Lannate	1.0 lb/ "	22.5	June 1	64%-3rd
			1.0 lb/ "	22.5	June 5	
	6	Matacil	1.5 lb/ "	22.5	May 30	68%-3rd
			1.5 lb/ "	22.5	June 5	
CC-001 Part 3	8	Ciba 17974	2.0 lb/ "	22.5	June 12	40%-4th
	14	Dylox	4.0 lb/ "	35.0	June 17	37%-6th
			4.0 lb/ "	35.0	June 19	
	12	Lannate	1.0 lb/ "	22.5	June 22	74%-6th
			1.0 lb/ "	22.5	June 23	
	11	Matacil	1.5 lb/ "	47.5	June 18	39%-5th
CC-001 Part 4	10	Pyrethrin (7014)	0.2 lb/ "	68.5	June 8	51%-4th
	7	"	0.2 lb/ "	47.5	June 22	70%-6th
			0.2 lb/ "	37.5	June 26	
	9	Pyrethroid (SBP 1382)	0.8 lb/ "	22.5	June 20	57%-6th
CC-001 Part 5	Calibration Trials - AU 3000 Micronair Comparison of Curved Fans V/S straight fans				July 4	

* Fenitrothion - (Accothion, Sumithion, Novathion)

Part 1 - The effect of early ultra-low volume spray application of Matacil, Sumithion and Zectran on 2nd instar spruce budworm larvae and host tree defoliation.

Part 2 - Ultra-low volume application of Dylox, Ciba 17974, Lannate and Matacil on 3rd instar spruce budworm larvae and subsequent tree defoliation.

Part 3 - The effect of late spray application of Dylox, Lannate and Matacil on spruce budworm larvae and tree defoliation.

Part 4 - Field evaluation of new stabilized Pyrethrum and Pyrethroid formulations against spruce budworm larvae.

Part 5 - AU-3000 Micronair calibration trials.

Plot Size and Spraying Procedure

The dimensions of the plots (1 mile by ½ mile) were selected to provide swath runs of sufficient length to allow rpm stabilization of the rotating ULV spray equipment and sufficient plot depth to enable overlapping of spray runs on a cross wind spray emission to provide an incremental dosage pattern across the experimental plot as shown in Fig. 2. Each plot contained two sampling lines at right angles to the base line. Biological and chemical sampling stations were established at 1 chain intervals along each line to provide a total of 72 sample trees per plot.

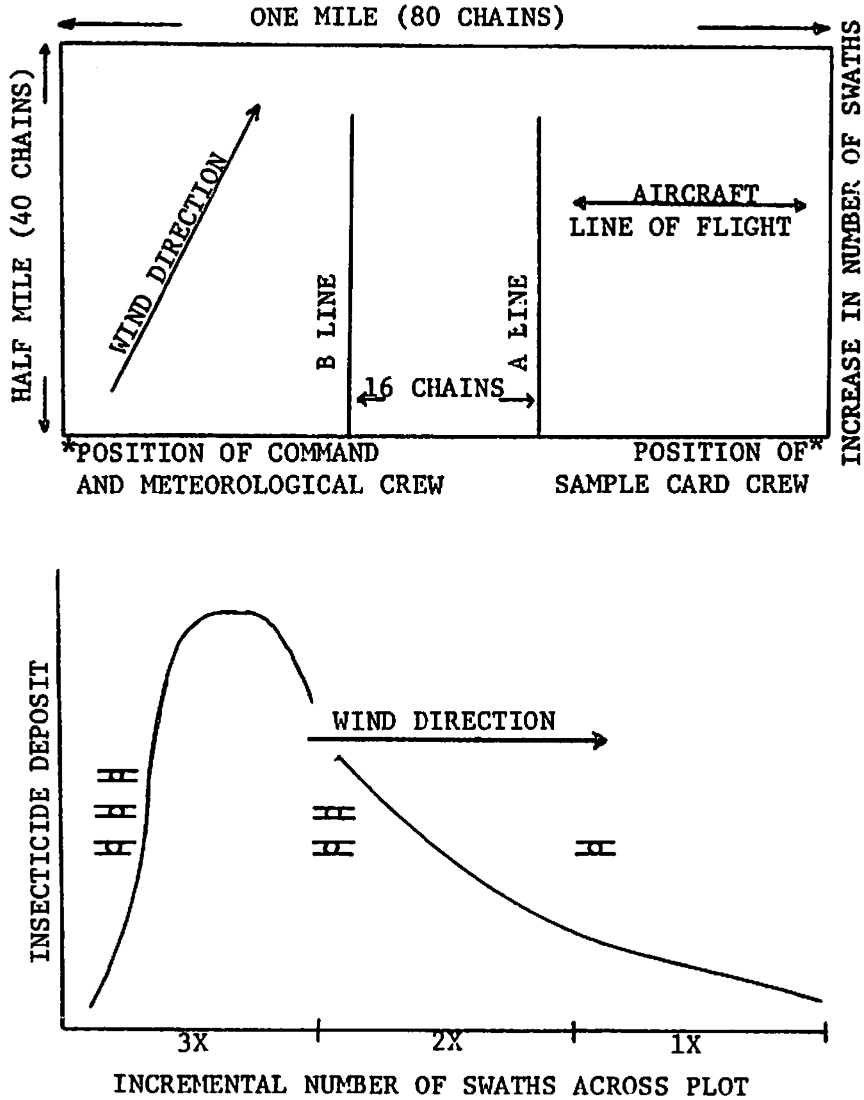


FIGURE 2

<u>Natural Mortality and Experimental Mortality</u>

The experiments were designed to investigate the effects of very early (pre 2nd instar emergence), early (3rd instar), and late (5th and 6th instar) sprays. Untreated control plots were established within the experimental area to determine the natural progression of larval mortality as shown in fig. 3

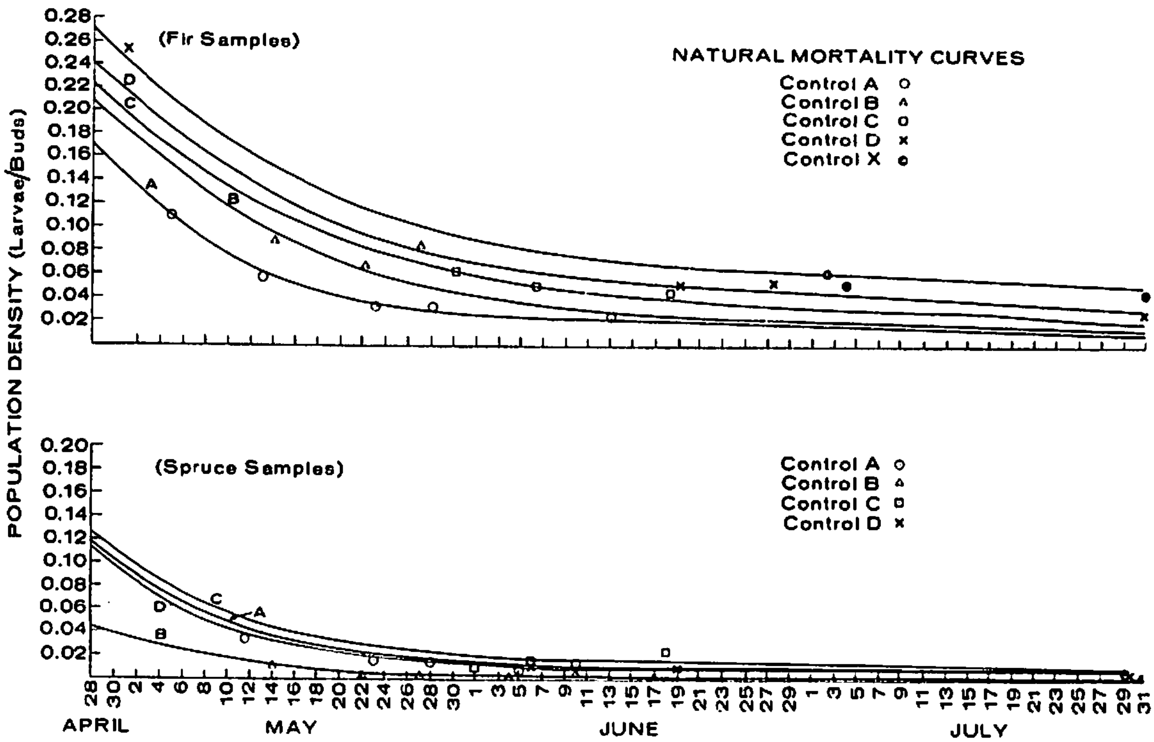


Fig. 3 Natural Mortality curves for spruce budworm larvae on fir and spruce in the untreated control plots.

The effectiveness of the treatment was measured by comparing the post-spray population trend on each plot with the expected untreated population levels derived from the extrapolation of the pre-spray larvae densities from each plot. Thus the percentage population mortality levels were calculated using a modified Abbott's formula as follows:

$$\% \text{ population reduction} = \frac{\text{expected larval density} - \text{observed larval density}}{\text{expected density}} \times 100$$

Results and Conclusions

Part I - The effect of early ultra-low volume spray application of Matacil, Sumithion, and Zectran on 2nd instar spruce budworm larvae and host tree defoliation.

Results of a single application of Matacil, Sumithion, and Zectran indicated that a relatively high degree of budworm control and foliage protection can be obtained by a very early application of a systemic insecticide as shown in the following Table

Table I

Summary of plot treatments, larval reduction and defoliation. (99% - 2nd Instar)

Plot No. Treatment	Application Date	Spray Deposit Category		% Population Reduction		% Defoliation	
		drops/cm^2	oz/ac (active)	Fir	Spruce	Fir	Spruce
P-3 Sumithion 2 lb/gal	May 16/70 5	0-1 10-15 20-25	0.24 1.24 2.75	0 42 84	0 - 68	40 13 12	28 10 5
P-4 Matacil 2.6 lb/gal	May 15/70	1-5 20-25 25-30	0.27 1.70 1.80	0 25 68	- 9 55	60 27 14	55 8 10
P-5 Zectran 6 oz/gal	May 15/70	0-1 5-10 20-25	0.07 0.21 0.65	0 38 68	0 32 -	17 5 5	15 10 -
Untreated Control	-	-	-	-	-	17	22

In P-3 and P-4 the lowest category of spray deposit show a high order of defoliation which is indicative of a higher pre-spray population density in these plots than the untreated controls. With increasing spray deposit, Sumithion, Matacil and Zectran showed a progressive increase in larval mortality and a decrease in host tree defoliation. The order of effectiveness appears to be - (1) Sumithion (2) Matacil and (3) Zectran, at comparable dosages tested.

Part 2 - Ultra-low-volume application of Dylox, C-17974, Lannate and Matacil on 3rd instar spruce budworm larvae and subsequent tree defoliation.

This series of trials was established to determine whether Dylox, C-17974, and Lannate exhibited systemic toxicity to the early instar budworm larvae. Matacil, a proven systemic insecticide, was used as a standard. The results as shown in the following Table confirm the effectiveness of Matacil and show that Lannate is relatively ineffective as an early spray insecticide at the dosages tested. Dylox, however, shows moderate effectiveness at a dosage rate approximately five time that of Matacil.

Table II

Plot No. Treatment	Application Date	Spray Deposit Category		% Population Reduction		% Defoliation	
		drops/cm^2	oz/ac (active)	Fir	Spruce	Fir	Spruce
P-1 Dylox 4 lb/gal	May 29/70 June 4/70	0-1 10-15 30-40	1.01 2.7 5.8	0 24 63	0 0 21	- 8 5	5 10 5
P-2 Lannate 1 lb/gal	June 1/70 June 5/70	1-5 15-20 30-40	0.14 0.33 0.64	0 0 0	0 0 0	12 12 15	10 10 7
P-6 Matacil 1.5 lb/gal	May 30/70 June 5/70	0-1 5-10 20-30	- 0.57 1.17	0 53 79	0 17 65	16+ 14 11	- 36 10
Control	-	-	-	-	-	16	22

Part 3 - The effect of late spray application of Dylox, Lannate, and Matacil on spruce budworm larvae and tree defoliation.

Results of a double application of Dylox, Lannate, and Matacil on 5th and 6th instar budworm larvae indicated that all three compounds are highly effective in controlling budworm on both fir and spruce trees at deposit densities of 15 to 20 drops/cm^2. Ciba-17974 was relatively non-effective at comparable dosages. The order of toxic efficacy appears to be (1) Matacil, (2) Lannate, (3) Dylox and (4) C.-17974.

Table III

Summary data from late spray application experiments.

Plot No. Treatment	Application Date	Spray Deposit Category		% Population Reduction		% Defoliation	
		drops/cm^2	oz/ac (active	Fir	Spruce	Fir	Spruce
P-8 Ciba 17974 2 lb/gal	June 12/70	0-1 5-10 25-30	0.15 0.55 1.8	27 34 40	25 21 76	97+ 70 -	70+ 61 45
P-14 Dylox 4 lb/gal	June 17/70 " 19/70	1-5 15-20 30-40	0.46 2.45 5.24	85 100 100	85 82 100	12 12 10	21 15 13
P-11 Matacil 15 lb/gal	June 18/70 " 18/70	0-1 15-20 25-30	0.07 0.76 1.50	82 100 100	60 100 100	8 3 2	10 5 5
P-12 Lannate 1 lb/gal	June 22/70 " 23/70	0-1 10-15 25-30	0.09 0.27 0.85	46 92 97	13 94 94	97 75 30	85 48 35
Control CX	Aug. 10/70	-	-	-	-	98	97

Analysis of foliage protection of late application sprays indicates that a moderate to heavy degree of defoliation had occurred prior to spray application. The degree of defoliation increases directly with time and reaches its maximum with high larval density such as in the control plots i.e. 98% defoliation. The original larval density within each experimental plot is suggested by the defoliation that occurs in the 0-1 drop category. For example, in Plot 11 and P-14, the maximum defoliation (8% to 12%) is due to a relatively low population density of budworm. Thus any protection effected by the action of the insecticide will be reflected by a decrease in defoliation in the higher spray droplet categories.

Part 4 Field evaluation of the new stabilized Pyrethrum and Pyrethroid formulation against spruce budworm larvae.

Preliminary field trials on the use of botanical insecticides (stabilized pyrethrum and synthetic pyrethroid SBP-1382) for the control of the spruce budworm larvae show that both compounds are extremely effective against the exposed larvae at very low dosages as shown in the following Table.

Table IV

Plot No. & Treatment	Application Date	Spray Category		% Pop. Reduction		% Defoliation	
		drops/cm^2	Oz/ac (Active)	Fir	Spruce	Fir	Spruce
P-10 Pyrethrin (7014) 0.2 lb/gal	June 8/70	0-1 1-5 10-15	0.01 0.02 0.09	0 0 10	0 0 0	100 67 78	82 96 80
P-9 Pyrethroid SBP (1382) 0.8 lb/gal	June 20/70	1-5 5-10 10-15	0.06 0.12 0.10	5 67 100	- 57 -	29 15 8	29 16 -
P-7 Pyrethrin (7014) 0.2 lb/gal	June 22/70 June 26/70	10-15 20-25 30-40	0.11 0.19 0.38	8 26 63	68 70 92	86 94 50	97 95 90
Control CX	-	-	-	-	-	98	97

The order of effectiveness appears to be (1) Pyrethroid SBP-1382 (100% larval mortality at 0.10 oz/ac active); (2) Pyrethrum 7014 (90% larval mortality at 0.4 oz/ac). The early application trials for pyrethrum 7014 indicate that this material is non-systemic and thus in-effective as an early spray insecticide. Pyrethroid SBP-1384 on the other hand in addition to being highly effective as a contact material exhibits some systemic properties as evidenced by the reduction in foliage damage with increasing spray deposit. Both of these compounds warrant further study.

Part 5 - AU-3000 Micronair Calibration Trials

Results of four calibration trials to compare the effectiveness of the new curved fan blades to the standard flat blades on the micronair units show that the new blades are superior in performance as evidenced by the decrease in the (mass median diameter) (MMD) and (number median diameter) (NMD) of the spray cloud. The results of these trials are summarized below for comparable flow rates and air speeds.

Table V

AU-3000 Micronair Calibration Trials

Spray Classification	Flat Fans		Curved Fans	
	#4 disc	#5 disc	#4 disc	#5 disc
NMD	33	38	27	28
MMD	84	83	79	68
D max	145	155	130	145

Note

The preliminary results presented in this report have be condensed for the sake of brevity, to show only the effectiveness of the experimental insecticides on the insect and their host trees. The chemical, physical, toxicological, and biological data on other life forms will appear in the final report.

APPENDIX 11

THE OPERATIONAL APPLICATION OF CANDIDATE INSECTICIDES FOR THE CONTROL OF THE SPRUCE BUDWORM (CHORISTONEURA FUMIFERANA CLEM.)

J.A. Armstrong

Three insecticides, Lannate, Matacil, and Dylox were applied to 2,500 acre blocks by Forest Protection Limited according to standard operational procedures. The purpose was to provide more complete data to follow the laboratory trials and the experimental applications on the use of these insecticides. This was a cooperative scheme involving the Chemical Control Research Institute, Canadian Forestry Service (Fredericton Laboratory). Forest Protection Limited, Canadian Wildlife Service and the Fisheries Research Board to study the effect of the insecticides on birds, fish and some other insect species.

Each insecticide was applied as two half doses at 5 day intervals. Lannate, with an aimed-for 1.6 ounces per acre, was applied to peak II-III instar budworm; Matacil, with an aimed-for 2.5 ounces per acre was applied to two blocks; one at a peak II-III population and other at peak IV-V instar population; and Dylox with an aimed-for 12 ounces per acre was applied to a peak IV-V instar population. Budworm densities were determined using sequential sampling procedures at a pre-spray date and three post-spray dates. The final post-spray sample was a pupal count in which living pupae were recorded. The normal population decline in untreated control trees was determined and from this the corrected population reductions for each treated plot were determined. At each sample date upper and mid-crown branches from 20 balsam fir, and 20 spruce were cut and the budworm density ascertained. At the time of the aerial spray 40 kromekote cards and 40 petri dishes were set out at 2 chain intervals across the plot and at right angles to the line of flight of the aircraft.

The tests showed the following order of effectiveness from most to least effective:

Matacil > Dylox > Lannate

In the following table the insecticide deposit for each plot and the corrected insect reduction at each of the three post-spray sampling dates are shown. The percentage reduction due to fenitrothion treatment in an operational block is also shown.

TABLE

The percentage reduction in spruce budworm population after application of insecticide.

Insecticide	Peak Instar at Application	Deposit (oz/a)		1st post-spray count (Larval)			2nd post-spray count (Larval)			3rd post-spray count (pupal)		
		Planned	Actual	Day Int*	B.fir	Spruce	Day int*	B.fir	Spruce	Day int*	B.fir	Spruce
Lannate	II-III	1.6	0.73	0	11.7	38.5	7	24.3	47.5	35	0	14
Matacil	II-III	2.5	1.5	2	41.9	44.5	9	69.4	37.8	31	63.4	28.1
Matacil	IV-V	2.5	2.4	3+	32.1	12.5	2	62.6	32.8	23	91.7	100
Dylox	IV-V	12	8.3	2'	40.2	20.6	1	64.5	64.4	17	88.4	94.9
Fenitrothion	IV	4	-	4	35.3	24.2	9	60.7	38.8	26	26.6	20

* Day interval - the number of days after the second application

\+ Day interval - three days after the first application

' Day interval - two days after the first application

DISCUSSION

All plots received good coverage across their width. The spray application times were, with the exception of the first application of the early Matacil, under ideal conditions. The early Matacil block reveived its treatment in the evening and at the time of the spray the cloud was observed to hang, suggesting that weak inversion conditions existed.

Lannate** - Nigam (see P.13) has shown that Lannate ceases to be biologically active after 48 hours exposure to weathering. The operational application employed a 5 day interval between each half dose. It would therefore appear that the low kill on the Lannate block was caused partially by the lack of accumulation of the deposits and partially by the low total deposit.

Matacil - The early application of Matacil resulted in less insect reduction than the late application. The early treatment block received a deposit of only 1.5 ounces per acre whereas the late treatment block received 2.4 ounces per acre. Matacil also gave excellent control of blackflies but did not affect the mosquitoes. Matacil could be successful if applied at the rate of 2.5 oz. per acres (2 x 1.25).

Dylox - Dylox gave very good control. The block received 75 percent of the planned deposit. Dylox could be successful if applied at 12 oz per acre (2x6 oz very short time interval).

Fenitrothion - The operational block received a light coverage which resulted in poor control. With a drop density of $3.9/cm^2$ giving a population reduction of 20-25 percent at the final count these results are in direct agreement with studies by Randall in 1969.

** Lannate = Methomyl

Tests of Virus for Control of the Spruce Budworm, *Choristoneura fumiferana*

F. T. Bird

Studies on the artificial dissemination of the nuclear polyhedrosis virus of the spruce budworm, *Choristoneura fumiferana* were continued in 1970 on balsam as well as on spruce. The much more infective but less lethal cytoplasmic polyhedrosis virus was also tested singly and in combination with the nuclear polyhedrosis virus. Groups of trees rather than individual trees were treated and a small pressure sprayer delivering a fine mist was used in making the applications.

Both viruses are inactivated by solar radiation and there was no infection when trees were sprayed prior to emergence of the larvae from hibernacula, and very little infection until most of the larvae had emerged. Larvae commenced emerging on April 30. There was no infection on trees sprayed with virus on April 30, and May 5, and only a few larvae were infected on trees sprayed on May 8. High infection was obtained on trees sprayed on May 12 and thereafter. There appeared to be no difference in rates of infection on spruce as compared to balsam and results similar to those obtained on spruce in 1969 were obtained both on spruce and on balsam in 1970.

A suspension of the nuclear polyhedrosis virus containing 1/2 gm of freeze-dried virus-diseased tissue (about 40 diseased sixth instar larva) macerated in 1 gallon of water is sufficient to initiate an epizootic which will infect and destroy most of the larvae on a tree sprayed with the virus.

High percentages of infection can be obtained throughout the season. An early application has the advantages of (1) additional later infection by natural transmission of virus and (2) reducing defoliation.

High percentage of infection was also obtained with the cytoplasmic polyhedrosis virus using as little as 5 diseased larvae in 1 gallon of water. There was no evidence that larvae were killed by the virus but it did produce severe gut infections. However, it was not as infectious in the field as in the laboratory and this is attributed to its inactivation by drying. Almost 75% of the virus in a larva infected with the cytoplasmic polyhedrosis virus is in the form of unoccluded virions. Apparently this virus can withstand freezing but not drying. The material is therefore not freeze-dried but simply frozen. However it appears to be inactivated rapidly on foliage so the end results of using simply frozen or freeze-dried material are the same. The possibility of obtaining improved results by disseminating virus during a rainy period will be investigated.

Virus can be disseminated 2 or more times during the season. Spraying during the second instar and again during the fourth instar would appear more effective than spraying twice as much virus at one time.

Encouraging results were obtained using both viruses, spraying the less infectious nuclear polyhedrosis virus first and the cytoplasmic virus about 2 weeks later. Similar results might be obtained by spraying both viruses at the same time giving the less infectious nuclear polyhedrosis virus a large advantage in dosage.

These tests do not give any real indication of the quantities of virus that may be required for an operational spray on a large scale. Mass propagation of the nuclear polyhedrosis virus is in progress and it is expected that sufficient quantities of this virus will be available for large scale experiments possibly using aircraft in 1971.

1970 Testing of Bacterial Microbial Insecticides against *Choristoneura fumiferana*

T. A. Angus

In 1969, the microbial insecticide Thuricide 90TS was tested against larvae of the spruce budworm *Choristoneura fumiferana* on balsam-fir and spruce near Chipman, N.B. The spray was applied on June 13 and at that time the development of spruce buds lagged behind that of balsam-fir. It had been anticipated that there would be less mortality on spruce because, at the time of spraying, larvae were feeding in buds still enclosed by bud-caps. The results were contrary to expectation in that there was no appreciable diff-erence in the mortality observed.

In 1970 in Parkinson Twp. District of Algoma, small isolated white spruce trees (7-10 feet high) heavily infested with spruce budworm received a single spraying on one of the following dates: Apr. 31, May 1-7-13-19-22-26-29, June 3-8-13 and 17. These spanned the period from emergence of larvae from their hibernacula until sixth instar larvae were noted. Two commercial formulations, Thuricide 90TS (International Minerals Corp., Skokie, Ill., U.S.A.) and Dipel (Amdal, Division of Abbott Laboratories, North Chicago, Ill., U.S.A.), and some experimental formulations of wetters and stickers were used. Sprays were applied in water to run-off in order to achieve a frank overdose.

Although the data are still being analyzed in detail, some preliminary conclusions can be drawn. Both of the commercial formulations were effective and it was found that on coniferous foliage the use of wetters and stickers is beneficial. A Geon latex preparation gave especially good adhesion.

Larvae in the needle-mining stages (Apr. 30-May 13) were found dead in needles, and cadavers were positive for *B. thuringiensis* (the basis of the microbial insecticides). Larvae feeding in covered buds (May 19-29) seemed to be less vulnerable but some mortality was noted. After June 3 most of the bud-caps had been shed and much mortality was observed.

Examination of the sprayed trees and adjacent controls indicated that the early sprays (Apr. 30 to May 22) had appreciably reduced bud-damage. The sprays of May 26 and 29 appeared to be less effective in preventing bud damage. Greater damage was noted on trees sprayed June 3 to June 12 and was heavy on trees sprayed after this date.

It would appear that early sprays with these microbial insecticides should be investigated further since unlike late sprays they provide considerable protection of the current years foliage. It is recommended that in 1971 tests be continued using larger trees (15 to 20 feet) and that several new stickers be evaluated.

CONTENTS

INTRODUCTION

At the time of the meeting of the Interdepartmental Committee on forest spraying operations a year ago Forest Protection Limited and the Province of New Brunswick had already tentatively agreed to support the spraying of some three million acres of budworm infested forest in 1970 using substantially the same insecticide mixture, dosage and application technique as in 1969.

At this time a decision has not yet been taken regarding the spraying in 1971.

BUILDING THE SPRAY/PLAN

Actually the plan as carried out involved spraying almost $4\frac{1}{4}$ million acres and this area was arrived at after much discussion throughout the winter and spring. Planners had available results of the 1969 defoliation and egg mass surveys and a forest hazard estimate. Also available was an estimate of non susceptible forest which was built up from interpretation of the latest air-photo mosaics which were checked by air reconnaisance.

Survey area of anticipated heavy feeding totalled approximately six million acres. Subtracting areas of low susceptibility reduced this to approximately 4-3/4 million acres. Of this the fraction considered to be in need of spraying (from forest risk point of view) aggregated some 3-6/10 million acres and this number was accepted as the minimum plan along with the usual leeway for late spring amendments. During May-June approximately 625 thousand acres were added to the plan on the advice of Canadian Forestry Service bringing the total back up to approximately 4¼ million acres.

The task force which produced the plan consisted of Mr. E. Kettela of Canadian Forestry Service and the Company Management assisted by representatives of the sponsoring agencies.

The forest area to be sprayed was broken down into three categories. In category 1 a small category of forest in critical condition the plan called for spraying to prevent any further defoliation with the necessary application of 1/8 pound active fenitrothion applied at a rate of 0.15 U.S.G./ac.

In category 2 were conditions of first priority and the plan provided for spraying these twice whenever possible each time applying 1/8 pound of active fenitrothion in emulsion form at a rate of 0.15 U.S.G./ac.

In category 3 or lower priority areas the plan called for a single application at the same rate (0.15 U.S.G./ac.) but a dosage of 3/16 pound active ingredient.

PROCUREMENT OF INSECTICIDE INGREDIENTS

Over 980,000 lbs. of technical material was purchased from four sources of fenitrothion technical grade and one source of phosphamidon technical grade.

In addition over 110,000 pounds of emulsifier and about 200,000 pounds of solvent oil and all of 250 lbs. of dye were required to formulate the technical materials into emulsifiable concentrates. All of these are identified in Appendix I.

AIRCRAFT

The sprayer fleet was entirely T.B.M. In planning for the necessary number of sprayers it was assumed that a minimum of 55 hours would be available for spraying that production would be approximately one sortie/hour or 625 gallons. On this basis it was determined that a fleet of 27 sprayers would be sufficient. Twenty of these were procured in Canada and seven from the Western U.S.

Twenty-two Cessna aircraft were required to operate the guidance system and such other tasks as require availability of light aircraft.

One rescue and survey Helicopter was stationed at the central airfield (Dunphy) for the duration of operations.

CALIBRATION

Sprayer aircraft were all on site by May 24 and were calibrated for emission rate and spray break-up according to specifications identical with those of 1969.

OPERATIONS

Spraying took place during a long month beginning May 28 and ending June 28. In controlling the order of the work the Company kept a vigilant eye on the weather, insect and forest development and priority class. Spraying went slowly at first, running well behind 1969 for two weeks, then picked up speed (See Table 2 Appendix). Adverse weather prevented full coverage at or near optimum time. Especially was this so in category 3 where areas were added during rapid larval development and coastal fog slowed up work limiting the use made of a satellite spray field at Saint John Airport.

A log of the progress of the operations is shown in Table I Appendix in which gallons sprayed are listed by date for all spray sessions, separately for AM and PM, by weekly periods, out of each airfield and total.

On completion of spraying the coverage in three categories was as follows:-

Priority	Acres	Application	Dosage
1	67,000	3X	1/8 + 1/8 + 1/8 lb. active
2	1,983,000	2X	1/8 + 1/8 lb.
3	2,187,500	1X	3/16 lb.
Total	4,237,500	All applications 0.15 U.S.G./ac.	

Canadian Forestry Service nominated areas for spraying to about June 20, at which time the plan area and coverage by all available insecticide were roughly equal.

The Company was able to complete the plan with little time to spare and used up all stocks of insecticide.

General maps depicting extent of operations are distributed to sponsors and a few interested collaborators. Spray records too detailed to appear on maps are kept in Company files and can be examined by interested investigators.

THE MIXING OF INGREDIENTS FOR USE

Mixing was carried out as in 1969 with the exception that technical fractions were increased approximately 5% in order to make dosages read in lbs. of active ingredient.

CHECK ON PLANNED DOSAGES AND APPLICATION RATES DOSAGE

Pounds of technical purchased	982,000
Formulated for P.Q. Project	9,000
Available for N.B. Project	973,000
Equivalent pounds active ingredient	927,000
Required (theoretical) for map area treated	931,032
Difference (less than 0.5%)	4,032
Application rates	
Gallons sprayed	- 936,482
Gallons theoretical for map area treated	- 948,075
Difference (1.2+%)	11,593

OPERATIONAL HIGHLIGHTS

The guidance system functioned well - in fact it was thought to have improved in performance over earlier years.

There were several flying incidents. Early in the programme a T.B.M. was lost on take-off at Dunphy. The pilot was unhurt. A short time later a T.B.M. got out of control on take-off at Chipman and ended up off the runway but still intact, except for the propellor. Again the pilot was unhurt. This aircraft was back at work after repairs.

Most serious was the loss of a T.B.M. and pilot out of Chipman. After a reported oil leak and an attempt to reach Saint John Airport for repairs, the plane was seen to go out of control and crash in timber and burn. The pilot and aircraft were from Yakima, Washington.

Airfields enjoyed a larger measure of control over their individual parts of the work-pile than has been the custom for some time and this paid off in closer liaison between field and H.Q. personnel.

EFFECTIVENESS OF SPRAYING

Populations of budworms were high in 1970. Wherever heavy populations went unsprayed the forest changed colour from green to red. Some areas of red showed up in the Southern counties and some but not all of this was expected either because of late addition to the plan or late coverage because of adverse weather or both.

Over a large part of the sprayed forest the colour did not change to red but something closer to its original tone and sometimes the original colour remained.

The insecticide performed much as it did in 1969 and it must be assumed that in most cases the insecticide got to the target in time to save some needles. The fact that it was an excellent foliage year compared with 1969 takes little away from the effect of the treatment.

A large fraction of the severely defoliated forest in 1970 lies outside the sprayed area.

PROVINCE OF QUEBEC SPRAY PROJECT

At the request of the Department of Lands and Forests, Quebec, the Company carried out a small spray project in the area of Gatineau Park and the lower Gatineau as far north as Low.

The coniferous areas infested with spruce budworm were scattered in distribution (thirty areas aggregating some 27,000 acres were treated) and the spraying was necessarily of a discontinuous nature.

The Company employed three Stearman sprayers guided by a leading Cessna.

Operations were from Carp Airport.

Emulsifiable concentrate was mixed in New Brunswick and transported to Carp. Final batch mixing of emulsion took place only as needed.

Dosage and application rate was the same as in N.B. Calibration was the same as in Ontario 1968. Two applications were made as much as 10 days apart.

Afterward the sprayers moved to Mont Laurier and from a local field sprayed some 2,500 acres of Jackpine infested with Jackpine budworm.

MAINE SPRAY PROJECT

The State of Maine sprayed about 210,000 acres of forest infested with spruce budworm. The Company assisted in a number of ways - by consultation during planning, supply of aircraft servicing equipment and provision of one unit of the guidance system.

Spraying was in all respects like that in N.B., Category 2, including the insecticide mixture. The sprayer force consisted of three T.B.M. aircraft which were calibrated by the Company.

Results were almost identical with those in N.B. There was a saving of foliage and a slight reduction of insect population.

The State Forestry Dept. has recommended no spraying in 1971.

A very interesting monitoring of the work to evaluate the effects of the spraying on off target organisms as well as budworm was made by a number of services including State and Federal fish and wildlife services, U.S.D.A. Forest Service, Maine Forest Service, and Health and Welfare.

All investigators agreed to pool their findings in a single report which should become available about February next from the N.E. Forest Experiment Station, U.S.F.S.

CANADIAN FORESTRY SERVICE - C.C.R.I. - F.P.LTD.

large scale testing of candidate chemicals.

The Company part in this project is confined to the application of materials which was successfully carried out in 9 sorties.

ASSISTANCE TO OTHER PROGRAMMES

The Company made available a Stearman sprayer to the C.C.R.I. testing programme which located at Scondouc Airport.

Vehicles, aircraft and personnel when needed were provided C.C.R.I. and C.F.S. over and above that customarily provided surveys (larval, pupal, egg mass, etc.).

Assistance was also given the C.F.S. epicentre project.

SPRAYING OF FEDERAL LAND AREAS IN N.B. INFESTED WITH SPRUCE BUDWORM

The Company sprayed the complete area of Fundy Park in the manner described for Category 2.

There was a most spectacular improvement in the appearance of the trees afterward but for many fir trees on several thousand acres split by the main access road the decision to spray came two years too late.

Camp Gagetown and Acadia Forest Experiment Station were not in the spray plan, however one corner of the Acadia area was treated by mistake.

DEFOLIATION SURVEY

In 1969 and again this year the Company made a partial survey as soon as possible after spraying turning the aircraft over to C.F.S. to complete the work in the corners of the Province not recently supporting heavy populations of insects.

This is not the best or cheapest way to work. It is suggested that another time cooperation should extend as far as paying for the work but that the survey itself should be continuous and directed by one authority.

APPENDIX I

PURCHASED FOR 1970 PROJECT AND USED IN FORMULATION OF INSECTICIDE EMULSION

ORGANOPHOSPHATES	SUPPLIER	QUANTITY
Fenitrothion Technical:		
Sumithion	Sumitomo Shoji Canada	374,087 lbs.
Folithion	Chemagro Limited	299,839 lbs.
Accothion	Cyanamid of Canada	250,250 lbs.
Novathion	P. Leiner & Sons (Canada) Ltd.	551 lbs.
Phosphamidon Technical	CIBA Company Ltd.	57,661 lbs.
	TOTAL	982,388 lbs.

Other		
Aerotex 3470 Solvent	Texaco Canada Ltd.	20,918 Imp.Gal.
Atlox 3409 Emulsifier	Atlas Chemical Industries Ltd.	55,559 lbs.
Toximul MP8 Low Viscosity Emulsifier	Chas. Tennant & Co. (Canada) Ltd.	56,767 lbs.
Calco Red Y	Cyanamid of Canada	250 lbs.

APPENDIX II

COMPARISON 1969 & 1970 OPERATIONS
PRODUCTION BY WEEKS

WEEK	A.M. GALLONS	P.M. GALLONS	PERCENT A.M.	PERCENT P.M.	WEEK GALLONS	PERCENT PROJECT
'69 27-2	115,657	39,115	75	25	154,772	18.5
May-June						
'70 28-3	66,288	29,584	69	31	95,872	10.2
'69 3-9	187,500	44,463	81	19	231,963	27.8
June-June						
'70 4-10	101,852	83,770	55	45	185,622	19.8
'69 10-16	55,156	20,625	73	27	75,781	9.1
June-June						
'70 11-17	229,465	47,871	83	17	277,336	29.7
'69 17-23	250,829	93,818	73	27	344,647	41.3
June-June						
'70 18-24	218,187	55,619	80	20	273,806	29.2
'69 24-30	10,625	16,875	39	61	27,500	3.3
June-June						
'70 25-28	85,029	18,817	82	18	103,846	11.1
TOTALS	619,767	214,896	74	26	834,663	100.0
	700,821	235,661	75	25	936,482	100.0

APPENDIX III

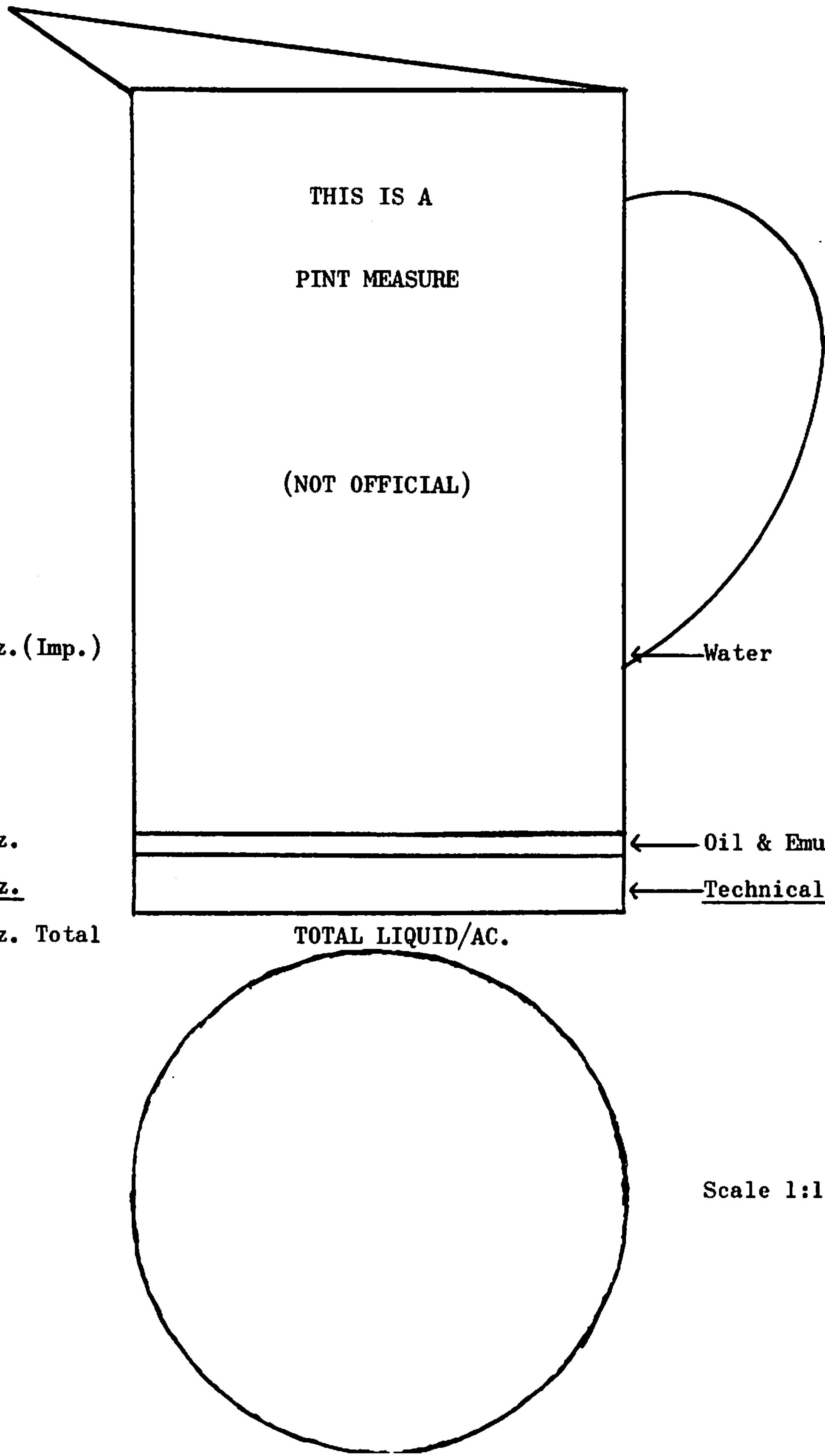
OPERATIONS LOG - GALLONS - N.B.

DATE	JUNIPER			DUNPHY			CHIPMAN			SAINT JOHN			PROJ. TOTALS		
	A.M.	P.M.	DAY TOTAL	A.M.	P.M.	DAY TOTAL	A.M.	P.M.	DAY TOTAL	A.M.	P.M.	DAY TOTAL	A.M.	P.M.	DAY TOTAL
May 28				2,604		2,604		625	625				2,604	625	3,229
29	9,339	5,104	14,443	6,250	3,125	9,375	7,504	6,876	14,380				23,093	15,105	38,198
30	11,216		11,216	6,250		6,250	6,875		6,875				24,341		24,341
31	5,625		5,625		3,125	3,125	6,875		6,875				12,500	3,125	15,625
June 1							3,750	6,042	9,792				3,750	6,042	9,792
2		4,687	4,687											4,687	4,687
3															
WK. 1	26,180	9,791	35,971	15,104	6,250	21,354	25,004	13,543	38,547				66,288	29,584	95,872
June 4	12,498	8,750	21,248	7,500	3,125	10,625	14,042	7,509	21,551				34,040	19,384	53,424
5				3,125		3,125	8,761		8,761	13,115		13,115	25,001		25,001
6															
7		7,500	7,500		18,125	18,125		24,376	24,376					50,001	50,001
8	11,251	5,635	16,886		1,250	1,250		7,500	7,500				11,251	14,385	25,636
9	11,260		11,260	9,050		9,050	11,250		11,250				31,560		31,560
10															
WK. 2	35,009	21,885	56,894	19,675	22,500	42,175	34,053	39,385	73,438	13,115		13,115	101,852	83,770	185,622
June 11	5,639		5,639	5,000		5,000							10,639		10,639
12	11,252	1,875	13,127	3,471		3,471	9,375		9,375	7,500		7,500	31,598	1,875	33,473
13	28,138	5,001	33,139	9,185	3,125	12,310	23,126	11,928	35,054				60,449	20,054	80,503
14	11,260	1,876	13,136	7,500	3,437	10,937	25,570	7,501	33,071				44,330	12,814	57,144
15	22,142		22,142	10,625	3,750	14,375	34,682	7,502	42,184	5,625		5,625	73,074	11,252	84,326
16	5,625	1,876	7,501	3,750		3,750							9,375	1,876	11,251
17															
WK. 3	84,056	10,628	94,684	39,531	10,312	49,843	92,753	26,931	119,684	13,125		13,125	229,465	47,871	277,336
June 18															
19															
20					3,750	3,750								3,750	3,750
21	11,254	5,625	16,879	18,750	5,000	23,750	5,250	10,000	15,250	6,797		6,797	42,051	20,625	62,676
22	28,760	5,626	34,386	36,875	5,625	42,500	4,999	4,366	9,365	15,625*		15,625	86,259	15,617	101,876
23	16,252	5,627	21,879	16,875	5,625	22,500	10,000	4,375	14,375				43,127	15,627	58,754
24	16,875		16,875	14,896		14,896	14,979*		14,979				46,750		46,750
WK. 4	73,141	16,878	90,019	87,396	20,000	107,396	35,228	18,741	53,969	22,422		22,422	218,187	55,619	273,806
June 25															
26	43,768	5,628	49,396	28,125	13,189	41,314							71,893	18,817	90,710
27															
28	9,386*		9,386	3,750*		3,750							13,136		13,136
WK. 5	53,154	5,628	58,782	31,875	13,189	45,064							85,029	18,817	103,846
TOTAL	271,540	64,810	336,350	193,581	72,251	265,832	187,038	98,600	285,638	48,662		48,662	700,821	235,661	936,482

*Final Spray Period

APPENDIX IV

APPLICATION RATE 0.15 U.S.Gallons/AC. = 1 Pint (Imp.)



		Parts
18.06 Fl.Oz.(Imp.)	Water	9,030
0.42 Fl.Oz.	Oil & Emulsifier	212
1.52 Fl.Oz.	Technical Fenitrothion	758
20.00 Fl.Oz. Total	TOTAL LIQUID/AC.	10,000

APPENDIX V

TBM AIRCRAFT CALIBRATION 1969

By R. Hanusiak

Flow Rate:* 20.6 U.S. Gallons per Minute
Swath Width (theoretical): 440 feet (1/12th mile)
Air Speed: 156 miles per hour
Application Rate: 0.15 U.S. Gallons per Acre
Nozzle Type: No. 4664 Diaphragm Check Valves (Spraying System)
Tip: No. 8010 Flat Fan (Spraying System)
Orientation of Nozzles: Down

PRESSURE SETTINGS AND NOZZLE NUMBER

A/C PROJECT NO.	NO. NOZZLES	PRESSURE LBS.	A/C PROJECT NO.	NO. NOZZLES	PRESSURE LBS.
601	20	41.0	501	20/19	40.0
602	20	40.0	505	20	42.0
604	20	40.5	506	20	42.0
605	20	40.75	507	20	41.0
606	20	43.0	508	20/19	42.0
609	20	45.0	x900	20	42.0
612	20	41.0	911	22	49.0
614	20	36.5	922	21	38.0
615	20	37.0	NIC	20	41.0
616	20	43.0	N2C	20	41.0
617	20	40.25	xA11	20	42.0
618	20	40.0	xA15	20	42.0
619	20	41.0	xD6	20	44.0

Average number nozzles - 20   Average pressure 41+ pounds

* Determined on ground by use of rotometer.

/ Recalibrated with 19 nozzles.

x Non-rotatable boom.

Note: This prescription is for 1970.

SPRUCE BUDWORM
1970-1971
SUMMARY REPORT

October 16, 1970

You have heard the technical details this morning of the budworm situation. Our goal, as in New Brunswick, is two-fold - (1) population reduction, (2) foliage-tree protection.

Populations are determined by statistical sampling systems trustworthy over many years.

Foliage protection or tree protection, and condition is decided on an ocular, long-experience, basis.

Population-wise reductions of 83-90% averaged 84%. Budworm was hurt but not extensively wounded. Reproduction-wise under populations of severe infestation conditions it was reduced by 1/7 - 1/8. Under the light-infestation conditions normally less expected to show increase, it more than doubled by 1-1/3 times. Thus the population reduction was real. The budworm, however, stayed as a potential.

Foliage/tree protection was very good - to the extent that the 1970 critical situation is relieved for 1971. Associated with it was the general observation that areas having the highest defoliation up to 1970 had the best tree protection by the spray operation. It has been quite generally recognized even with DDT that the higher the defoliation the better the reduction in population.

Areas of Concern - These consist of four, centered at, (1) Oxbow, (2) Cross-Madawaska Lakes, (3) East of Squa Pan, (4) Washington County. Area No. 1 has been discussed in detail earlier. In Nos. 2 and 3 defoliation is recent, and Washington County area shows a lessening or is at least no worse than in 1969.

Conclusions

(1) Operational control action is not recommended for 1971. Our belief is that stands were sufficiently benefitted that they will go through next year. Expectancy is for action 1972 but that is conjecture - actualities will depend on results of next year's surveys.

(2) Experimental or test applications should be made. This should include variations in formulations, i.e. especially in the field of oil solution as opposed to water emulsion. If time, other candidate insecticides should also be sought and considered. However, if such is decided, funding for same should be provided.

(a) Area involved should be of sufficient size to allow good interior areas to be sampled for the data.

(3) With the currently usable insecticide, evidence is that severe populations cannot be drastically reduced in the next generation, although tree protection can be accomplished.

(a) For this reason we will in the future need to be more discreet in deciding areas needing treatment for protection. With this undertaking owners should join more closely in arriving at these decisions.

(4) Shifting of cutting plans to operate in the high population areas could well be continued from the pre-salvage viewpoint. A side-light in an area cut last winter was that the few residual trees has unexpectedly light feeding 1970. An explanation could be that these were suppressed or at most intermediate trees before cutting and did not have eggs laid on them in 1969. However, egg numbers returned in 1970.

(5) Publicity should be increased to convince the public of the full importance of forests, of the serious potentialities of the budworm, and of the need to prevent tree killing. This is a continuous need to counteract and anti-pesticide publicity. Re: the 2-4-5-T case in Arizona.

Copied November 3, 1970

jm

SPRUCE BUDWORM IN MAINE - 1970

(Preliminary Report - Further data are expected and rechecking of present data may result in minor corrections but no significant change is expected.)

As recommended in the Fall of 1969, a control project using Fenithrothion (Accothion) was carried out against the spruce budworm in 1970. Some 210,000 acres were sprayed from a base in Presque Isle. The operation, centered on Oxbow, had two goals: population reduction and tree protection. Laboratory Facilities and Maine Forest Service field crews were based at Portage as usual.

Reduction of the spruce budworm population as a result of the treatment was less than had been experienced in previous projects using DDT. Reduction in 1970 was of the order of 84% as compared to 86.8% in 1967, 95.7% in 1964, and 98.5% in 1963. Many budworm were killed as indicated by field evidence and drop sheets and the 1969-1970 egg mass population trend in the treated area was downward (as will be seen later) but the goal of population reduction was not satisfactorily realized.

The tree protection goal on the other hand seems to have been realized within the treated area. Many of the worst areas saw an improvement in tree condition and while we have little experience in measuring this, it was the general opinion of field crews and others that much protection of the 1970 foliage resulted from the fenitrothion treatment and that the forest was in generally improved condition.

However, irregular heavy defoliation was observed throughout the treated area. No pattern to this defoliation could be found. In addition medium and heavy defoliation was found outside the treated area, especially near its perifery. The infestation is now larger, especially to the east.

Of particular interest was a heavy infestation that arose in the Cross Lake-17R5-Westmanland-New Sweden area. Heavy larval populations were found in this area and extensive medium and heavy defoliation were noted in areas that have not been troubled since 1958.

Elsewhere in northern Maine populations were present but not at serious levels.

Medium to heavy budworm larval populations and considerable defoliation was noted in parts of Washington County but this apparently heavy infestation did not persist through the egg mass survey.

The budworm threat continues to be serious for 1971 although the tree condition is improved. Egg mass numbers within the treated area decreased slightly from an average of 1.440 egg masses per 15-inch fir sample tip in 1969 to an average of 1.245 in 1970.

Outside the treated area, egg mass numbers more than doubled from an average of .171 per 15-inch fir sample tip in 1969 to an average of .400 in 1970.

It would seem that a highly active, extending budworm population still exists around Oxbow and threatens the surrounding area while a new epicenter has arisen around the Cross Lake-Madawaska Lake area. It also seems that it is no longer practical to embrace the hope of population reduction and future emphasis may need to be placed on tree protection. The problem gives every indication of becoming worse. It would appear that further experimentation with methods and treatment is needed to meet the threat.

Further survey data are expected and natural control data have not yet been examined but no great changes are expected.

John Coughlin
October 10, 1970

Copied November 3, 1970
jm

JUNE, 1970, AROOSTOOK COUNTY, MAINE, SPRUCE BUDWORM PROJECT, 210,000 ACRES, AND ACCOMPANYING SURVEYS.
BASE-Presque Isle Municipal Airport

OPERATED BY:
STATE OF MAINE
FOREST SERVICE
DIVISION OF ENTOMOLOGY

OPERATING FUNDS:
STATE, PRIVATE FEDERAL

COOPERATION BY:
1) U.S. FOREST SERVICE NORTHEASTERN AREA S.&P.F.
2) FOREST PROTECTION LTD. OF NEW BRUNSWICK
3) PRESQUE ISLE CITY MANAGER FIRE-POLICE DEPARTMENT
4) NORTHERN MAINE VOCATIONAL TECHNICAL INSTITUTE

Forest Commissioner
A. H. Wilkins

Deputy Commissioner
Fred Holt

Business Manager
William Cross

U.S. Forest Service Coordin.
John Chansler

Project Director
R. W. Nash, State Entomologist

Overall Budworm Reduction
Maine Forestry Department

Tech. Supervisor
John Coughlin

Tech. Ass't
Trefts
Stark
(Ouellette)

Collectors
Atwood
McMullen
McBreairty
Holmes
Breton
Pratt

Laboratory Analysis
B. Greenlaw, M. Congdon
V. Robinson, I. Currie
J. St. Peter, M. Anderson
C. Morreault, E. Gonya
V. Morris, M. Sear
D. Martin

Accompanying Surveys For Dist. 3, 4, 5, and 6. Same Men Alternating

Efficacy Study of Accothion
U. S. For. Service
McCowan
Ford
White
6 helpers

Associated Monitoring
Maine Forestry Department
Terrestrial Insects — Dr. Brower
Aquatic Insects — Dr. Dimond & Malcolm
Me. Fish & Game — Bourque & Spencer
Me. Dept. Agric. — Johnson
Me. Dept. Health — Richardson & Epstein
Me. Sea & Shore — Hurst
U.S. Fish & Wildlife — Peterson, Cramlich & Fillmore
U.S. Forest Service — Rushmore

Pre-spray Contacts, residents.
Trefts & Holmes

Radio Tech.
Cram & Staff

Communications and Weather Base Station - Presque Isle
J. Elliott and U.S. Weather Bureau

Sub-stations
Oxbow Road
W. Rafford
Ashland
R. Tucker

Airport Setup
Tingley

Activity Recorder
Marsh

Barracks Custodians
Townsend
York

Advice & Assist.
B. Flieger
B. McDougall
Forest Protection Limited

Maps & Progress
J. Walker
J. Hinkley

Airport Affairs, Calibration, Supply & Loading Clerk
Chadwick

General Safety & Caution Areas
Lipovsky

Handler's Safety & Condition
Richardson
Epstein

Pumps & Mixing
M. Bragdon-Leader
B. Downs
D. Hicks
R. Luce

Insecticide Loaders
A. Gibson
G. Michaud
H. Worcester

2 Flag Planes
George Graham) Pointers
David Roberts)
Holmes Hansel) Pilots
Allyn Caruso)
B. Cunningham -Mechanic

3 TBM Spray Planes
Jim Holland)
Wayne Hughes) Pilots
Wendell Reid)

Plane Advisors
Wright & Robinson

Cooks
Mrs. M. Keagan
Mrs. J. Sawyer
Mrs. F. Fitzgerald

Airport Facilities and Gas Supply.
Aroostook Airways Inc.

Spray Contractor*
Supervisor -
Jerry Wilson

Chief Mechanic -
B.J. Smith,
Assistants & Re-fueling -
Allan Fox
Gale Wilson
Terry Bateman

*Hillcrest Aircraft Company
Lewiston, Idaho

FOREST RESEARCH LABORATORY
FREDERICTON, NEW BRUNSWICK

SUMMARY STATEMENT ON THE ENTOMOLOGICAL ASSESSMENT OF THE 1970 SPRUCE BUDWORM AERIAL SPRAYING PROGRAM IN NEW BRUNSWICK AND FORECAST OF CONDITIONS FOR 1971.

E. G. Kettela

October, 1970

Introduction

The 1970 aerial spraying operation was the eighteenth to protect the forests of New Brunswick from the spruce budworm. A summary of the results of operational spraying and a forecast of conditions for 1971 are presented. Analyses of data are still underway and although conclusions in the report are thought to be valid they are subject to change.

Assessment of the 1970 Aerial Spraying Program

General - Surveys for egg masses in 1969 delineated 5,000,000 acres of high and 2,000,000 acres of moderate infestations. Hazard to trees was extreme on 1,056,000 acres, high on 1,049,000 acres, and variable on 4 4,100,000. Based on this information, the basic spray plan adopted for 1970 included 3.5 million acres and provision was made for the addition of areas if larval and tree condition surveys in the spring of 1970 indicated their necessity.

Fenitrothion and Dimecron 110, formulated as an emulsion were applied by teams of 3 T.B.M. aircraft to spray blocks of 12,600 acres each. A summary of the acreages sprayed with Fenitrothion and Dimecron 110 is presented in Table I. Areas of forest added to the plan received only one application of poison at a dosage of 3/16 lb. per acre.

The spring of 1970 was warm and wet. Larval activity was first detected on 26 April, a full week earlier than in 1969. Spraying operations commenced on 28 May at a time when insect development had reached the peak of the third instar. Through May and June insect development progressed at a regular rate and larval populations reached the peak of the sixth instar about the 24 of June. The rapid development of fir and spruce shoots was probably due to the warm wet weather, a marked difference from 1969. Spraying operations in 1970 ceased on 28 June a.m.

Surveys for spruce budworm larvae and pupae - Pre-spray sequential surveys were conducted during May and early June to determine budworm population densities throughout the proposed spray area and in the peripheral area. As a result of this survey about 706,000 acres were added to the plan, mostly along the northern and southwestern edges of the spray plan. A series of points were sampled to supply population and larval development data for unsprayed areas. In addition 18 operational spray blocks were sampled more intensively to provide data on the efficacy of spray treatments in relation to insect development.

Post spray surveys for pupae and defoliation were conducted in July at all points and on all spray blocks sampled in the pre-spray survey.

Efficacy of the Spray Operation in terms of Budworm Survival and Protection to Foliage - In previous reports I have illustrated the efficacy of spray operations in terms of per cent reduction in survival. These figures and the calculation of them tend to mask more important measures of efficacy such as the number of survivors (pupae/18" br tip) and survival following spraying, and of course damage to foliage. Data on budworm survival ($\frac{\text{pupae}}{\text{larvae}}$ x 100) for select sample points and spray blocks are presented in Tables 4, 5 and 6. For ease of comparison I have also included figures on per cent reduction in survival in Table 4.

(1) In Table 4 it appears that areas sprayed twice had similar numbers of survivors in 1969 and 1970. The number of survivors in areas sprayed once and twice in 1970 are similar and both are markedly less than the number of survivors in unsprayed areas. Areas sprayed once in 1970

with 3/16 lb. of poison had fewer survivors and a lower survival than areas sprayed once in 1969 with 1/8 lb. of poison.

Although the number of survivors per 18 inch branch tip was similar on both fir and spruce in 1970, the number of survivors was greater on spruce than in 1969. Survival in most areas in 1970 was markedly lower than in unsprayed areas.

(2) From Tables 5 and 6 it appears that there is no major difference between survivors and survival on balsam fir in blocks sprayed once and those in blocks sprayed twice. Higher survival was detected on those blocks sprayed early and late as against those sprayed near the peak of the fourth and fifth instar of development. This situation is generally the same on spruce. Of particular note is the fact that counts of survivors on spruce are similar to those on fir except on spray blocks 649 and 642 (Table 6).

Survivals on block 115 (1/4 lb./application) and block 414 (3 applications of 1/8 lb.) are similar (Tables 5 & 6) on both fir and spruce. In both instances the number of survivors and survival are slightly less than that for blocks sprayed once at 3/16 lb. and twice at 1/8 lb. per application.

On blocks sprayed with Dimecron 110 (Table 5) the number of survivors and survival are lower on spruce than on fir. This is due to the fact that insect development on fir was more advanced than that on spruce. Survivor counts on these blocks are similar to those sprayed with Fenitrothion at the same stage of development.

<u>Damage to foliage</u> - An aerial survey conducted by Forest Protection Limited and the Canadian Forestry Service mapped 1,988,800 acres of light, 1,040,700 acres of moderate and 379,000 acres of severe current defoliation (Table 2).

Acreages of defoliation in sprayed and unsprayed areas were:

	Light	Moderate	Severe
Sprayed	1,002,000	508,000	131,000
Unsprayed	986,800	532,700	248,300

It is important to note that 84% of the high infestation area delineated in 1969 was sprayed in 1970. Most of the severe defoliation in unsprayed areas occurred in the remaining 16% of high infestation area which was not sprayed. Pre-spray populations in both sprayed and unsprayed areas had high larval counts. Certainly, there would have been extensive acreages of severe defoliation if it were not for the spray operation. Thus, in terms of foliage protected the 1970 operation was a success (Fig. 2).

The main areas of severe defoliation were:

(1) 130,000 acres bounded by Heath Steele Mine in the north, southeast to Wayerton, hence west to Clearwater Stream, north towards Big Bald Mountain then east to Heath Steele Mines, in eastern Northumberland county;

(2) 30,000 acres in the northern tip of York County;

(3) 120,000 acres in and about Base Gagetown,

and (4) 90,600 acres in central Kings county, the largest patch (50,000 acres) being located at the upper end of the Kingston Peninsula.

A synopsis of defoliation in each county is presented in Table 2. The sizable acreages of severe, moderate and light defoliation detected in the Iroquois and Madawaska river valleys in Madawaska county, and in Charlotte county (Table 2) are of particular interest.

Spruce Budworm Egg-mass Infestations in 1970 and Forecasts for 1971

The 1970 egg-mass survey was based on sequential counts of egg-masses per 100 square feet of balsam fir foliage at 1169 sample locations. Acres of infestation in light, moderate and severe categories in 1970 and 1969 are:

	Light	Moderate	Severe
1970	4,200,000	700,000	7,900,000
1969	3,000,000	2,000,000	5,000,000

The total area of infestation in 1970 is 12.8 million acres, an increase of 2.8 million acres over 1969.

Of the 1,169 points sampled 306 had a population of between 400 and 999 egg-mass per 100 square feet, and 124 had a population of over 1000+ per 100 square feet. This was an increase over 1969 in both the number of points in these categories and population density. Table 3 shows large increases in population density in all unsprayed areas of the province while egg-mass population levels within the sprayed portion of the province remained at the same level as in 1969.

The largest area of high egg-mass infestation is bounded by a line extending northwest from a point 20 miles east of Newcastle, to about 10 miles west of Bathurst, then more or less southwest to Plaster Rock, then southeast through Juniper to Mactaquac, then south to the eastern third of Charlotte county, east to St. John, along the Bay of Fundy coast to Sackville in Westmorland county, north to Barachois, then more or less along the coast northwest to Miramichi Bay near Chatham, - 7,800,000 acres (Fig. 3).

In Madawaska and Restigouche counties the number of points with positive budworm egg mass counts increased three fold but by and large the population remained in a low category. An area of approximately 60,000 acres of high infestation on the New Brunswick-Quebec border north of Edmundston is an exception; the infestation in this area increased substantially over 1969.

The egg-mass survey indicated that moderate and severe defoliation by the spruce budworm should be expected on balsam fir and spruce trees over a major portion of New Brunswick.

Hazard

The map (Figure 4) depicting hazard to trees for 1970 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 (1969-1970);

(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. These categories are:

1. Extreme - tree mortality and extensive top killing is expected in 1971. - 370,000 acres.
2. High - tree vigor will be reduced and top killing is expected in forest stands. - 2,160,000 acres.
3. Hazard variable - low to moderate - trees more or less in fair to good condition. A high insect population is present. In 1971 tree vigor

will be reduced and there may be top killing in some scattered locations. - Total 5,370,000 acres.

To protect the 1971 foliage crop and that portion of the 1970 foliage crop that was saved from the budworm it will be necessary to take remedial actions in hazard categories 1, and 2 and on some of the areas in category 3.

Table I - Synopsis of the 1970 Operational Spray Program

Insecticide	Treatment	Acres
Fenitrothion	- 1 application of 3/16 lb. in 0.15 U.S. gal. of formulation per acre	- 1,880,500
	- 2 applications each of 1/8 lb. in 0.15 U.S. gal. of formulation per acre	- 1,983,000
	- 3 applications each of 1/8 lb. in 0.15 U.S. gal. of formulation per acre	- 67,000
	Sub-total	- 3,930,500
Dimecron 110	- 1 application of 3/16 lb. in 0.15 U.S. gal. of formulation per acre	- 307,000
	Total	- 4,237,500
	Original number of acres in plan	3,531,500
	Number of acres added to plan	706,000

Table II - Acreages of Light, Moderate, and Severe Current Defoliation by County

County	1969			1970		
	Light	Moderate	Severe	Light	Moderate	Severe
Saint John	22,900	52,800	8,000	38,800	41,800	8,000
Albert	20,900	41,800	32,900	72,700	42,800	2,000
Westmorland	38,800	16,900	9,000	101,600	37,900	5,000
Kings	146,400	111,600	60,800	57,800	276,900	90,600
Queens	149,400	203,200	39,800	164,300	100,600	19,900
Charlotte	2,000	---	---	130,400	56,800	4,000
Sunbury	54,800	156,400	45,800	72,700	116,500	65,700
Kent	104,600	64,700	9,000	154,400	25,900	4,900
York	152,400	451,200	127,500	387,400	145,400	38,800
Northumberland	206,200	629,500	247,000	539,800	22,700	122,500
Carleton	15,900	67,700	30,900	68,700	61,700	8,900
Victoria	49,800	14,900	2,000	134,500	82,800	8,000
Madawaska	8,000	---	---	18,900	11,000	1,000
Restigouche	---	---	---	---	---	---
Gloucester	---	---	---	46,800	17,900	---
Totals	972,100	1,810,700	612,700	1,988,800	1,040,700	379,300

Total Acreages Showing Some Degree of Defoliation - 1969 - 3,395,500

1970 - 4,016,300

Table III - Trends in Spruce Budworm Populations by Sector (Number of Sample Points in Brackets)

	Egg-masses per 100 Square Feet of Foliage				Ratios of No. Egg-masses		
	Year				Year		
	1967	1968	1969	1970	68/67	69/68	70/69
Sprayed in 1970	138 (425)	431 (444)	483 (481)	498 (491)	3.12	1.12	1.03
Unsprayed in 1970							
North -West	3 (120)	5 (123)	6 (133)	21 (174)	1.67	1.20	3.50
-East	15 (68)	50 (72)	89 (94)	415 (110)	3.33	1.78	4.66
Central -West	14 (94)	34 (101)	46 (104)	77 (113)	2.35	1.35	1.70
-East	69 (45)	352 (51)	711 (55)	1073 (74)	5.10	2.02	1.51
South -West	13 (52)	65 (56)	174 (67)	301 (88)	5.00	2.68	1.74
-East	44 (85)	145 (86)	313 (86)	667 (95)	3.29	2.16	2.13

Table IV - Comparison of Two Sets of Insect Survival Data (1969, 1970) at Sprayed and Unsprayed Locations

Year	Larvae per 18" branch tip (Pre-spray)	Pupae per 18" branch tip (Post-spray)	Survival % ($\frac{pupae}{larvae}$ x 100)	% Reduction in survival	Treatment and dosage of poison
			Balsam fir		
1969	40	2.4	6	89)	2 applic. of 1/8 lb.
1970	40	2.7	7	70)	
1969	21	3.1	15	75	1 applic. of 1/8 lb.
1970	27	2.3	8	69	1 applic. of 3/16 lb.
1969	30	7.8	27	)	Unsprayed
1970	20	4.7	23	)	
			Red spruce		
1969	51	0.7	1	81)	2 applic. of 1/8 lb.
1970	35	2.5	7	65)	
1969	22	1.0	5	65	1 applic. of 1/8 lb.
1970	29	2.4	8	70	1 applic. of 3/16 lb.
1969	29	3.3	11	)	Unsprayed
1970	19	3.3	17	)	

Table V - Data For Spray Blocks Sampled

1 Application Fenitrothion - 3/16 lb.

Spray Block	Insect Development					Insect Populations		
	% in each instar					Pre-spray larvae per 18" br. tip	Post-spray pupae per 18" br. tip	Survival % ($\frac{pupae}{larvae}$ x 100)
	III	IV	V	VI	Pupae			
				Balsam fir				
202	4	8	79	9		31	2	7
89		14	20	62	4	12	2	17
200		14	21	65		45	0.6	1
141			13	77	10	28	2	7
98			8	84	8	3	0.4	13
94			8	92		10	2	20
				Spruce				
202	14	30	50	6		39	1	3
89			54	46		11	2	18
200		6	50	44		50	1	2
141			30	70		31	0.5	2
98		6	15	75	4	4	0.2	5
94			24	76		9	0.7	8

....Continued

Table V - Data For Spray Blocks Sampled (Continued)

1 Application Fenitrothion - 1/4 lb.

Spray Block	Insect Development					Insect Populations		
	% in each instar					Pre-spray larvae per 18" br. tip	Post-spray pupae per 18" br. tip	Survival % (pupae/larvae x 100)
	III	IV	V	VI	Pupae			
					Balsam fir			
115	4	8	79	9		20	0.4	2
					Spruce			
	14	30	50	6		30	0.5	2

1 Application Dimecron - 3/16 lb.

Spray Block	III	IV	V	VI	Pupae	Pre-spray larvae per 18" br. tip	Post-spray pupae per 18" br. tip	Survival % (pupae/larvae x 100)
					Balsam fir			
196		15	24	61		45	2	4
701			8	84	8	8	0.9	11
137			8	84	8	16	4	25
801			8	84	8	13	2	15

....Continued

Table V - Data For Spray Blocks Sampled (Concluded)

Spray Block	Insect Development: % in each instar III	IV	V	VI	Pupae		Insect Populations: Pre-spray larvae per 18" br. tip	Post-spray pupae per 18" br. tip	Survival % (pupae/larvae x 100)
						Spruce			
196		13	48	39	4		49	2	4
701		6	15	75	4		9	0.6	7
137		6	15	75	4		6	1	17
801		6	15	75			12	1	8
Unsprayed						Balsam fir	20	4.7	27
						Spruce	19	3.3	17

Table VI - Data for Spray Blocks Sampled

2 Applications of Fenitrothion (1/8 + 1/8)

Block No.	Insect Development										Insect Population			
	1st application % in each instar					2nd application % in each instar					No. of days between appli- cation	Pre-spray larvae per 18" br. tip	Post-spray pupae per 18" br. tip	Survival %
	II	III	IV	V	VI	III	IV	V	VI	Pup.				
									Balsam fir					
438		6	50	44			4	10	86		10	23	2	9
420		36	56	8			21	15	64		13	26	0.7	3
631		8	78	14			9	35	56		10	22	0.4	2
649			60	40				8	92		9	47	2	4
642			82	18				12	82	6	19	27	1	4
									Spruce					
438		24	49	27		3	20	24	53		10	19	2	11
420	16	48	28	8		5	31	28	36		13	27	2	7
631		48	48	4			32	36	32		10	20	0.7	4
649		4	44	42	10			12	88		9	24	4	17
642		40	52	8					70	30	19	23	4	17

....Continued

Table VI - Data for Spray Blocks Sampled (Concluded)

3 Applications of Fenitrothion (1/8 + 1/8 + 1/8)

Block No.	Insect Development										No. of days between application	Insect Population		
	1st application % in each instar					2nd application % in each instar						Pre-spray larvae per 18" br. tip	Post-spray pupae per 18" br. tip	Survival %
	II	III	IV	V	VI	III	IV	V	VI	Pup.				
							Balsam fir							
414		36	56	8			48	52			6	33	1	3
							Spruce							
414	16	48	28	8		21	48	31			6	31	1	3
Unsprayed							Balsam fir					20	4.7	27
							Spruce					19	3.3	17

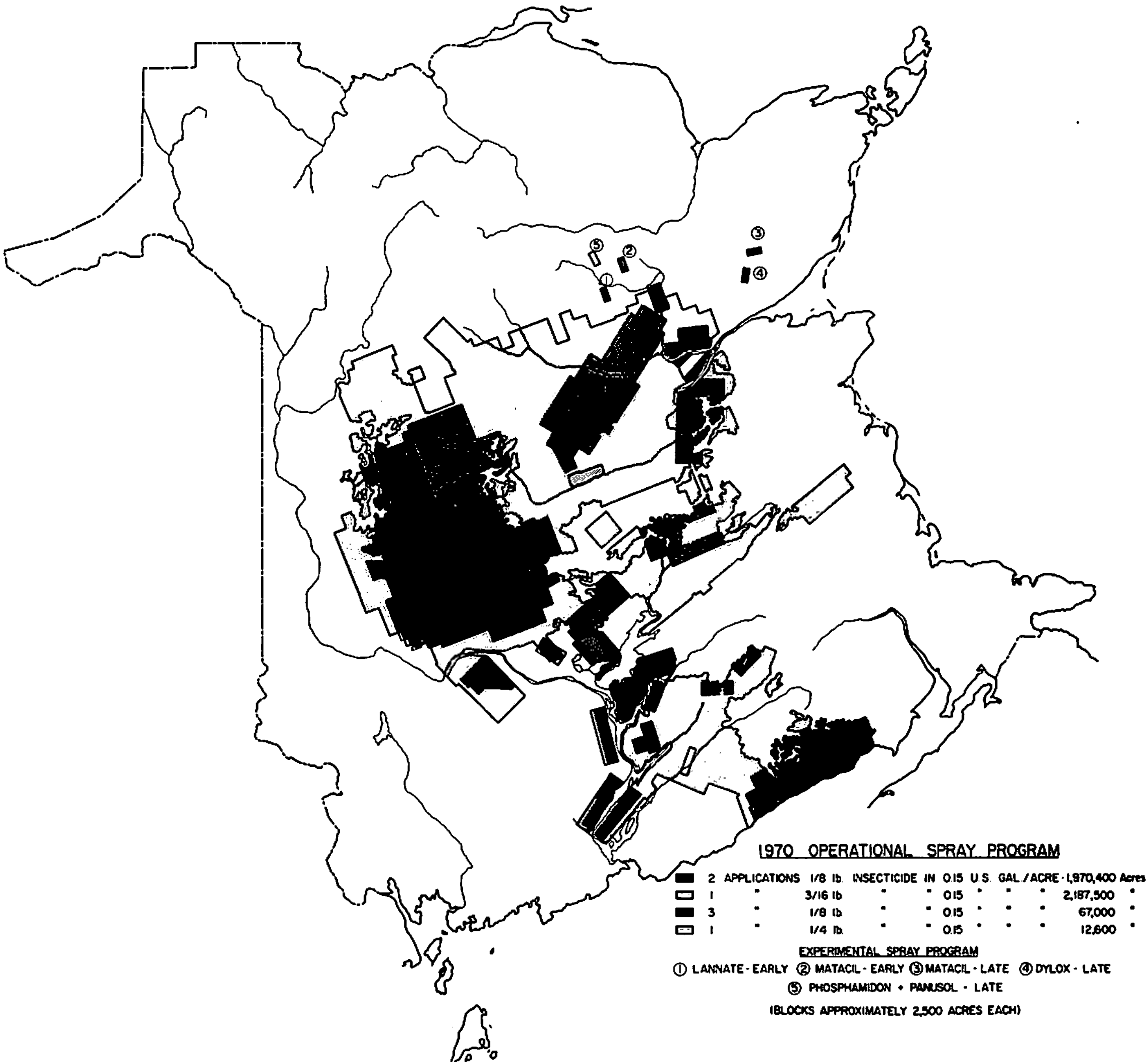

1970 OPERATIONAL SPRAY PROGRAM
2 APPLICATIONS 1/8 lb. INSECTICIDE IN 0.15 U.S. GAL./ACRE - 1,970,400 Acres
1 " 3/16 lb " " 0.15 " " " 2,187,500 "
3 " 1/8 lb " " 0.15 " " " 67,000 "
1 " 1/4 lb " " 0.15 " " " 12,600 "
EXPERIMENTAL SPRAY PROGRAM
① LANNATE - EARLY ② MATACIL - EARLY ③ MATACIL - LATE ④ DYLOX - LATE
⑤ PHOSPHAMIDON + PANUSOL - LATE
(BLOCKS APPROXIMATELY 2,500 ACRES EACH)
①
②
③
④
⑤

Figure 1

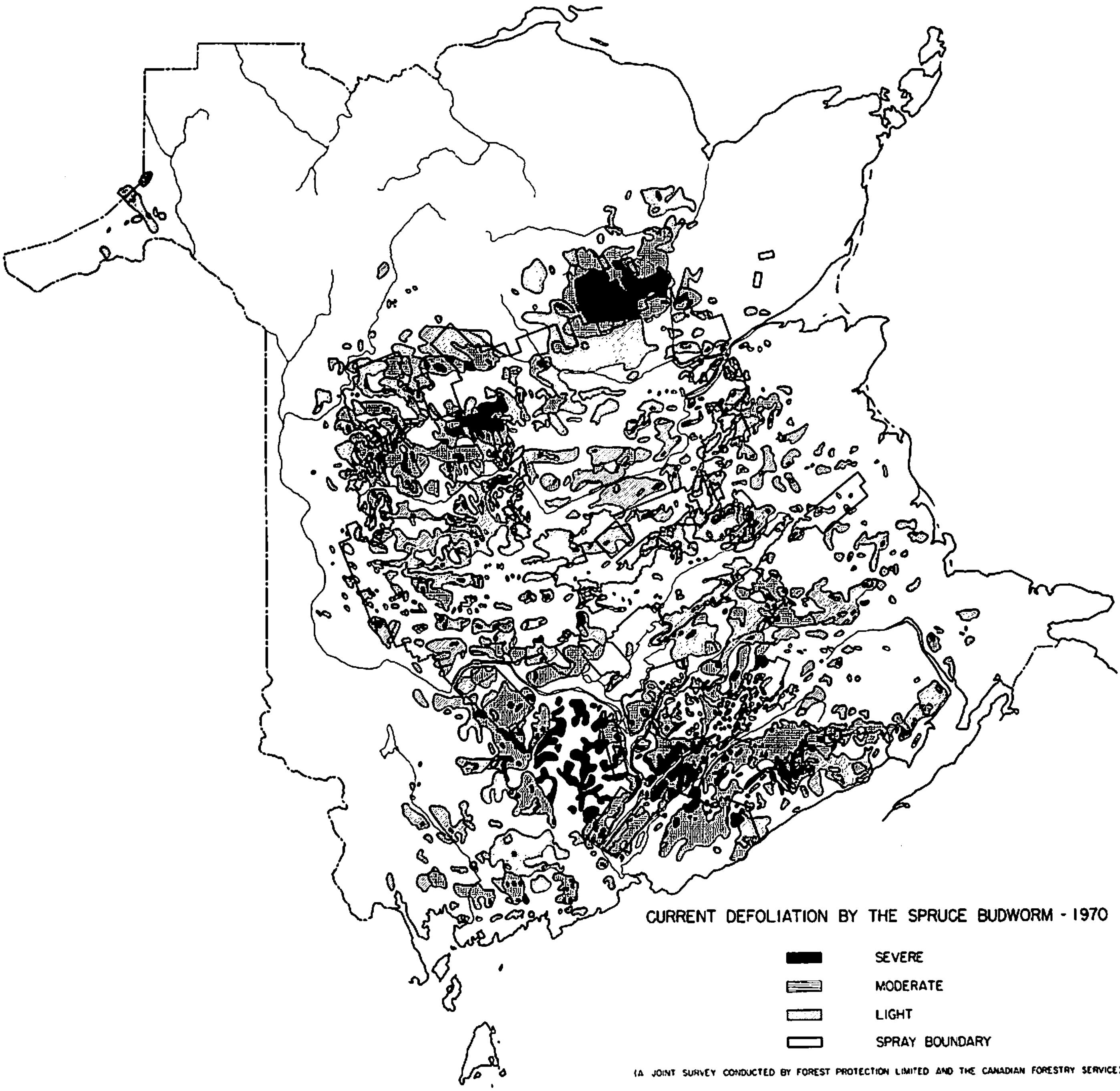

CURRENT DEFOLIATION BY THE SPRUCE BUDWORM - 1970
SEVERE
MODERATE
LIGHT
SPRAY BOUNDARY
(A JOINT SURVEY CONDUCTED BY FOREST PROTECTION LIMITED AND THE CANADIAN FORESTRY SERVICE)

Figure 2

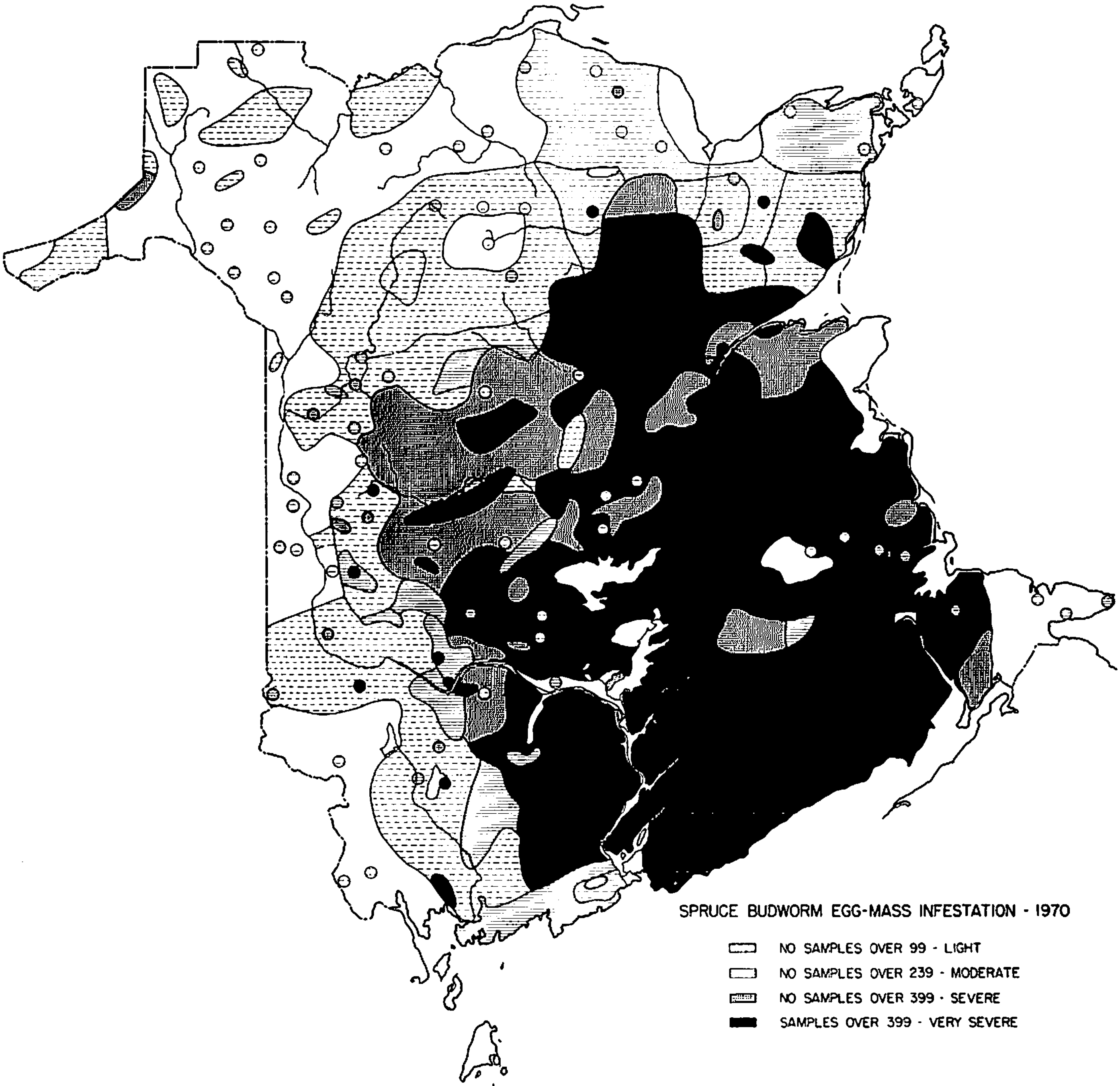

SPRUCE BUDWORM EGG-MASS INFESTATION - 1970
NO SAMPLES OVER 99 - LIGHT
NO SAMPLES OVER 239 - MODERATE
NO SAMPLES OVER 399 - SEVERE
SAMPLES OVER 399 - VERY SEVERE

Figure 3

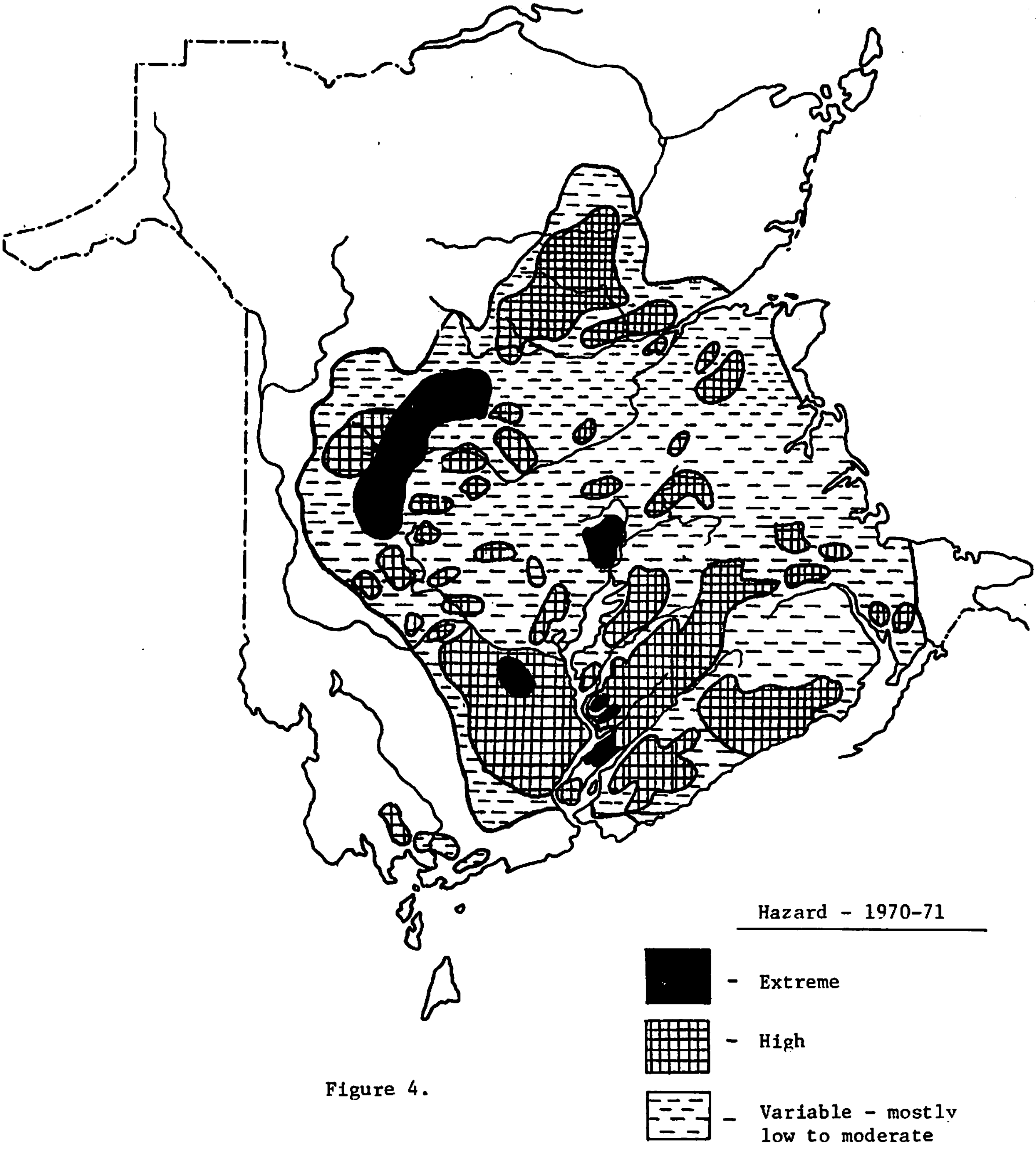

Hazard - 1970-71
- Extreme
- High
- Variable - mostly low to moderate

Figure 4.

Resume of Trials with Lannate, Matacil, Dylox and Phosphamidon

Part of this year's experimental program was to test the efficacy of Matacil, Lannate, Dylox and Phosphamidon in reducing spruce budworm populations when applied with teams of T.B.M. spray aircraft equipped with boom and nozzle spray equipment. The following organizations took part in this venture; Forest Protection Limited, Canadian Wildlife Service, Department of National Health and Welfare, and the Resource Development Branch (Halifax), Chemical Control Research Institute, and Forest Research Laboratory (Fredericton) of the Department of Fisheries and Forestry. C.C.R.I. and C.W.S. were involved only to a minimal degree in the Phosphamidon trial.

The five experimental trials conducted (2,500 acres each) were:

(1) Lannate - block 1 - early - two applications of 0.8 ounces of poison in 0.15 U.S. gallons of formulation per acre (solvent - ethylen glycol).

(2) Matacil - block 2 - early - two applications of 1.25 ounces in 0.15 U.S. gallons of formulation per acre - (Dowanol TPM solvent).

(3) Matacil - block 3 - late - two applications of 1.25 ounces in 0.15 U.S. gallons of formulation per acre - (Dowanol TPM solvent).

(4) Dylox - block 4 - late - two applications of 6 ounces in 0.15 U.S. gallons of formulations per acre.

(5) Phosphamidon and panusol (a new formulation) - one application of 2 ounces of poison in 0.15 U.S. gallons of formulation per acre.

In addition, one operational Fenitrothion block and a series of unsprayed plots were sampled to provide comparative information. The Fenitrothion block (534) received 2 applications of 2 ounces of poison in 0.15 U.S. gallons of formulation per acre. The experimental blocks were sprayed with solutions of poison in organic solvents, while the operational block was sprayed with an emulsion.

Each spray block and the unsprayed control plots were sampled four times, once prior to spraying, once after each spray application and once about the time of adult emergence from pupae.

Table 1 shows the stage of insect development at the time of each spray application and Table 2 shows the mean budworm population at each sample period, resultant survival, and defoliation for each of the spray blocks and the unsprayed control.

It appears from Table 2 that trials 2, 3, 4 and 5 had similar survival rates, with the lowest survival rate (on fir and spruce) being on trial 3 (Matacil, late). This, however, may not be a valid test since the initial population on trial 3 was low. In terms of foliage protection trial 2 (Matacil early) was certainly the most outstanding (Table 2). Balsam fir trees in this block experienced only light defoliation.

Lannate at 1.6 ounces per acre gave the poorest results in terms of both insect control and foliage protection. Trials 3, 4 and 5 certainly did not alter the expected defoliation significantly and it is worthwhile to note that the conifers in trial 5 were severely defoliated prior to treatment. Insect survival was higher on the fenitrothion block than in trials 2, 3, 4 and 5, but severe defoliation was prevented.

Until a more complete analysis is conducted this is all that can be said about these trials at this time.

E. G. Kettela

Table 1 - Insect development at the time of each application of insecticide for five experimental and one operational spray block

Insecticide	Spray Block	Insect development as % of each stage										
		1st application						2nd application				
		Larval instars						Larval instars				
		II	III	IV	V	VI	Pupae	III	IV	V	VI	Pupae
Balsam fir												
Lannate	1	8	75	17				21	57	22		
Matacil	2		36	56	8			9	51	40		
Matacil	3		10	12	72	6			14	22	63	
Dylox	4		5	8	78	9				5	80	15
Phosphamidon[1]	5			21	15	64		-	-	-	-	-
Fenitrothion[2]	534		12	18	70				14	22	63	
Spruce												
Lannate	1	12	84	4				42	39	19		
Matacil	2	20	50	30				24	50	26		
Matacil	3		26	33	41				7	51	42	
Dylox	4		17	30	53					13	78	9
Phosphamidon[1]	5		5	31	28	36		-	-	-	-	-
Fenitrothion[2]	534		33	35	32				7	51	42	

[1]Phosphamidon - new formulation with a new additive - Panusol.

[2]Fenitrothion 534 - operational block.

Table 2 - Budworm populations at each sampling period, resultant survival, and defoliation

Insecticide	Spray Block	Budworms per 18 inch branch tip: Pre-spray Populations 1	Post-spray populations 2	3	Pupae 4	Survival (%)[1]	Defoliation[2] Exp.	Obs.
Balsam fir								
Lannate (early)	1	24.7	15.8	9.3	4.52	20	S	S
Matacil (early)	2	20.9	7.6	2.4	0.48	2	S	L
Matacil (late)	3	2.5	2.3	0.8	0.03	1	L	L
Dylox (late)	4	6.6	4.2	1.4	0.18	3	L-M	L-M
Phosphamidon (late)	5	30.9	3.5	2.6	0.98	3	S	S
Fenitrothion	534	22.8	6.6	3.0	1.85	9	S	M
Unsprayed control		31.9	17.5	13.8	5.33	16	S	S
Spruce								
Lannate (early)	1	37.4	11.4	8.6	2.14	5		
Matacil (early)	2	19.9	5.5	5.5	0.58	3		
Matacil (late)	3	1.7	1.5	0.2	0.03	1		
Dylox (late)	4	4.2	2.2	0.7	0.05	1		
Phosphamidon (late)	5	19.8	5.2	6.8	0.53	13		
Fenitrothion	534	10.2	6.2	3.9	1.30	13		
Unsprayed control		19.3	16.0	14.6	3.42	16		

1 - Survival expressed as a per cent - $\frac{\text{Pupae}}{\text{Larvae (pre-spray)}} \times 100$

2 - Defoliation - Exp. - Expected defoliation from pre-spray population - Balsam fir only
Obs. - Observed defoliation - S - Severe, M - Moderate, L - Light

SPRUCE BUDWORM SPRAYING OPERATION

NEW BRUNSWICK 1970

HEALTH ASPECTS

This year's spraying operation was carried out without illness or accident directly attributable to the toxic effects of pesticide.

A clinical consultant of the occupational health division of the Dept. of National Health & Welfare was assigned to the project full time and, in co-operation with the Department of Epidemiology and Health of McGill University, a limited program of biological monitoring was carried out. The co-operation of Forest Protection Limited made it possible to visit and inspect all sites from which operations were being conducted and ensured the success of the monitoring program.

With respect to issues that might profitably be discussed by this committee, the following items are submitted for consideration:

I Experimental Spraying Programs Conducted by the Federal Government

The health of all persons engaged in forest spraying operations should be overseen by competent health authorities. In federal government operations involving the use of any pesticides but particularly new, unregistered or experimental pesticides, an opportunity should be afforded the Department of Health to examine the relevant data and to express an opinion regarding the probable health effects on exposed workers. Departure from usual formulation, such as the use of other diluents or solvents or the use of combinations of pesticide, should also be submitted to the health department for an opinion before use.

Maintaining the health and safety of federal employees would require those engaged in pesticide application or those exposed to pesticide to have physical examinations prior to beginning and at the end of each spraying season.

Because of the very large areas involved in forest spraying every effort should be made by federal authorities to keep the provincial health authorities informed as to the kind of chemical to be used, area to be treated, and time of treatment as well as the rate of application and time required for the pesticide to degrade. All toxicological data on pesticides for proposed use should be made available to provincial health authorities.

II Information on Decontamination Procedures

The unexpected persistence of pesticide residues in the soil and in containers in spite of vigorous attempts at decontamination gives cause for concern since spills that are likely to occur in forestry spraying operations may involve hundreds of gallons. Information that is readily available on decontamination of spills has usually been written with a few pounds of active material in mind. Plans should be made before beginning operation on procedures to be used and these should ideally be proven to be effective.

Procedure to be followed in the event of a major spill in an area supplying drinking water should also be developed and should be ready for immediate use if required.

The problem of disposal of pesticide containers, particularly steel drums, is proving to be difficult. Steam cleaning with alkali has not been effective, nor has holding empty drums in the open for a year. Consideration should be given to the development of a field procedure for decontaminating drums that is practical and effective. Collecting drums and returning them to the supplier for decontamination may be a practical alternative.

Annual spraying to prevent forest deterioration appears now to be an accepted necessity. In view of the widespread concern being expressed regarding environmental contamination and the extensive areas involved in forest spraying operations, health authorities should be involved in every phase of these operations from planning to execution.

Tx Mr Carter
M Howard

i) Residues in stored drums.

During his involvement in the New Brunswick spraying operation in May/June, 1970, Dr. T.F. McCarthy, arranged for the collection of sample residues from four drums which had been emptied, cleaned, and stored. The drums had contained a concentrate of what will be called Sumithion in this report, although it could have been Accothion of Femitrothion, depending on the supplier. The drums had been drained, then cleaned with steam and soda ash. Two samples were taken from drums used in the 1969 spraying operation and two from drums used in the 1970 operation.

The procedure for obtaining samples was to add approximately one pint of xylene to the drum, rinse it around and pour out the sample. The xylene solutions were the samples shipped to the laboratory for analysis.

The samples were analyzed on the infrared spectrophotometer by making up 25 volume percent solutions in spectro grade carbon tetrachloride. Spectra of xylene, Sumithion and decomposed Sumithion were also obtained for comparison purposed.

Sumithion was identified by its infrared band at 970 cm-1 which disappears when Sumithion is decomposed by hydrolysis. A second band at 1230 cm-1 is present in both Sumithion and its decomposition products. It was determined that a two percent solution of technical Sumithion gave an absorbance of 0.20 at 970 cm-1 and 0.11 at 1230 cm-1. From these values the total concentration of "Sumithion residues" as well as the concentration of active (undecomposed) Sumithion in each sample were determined. The results are given below.

Sample	Ounces of Sumithion Residue in Drum	Percentage of Active (undecomposed) Sumithion in Drum Residue
1969 #1	1	60
1969 #2	5	85
1970 #1	2	85
1970 #2	12	81

Conclusions:

The tests show residues varying from 1 oz. to ¾ lb. in the drums. Present drum treatment does not destroy the active ingredient, most of which still remains even after a year of storage.

ii) Soil residues resulting from accidental spill.

The samples involved in this report were shipped to this laboratory by Dr. T.F. McCarthy and analyzed at his request.

On May 28, an aircraft crashed on take-off and dumped a load of Sumithion at the end of the runway and partly onto the edge of a farmer's field. The area was roped off and decontaminated. It rained heavily on the night of June 1, two soil samples being taken on June 3. These details were provided by Dr. McCarthy in a covering letter. The samples are referred to as the June 3 samples.

In a letter dated June 10, Dr. McCarthy added the details that the spill had been washed down with 125 lbs. of soda ash in 800 gallons of water. The spilled Sumithion had consisted of 625 gallons of a 1-in-9 dilution of an emulsifiable concentrate containing 75% active material. (This amounts to approximately 50 gallons of pure Sumithion). The area of the crash was bull-dozed and covered with earth (after the June 3 samples were obtained).

In addition to the letter, two samples were supplied from a small area, approximately 20 x 40 feet, of the farmer's field mentioned above. It had also been roped off. These are referred to as the June 10 samples.

The samples were weighed and treated with enough spectro grade carbon tetrachloride to wet them and provide a small excess. The samples were left overnight, then mixed and 1 ml. of the carbon tetrachloride extract pipetted off. This was reduced in volume to 0.2 ml. to concentrate the extract and provide a convenient volume for testing. The extracts were analyzed by infrared spectroscopy.

The analysis was done in the same way as the drum samples reported elsewhere. That is to say, the band at 970 cm-1 was used to evaluate active (undecomposed) Sumithion and the band at 1230 cm-1 was used to evaluate "Sumithion residues", comprising undecomposed Sumithion plus Sumithion decomposition products. In this way amounts of the active compound originally present and still remaining were obtained, the quantities being determined from spectra of known concentrations. The results are given in Table 1.

TABLE 1

Sample	Result at 970 cm-1. Grams Sumithion per 100 grams soil	Result at 1230 cm-1. Grams "Sumithion residues" per 100 grams soil
June 3 - No. 1	0	.81
June 3 - No. 2	.93	1.15
June 10 - No. 1	.22	.31
June 10 - No. 2	.34	.45

If it is assumed that the density of the soil is approximately 1.2 (as indicated by a specific gravity determination), the results can be expressed as grams of residue per cubic foot of soil as shown in Table 11.

TABLE 11

Sample	Active Sumithion present in soil Ozs./cu. ft.	Total Sumithion residue in soil Ozs./cu.ft.	Percentage "Sumithion" still in active form
June 3 - No. 1	0	6.8	0
June 3 - No. 2	7.8	9.6	81
June 10 - No. 1	1.8	2.6	69
June 10 - No. 2	2.8	3.8	74

REMARKS

The figures show a high degree of contamination of the soil, but this is not surprising for such a large scale accidental spill.

The large difference in active Sumithion content between samples 1 and 2 of June 3, must indicate that the decontaminating liquid reached the site of the first sample but not the second. The June 10, values for the samples taken from the adjacent field show that around 70% of the spilled product is still active Sumithion after one week of weathering. Actually, if our conversion figure is in error it is probably in the direction of indicating more decomposition than actually exists. This conversion figure is being re-checked. Also, we are setting up an experiment to determine the rate of decomposition of Sumithion in soils. This test will require several weeks but may provide usable data for next year's forest spraying operation.

APPENDIX 18

SUMMARY REPORT ON THE EFFECTS OF FOREST SPRAYING IN NEW BRUNSWICK IN 1970 ON JUVENILE SALMON AND THEIR FOOD ORGANISMS

prepared for

THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

OTTAWA,

OCTOBER, 1970

G. H. Penney,
Dept. of Fisheries & Forestry
Resource Development Branch
Halifax, N. S.
October, 1970

INTRODUCTION

In 1970, approximately 4.2 million acres of New Brunswick forests were operationally sprayed for control of the spruce budworm. Fenitrothion was sprayed on approximately 75,000 acres in three applications at 1/8 lb./acre each; on 1,925,000 acres in two applications at 1/8 lb./acre each and on 1,897,600 acres in one application, at 3/16 lb./acre. Phosphamidon was sprayed on approximately 300,000 acres in one application at 3/16 lb./acre. Operational-experimental spray blocks of 2500 acres each were located outside the main operational spray area. They were separately sprayed with two applications of dylox at 3/8 lb./acre; two applications of lannate at 1/16 lb./acre and two applications of matacil at 1 ¼ oz./acre.

This is a preliminary summary of a report in preparation and outlines Resource Development studies and results in 1970.

STUDIES

Effects of the double dylox, fenitrothion, lannate and matacil sprays were evaluated by:

(a) Caged fish tests.

(b) Population density determinations of juvenile Atlantic salmon.

(c) Sampling of aquatic insects.

Studies on the effects of the double fenitrothion spray on caged fish and aquatic insects were carried out in Fundy National Park. Juvenile salmon populations were also determined at two stations in the park.

RESULTS

Caged fish tests

No mortalities were found among caged juvenile Atlantic salmon exposed to the dylox, fenitrothion, lannate or matacil sprays.

Population densities of juvenile Atlantic salmon

In late summer, populations of juvenile salmon were determined by electrofishing at 31 stations in spray area streams. Underyearling salmon densities found in the Main Southwest Miramichi River and its tributaries averaged 17.7 per 100 sq. yds. Small parr averaged 3.7 and large parr 4.9 per 100 sq. yds. In streams sprayed with dylox, lannate and matacil, average densities were 14.9 per 100 sq. yds. for underyearlings, 11.9 for small parr and 6.4 for large parr.

Aquatic Insect Populations

Aquatic insect sampling began in late May and continued on a regular basis throughout the summer to mid-August. Insects were identified to order, counted and insect volumes of the samples were determined. Streams sampled received the double dylox, fenitrothion, lannate and matacil sprays. The 1970 data indicated that none of the above insecticides caused significant reductions in aquatic insect populations.

DISCUSSION

The caged fish method of comparing the effects of various insecticides and rates of application on juvenile Atlantic salmon was again used in 1970. Results show no short term toxic effects to juvenile salmon from the 1970 spraying of dylox, fenitrothion, lannate or matacil. Previous caged fish tests conducted by Resource Development staff show insignificant mortalities resulting from the spraying of ½ lb./acre of phosphamidon, ½ lb./acre of sumithion (fenitrothion), ¼ lb. sumithion mixed with ¼ lb. phosphamidon/acre, 3/8 lb. sumithion mixed with 1/8 lb. phosphamidon/acre and 1/8 lb./ acre of zectran.

Average populations of underyearling salmon found in spray area streams in 1970 were generally good, being on the average four times greater than in 1969. Small and large parr populations found in 1970 were low. This is not indicative of insecticide spraying in 1970, as low parr populations were expected due to the extreme low water levels of 1968, which evidently affected the success of that year's spawning run.

Variations in numbers and bulk of aquatic insects found in the 1970 dylox, fenitrothion, lannate and matacil spray tests indicate insignificant reductions attributable to spraying. Fluctuations in levels of insect populations were more likely due to natural variation rather than to insecticide spraying.

In 1966 and 1967 it was found by Resource Development studies that sumithion (fenitrothion) sprayed at the rate of ½ lb./acre caused significant reductions in aquatic insect populations. The 1968 sampling showed good recovery from the losses encountered in

DISCUSSION (continued)

1967. The 1968 and 1969 results of aquatic insect sampling of sumithion spray varying from ¼ to 3/8 lbx./acre show moderate decreases. The 1970 results are generally consistent with those found in 1968 and 1969.

FISHERIES RESEARCH BOARD OF CANADA

BIOLOGICAL STATION

ST. ANDREWS, N. B.

REPORT ON ACTIVITIES TO INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

1. Toxicity of insecticides: The new insecticide, DDF had a 7-day lethal concentration of 0.12 mg/l for Atlantic salmon parr. The organophosphates Dylox and Bay 77488 had 4-day lethal concentrations of 3 and 1 mg/l for Atlantic salmon parr.

   - J.B. Sprague

2. PCB (Polychlorinated biphenyls): PCB are solubilized by certain nonionic surfactants. The resulting PCB solutions were used in bioassay experiments. The lethal threshold is 0.001-0.01 mg/l for *Gammarus oceanicus* and 2-4 mg/l for Atlantic salmon parr.

   - D.J. Wildish and V. Zitko

3. Some effects of Fenitrothion in two New Brunswick streams:

   The drainage basins of Trout Brook, Miramichi system, and Nashwaaksis Stream, Saint John system, were sprayed with Fenitrothion in June of 1969 and of 1970. Following spraying in both years population densities of stream invertebrates, during the normally productive summer months, were below the then record lows established in 1966 following aerial spraying of DDT and Phosphamidon. In Trout Brook, postspraying densities (no./ft^2 by Surber sampling) were 31 in 1969 and 1970; 74 in 1966; 250 in 1967, a spray-free year. Patterns were similar in Nashwaaksis Stream.

   There was no evidence of fish mortalities immediately after Fenitrothion spraying. However summer electrofishing showed that trout stocks have remained low since 1966 when severe delayed mortalities of salmon (and other species), attributable to DDT-and-derivative residues occurred in the autumn following spraying. No such delayed mortalities were observed in the autumn of 1969. In 1969 substantial numbers (448) of pre-smolt parr moved out of the stream, as was also the case in 1966.

   - J.W. Saunders

4. <u>Lower return rates from Atlantic salmon smolts exposed to sub-acute DDT poisoning:</u> In 1968 and 1969 it was reported that sub-acute DDT poisoning affected a variety of responses including simple learning, in young salmonids. An experiment to test the ecological significance of such sub-acute treatment was begun in 1969 using wild Northwest Miramichi smolts. The smolts were serially tagged. Four thousand were then exposed for 24 hours to 20 ppb DDT in the ambient water. Another 4,000 were given identical treatment but without DDT. Similar numbers of treated and untreated fish were liberated each day.

As grilse returns came in during the 1970 season the ratio <u>controls</u>: <u>DDT-treated</u> remained consistently near 2:1. There have been 86 records of control fish and 42 of DDT-treated to October 8. A 2% rate of return from tagged, wild Northwest Miramichi smolts is close to the past average. Returns of control and treated grilse captured in distant and home waters have also approximated the 2:1 ratio. But among the DDT-treated fish a higher percentage (14% as against 7%) of strays into Miramichi fresh waters other than the stream of origin has been reported.

- J.M. Anderson and P.F. Elson

5. After exposure for 24 hours to 1.0 ppm of the organo-phosphate insecticide, Fenitrothion, Atlantic salmon parr were more vulnerable to predation by large brook trout. The experiments were conducted in large out-of-doors concrete pools in which the salmon had access to a safe haven. Sumithion at 0.1 ppm, and 0.07 ppm DDT, had no noticeable effect. The results, particularly for Sumithion, correlate well with previous laboratory work on the effect of insecticides on the learning ability of salmon.

- C.T. Hatfield and J.M. Anderson

Compiled by: F.D. McCracken
October 20, 1970.

Summary of Canadian Wildlife Service supported projects -- 1970 New Brunswick spruce budworm control program

P. A. Pearce
Canadian Wildlife Service
Department of Indian Affairs and Northern Development
Fredericton, N. B.

For Interdepartmental Committee on Forest Spraying Operations

October 1970

The briefest outline of Canadian Wildlife Service activities and findings during the 1970 spruce budworm control program in New Brunswick is presented in the following few pages.

1. Experimental Spray Program

(a) Large block trials

In cooperation with the Resource Development Branch, Chemical Control Research Institute, and Canadian Forestry Service, CWS undertook to assess effects on bird populations of large-block (2,500 acres) trials under operational conditions of the carbamate insecticides Lannate and Matacil as well as the phosphonate Dylox. By mutual consent study areas were finally selected north and northeast of the proposed operational area in the following watersheds: Lannate - Sevogle River, Matacil (for "early" spraying) - Tomogonops River, Matacil (for "late" spraying) - Big Escedelloc River, and Dylox - Bartibog River. The monitoring technique used was the line transect, described in previous years to this committee. Existing roads were utilised as census routes, which ranged in length from 2.2 to 2.5 miles, and blocks oriented so as to be roughly diagonally bisected by these routes. As many bird censuses were made as time permitted--before the first spray, between the first and second sprays, and after the second application. Population indices were derived from the data. It was hoped that all sprays would be made in the morning so that birds would be subjected to maximum exposure. Again, as in other years, uncooperative weather did not permit this. Sprays were followed up by searches for carcasses, intoxicated birds and other evidence of effect. Control counts were made concurrently throughout the period.

Spray regimes and census schedules are summarised in Table 1. In a departure from the normal procedure and in the interest of time economy, individual census results are not presented here but population indices are shown graphically in Figures 1 and 2. These figures illustrate two phenomena: (i) the marked variability of day-to-day bird activity, which depends so much on weather conditions, and (ii) the essential parallelism of the indices in control and spray areas. In short, census data failed to reveal any spray effect. In support of this, nothing untoward was noted during searches of sprayed areas except in the Lannate block. There we found one dead least flycatcher on the morning after the second spray. On the same morning three dead warblers were found by members of a geological survey crew--one in the southwest corner of the plot and two on the road between two and three miles west of the plot. The only useful comment that can be made concerning these birds is that they might possibly have been spray victims as (i) they were on the probable approach path of spray aircraft and (ii) exceptionally large droplets on detection cards placed by CCRI indicate that one of the aircraft must have been leaking.

Six man-hours of searching, but no censusing, were carried out in experimental block #5 (North Little River Lake) sprayed with a new phosphamidon formulation at 2 oz active ingredient/acre. Some evidence of effect was noted. The following severely intoxicated birds were seen, two of which were captured: 1 unidentified flycatcher, 1 Swainson's thrush, 1 Tennessee warbler, 1 myrtle warbler, and 2 Wilson's warblers. The myrtle warbler consumed large numbers of mosquitoes caught for it but died within 24 hours.

(b) Ultra low volume trials

The ULV trials conducted out of Shediac by the CCRI did not lend themselves to an assessment of bird hazard by the usual methods for two reasons: (i) the plots were too small (about 320 acres) to accommodate line transects of adequate length, and (ii) sprays were not uniformly applied, dosages being deliberately graduated from light to heavy over the plots. An attempt to measure bird activity was therefore made by taking five-minute song counts at eight-chain intervals along two parallel lines marked in each plot by CCRI for purposes of access to sample trees. Post-spray searches were made in the usual fashion. Assistance was also supplied to Fisheries' Resource Development Branch in the collection of aquatic invertebrate samples from one of the pyrethrin plots. A summary of the sprays monitored is given in Table 2.

Table 1. Spray and bird census schedules

Block designation	Insecticide	Formulation	Dates sprayed	Number of censuses	Period
1	Lannate	0.8 oz in 0.15 USG ethylene glycol/acre x 2	June 4 am June 9 am	5 3 5	May 28 to June 27
2	Matacil ("early")	1.25 oz in 0.15 USG Dowanol TPM/acre x 2	June 8 pm June 13 pm	7 3 4	May 28 to June 27
3	Matacil ("late")	1.25 oz in 0.15 USG Dowanol TPM/acre x 2	June 13 am June 20 pm	3 4 3	June 1 to June 24
4	Dylox	6.0 oz in 0.15 USG Dowanol TPM/acre x 2	June 14 am June 21 am	3 2 3	June 1 to June 24
5	Phosphamidon	2.0 oz in 0.15 USG/acre	June 21 am	0	----
Control	-----	-----		24	May 28 to June 30

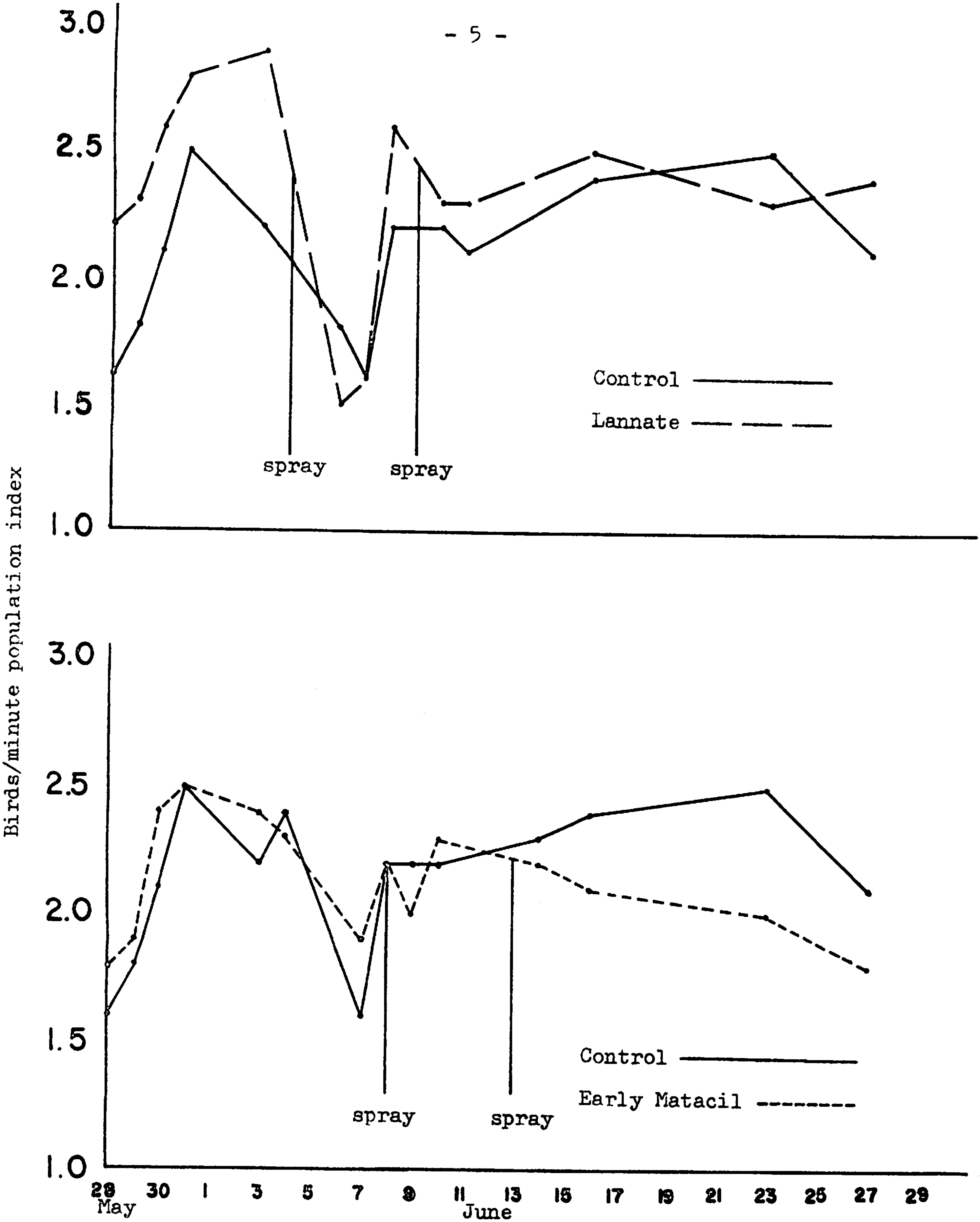


Figure 1. Variation of population indices.

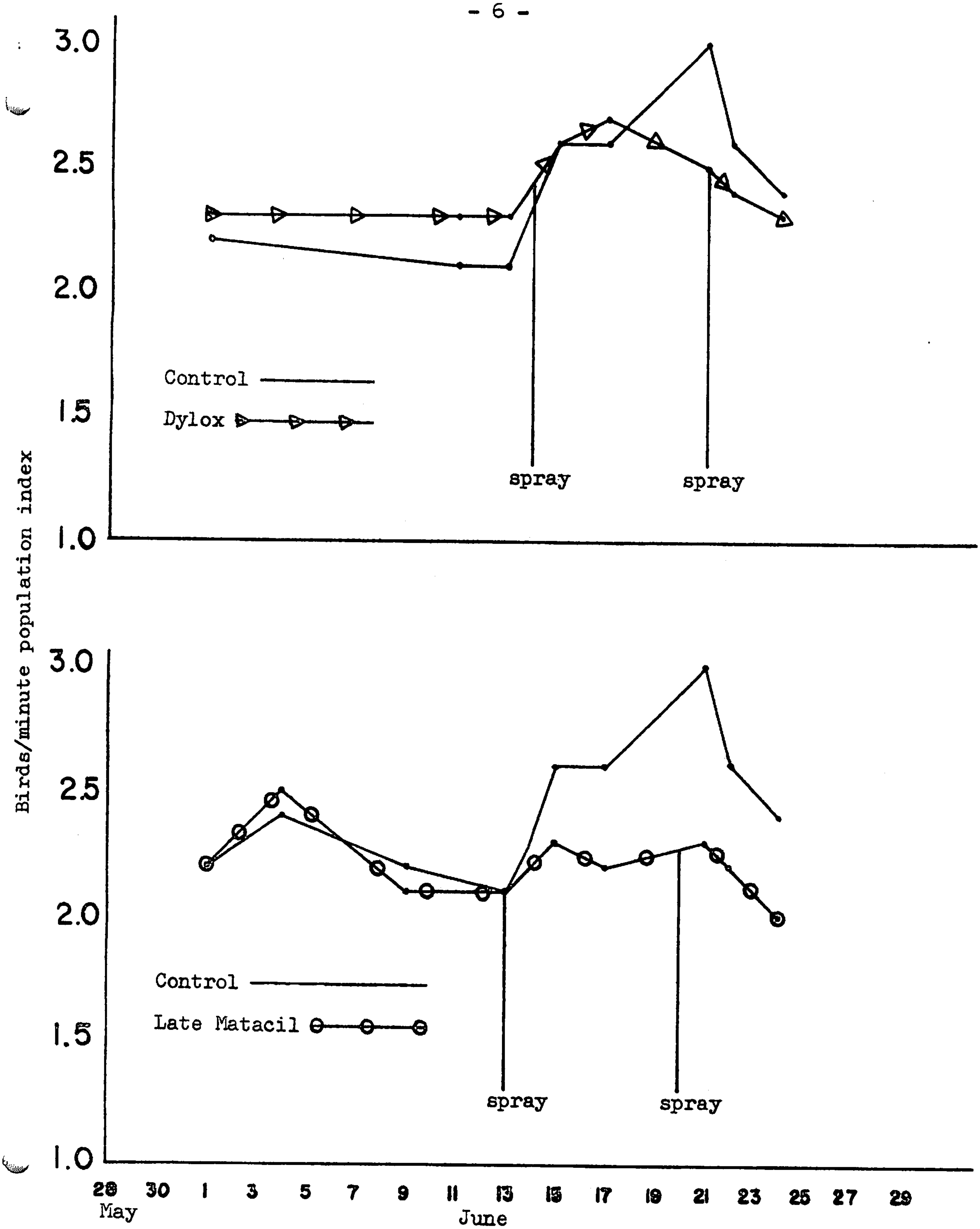


Figure 2. Variation of population indices.

CWS was able to assign only one observer to the ULV trials. The difficulties he encountered--some inherent in the system and some externally imposed--need not be enumerated here. Census data were quite variable and it was not always possible to make control counts at the critical times. No carcasses were found, no intoxicated birds seen, and no abnormal behaviour noted. Findings may be summed up as follows: nothing of a catastrophic nature befell birds as a result of the nine treatments monitored.

In practice our monitoring of the large-block sprays and the ULV trials were two separate activities but the findings, negative though they appear to be, should be considered together. From the bird hazard viewpoint, past experience indicates that dosage is the most critical factor though there has been some suggestion that the extent to which the spray is broken up may also be important. The deposit data from the "heavy" sides of the plots where Matacil, Dylox, and Lannate were applied in a ULV manner should provide a clue to what extent dosages may be safely increased if present knowledge of the budworm control effectiveness of these insecticides indicates the need for further operational trials.

2. <u>Operational Spray Program</u>

(a) Effects on birds

Once the decision to spray Fundy National Park was made, CWS, in response to a request from the National and Historic

Table 2. ULV spray schedules and CWS activity in plots

Plot designation	Insecticide	Active content (lb/USG)	USG applied	Dates sprayed	CWS activity census & search (**) search only (*)
P-1	Dylox	4.0	37.5(x2)	May 29 pm June 4 pm	**
P-2	Lannate	1.0	25(x2)	June 1 pm June 5 am	*
P-4	Matacil	2.6	40	May 15 am	*
P-6	Matacil	1.5	25(x2)	May 30 am June 5 am	**
P-7	Pyrethrum	0.2	50	June 22 pm	**
P-8	Ciba 17974	2.0	25	June 12 am	**
P-10	Pyrethrum	0.2	70	June 8 am	*
P-11	Matacil	1.5	50	June 18 am	*
P-14	Dylox	4.0	37.5(x2)	June 17 am June 19 pm	**

Parks Branch, agreed to conduct a study there. Objectives were as follows: (i) to determine population density and distribution of birds on a sample plot; (ii) to observe the effect, if any, of two operational applications of fenitrothion at 2 oz/acre on the survival, distribution, and behaviour of birds; and (iii) to provide ecological information of value to the park, particularly to the interpretive program.

A square, gridded plot of 25 acres was established in the park near the height of land just east of Bennett Lake, well within the boundaries of spray block 654 (first spray application) and 308 (second application). A similar control plot was set up at Brookville, east of the park and five miles from the nearest spray zone. Thirty censuses of each plot were made in the period May 23 to July 2 and the territories of singing males delineated. Numbers of territories are shown in Table 3.

Although the data have not yet been fully examined, several points may be of interest. A difference between arrival and territory establishment dates of several warbler species is related to phenological differences between the spray and control plots, separated in elevation by several hundred feet. Both areas supported high budworm populations but conifers in the spray plot had been much more seriously defoliated, the tops of many trees being devoid of leaves. This was reflected in the numbers of resident Cape May warblers, typical tree-top

Table 3. Estimated number of territorial males per 100 acres for each census period on spray and control plots

Census period	Spray plots	Control plot
Pre-spray (May 23 to June 4)	286	474
Post-spray #1 (June 6 to June 20)	352	462
Post-spray #2 (June 22 to July 2)	266	394

exploiters: there were 11 breeding pairs on the control plot but none on the spray plot. Also there was a great deal of deer and moose browse damage to shrub growth and coniferous and hardwood regeneration in the spray plot. The comparative numbers of magnolia warblers, which typically utilise such a niche, may illustrate this: the control plot supported 14 breeding pairs, the spray area only six.

Block numbers 654 and 308 were sprayed on the mornings of June 5 and 21 respectively. Detection cards placed prior to each application indicated that on both occasions the spray coverage was poor ("poor" being somewhat arbitrarily considered as less than five droplets per square cm). Of course, 25 acres is a small area and selection of this monitoring technique was made with the full realisation that spray coverage might be poor. This strengthens our view that the line transect method, in spite of its imperfections, is the one best suited to operational spray conditions. In addition there was an exceptionally long interval of 16 days between the two treatments. For both these reasons the sprays could not be considered as typical of the operation.

Certain birds did not arrive on either plots until after the first week in June so that they did not begin to establish territories until the second census period. Some are normally late spring arrivals and others, particularly the American redstart and the Tennessee warbler, increased in numbers during this census period. The former species increased on both plots at the same time. Tennessee warbler territories had been established on the control plot during the pre-spray census period, but more than one-half of the total Tennessee warbler territories were not established on the spray plot until the second census period. These late arrivals contributed to the obvious increase in the number of territorial males that occurred on the spray plot at this time (see Table 3). The greatest change in total numbers of territorial males during the study was a 24 per cent decrease on the spray plot and at 15 per cent decrease on the control plot. Many factors could be responsible for this. These might include abandonment of territory, predation, or gradual decrease in activity to the point where the bird may be undetected during the census. There was a slight decrease in the number of territorial American redstarts on the spray plot after the first treatment and a noticeable one after the second. Neither decrease was matched in the control plot.

No dead redstarts were found in the plot but our belief that this species was affected is supported by the finding of five dead ones as well as five sick ones elsewhere in the park. A Cape May, a Canada and four Blackburnian warblers were also found dead in other parts of the park. All affected birds were found one or two days after the areas had been sprayed. Had it not been for the vigilance of park staff, probably fewer casualties would have been noted. The redstart is a warbler of incessant motion and activity, much more so than other members of its family, constantly hopping and fluttering from perch to perch. It may thus pick up more poison than other birds and this may account for its apparent greater vulnerability to the spray. In other years we have recovered affected redstarts from fenitrothion-sprayed areas in numbers that might have suggested it was the most abundant species there. In the type of forest usually sprayed, however, it is frequently one of the least abundant species.

Estimates from three similar study plots in central New Brunswick in 1965 and 1966 indicated that bird populations in areas of moderate budworm infestation numbered from 140 to 180 breeding pairs per 100 acres. A fourth plot supported 292 pairs in 1968 and 282 pairs in 1969, during which year it was sprayed once with 2 oz/acre of fenitrothion without apparently affecting the bird population. The relatively large breeding population in the present plots, especially the control, may reflect a numerical response by some species to the high numbers of budworm present.

Each year, with increasing frequency, instances concerning the finding of dead birds are brought to our attention. Particularly in New Brunswick during the spring, forest spraying is, it seems, often suspected as the cause. When following up such reports it is sometimes difficult to separate fact from fiction and, in the usual absence of specimens to determine the probable cause of death. The following examples illustrate the problem and may interest the committee.

(i) An unusually large influx of scarlet tanagers into New Brunswick was recorded in late May. This is not a common species in the province and is, in a sense, pioneering at the northeastern extremity of its breeding range. Several were found dead in various places, six in one garden. Although the available specimens have not yet been examined it is possible that the birds arrived in a weakened condition, perhaps via an over-water route, and that their arrival coincided with a period of cold, wet weather when natural food was not obtainable. The deaths of some of the birds occurred in areas subsequently sprayed, but at least two weeks before actual treatment.

(ii) We investigated reports of dead birds having been found at the counting fence on Big Salmon River. Carcasses had apparently been recovered there during the period May 21 to 24, May 27 to 28, and June 6 to 8. Cold, wet weather occurred during the last two of these periods. Budworm spraying did not begin in that region until June 5, the major part of the watershed not being sprayed until one week after that date. Several species were involved including, oddly, a sharp-shinned hawk. Two warblers from the last of the three kills are being analysed.

(iii) A third-hand report of large numbers of sick and dead birds having been found in the UNB forest during the week following spraying proved on enquiry to concern the finding of two or three birds, not retained, at about that time and place.

As a contribution to a better understanding of the fate of fenitrothion in various components of the forest ecosystem, three bird species were selected for study. These were the Tennessee warbler, bay-breasted warbler and white-throated sparrow. The two warblers are arboreal, though the Tennessee nests on the ground. They exploit the outer parts of the middle of the tree crown. The whitethroat is a ground frequenter. In operational fenitrothion block 534 (redesignated as 176 at second spray, nine days after the first) six individuals of each species were collected on the day following the first spray and again six days later. The procedure was repeated after the second spray application. Seventy-two birds thus constituted the eventual sample. All were normally behaving, singing males. They were taken at points randomly located through the block. We have no assessment of spray deposit: some or all of the birds may or may not have become contaminated during the spray operation. Several males of the same species were collected as controls just prior to the start of operations in that region and 12 miles from amy area subsequently treated.

Brain acetylcholinesterase determinations are being made on three randomly selected and pooled specimens from each group of six exposed birds and on three separate individuals of each species of non-exposed birds. These are being done by Dr. P. E. Braid of the Occupational Health Division of the Department of National Health and Welfare. Matching composite samples of the carcasses of the same birds are being analysed for residual fenitrothion by Dr. L. M. Reynolds, Ontario Research Foundation, with whom the CWS contracts for toxic chemicals analytical work. Some one dozen dead birds recovered from other fenitrothion treated areas are also being analysed. Results are regrettably unavailable from both laboratories at the time of preparation of this report.

(b) Effects on amphibians (written by Anne Meachem Rick and Iola M. Gruchy)

We conducted an amphibian monitoring study in Fundy National Park from June 2 to 22 during forest spray operations in which the insecticide fenitrothion was aerially applied to the study sites in two sprays of 2 oz/acre each, nine to 17 days apart. During this study observations were made on three species of salamanders (Ambystoma maculatum, Plethodon cinereus, Notophthalmus viridescens), six frog species (Rana clamitans, R. septentrionalis, R. sylvatica, R. pipiens, R. palustris, Hyla crucifer) and one toad species (Bufo americanus) as well as on tadpoles and salamander larvae.

There was no immediate post-spray mortality among caged frogs (R. clamitans and R. septentrionalis), toads or tadpoles exposed to one application of 2 oz/acre. Among free-living amphibians, no deaths or unusual activity were noted after each spray, with the exception of one wood frog (R. sylvatica) found nearly immobile on the evening of the June 12 spraying.

Continuous census counts of green frogs (R. clamitans) were made once or twice daily at most of 14 selected ponds within the park area from June 3 to 22. Based on the census counts, fenitrothion spraying had no observable effect on green frog populations.

We conclude that this forest spraying of Fundy National Park with fenitrothion had no discernible effect on the park's amphibian fauna, and that future sprayings under similar conditions will present minimal hazard to amphibians.

3. Conclusions

We conclude that Lannate, Dylox, and Matacil present no significant hazard to birds when sprayed in the manner and at the dosages employed during the experimental program for budworm control in New Brunswick in 1970. Fenitrothion, applied as during the 1970 operational program, presents a minimal hazard to amphibians but does produce a discernible bird effect. The small number of bird casualties would be expected to increase with an increase of dosage of this insecticide.

4. Comment

Poor liaison between side-effects investigators and othersparticularly concerned with this year's experimental program resulted in frantic last-minute activities in the field in attempts to locate study areas that met the requirements of all cooperating agencies. The problem might be lessened by more frequent consultation, initiated as soon as spray proposals began to take shape in late winter.

As the lack of suitably qualified support staff is often a factor limiting the extent of our monitoring activities, those fenitrothion-replacement candidates with only the strongest chances of operational use should, if possible, be identified early in the year. We would then know where our efforts should best be concentrated.

Sincere thanks are expressed to the following for their assistance and suggestions during sometimes rather trying circumstances: E. G. Kettela (Canadian Forestry Service), J. A. Armstrong and A. P. Randall (Chemical Control Research Institute), G. H. Penney and D. Banks (Resource Development Branch), and B. A. McDougall and J. Hallett (Forest Protection Limited).

APPENDIX 22

SUMMARY STATEMENT
ON THE 1970 SPRUCE BUDWORM AERIAL OPERATIONS IN QUEBEC
AND FORECAST FOR 1971

by

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Quebec Department of Lands and Forests

R. Martineau, Forest Research Laboratory, Quebec Region,
Canada Department of Fisheries and Forestry

Prepared for The Interdepartmental
Committee on Forest Spraying Operations

October 1970

TABLE OF CONTENTS

SPRUCE BUDWORM AERIAL SPRAYING OPERATIONS

QUEBEC

by

Desaulniers, R.[1] and R. Martineau[2]

INTRODUCTION

Pulpwood stands in Quebec were severely damaged at the time of the last spruce budworm outbreak which lasted from 1939 to 1959. The forest in Quebec was free of budworm until 1965 when first evidence of a new build up appeared in a 30-year old white spruce plantation at Grand'Mère, in St. Maurice River watershed. The situation has worsened considerably since then and by 1970, the insect has reached outbreak proportions in three different regions: the Dumoine-Gatineau, the St. Maurice, and the Temiscouata Lake respectively in western, central and eastern Quebec (Figure 1). Representatives of the Conservation Branch of the Department of Lands and Forests and of the Canadian Forestry Service, Quebec Region, held several meetings during the winter 1969-1970 as well as during the summer 1970, to appraise the situation in each of these regions. Project responsibilities were shared by provincial and federal organizations on the basis of personnel and material available. Generally, the province was responsible for aerial spraying operations and aerial surveys, whereas the federal personnel were mainly concerned with ground surveys.

1.- Conservation Branch, Department of Lands and Forests, Quebec.

2.- Forest Research Laboratory, Quebec Region.

I. The Dumoine-Gatineau Infestation

History

The Dumoine-Gatineau infestation is by far the most extensive of the three infestation areas and was first discovered at Low, Gatineau in 1967. There is some evidence that some defoliation had occurred one year prior to its discovery. In 1967, the infestation covered four square miles where defoliation was light in a semi-mature balsam fir and white spruce stand. The insect was also recorded in surrounding localities but in much lower numbers. The area of infestation increased markedly in 1968 and an aerial survey made by the province in late July and early August 1969 revealed the presence of moderate to severe defoliation of the current year foliage over an area of 560,000 acres. Subsequent ground observations showed that a small part of the area had already suffered three successive years of moderate to severe defoliation. Provincial and Federal authorities agreed that 24,000 acres of infested balsam fir stands should be sprayed in 1970 to prevent tree mortality.

Aerial Spraying Operation, 1970

The aerial spraying operation in the Dumoine-Gatineau was carried out in an attempt to protect foliage on 1,800 acres of forest in Gatineau Park, and to prevent tree mortality on 22,500 acres in the Lower Gatineau River watershed.

Pre-Spray Survey and Insect Development

A pre-spray survey was conducted in May and early June to measure insect development and determine population densities in areas to be sprayed and in nearby unspread control points. Twenty-two sample plots measuring 10 square chains were monitored, 15 in sprayed areas and 7 outside. The sample for each plot consisted of two 18-inch branches from each of 10 trees, at a spacing of one chain between trees.

The Spraying Operation

The area sprayed was a mixedwood forest where white spruce and balsam fir are associated with paper birch, white pine and sugar maple. A total of 24,300 acres (Figure 2) were treated by Forest Protection Limited with three Stearman spray aircraft and one Cessna 172 as pointer.

The insecticide used (Fenitrothion) was formulated at a mixing plant in New Brunswick and trucked in barrels to the airport at Carp, Ontario, where it was mixed with water and loaded into the aircraft. The operational plan called for two applications of Fenitrothion, at a dosage of 1/8 pound per acre in 0.15 U.S. gallons of formulation.

Spraying commenced on the morning of May 28 when the majority of the larvae were in the third instar. Poor weather conditions kept the aircraft grounded from May 30 to June 4. The operation was completed by June 8.

Population Reduction in the Area Sprayed

A post-spray survey was conducted at all points where pre-spray insect densities had been determined. At that time, more than 70 per cent of the insects had reached the pupal stage.

Per cent budworm mortality due to treatment was based on data from pre and post-spray surveys using Abbott's formula*.

The following observations can be made from the data in Table 1. Reduction in population due to spray varied considerably from one sample plot to the next and ranged from 98 per cent to zero. It is interesting to note that in the case of the blocks where mortality was highest the interval between the two applications was 4 days or less, while in the case of the blocks where little or no mortality occurred the interval between applications varied from 6 to 9 days, except in one instance. Also, the spray blocks where good results were obtained were generally larger than 200 acres. This indicates that interval between applications and spray block size might have influenced the results.

* Abbott's formula: Per cent mortality due to treatment = $\frac{x - y}{x} \times 100$

where x = per cent survival in control plots.

y = per cent survial in spray plots.

Aerial Survey of the Current Defoliation, 1970.

The Quebec Department of Lands and Forests conducted an aerial survey of the current defoliation over an area of 12 million acres in western Quebec. Results indicate that defoliation of the current year's growth was severe in an area of 1,980,000 acres, moderate in an area of 1,370,000 acres and light in an area of 1,660,000 acres (Figure 3). This is a substantial increase over 1969 when 97,200 acres of severe 463,000 of moderate and 1,725,300 acres of light defoliation were recorded.

Forecast for 1971.

Extensive spruce budworm defoliation and egg-mass surveys were carried out during late August and early September 1970 to determine the potential hazard for 1971. The work was under the supervision of the Forest Insect and Disease Survey, Quebec Region, in co-operation with the Quebec Department of Lands and Forests and the limit holders. A total of 297 localities well distributed over the area of infestation were sampled for eggs and gave the following: nil 1.3%, light 9.8%, severe 88.9% (Figure 4). An average of 940 egg-masses per 100 square feet of foliage was found (min. 0, max. 7133). When it is considered that 313 egg-masses per 100 square feet of foliage are sufficient to produce a severe defoliation of the current growth on balsam fir the following year, it can be expected that defoliation will be extremely severe in most of the infestation area, (approx. 5,000,000 acres) in 1971. The data obtained from the egg sampling have been summarized by sector and are presented in Table 2.

Additional sampling was done by the Quebec Department of Lands and Forest personnel in the Lièvre River watershed, immediately east of the main infestation area. A total of 59 localities were sampled and are included in Figure 4. The results obtained were as follows: nil 41%, light 39%, severe 20%, this indicating that severe defoliation in 1971 is expected in a relatively small part of this watershed.

At the time of the egg-mass survey ground observations were made on current and previous years defoliation. Records on defoliation of the current year's growth were generally in accord with the aerial observations. Records on past defoliation indicated that in a number of areas totalling 660,000 acres, past defoliation had been severe for two consecutive years. Therefore, most stands in these areas have been subjected to three consecutive years of severe defoliation since the 1970 growth was also severely attacked. These are considered as high hazard areas where balsam fir mortality can be expected in 1971 should no protection measures be taken. These high hazard areas with proper buffer zones have been recommended for treatment in 1971. Serious consideration is being given to the possibility of including in the 1971 spraying program certain areas showing two years of severe defoliation within the range of operational airfields, and which would require protection in 1972, should the infestation continue.

II. The St. Maurice Infestation

History

A spruce budworm infestation was detected in the vicinity of Lac à la Tortue in white spruce plantations in 1966. An aerial spraying operation was carried out in 1968 on 3,350 acres to bring to an end this infestation before it had a chance to spread. Although budworm populations were greatly reduced, the objective was not achieved as evidenced by surveys conducted in 1969.

Aerial Spraying Operation, 1970

Consultation between Consolidated Bathurst Limited, owner of these plantations, and the Quebec Department of Lands and Forests led to the decision to spray the 4,500 acres of white spruce plantations that were still infested (Figure 5). This program was carried out in June 1970.

A pre-spray survey was conducted in eleven sample plots previously used in 1969 and measuring 10 square chains. The sample for each block consisted of two 18-inch branches from each of 10 trees, at a spacing of one chain. The purpose of this survey was to measure insect development and population densities. It was impossible to establish control plots because the entire area under attack was sprayed.

Spraying commenced on June 10, when 70 per cent of the population was in the fourth and fifth instars, and was completed by June 15. The operation was carried out by Yvon Fournier Limitée with two Bell G-4 helicopters equipped with Automatic Flagman. The operational plan called for one application of Fenitrothion at a rate of 3.5 ounces per acre in 0.4 gallon of formulation. The mixing and loading crews were composed of personnel from Quebec Department of Lands and Forests and Consolidated-Bathurst Limited.

Population Reduction in the Area Sprayed and Forecast for 1971

Effect of the spraying was not determined at a level of analysis comparable to that for the Dumoine-Gatineau infestation since no control points could be established. However, considerable information regarding spray-effects is available from other sources.

Pre- and post-spray surveys indicated that the weighted mean per cent reduction in budworm population was 89 per cent (Table 3). An overall reduction of 85 per cent occurred in pupal densities at the same locations from 1969 to 1970. An aerial survey conducted over 7,200 square miles in central Quebec and including part of the St. Maurice River watershed, indicated that there were 450 acres of light defoliation in the plantations sprayed this year (Figure 6). In addition there were 2,590 acres showing light defoliation of the current growth in close proximity of the plantations indicating that the original infestation is spreading. The egg-mass survey carried out in the eleven sampling blocks (Figure 7) indicate that the population can be expected to be high again in 1971 since the number of egg-masses per 100 square feet of foliage is even higher than it was in 1969 (Table 3).

III. The Temiscouata Lake Infestation

History

The first signs of an increase in spruce budworm populations in Temiscouata region appeared in 1968 in the Green River watershed where very light defoliation was recorded. In 1969 light defoliation was observed in the same area and in a new area north of Pohenegamook Lake, 50 miles to the southwest. This year, severe defoliation was recorded in a few localities in the above areas and again new sectors were infested. This situation was reported to provincial and federal authorities, and although the infestation was still considered at an early stage of development, it was decided to get more detailed information on the prevailing conditions, in view of the importance of balsam fir forests in the general area. Aerial and ground surveys were carried out by provincial and federal personnel along the same lines as reported for western Quebec. The work was completed by mid-September and the results are presented below.

Aerial Survey - 1970

The aerial survey in Temiscouata region was done in late August by two experienced observers working in an helicopter Bell G 4 to obtain records on all degrees of defoliation including light defoliation. An area of approximately 3,000 square miles was surveyed and budworm defoliation was recorded in 10 separate "islands" shown on the map (Figure 8). These areas total 42,500 acres. Defoliation of the current year's growth was estimated as light, in all the "islands" except one which measured 2,800 acres and where defoliation was classified as moderate.

...10

Forecast for 1971

An egg-mass and ground defoliation survey was carried out in early September and special attention was given to the areas where defoliation was recorded from the air. A total of 51 localities well distributed throughout the territory was sampled for eggs; results are as follows: nil 53%, light 40%, severe 7% (Figure 9). Eggs were found only north of Pohenegamook Lake and around Temiscouata Lake. The only area where the insect is expected to cause moderate to severe defoliation in 1971 on the basis of egg counts is located southeast of Temiscouata Lake. The average number of eggs per 100 square feet of foliage for the localities where eggs were found, was 102 (min. 8, max. 615).

Defoliation of the current year's growth as observed from the ground, was generally estimated as trace or light. Moderate to severe defoliation was however found in a few localities north of Pohenegamook Lake and southeast of Temiscouata Lake. The moderate to severe defoliation seen from the ground in the last area was apparently missed from the air and is not shown in Figure 8. These two last areas are also the only ones where defoliation on previous years' foliage, that is, light defoliation in 1969, was recorded. No important damage is expected from budworm attack in this area in 1971. The Temiscouata infestation may however, be considered as the beginning of a more general infestation. Aerial spraying should seriously be considered with the object of bringing to an end these isolated foci of infestation.

SPRUCE BUDWORM SITUATION OUTSIDE INFESTATION AREAS IN QUEBEC

The spruce budworm population is generally on the increase in pulpwood stands in Quebec. This phenomenon has been made apparent through insect collections, light trap captures and surveys.

The number of budworm collections received each year from different regions of the province, by the Quebec Department of Lands and Forests increased markedly since 1965 as shown by the following data: 1965, 2; 1966, 29; 1967, 42; 1968, 94 and 1969, 210. An important increase is also shown in the records of light traps outside (min. distance 40 miles) of the main areas of infestation.

This is illustrated by the following data for light-trap captures:

Locality	County	Number of budworm adults		
		1968	1969	1970
Harrington	Argenteuil	-	-	156
Normand Lake	Laviolette	7	7	5639
Chûte aux Galets	Chicoutimi	0	0	2763
Forêt-Montmorency	Montmorency	-	38	241
Port au Saumon	Charlevoix	-	-	1145
Causapscal Lake	Matapédia	-	0	120

The light-trap captures given for 1970 cover the period extending from July 1 to August 6, dates of the first and last budworm captures. The most important catches occurred on the 10, 11 and 15 of July. Mass moth flights were also reported for a few areas namely Hull and La Tuque.

Supplementary egg-mass sampling was carried out in 160 localities outside of known infestation areas; the results are shown below:

Sector	No. of localities	Forecast for 1971		
		Nil	Light	Severe
Abitibi	19	4	11	4
Rouge River-Mt Tremblant	42	31	11	0
St-Maurice-Batiscan watersheds	34	24	10	0
Laurentide Park-Charlevoix	43	41	1	1
Gaspe Peninsula	22	11	11	0

Eggs were found in all sectors, but generally in small numbers. In the Abitibi sector, 4 localities were classified as severe but all in the vicinity of the Dumoine-Gatineau infestation. In the Laurentide Park-Charlevoix County locality gave a forecast for severe populations, this was at Cap à l'Aigle in a small stand which showed severe defoliation of the current year's growth and light defoliation of 1969 growth. This area will be checked closely in 1971. Elsewhere defoliation was either non-apparent or negligible.

Table 1 - Per Cent Mortality Due to Treatment in Selected Spray Blocks in Dumoine-Gatineau Infestation 1970

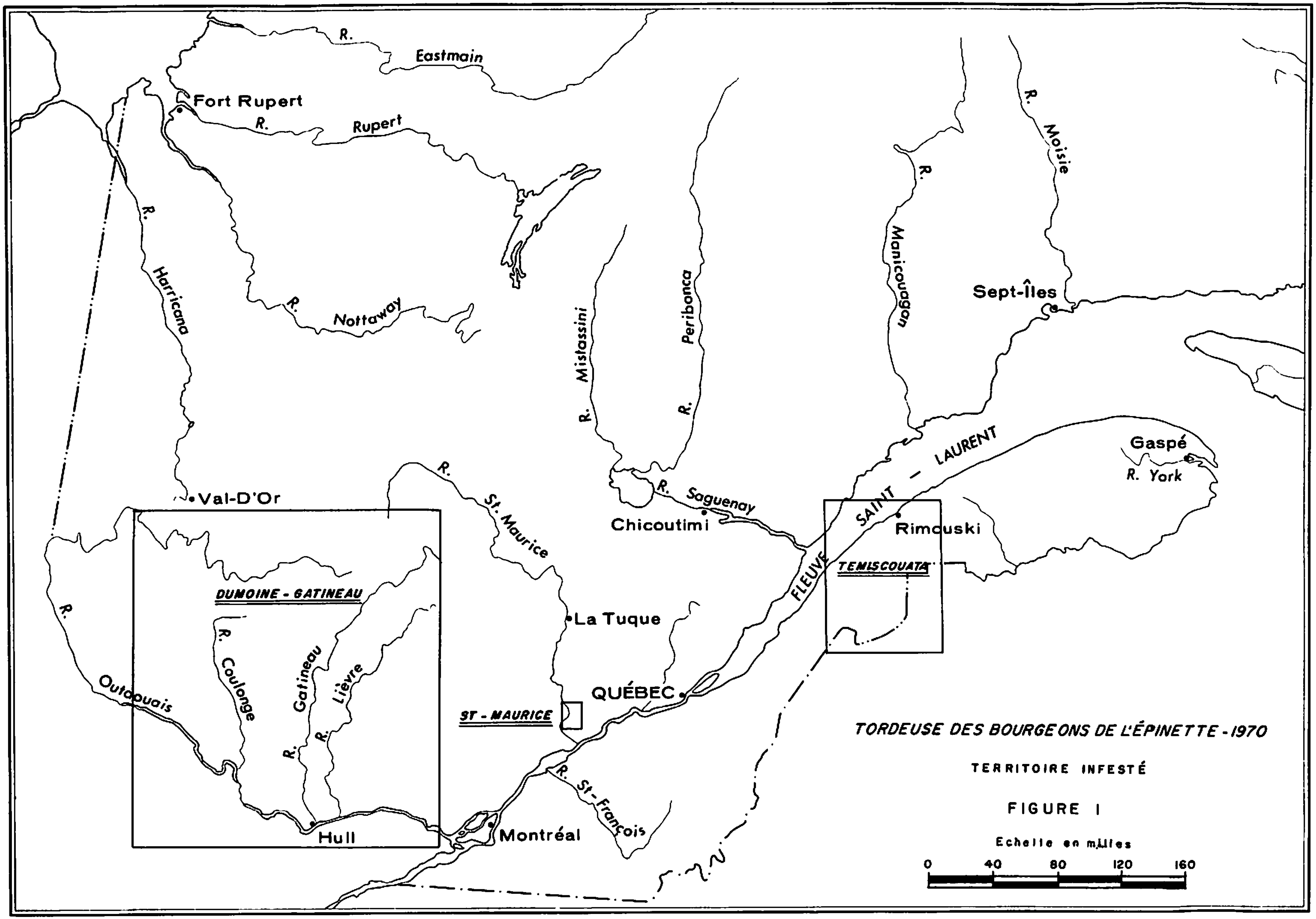
Sample plot No.	Area of Spray block in acres	Insect development: 1st application % in each instar II	III	IV	V	VI	Days between appli-cations	2nd application % in each instar III	IV	V	VI	Insect population: Pre-spray larvae per 18" br. tip	Post-spray pupae per 18" br. tip	Per cent reduction in survival
1	1010			21	49	23	4		5	41	54	20.2	1.3	91
2	330			12	55	33	2		7	47	46	14.5	1.1	89
3	600			12	55	33	3		5	41	54	31.1	3.9	83
4	2420		7	21	49	23	2		10	52	38	21.7	0.4	98
5	200			7	47	46	1		5	41	54	32.4	3.5	86
6	380			12	55	33	3		5	41	54	21.3	3.6	76
7	480			7	47	46	1		5	41	54	23.2	4.0	76
8	40			7	47	46	1		5	41	54	7.2	4.0	10
9	500	1	49	47	3		6	7	21	49	23	9.2	6.2	0
10	3680	4	71	23	2		9		10	52	38	4.8	1.8	38
11	110	4	71	23	2		7	7	21	49	23	23.9	12.8	27
12	470	1	49	47	3		6	7	21	49	23	8.6	3.6	34
13	30	4	71	23	2		7	7	21	49	23	15.5	12.8	0
14	260	4	71	23	2		7	7	21	49	23	33.3	12.5	53
15	170	4	71	23	2		7	7	21	49	23	27.9	12.7	40
Weighted mean							4.4					19.1	5.6	58

Table 2.- 1970 Spruce Budworm Egg-Mass Counts for the Dumoine-Gatineau Infestation Area.

Sector	No. of Localities Sampled	No. of Egg-Masses per 100 sq.ft. of foliage Minimum	Maximum	Mean
Pomponne	36	221	3385	1164
Nigault	22	400	4077	1110
Dumoine	16	248	2380	868
Ottawa-Noire	21	50	2200	995
Coulonge	24	15	3492	891
Ottawa-Low Gatineau				
Unsprayed	29	0	2988	890
Sprayed-1970	22	10	1800	326
Gatineau (Central)	89	0	7133	1083
Baskatong-Cabonga	38	0	1777	646
Total	297	0	7133	940

Table 3 - Per Cent Reduction in Population Based on Pre- and Post-Spray Surveys in St. Maurice Area and Egg-Masses per 100 ft^2 in 1969 and 1970

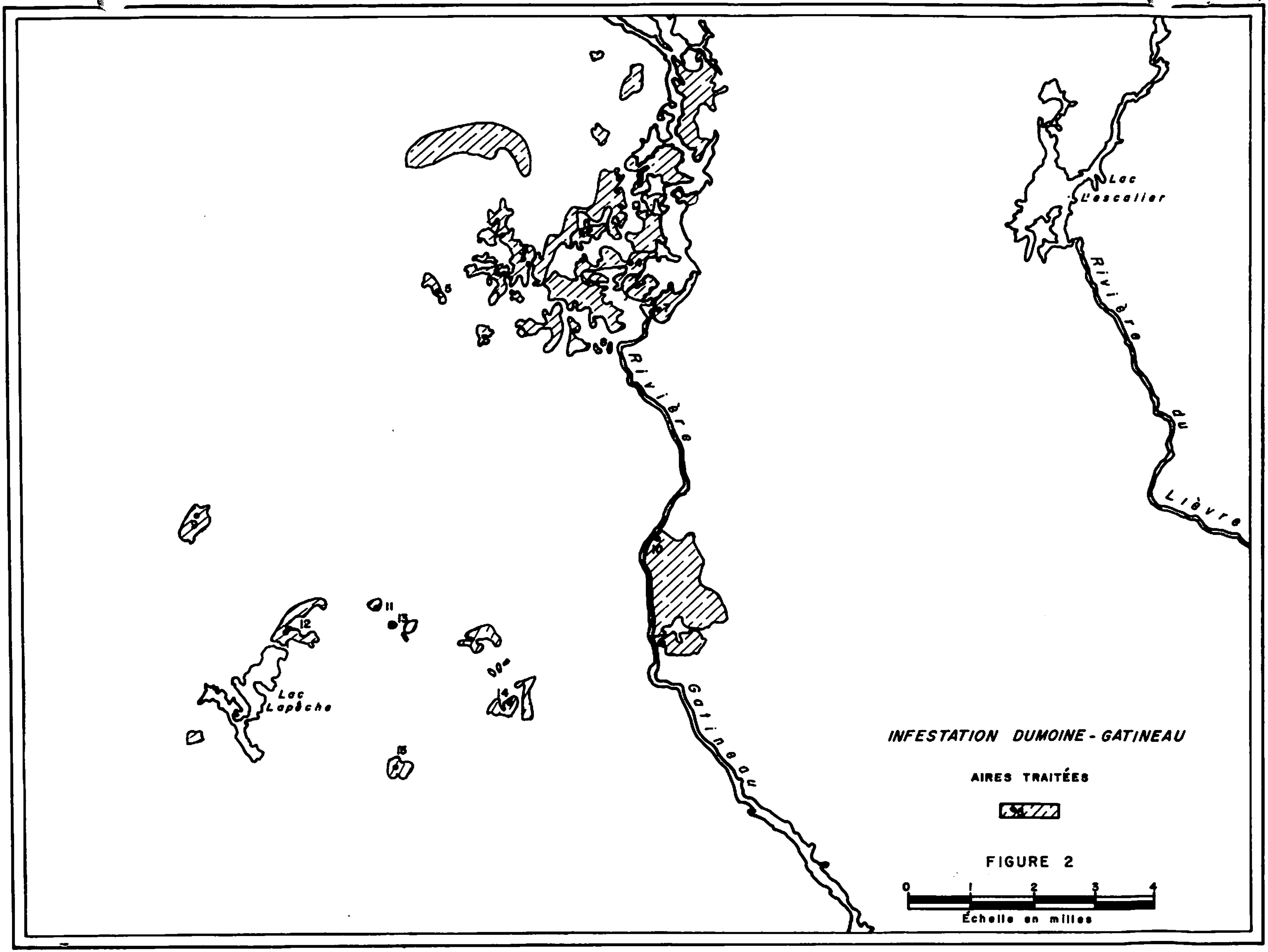
Sample No.	Larvae per 18" branch tip	Pupae per 18" branch tip	Per cent population reduction	Egg-masses per 100 ft^2 of foliage	
				1969	1970
Treated in 1968					
1	10.8	3.8	65	22	322
2	12.7	1.1	91	466	204
3	11.2	0.5	96	94	67
4	17.5	1.2	93	6	316
5	22.8	1.2	95	10	101
6	18.2	1.4	92	35	86
Average	15.5	1.6	90	38	148
No previous treatment					
7	24.2	1.0	96	72	124
8	29.6	4.6	85	325	102
9	16.5	4.8	71	333	119
10	17.4	1.4	92	147	375
11	16.3	0.6	96	12	96
Average	20.8	2.5	88	136	126
Weighted mean	18.0	2.0	89	94	138



TORDEUSE DES BOURGEONS DE L'ÉPINETTE - 1970

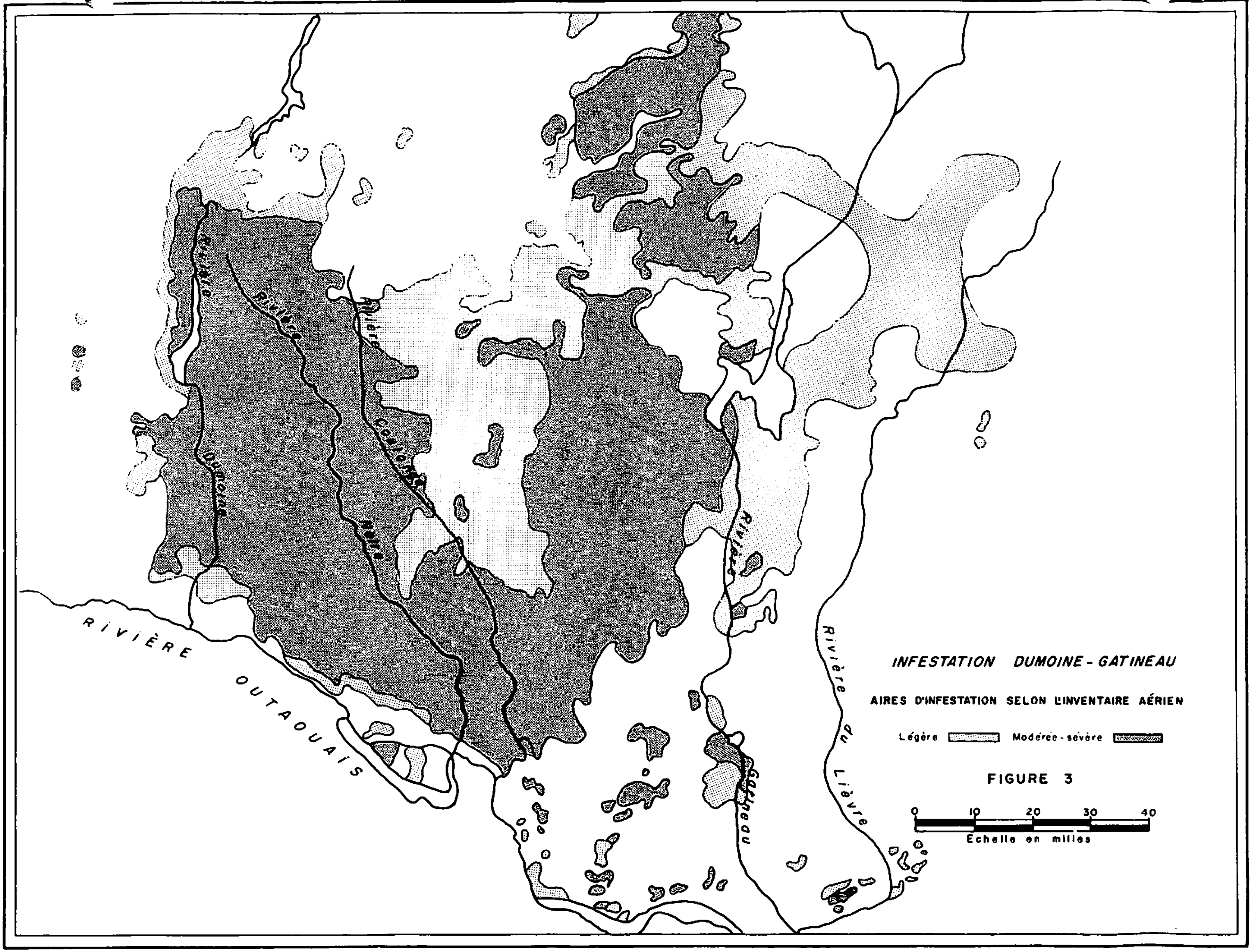
TERRITOIRE INFESTÉ

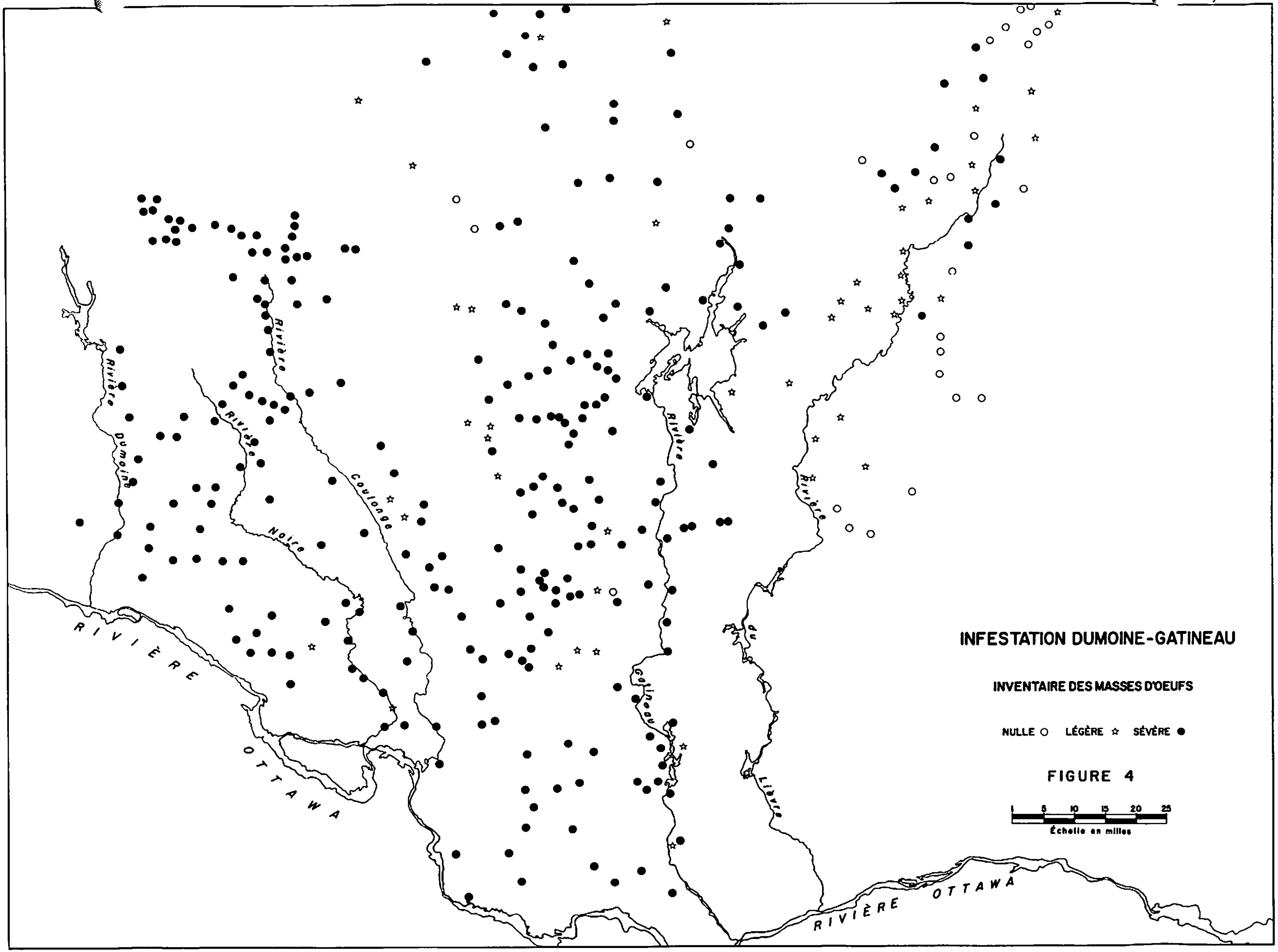
FIGURE I

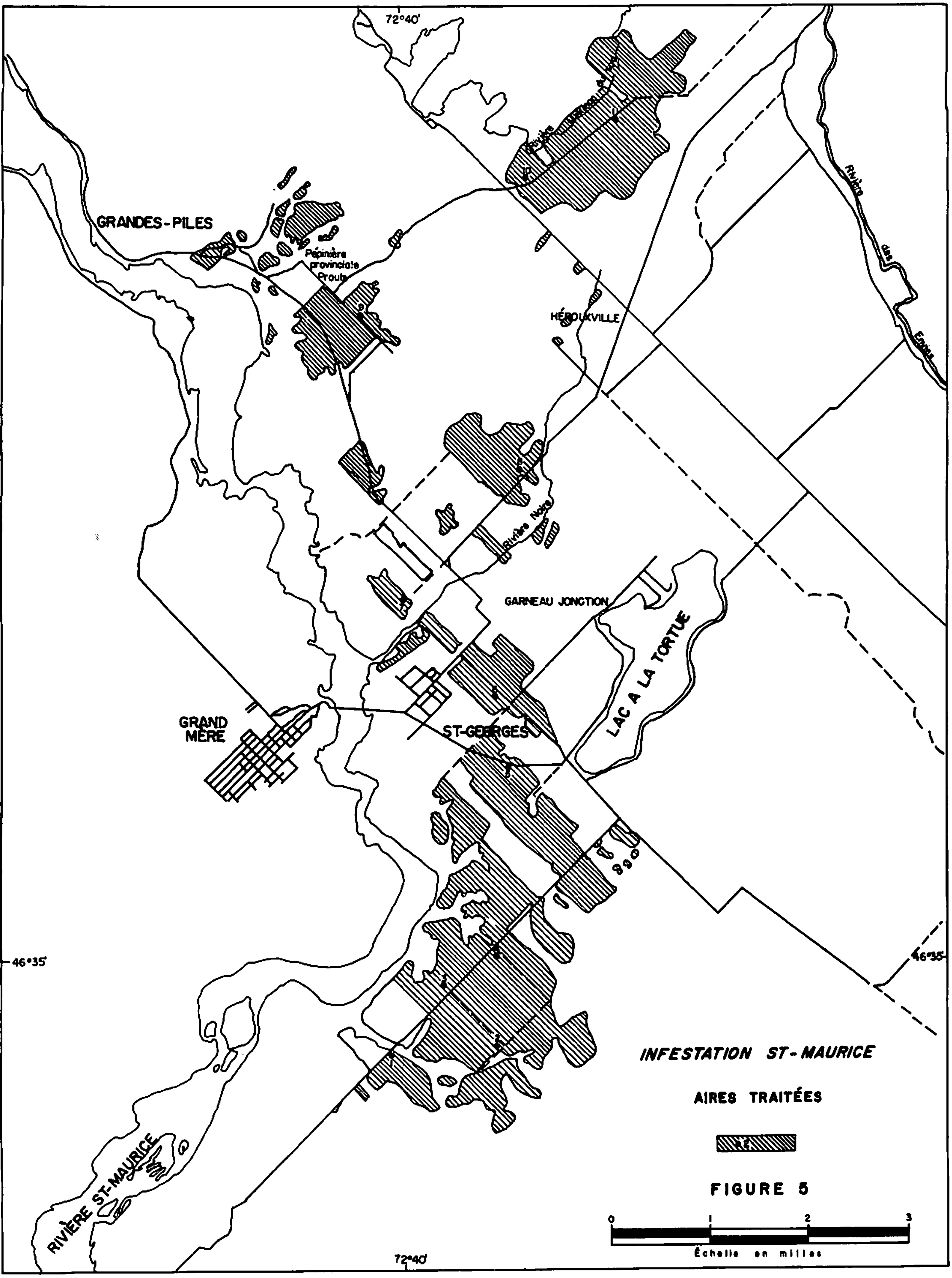


INFESTATION DUMOINE - GATINEAU

FIGURE 2


RIVIÈRE OUTAOUAIS
Rivière Dumoine
Rivière Noire
Rivière Coulonge
Rivière Gatineau
Rivière du Lièvre
INFESTATION DUMOINE - GATINEAU
AIRES D'INFESTATION SELON L'INVENTAIRE AÉRIEN
Légère
Modérée - sévère
0 10 20 30 40
Échelle en milles
FIGURE 3

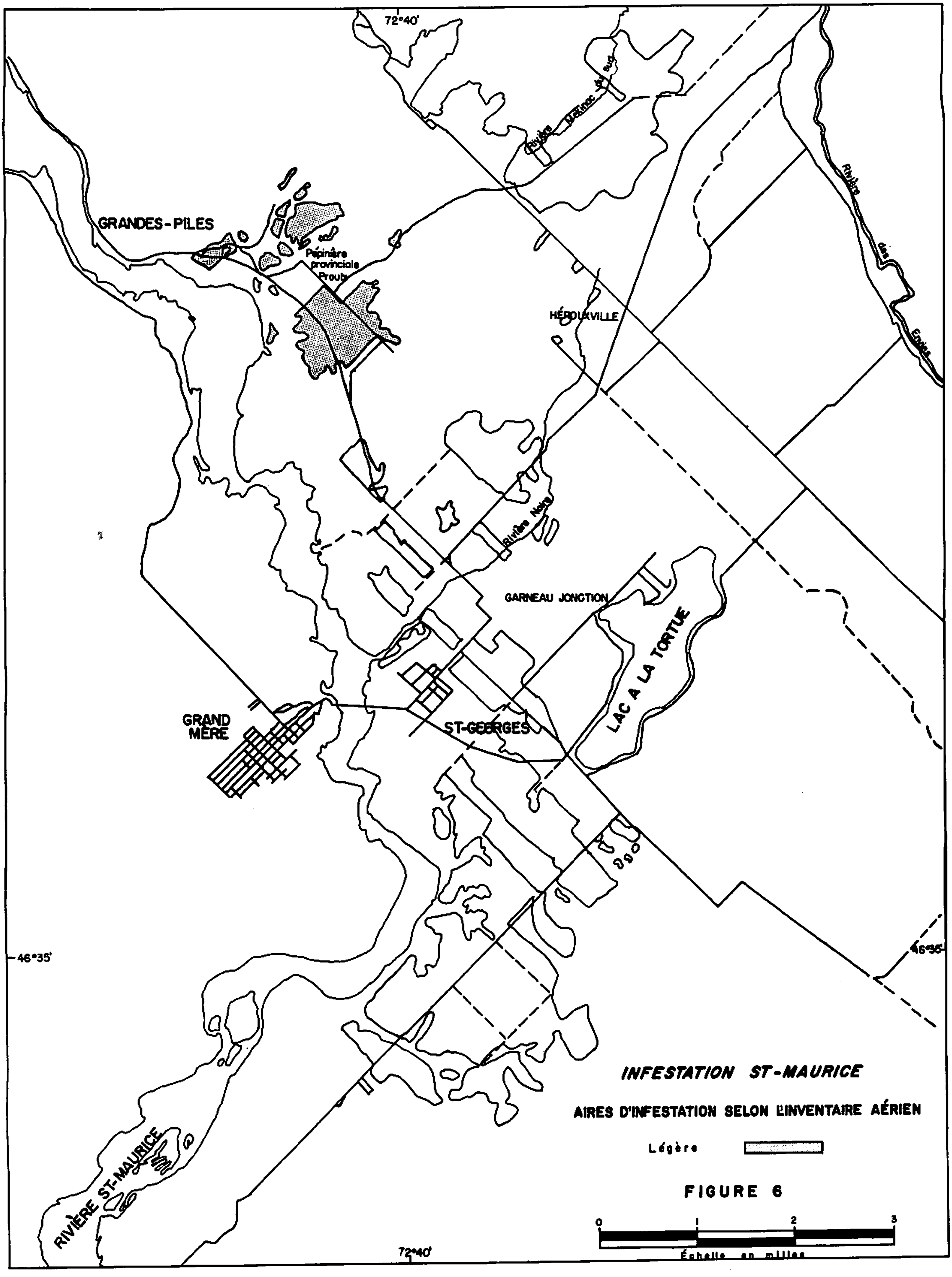

INFESTATION DUMOINE-GATINEAU
INVENTAIRE DES MASSES D'OEUFS
NULLE ○ LÉGÈRE ☆ SÉVÈRE ●
FIGURE 4
5 10 15 20 25
Échelle en milles
Rivière Dumoine
Rivière Noire
Rivière Coulonge
Rivière Gatineau
Rivière du Lièvre
RIVIÈRE OTTAWA
RIVIÈRE OTTAWA



INFESTATION ST-MAURICE

AIRES TRAITÉES

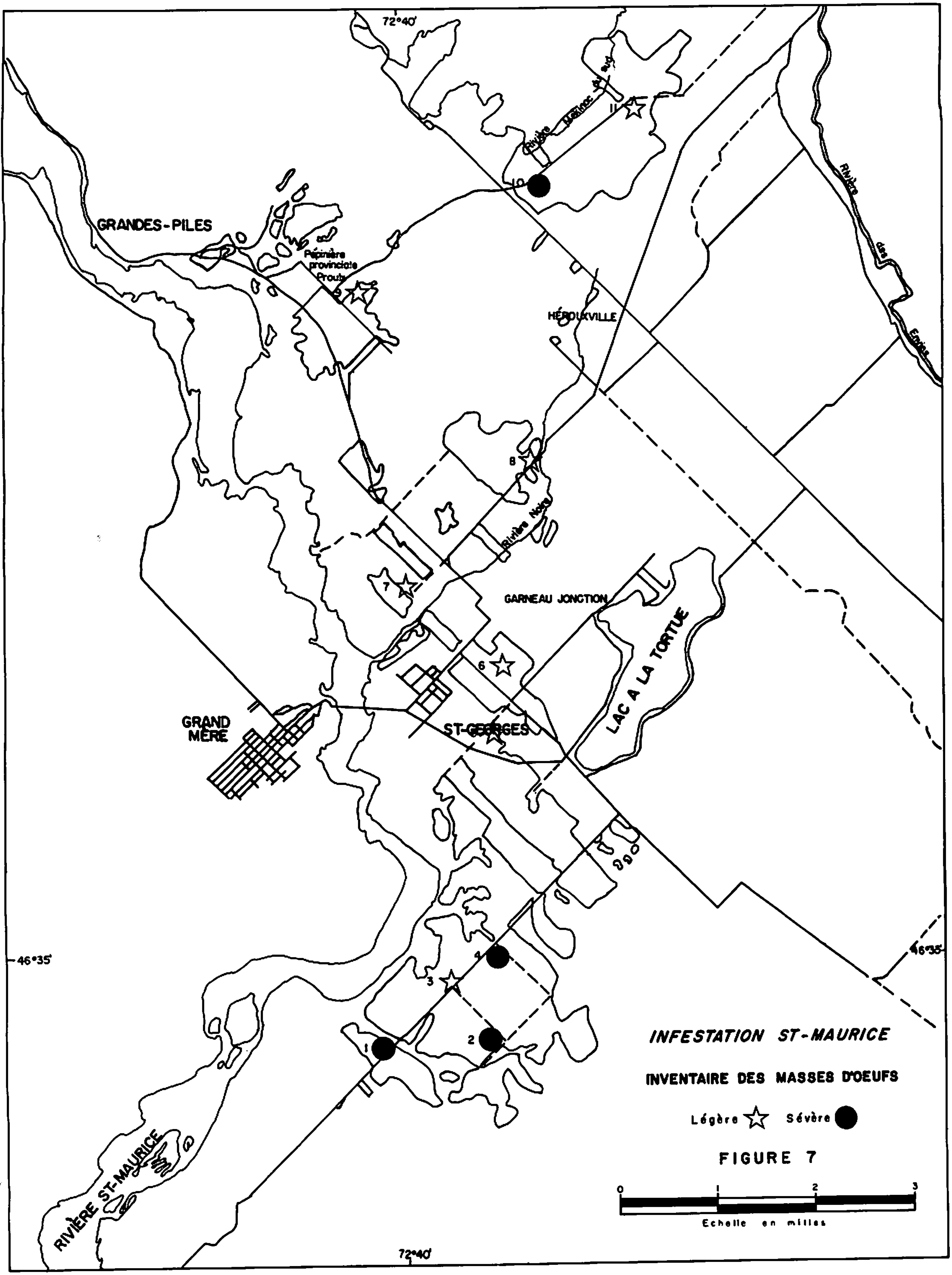
FIGURE 5



INFESTATION ST-MAURICE

AIRES D'INFESTATION SELON L'INVENTAIRE AÉRIEN

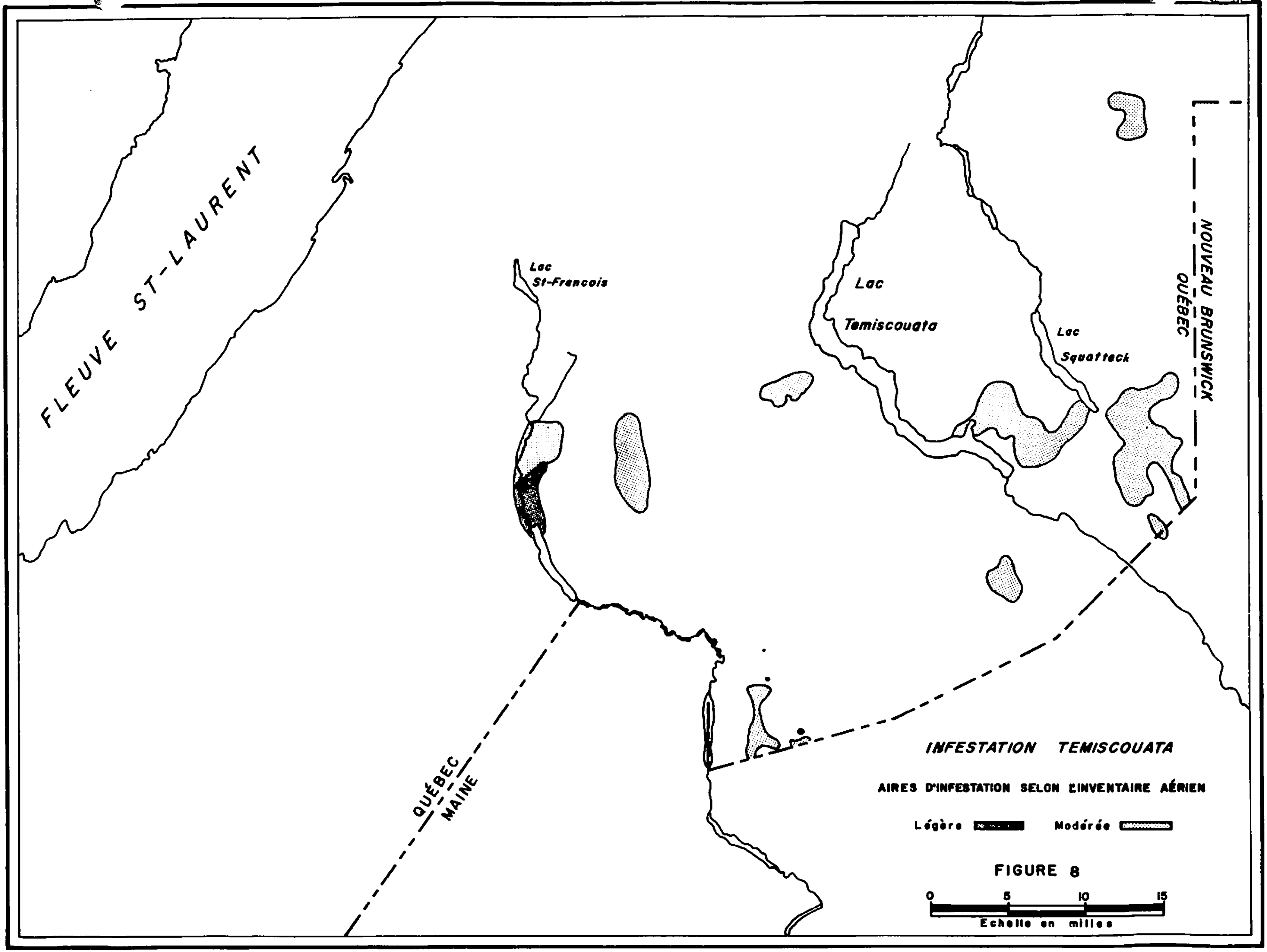
FIGURE 6



INFESTATION ST-MAURICE

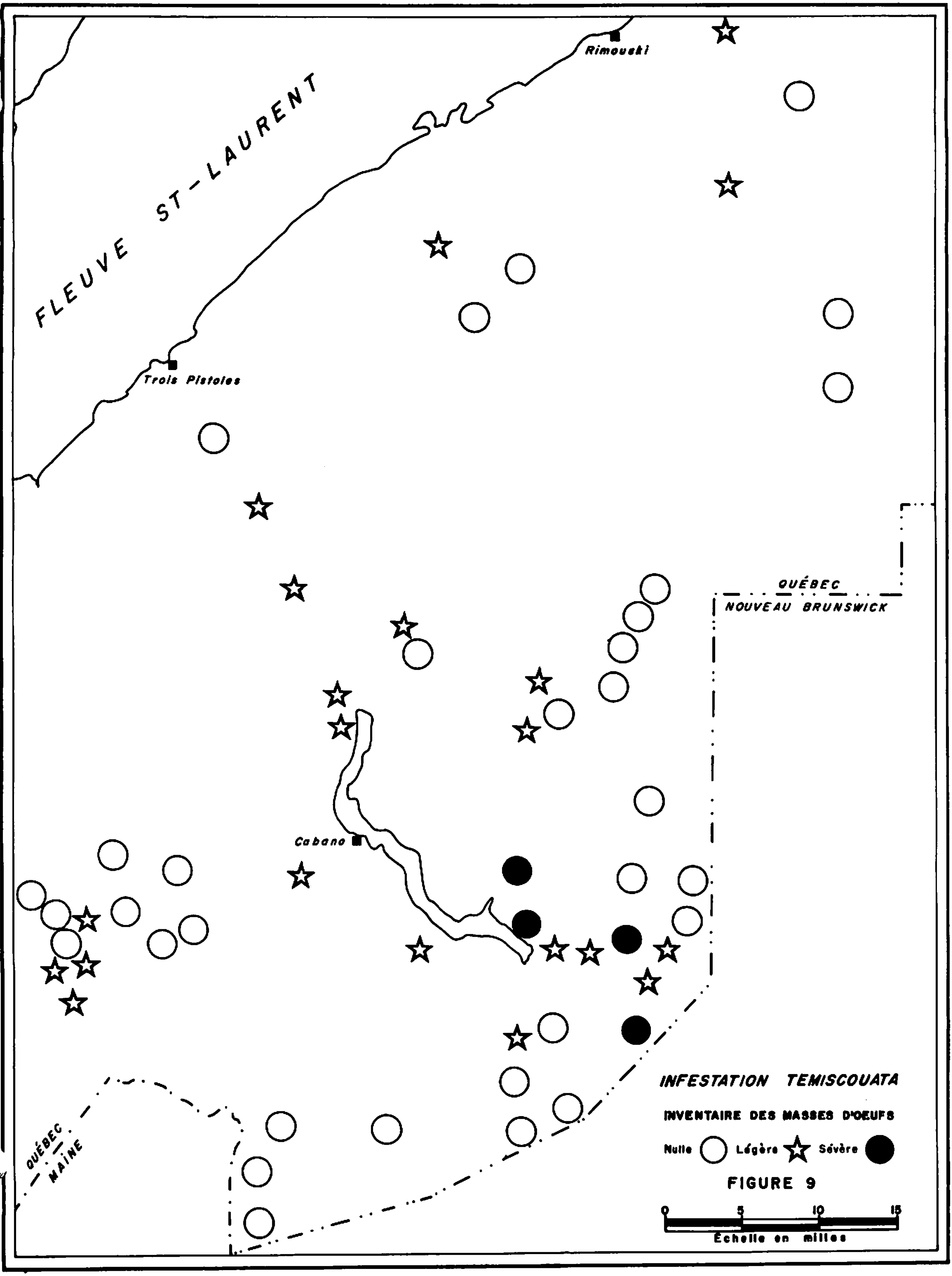
INVENTAIRE DES MASSES D'OEUFS

FIGURE 7



INFESTATION TEMISCOUATA

FIGURE 8


FLEUVE ST-LAURENT
Rimouski
Trois Pistoles
Cabano
QUÉBEC
NOUVEAU BRUNSWICK
QUÉBEC
MAINE
INFESTATION TEMISCOUATA
INVENTAIRE DES MASSES D'OEUFS
Nulle
Légère
Sévère
0
5
10
15
Échelle en milles
FIGURE 9

Environmental Contamination - Pesticides

by W.N. Yule
Chemical Control Research Institute

Fenitrothion.

A large part of the winter's programme of analysis was devoted to measuring the concentration of phosphorus and fenitrothion in the various air samplers that were used in the 1969 N.B. atmospheric survey. These results, together with weather and spray operation data are still being correlated, but in general it can be reported that most daily air samples contained phosphorus at the nanogram ($1x10^{-9}$g.)/cubic metre level, some of which was still in the form of parent fenitrothion. These amounts, together with their brief occurrence, are considered not to constitute a human health hazard.

A Departmental research grant was obtained for Dr. J.R. Duffy, University of P.E.I., to study methodology for fenitrothion and its breakdown products in the forest environment. Field work for this study was carried out during the 1970 N.B. spray operation. This comprised a sequence of sampling from pre-spray to 64 days post-spray of balsam fir foliage, mixed spruce foliage, and soil, at three locations in the Priceville experimental area. Same-day extraction with several different solvent systems was carried out in a temporary laboratory set up at the Fredericton Research Laboratory. The individual extracts were split, deep-frozen, and distributed between P.E.I. and Ottawa for methodology research and ecological interpretation, respectively, in order to gain information on the persistence and breakdown of fenitrothion in several components of the forest environment. Dr. Duffy has already made some progress with developing methods for extraction, cleanup and chromatographic analysis of fenitrothion and two primary metabolites. Major progress is anticipated with the coming winter's programme of laboratory analysis.

Other developments in connection with fenitrothion research are in expansion of laboratory facilities for analysis, and in the application of these and of drift-sampling techniques to the study of operational spray-spectrum characteristics, reported here by Dr. Armstrong.

DDT

The analyses of Priceville soils for the 1968 intensive survey and for 1969 and 1970 persistence records have been completed, and a comprehensive report is in preparation. Analysis of parts of four tree species growing in Priceville soil was completed last winter, and further field work on DDT-uptake by plants was undertaken in 1970. An extensive sampling survey of soil (and some foliage) was made in the forests of Northern N.B., where DDT was applied between 1952 and 1958, as an extension of the DDT persistence and cycling study. Sample sites were selected to give permutations of total dosage applied, time range and number of applications, time lapsed, forest type and soil type, geology, and topography. W. Varty of the Fredericton laboratory intends making a parallel survey of invertebrate communities when our residue data are available.

SPRUCE BUDWORM AERIAL SPRAYING OPERATIONS

ONTARIO, 1970

by

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Canadian Forestry Service

Forest Research Laboratory

Sault Ste. Marie, Ontario

Introduction

In 1970, the Canadian Forestry Service and the Ontario Department of Lands and Forests, on a co-operative basis, carried out seven aerial spraying operations against the spruce budworm over some 23,000 acres in Ontario. Two of these operations were in southeastern Ontario, namely at the Petawawa Forest Experiment Station and Larose Forest (discussed under heading A); two in northeastern Ontario, Missinaibi and Ivanhoe provincial parks (B); and three in northwestern Ontario, Northern Light Lake, Granite Lake and Gunflint Lake (C). The locations of these areas are shown in Figure 1. This statement describes each operation and the results obtained, and outlines infestation forecasts for 1971, especially those pertaining to probable aerial spraying operations.

A. Southeastern Ontario Aerial Spraying Operations

Background

The first of the two locations sprayed consisted of 800 acres of white spruce plantations in the Larose Forest, located in Clarence Township about 25 miles east of Ottawa. This demonstration forest is under the management of the Ontario Department of Lands and Forests, and they wished to prevent further severe damage to these plantations which had been heavily infested in 1968 and 1969. At the Petawawa Forest Experiment Station (PFES), some 28 plantations and three natural stands totalling about 450 acres were sprayed to prevent damage to high value research areas. Although the spruce research areas suffered little defoliation in 1969, egg-mass counts in the fall of 1969 were so high on the PFES that some form of protection in 1970 was considered essential.

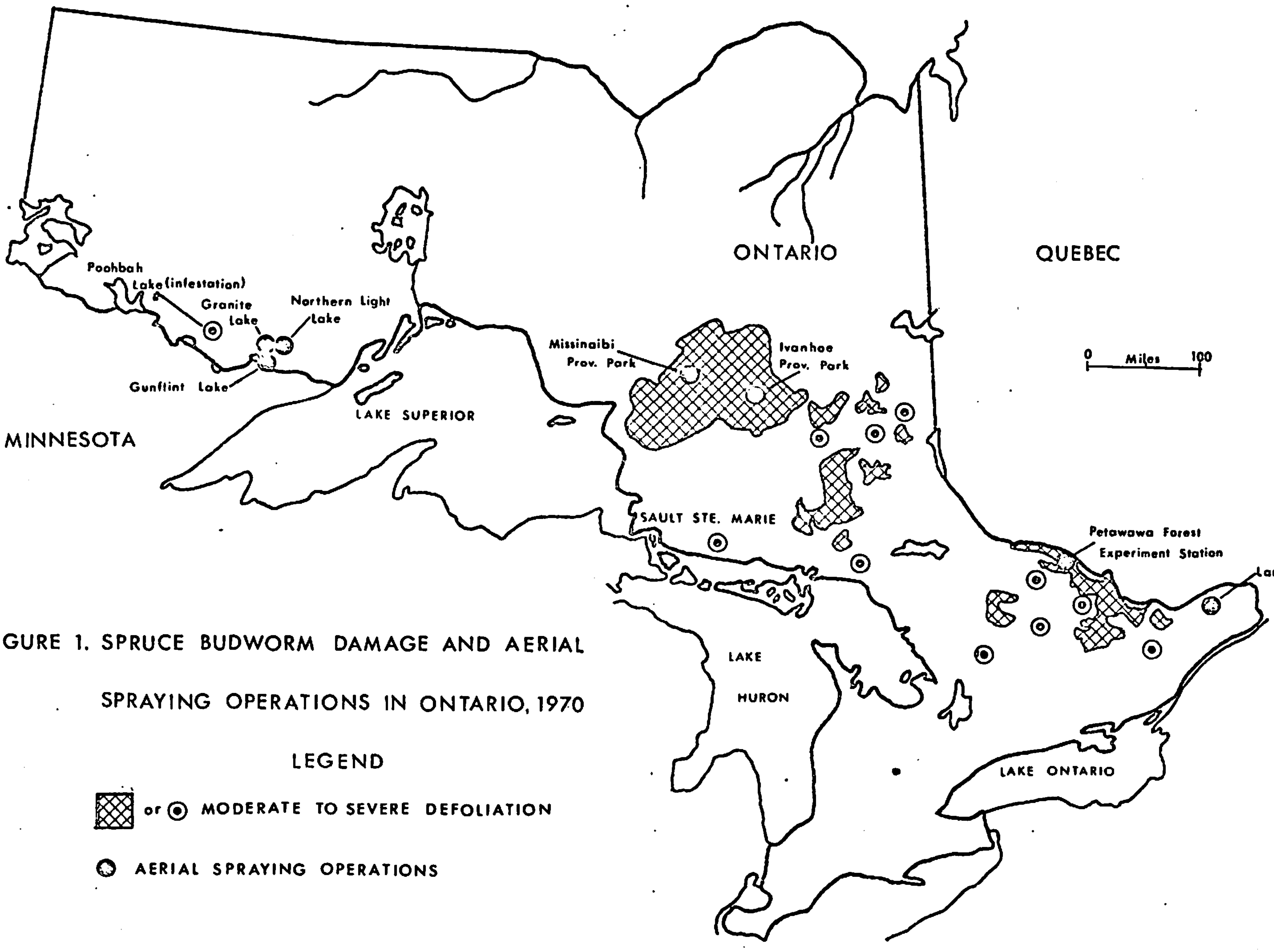

FIGURE 1. SPRUCE BUDWORM DAMAGE AND AERIAL SPRAYING OPERATIONS IN ONTARIO, 1970

LEGEND

[crosshatch] or ⊙ MODERATE TO SEVERE DEFOLIATION

○ AERIAL SPRAYING OPERATIONS

Pre-spray Larval Surveys and Larval Development Work

Pre-spray larval counts in May, 1970 at Larose and PFES confirmed the abundance of budworm at both locations. Larval counts at Petawawa were extraordinarily high. One stand of large white spruce, for example, yielded an average of 110 budworm larvae per 18" tip, with the highest count from a single 18" tip being 610. Spray boundary determination was not involved in pre-spray larval surveys in either case since areas to be treated were readily determined from compartment borders.

The original plans for Larose Forest called for one application of fenitrothion at 4.3 ounces per acre at the peak of fourth instar. For Petawawa, two applications of fenitrothion, each of 4.3 ounces per acre were to be applied hopefully no later than the peak of fourth instar and following the completion of the Larose operation.

Larval emergence at Larose and PFES occurred in early May and insect development proceeded at a normal pace with development at PFES lagging behind Larose by a few days. On May 21, the Canadian Forestry Service recommended that the appropriate time to begin spraying at Larose Forest was May 25, and that as soon as this job was completed the aircraft should proceed promptly to PFES.

Insect development on white spruce at Larose was mostly fourth instar with some fifths on May 25. Insect development on white spruce at Petawawa was mostly third instars with a few fourths on this date, hence the timing proved suitable and phenological differences developed as expected. However, a spray plane did not arrive at Larose until May 28. The spraying was carried out on May 29 and the aircraft then proceeded to PFES on May 30. By May 29, budworm development on white spruce at Larose had reached the peak of fifth instars and at PFES the peak of fourth instar. The delay in getting an aircraft to Larose was apparently caused by the spray contractor (General Airspray of St. Thomas, Ontario) being committed to completing gypsy moth spraying operations near Kingston, Ontario and near Valleyfield, Quebec.

The Spraying Operations

On the evening of May 29, a Stearman spray plane, working on floats, sprayed the 800 acres of planted white spruce at Larose with fenitrothion at a rate of 5.1 ounces per acre. Eighty acres which had been the most severely damaged received a second application of 5.1 ounces per acre. Observations made in the sprayed area on June 1 and again on June 5 showed no evidence of dead or dying larvae. Officials of the Ontario Department of Lands and Forests decided to respray and on June 7 a Super Agcat repeated the operation. At this point, the budworm was mostly in sixth instar with some pupae present. The respray consisted of one application of fenitrothion at a rate of 5.6 ounces per acre over 800 acres and a second application of 5.6 ounces per acre on the more severely damaged 80 acres. Thus, 80 acres in the Larose Forest received at least 21 ounces of fenitrothion per acre and the remaining 720 acres received over 10 ounces per acre. On June 8, large numbers of spruce budworm and blackheaded budworm larvae were observed dropping from the trees.

On May 30, the spray plane proceeded to Petawawa. Poor spraying weather (wind and rainshowers) prevailed over the next three days. Despite the threatening weather conditions, it was decided to spray on the evening of May 31. No wind was noted, but a definite threat of rain existed. By this time, budworm development on white spruce had advanced to almost equal proportions of fourth and fifth instar larvae. About 300 acres were treated with fenitrothion at 4.3 ounces per acre before the pilot stopped spraying, with the onset of darkness at 9:00 p.m. Almost ½ inch of rain fell in a hard downpour starting at 11:00 p.m.; thus for practical purposes the evening's work was considered a "wash out". On the morning of June 2, the remainder of the load from May 31 was sprayed on a large plantation of 5' to 10' spruce trees in gusty weather conditions. By the evening of June 3, the weather had settled and spraying under good conditions resumed. By this time, budworm larvae had developed to mostly fifth instars with some fourths and sixths present. After spraying about 300 acres at a rate of 5.1 ounces per acre, the aircraft crashlanded while attempting to land on Corry Lake and went to the bottom. This accident resulted in a further delay until another spray plane arrived at PFES on June 5. The operation was finally completed on June 7, by which time there were equal proportions of fifth and sixth instar larvae on white spruce. Thus, at PFES 450 acres received two applications of 5.1 ounces and 300 acres received one application of 4.3 ounces per acre (which was rained on).

Entomological Assessment

Pre-spray foliage samples collected from Larose Forest on May 24 averaged 11.4 budworm larvae per 18" tip. Post-spray samples collected June 18 yielded an average of 4.0 living or emerged pupae per 18" tip which indicates less than good control, particularly when one considers that all sampling was done in the 80-acre area that received about 21 ounces per acre. However, defoliation was recorded as light, averaging about 14% and egg-mass counts in August, 1970 forecast only light defoliation for 1971 (Table I).

TABLE I

Egg-mass Counts and % Defoliation at Four Locations from Larose Forest, Clarence Township, 1970

	% defoliation 1970	No. of egg-masses per 100 sq. ft. of foliage	Predicted hazard 1971 1/
Larose Forest			
Centre of infestation	28	16	L
Centre of infestation	5	7	L
West edge of infestation	13	10	L
East edge of infestation	11	10	L

1/ L - light.

At Petawawa, a full entomological assessment was carried out, i.e., comparisons were made of population densities in sprayed plots and unsprayed check plots before and after spraying. These data remain to be analyzed but other types of information are available. Pupal counts from sprayed areas ranged from 0 to 24 per 18" tip and averaged about 7 per 18" tip. Defoliation in the sprayed plots was variable, ranging from very light defoliation in some plantations to very severe in others. In unsprayed control plots, pupal densities overall averaged 16 per 18" tip and defoliation was uniformly severe. Plantations which were sprayed on the evening of May 31 and which were later rained on had lower pupal densities and less defoliation than plantations that were sprayed later for the first time under favourable weather conditions. Egg-mass counts (22 locations) at PFES virtually all supported a forecast of severe defoliation on spruce throughout the station in 1971. This was to be expected since PFES is located within a large outbreak area which extends in both directions along the Ottawa Valley.

Conclusions

Since the purpose of the Larose operation was to protect white spruce trees from further damage, it is concluded that from this point of view the operation was successful. However, it was necessary to apply four doses for a total of 21 ounces of fenitrothion per acre to accomplish it.

At PFES, the purpose of spraying was similar but the trees had not previously sustained severe damage. Variable success was achieved here in that some plantations were not damaged or only lightly so, whereas others suffered severe defoliation of the current year's foliage despite spraying. It was abundantly clear that at the population levels dealt with at PFES, feeding by all larval instars up to and including instar IV, against which sprays were applied, was alone sufficient to cause considerable defoliation. The primary causes of the poor protection achieved, therefore, were: the unusually high initial levels of larval populations, 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 Spruce Budworm Situation in Southeastern Ontario and Forecasts for 1971

In 1970, the outbreak that began in the Ottawa Valley more than doubled in size compared with 1969, with many new infestations and extensions of old ones being reported. A new and somewhat separated infestation of 150,000 acres was reported from the south central part of Algonquin Park around Opeongo Lake, and a major northwestward extension occurred up the Ottawa River Valley as far as Dieux Rivieres (Fig. 1). Egg-mass counts obtained from more than 60 locations throughout southeastern Ontario forecast a continuation of damage accompanied by some further enlargement of the outbreak in 1971.

Two spray operations are being considered for 1971. The experimental plots on the Petawawa Forest Experiment Station must be protected since the high values at stake remain unchanged and the 1970 fall egg-mass counts are high. Obviously, alternative operational methods must be planned for 1971 to prevent a further recurrence of insect interference with the research goals.

The alternative approach to the problem will not be known until January, 1971 when a meeting of those concerned is planned. Secondly, the Department of Lands and Forests has expressed an interest in protecting a small stand of white spruce, about 800 acres in size, and located near Achray in the north-east corner of Algonquin Park. This stand has been severely damaged for the past two years.

B. Northeastern Ontario Aerial Spraying Operations

Background

Spraying was carried out in two provincial parks in the Chapleau District--Missinaibi and Ivanhoe. Only 8,000 of the 157,000 acres of Missinaibi Park were treated whereas all 3,000 acres in Ivanhoe Park were sprayed. Both of these areas contained a high component of white spruce and balsam and had been severely defoliated for two consecutive years, 1968 and 1969. Forecasts based on egg-mass counts in 1969 were for severe defoliation in 1970, and it was hoped that, by spraying in 1970, a third consecutive year of severe defoliation could be prevented.

Pre-spray Larval Surveys and Insect Development

The determination of spray boundaries was a simple procedure in each of these operations. At Ivanhoe Park, since the entire park was sprayed, spray boundaries coincided with park boundaries, and at Missinaibi, spray boundaries were determined by the limits of defoliation in 1969. Pre-spray larval counts were made in the spring only to ensure that spraying was necessary. These counts showed a high overwintering survival at both locations; in some cases, more than 40 established larvae per 18" tip.

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, namely when budworm populations peaked out at instar IV.

The Spraying Operations

Based on advance notice of expected insect development, two spray planes arrived in Chapleau on the evening of June 9, ready to commence spraying immediately. The peak of fourth instar occurred on or about June 9, but poor spraying weather, owing primarily to windy conditions, delayed the operation until June 13. This delay, accompanied by very warm, dry, sunny weather, resulted in continued rapid larval development so that by the time spraying actually started on the morning of June 13, many fifth instars were present in the population. However, when started, the spraying was carried out quickly and was finished by the evening of June 15, by which time sixth instars were present. A total of 11,000 acres received one application of fenitrothion at a rate of 4.3 ounces per acre.

Entomological Assessment

Normally, the success of protection spraying is judged by the degree to which current foliage was preserved. In 1970, a condition characterized by the failure of most white spruce and balsam fir vegetative and flower buds to burst, became evident throughout much of northern Ontario. This made it doubly difficult to achieve a good measure of protection, since under these conditions, not only must there remain after spraying a smaller proportion of surviving larvae commensurate with the reduced amount of new foliage on trees to be protected, but like all other protection spraying the reduction in numbers must be accomplished when larvae are yet in their early instars and before the opening buds become badly damaged. Any delay in spraying whatever, therefore, is critical to the success of the operation. In this case, a high proportion of fifth and some sixth instar larvae were present when the parks were finally sprayed and much of the damage to new shoots which was to have been avoided already had occurred, by the time spraying was underway. The difficulty of achieving a high level of protection is further complicated by the high larval densities which were present in the two parks.

During aerial defoliation surveys, both sprayed areas were categorized as being moderately to severely defoliated and no apparent differences in the degree of defoliation could be detected from the air between the sprayed areas and surrounding unsprayed forests. In general, ground checks in both areas confirmed these aerial observations.

High egg-mass counts were made in the sprayed areas in the fall of 1970. This was anticipated regardless of the degree of protection that might have been achieved, since both Ivanhoe and Missinaibi lie within a massive infestation over about some 4.5 million acres of northeastern Ontario.

Conclusions

Under the very confusing circumstances created by the failure of buds of white spruce and balsam to burst in the spring of 1970, it is difficult to draw sound conclusions. The extremes of high budworm populations, coupled with a major reduction in the number of new shoots on which these populations could feed, created a situation in which major damage had already been done by the time sprays were to have been applied. The lateness of spraying, owing almost completely in this case to unfavourable spraying conditions, further accentuated the difficulty. It is fairly certain that spraying accomplished little of measurable value in these two parks except perhaps to reduce the amount of back-feeding, i.e., feeding on old foliage.

The Broad Spruce Budworm Situation in Northeastern Ontario and 1971 Forecasts

In 1970, at least 5,000,000 acres of forest in northeastern Ontario, mainly in the Chapleau and Sudbury districts, was infested by spruce budworm. The extent and location of the defoliation which could be detected by aerial surveys is shown on the accompanying map (Fig. 1). The total area of moderate to severe defoliation represents more than a three-fold increase over the total area defoliated in 1969.

Egg-mass surveys conducted in August, 1970 forecast a continuation of high populations within the areas of defoliation and a currently uncertain amount of increase in extent. Egg-mass counts from additional samples now awaiting examination should provide a clearer picture of the order of enlargement.

Anticipated spraying for 1971 in northeastern Ontario, at the present stage of discussions with the Ontario Department of Lands and Forests, includes a repeat of the Ivanhoe and Missinaibi operations, and for the first time, parts of neighbouring provincial parks. All of Missinaibi was infested in 1970 as were The Shoals and the easternmost part of Lake Superior Provincial Park. Other parks such as Five Mile Lake and Wakami Lake, while not severely infested, are under close scrutiny (Table II).

The question of protecting areas other than provincial parks has been under discussion with provincial authorities since early August but as yet no firm decisions involving both departments have been reached.

TABLE II

Egg-mass Counts and % Defoliation in Five Provincial Parks
Chapleau District, 1970

			No. of egg-masses per 100 sq. ft. of foliage	Predicted hazard 1971 1/
Ivanhoe Lake Prov. Park		3,000 acres		
(Defoliated in 1968 & 1969;	wS		716	S
Sprayed in 1970)	bF		257	S
Missinaibi Lake Prov. Park		157,000 acres		
(Defoliated in 1968 & 1969;	wS		280	S
Sprayed in 1970)	bF		363	S
The Shoals Prov. Park		26,600 acres		
(Defoliated in 1970)	wS		580	S
	bF		214	S
Five Mile Prov. Park		1,000 acres		
(Light defoliation in 1970)	bF		14	L
Wakami Lake Prov. Park		5,900 acres		
(Light defoliation in 1970)	bF		10	L

1/ L - light defoliation; S - severe defoliation.

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 knock-out 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 and by the fall of 1969, egg-mass surveys showed that very low population densities existed throughout the Burchell Lake and Lac des Mille Lacs regions.

However, also in the fall of 1969, two relatively small infestations, which could have resulted either from lingering populations that carried over from an earlier outbreak, or from moth flights from Minnesota, were discovered near the international border, about 25 miles south of Burchell Lake. One of these infestations was located on the south shore of Northern Light Lake and affected over 2,800 acres. The other infestation was located near Granite Lake and here 1,200 acres of defoliation was mapped. Egg-mass counts indicated moderate to severe defoliation in both areas for 1970, although counts at locations in the surrounding vicinity were low. This indicated that no significant spread had occurred and that the infestations were apparently discrete entities.

During the winter of 1969-70, discussions between the Ontario Department of Lands and Forests and the Canadian Forestry Service led to the decision to spray with the purpose of knocking out these infestations in June, 1970. It was felt that if these infestations were allowed to increase and spread, the objectives and results of the 1968 and 1969 operations would be compromised.

Pre-spray Surveys and Insect Development

The determination of meaningful spray boundaries was a problem anticipated in 1969. As stated in the 1969 report to the Interdepartmental Committee on Forest Spraying Operations, two possibilities lay open to forest management, namely,

"1. Spraying could be confined to those forests found to harbour high populations. This approach would require rather intensive field sampling next spring to determine spray boundaries.

2. Forested areas could be roughly blocked out for spraying based simply on the defoliation information, egg sampling data, and a limited number of larval counts made next year."

Since it proved impractical to conduct an intensive pre-spray larval survey owing to the inaccessibility of terrain, the second of these two methods of delineating areas to be sprayed was employed. Defoliation maps, egg-mass sampling data, early instar larval counts from 45 locations, and information from forest type maps were used to block out the spray areas.

It was decided to spray 5,200 acres at Northern Light Lake, 2,300 acres at Granite Lake, and 3,500 acres on the north shore of Gunflint Lake (Fig. 1). The highest populations were found in the Northern Light Lake infestation and it was recommended that this area should be sprayed twice.

An additional 50 locations were sampled in the Burchell Lake, French Lake and Lac des Mille Lacs regions. Very low larval counts were common throughout this entire area.

Emergence from hibernaculae was complete by May 18 which was about 10 days later than usual. Field personnel of the Canadian Forestry Service followed insect development and host development and this information combined with accumulated heat units was used to determine the optimum time for the start of spraying. Spraying was to start when the budworm had reached 50% third instar and 50% fourth instar.

The Spraying Operations

It was recommended on June 6 that spraying should commence immediately, i.e., as soon as a spray plane could get to Northern Light Lake. However, a plane was not available until June 13. A period of exceptionally warm weather from June 6 to 10 resulted in rapid insect development and about equal proportions of the larval population were in fourth and fifth instars when spraying actually commenced on the morning of June 14. Spraying was completed by June 26 but by then most of the budworm were in sixth instar with some pupae present. The continuance of spraying at this late time was, of course, commensurate with the objective here of knock-out spraying.

Fenitrothion was applied at the rate of 5.1 ounces per acre except for the first four loads when 4.3 ounces per acre was applied. The dosage rate was increased owing to the advanced stage of larval development. A total of 5,250 acres at Northern Light Lake were treated twice with about 6 days between applications, and 2,250 acres at Granite Lake plus 3,500 acres at Gunflint Lake received a single application.

Entomological Assessment

Pupal counts in the sprayed areas showed that a substantial population, 1.6 pupae per 18" tip, survived in the Northern Light Lake infestation. No pupae were found at Granite Lake or Gunflint Lake. Aerial surveys showed considerably smaller areas of moderate to severe defoliation this year than last; 750 acres at Northern Light Lake compared to 2,800 acres in 1969, and 650 acres at Granite Lake compared to 1,200 acres in 1969. No defoliation was detected at Gunflint Lake.

Egg-mass surveys in August, 1970 confirmed the presence of populations high enough to cause moderate and severe defoliation at Granite Lake and Northern Light Lake in 1971. At Gunflint Lake, the egg-mass counts were considerably lower and defoliation should not exceed light next year (Table III).

TABLE III

Egg-mass Counts and % Defoliation in Sprayed Areas,
Thunder Bay District, 1970

	% defoliation 1970	No. of egg-masses per 100 sq. ft. of foliage	Predicted hazard 1971 1/
Northern Light Lake			
Location 1	76	390	S
" 2	38	80	M
Granite Lake			
Location 1	12	168	M-S
" 2	31	193	M-S
" 3	46	106	M
Gunflint Lake			
Location 1	0	38	L
" 2	2	0	Nil

1/ L - light defoliation; M - moderate defoliation; S - severe defoliation.

Egg-mass counts obtained from an additional 15 locations outside of but close proximity to sprayed areas revealed very low populations.

Conclusions

Since the primary objective of this operation was to eliminate the two pockets of heavy infestation, it must be concluded that the operation was not completely successful. The problems encountered were largely logistical in nature, such as the prompt procurement of a spray plane when spraying was to commence. Spraying of budworm when the larvae were in an advanced state of development undoubtedly contributed to the lack of adequate knock-down at Northern Light Lake and Granite Lake. The consequence is that the status of these two infestations has changed little from 1969 to 1970 except that they have been reduced somewhat in size. Perhaps also due to spraying, no indication was found of population increases or of infestations spreading into surrounding forest.

The Spruce Budworm Situation in Northwestern Ontario and Forecasts for 1971

In addition to the areas immediately affected by spraying in the Thunder Bay District, larval, pupal and egg-mass counts were obtained and aerial defoliation surveys were flown throughout the Thunder Bay, Fort Frances, Sioux Lookout and Geraldton districts in order to detect new infestations and to assess the overall status of spruce budworm in northwestern Ontario.

One new infestation, comprising 800 acres of moderate to severe defoliation, was detected on Poohbah Lake in the Quetico Provincial Park, Fort Frances District. Egg-mass samples from this infestation and nearby areas indicate that a rather sizeable area may be infested (Table IV). Additional foliage samples have been collected from the Fort Frances District to try to determine the extent of this infestation but they have not been examined at the time of writing.

TABLE IV

Egg-mass Counts and % Defoliation in New Infestations
Fort Frances District, 1970

	% defoliation 1970	No. of egg-masses per 100 sq. ft. of foliage	Predicted hazard 1971 1/
Poohbah Lake	76	604	S
Bayley Bay	4	76	M
Agnes Lake (south end)	0	52	M
Tanner Lake	5	120	M-S
Lac La Croix	3	36	L-M

1/ L - light defoliation; M - moderate defoliation; S - severe defoliation.

In summary, with the exception of the Northern Light Lake, Granite Lake and Poohbah Lake infestations, budworm populations are still very low throughout northwestern Ontario. No decisions have yet been reached by the Ontario Department of Lands and Forests regarding aerial spraying operations in northwestern Ontario for 1971. It should be clear, however, that the situation at Granite Lake and Northern Light Lake has not changed since 1969 and the same reasons exist now for spraying as they did one year ago.

Statement prepared for the Interdepartmental Committee on Spraying Operations

October 22, 1970.

Summary of Verbal Statement presented by the President of Forest Protection Limited (K. B. Brown) re Spraying to Protect the Forests of New Brunswick from the Spruce Budworm

(In the context of the report and Forecast of Conditions for 1971 by E. G. Kettela and a question concerning the benefits of spraying)

The large high hazard area (Appendix 16, Figure 4) in the west-central part of the Province is mainly solid forest that originated after the spruce budworm attack more than 50 years ago. It includes a relatively high volume per acre of fir and spruce that was too young and small for economic cutting when first protected by spraying in the 1950's. It is contained in the limits of pulp and paper companies.

The smaller patches in the south, east of the Saint John River, consist mainly of farm woodlots with stands of fir and spruce originating after fires and cutting. The volume per acre is less and more variable but may be more valuable to the individual owners. Until recently, such forests were thought to be relatively immune to budworm attack but the damage is now apparent and the owners are looking to the government for protection of their woodlots from the budworm.

As far as benefits are concerned, the study made a few years ago indicated that it was worthwhile to continue spraying. I think that this is still true. If we had thrown up our hands in 1951 and said there is nothing we can do to protect the forests from the budworm, there would have been no expansion of the wood-using industries in the Province and it would have been difficult to supply what we had at reduced capacity. By protecting the forests we have been able to maintain and expand the industry and there appears to be confidence in supplies of wood for future expansion. The economy of New Brunswick depends to a large extent on our ability to justify and maintain that confidence.

Perhaps I should say something about the decision making process related to aerial spraying. The question was raised as to what we are going to do about spraying in New Brunswick next year. What will happen is that a group headed by the Manager of Forest Protection Limited and including employees of the participating companies, the Province and the Canadian Forestry Service will prepare a plan and recommendation for spraying. The plan and recommendation will be submitted to the directors of Forest Protection Limited representing the Province and the participating companies. It is then necessary for F.P.L. to obtain funds to execute the spray plan as approved or amended. In the past the participating companies have collectively contributed one third of the cost and the balance has been paid out of public funds.

Usually a decision has been reached by this time of the year but this year we have had an election and we will have a new Minister of Natural Resources and a new Treasury Board in about two weeks time. It will be the responsibility of the Deputy Minister, for whom I have great sympathy, to convince his new Minister and Treasury Board that (a) the forests need protection in accordance with the plan, (b) there is no alternative to spraying at the present time, and (c) the money should be found to carry out the plan.

I cannot speak for the Province or the participating companies concerning the aerial spraying operation against the spruce budworm in New Brunswick in 1971. I expect that spraying will be continued in accordance with previous policy with the objective of preventing extensive damage to the forest resources without serious side effects. I also expect we will use the insecticide and spraying methods we know something about rather than adopt new and untried materials and methods.