CANADA
DEPARTMENT OF FORESTRY
AND RURAL DEVELOPMENT

FOREST RESEARCH LABORATORY
FREDERICTON, NEW BRUNSWICK

REPORT ON MEETING CALLED BY FOREST PROTECTION LIMITED TO DISCUSS PLANS AND REQUIREMENTS FOR THE 1968 SPRAYING OPERATION AGAINST THE SPRUCE BUDWORM

FREDERICTON, 13 FEBRUARY 1968

DEPARTMENT OF FORESTRY & RURAL DEVELOPMENT

MARITIMES REGION

REPORT ON MEETING CALLED BY FOREST PROTECTION LIMITED TO DISCUSS PLANS AND REQUIREMENTS FOR THE 1968 SPRAYING OPERATION AGAINST THE SPRUCE BUDWORM

FREDERICTON, 13 FEBRUARY 1968

Present:

B. W. Flieger, Chairman, Forest Protection Limited

B. A. McDougall, Forest Protection Limited

S. S. Aggiman, Forest Protection Limited

H. H. Hoyt, N. B. Dept. of Natural Resources, Fredericton

R. L. Bishop, N. B. Dept. of Natural Resources, Fredericton

J. J. Fettes, Dept. of Forestry & Rural Development, Ottawa

A. P. Randall, Dept. of Forestry & Rural Development, Ottawa

W. N. Yule, Dept. of Forestry & Rural Development, Ottawa

W. A. Reeks, Dept. of Forestry & Rural Development, Ottawa

I. C. M. Place, Dept. of Forestry & Rural Development, Fredericton

R. S. Forbes, Dept. of Forestry & Rural Development, Fredericton

D. R. Macdonald, Dept. of Forestry & Rural Development, Fredericton

E. G. Kettela, Dept. of Forestry & Rural Development, Fredericton

P. A. Pearce, Canadian Wildlife Service, Fredericton, N. B.

J. R. MacDonald, Dept. of Fisheries, Halifax

G. H. Penney, Dept. of Fisheries, Halifax

K. Weagle, Dept. of Fisheries, Halifax

J. B. Sprague, Fisheries Research Board, St. Andrews

J. W. Saunders, Fisheries Research Board, St. Andrews

N. R. Brown, University of New Brunswick, Fredericton

R. W. Nash, Maine Forest Service, Augusta

Mr. B. W. Flieger, Chairman, explained that the purpose of the meeting was to devise a spray program for 1968 to suit all interests. He reviewed the highlights of the Forest Protection Limited meeting held in December 1967, and emphasized that the extent of the spray program proposed by F.P.L., 300,000 to 400,000 acres, is smaller than in 1967 because of patchy infestations and good conditions of trees. He added:

(a) the northward extension of infestation should be watched closely;

(b) the spray plan is limited to areas needing treatment and that will yield the most information;

(c) the plan proposed by F.P.L. is basically experimental, and is designed to test Sumithion and Phosphamidon operationally at various dosage rates, application rates, calibrations, mixtures, and times of application to determine the best and cheapest method of spraying;

(d) cost is a critical factor, as the two organophosphate insecticides are much more expensive than DDT;

(e) by using Sumithion and Phosphamidon the problems of budworm resistance to DDT, and DDT residues will be circumvented;

(f) the Department of Health and Welfare will not be able to supply a Physician to advise on the handling of organophosphate poisons, but that F.P.L. will have on hand a project Physician, possibly an intern from the Saint John Hospital;

(g) there are on hand 80,000 lbs. of Sumithion, 22,500 lbs. of Phosphamidon, and enough DDT ~~available~~ for all experimental operations and any routine operations;

(h) F.P.L. intends to use 3 T.B.M. Avenger aircraft in formation, each carrying a 600 gallon load, to spray 9,000-acre blocks in 12 passes, a system that worked well in the 1967 operation in Maine, and one that may reduce costs.

In a discussion on calibration, Dr. J. J. Fettes, Chemical Control Research Institute, suggested that a finer break-up of spray could be achieved using "flat-fans" and increasing the pressure in the tanks. However, Ultra-Low-Volume could only be approached and not attained.

It was decided that Dunphy airstrip would be headquarters for all groups. The leaders of each group are to inform Mr. B. A. McDougall of their requirements. Individuals involved will total between 100 and 110. Arrangements will be made to provide a hall or some other suitable building near the airstrip to house the counters. Dr. Fettes requested that four axemen be supplied by F. P. L.

Mr. P. A. Pearce suggested that a co-ordinator of studies be named to keep track of events, and Dr. C. D. Fowle was suggested as a likely candidate for this position. In addition Mr. Flieger suggested that a complete record be kept for each spray block.

After some discussion it was agreed that Mr. E. G. Kettela and associates would monitor 12 spray trials and one control with pre- and post-spray insect counts, the maximum that they could handle. From the 12 trials suggested it was decided that number 6 should be changed from 3/8 lb. Sumithion to 3/8 lb. Phosphamidon, and trial number 8 be changed from 1/8 lb. Sumithion + 1/8 lb. Phosphamidon to 1/8 lb. Sumithion + ¼ lb. Phosphamidon.

Mr. Pearce stated that the Canadian Wildlife Service would be limiting its attention to refining census techniques with emphasis on trials with Sumithion. After some discussion it was agreed that C.W.S. should monitor blocks receiving 3/8 lb./acre Sumithion, 3/8 lb./acre Phosphamidon, and ½ lb./acre Sumithion. However, Mr. Pearce emphasized that only two of these three blocks would be monitored intensively.

Mr. A. P. Randall, Chemical Control Research Institute, reviewed plans to experiment with some new insecticides, U.L.V. and near U.L.V. applications, new equipment, and times of application. Test blocks of 200- to 400-acres located south of the Main Southwest Miramichi River, away from any habitation, would be sprayed with a small aircraft (e.g. - Stearman). It was agreed that F.P.L. would arrange to have a small plane available for C.C.R.I. a day or two before operations begin. With respect to new equipment, Mr. Randall revealed that "Micronair" is an improvement but that it is still in the experimental stage. Dr. W. N. Yule will soon release a statement on drift and contamination studies conducted in 1967. Preliminary results suggest that no DDT is present in the air a few days after spraying. Dr. Fettes suggested that the organophosphates should be studied for drift and pollution. Mr. D. R. Macdonald agreed, adding that measurements should be made soon after spraying.

Mr. J. R. MacDonald, Department of Fisheries, decided that blocks treated with Sumithion at 3/8 lb./acre and Sumithion ¼ lb. + Phosphamidon 1/8 lb./acre would be tested for effects on fish and aquatic insects. If possible, they would work in blocks to be monitored for spray droplet assessment, but this was not absolutely necessary.

Representatives of the Fisheries Research Board stated they were present (a) to see that F.R.B. test areas were not in the spray plan, and (b) to find out what chemicals will be used that they have not tested. It was disclosed that Baygon and Matecil are to be used by C.C.R.I. and these have not been tested by the Fisheries Research Board.

It was agreed that droplet assessment would be the responsibility of C.C.R.I., who will provide instructions to field crews and supervise a droplet counting-mill manned by two of their students and two students from the biological assessment crew. It was emphasized that the spray must be dyed intensively so fine droplets would show on the cards. This could be done at the airstrip and only insecticide for blocks to be monitored for droplets would be dyed.

Mr. Flieger stated that, if it was necessary, additional areas on the north boundary of the present infestation would be sprayed with DDT at ½ lb./acre. After some discussion, Mr. J. R. MacDonald agreed to this proposal but insisted that Phosphamidon be sprayed along the streams.

Other aspects of the meeting are outlined in the following paragraphs.

(a) In a discussion on resistance to DDT representatives of C.C.R.I. claimed that synergists at present are not effective against spruce budworm even though good results have been obtained with other insects.

(b) In a review of other possible control methods it was revealed that the use of Bacillus thuringiensis, sterile male techniques, and sex attractants were still in the experimental stage. Dr. I. C. M. Place mentioned that some staff at the Fredericton Laboratory were exploring these fields.

(c) With respect to timing of spray applications, Mr. D. R. Macdonald said that the earliest possible time to spray with Sumithion and Phosphamidon is when the spruce budworm is in the third instar.

(d) All parties agreed that mixtures of Sumithion and Phosphamidon seemed to have the least effect on birds and generally were less toxic to aquatic life. It was suggested that dosages of organophosphates applied at less than ½ lb./acre might give satisfactory results at finer calibrations.

(e) Mr. Flieger indicated that F.P.L. is interested in determining if dosages of organophosphates at ¼ lb./ acre do or do not kill budworm. Since they intend to spray some blocks with ¼ lb./acre of organophosphate, Prof. N. R. Brown suggested that F.P.L. hire for part of the summer Mr. P. Samanya, an External Aid Student at the University of New Brunswick, and Mr. J. Stewart of C.I.B.A. to study trials with ½ lb./acre of organophosphate. Mr. Flieger agreed to look into the matter.

(f) Dr. R. S. Forbes reviewed the status of the budworm infestation in Fundy National Park. Mr. Flieger said that F.P.L. had not been contacted by Park personnel to spray the area. However, he said that F.P.L. would do the job if asked, but that a warrant would be needed from the appropriate Department Head before it was done.

At the end of the meeting it was decided that Messrs. Kettela, McDougall, Pearce, and J. R. MacDonald would meet on February 14 to select blocks for the various treatments.

E. G. Kettela

29 February 1968

REPORT OF MEETING OF THE INTERDEPARTMENTAL COMMITTEE
ON FOREST SPRAYING OPERATIONS

West Memorial Building, Ottawa

November 20-21, 1968

In Attendance:

<u>Members of the Committee</u>

R. R. Logie	Department of Fisheries & Forestry, Ottawa
J. A. Keith	Canadian Wildlife Service, Ottawa
H. W. Beall	Department of Fisheries & Forestry, Ottawa
M. L. Prebble	Department of Fisheries & Forestry, Ottawa
E. W. Burridge	Department of Fisheries & Forestry, Ottawa

(Prebble, Chairman, Nov. 20; Reeks, Chairman, Nov. 21;
Burridge, Secretary)

<u>Others</u>

J. R. MacDonald	Fisheries Operations, Halifax
W. J. Carroll	Forestry Branch, St. John's
G. L. Warren	Forestry Branch, St. John's
I. C. M. Place	Forestry Branch, Fredericton
E. G. Kettela	Forestry Branch, Fredericton
H. Schwartz	Forestry Branch, Ottawa
J. J. Fettes	Forestry Branch, Ottawa
W. A. Reeks	Forestry Branch, Ottawa
R. M. Prentice	Forestry Branch, Ottawa
A. P. Randall	Forestry Branch, Ottawa
W. N. Yule	Forestry Branch, Ottawa.
W. L. Sippell	Forestry Branch, Sault Ste. Marie
D. R. Macdonald	Forestry Branch, Victoria.
P. A. Pearce	Canadian Wildlife Service, Fredericton
C. D. Fowle	York University, Toronto
T. McCarthy	National Health and Welfare, Ottawa

B. W. Flieger	Forest Protection Ltd., Campbellton
J. A. Brennan	Newfoundland Forest Service, St. John's
M. Squires	Price (Nfld.) Pulp and Paper Ltd., Grand Falls
W. A. Dickson	Bowaters Nfld. Ltd., Corner Brook
R. L. Bishop	Dept. of Natural Resources, Fredericton
K. B. Brown	Dept. of Natural Resources, Fredericton
H. H. Hoyt	Dept. of Natural Resources, Fredericton
K. B. Turner	Dept. of Lands and Forests, Toronto
H. A. Richmond	Loggers Division, Council of Forest Industries, B.C., Vancouver

The Chairman introduced a draft agenda, which was adopted following motion by Dr. Place and D.R. Macdonald. The agenda follows:

1. Hemlock looper, Newfoundland
2. Spruce budworm problem, New Brunswick
3. Spruce budworm problem, Ontario
4. Balsam woolly aphid problem, Atlantic Region and British Columbia
5. Other problems that may be brought to our attention

Sequence of discussions under each problem would proceed in the following order, where applicable:

- experimental studies with insecticides, 1968
- experimental studies with pathogens, 1968
- operational control projects, 1968
- hazards to humans
- hazards to fish and other aquatic life
- hazards to wildlife
- studies of insecticide residues
- infestation status, fall of 1968, and areas of hazard for 1969
- proposals for definitive spray programs, 1969

Following introduction of representatives, Dr. Prebble commented briefly on the purpose of the Committee. He emphasized that ICFSO is <u>not</u> a decision-making body but is for the dissemination and review of information related to forest spraying operations. Decision on action to be taken rests with the provincial authorities.

1. <u>The hemlock looper problem - Newfoundland</u>

Experimental insecticide studies -

Dr. Fettes indicated that sumithion is considered to be the best material to control this insect. Phosphamidon is also very good. He suggested that control programs of this type should not be undertaken with dosage rates that are too low to be effective. He commented on other chemicals that could be used, matacil and zectran - the latter is not yet available but may be available by 1969. Of the total quantity of material released from the aircraft, ¼ to 1/3 reaches the target. He suggested that the use of sumithion at 1/8 lbs. twice is getting close to the sub-lethal dose level. He would prefer to see two applications of ¼ to 1/3 lbs./acre at an interval of 3 to 4 days.

Operational control, 1968 -

There was considerable discussion of the general nature of hemlock looper outbreaks and the requirements for successful control. Outbreaks tend to build up very quickly, with peak defoliation for 1 or 2 years, and then quickly collapse. Dr. Carroll noted that outbreak cycles in Newfoundland may have a duration of 4 or 5 years over the territory as a whole, although severe defoliation in any one locality may not exceed 2 years. To save trees, 80% to 90% of the loopers must be killed. Effectiveness of a spray program is reduced if spraying takes place late in the larval period, owing to the wasteful feeding that precedes late killing of the insects.

Mr. Brennan pointed out that in 1968 an attempt was made to maintain the interval between spray applications to six days. Fettes noted that owing to systemic action, the trees may be protected for 3 weeks if the dosage is sufficient. If the dosage rate is insufficient and the lag between applications is too great, the effect of the first application is lost by the time the second application is made.

Mr. Warren commented on the more important features of the 1968 control program in Newfoundland (see Appendix 1). Areas recommended for control action, based on priorities, were:

first priority - (active infestations)	36,000 acres, in western, central, and eastern parts of the Island
second priority - (susceptible stands, heavy moth flights in 1967)	467,000 acres in western and central Newfoundland
third priority - (susceptible stands but few moths seen in flight in 1967)	240,000 acres

The spray program was forecast at about 500,000 acres, and commenced July 7, employing sumithion and phosphamidon in different areas at two applications of 2 ounces each. 335,000 acres were thus treated in western and central Newfoundland by July 22. New infestations were then noted in central and eastern Newfoundland, and some 145,000 acres in these regions were treated with sumithion at 4 ounces per acre, in a single application. (See App. 1, maps 3a, 3b, 3c). Looper kill ranged from about 86% to 95%, but was lower with one application and when the spray was applied late in the larval period. Spraying was generally effective when defoliation from the previous year was light. However, spraying was quite ineffective where previous defoliation was eevere. Spraying in east-central Newfoundland was apparently too late for one application to be effective.

Hazards to humans -

Mr. Brennan stated that they had received no reports of problems in this area. Mr. Pearce advised that he had developed a headache working in the spray area.

Hazards to fish and other aquatic life -

Mr. Burridge read a report from the Department of Fisheries Newfoundland office (App. 2).

Hazards to wildlife -

Mr. Pearce reported that birds in the sumithion sprayed area were not affected by the first application. However, after the second application some birds showed signs of distress. Studies in the phosphamidon sprayed area showed that there was some effect on bird populations and warblers appeared to be the most susceptible (App. 3).

Infestation status, fall of 1968, and areas of hazard for 1969 -

Mr. Warren reported that 810,000 acres had suffered defoliation in 1968 and that 260,000 acres were classed as "severe damage" to "dead". As a result, approximately 3 million cords of fir had been killed by the end of 1968. Surveys in the fall of 1968 showed heavy moth flights (App. 1). Some quite young stands (25 to 30 years old) have been severely defoliated. Warren indicated that protection may be needed for upwards of 3 million acres in 1969, of which 1.5 million acres are susceptible stands already partially defoliated. It is hoped that a more precise definition of the affected areas will be available later in the year for establishing priorities for the program.

Mr. Brennan indicated that the entire operation depends on information obtained from the surveys. There is a widespread outbreak to be dealt with in 1969. Indications are that more sampling is required to obtain the necessary information. He emphasized the need for greater flexibility in conducting surveys. He also suggested that spraying in 1968 had saved 5 million cords of wood - proving that a relatively small investment produced a substantial benefit.

Dr. Prebble indicated the Department's awareness of the need for additional surveys but referred to current budgetary problems. Reference was also made to the difficulty of surveying for this particular problem. It was agreed the federal and provincial forces would combine to study ways and means of dealing with the problem under existing financial restrictions. Surveys must be conducted by helicopter, due to inaccessibility of the areas in question, and to the short (2-3 week) period in the summer preceding actual spraying operations.

In addition to the planned spray area there will be a need to treat patch outbreaks as they are detected. A major difficulty in 1968 was the abundance of patch outbreaks, too little spray and too little time.

Mr. Dickson indicated that the Bowaters Company has invested heavily to salvage looper-killed fir. A total of 106,000 cords of killed fir will be taken in 1969. This must be combined with a proper proportion of spruce. He stated that if the infestation continues at its present rate, in 10 years' time the industry would be ruined.

Mr. Squires advised that the situation for Price (Newfoundland) is similar. Approximately 90,000 cords of killed wood will be cut in 1969. Killed trees must be cut within three years if they are to be salvaged.

Mr. Brennan stated that the present infested acreage of 2 to 3 million acres, although not all merchantable timber, are primarily good stands. It was indicated that the total merchantable timber stands in the province total 4.5 million acres. Messrs. Squires and Dickson emphasized the importance of the forest industry to Newfoundland and the seriousness of the present situation. If the outbreak is not brought under control the entire industry is in jeopardy. Reference was also made to the third mill which will commence logging in late 1969. The wood supply for this mill must also be considered in the overall picture.

Dr. Prebble stated that industrial, provincial and federal officials must combine in developing a proposal for 1969. He added that the situation had been described to the Minister of Fisheries and Forestry, who has in turn presented the matter to another federal Minister in an attempt to obtain consideration for a reasonable level of financial assistance. Dr. Prebble stated that all provinces should be treated alike when it comes to matters of this sort.

At the conclusion of this discussion concerning possible financial assistance to the 1969 Newfoundland forest spray program, Mr. Burridge spoke on the large-scale use of insecticides and their effects on fish. Speaking for fish and wildlife interests, he urged those concerned with forestry and the forest industry to use non-persistent chemicals such as sumithion and phosphamidon rather than DDT to control forest insect pests.

2. Spruce budworm problem - New Brunswick

a) Experimental studies with insecticides

Dr. Fettes reviewed for the meeting results of experimental studies (App. 4, 5). Considering various characteristics, sumithion is still the best chemical control agent. Studies with ultra-low volume (ULV) applications showed that comparable control can be attained using 1/8 the volume of spray but the same amount of the chemical compound. It has been demonstrated that a good application of systemics early in the season gives foliage good protection. Various types of ULV equipment have been tested. Field work with conventional boom and nozzle equipment has shown that this type of gear can produce higher kill with smaller breakup of spray droplets. It was pointed out that off-target drift with new non-persistent chemicals is not as serious as it was with DDT.

Dr. Fettes referred to the use of aircraft guidance devices which are now being used elsewhere. He suggested that the use of this type of equipment should be thought of seriously.

Mr. Flieger pointed out that ULV is not suitable for use where fast aircraft are in use. Mr. Flieger did not agree that the present guidance system needed to be replaced with the electronic guidance technique.

Mr. Flieger raised a number of points related to the F.P.L. experimental program:

- two doses are better than one but are not for the same price
- greater dilution of insecticide than necessary is not advantageous
- the timing of application is important

The flying formation is being modified. Formerly pilots would not approve of more than 2 a/c per formation, but now accept 3. Formation flying increases the efficiency of the operation by cutting down the number of passes and the number of control a/c required.

Good results were obtained in the F.P.L. trials with DDT in 1968. He questioned whether resistance of the budworm to DDT wholly accounted for some of the poor results with DDT in recent years.

Flieger also expressed the view that where late spraying was unavoidable, it might be advantageous to use a mixture of sumithion and phosphamidon.

b) Experimental studies with pathogens, 1968

Mr. Reeks indicated that nothing in this line has been done in recent years. He referred to earlier studies with Bacillus Thuringiensus in B.C. and N.B. on the black-headed and spruce budworm. Recent work on B.T. shows this material to be ten times as effective as material developed in 1960. Reeks suggested that Dr. Fettes' group and the Sault Ste. Marie laboratory might work in conjunction in field trials of B.T. in 1969.

c) Operational control project - 1968

Mr. Kettela presented a summary of his report (App. 6) and indicated that the 1968 project was primarily an experimental operation. A total of 480,000 acres were sprayed, including 200,000 acres that were added to the original plan because of infestations discovered along the northern boundary of the original spray area. He stated that usual precautions were taken with forested areas bordering known salmon waters. These are treated with organophosphates. Assessment of sprayed areas showed that control on fir was about 79% (lower than previous years) and on spruce higher than before. Comparable control was obtained in areas treated with DDT at ½ lb./ acre and with sumithion at ½, 3/8 and ¼ lb./acre.

Attention was drawn to the fact that phosphamidon gave rather poor results against the budworm in New Brunswick in 1968. The material came from a different production batch than the phosphamidon used in Newfoundland and in Ontario.

Mr. Flieger presented an operational summary of spray programs in three provinces in 1968 (App. 7).

d) Hazard to humans -

Mr. Flieger made reference to concern by the Department of National Health and Welfare over the handling of dangerous materials. Discussion followed on the destruction of chemical insecticide containers. No untoward incidents occurred in 1968.

e) Hazards to fish and other aquatic life -

Mr. J.R. MacDonald reported on the Department's monitoring program in the spray area as presented in Appendix 8. Caged fish studies in areas treated with 3/8 lb./acre sumithion showed no fish mortalities. Studies also indicated little reduction in aquatic insect bulk in areas where sumithion was applied at 3/8 and ¼ lb./acre and recovery rate was rapid. One unexplainable fish kill occurred in Rocky Brook where phosphamidon and sumithion only were applied.

Tests with Bayon on juvenile salmonids showed it to be relatively non-toxic when compared to DDT (48 hour Tlm 40 ppm whereas the 48 hour Tlm for DDT is .047 ppm.). Summer census of the spray area showed the following:

a) fry populations at good levels
b) small parr populations far below control average and Elson's index - probably reflect use of DDT in 1967
c) large parr populations - compared favourably with Elson's index

Forest insecticide spraying in 1968 is known to have caused some losses to juvenile salmon stocks and to fish food organisms but these losses appear to be moderate in comparison to losses observed in earlier years of spraying. The use of DDT in previous years continues to be reflected by population densities of salmon parr. In general, stocks of the smaller salmon parr are poor but underyearlings and large parr stocks appear to be in good condition.

Mr. MacDonald referred to a seven-year summary report entitled "Some Effects of Forest Spraying on Atlantic Salmon in New Brunswick". Copies are available from the author or the Department's Ottawa office.

Dr. Prebble noted that a report had been received from the St. Andrews station of the Fisheries Research Board, referring to studies of toxicity to fish of several insecticides and commenting on a paper published by B.W. Flieger in September of 1968. The Flieger paper and the St. Andrews comments appear in Appendices 9 and 10.

f) Hazards to wildlife -

Dr. Fowle referred to brief reports of the 1968 work that appear in Appendix 11. In the ecological investigations, it appears that operational application of DDT has no obvious immediate effects on bird population or behaviour. In the studies on residues, it has been shown that DDT occurs in all ages of the birds and is passed from generation to generation. High levels were also found in shrews. Dr. Fowle noted that Dr. Yule has found DDT and breakdown products in the upper organic layers of the forest floor (Appendix 12) and it is assumed that shrews living in this environment acquire DDT by licking it from their coats as well as by feeding on animals containing DDT.

Mr. Pearce referred to his studies on the effects of aerial sprays on birds (Appendix 13). To conserve time he read the main conclusions which can be found on page 55 of his report. In 1968, sumithion and phosphamidon caused greater disturbance among birds than earlier and he thought this might be due to finer breakup of the spray, or in the case of phosphamidon, to quality of the particular batch used in New Brunswick in 1968.

Mr. Keith suggested that bio-assays of sample lots of insecticides be carried out before field operations are conducted, so that the results of field trials could be matched against a standard. Dr. McCarthy indicated that the Department of Health and Welfare would be willing to run bio-assays with small mammals. Dr. Fettes stated that such tests should be quite intensive to produce valid results, owing to variability in test animals. He suggested a simpler and more valid basis for testing chemical quality of an insecticidal batch would be by gas chromatography. Mr. Flieger proposed that samples of insecticide be saved by the operators, from each "batch", that could be studied in detail if aberrant field results were obtained by individual study teams.

g) Studies of insecticide residues -

Dr. Yule's studies of DDT residues in soil, water and air in New Brunswick (App. 12) were referred to briefly. A substantial part of the total DDT emitted in the study area since 1956 persisted in the upper soil layers in 1967. Very little leaching has occurred. Bio-assays with Drosophila flies showed much less biological activity than would be expected from the amount of DDT present in the soil. In stream water, in the study area, there is a low "background" DDT content, and some evidence of changed isomer composition in the stream sediments. Air sampling showed traces of DDT wherever samples were taken, and evidence was obtained of spray drift of up to nine miles. It appeared that particulate DDT may be carried into the air with soil dust during dry periods.

Mr. Richmond enquired whether any problems had arisen with regard to domestic water supplies. Dr. McCarthy stated that there was no evidence of illness from use of DDT-contaminated water.

h) Infestation status, fall of 1968, and areas of hazard for 1969

Mr. Kettela referred to data contained in Appendix 6. Defoliation in 1968 was as follows:

light	300,000 acres
medium	700,000 "
severe	200,000 "

in the same general area that had been defoliated in 1966 and 1967.

Very high budworm egg populations occurred over an area of some 2.2 million acres.

Three hazard classes were defined for 1969:

moderate-leading to loss of increment	710,000 acres
high-leading to bare tops and top-killing	194,000 "
very high-leading to tree killing	82,000 "

These hazardous areas occur in the Miramichi and Nashwaak drainages.

Mr. Bishop stated that provincial authorities were very much concerned by the budworm build-up in 1968. He expressed the hope that the Department of Fisheries and Forestry would continue its efforts to find other means of budworm control. The Province will continue to press for financial assistance in the 1969 program.

i) Proposed budworm spray program, New Brunswick, 1969

Mr. K.B. Brown stated that the directors of Forest Protection Limited had arrived at a general recommendation for 1969 at a meeting in October. Mr. Flieger outlined the proposals by reference to Figure 7 in Appendix 6:

(a) Some 2.4 million acres lying within the encirled area should be sprayed.
(b) The spray treatment should be two applications of sumithion, each of one-eighth pound per acre.

Flieger noted that other hazardous areas aggregating some hundreds of thousands of acres occurred outside the encircled area. If these were included in the spray plan, the total acreage might amount to about 2.75 million acres.

Mr. Brown stated that the proposed treatment area is about 20 per cent of the productive forest area of the province, and the high egg population acreage is approximately 33 per cent of the productive forest area of the province. Mr. Brown referred to a proposed public relations program to explain to the people of New Brunswick what is happening as a result of the spray program. They would appreciate receiving comments on the hazard to humans, fish and wildlife, for use in this P.R. program.

Dr. Prebble asked for clarification of various areas shown on the hazard map. He questioned the inclusion of low and moderate hazard zones which make up a large percentage of the proposed spray area. Flieger pointed out that the distances between high hazard patches were small, and that high egg populations occurred in the intervening areas of lesser hazard. It would not be operationally feasible to exclude the irregular intervening areas, and moreover, the high infestation level would jeopardize results unless the whole encircled area were treated as a unit.

Fisheries and Wildlife representatives found no objectives to the spray program as outlined by Mr. Flieger.

3. Spruce budworm problem - Ontario

a) Operational control project 1968 -

Mr. Sippell reported that beginning in 1965 an infestation covering approximately 200,000 acres developed west of the lakehead by the fall of 1967. Some 4.5 million acres of spruce and fir were endangered by this rising infestation (App. 14).

A decision was made by Ontario to undertake a "knock out" spray program which would suppress budworm populations in the relatively small infestation area. As a result of early season surveys in 1968, the spray area was set at 275,000 acres. The spray plan called for a first application of sumithion at 6 oz. per acre, followed by a second application of phosphamidon at 4 oz. per acre.

Forest Protection Ltd. acted on behalf of the Ontario Government in developing a contract with a spray operator and in providing a guidance system. Operational details are contained in Mr. Flieger's report (App. 7).

The Ontario Regional Establishment of the Department of Fisheries and Forestry carried out the pre-spray and post-spray surveys and assessed the results of the spray operation. It was difficult to assess effectiveness in terms of population reduction, compared against population trends in unsprayed areas. In fact, the program design, which was to knock out the population in an epicentre, did not permit retention of a check area with budworm populations equivalent to those in the area sprayed. The assessment was composed of three factors:

(i) area of defoliation, 1968
2650 acres of light to heavy defoliation were mapped, compared to 40,000 acres of heavy defoliation in 1967

(ii) pupal populations were low in 1968 in the sprayed area and beyond, except for some areas east of Burchell Lake

(iii) egg populations in 1968 were greatly reduced from those recorded in 1967, but were sufficiently high in a central core area of about 35,000 acres to cause concern for 1969 (Appendix 14).

Mr. K.B. Turner reported on several background and operational aspects of the program (Appendix 15). He drew attention to an omission in line 9 of page 1 of his report, where the words "in the immediate area of operations" should be inserted between "spruce" and "represents". He also noted that the Province was interested in the recreational value of the area, as well as in minimizing of fire hazard - both of which are closely related to prevention of timber destruction.

b) Hazards to humans

Mr. Turner described services provided by the Occupational Health Service of the Ontario Department of Health (Appendix 15, page 3).

c) Hazards to fish and wildlife

Mr. Turner pointed out that the Ontario Department of Lands and Forests was greatly concerned that the project should be accurately explained to all interested parties in advance of the operation. The Fish and Wildlife Branch of the Department held meetings with appropriate associations and groups in the Toronto area and also at the Lakehead. The program was well received by all groups.

A well-organized monitoring program was undertaken to determine the possible effects of spraying on fish and wildlife in the spray area. From observations it was found that a small number of song birds were found to have succumbed to the spray. However, a few days after spraying had been completed it was impossible to measure any population difference.

d) Infestation status, fall of 1968, and areas of hazard for 1969

Egg populations remained at sufficient levels in an area of 35,000 acres within the 1968 program area to lead to defoliation and further build-up in 1969.

Spruce budworm increases were noted in other parts of Ontario, especially in the northeast.

Mr. Turner indicated that the Ontario Department of Lands and Forests plans to respray the remaining core area of 35,000 to 40,000 acres in 1969, but no plans have been made to carry out a sizeable operation against the spruce budworm in northeastern Ontario. Flieger recommended the use of wider spray buffer zones around infestations that are to be treated.

4. Balsam woolly aphid problem

a) Experimental studies with insecticides, 1968

Dr. Fettes referred to experimental aerial tests with four insecticides against the aphid in Newfoundland (Appendix 16). Although it was planned that the nominal rate of application would be one pound per acre, in two gallons of spray, adjustments were necessary at the time of the operation. The actual deposits of active ingredient per acre (App. 16, Table II) were, in the case of 3 insecticides, at average rates of less than 2 ounces, and in the fourth insecticide (baygon) from 5 to 10 ounces. None of the applications yielded satisfactory aphid kill. When the data were arranged by rate of deposit (ounces per acre, or drops per square centimeter) there was little evidence of a relationship between rate of deposit and aphid mortality (Table V). In fact, at these rates of deposit, mortality was less than in the check plots, suggesting some protective action for the aphid.

It was noted that Bryant had observed an inhibition of the settling of crawlers caused by sumithion during the hemlock looper spray program.

b) Infestation status, fall of 1968, and areas of hazard for 1969

The balsam wooly aphid is generally present throughout most balsam fir stands in Newfoundland and damage is increasing. Warren expressed the hope that increased sampling would be possible as part of the widespread looper survey program proposed for 1969. Dr. Place noted there has been little change in the Maritime Provinces where aphid numbers are very low. D.R. Macdonald reported little change in British Columbia - surveys in the interior of the Province failed to turn up any new infestations.

If laboratory trials by the Chemical Control Research Institute and the Fredericton Laboratory during the winter of 1968-69 are promising, it is expected that further field experiments will be carried out in Newfoundland in 1969.

5. Other problems

a) Ambrosia beetles

Mr. H.A. Richmond presented an outline of developments in chemical control of ambrosia beetles during recent years (App. 17). Continued use of BHC has been discouraged because of residues found in trout and in oysters. In field tests methyl trithion showed considerable protective action against ambrosia beetle attack in log booms, but not as good results as BHC. Methyl trithion was also used in the 1968 operational control program, 3476 gallons being applied at the rate of 1 pound of active ingredient in 10 gallons of spray per acre of log surface. The cost was 34 cents per M fbm, compared with 24 cents for BHC. No adverse effects of methyl trithion on fish were noted. This material can be used beyond the April 15 cut-off date for BHC. Methyl trithion seems likely to replace BHC for ambrosia beetle control within a year or two.

b) Jack pine budworm

Dr. Sippell described build-up of infestations of the jack pine budworm in northwestern Ontario over the past three years, and heavy infestations in central and southeastern Ontario reported in 1968 (App. 18). About 1,200 acres of infested jack pine stands in northwestern Ontario were sprayed with sumithion at 6 ounces per acre on June 22, with little evident effect on reduction of defoliation injury.

Reference was made to the possibility that a spray program might be developed by the Ontario Department of Lands and Forests against the jack pine budworm in the Kirkwood Management Unit, and in the Pembroke area, in 1969. Mr. Turner noted that methoxychlor had been reported to have given good results against the jack pine budworm in Michigan.

6. Conclusion of business

It was suggested that future fall meetings of the Committee be held regularly at a specified time, e.g. the third week of November.

A motion from the floor expressed regret over the absence, due to illness, of Mrs. M.K. Pearson, who had regularly been in attendance and assisted with secretarial functions during the past ten years, and expressed the hope for her speedy recovery.

E. W. Burridge
Secretary

M. L. Prebble
Chairman

Ottawa, January 27, 1969.

appendix 1

The Eastern Hemlock Looper in Newfoundland

Chemical Control Program 1968 and Forecast 1969

G.L. Warren
Annual Meeting Interdepartmental
Committee on Forest Spraying Operations
November 20-21, 1968

The Eastern Hemlock Looper in Newfoundland:

Chemical Control Program 1968 and Forecast 1969

INTRODUCTION

Outbreaks of the eastern hemlock looper have been recorded in balsam fir stands in Newfoundland since 1912. An estimated 1,150,000 cords of merchantable fir were killed in two outbreaks dating from 1947 to 1953, and 1959 to 1963. The present outbreak began in 1966 and by 1967 was the largest and most serious recorded having defoliated about 151,000 acres of mature and overmature fir in western (Fig. 2A), 7,500 acres in central (Fig. 2B, 2C), and 3,500 acres in eastern Newfoundland. An estimated 1,000,000 cords of merchantable fir were severely damaged or killed, primarily in the Crabbs River and Little Barachois Brook watersheds of the west coast. Most mortality occurred in older stands that had previously been damaged by the balsam woolly aphid. In 1968, a chemical control operation was conducted to protect the less severely defoliated and infested adjacent stands.

This report provides a summary of survey methods and problems, a review of the spray operation, the status of the looper in 1968, and a prognosis for 1969.

CONTROL OPERATIONS 1968

Defining Hazard Areas

Infestations of the hemlock looper are usually scattered, have discrete boundaries, and develop rapidly in mature balsam fir stands which may be completely defoliated in one year. Larval counts from annual forest insect surveys provide an indication of impending outbreaks but do not indicate specific locations because most outbreaks are initiated in inaccessible stands. Areas of defoliation may be defined by aerial surveys. This method of assessment does not provide information on the status of the looper in undefoliated stands. Therefore, more intensive sampling methods are required to define potential outbreak boundaries. The use of more sophisticated sampling is complicated by the immense areas to be covered (12,000 square miles of forested area), lack of inventory data and forest type maps, and difficulties in obtaining aircraft at appropriate times and cost (approximately $100 per aircraft sample). Egg sampling may offer the most reliable method for determining outbreak boundaries. However, it is difficult to define a sampling universe because looper eggs are deposited singly and in a wide variety of locations including moss, rough bark of all tree species and in parts of the tree crown. Furthermore, egg sampling has the same inherent problems of distribution and cost as other sampling methods.

The incidence of looper moths is the only practical indicator presently being used to forecast outbreaks. A high population of moths does not necessarily mean a high larval population the next year but it does provide a basis for broad planning of chemical control operations. It is necessary to confirm predetermined areas needing protection by pre-spray larval sampling.

Establishing Priorities

Results of surveys conducted in the fall of 1967 were used to establish hazard levels for areas requiring protection in 1968. These levels were determined by incidence of defoliation, occurrence of moths, and age and percentage of fir. Stands more than 60 years old and containing 60% or more fir were considered the most susceptible. Areas recommended for control action were delineated into three priority classes as follows:

Priority "A" - Defoliated stands excluding salvage areas in parts of the Crabbs to Robinsons rivers and Little Barachois Brook watersheds. Acreage involved included 30,000 western (Fig. 2A), 3,000 central (Fig. 2B, 2C) and 3,000 eastern Newfoundland - total 36,000 acres.

Priority "B" - High potential for outbreak based on traces of defoliation, heavy moth flights and stand susceptibility. Acreage involved included 410,000 acres western (Fig. 2A) and 57,000 central Newfoundland (Fig. 2B, 2C) - total 467,000 acres.

Priority "C" - High stand susceptibility, no defoliation, few moths. An additional 240,000 acres were designated in this category.

A total of 733,000 acres were delineated as needing protection and it was also suggested that insecticide be ordered to provide for an overrun of about 30 per cent. The Department of Mines, Agriculture and Resources made the final decision on which areas were to be sprayed, on the basis of stand hazard and economic value. Economic necessity dictated that only about 500,000 acres could be treated and a spray contract was given to Forest Protection Limited of New Brunswick.

Larval development was followed from late May. The first larva was recorded on June 5 but no appreciable numbers were collected until the last week of June. Pre-spray sampling was conducted in the southern part of the outbreak area (Codroy Pond to Flat Bay Brook) on June 27 and 28. Sampling was not started in the more northerly areas (Southwest Brook to Red Indian Lake) until July 4 because of later larval development. A total of 97 samples were taken at pre-determined locations in "A" and "B" priority areas. Samples were taken by beating one side of a tree over a 7 by 9-foot beating sheet. Six trees constituted a total sample at any one location. However, sampling was discontinued if 10 or more larvae were collected from one tree. Results of this survey indicated that spraying should be conducted as prescribed except for the headwaters of Bottom Brook and Southwest Brook, an area of about 200,000 acres.

Spray Operation

Aerial spraying began on July 7 using the insecticides Sumithion and Phosphamidon. The latter chemical was applied to most major salmon streams. Areas were treated with two applications of insecticide at 2 ounces each with a recommended interval of 7 days. Approximately 335,000 acres were treated by July 22 when unexpected new outbreaks were observed in central and eastern Newfoundland. An estimated 145,000 acres of the most severely defoliated stands were then treated with the remaining Sumithion in one application of 4 ounces. Figures 3A, 3B, and 3C show the locations and treatments applied during the spray operation.

The effects of the various treatments are indicated by the pre- and post-spray larval counts as follows:

Region	Insecticide	Applications	Average Number Larvae/Tree Sample Pre-Spray	Post-Spray	Number of Samples
Western	Not sprayed		460	1,022	11
Western	Phosphamidon	2 oz. x 2	921	16	6
Western	Sumithion	2 oz. x 2	220	29	30
Central	Sumithion	4 oz. x 1	448	171	7

On the basis of the above data and results of aerial surveys in the fall of 1968 the following observations have been made.

(1) Population levels more than doubled in unsprayed areas.

(2) Phosphamidon was more effective than Sumithion giving an average of more than 95% larval mortality compared with an average of 86% by Sumithion.

(3) Two treatments of Sumithion were more effective than one giving an average of over 86% mortality compared to 60%.

(4) In general, spraying was effective in restricting damage where defoliation was light or not evident. Spraying was less effective in the moderate to severe defoliation classes even though larval numbers were reduced.

(5) In western Newfoundland tree mortality increased in the moderate to severe defoliation classes. The continuing tree mortality was apparently caused by previous balsam woolly aphid damage.

(6) In east-central Newfoundland damage symptoms increased in the moderate to severe defoliation classes even after spraying, probably because the insecticide was applied too late or because only one treatment was used.

It is recognized that the above observations are based on a very small number of samples and results from aerial surveys which are somewhat subjective. However, the results substantiate the recommendation made by Dr. J.J. Fettes of the Chemical Control Institute, that the insecticide be applied twice to compensate for the extended hatching period of looper eggs. Possibly some consideration might even be given to three treatments of insecticide at five or six-day intervals. The first spray should be applied as soon as larvae start feeding on the foliage.

INFESTATION STATUS 1968

Results of aerial surveys show that the looper has now defoliated fir stands throughout the Island, including areas on the Northern and Avalon Peninsulas. Outbreaks are shown in Figures 4A, 4B, and 4C. Preliminary estimates indicate that light to severe defoliation has occurred on balsam fir in 265,000 acres in western, 534,000 acres in central, and 12,000 acres in eastern Newfoundland, giving a total of more than 810,000 acres, an increase of 650,000 over the previous year. Nearly 260,000 acres were severely defoliated or killed, an increase of 170,000. Reliable figures are not available but it seems probable that total loss in the two-year period may exceed 3,000,000 cords of merchantable fir.

FORECAST 1969

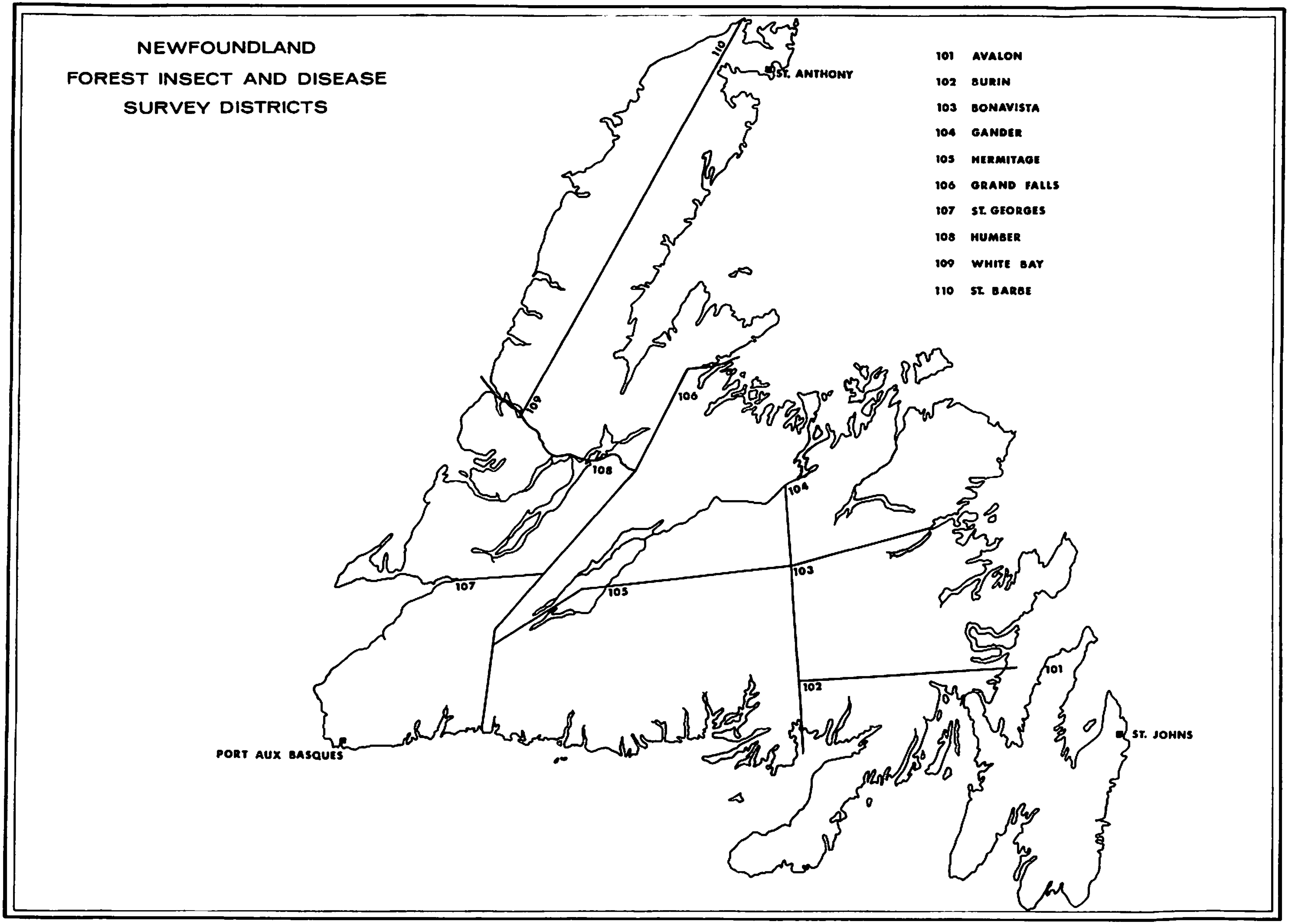
Moth sampling was conducted at 150 locations. The majority of these samples were collected from areas that were sprayed or from undefoliated stands in the vicinity of outbreaks. From these data spray priorities have been established as follows:

Priority "A" - All defoliated and immediately adjacent areas except those relegated to salvage or considered economically unmerchantable (1.5 million acres).

Priority "B" - No defoliation but with moths present and highly susceptible stands (1 million acres).

Priority "C" - To include all other areas of balsam fir over 30 years old and comprising 30 per cent of the stand. It is presently impossible to define these areas.

Preliminary estimates suggest that as much as 3 million acres may require protection in 1969. However, this is a very broad estimate that probably includes areas of recent cutover, stands with a high spruce content and stands that are economically unmerchantable. Areas requiring protection will be more precisely delineated later in the year in co-operation with industry and the Province who will supply additional data from recent aerial photographs and inventory records and apply economic priorities. Areas to be sprayed will finally depend on the results of pre-spray larval sampling. However, even with a very intensified pre-spray sampling program it may still be necessary to rely somewhat on initial signs of defoliation.



NEWFOUNDLAND
FOREST INSECT AND DISEASE
SURVEY DISTRICTS
101 AVALON
102 BURIN
103 BONAVISTA
104 GANDER
105 HERMITAGE
106 GRAND FALLS
107 ST. GEORGES
108 HUMBER
109 WHITE BAY
110 ST. BARBE
ST. ANTHONY
ST. JOHNS
PORT AUX BASQUES
110
109
108
106
107
105
104
103
102
101

Fig. 1:

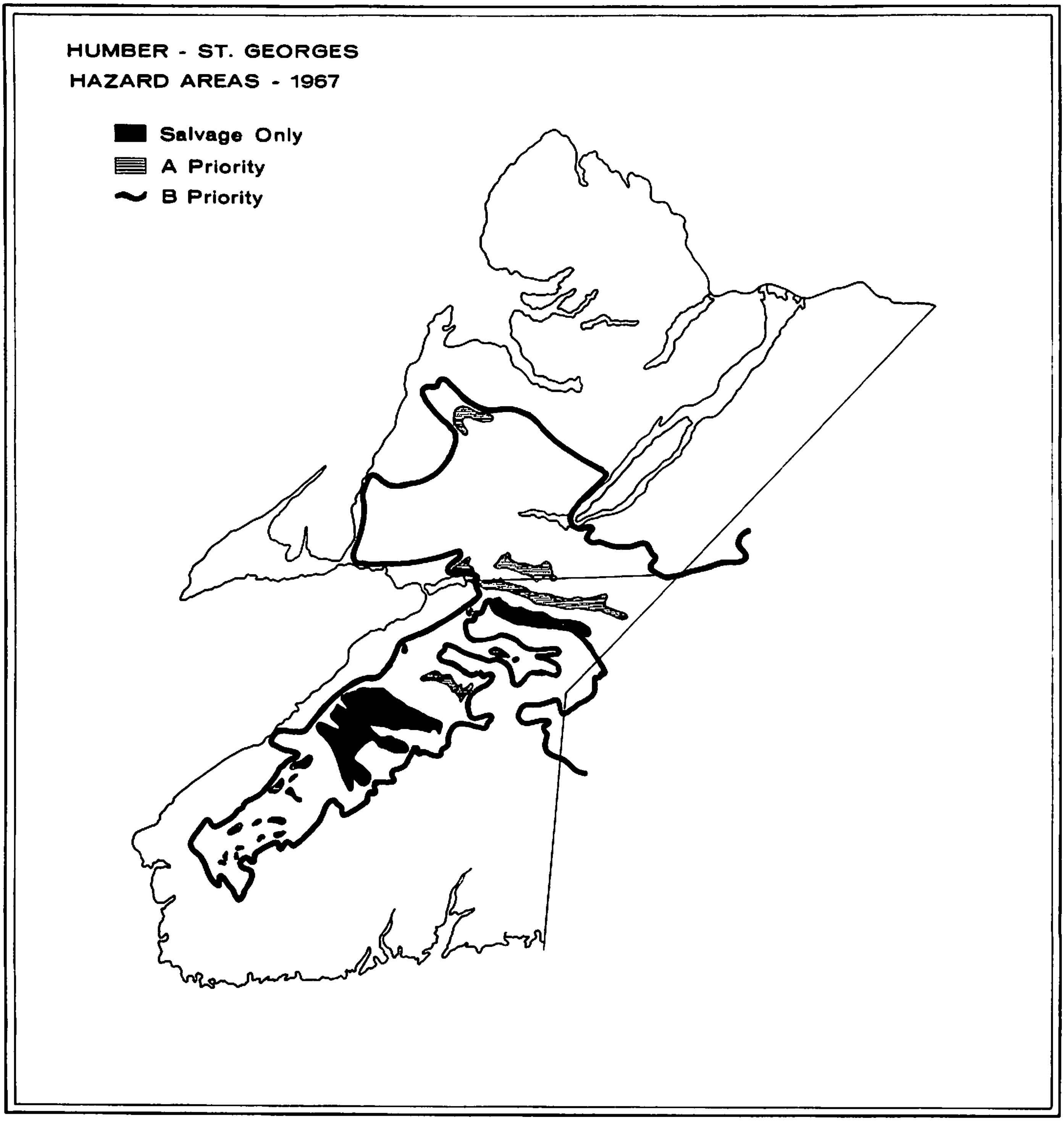

HUMBER - ST. GEORGES
HAZARD AREAS - 1967
Salvage Only
A Priority
B Priority

Fig. 2A:

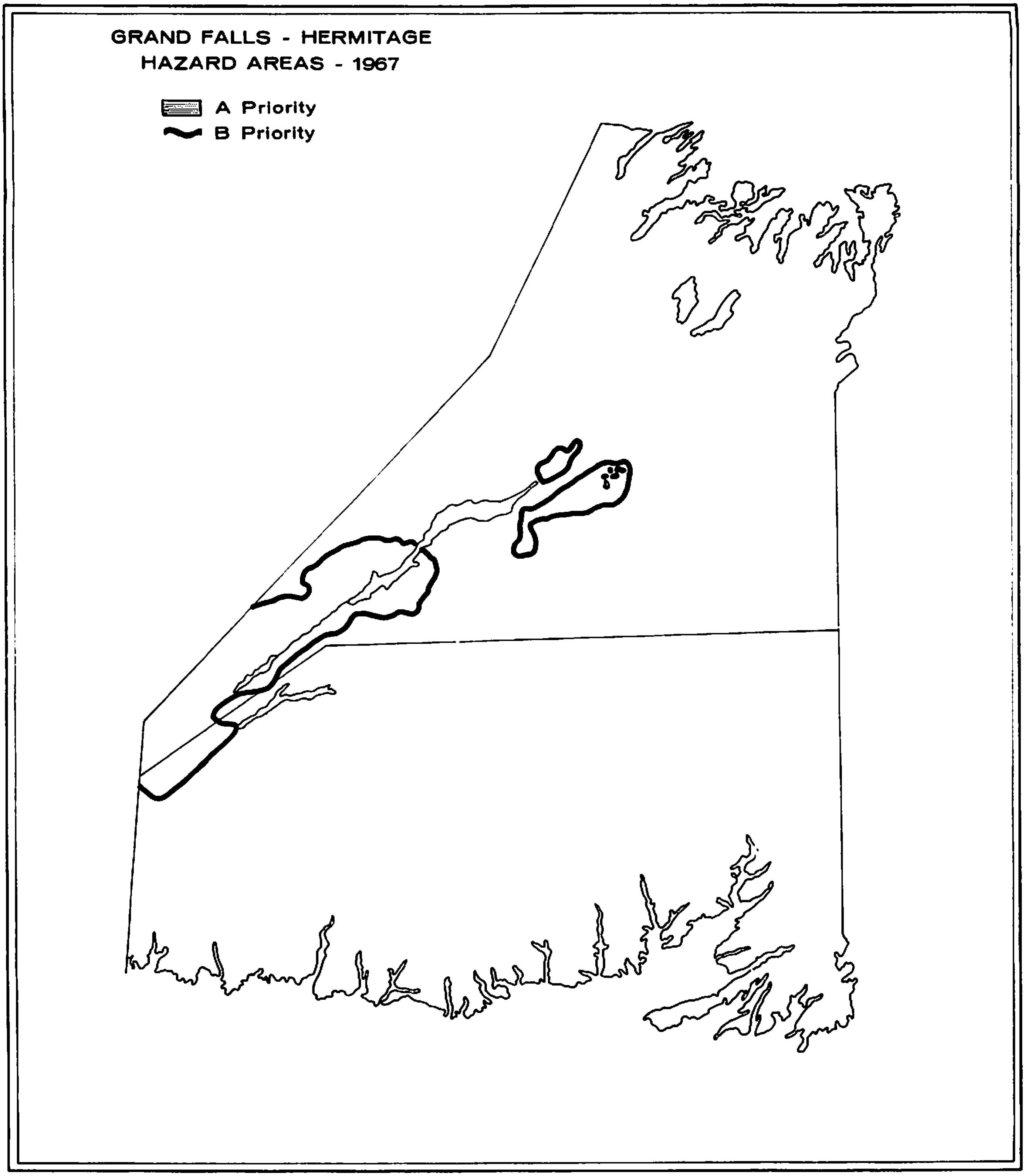

GRAND FALLS - HERMITAGE
HAZARD AREAS - 1967
A Priority
B Priority

Fig. 2B:

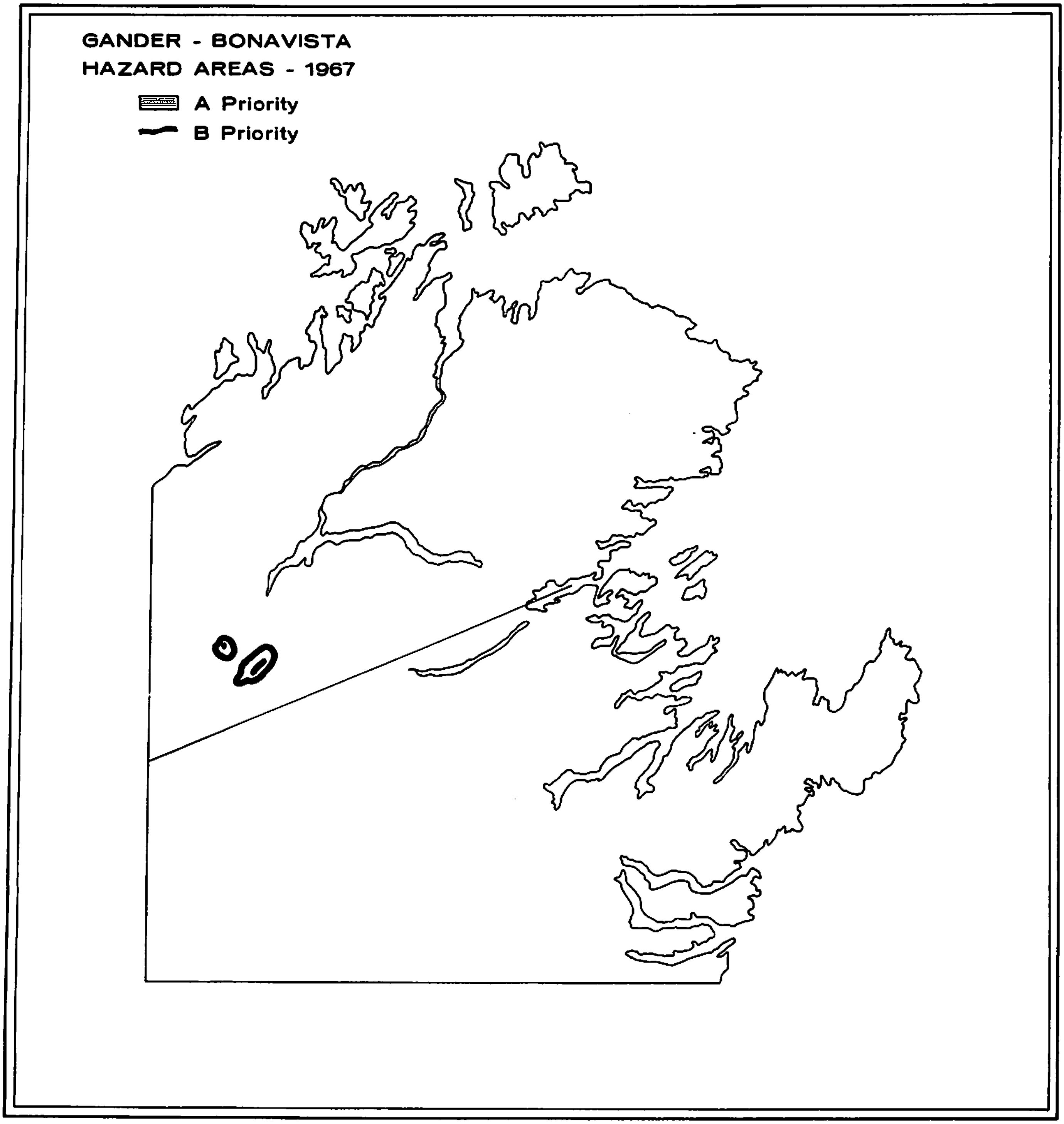


Fig. 2C:

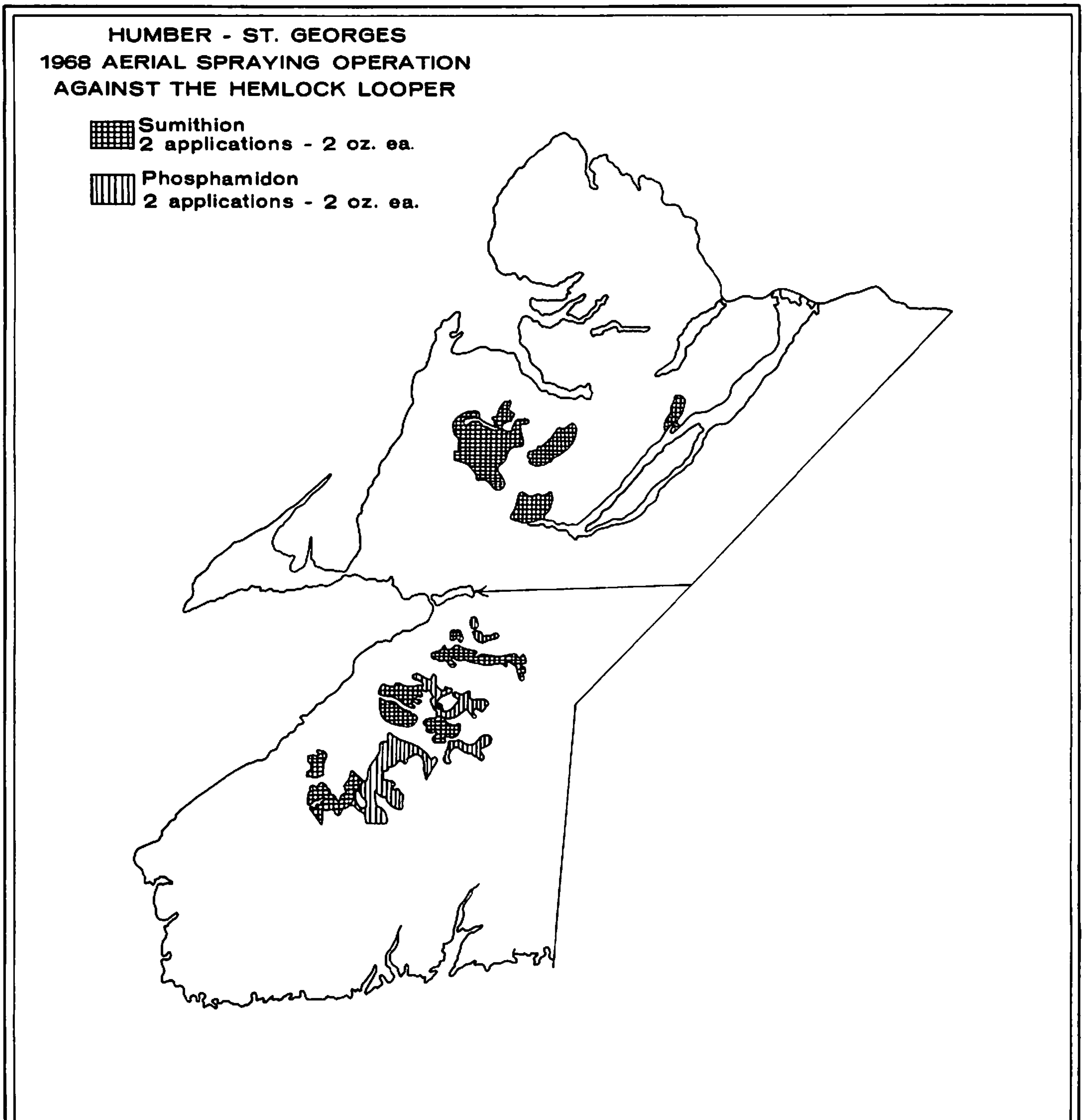

HUMBER - ST. GEORGES
1968 AERIAL SPRAYING OPERATION
AGAINST THE HEMLOCK LOOPER
Sumithion
2 applications - 2 oz. ea.
Phosphamidon
2 applications - 2 oz. ea.

Fig. 3A:

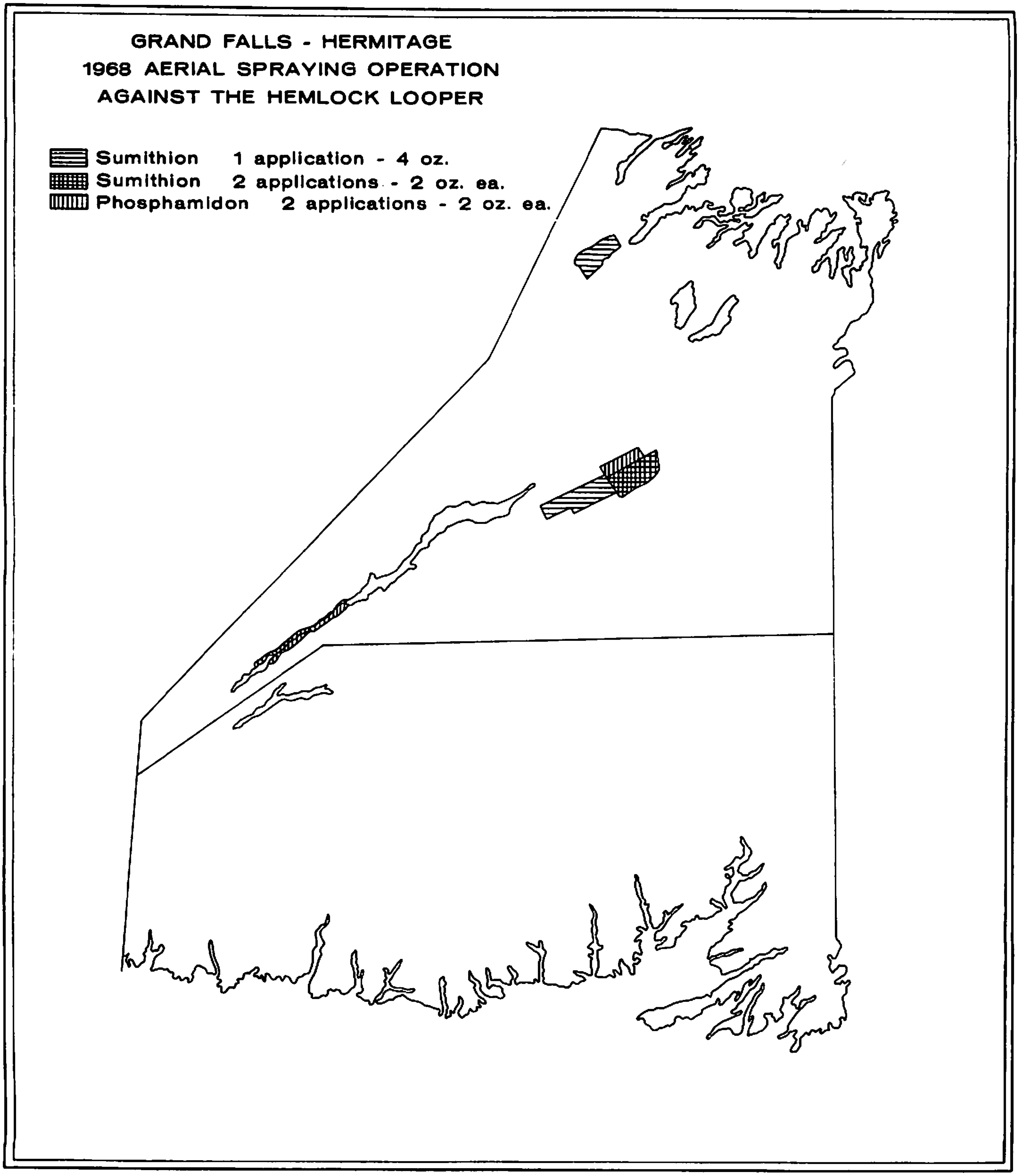

GRAND FALLS - HERMITAGE
1968 AERIAL SPRAYING OPERATION
AGAINST THE HEMLOCK LOOPER
Sumithion 1 application - 4 oz.
Sumithion 2 applications - 2 oz. ea.
Phosphamidon 2 applications - 2 oz. ea.

Fig. 3B

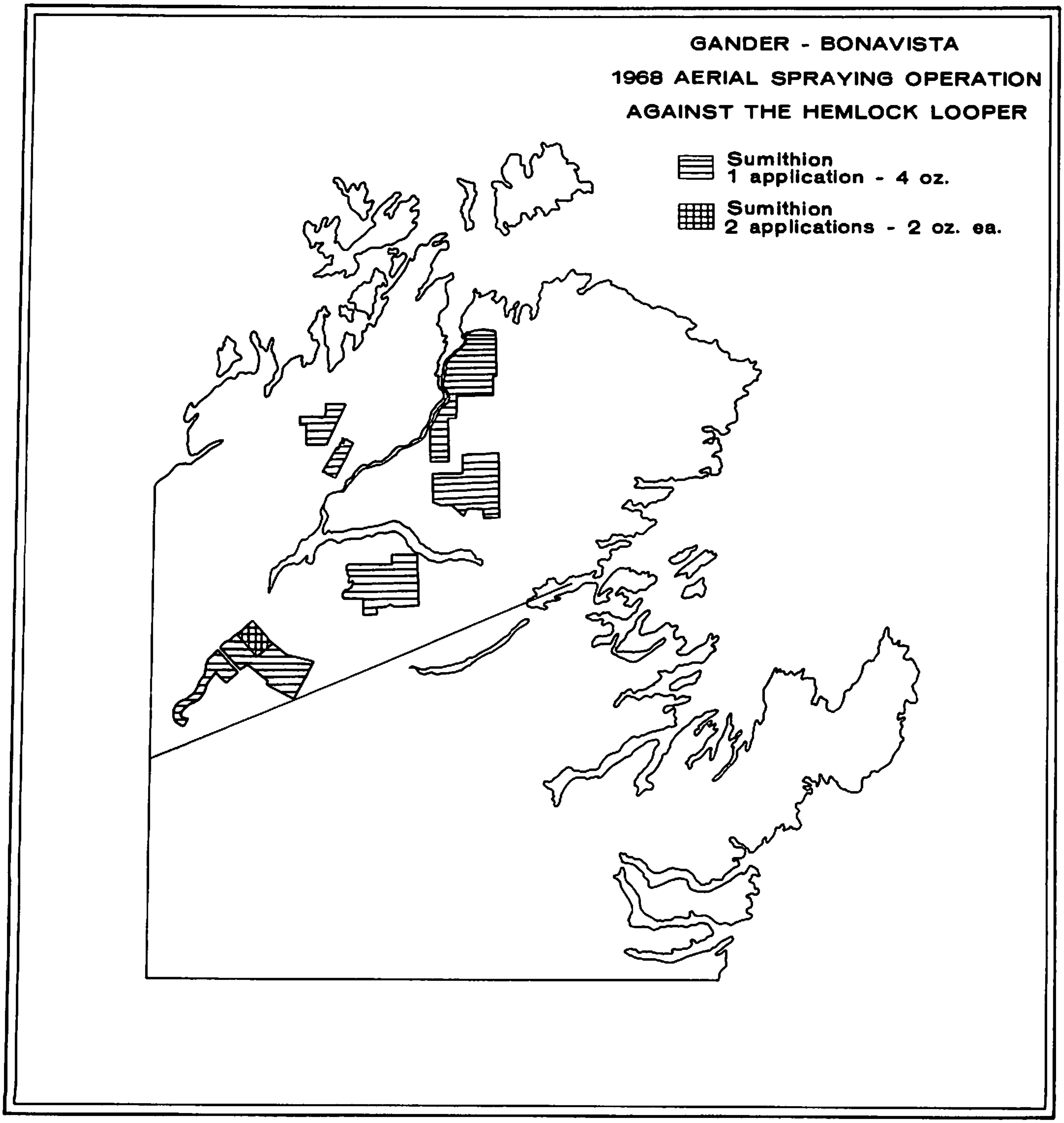

GANDER - BONAVISTA
1968 AERIAL SPRAYING OPERATION
AGAINST THE HEMLOCK LOOPER
Sumithion
1 application - 4 oz.
Sumithion
2 applications - 2 oz. ea.

Fig. 3C:

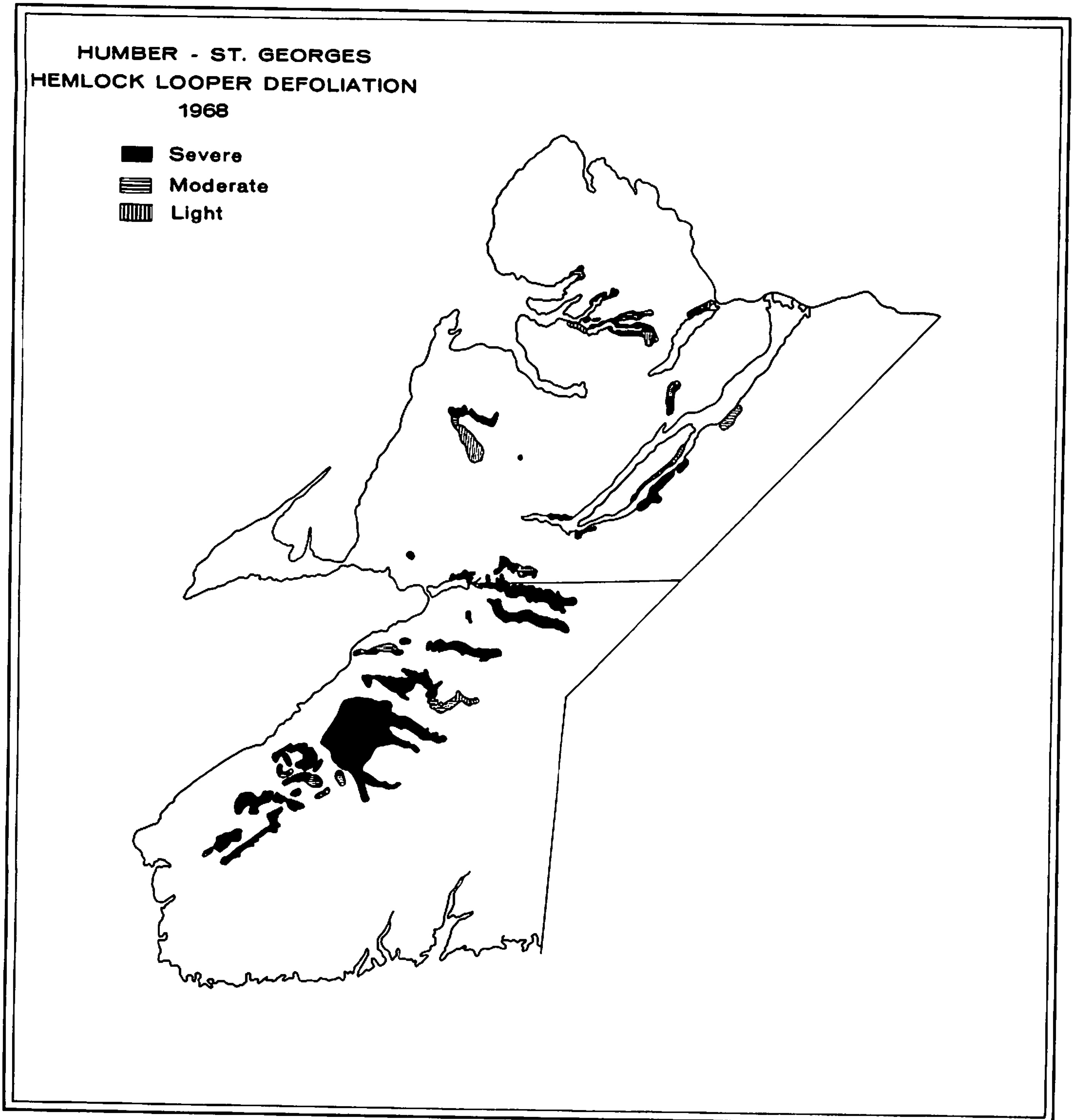

HUMBER - ST. GEORGES
HEMLOCK LOOPER DEFOLIATION
1968
Severe
Moderate
Light

Fig. 4A:

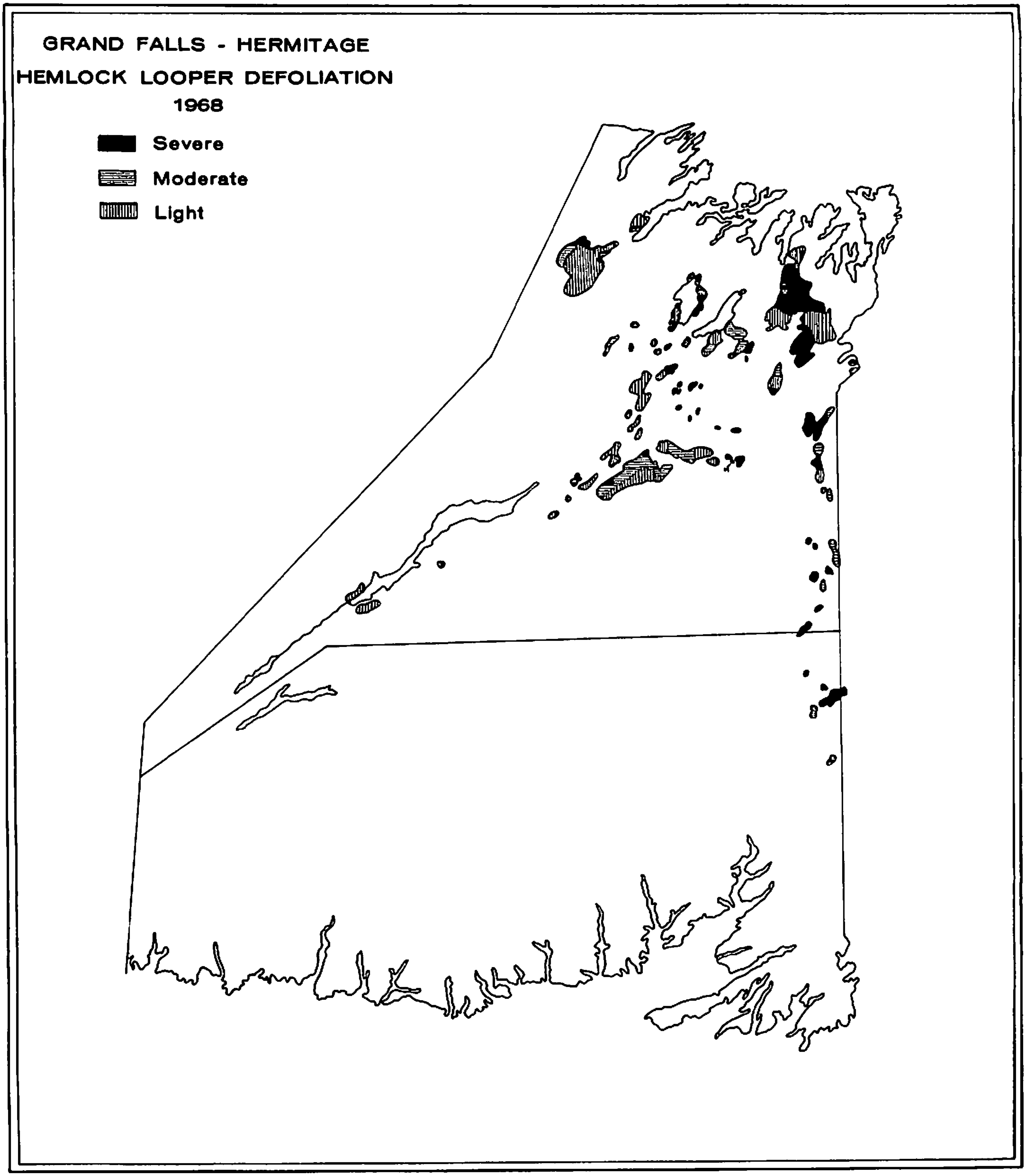

GRAND FALLS - HERMITAGE
HEMLOCK LOOPER DEFOLIATION
1968
Severe
Moderate
Light

Fig. 4B:

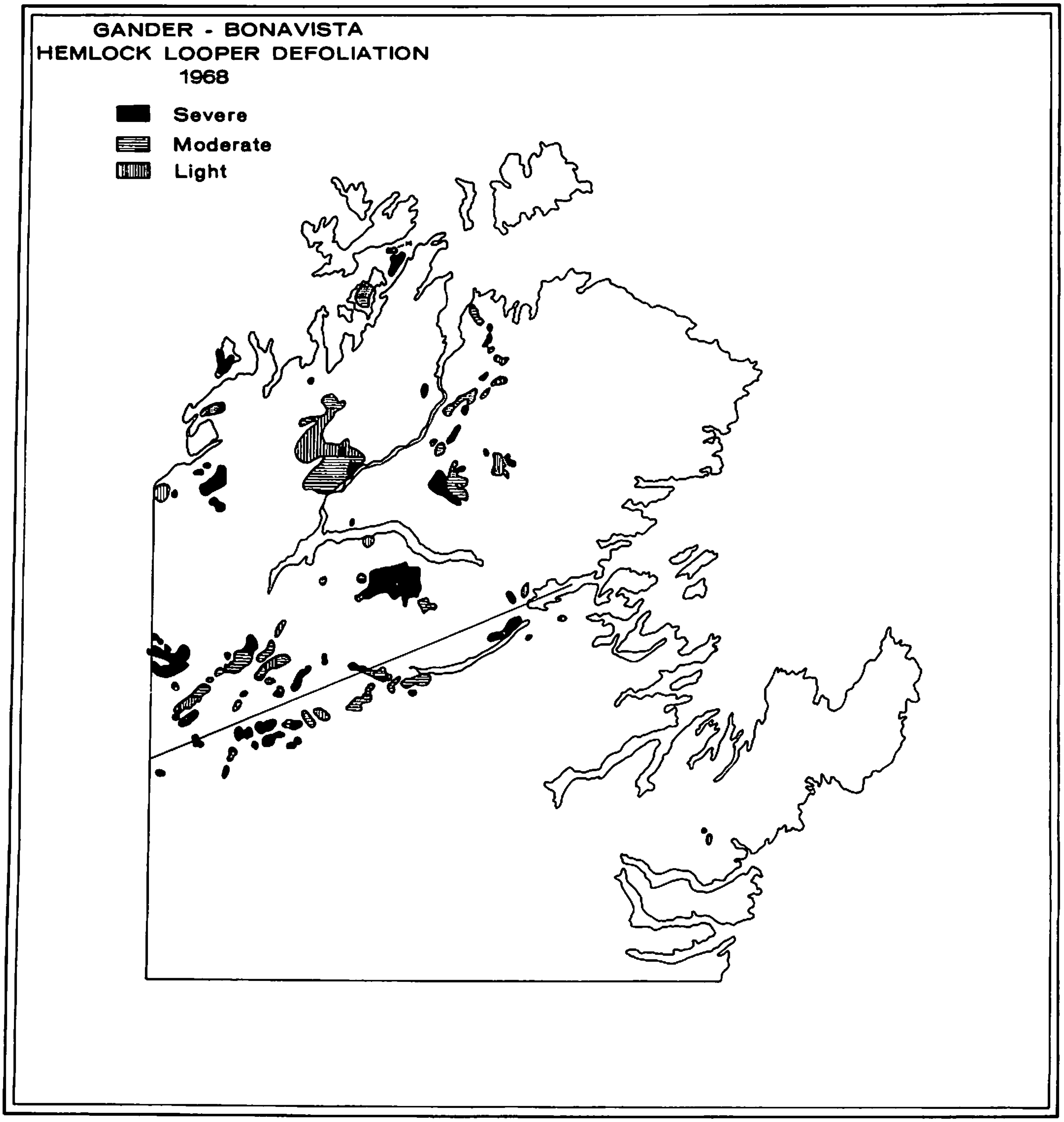

GANDER - BONAVISTA
HEMLOCK LOOPER DEFOLIATION
1968
Severe
Moderate
Light

Fig. 4C:

APPENDIX 2.

COMMENTS ON THE EFFECTS OF FOREST SPRAYING ON FISH NEWFOUNDLAND 1968.

FOR THE INTERDEPARTMENTAL COMMITTEE

ON FOREST SPRAYING OPERATION

NOVEMBER 1968.

L. J. COWLEY,
DEPARTMENT OF FISHERIES,

NOVEMBER, 1968.

(1) Area Sprayed was approximately 780 square miles.

(2) In Western Newfoundland, sumithion and phosphamidon were applied in two applications of 1/8 lb./acre. Sumithion was used over high country and phosphamidon applied as buffer zones along waterways. In central Newfoundland, sumithion was applied in one application of ¼ lb/acre.

(3) The Department monitored the effects of the spraying in Western Newfoundland. The Department initially set up for monitoring operations on three brooks:-

(a) Trout Brook - Control

(b) Southwest and Bottom Brooks - Spray Areas

However, a last minute change in spray areas resulted in Trout and Southwest Brooks used as control areas and Flatbay Brook as the spray area.

The effects of the spray program were evaluated by:

(a) Caged fish experiments

(b) Drifting insect sampling

(c) Invertebrate sampling

(d) Water Analysis

(4) Results

(a) <u>Caged Fish</u>

Results from the caged salmon and trout parr experiments indicated no effect from the spray. No dead fish were found in cages for three weeks following the last insecticide application on July 14, although some fish contained sumithion.

<u>Wild Fish</u>

(a) Flatbay Brook (test stream).

No dead wild fish were observed in Flatbay Brook during the study. Some fish contained insecticide. Fyke nets used in the twenty-four hour drifting insect experiment caught nine dead salmon fry July 12, one dead fry July 14, 1 dead stickleback July 17 and seven dead fry on July 20.

...2

No dead fry were caught in nets set on the same dates for the same length of time in the control brooks - Trout and Southwest Brooks. This indicates that there were some effects on fry populations. There were numerous live fry and parr observed in Flatbay Brook every day during the study period.

(b) Home Lake - near Gander

On July 31, ten dead parr were found on a ½ mile of a major brook emptying into Home Lake, near Gander. These fish all had relatively high insecticide readings. Many live parr were also seen. This brook had been sprayed two days previous with sumithion at ¼ lb. per acre. No other dead fish were found on other brooks walked either within or outside of the spray plots during the one day helicopter survey. Drifting insect fyke nets set for 24 hrs. in Barry's Brook, Big Tree Brook and two culvert brooks (latter two brooks no map name) during a spray, caught numerous dead sticklebacks. However, it was concluded that these were natural mortalities as two culvert brooks, the control outside the spray area, caught as many dead sticlebacks as the other two nets set inside the area.

No unusual mortality or peculiar behavior of trout or salmon fry, parr or adults was reported by any of the sports fishermen or fisheries wardens on the brooks in central Newfoundland.

Bottom Invertebrates

Data for the invertebrate plot counts was not continuous for the study because of station moves and washouts. Comparison of total counts taken on Trout (control) and three stations on Flatbay Brook show a decline after the spray at all the experimental stations.

Individual species all showed a decline after the spray.

Drifting Insects

Fifteen minute emersions of the three fyke net units at each station before, and after the spray yielded data indicating an insect kill. Lack of personnel and pre spray information concerning the exact spray times and boundaries of the spray plots made it difficult to do precise follow-up measurements of the drifting insects by the 15 minute method.

The 24 hour net sets at one experimental and one-control station for three weeks after the start of spraying indicated a definite mortality of insect larvae. Many of the insect larvae caught in Flatbay were dead. Almost all the larvae caught in the control station were alive. Mayflies seemed most affected.

...3

Emerging insects

The rate of emergence of adult insects from larvae in the brooks showed no increase or decrease that could be attributed to the spray. No pre-spray data was collected on Flatbay Brook. Plecopterans were the largest group of adults to emerge from the nine square yards of gravel on Trout brook, while Tricopterans constituted most of the Flatbay total. Ephemeropteran emergence increased at both stations later in the summer.

Several reports of large numbers of dead adult insects floating on the water surface and on the ground after each spray were received from sports fishermen and fisheries wardens on the brooks.

Water Chemistry

Total alkalinity, pH, dissolved oxygen, total hardness, specific conductivity and turbidity remained relatively constant for the duration of the study. Water temperatures and levels fluctuated widely.

Conclusions

1. Sumithion had no effect on caged trout and salmon parr in Flatbay Brook.

2. Sumithion sprayed in two applications of 1/8 lb./acre had no effect on wild trout and salmon parr or adults. However, some salmon and trout fry mortality did occur.

3. Bottom invertebrates were reduced over a period of time after the spray.

4. Drifting insect nets set for a twenty-four hour period indicated aquatic insect larvae and adult insect kills after the spray.

5. Emergence rates of insects from the brooks were little affected by the spray.

6. Water chemistry remained similar for the duration of the study.

7. Sumithion sprayed in one application of ¼ lb./acre over a plot bordering Home Lake near Gander caused some mortality in salmon parr.

L. J. Cowley,
Department of Fisheries,
Newfoundland,
1968.

Appendix 3

Preliminary report on the effects on populations of forest birds of chemicals used to control the hemlock looper, Newfoundland, July, 1968.

by

P. A. Pearce
Canadian Wildlife Service
Fredericton, N. B.

For Interdepartmental Committee on Forest Spraying Operations, November 1968.

INTRODUCTION

The reasons for Canadian Wildlife Service interest in the chemical operation mounted in Newfoundland to control the hemlock looper were twofold: (a) exercise of statutory responsibilities under the Migratory Birds Convention Act, and (b) further investigation of the effects on populations of forest birds of aerial application of the organophosphates phosphamidon and sumithion, insecticides used to combat the spruce budworm in New Brunswick.

Two officers of the Service's Pesticides Section were in Newfoundland from July 6 to 18. Their monitoring activities were confined to the following spray areas: 24-25 (Grand Lake) in which bird counts as well as post-spray searches were made, and 14 (Fishel's Brook) and 32 (Lloyd's River) in which searches only were made for dead or incapacitated birds. Bird counts were also made in a control area at Black Duck.

METHOD

The method of assessing the impact of spraying on bird populations was essentially that employed by Fowle (1965). A bird-count route two miles long was marked with flagging tape along roads in spray area 24-25, beginning one mile to the east of the Trans-Canada Highway forming the western boundary. The route followed a side hill and ended just over the crown of the hill. Another route of the same length was marked in a control area at Black Duck. Both areas were selected essentially because of their accessibility and relative proximity to base.

The observer walked slowly along the route counting the number of individual birds seen and heard. A tally of the number of birds by species was kept. In addition, a running tally was made of the number of songs heard. Rather indeterminate songs of some species were not recorded. Notes were made of weather conditions at the start and the finish of the count. Rough population indices were obtained by dividing the time taken to complete the count into the total number of songs heard and the total number of individual birds noted. All counts were started at approximately the same time at each coverage. This was early in the morning when birds are usually more vocal than at other times of the day. Counts were begun at about 5:20 a.m. in the control area and at about 5:40 a.m. in the spray area. An observer made counts on his assigned route only: the need to make a difficult evaluation of the differences between observers' identification abilities was thus obviated. Post-spray searching for dead or incapacitated birds was considered to be an important part of the technique, and was continued for as long as it seemed profitable.

Insecticide was applied by modified T.B.M. (Avenger) aircraft in the manner described by Flieger (1964).

RESULTS

Results of bird counts and population indices for spray area 24-25 and for the control area are shown in tables 1 to 4.

Spray area 24-25 (Grand Lake)

This area was sprayed on the morning of July 9 with sumithion at 1/8 lb. in 1/5 USG formulation per acre, fine calibration. This treatment was repeated on the morning of July 15.

It was not known until a very late hour whether the looper population in the area was of sufficient size to warrant chemical control. Consequently there was time to make one pre-spray bird count only. The route was sprayed at about 9:00 a.m., two hours after completion of the count. The second application was made six days later on July 15 when the bird count was being made. At 6:45 a.m. spray aircraft were over the observer who sought temporary refuge in a thicket. Aircraft noise interfered with this count, and time was taken out several times. Spray detection cards were placed before the arrival of the spray air-carft. These showed a fairly good droplet distribution, lighter on the first half of the route, much heavier in patches on the second half.

There was apparently no population depression after the first treatment. The area was searched for six man-hours during the afternoon of July 9. Vocal activity was thought to be normal for that time of day. A few birds were noted to be bill wiping. A yellow-bellied flycatcher flew down to within a few feet of one observer. It retained its equilibrium and appeared to be in no distress. This species is normally of rather secretive habits. Searching was continued for a short period after the first post-spray count. Nothing untoward was noted.

There was a depression of the numbers of black-throated green and blackpoll warblers after the second treatment. The number of the latter species remained low three days later. The area along and near the count route was searched for six man-hours during the afternoon of

July 15. During this period several birds (myrtle warblers, blackpoll warblers, slate-colored juncos, and white-throated sparrows) were seen carrying food. Several birds of the same species were seen, particularly near the brow of the hill, to be indulging in excessive bill wiping.

Little song was heard, though the calls of young birds were heard throughout the searched area. While the count was being made on July 16, two incapacitated adult slate-colored juncos were seen, one of which was nearly taken in the hand. Many geometrid moths were fluttering on the ground. On the morning of July 18, one ruby-crowned kinglet, one slate-colored junco, and one white-throated sparrow, all adults, were seen to be in distress. Vocal utterances of young birds were noted to be considerably diminished. Three blackpoll warbler nestlings, discovered three days before, were dead in the nest.

Spray area 32 (Lloyd's River)

The area was sprayed on the morning of July 14 with phosphamidon at 1/8 lb. in 1/5 USG formulation per acre, fine calibration. One observer was flown by helicopter to search the area from 1:45 to 3:15 p.m. of the same day. During a five-minute period in a stand of black spruce and balsam fir, one pine grosbeak was heard singing and a small flock of crossbills was heard flying over. There was no other vocal activity. In another stand of balsam fir, no bird song was heard. In a third location, a bog surrounded by alders, one Tennessee warbler sang once and several Lincoln's sparrows were busy wiping their bills. In places sheltered from the breeze, mosquitoes were thick and a great nuisance.

Along the river, a spotted sandpiper, two greater yellowlegs, and a northern waterthrush all behaved normally. An osprey nest containing young was flown over, to the alarm of the two adult birds.

Spray area 14 (Fishel's Brook)

This area was sprayed on the morning of July 7 and 14 with sumithion at 1/8 lb. in 1/5 USG formulation per acre, fine calibration. Searching was carried out by one observer between 5:15 and 8:15 p.m. on July 14 in heavy, mature coniferous forest. No evidence of bird incapacitation was detected. Random song counts were made and ranged between three and 18 per minute.

Table 1. - Bird Count Results, Spray Area 24-25

Species*	9**	10	11	12	14	15**	16	18
	Number of birds seen and/or heard							
	July							
Common loon	0	1	0	0	0	1	0	0
Downy woodpecker	2	2	1	1	1	3	0	1
Black-backed 3-toed woodpecker	0	0	0	2	3	3	2	0
Northern 3-toed woodpecker	1	0	0	0	0	0	0	0
Yellow-bellied flycatcher	13	10	10	13	14	14	11	8
Olive-sided flycatcher	1	1	1	1	0	1	0	0
Tree swallow	2	6	0	0	0	0	0	0
Gray jay	2	3	1	1	2	3	2	2
Common raven	1	1	1	0	0	0	2	1
Common crow	0	1	1	2	1	1	1	1
Black-capped chickadee	2	3	3	3	2	3	6	7
Boreal chickadee	4	3	0	1	0	0	2	4
Red-breasted nuthatch	0	0	2	1	1	1	1	1
Brown creeper	1	0	0	0	0	0	0	0
Winter wren	1	1	1	1	1	1	1	1
Robin	2	1	4	6	6	4	3	7
Hermit thrush	6	6	8	7	7	6	6	5
Swainson's thrush	4	6	2	3	3	4	5	5
Ruby-crowned kinglet	2	3	2	0	2	2	2	3
Black-and-white warbler	1	3	2	2	3	3	1	0
Tennessee warbler	2	0	0	0	0	2	1	0
Magnolia warbler	3	4	2	2	2	2	3	1
Myrtle warbler	8	7	6	6	7	5	4	4
Black-throated green warbler	15	18	15	15	14	16	9	13
Blackpoll warbler	18	16	17	12	11	15	5	5
Ovenbird	3	3	4	1	1	1	2	1

Table 1. - Cont'd.

Species*	July 9**	10	11	12	14	15**	16	18
Northern waterthrush	3	2	4	3	2	1	3	1
Mourning warbler	4	5	4	5	6	5	3	4
Yellowthroat	0	0	0	0	1	0	0	0
Wilson's warbler	2	1	0	0	0	0	0	0
Rusty blackbird	1	0	0	0	0	0	0	0
Pine grosbeak	4	9	2	3	2	4	2	7
Slate-colored junco	4	6	3	7	7	8	12	6
White-throated sparrow	21	15	17	16	12	22	18	14
Fox sparrow	8	10	6	9	6	9	6	4
Lincoln's sparrow	1	1	1	1	1	1	1	0
Unidentified:								
Woodpecker	5	6	4	5	3	6	7	5
Warbler	2	1	0	0	0	0	0	0
Other	0	1	3	1	0	0	0	4

* Pine siskins and both red and white-winged crossbills in small, highly mobile foraging bands were noted during most counts. It was not possible accurately to count individuals and these species have been excluded from the tabulation.

** Areas sprayed on morning of July 9 after bird count made, and again on the morning of July 15 while count was being made.

Table 2. - Population Indices, Area 24 and 25

Date	Total Birds	Time (minute)	Birds/ minute	Total Songs	Songs/ minute	Total Species
July 9	149	95	1.6	1464	15.4	31
July 9	Spray applied in morning, after bird count					
July 10	156	94	1.7	1488	15.8	29
July 11	127	88	1.4	1083	12.3	27
July 12	130	91	1.4	1141	12.5	26
July 14	121	82	1.5	953	11.6	26
July 15	147	83	1.8	940	11.3	28
July 15	Spray applied in morning, during bird count					
July 16	121	81	1.5	920	11.4	27
July 18	115	82	1.4	856	10.4	24

Table 3. - Bird Count Results, Control Area

	Number of birds seen and/or heard								
	July								
Species*	9	10	11	12	14	15	16	17	18
American bittern	0	0	0	1	0	0	0	0	0
Yellow-shafted flicker	0	2	2	0	1	1	1	0	1
Hairy woodpecker	0	0	0	1	0	0	0	0	0
Yellow-bellied flycatcher	15	18	18	27	17	27	21	16	19
Olive-sided flycatcher	0	1	1	1	0	0	1	0	1
Gray jay	0	1	0	0	0	1	0	0	2
Blue jay	0	0	0	0	0	1	0	0	0
Common crow	0	0	0	3	0	3	0	0	0
Black-capped chickadee	1	0	0	1	1	2	0	0	0
Boreal chickadee	0	0	0	1	2	0	1	0	2
Red-breasted nuthatch	0	0	1	0	0	1	0	0	0
Winter wren	1	0	0	0	0	0	0	0	0
Robin	15	9	13	9	14	10	9	8	8
Hermit thrush	1	0	2	3	1	1	7	1	5
Swainson's thrush	1	1	3	4	6	3	2	2	0
Ruby-crowned kinglet	3	1	3	2	1	1	4	0	3
Black-and-white warbler	4	9	5	4	2	4	7	6	7
Tennessee warbler	0	0	0	0	0	0	1	1	1
Magnolia warbler	14	12	8	13	13	7	9	11	15
Myrtle warbler	0	0	0	2	1	1	0	1	0
Black-throated green warbler	2	3	3	2	1	2	0	2	0
Blackpoll warbler	25	23	19	17	16	22	24	16	18
Ovenbird	1	2	1	1	0	1	1	2	0
Northern waterthrush	2	4	3	4	6	6	3	2	4
Mourning warbler	1	6	6	7	5	7	10	9	13
Wilson's warbler	5	8	5	7	3	2	4	2	3

Table 3. - Cont'd.

Species*	July 9	10	11	12	14	15	16	17	18
American redstart	0	0	0	2	2	2	2	2	2
Purple finch	1	5	5	1	5	3	4	5	2
Pine grosbeak	1	1	4	0	4	4	3	2	3
Slate-colored junco	1	1	1	0	0	1	1	1	1
White-throated sparrow	16	21	12	15	9	11	12	9	8
Fox sparrow	20	20	21	24	16	25	16	12	16
Unidentified:									
Woodpecker	2	3	0	2	0	0	0	0	0
Chickadee	0	0	0	0	0	1	1	0	0
Thrush	2	0	0	1	2	0	1	5	3
Warbler	5	2	3	5	4	4	4	2	3
Blackbird	1	0	0	0	0	0	0	0	0
Other	12	11	16	13	14	18	14	15	13

* Pine siskins and both red and white-winged crossbills in small, highly mobile foraging bands were noted during most counts. It was not possible accurately to count individuals and these species have been excluded from the tabulation.

Table 4. - Population Indices, Control Area

Date	Total Birds	Time (minutes)	Birds/ minute	Total Songs	Songs/ minute	Total Species
July 9	152	82	1.8	1013	12.4	22
July 10	164	73	2.2	1000	13.7	20
July 11	155	71	2.2	888	12.5	21
July 12	173	74	2.3	1075	14.5	24
July 14	146	80	1.8	937	11.7	21
July 15	172	83	2.1	895	10.8	26
July 16	163	79	2.1	1178	14.9	22
July 17	132	71	1.9	879	12.4	20
July 18	153	75	2.0	1103	14.7	21

DISCUSSION

Although the control area was floristically rather dissimilar to spray area 24-25, several of the most abundant bird species were common to both locations. Counts were made concurrently in both areas. Small fluctuations in the number of birds noted (and consequently in the population indices) on each route from day to day can be attributed to the effect on activity of such factors as light intensity, wind, and temperature. Fortuitously, all counts were made in virtually windless conditions. Daily fluctuations in the numbers of birds counted are, nevertheless, reflected in the tables. Censusing birds at the height of or late in the nesting season is difficult, based as it is on identification by song. The observer in the control area attempted to count young birds calling, hence his relatively large totals of unidentified birds.

No dead birds were found in spray areas. Unless there has been a massive bird kill carcasses are difficult to find, especially in areas with a thick undergrowth or lacking in a good network of woods roads. Bird intoxication may manifest itself in several ways—by unusual tameness, the appearance of high-foraging species on the ground, loss of equilibrium, inability to fly, or by severe tremoring. A few birds were seen that exhibited some of these phenomena. Bill wiping is performed by birds after bathing and during activities associated with feeding. We have frequently noted this behaviour in New Brunswick during experimental dosing of captive birds with organophosphates. It may be a response to increased salivation which is believed to be a symptom of anticholinesterase poisoning. Birds seen bill wiping repeatedly in the spray area may have picked up toxic doses of insecticide.

There was a gradual decrease in the songs/minute index in spray area 24-25. As there was no accompanying drop off in the birds/minute index apparently the same number of birds was singing, but less frequently. Normally this would have been attributed to a natural decline in vocal activity with the progression of the nesting season. There was no song depression in the control area, however, suggesting that birds in the area sprayed were constrained from singing by some artificially imposed factor.

Birds could pick up toxic doses of insecticide orally by eating contaminated food. Fowle's work in New Brunswick has demonstrated the ability of birds to pick it up dermally—by absorption through the feet in contact with sprayed foliage. Inhalation is a possible third mode of entry. Work in New Brunswick this year has shown that birds were poisoned by unexpectedly low dosages of both sumithion and phosphamidon. A fine calibration (relatively small droplet size) was a new variable introduced in 1968 for the first time. The importance of this factor and its effect on birds is not yet properly understood.

Spraying in southwestern Newfoundland posed many problems for the operator. Those of a navigational kind stemmed largely from the extremely rugged nature of the terrain. To cite but three possibilities, the hazard to birds could be augmented by an increased dosage resulting from overlapping spray swaths, from a decrease in speed of spraying aircraft, or from a lack of drift during application in still air conditions.

The alkalinity of the water used in the formulation may have resulted in changes in the toxic properties of the insecticide. These operational variables are imponderable. It should be noted though that the "bird effect" in spray area 24-25 was apparently localized at the summit of a hill.

Spraying took place at a critical time for young birds unable to feed themselves. A depletion of food sources as a direct result of spraying, or death or even temporary incapactiation of adults would have serious consequences for young birds requiring constant and frequent attention. A torrential downpour occurred in the areas monitored late in the morning of July 16. The three blackpoll warbler nestlings which were found dead two days later were saturated and the nest still held pockets of water. They probably succumbed to exposure, but poisoning as well as hunger could have been contributing factors. That such a fate befell other birds at a similar stage of development seems likely and is suggested by the noticeable depression of the number of calls of young birds heard during the last counts, particularly in the spray area.

No evidence of birds in difficulty was detected in spray area 14 when it was searched about ten hours after the second application of sumithion. Except for the bill-wiping phenomenon, little abnormal behaviour was noted in spray area 24-25 during the two first post-spray searches which were begun six to seven hours after treatment. It is thought that sumithion is slower acting than phosphamidon. Had manpower and time been available, searching of spray area 14 might profitably have been extended another day or two. Spray area 32 was searched about six hours after the first application of phosphamidon. Here two possible effects were noted—bill wiping and the almost complete absence of bird song, the latter being much more noticeable than in the sumithion areas searched.

As usual, more questions have been raised than have been answered. When the findings are viewed in the light of a yet incomplete examination of the effects on birds of both sumithion and phosphamidon used in 1968 for spruce budworm control in New Brunswick, it is hoped that some matters will be clarified. The writer has received an unsubstantiated report that sick birds were found by forestry personnel in areas subjected to a 1/4 lb. dosage in one application. The material used and the numbers and kinds of birds seen remain unknown. New Brunswick experience has shown that this finding would not be unexpected.

SUMMARY

During the July 1968 operation mounted in Newfoundland to control the hemlock looper, two Canadian Wildlife Service officers monitored the effects on birds. Materials used were sumithion and phosphamidon, applied in two treatments at 1/8 lb. in 1/5 USG per acre, fine calibration, six or seven days apart. Most birds were apparently little affected. A few incapacitated birds, which may subsequently have died, were found after the second application of sumithion and census data indicated a slight depression of the number of blackpoll warblers. Phosphamidon probably caused a greater effect. Spraying occurred at a time critical to nestlings

and a natural event may have exacerbated the hazard to such birds. Operational variables, difficult to avoid and impossible to assess, may have contributed to the bird hazard.

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APPENDIX 4

Laboratory Evaluation of Insecticides Against Forest Insect Pests - 1968

By
P. C. Nigam

(A) Laboratory Screening of Twelve Insecticides for Contact Toxicity against Ambrosia Beetle Adults, Trypodendron lineautum (Oliv.) - 1968.

(B) Effectiveness of Six Insecticides Under Laboratory Condition against Eastern Hemlock Looper larvae, Lambdina fiscellaria fiscellaria (Guen.) - 1968.

(C) Contact Toxicity of Seventeen Insecticides against Fifth Instar Spruce budworm larvae, Choristoneura fumiferana (Clem.), Collected from Areas not Sprayed with DDT for its Control - 1968.

(D) Susceptibility of Sixth Instar Jack-pine Budworm larvae, Choristoneura pinus (Free.), to Insecticides under Laboratory Conditions - 1968.

(E) Contact Toxicity of Insecticides against Larvae of European pine Sawfly, Neodiprion sertifer (Geoff.), and Larch Sawfly, Pristiphora erichsonii (Htg.) - 1968.

(F) Residual and Systemic Toxicity of Insecticides against Black-headed Jack-pine sawfly, Neodiprion pratti banksianae (Roh.) and Larch Sawfly, Pristiphora erichsonii (Htg.) under Laboratory Conditions - 1968.

Chemical Control Research Institute

Forestry Branch

Department of Fisheries and Forestry

Ottawa, Ontario

November, 1968

(A) La… …creening of Twelve Insecticides for Contact Toxicity Against … Beetle Adults (<u>Trypodendron</u> <u>lineatum</u> (Oliv.)) - 1968

By

P. C. Nigam

…roposed to spray 240 million board feet of logs against the
Ambro… …n British Columbia in 1967. BHC spraying was recommended
but a… …blic resistance to the use of BHC and the appearance of young
salmo… …181.5 million board feet could be sprayed, thus approximately
one … the proposed programme was eliminated (ICFSO meeting - 1967)
Appen… ….

…the same loss was predicted to the logging industry i.e.
appr… 2.6 million dollars, if calculated at the rate of potential
loss… $11.00 per thousand fbm. It was agreed to intensify the
scre… insecticides in search of an effective and acceptable
inse… to fisheries, wildlife and the public) for the control of
the … ICFSO meeting - 1967 page 14). The data on fish, birds and
mamm… …xicity of the insecticides screened are presented at the end
of t… …t.

…r, twelve insecticides were screened by the Chemical Control
Rese… …titute, in the laboratory for contact toxicity against the
Ambr… …tle. The preliminary results were communicated to Mr. R.A.
Rich… April, 1968, for carrying out field trials; he has used
Sum… …ethyl Trithion and BHC. The final results are presented
in … The adults were sprayed under a modified Potter's tower
with… …t dosages of insecticides and LD 50 and LD 95 values in
µg/… calculated. At least 30 adults were sprayed with each dose
and … …re six to eight dosages of each insecticide. The adult
bee… supplied by Dr. L. H. McMullin of the British Columbia
For… …rch Laboratory. The insecticides are arranged in descending
ord… …icity on the basis of LD 50 values in Table I, with their
slo… values and fiducial limits of LD 50 values. The LD 95
val… converted into oz/acre for field evaluation of the insecticides.

…ing to LD 50 and LD 95 values at 48 hours, the relative toxicity
of … …cticides are rated below taking LD 50 and LD 95 values of BHC
(L… …qual to 1.

…50 level - Sumithion 10.0 > Sum & Phos Mix 9.0 > Zectran 6.4 >
Im… > Dibrom 5.9 > phosphamidon 5.8 > Matacil 2.9 > Methyl Trithion 1.4 >
BH… …aygon 0.6 > VCS 506 0.6 > Cygon.

…95 level - Sum & Phos Mix 21.5 > Sumithion 18.4 > Zectran 15.4 >
pr… …n 12.6 > Dibrom 7.0 > Imidan 5.0 Matacil 3.3 > Methyl Trithion 2.0 >
…aygon 0.54 = VCS 506 0.54. The relative toxicity values for
L… …95 are different because the regression lines of the insecticides
ar… …rallel.

Except for VCS 506 and Baygon, all the insecticides tested were superior to BHC while sumithion is best at LD 50 values and Sum & Phos Mix at LD 95 values. On the basis of LD 50 values, sumithion is 10 times more toxic than BHC and 7.1 times to Methyl Trithion, however, on the basis of LD 95 Sum & Phos Mix is 21.5 times more toxic than BHC, while Sumithion is 18.4 times. The relative toxicity of Sumithion as compared to Methyl Trithion at LD 95 values is 9.0 times. Sumithion is already in use in the field against spruce budworm and other forest insects and appears to be promising as a contact insecticide against the beetles, but field results only will prove its potentialities against it.

Chemical Control Research Institute
Ottawa, Ontario
November, 1968.

TABLE I

Contact Toxicity of Insecticides Against Adults of Ambrosia Beetles
(*Trypodendron lineatum* (Oliv.))

Insecticides	Slope	LD 50 (48 hours) µg/cm²	LD 50 (48 hours) Fiducial Limits 95%	LD 95 (48 hours) µg/cm²	LD 95 (48 hours) oz/acre***
Sumithion®	4.050	0.138	0.119 0.160	0.353	0.50
Sum & Phos Mix	5.586	0.153	0.135 0.172	0.302	0.43
Zectran®	4.006	0.164	0.134 0.189	0.423	0.60
Imidan®	1.953	0.190	0.138 0.242	1.324	1.89
Dibrom®	2.762	0.233	0.177 0.287	0.919	1.31
Phosphamidon	4.966	0.236	0.202 0.273	0.506	0.72
Matacil®	2.643	0.467	0.373 0.560	1.956	2.79
*Methyl Trithion®	3.189	0.959		3.147	4.49
BHC (Lindane)	2.440	1.377	0.998 1.691	6.504	9.28
Baygon®	1.923	1.694	1.354 2.261	12.140	17.33
VCS 506	2.260	2.254	1.749 2.878	12.040	17.18
**Cygon	63% mortality at 4.412 µg/cm² or 6.30 oz/acre (48 hours)				

* Fiducial Limites not computed

** No regression line

*** 1.121 µg/cm² = 1.6 oz/acre = 1% @ 1 gal. per ac

(B) Effectiveness of Six Insecticides Under Laboratory Conditions Against Eastern Hemlock Looper larvae, Lambdina fiscellaria fiscellaria (Guen.) - 1968

By

P. C. Nigam

A rapid build-up of Eastern Hemlock Looper outbreak in Balsam Fir occurred in Western and Central Newfoundland in 1967. Approximately 45,000 acres were completely defoliated i.e. death of 600,000 cords of balsam fir was imminent and about 2,000,000 cords were threatened with severe defoliation which necessitated control operations in 1968 to prevent further timber mortality. In a joint meeting of departments of Forestry, Fisheries and Wildlife at Newfoundland, it was decided to use sumithion at the rate of 1/4 lb/acre for the control operation and DDT was avoided due to numerous streams in the infested area (ICFSO - 1967, p. 10-11).

In order to confirm the recommendation, toxicity tests of sumithion, against the Eastern Hemlock Looper larvae, were carried out at Chemical Control Research Institute and the preliminary results were communicated to Dr. W.J. Carroll, of Newfoundland, Forest Research Laboratory, in February, 1968, for field application.

The present report describes the comparative contact toxicity of six insecticides against 4th instar larvae of the Eastern Hemlock Looper for future selection of insecticides against it. First and second instar looper larvae were supplied by Dr. Carroll from Newfoundland, they were reared to 4th instar in the Ottawa laboratory before using in the toxicity test. Thirty to forty larvae were sprayed under modified Potter's Tower with six dosages of each insecticide.

The mortality observations were taken after 24, 48 and 72 hours. The results are presented as corrected percentage mortality after 72 hours, in Table I. The lowest dose of each insecticide at which highest mortality was observed is expressed in oz/acre. According to these results the effectiveness of the insecticides against 4th instar larvae of the Eastern Hemlock Looper is arranged in the following descending order:-

Zectran > Matacil > Sumithion > Phosphamidon > Baygon.

The mammalian, fish and bird toxicity of these insecticides is tabulated at the end of the report. DDT was not included in these tests as it can no longer be used in the field against the looper. However, Zectran at 0.64 oz/acre seems to be best and Baygon at 3.2 oz/acre is poorest, on the basis of contact toxicity of the insecticides tested under laboratory conditions. The final recommendations will depend upon field evaluation.

Chemical Control Research Institute
Ottawa, Ontario
November, 1968

TABLE I

Corrected Percentage Mortality of 4th Instar Eastern Hemlock Looper (L. f. fiscellaria (Guen.)) after 72 hours of Insecticide Treatment

Insecticide	Conc. %	Rate of Application in gallons/acre						Highest Mortality at Lowest Dose	
		0.1	0.2	0.4	0.6	0.8	1.0	oz/acre*	% Mortality
Zectran®	1%	38	87	100	100	100	100	0.64	100
Matacil®	1%	0	0	54	97	100	100	1.28	100
Sumithion®	1%	0	36	30	87	83	90	1.60	90
Phosphamidon	1%	7	13	6	29	20	40	1.60	40
Baygon®	2%	0	6	14	0	6	35	3.20	35

* 1% @ 1 gal. per acre = 1.6 oz/acre

(C) Contact Toxicity of Seventeen Insecticides against Fifth Instar Spruce budworm larvae, Choristoneura fumiferana (Clem.), Collected from Areas not Sprayed with DDT for its control - 1968.

By

P. C. Nigam

Spruce budworm infestation is a perpetual problem in Canadian forests. In 1967 approximately 1.04 million acres were treated for its control. DDT had been used in New Brunswick since 1956, but in recent years there are signs of development of resistance in Spruce budworm against DDT, as well as, there is an opposition to the use of DDT due to hazards to wildlife and fish. Phosphamidon and Sumithion have been tried in operational control but still there is a search for a better insecticide for its control.

In 1968, seventeen insecticides were tested for contact toxicity against 5th instar spruce budworm larvae collected from Ottawa, Ontario. This population had no previous history of any control operation against it. The dosage mortality regression lines of the insecticides obtained from this population will act as a reference, for populations had continuous pressure of insecticides (New Brunswick population).

The insecticides used in this study are arranged in descending order of toxicity on the basis of LD 50 values in Table I. In case of Cidial, Baygon, Abate and Zytron, no regression lines were obtained so the lowest concentrations at which highest mortality was obtained are expressed in the Table.

The larvae were sprayed in a similar manner as reported in previous reports. The statistical analysis after 48 hours of spraying is presented in Table I, the LD 95 values are converted into oz/acre. The mammalian, fish and bird toxicity of the insecticides tested is reported at the end of the report.

According to LD 50 and LD 95 values (Table I) the relative toxicities of different insecticides, taking LD 50 and LD 95 values of DDT as one, are as follows:-

At LD 50 level - Zectran 48.6 > Matacil 40.6 > Dibrom 12.3 > Sumithion 6.0 > Phosphamidon 4.9 > Cyan 47031 4.5 > Ciba 9496 3.4 > VCS 506 2.7 > Imidan 2.4 = Baytex 2.4 > Cygon 1.9 > Anthio 1.8 > DDT 1.0.

At LD 95 level - Matacil 94.3 > Zectran 91.9 > Dibrom 42.5 > Sumithion 22.1 > Phosphamidon 19.4 > Cyan 47031 14.1 > Ciba 9491 12.9 > VCS 506 9.9 > Imidan 9.0 > Anthio 5.4 > Cygon 3.4 > Baytex 1.4 > DDT 1.0.

Zectran and Matacil at 0.22 oz/acre were best as contact insecticides among the insecticides tested. They have already entered into field evaluation trials along with others.

Chemical Control Research Institute

Ottawa, Ontario

November, 1968

TABLE I

Contact Toxicity of Insecticides Against 5th Instar Spruce Budworm (*Choristoneura fumiferana* (Clem))

Insecticides	Slope	LD 50 (48 Hours) µg/cm^2	LD 50 (48 Hours) Fiducial Limits 95%	LD 95 (48 Hours) µg/cm^2	LD 95 (48 Hours) ** oz/acre
Zectran®	2.833	0.041	0.034 0.049	0.157	0.22
Matacil®	3.302	0.049	0.041 0.057	0.153	0.22
Dibrom®	5.094	0.162	0.142 0.182	0.339	0.48
Sumithion®	5.598	0.333	0.289 0.376	0.654	0.93
Phosphamidon	6.163	0.403	0.178 0.607	0.744	1.10
Cyan 47031	4.554	0.447	0.353 0.524	1.026	1.46
Ciba 9491	5.210	0.586	0.506 0.668	1.121	1.60
VCS 506	5.567	0.737	0.659 0.837	1.456	2.08
Imidan®	5.838	0.834	0.697 0.947	1.596	2.28
Baytex®	1.513	0.844	0.569 1.186	10.32	14.73
Cygon®	2.739	1.053	0.455 5.759	4.199	5.99
Anthio®	4.163	1.079	0.901 1.243	2.681	3.83
DDT	1.913	1.992	1.538 2.553	14.43	20.59
*Cidial®	100% mortality at 3.587 µg/cm^2 or 5.12 oz/acre at 48 hours				
*Baygon®	52% mortality at 3.432 µg/cm^2 or 4.9 oz/acre at 48 hours				
*Abate®	40% mortality at 4.484 µg/cm^2 or 6.4 oz/acre at 48 hours				
*Zytron®	0% mortality at 4.484 µg/cm^2 or 6.4 oz/acre at 48 hours				

* No regression line

** 1.121 µg/cm^2 = 1.6 oz/acre = 1% @ 1 gal. per acre

(D) Susceptibility of Sixth Instar Jack-pine Budworm larvae, Choristoneura pinus (Free.), To Insecticides Under Laboratory Conditions - 1968

By

P. C. Nigam

The Jack pine budworm infestation occurs in the North-western Ontario Region, eastern Manitoba and in the Spruce Woods Forest Reserve. In 1967, about 1,500 acres were sprayed in Manitoba, with DDT at the rate of 1/2 and 3/4 lb/acre, the dosages reduced 87% and 99% of the population respectively, but it was suggested that DDT should not be used in future operations (ICFSO - 1967, p. 12 & 13).

Screening of nine compounds was carried out in 1968 in order to establish contact toxicity data against Jack pine budworm larvae for future reference and for evaluation of insecticides for field trials.

The insecticides used in this study are tabulated in Table I in descending order of toxicity on the basis of LD 50 values. Where LD 50 and LD 95 values could not be calculated, the data are expressed as highest mortality at lowest concentration at a given period of time. The Jack pine budworm larvae were collected in 5th or 6th instar from Chalk River Ontario. Thirty to forty larvae per dosage were sprayed in three to four replications of ten larvae. There were six to eight doses of each insecticide. The spraying was carried out under a modified Potter's tower and mortality observations were taken after 24, 48 and 72 hours. The LD 50 and LD 95 values in $\mu g/cm^2$ were calculated for 24, 48 and 72 hours. The summary of the statistical analysis is presented in Table I along with conversion of LD 95 values into oz/acre.

According to LD 50 and LD 95 values at 48 hours, the relative toxicity of insecticides is presented below, taking LD 50 and LD 95 values of sumithion as one.

At LD 50 values - Zectran 6.2 > Matacil 4.1 > Sumithion 1.0 > Sum & Phos Mix 0.8 > Imidan 0.2 = Anthio 0.2 > Baygon 0.1 = Cygon 0.1.

At LD 95 values - Zectran 6.2 > Matacil 4.8 > Sumithion 1.0 > Sum & Phos Mix 0.8 > Anthio 0.2 > Imidan 0.1 = Baygon 0.1 > Cygon 0.05

DDT or other chlorinated hydrocarbon insecticides were not tested as they can no longer be used in the field due to hazards to fish and wildlife. Mammalian, fish and bird toxicity of insecticides tested is given at the end of the report.

Zectran at 0.20 oz/acre is best for 95% mortality of the budworm. Matacil at 0.26 oz/acre is second followed by phosphamidon and sumithion etc.

These contact toxicity results give an indication of promising insecticides, their field worthiness will be finally proved by field trials.

Chemical Control Research Institute
Ottawa, Ontario
November, 1968

APPENDIX 5

Not for Publication

CHEMICAL CONTROL RESEARCH INSTITUTE - REPORT TO THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

A series of reports on projects of the Chemical Control Research Institute, pertinent to the business of the Interdepartmental Committee on Forest Spraying Operations, Meeting of November 20-21, 1968

Chemical Control Research Institute

J. J. Fettes, Director

Forestry Branch

Department of Fisheries and Forestry

Ottawa, Ontario

November, 1968

Summary Report on Insecticide Investigations 1968

Project (CC 1 - 1) Aerial application of pesticides for the control of the Spruce budworm, C. fumiferana (Clem.) in New Brunswick, 1968.

Part I: Assessment of the AU 3000 Micronair Units for Ultra low volume application of experimental insecticides in the control of spruce budworm.

By
A. P. Randall
Chemical Control Research Institute
Ottawa, Ontario

Three years of experimentation on ultra low volume emission of concentrate insecticides with Mini-spin, turbair, and flat fan nozzles has confirmed the hypothesis that the ULV concept of spraying for the control of forest insects is basically sound. The major drawback to this approach on an operational basis, however, has been the failure of experimental equipment to withstand continual usage and the potential hazards associated with concentrate insecticide solutions. The development of the AU 3000 Micronair units by Britten-Norman Ltd. of England, presented a commercial apparatus that might well meet the requirements of a ULV spray unit for operational use. The methods of experimentation, pilot and field plans were basically the same as used in 1965, 66 and 67. The aircraft, however, was a Grumman Ag-Cat; a modern spray aircraft with approximately the same air speed, load, and flight characteristics to that of the Stearman.

Objectives

A. Systems evaluation: Calibration and appraisal of the Micronair units as adapted to the Ag-Cat aircraft for spray emission at air speeds of 90-100 mph.

B. Field appraisal of currently recommended insecticides against new experimental materials.

C. Comparison of ULV vs boom-and nozzle application of pesticides for spruce budworm control.

Results and Discussion

A. Systems Evaluations:-

1. Results of the calibration trials of the Britten-Norman Micronair units as ULV spray emission equipment indicated that the desired droplet size spectra could only be achieved at the maximum cage rotation settings of the blades (15°) when a concentrate insecticide was used within the system at an economical emission rate for four units/aircraft. The conditions set for these trials was a half gallon emission rate/min./unit. Decreasing the emission rate or alteration of flow rate and fluid pressure would allow lower rotational speed for the wire cages without a major alteration of the droplet size spectrum.

2. Droplet size and number distribution were improved with the replacement of the 13.5" blade with those of the 15.5" diameter blades using malat.ion as the test insecticide at 40 psi with a No. 6 flow restrictor.

3. Blade angle settings of minimum angle of rotation (35°) produced a droplet size spectrum comparable to that of of boom spraying systems nozzle No. 8010 at + 45° setting into the flight air stream.

4. The micronair equipment was found to be well engineered and able to withstand continual usage as would occur under operational condition.

B. <u>Field appraisal of test insecticides:-</u>

1. With the exception of Plots 1, 3, 4 and 10 all data presented in this report are representative of ULV spray application with Micronair devices using concentrate insecticide formulations. A summary of the experimental data relevant to each plot is presented in Table A-I. Biological effectiveness of the test insecticides against the spruce budworm larvae and pertinent spray deposit data are presented in Table A-II and Table A-III for balsam fir and spruce host species respectively.

2. Early application of 6.25% DDT failed to provide adequate kill of 2nd instar spruce budworm larvae at dosage deposit levels of 10 to 20 drops/cm^2. Deposits of 20-40 drops/cm^2 accounted for less than 25% population reduction of larvae. In light of these findings it is not logical to assume population reduction of early instar larvae from residual accumulations of DDT from previous spraying operations.

3. Of the new insecticides field tested, only Matacil compared favourably with Sumithion and phosphamidon as a potential material for spruce budworm control. This material is closely related to Zectran, a highly effective carbamate insecticide against larvae of the spruce budworm.

4. The systemic insecticides (i.e. phosphamidon and Sumithion) were found to have a greater lethal time effectiveness against the spruce budworm larvae than a residual contact insecticide such as DDT which has a very narrow time application period. This can be extremely important on an operational spray project where available spraying time is a critical factor.

C. <u>ULV vs. Boom-and Nozzle:-</u>

1. Results of the ULV vs. Boom-and-nozzle trials showed no significant difference in budworm mortality due to method of application when equal amounts of active ingredient was applied per unit area (Table A-II, Plots 4 and 5). The advantages of the ULV method of application may be measured in terms of improved pay load per aircraft and increased availability of spraying weather and ferry time.

2. Further study on spray systems evaluation and insecticide formulations should be undertaken in 1969.

Project (CC 1 - 1) Aerial application of pesticides for the control of the spruce budworm, C. fumiferana (Clem.) in New Brunswick, 1968.

Part B : Evaluation of early vs late spray application; systemic vs residual insecticides; and the effects of both systems in terms of the protection of forest trees.

In the spring of 1968, a series of intensive spray experiments were undertaken to compare ULV spraying against that of standard boom and nozzle emission and to re-asses the effectiveness of the systemic insecticides not only in terms of insect kill but in terms of the protection of growing foliage on forest trees. The experiments were confined to those insecticides currently recommended or suggested for budworm control (i.e. DDT, phosphamidon and Sumithion) and were directed with the objective of reducing insect numbers and defoliation damage to growing trees.

The experimental plots were scheduled to be sprayed in early May when the budworm larvae were active, in the 2nd instar, and predominantly in the needle-mining stage. During this period the forest trees would have broken dormancy and the resumption of active growth would be evident by the swelling of buds and the occurrence of male and female flower development on such hardwoods as maple and birch. Of prime importance, however, is the fact that the early summer canopy of hardwood foliage such as maple, beech and birch would be absent, thus leaving all the softwood trees exposed to spray droplet penetration and deposition.

The plots were sprayed using four Micronair Au 3000 units for ULV-emission (2 GPM) and twenty 8010 spraying systems nozzle for boom-and-nozzle high volume emission (20 GPM). The quantity of active ingredient applied per 400 acre plot by each system was the same; e.g. 15 gallons, 90% technical phosphamidon concentrate for ULV emission (4 oz/ac) or 15 gallons 90% phosphamidon concentrate formulated with H_2O to give 200 gallons of 6.25% insecticide applied at 1/2 gal./ac. The difference in larval mortality between the two plots would be attributed to formulation and mode of application provided all other factors are constant.

Objectives

A.(1) - Evaluation of the systemic action of Sumithion and phosphamidon; and the contact activity of DDT against the 2nd instar larvae of the spruce budworm.

(2) - Comparison of the effectiveness of the systemic activity of concentrate phosphamidon and Sumithion to that of diluted H_2O formulations of the same insecticides.

B.(1) - An appraisal of early vs late application of insecticides in terms of foliage protection to the host trees.

(2) - An appraisal of the effectiveness of systemic vs contact insecticides in terms of foliage protection of host trees.

Results and Discussion

A. 1. The results of early ULV vs Boom-and-Nozzle spray application methods for phosphamidon, Sumithion, and DDT are shown in Table A-1.

2. Early application of DDT prior to shoot development (i.e. flared new growth) resulted in no significant budworm mortality at deposit densities as high as 20 drops/cm^2 of a 6.25% DDT formulation.

3. Early application of phosphamidon or Sumithion resulted in budworm mortalities as high as 70-86% for droplet deposit densities of up to 15 drops/cm^2.

4. A comparison of ULV vs boom-and-nozzle application of phosphamidon or Sumithion showed that a high degree of budworm mortality could be achieved by either mode of application; and that the addition of large quantities of diluent is not a prerequisite for improved control.

The results suggest that the distribution of active ingredient per unit area is more important than quantity or dosage. This is evident in the results from plots 4 and 5 which were sprayed on the same day. A comparison of Plots 1 and 2 which were separated in time by a period of 10 days are not valid due to the phenological difference of the trees. The results, however, do show the effectiveness of the systemic activity of phosphamidon.

5. A comparison of DDT treatments between Plot 3 (early) and Plot 10 (late) indicates that the effectiveness of DDT treatment is related to surface impingement of DDT onto the food source and that budworm kill is due to the contamination of new foliage growth, and exposure of the larvae to DDT.

6. These trials confirm the systemic effectiveness of early application of phosphamidon and Sumithion against the larvae of the spruce budworm.

B. 1. Results of early ULV vs Boom-and-Nozzle application of phosphamidon, Sumithion and DDT expressed in terms of foliage protection of forest trees are shown in Table B-II. The criteria of defoliation was based on the index of 100% defoliation as the complete destruction of current buds or shoot growth for 1968.

2. Results of the defoliation counts taken from the early DDT sprayed Plot #3 indicated that 100% to 70% defoliation occurred on trees receiving 0 to 10 drops/cm^2 and 70% for 10-20 drops/cm^2. Since no control was achieved in these droplet deposit ranges (Table B-I), these figures would then represent normal destruction of foliage due to budworm feeding at the epidemic level.

3. The late application of DDT (Plot 10) shows similar degrees of defoliation for similar deposits. The degree of budworm control achieved by 10-20 drops/cm^2 was 70% indicating that most of the defoliation had occurred before spray application. Thus the overall effect of late DDT application would be the reduction of the insect population with very little foliage protection.

4. By comparison the application of an early spray of a systemic insecticide may be expressed both in terms of insect mortality and foliage protection as shown by the results in Plots 1,2,4 and 5 (Table B-II).

5. The criteria of high budworm mortality does not necessarily mean a high degree of foliage protection as shown in Table B-II by the results obtained in plot 10 (12.5% DDT at 1/4 GPA). By comparison a moderate degree of control very early in the season through the use of a systemic insecticide (see Plot 2 59% at 15-20 drops/cm^2) can provide a greater degree of foliar protection than a much higher degree of budworm kill with a residual insecticide such as DDT applied later in larval development (see Plot 10, Table B-I).

The practice of applying two applications of an insecticide operationally would further favour the systemic insecticides over those of a contact material such as DDT.

TABLE A-I

Summary of Field Data from the 1968 Aerial Spray Trials in New Brunswick
Using AU 3000 Micronair Units and Boom & Nozzle Spray Emission Systems

Plot No.	1	2	3	4	5	6	7	8	9	10
Date	3-6-68	23-5-68	2-6-68	28-5-68	28-5-68	22-6-68	24-6-68	22-6-68	23-6-68	19-6-68
Spray Time	PM	PM	AM	PM	AM	AM	AM	AM	PM	AM
Insecticide	Phosphamidon	Phosphamidon	DDT	Sumithion	Sumithion	Malathion	Ciba 9491	Baygon	Matacil	DDT
% Active	6.25	90	6.25	9.3	98	97	20	22.5	34	12.5
Solvent	H_2O	None	Fuel Oil	Aerotex 3134 } Atlox 3409 } H_2O	None	None	Unknown	None	None	Fuel Oil
Plot Size ac.	400	400	400	400	400	600	400	600	400	400
Gal. emitted	200	15	200	200	20	20	50	50	50	110
Aircraft Data (Grumman Ag-Cat)										
Speed (mph.)	90	90	100	90	90	90	90	90	90	100
Height (ft.)	50-100	30-50	30-50	50-100	30-50	50-75	50-75	50-75	50-75	50-100
Equipment	B&N 8010	Micronair	B&N 8010	B&N 8010	Micronair	Micronair	Micronair	Micronair	Micronair	B&N 8006
No. of Units	20	4	20	20	4	4	4	4	4	20
No. of Swaths	10	8	18	13	12	12	15	15	19	24
Spray Time (min.)	12	8	10	10	10	10	20	15	16	16
Disc. No.	None	6-13.5" Fan	None	None	6-13.5" Fan	6.15.5" Fan	6-15.5"	6-15.5" Fan	6-15.5" Fan	None
Emission (GPM)	20	2	20	20	2	2	2	2	2	20
Pressure (PSI)	40	40	40	40	40	40	40	40	40	40
Weather Data										
Wind Speed (mph.)	0-2	2-4	3-5	4-6	0-4	4-6	4-8	6-8	8-3	1-2
Temp °F	34	57	50-65	40	35	48-49	100-88	55	67-64	70
RH %	70-78	68-70	62	--	90-87	98-94	48-5	88-89	58	76-82
Stability	Inversion	Inversion	Inversion	Lapse-Inv.	Inversion	Inversion	Inv.-Lapse	Inversion	Inversion	Inversion
Cloud	3/10	1/10	3/10	8/10	2/10	0/10	10/10-5/10	3/10	9/10	8/10
Post Spray	cloudy	clear	clear-hot	clear-cool	clear-cold	clear		clear	clear	clear
Spray Charac.										
Stain (D max μ)	1100	700	2100	1100	700	800	500	500	500	1500
Drop (D max μ)		136	350		128	148				265
Spray Class	coarse	fine	coarse	coarse	fine	fine	fine	fine	fine	med. coarse
Spray coverage	good	good	good	fair	good	poor	poor	fair	fair	good
Max. Drops/cm²		23	65	14	27	14	12	17	14	28
Max. oz/ac.										
Min. oz/ac.										

TABLE A-II

Results of Aerial Application of Experimental Insecticides against Spruce Budworm Larvae on Balsam Fir Trees

Plot No.	Treatment	Spray Date	No. Drops /cm²	Deposit Liquid oz/ac.	No. of Branch Samples	Maximum stain μ	Maximum drop μ	Percentage Population Reduction 1st Count	Percentage Population Reduction 2nd Count	Percentage Population Reduction 3rd Count	Percentage Population Reduction Ave.	Days After Treatment 1st	Days After Treatment 2nd	Days After Treatment 3rd	Larvae Instar
1	Phosphamidon 6.25% (B&N 8010)	3-6-68 PM	0-5 5-10 10-15 15-20 20-35		62 42 18 4 6	1100	---	36 36 73 21 45	9 26 62 59 68	6 47 75 33 81	17 36 70 38? 65	4	9	14	10%-2nd 39%-3rd 51%-4th
2	Phosphamidon 90% (ULV)	23-5-68 PM	1-5 5-10 10-15 15-20		26 76 16 6	700	136	35 43 43 58	50 54 53 61	45 42 35 58	43 46 44 59	4	8	14	90%-2nd 10%-3rd
3	DDT 6.25% (B&N 8010)	2-6-68 AM	0-10 10-20 20-30 30-40+		26 24 16 6	2100	350	0 0 0 23	0 0 13 0	0 0 25 92?	0 0 13 38	4	8	15	33%-2nd 62%-3rd
4	Sumithion 9.4% (B&N 8010)	28-5-68	0-1 1-5 5-10 10-15		54 26 22 30	1100		29 67 86 70	27 65 86 85	0 57 86 81	19 63 86 77	6	12	16	74%-2nd 26%-3rd
5	Sumithion 98% (ULV)	28-5-68	0-1 1-5 5-10 10-15 15+		30 50 30 12 10	700	128	28 25 78 59 86	11 24 64 80 82	5 23 70 85 83	15 24 71 75 84	5	8	12	70%-2nd 30%-3rd
6	Malathion 97% (ULV)	22-6-68	0-1 1-5 5-10 10-15		8 38 36 24	800	148	25 23 0 27	48 38 41 32	44 26 49 35	39? 29 30 31	2	5	7	10%-5th 90%-6th
7	Ciba 9491 20% (ULV)	24-6-68	0-1 1-5 5-10		34 46 6	500		32 34 23	21 49 43	30 32 31	28 38 32?	2	4	6	95%-6th
8	Baygon 22.5% (ULV)	22-6-68	0-1 1-5 5-10 10-15		22 30 16 6	500		4 7 4 14	12 0 23 0	-- -- -- --	8 4 13 7	4	8	-	95%-6th
9	Matacil 34% (ULV)	23-6-68	0-1 1-5 5-10 10-15		6 30 26 10	500		26 -- 14.5 0	94 88 89 90	98 86 90 90	73 87	2	4	8	95%-6th
10	DDT 12.5% (B&N 8006)	19-6-68	0-10 10-20 20-30 30-50		30 22 24 24	1500	265	44 58 64 65	70 79 71 70	78 74 76 88	64 70 70 74	3	5	6	10%-5th 90%-6th

TABLE A-III
Results of Aerial Application of Experimental Insecticides against Larvae of the Spruce Budworm on Spruce Trees

Plot No.	Treatment	Spray Date	No. Drops /cm^2	Deposit Liquid oz/ac.	No. of Branch Samples	Maximum stain µ	Maximum drop µ	Percentage Population Reduction 1st Count	Percentage Population Reduction 2nd Count	Percentage Population Reduction 3rd Count	Days After Treatment 1st	Days After Treatment 2nd	Days After Treatment 3rd	Larvae Instar
3	DDT 6.25% (B&N 8010)	2-6-68	0-10 10-20 20-30 30-40+		10 30 14 6	2100	350	0 0 0 58	0 0 0 64	0 0 0 77	4	8	15	33% - 2nd 62% - 3rd
6	Malathion 97% (ULV)	22-6-68	0-1 1-5 5-10		8 10 12	800	148	0 47 28	31 0 0	16 38 7	2	5	7	- 6th
7	Ciba 9491 ULV	24-6-68	0-1 1-5 5-10 10-15		6 20 14 6	500	---	34 0 7 88	60 34 0 86	0 30 40 89	2	4	6	- 6th
8	Baygon 22.5% (ULV)	22-6-68	0-1 1-5 5-10 10-15		12 24 10 6	500		5 8 0 0	29 0 0 0	-- -- -- --	4	8	-	- 6th
9	Matacil	23-6-68	0-1 1-5 5-10 10-15		6 20 20 10	500		0 0 0 0	87 80 83 91	100 94 69 91	2	4	8	- 6th
10	DDT	24-6-68	0-10 10-20 20-30		18 28 4	1500	265	32 27 12	36 45 77	70 65 37	2	4	6	90% - 6th

TABLE B-I

Comparison of ULV Concentrate Spraying vs. Boom-and-Nozzle Application of Dilute Formulations of Insecticides. (1968)

	Plot No.	Date Sprayed	Treatment	Spray Category	Drops/cm^2	No. Samples	% Mortality 4-16 day	Instar Sprayed
Early	1	3/6/68	PHOS. 6.25%	BOOM (200 gal.)	5-10 10-15	42 18	36% 70%	3rd-39% 4th-51%
Early	2	23/5/68	PHOS. 90%	ULV (15 gal.)	5-10 10-15	76 16	46% 44%	2nd-98%
Early	3	2/6/68	DDT 6.25%	BOOM (200 gal.)	0-10 10-20	26 24	0 0	2nd-33% 3rd-62%
Early	4	28/5/68	SUM. 6.25%	BOOM (200 gal.)	5-10 10-15	22 30	86% 77%	2nd-74%
Early	5	28/5/68	SUM. 98%	ULV (2x10 gal.)	5-10 10-15	30 12	71% 75%	2nd-70%
Late	10	19/6/68	DDT 12.5%	BOOM (100 gal.)	0-10 10-20	30 22	64% 70%	6th

TABLE B-II

Protection of Balsam Fir Foliage as related to Spray Treatment. (1968)

	Plot No.	Date Sprayed	Treatment	Spray Category	% Defoliation by Drop Deposit Class (B. Fir)						
					0-1	1-5	5-10	10-15	15-20	20-30	30-40
Early	1	3/6/68	PHOS. 6.25%	BOOM (200 gal.)	60	58	38	33	--	30	25
Early	2	23/5/68	PHOS. 90%	ULV (15 gal.)	←	40→	35	38	18	15	--
Early	3	2/6/68	DDT 6.25%	BOOM (200 gal.)	←	--	73→	←	70→	58	36
Early	4	28/5/68	SUM. 6.25%	BOOM (200.gal.)	61	30	12	6	--	--	--
Early	5	28/5/68	SUM. 98%	ULV (2x10 gal.)	48	30	32	15	--	--	--
Late	10	19/6/68	DDT 12.5%	BOOM (100 gal.)	←	--	72→	←	68→	56	38

APPENDIX 6

CANADA
DEPARTMENT OF FORESTRY
AND RURAL DEVELOPMENT

FOREST RESEARCH LABORATORY
FREDERICTON, NEW BRUNSWICK

SUMMARY STATEMENT ON THE ENTOMOLOGICAL ASSESSMENT OF THE 1968 SPRUCE BUDWORM AERIAL SPRAYING PROGRAM IN NEW BRUNSWICK AND FORECAST OF CONDITIONS FOR 1969.

E. G. Kettela

November, 1968

The spring of 1968 was one of the warmest in recent years. Budworm emergence from hibernation at Fredericton commenced about 26 April, 5 to 6 days earlier than normal. The weather continued to be unseasonably warm through May resulting in rapid larval development. Cooler weather during the last week of May and the first week of June slowed insect development bringing it into line with the mean for the past 10 years (Figure 4). Operational spraying commenced on 4 June which is about the usual time. The cumulated day-degrees above a 37F threshold temperature provide a good index of budworm development. The daily cumulations at Fredericton for May and June are shown in Figure 4. The spring of 1968 differed markedly from that of 1967 which was very cold.

Pre-spray and post-spray budworm surveys - Pre-spray surveys of early-instar budworm larvae were conducted in late May and early June to: (1) give a population fix on spray blocks; (2) determine larval densities along the northern and western edge of the main infestation; and (3) provide a series of unsprayed control points. With respect to (1), pre-spray populations on both fir and spruce were determined for 19 spray blocks at a minimum of 10 locations per block. With respect to (2), populations along the northern and western boundaries of the infestation were sufficiently high to warrant adding approximately 200,000 acres to the spray plan. Samples taken at 50 points outside the spray plan served as unsprayed control points.

Post-spray pupal surveys were conducted in July to determine the effectiveness of spraying. Included were all points sampled during the pre-spray survey and locations in 10 additional spray blocks. This provided information on 29 spray blocks and at 50 control points.

Population reduction in the sprayed area - Population reductions for sprayed areas were determined by comparing the results of pre- and post-spray surveys. A summary of the results by insecticide and dosage is shown in Table 2. The average reduction on balsam fir, 79%, is lower than the 1960-1967 average of 83%, and the reduction of 70% on spruce is slightly higher than the long-term average of 67%. However, deviations from the means were expected due to the experimental nature of the spray trials.

Estimates of the percentage reduction in survival, corrected for the influence of population density, were determined for each block sampled in pre- and post-spray surveys (Table 2). Estimates of the percentage reduction in population were determined for the blocks sampled during the post-spray survey only using the unsprayed control data as a reference index. The latter estimate is generally comparable to the estimate of percentage reduction in survival, but is inherently less precise.

The following conclusions seem justified from the data in Table 2 and from field and laboratory observations:

(1) Treatments with 0.5 lb./acre of DDT, 0.5 lb./acre of Sumithion, 0.375 lb./acre of Sumithion, and 0.25 lb./acre of Sumithion gave similar results. There is a greater range of population reductions in trials with 0.25 lb./acre of Sumithion which suggests that this is the lower limit of effectiveness. However, Sumithion applied in two 0.125 lb./acre loads in the same day gave excellent results. Population reductions with 0.5 lb./acre of DDT are higher than in recent years and may be due to the fact that blocks 4 and 5 were outside the areas with DDT-resistant budworm populations;

(2) more uniform control and better coverage were obtained where the total dosage was split and applied in two separate loads (blocks 4, 5, 19, 20, and 34);

(3) from the insect control point of view, there appears to be no particular advantage in mixing insecticides, as the results with mixtures are similar to results with single insecticides;

(4) percentage reduction in population is not significantly different between application rates of 0.2 and 0.5 gallons per acre. This means that spray aircraft can carry less water and more insecticide, thus spending more time spraying and less time ferrying insecticide;

(5) no significant difference in average population reduction was detected between blocks treated with coarse and fine sprays, but fine sprays gave a more uniform coverage and more uniform control;

(6) the relationship between timing of spray application and control in 1968 is not well defined, but the trend is similar to that in 1967 when there was a definite relationship between insect control and timing of application. The optimum spray periods appear to be between the 3rd and 4th instars and at the peak of the 5th larval instar;

(7) the results with Phosphamidon were poor and do not compare with past results. At present there seems to be no logical explanation for this phenomenon;

(8) population reductions with Fenitrothion were low but this was due to the fact that budworm development at the time of spraying was at the peak of the 6th instar;

(9) the three-plane formation devised by Forest Protection Limited worked well, particularly when applying 0.2 gallons per acre. This means more spray time and less ferry time.

Current Defoliation by Spruce Budworm in 1968

An aerial survey of defoliation was conducted. Forest Protection Limited acted as co-ordinator, provided aircraft, and some of the observers. Other observers were from the Canada Department of Forestry and Rural Development, and Consolidated Bathurst Ltd. Parts of the Province were resurveyed by the Forest Insect and Disease Survey. The resultant map (Figure 5) shows sizeable areas of severe, moderate, and light defoliation in the central, south-central, and Fundy Coast areas of New Brunswick. Scattered patches of defoliation were mapped between these areas. Altogether 197,000 acres of severe defoliation, 766,000 acres of moderate defoliation, and 359,000 acres of light defoliation were mapped. Also, one very small patch of trace defoliation was recorded west of Horne's Gulch in Restigouche County. This is a considerable increase from 1967 when only 12,000 acres of severe defoliation, 48,000 of moderate, and 202,000 of light were recorded primarily in the Nashwaak River and Miramichi River drainages.

Within the sprayed area 14,000 acres were severely defoliated, 108,000 acres moderately defoliated, and 101,000 acres lightly defoliated. The nature and extent of defoliation by county and for the sprayed area are shown in Table 3.

Severe defoliation was found along the Little Sevogle River north of Redbank, at Strathadam west of Newcastle, east of Gray Rapids, near Millerton, at Parks Brook, in the lower parts of the North Renous River Valley, between the South Renous and Dungarvon Rivers, at the west end of the Bartholomew River Valley, near Todd Mountain, at the upper end of Burnthill Brook, along the McLean Brook Valley, and at McKiel Lake. Farther south severe defoliation of new shoots was reported south of McGivney Junction, in the Napadogan Brook Valley, and in an area bounded by Cross Creek, Stanley, and the South Tay River. Scattered patches of severe defoliation were noted in the Little River-Bear Brook area of Sunbury County, and in the Pangburn, Redbank, Bronson Settlement, and Cambridge areas of Queens County. Still farther south a wide band of moderate to severe defoliation was observed from Alma west to Arnold Lake. A small patch of severe defoliation was found at the southern end of the Kingston Peninsula.

Spruce Budworm Egg-Mass Infestation in 1968 and Hazard for 1969

Egg-mass Infestations - The annual egg-mass survey, based on sequential counts of egg-masses per 100 square feet of mid-crown foliage from balsam fir trees, included 1,219 locations. The areas of very severe infestation increased from 605 square miles in 1967 to 3,580 square miles in 1968 (Table 4). Moderate to severe infestations adjacent to the areas of very high populations covered 3,660 square miles. In contrast to 1966 and 1967 the very severe infestations are evenly distributed. Some of the highest counts in recent years were obtained in 1968, with 50 points having counts of 1,000+ egg-masses per 100 square feet of foliage. Five general areas where egg-mass numbers are highest (over 399 per 100 square feet of foliage) include:

(1) 1,529,000 acres over much of the Sevogle, Little Southwest Miramichi; Main Southwest Miramichi, Cains, and Nashwaak River watersheds where egg-mass numbers average 713;

(2) about 397,000 acres around Grand and Washademoak lakes, average 527 egg-masses;

(3) 73,000 acres in five patches south of Fredericton and west of the Saint John River, average 449 egg-masses;

(4) two areas on the Kingston Peninsula totaling 81,700 acres, average 556 egg-masses;

(5) 167,000 acres along the Bay of Fundy coast, including Fundy National Park, average 784 egg-masses.

In addition, five large areas where moderate to severe defoliation is expected in 1969 are:

(1) 245,000 acres in the Northwest Miramichi River Watershed;

(2) 101,000 acres between the headwaters of Burnthill Brook and Nashwaak and Miramichi lakes;

(3) 365,000 acres between Doaktown and Chipman;

(4) 387,000 acres in southeast Queens County and northeast Kings County;

(5) 96,000 acres between Fredericton and Grand Lake.

It should be noted that the distribution of the severely infested sample points and the general configuration of the severely infested areas suggests that the population is uniformly distributed over the areas described (Figure 6). An egg-mass density index* for severely infested areas shows a marked rise from 1967. The indices for the past 7 years are:

1962	1963	1964	1965	1966	1967	1968
347	320	332	457	282	358	493

The higher index in 1968 suggests that defoliation in 1969 will probably be much more extensive than in 1968.

---

* Egg-mass density index

$$\frac{\sum_{\substack{\text{Of each high}\\ \text{egg-mass}\\ \text{density unit}}} (\text{Av. No. egg-masses/100 sq. ft. of foliage X acres infested per unit})}{\text{Total acres of high egg-mass infestation}}$$

Populations in northern New Brunswick remain low; however, there is a marked increase in the number of positive egg-mass points in Gloucester, Restigouche, and Madawaska counties (Tables 5 and 6), and a significant northward extension of the northern boundary of the infestation, particularly in Gloucester and northeast Northumberland counties (Figure 6).

The average egg-mass density in the sprayed area increased only slightly from 1967 (Table 5).

There was a substantial increase in egg-mass density in the southeast from 69 to 261 egg-masses per 100 square feet of foliage, and an increase in the percentage of positive points from 8 to 67 in the southwest (Tables 5 and 6, Figures 1 and 6).

This general increase in budworm population and infestation was due to:

(1) favourable weather during larval development;

(2) an abundant food supply;

(3) excellent weather conditions at the peak of moth activity which resulted in mass moth migrations.

Large moth flights in July were reported at Newcastle, Doaktown, Stanley, Fredericton, Fundy National Park, and Martin Head in New Brunswick, and at Cape D'Or on the Chignecto Peninsula in Nova Scotia.

<u>Hazard</u> - Observations of current and previous defoliation and crown recovery for hazard ratings were made at each egg-mass sampling location. Of the 1,219 hazard ratings, 27 were very high and 168 were high; a great increase from 1967 when only 22 high hazard points were noted. Most of these points are located in the large egg-mass infestation areas of central New Brunswick (Figure 6), in and west of Fundy National Park, and just east of Grand Lake. The results of this damage survey, the 1968 egg-mass infestation map, the aerial survey defoliation maps for 1967 and 1968, and personal observations were used to delineate areas of:

(1) very high hazard where tree mortality is expected in 1969;

(2) high hazard where bare tops and top killing are now evident and more is expected in 1969;

(3) moderate hazard where loss in growth increment is imminent (Figure 7).

Of these three hazard categories, there are approximately 82,000 acres of very high hazard, 194,000 acres of high, and 710,000 of moderate. Most of the very high and high hazard areas are dispersed throughout the Nashwaak River and Miramichi River drainages (Figure 7). Other areas of high hazard are in and around Fundy National Park, and east of Grand Lake. It is of interest to note that these high hazard patches are located in the main budworm infestation areas where populations are uniformly very high.

A tentative estimate by Forest Protection Limited for aerial spraying in 1969 includes an area of approximately 2.4 million acres enclosed by the dotted lines in Figure 7. Most of the areas of high and very high hazard, and a large portion of the areas of very high egg-mass infestation are included inside the proposed spray outline. If this forest is left untreated in 1969, and the current trend in budworm population continues, the result could be a very high hazard condition in 1970 over extensive areas.

Two other factors that might seriously aggravate this situation are:

(1) the drought experienced over much of New Brunswick in 1968 could adversely affect the quantity and quality of foliage produced in 1969;

(2) there is a chance that there will be an abundant crop of flowers on balsam fir in 1969. If so most nutrients normally intended for foliage production would be diverted to flower production and conditions for larval development and survival will be particularly favorable.

Taking all these factors into consideration, the hazard estimates for 1969 may well be conservative.

Table 1. Acreages Sprayed in 1968

Insecticide	Acres (approximately)			Total
	One application	Two applications		
DDT				
Original plan	-	18,000		
Added to plan	135,000	3,000		
			Sub-total	156,000
Sumithion				
Original plan	144,000	18,000		
Added to plan	36,500	9,000		
			Sub-total	198,500
Phosphamidon				
Original plan	18,000	-		
Added to plan	18,000	-		
			Sub-total	36,000
Sumithion + Phosphamidon				
Original plan	54,000	-		
Added to plan	-	-		
			Sub-total	54,000
Sumithion + DDT				
Original plan	-	-		
Added to plan	9,000	18,000		
			Sub-total	27,000
Fenitrothion				
Original plan	-	-		
Added to plan	9,000	-		
			Sub-total	9,000
			Total	480,500

Table 2.

Treatments Assessed for Percentage Reduction in Survival or Population

Block Number	Insecticide	Dosage lb./acre	Application rate gal./acre	Calibration	Date sprayed June
4	DDT	0.25x2	0.5	coarse	8-17
5	DDT	0.25x2	0.5	coarse	10-17
43	DDT	0.375	0.375	fine	25
42	DDT	0.1875	0.375	fine	24
35	DDT	0.1875	0.375	fine	26
C	DDT	0.125	0.25	coarse	17
16	Sumithion	0.5	0.5	coarse	5
28	"	0.5	0.2	fine	4
9	"	0.5	0.2	fine	16
20	"	0.25x2	0.2	fine	16
19	"	0.25x2	0.2	fine	7
6	"	0.375	0.2	coarse	16
7	"	0.375	0.2	fine	6
29	"	0.375	0.2	fine	9
15	"	0.25	0.2	fine	11
21	"	0.25	0.2	fine	7
24	"	0.25	0.2	coarse	9
23	"	0.25	0.2	coarse	9
34	"	0.125x2	0.2	fine	23
39	"	0.25	0.2	fine	23
31	"	0.125	0.2	fine	14
30	Fenitrothion	0.25	0.2	fine	16
2	Phosphamidon	0.375	0.5	coarse	11
25	"	0.375	0.2	fine	7
32	"	0.125	0.2	fine	16
3	Sum. + Phos.	0.25S + 0.125P	0.2	fine	11
1	Sum. + Phos.	0.125S + 0.25P	0.2	fine	11
33	DDT + Sum.	0.10 DDT + 0.125S	0.2	fine	22
37	DDT + Sum.	0.10 DDT + 0.125S	0.2	fine	23

Larval development at time of spraying - as a % Instars					% reduction in survival or population due to spraying*	
II	III	IV	V	VI	Fir	Spruce
	1	25	42	32	95	77
	1	25	42	32	82	56
		5	85	10	81*	67*
			83	17	100*	100*
		2	10	88	55*	51*
	1	25	42	32	75*	78*
	7	68	25		88	78
4	39	57			86	70
		90	10		86	84
	1	32	41	26	87	85
	27	73			95	98
	1	20	50	29	96	76
8	47	42	3		77	69
	15	82	3		93	76
4	59	33	4		75	58
11	7	82			82	60
8	35	57			83*	40*
8	35	57			79*	55*
		10	80	10	100	94
		10	80	10	100*	100*
		4	65	31	56*	48*
		5	40	55	53	42
10	75	15			60	33
2	5	69	24		49	33
	1	41	32	26	47*	81*
10	75	15			76	55
10	75	15			84	73
		10	80	10	68*	66*
		10	80	10	90	82

* % reduction in population, calculated for block with only post-spray data.

Table 3. Spruce Budworm Defoliation by Counties

County	Number of Acres Defoliated Current Defoliation Category Light	Moderate	Severe
Saint John	10,000	17,000	7,000
Albert	16,000	8,000	6,000
Kings	12,000	6,000	6,000
Queens	23,000	17,000	6,900
Sunbury	13,000	36,000	2,900
York	86,900	240,000	81,600
Carleton	20,900	32,800	15,900
Victoria	6,000	16,900	3,000
Kent	2,000	5,900	-
Westmorland	4,000	1,000	-
Northumberland	165,200	385,400	67,700
*Totals	359,000	766,000	197,000
Within Sprayed Area	101,000	108,000	14,000

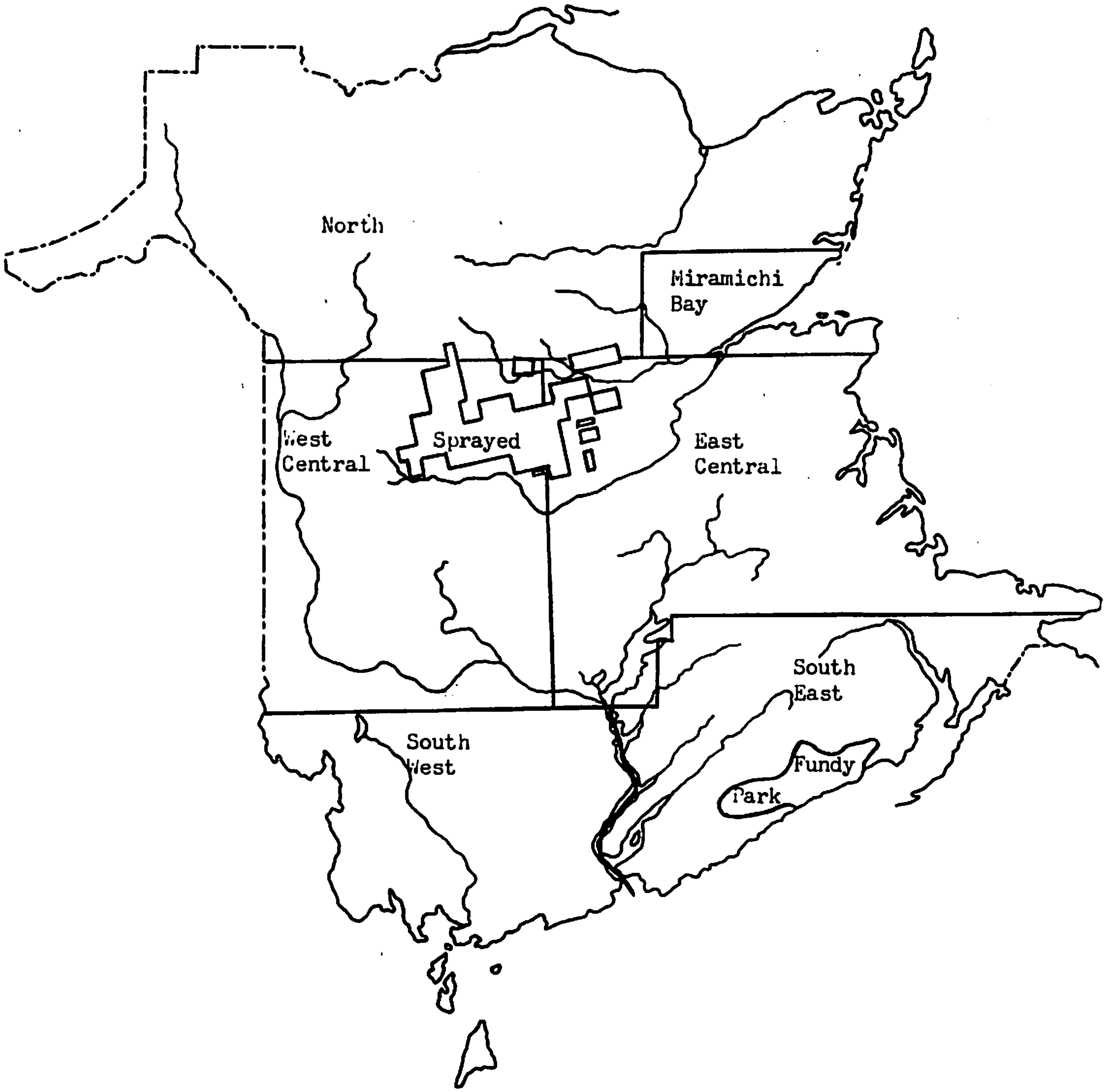
*Total acreage defoliated = 1,321,100

Table 4

Egg-mass Infestations by Density Classes in Square Miles*, 1960-1968

Egg Density (E.M./100 sq. ft. foliage)	1960	1961	1962	1963	1964	1965	1966	1967	1968
400 +	2,293	301	403	1,494	1,200	1,730	1,068	605	3,580
up to 399	767	705	95	528	1,496	656	1,040	694	2,041
up to 274	159	319	82	411	12	2,584	127	313	339
Sub-total	3,219	1,325	580	2,433	2,708	4,960	2,235	1,612	5,960
up to 174	346	981	276	266	508	1,220	583	831	1,281
Total	3,565	2,306	856	2,699	3,216	6,180	2,818	2,443	7,241
up to 99	1,203	886	824	1,270	1,636	2,919	2,168	1,491	2,337
up to 49	3,573	4,701	3,446	3,660	5,192	4,206	5,473	5,288	6,340
Total	4,776	5,587	4,270	4,930	6,828	7,125	7,641	6,779	8,677
Nil	19,408	19,597	21,933	20,120	17,704	14,445	17,291	18,528	11,842
unsampled	-	259	690	-	-	-	-	-	-

* Land area of New Brunswick is estimated to be 27,750 square miles.



North
Miramichi
Bay
West
Central
Sprayed
East
Central
South
East
South
West
Fundy
Park

See Table 5

Table 5

Trends in Spruce Budworm Populations by Area, 1964-1968 (Number of Sample Points in Brackets)

	Ave. No. Egg-masses/100 sq. ft. Foliage					Ratios of No. Egg-masses			
	1964	1965	1966	1967	1968	65/64	66/65	67/66	68/67
Sprayed in 1968	279 (56)	125 (53)	118 (76)	226 (76)	286 (76)	0.45	0.94	1.92	1.27
Unsprayed in 1968									
Central N.B.- East	189 (206)	271 (242)	150 (267)	120 (271)	418 (276)	1.43	0.55	0.80	3.48
- West	134 (288)	77 (281)	77 (281)	74 (310)	297 (324)	0.57	0.73	1.32	4.01
Northern N.B.	1 (177)	3 (175)	2 (181)	7 (189)	16 (208)	3.00	0.67	3.50	2.28
Miramichi Bay	45 (37)	44 (43)	27 (44)	55 (48)	181 (49)	0.98	0.61	2.04	3.29
South - East	68 (60)	148 (89)	64 (117)	69 (114)	261 (122)	2.18	0.43	1.08	3.78
- West	8 (57)	12 (65)	20 (73)	11 (66)	85 (70)	1.50	1.75	0.52	7.73
Fundy Park	4 (10)	32 (10)	130 (18)	270 (32)	663 (36)	8.00	4.06	2.08	2.45

Table 6

Trends in Spruce Budworm Egg-mass Populations in Eight Counties Outside the Main Infestation, 1960-1968

County	% Positive Samples								
	1960	1961	1962	1963	1964	1965	1966	1967	1968
Madawaska	15	10	0	4	0	11	7	17	23
Restigouche	8	11	5	1	3	3	3	10	16
Gloucester	42	13	12	4	11	14	18	28	52
Kent	98	95	58	59	68	85	71	74	97
Westmorland	28	20	0	14	60	72	76	71	100
Kings	14	7	13	12	50	53	46	39	98
Saint John	28	12	0	38	33	25	36	50	87
Charlotte	11	0	0	0	10	8	0	8	67

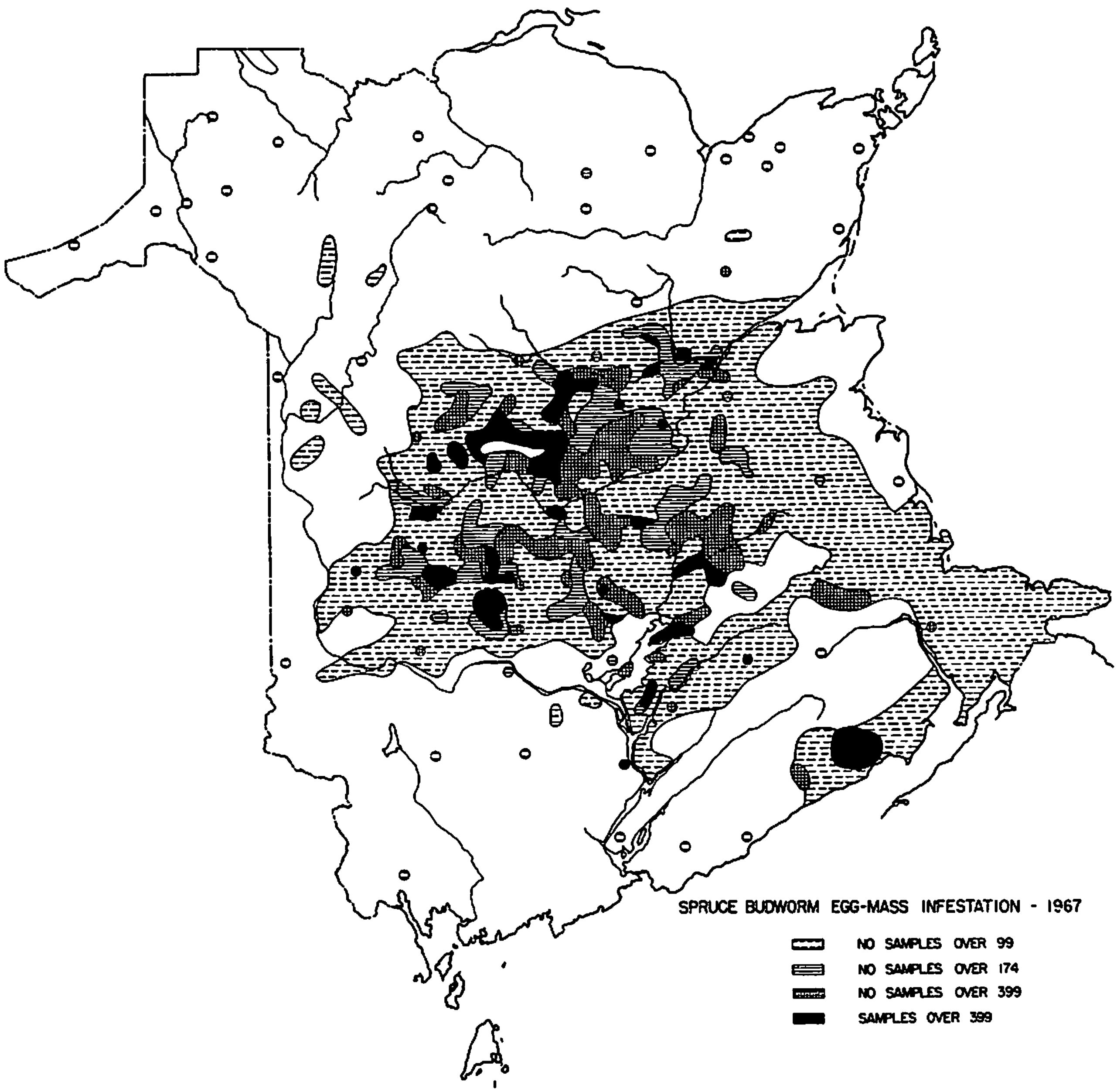
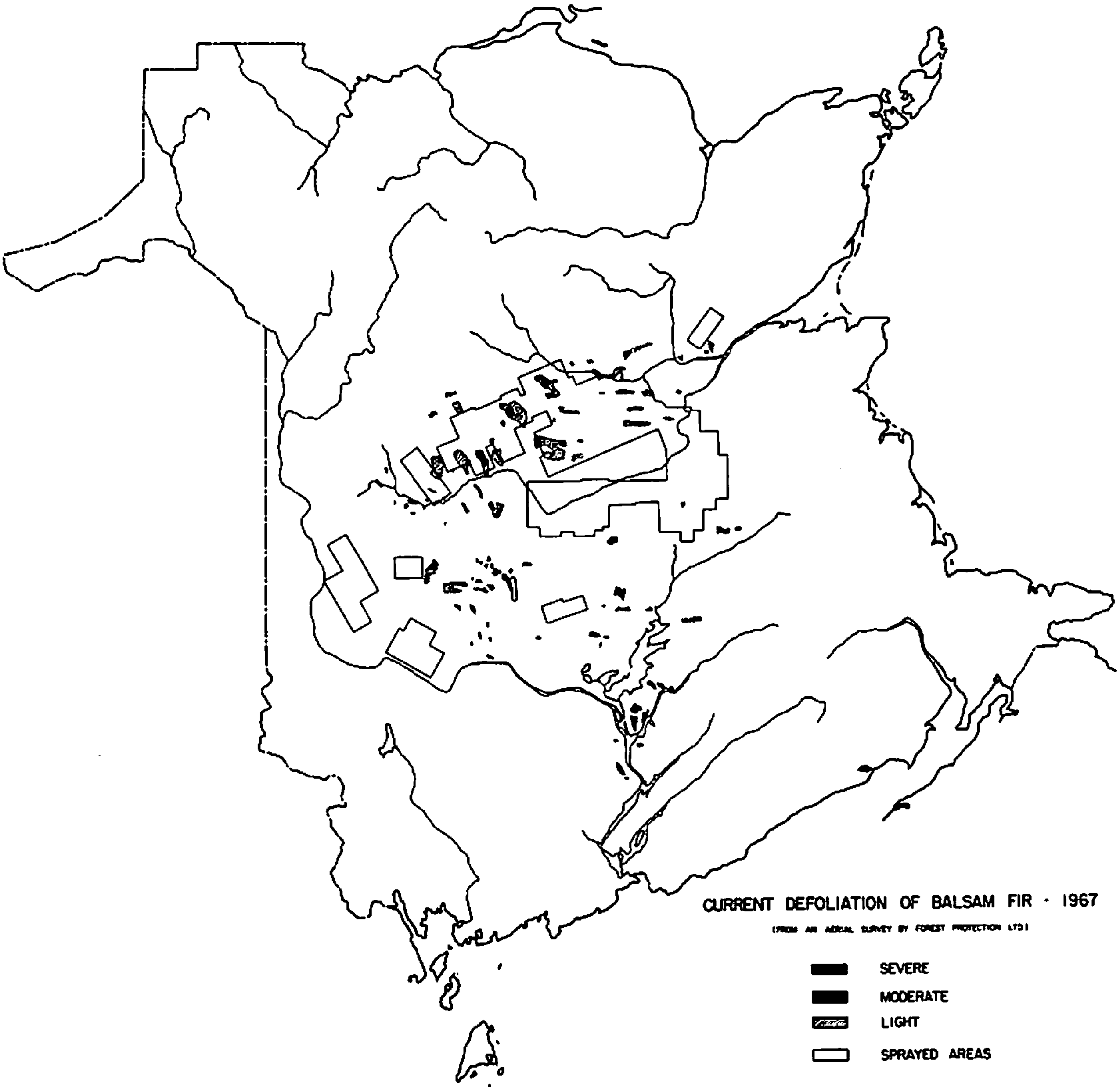
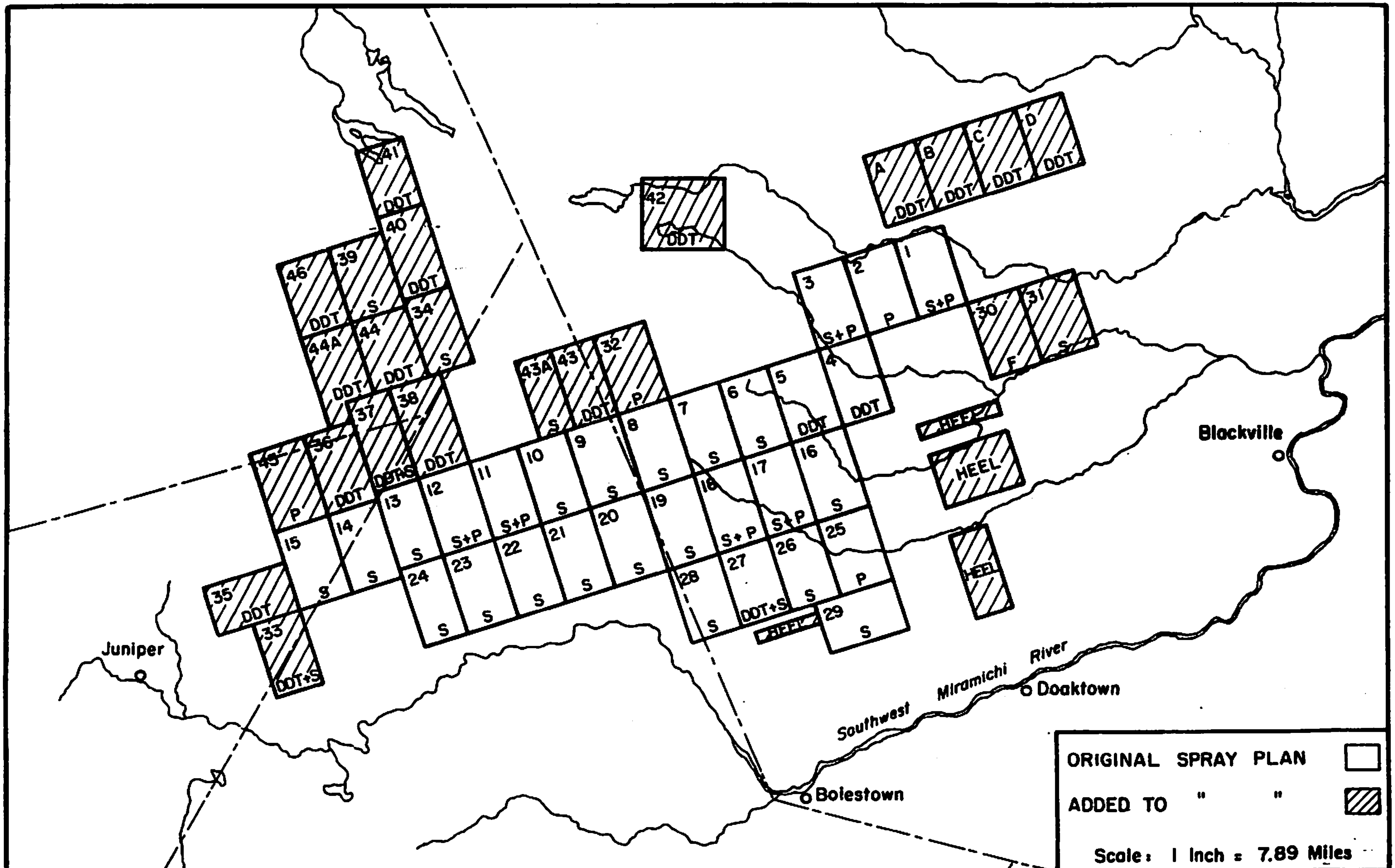

SPRUCE BUDWORM EGG-MASS INFESTATION - 1967
NO SAMPLES OVER 99
NO SAMPLES OVER 174
NO SAMPLES OVER 399
SAMPLES OVER 399

FIGURE 1



CURRENT DEFOLIATION OF BALSAM FIR - 1967
SEVERE
MODERATE
LIGHT
SPRAYED AREAS

FIGURE 2


Juniper
Blackville
Doaktown
Boiestown
Southwest Miramichi River
HEEL
ORIGINAL SPRAY PLAN
ADDED TO " "
Scale: 1 Inch = 7.89 Miles

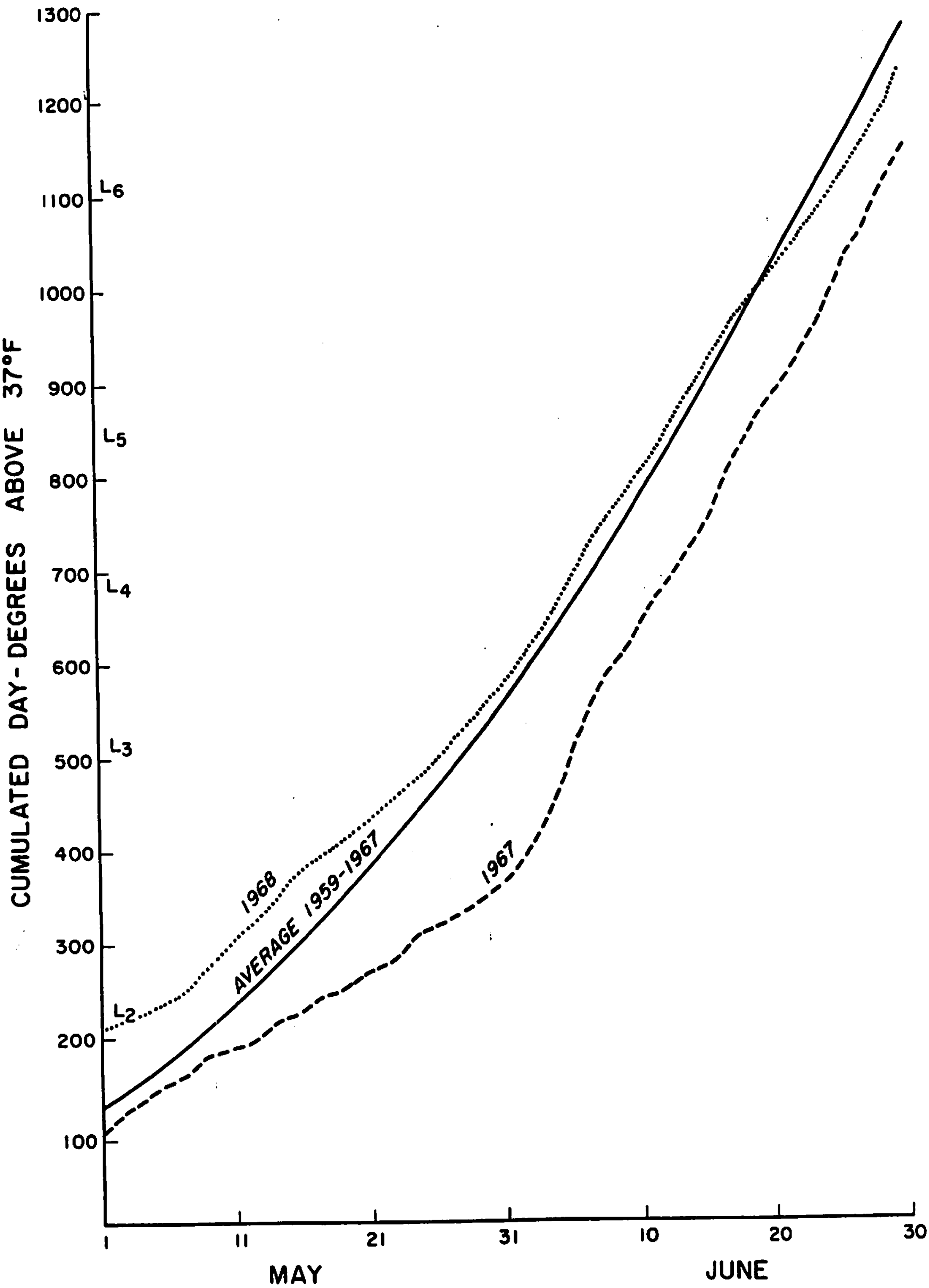

CUMULATED DAY-DEGREES ABOVE 37°F
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
L6
L5
L4
L3
L2
1968
AVERAGE 1959-1967
1967
1
11
21
31
10
20
30
MAY
JUNE

FIGURE 4

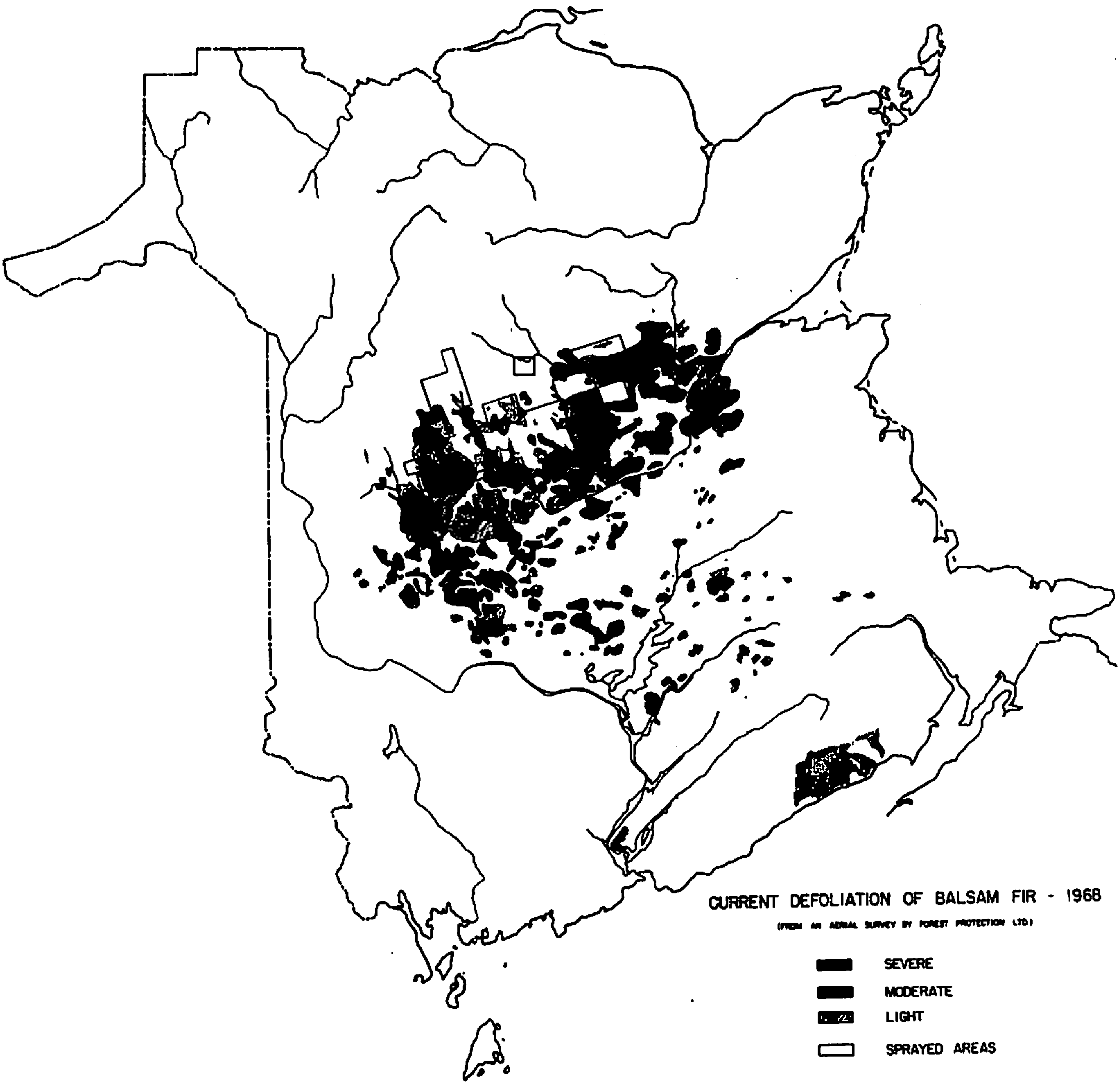

CURRENT DEFOLIATION OF BALSAM FIR - 1968
(FROM AN AERIAL SURVEY BY FOREST PROTECTION LTD)
SEVERE
MODERATE
LIGHT
SPRAYED AREAS

FIGURE 5

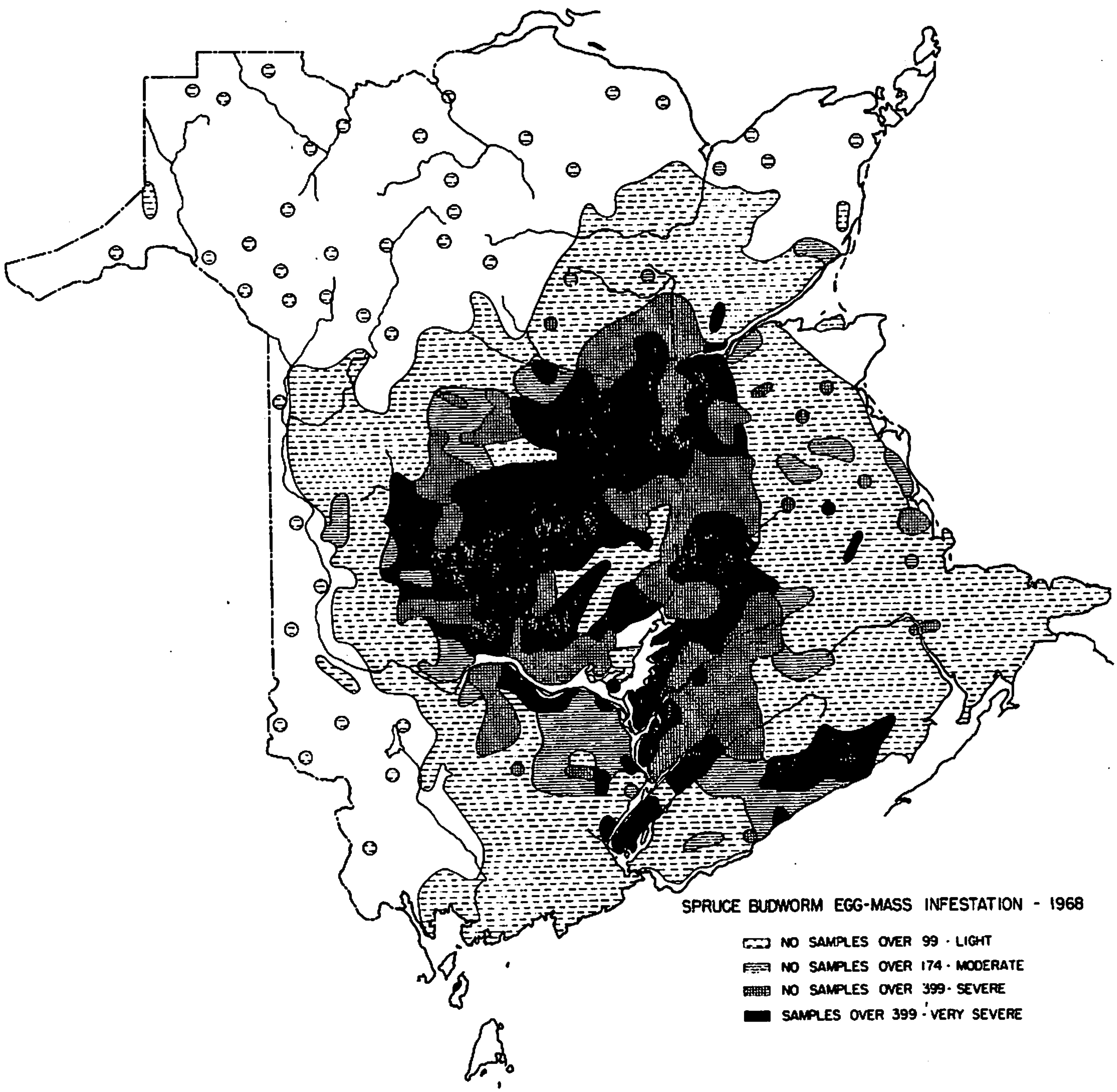

SPRUCE BUDWORM EGG-MASS INFESTATION - 1968
NO SAMPLES OVER 99 · LIGHT
NO SAMPLES OVER 174 · MODERATE
NO SAMPLES OVER 399 · SEVERE
SAMPLES OVER 399 · VERY SEVERE

FIGURE 6

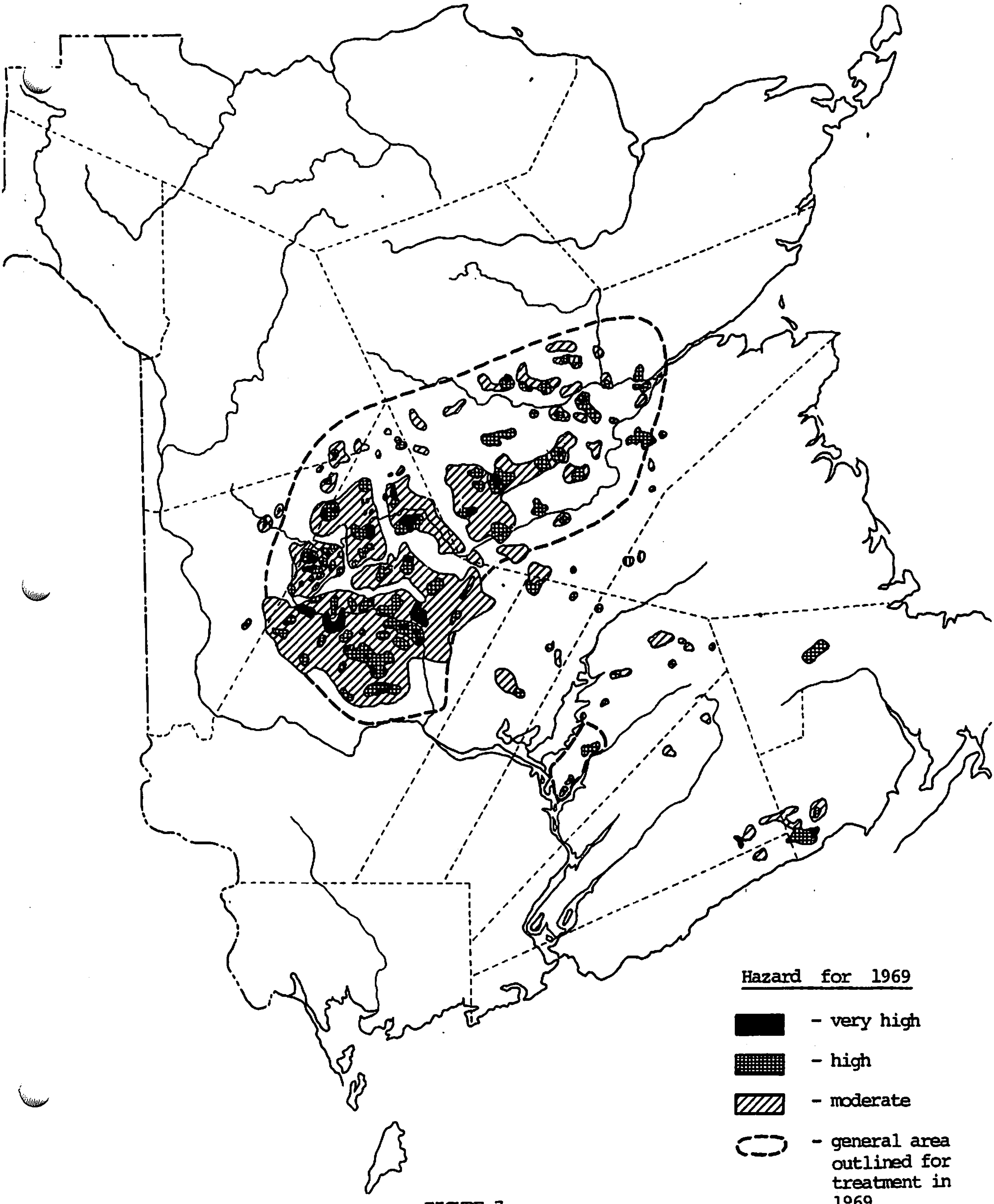

Hazard for 1969
- very high
- high
- moderate
- general area outlined for treatment in 1969

FIGURE 7

INTRODUCTION

The 1968 aerial spraying operation was the sixteenth to protect the forests of New Brunswick from the spruce budworm. This report assesses the operational-experimental program and forecasts spruce budworm conditions for 1969. Analyses of the data are still underway, and although conclusions in the report are thought to be valid they are subject to change.

It is a pleasure to acknowledge the help of N. R. Brown and R. W. Nash who were engaged by Forest Protection Limited to assist with pre-spray surveys and the timing of spray applications.

Assessment of the 1968 Aerial Spraying Program

Surveys for egg-mass infestations in 1967 showed that 605 square miles were severely infested and that 1,838 square miles were moderately infested (Figure 1). In 1967, New Brunswick's coniferous forests received little budworm defoliation (Figure 2) in relation to previous years and in general appeared to be in good condition. However, some areas with high egg-mass populations in 1967 were in poor condition. The spray plan developed for 1968 included approximately 300,000 acres in the basic plan. Provision was made for adding areas to the plan if larval surveys in the spring of 1968 detected high populations along the northern boundary of the infestation. This provision has been made for the past few years as there has often been considerable dispersal of young larvae from severely infested stands to those thought to be lightly infested.

The 1968 spray operation had a two-fold purpose: (1) to protect forests in relatively poor condition and with high insect populations; and (2) to provide as much information as possible on DDT, Sumithion, Phosphamidon, and mixtures of them applied at various dosages, application rates, calibrations, stages of larval development, and times of day using three T.B.M. aircraft in formation. Twenty-nine 9,000-acre blocks in the original plan were assigned treatments by representatives of Forest Protection Limited, the Canadian Wildlife Service, the Canada Department of Fisheries, and the Canada Department of Forestry and Rural Development.

The areas sprayed, except for two small spray blocks at Dubec in Kings County and at Fundy National Park, are shown in Figure 3. Spray block numbers and insecticides (DDT, S - Sumithion, P - Phosphamidon, F - Fenitrothion) used are indicated in Figure 3. As in recent years, river banks along salmon-producing streams located in DDT blocks were sprayed with an organophosphorus insecticide. "Heel" blocks were sprayed with insecticides left-over from small batches formulated for numbered blocks. The number of acres sprayed with each insecticide is listed in Table 1.

Appendix 7

FOREST PROTECTION LIMITED

1968 SPRAY OPERATIONS

B.W. (signature)

B.W.FLIEGER/jm

November 19, 1968

50 Years Ago

North Shore Leader—1918

Budworm

The spruce budworm, which is killing the spruce trees, and in some cases fir and hemlock, in several counties, is now in its fifth year in some parts. The insect spread from Ontario to Quebec and became widespread in New Brunswick in 1914, with balsam fir the chief victim.

Col. H. F. McLeod MP travelled the 60 miles from Half Moon Cove to Boiestown by canoe and said he saw no more than a dozen live spruce. He fears for the great forest assets of the province if something is not done to combat the spruce budworm.

CONTENTS PAGE

INTRODUCTION

The Company took part in forest spraying ventures in three Provinces of Canada in 1968, and can now claim more than a nodding acquaintance with budworms, sawflies and loopers as well as with the investigators who adorn the scene whenever these insects become real pests.

In the following pages there is no mention of the contributions of aircraft people, purveyors of poisons and of petrol pipes and peanut butter. But of course all these take their place and are covered by the word "Company" which in addition to being a body corporate represents all and sundry when at work.

NEWFOUNDLAND

In January last the Company agreed to act as agent for the Province of Newfoundland and Labrador in preparation for forest spraying in July directed against the Hemlock Looper and located mainly in the forest of the western part of the Island.

It was soon decided that operations would base at Harmon field. C.C.R.I. suggested that the looper could be controlled by using 1/4 pound total dose of organo phosphate insecticide in either one or two applications. The Company took steps to procure on behalf of the Province enough Fenitrothion (110,029 lbs.) and Phosphamidon (25,397 lbs.) to spray over 500,000 acres, which was roughly the area requiring attention as of last winter and spring. It was decided to use T.B.M. sprayer aircraft and guide these with Cessna 180 type aircraft. The necessary number of aircraft were placed under contract and arrangements made for fuel supply. The Company provided necessary tanks for mixing and storing liquids and the various pieces of aircraft loading equipment fuel and insecticide. Some items were provided by the Province one of which was accommodation and board for project personnel in Stephenville. This worked better for the town than for the project. There is nothing to equal a camp where all are easily available especially early in the morning.

The spray plan was based on the best information available at the time, some of which turned out to be poor stuff to plan on. By the time the Company moved into Harmon field in early July new information on the pest was beginning to accumulate. By July 12 the 500,000 plus acre plan had shrunk to about 240,000 acres and still going down when areas were being added and soon the total for spraying was on the way up again. Even Company personnel hardened to the unpredictable nature of spruce budworm behaviour were disconcerted by the rapidly changing situation.

Spraying began July 7th and continued to July 24th with less than 400,000 acres treated. The flying drill used in the flatter part of New Brunswick was changed along the West Coast where the land comes down suddenly to the sea and there are many steep narrow stream valleys stretching inland up to the 2,000 ft. plateau. It was necessary in many instances to lead the sprayers in the two or three plane formations with one guide Cessna while the other half of the guide system sat above and monitored the work.

Aircraft were back on the mainland on July 24th when a frantic call came to return to Gander to spray areas which for the first time were discovered to be in a heavily infested condition. One formation of three sprayers and one unit of the guidance system turned back from Fredericton to Gander and by their arrival time the Company had moved gear from Harmon to Gander by road and was ready to resume.

An additional 150,000 acres were sprayed from the new base between July 27th and Aug. 2. Due to the lateness of the season this was all single applications of 1/4 lb./ac. dosage. Insecticide stocks were practically exhausted. And so it went - not much as planned in the winter but perhaps not too badly all things considered.

This project had two novel twists. It turned out to be (a) the first time F.P.Ltd. took part in a distinctly two phase spray project and, (b) the first time in Company experience that the sprayers ran out of gas. The project was in charge of B.A. McDougall for F.P.Ltd.

The Company is grateful to Bowaters, Nfld., for seconding Stu Weldon to the New Brunswick program and to the looper project where he proved most helpful at Harmon field.

NEWFOUNDLAND LOOPER SPRAY
LOG

FROM HARMON FIELD, STEPHENVILLE U.S.G./LOAD-660					
DATE	A M	P M	LOADS	GALLONS	ACREAGE (THEORETICAL) AT APPLIC. RATE 0.2 G.P.A.C.
July 7	x		6	3,960	19,800
9	x		22	14,520	72,600
		x	8	5,280	26,400
10	x		17	11,220	56,100
11		x	10	6,600	33,000
12	x		18	11,880	59,400
14	x		18	11,880	59,400
		x	6	3,960	19,800
15	x		24	15,840	79,200
		x	12	7,920	39,600
16	x		2	1,320	6,600
18		x	8	5,280	26,400
19	x		12	7,920	39,600
21	x		15	9,900	49,500
22		x	7	4,620	23,100
23	x		14	9,240	46,200
24	x		11	7,260	36,300
14 out of 18	11	6	210	138,600 G.	693,000 ac.
FROM GANDER AIRPORT / LOAD -600					
July 27		x	6	3,600	18,000
29		x	3	1,800	9,000
30	x		8	4,800	24,000
31		x	6	3,600	18,000
Aug. 1	x		6	3,600	18,000
		x	3	1,800	9,000
2		x	8	4,800	24,000
3	x		9	5,400	27,000
7 out of 8	3	5	49	29,400 G.	147,000 ac.

For information mixing insecticide see Appendix I.

For detail on aircraft calibration see Appendix II.

The above log does not tell the full story. Interspersed in the loads from Harmon are 20 (1,320 gallons) which were delivered as single applications to great distances and in which the formulation was the strength of two light applications (i.e. 1/4 lb./ac. dosage). In addition the entire formulation at Gander was of the same kind for single application late in the insect development.

One way to compare material used with material purchased is to list gallons in terms of acres sprayed at 1/4 lb. per acre using only 0.2 gallons of spray.

From Harmon	138,600 gallons		
Less 20 Loads	- 13,200		
	125,400 + 2 =	62,700	gallons @ 1/4 lb. dosage
		13,200	"
		75,900	"
From Gander		29,400	"
Total Gallons		105,300	"

Total acres sprayed at 1/4 lb./ac. in 0.2 U.S.G./ac. and equivalent to what was actually done is 105300 x 5$^{ac.}$ to the gallon. or 526,500 acres.

Whereas materials purchased, had they been used according to theory, would have been sufficient for - 541,704 acres.

Difference is 2.9%.

NEW BRUNSWICK

This year the spray programme was double barreled consisting of (a) the most comprehensive series of trials on an operational scale in the Company experience,undertaken to find out how better to use insecticides especially Fenitrothion. At the finish this part of the programme extended to over 340,000 acres. And (b) a monitoring of the northern perimeter of the area of insect activity and the treating of some 135,000 acres because of higher insect populations than were expected. This part of the forest was sprayed with light doses of D.D.T. and often with much finer divided spray than formerly used ,apparently with some good results. (c) a small but substantial part of the total area sprayed was treated with mixtures of formulations of Fenitrothion and Phosphamidon which were extra to the requirements of the trials in (a) and which accumulated because of the nature of the mixing system which locked in piping valves and meters at shut-off about 225 U.S. gallons which had to be purged from the system each time the formulation changed before aircraft could be loaded with the current prescribed formulation. These "heels" were sprayed on some 22,000 acres as well as salmon stream borders in D.D.T. treated blocks.

The Company bought - (mainly for the trials program)

1. Fenitrothion

(a) Cyanamid of Canada	Accothion	50,053 lbs.
(b) P. Leiner & Sons	Novathion	40,233 lbs.
(c) C.I.B.A. Canada Ltd.	Fenitrothion	2,200 lbs.
Total		92,200 lbs.

2. Phosphamidon

C.I.B.A. Canada Ltd.	24,200 lbs.
3. D.D.T. Diamond Alkali	40,000 lbs.
1967 Inventory approx.	6,000 lbs.

The project used:-

1. Fenitrothion	
(a) Trials	84,450 lbs.
(b) Heels	7,770 lbs.
Total	92,220 lbs.
2. Phosphamidon	
(a) Trials	19,125 lbs.
(b) Heels	1,750 lbs.
(c) Malfunction of equip.	3,375 lbs.
Total	24,250 lbs.
3. D.D.T.	
Trials	15,975 lbs.
Northern perimeter ops.	30,000 lbs.
Total	45,975 lbs.

There is no insecticide in inventory at this time.

Logs of trials and of D.D.T. operations are shown separately.

Trial blocks were 9,000 ac. in size approx. by agreement. This is the area which is covered in one sortie by a 3 plane formation of T.B.M. aircraft loaded at 600 U.S. gallons each and applying 0.20 U.S. gallons of spray/acre. This block size suited C.W.S.

FOREST PROTECTION LIMITED 1968 SPRAY PROJECT TEST AREAS

Blocks are approx. 9,000 acres in size

Date Sprayed	A.M.	P.M.	Map Block No. All Users	Prescription
June 4		x	28	Sumithion 0.5 lb/ac. in 0.2 gal. fine, early.
5	x		16	Sumithion 0.5 lb/ac. in 0.5 gal. coarse, early.
6	x		7	Sumithion 0.375 lb/ac. in 0.2 gal. fine, early.
7	x		25	Phosphamidon 0.375 lb/ac. in 0.2 fine.
	x		19	Sumithion 0.25 lb/ac. in 0.2 gal. 2x fine.
	x		21	Sumithion 0.25 lb/ac. in 0.2 gal. fine.
8	x		4	DDT 0.25 lb/ac. in 0.5 gal. coarse.
	x		22	Sumithion 0.5 lb/ac. in 0.2 gal. fine.
	x		8	Sumithion 0.375 lb/ac. in 0.2 gal. fine.
		x	12	Sumithion 0.125 lb/ac. plus Phosphamidon 0.125 lb/ac. in 0.2 gal. fine.
		x	13	Sumithion 0.25 lb/ac. in 0.2 gal. coarse.
		x	11	Sumithion 0.125 lb/ac. plus Phosphamidon 0.125 lb/ac. in 0.2 gal. fine.
9	x		29	Sumithion 0.375 lb/ac. in 0.2 gal. fine.
	x		17	Sumithion 0.125 lb/ac. plus Phosphamidon 0.250 lb/ac. in 0.2 gal. fine.
	x		18	Sumithion 0.250 lb/ac. plus Phosphamidon 0.125 lb/ac. in 0.2 gal. fine.
	x		24	Sumithion 0.25 lb/ac. in 0.2 gal.coarse.
	x		23	Sumithion 0.25 lb/ac. in 0.2 gal. coarse.
10	x		27	DDT 0.1875 plus Sumithion 0.125 lb/ac. in 0.2 gal. - 2x coarse.
	x		5	DDT 0.25 lb/ac. in 0.5 gal. coarse.

Date Sprayed	A.M.	P.M.	Map Block No. All Users	Prescription
June 11	x		15	Sumithion 0.25 lb/ac. in 0.2 gal. fine.
	x		2	Phosphamidon 0.375 lb/ac. in 0.2 gal. coarse.
	x		3	Phosphamidon 0.125 plus Sumithion 0.25 lb/ac. in 0.2 gal. fine.
	x		1	Phosphamidon 0.25 plus Sumithion 0.125 lb/ac. in 0.2 gal. fine.
14		x	31	Sumithion 0.125 lb/ac. in 0.2 gal. fine.
16	x		30	Fenitrothion 0.25 lb/ac. in 0.2 gal. fine.
	x		26	Sumithion 0.125 lb/ac. in 0.2 gal. fine.
	x		20	Sumithion 0.25 lb/ac. in 0.2 gal. 2x fine.
	x		6	Sumithion 0.375 lb/ac. in 0.2 gal. coarse.
		x	9	Sumithion 0.5 lb/ac. in 0.2 gal. fine.
		x	10	Sumithion 0.5 lb/ac. in 0.2 gal. fine.
		x	32	Phosphamidon 0.125 lb/ac. in 0.2 gal. fine.
17	x		4	DDT 0.25 lb/ac. in 0.5 gal. coarse second application.
	x		5	DDT 0.25 lb/ac. in 0.5 gal. coarse second application.
19	x		14	Sumithion 0.25 lb/ac. in 0.2 gal. extra fine, late.
22	x		33	DDT 0.10 plus Sumithion 0.125 in 0.2 gal. fine 2x.
23	x		37	DDT 0.10 plus Sumithion 0.125 in 0.2 gal. very fine 2x.
	x	x	34	Sumithion 0.125 lb/ac. in 0.2 gal. fine 2x.
		x	39	Sumithion 0.25 lb/ac. in 0.2 gal. fine late.
26	x		43A	Sumithion 0.25 lb/ac. in 0.2 gal. fine.
27	x		45	Phosphamidon 0.25 lb/ac. in 0.2 gal. fine.

D.D.T. OPERATIONS

Date Sprayed	A.M.	P.M.	Map Block No. All Users	Prescription
June 14		x	31A-KCI	DDT 0.125 lb/ac. in 0.25 gal. coarse.
16		x	A	DDT 0.125 lb/ac. in 0.25 gal. coarse.=
17	x		KI-KCI	DDT 0.125 in 0.25 gal. coarse, 2nd app.
	x		B	DDT 0.125 in 0.25 gal. coarse.
	x		C	DDT 0.125 in 0.25 gal. coarse.
	x		D	DDT 0.125 in 0.25 gal. coarse.
23		x	38	DDT 0.1875 lb/ac. in 0.375 gal. fine late.
		x	36	DDT 0.1875 lb/ac. in 0.375 gal. fine late.
24	x		35	DDT 0.1875 lb/ac. in 0.375 gal. fine very late.
	x		40	DDT 0.1875 lb/ac. in 0.375 gal. fine late.
	x		41	DDT 0.1875 lb/ac. in 0.375 gal. fine late.
	x		42	DDT 0.1875 lb/ac. in 0.375 gal. fine late.
25		x	43	DDT .375 lb/ac. in .375 gal. fine.
26	x		35	DDT 0.1875 lb/ac. in 0.375 gal. fine.
	x		44A	DDT 0.375 lb/ac. in 0.375 gal. fine.
	x		44	DDT 0.375 lb/ac. in 0.375 gal. fine.
	x		46	DDT 0.1875 in 0.375 gal. fine.
28	x		42	DDT 0.1875 lb/ac. in 0.375 gal. fine.
	x		42S	DDT 0.1875 lb/ac. in 0.375 gal. fine.

When block size was agreed upon there had been no local testing of the 3 plane flying technique.

After a bit of practice during the calibration days the first trials were flown in this manner and it proved so successful that no attempt was made to go back to the two plane formation (except for non availability of aircraft).

This kind of coverage when it went smoothly assured investigators that there were no day joints in the block and that variation associated with time was eliminated.

No doubt insecticide deposit within blocks was of a high order of uniformity.

For details of mixing formulations see Appendix I and for calibration data see Appendix II.

The program for its size was very complicated because of the almost continuous changeover in formulations, calibration, trial block location, etc. etc. Before any spray action was taken it was necessary to clear with all interested parties. From a trial point of view the operations went fairly well and all work was completed although in the second half the weather was far from ideal.

The Company gained valuable experience in (a) calibration of aircraft, (b) in securing a more complete break-up of spray, (c) in operating three planes (T.B.M.) formations and, (d) in mixing insecticides.

On the chemical side (a) the most important result to come from the trials is the similarity in effect of 0.5 lb. D.D.T. and 0.5, 0.375 and 0.25 lb. dosages of Sumithion and, (b) probably the most unexpected was the failure of Phosphamidon to give results comparable to those of other years.

On the mechanical side the main finding was the effect of aircraft speed on spray break-up. Most of the experimental work of late has been done with slow flying aircraft. It is possible to break up liquids with standard hardware on the T.B.M. so finely that it cannot be recovered on paper (undesirable of course).

The trials confirmed several beliefs:-

(a) two sprays are better than one

(b) dilution of insecticide beyond that necessary is an expense and produces nothing.

(c) timing of spray during larvae development seems to be of some importance.

(d) formations of aircraft give better coverage and should be used whenever it is safe to do so.

The Company is convinced that mixtures of insecticides may still offer worthwhile options in certain places and at certain times in spite of the '68 trial results.

The Company is still confused by the apparent incompatability between results from D.D.T. spraying and the insect resistance trials of past years.

Several years ago the Company said "what the forest protection people need is a short life chemical that will kill enough budworms and not seriously affect fish and wildlife nor foul up the environment - one which could be used at the D.D.T. price or less". The trials of 1968 may have brought us temporarily much closer to filling the need.

ONTARIO

Forest Protection Ltd. was consulted by the Department of Land and Forests early in the year in connection with planning for the spraying of some 250,000 acres of budworm infested forest in the Lakehead region. The Company suggested this take the form of spraying with Stearman aircraft from a flying base to be built in the spring of '68.

An airstrip site was located in the Swallow Lake region and was constructed by Great Lakes Paper Company in May 1968 for immediate use. It is the conventional dirt dual strip with loading stands between the runways. The Company assisted with specifications and on the spot supervision. The strip performed satisfactorily.

During the winter the Company became an agent for the Department and was responsible for dealing with operators of aircraft (sprayer and guide). Eighteen Stearman aircraft were contracted for with General Airspray Ltd. of St. Thomas, Ontario. These were approximately the total available in Canada. Five Cessna 172 aircraft were procured for control flying.

The Company was responsible for providing insecticide mixing equipment,aircraft loading equipment and for the calibration of aircraft.

It assumed responsibility for directing the spraying of the forest which from time to time found its way into the spray plan.

Also the Company provided in "total" the aerial guidance system for controlling spraying which it uses in New Brunswick (planes, pilots, navigators, etc.) and key ground crew persons familiar with Stearman operations.

On the spot Company personnel mixed the insecticide formulations used (see Appendix I.formulations 1968) and kept a record of the flow of materials from the airstrip into aircraft.

Aerial work was directed by a field pilot of experience.

B.A. McDougall was in charge of operations for the Company.

It was expected that the spraying would begin in May but as time went by the record cool spring in the region allowed those preparing for the spraying to slow up.

Spraying began on June 5. Illustrative of the waiting game which sprayers must play at times is the complete blank between the morning of the 5th and the evening of the 12th when 14 potential splash periods went by without a gallon moving. There was rain. This unusual pattern is followed by one just as strange. Between evening 12th and morning 20th spraying took place on 13 out of 16 possible occasions. Withal the weird weather pattern spray weather averaged over 2.5 hrs./day which is not unlike much of the New Brunswick experience.

Fortunately wet and cold keep insect development at minimum and the spray got to the insects in good time.

An application of 6 ozs. Fentrothion/ac. followed by one of 4 ozs. Phosphamidon/ac. was recommended by C.C.R.I. of Canada Department of Forestry.

Lands and Forests purchased 124,802 pounds of Accothion Technical, which is the N.A. distributor's name for Sumithion made by the Sumitomo Chemical Corp. of Osaka, Japan, which is Fenitrothion. Also purchased from C.I.B.A. was 50,255 pounds of Phosphamidon Technical.

At the theoretical C.C.R.I. dosage this should make up when applied at 0.2 U.S.gallons/ac. enough formulation to cover 332,805 acres with Fenitrothion and 201,020 acres with Phosphamidon. As it turned out enough gallons were mixed to cover 348,300 acres with Fenitrothion and 212,625 acres with Phosphamidon. This represents the effect of caution in mixing to be certain not to run out before theoretical coverage is obtained. In short the mix is light by about 5% and the nominal 6 oz. 4 oz. theoretical dosages are now 5-3/4 ozs. and 3-3/4 ozs. This may be reversed by spraying but would require calibration to be on the high side. Actually we do not have a check on actual area sprayed, perhaps Ontario has. The spray map made for the occasion, Scale 1:50000 shows about 375 - 380,000 acres sprayed with Fenitrothion and 230 - 235,000 with Phosphamidon. There is a substantial area of water which must be subtracted to get approx. acreage covered but these rough figures are in line with gallonages mixed and with purchases of active ingredient.

See Appendix II. Calibration for calibration data.

See Appendix I. . Formulations for insecticide data.

Aircraft flew in echelon formations of 4 or 5 aircraft each depending on the number of planes usable at the time.

Group sprayer leader has radio contact with Cessna guidance pair.

LAKEHEAD SPRUCE BUDWORM SPRAYING LOG

DATE	A M	P M	APPROX. U.S. GALLONS Fenitro.	Phospham.	THEORETICAL COVERAGE AT 0.2 G. 5-3/4 oz./ac.	3-3/4 oz./ac.
June 5	x		10665		53325	
Longest foul weather gap in history of Can. spraying.						
FIRST APPLICATION						
12						
		x	6750		33750	
13	x		12285		61425	
14						
		x	7020		35100	
15	x		10260		51300	
		x	3780		18900	
16	x		9720		48600	
		x	4590		22950	
SECOND APPLICATION						
		x		540		2700
17	x			11475		57375
		x		3510		17550
18						
		x		5805		29025
19	x			11475		57375
		x		6885		34425
20	x			2835		14175
	x		4590		22950	
10	7	7	69660	42525	348300	212625
	Seven morning splashes 74305 gallons. Seven evening splashes 38880 gallons.					

APPENDIX I.

FORMULATIONS 1968 FOREST PROTECTION LTD.

1. FENITROTHION EMULSIONS

a) Stage 1. Prepare an emulsifiable concentrate by combining the active ingredient with a solvent oil and an emulsifier by volume as follows:-

From the containers pump to mixing tank -

Fenitrothion Technical	76.5%
Texaco 3470 Solvent	11.6%
Atlox 3409 Emulsifier	11.9%

Circulate and store until required. The E.C. is a fairly stable mixture and there is no measureable degrade of the insecticidal material over - say one week. Store in closed system because the E.C. is a concentrated poison.

b) Stage 2. When spray emulsion is needed pump from E.C. storage and from water storage mixing the two thoroughly and in amounts which are determined by (1) the dosage and, (2) the application rate required and which are given in the table below.

c) Do not store emulsions because there is a loss of potency overtime.

Dosage of Fenitrothion Technical in pounds per ac./8	APPLICATION RATE IN U.S. GALLONS PER AC./20						
	3	4	5	6	8	10	% Vol.
1	9.87	7.40 *	5.92	4.93	3.70	2.96	E.C.
	90.13	92.60	94.08	95.07	96.30	97.04	W
2	19.74	14.80	11.84	9.87	7.40	5.92	E.C.
	80.26	85.20	88.16	90.13	92.60	94.08	W
3	29.61	22.2 **	17.76	14.80	11.10	8.88	E.C.
	70.39	77.8	82.24	85.20	88.90	91.12	W
4	39.48	29.60	23.68	19.74	14.80	11.84	E.C.
	60.52	70.40	76.32	80.26	85.20	88.16	W

* Nfld. formulation '68   ** Ontario formulation '68

2. PHOSPHAMIDON DILUTIONS

Spray materials are obtained by adding Technical Phosphamidon to water and circulcating.

a) The technical phospham.is pumped from containers to storage where it is held safe from contact with personnel until needed in the same way as Fenitrothion E.C. It is even more poisonous then Fenitrothion.

b) The required amounts of water and Phosphamidon are pumped into a circulating system where they become thoroughly mixed. This is the final stage of mixing and should be undertaken only as material is required because of the unknown character of degrade in storage. The batch system should give way to a continuous mixing arrangement on large projects in order to avoid wasting time.

c) Combinations of ingredients as used during the past season are shown below:-

Dosage of Phosphamidon Technical in pounds per acre/8	APPLICATION RATE IN U.S. GALLONS PER AC./20						
	3	4	5	6	8	10	% Vol.
1	8.20	6.15 *	4.92	4.10	3.08	2.46	P
	91.80	93.85	95.08	95.90	96.92	97.54	W
2	16.40	12.30 **	9.84	8.20	6.15	4.92	P
	83.60	87.70	90.16	91.80	93.85	95.08	W
3	24.60	18.45	14.76	12.30	9.23	7.38	P
	75.40	81.55	85.24	87.70	90.77	92.62	W
4	32.80	24.60	19.68	16.40	12.30	9.84	P
	67.20	75.40	80.32	83.60	87.70	90.16	W

* Nfld. formulation '68 ** Ontario formulation '68

<u>Fenitrothion</u> Accothion) Sumithion) Novathion) etc.) yellow liquid S.G. 1.32 weighs about 11.lbs./U.S.Gal.

Is not soluble in water but may be emulsified. Accothion 1968 material in steel drums with inner plastic containers holding 100 kg. (20 U.S. gallons). Comes undyed. Dye (Calco Red Y) added in formulating for identification purposes.

<u>Atlox 3409</u> One of a line of Atlas chemical emulsifiers S.G. 1.02 about same weight as water. Comes in 54 U.S. gallon drums. Pours.

<u>Texaco 3470</u> An aromatic petroleum solvent S.G. approx. 0.92 comes in 45 imp. gallon drums.

<u>Phosphamidon</u> C.I.B.A. patent. Yellow liquid but comes already dyed as requested with deep purple Oleate dye S.G. 1.24 weighs about 10-1/4 lbs./ U.S. gallon. Is completely water soluble.

APPENDIX II

AIRCRAFT CALIBRATION 1968

1. STEARMAN - Ontario

(a) Flying speed 96 m.p.h.

(b) Theoretical swath 200 Ft.

(c) Application rate 0.2 U.S.G./ac.

Required emission rate in U.S.Gallons/Min. $= \frac{96 \times 5280 \times 200}{43560 \times 60} = 7.7$

In order to get delivery of 7.7 U.S.G./Min. at safe system pressure (40-50 psi) and at the same time get maximum break up of spray 30* No. 4664 diaphragm tee-jet nozzles equipped with D3 orifice discs, No. 45 cores and 50 mesh screens, were mounted on the boom and turned 45° into the wind.

2. TBM - Newfoundland

(a) Flying speed 156 m.p.h.

(b) Theoretical swath 440

(c) Application rate 0.2 U.S.G./ac.

Required emission rate in U.S.G./Min. $= \frac{156 \times 5280 \times 440 \times 0.2}{43560 \times 60} = 27.8$

With boom pressures of 52-59 p.s.i. and 24-26 No. 4664 diaphragm tee-jet nozzles equipped with flat fan tips No. 8010, this emission rate of 27.8 U.S.G./Min. is obtained. A fine break-up of spray (called fine) results when the flat fans are turned 45° into the wind.

3. TBM - New Brunswick

(a) D.D.T. spraying as in period 1960-1967

Flying speed 150-155 m.p.h.

Swath 412 Ft.

Application rate 0.5 g.p.ac.

* All hardware is Spraying Systems

24 (20-28) No. 4664 Diaphragm tee-jet nozzles stripped of screens, strainers and tips and operating at low pressure 18 p.s.i. (14-23) gave the required emission rate. These were oriented straight down and the break-up was caused almost entirely by the shear of the slip stream. This spray is called "coarse" in 1968 trials. Small adjustments are made by adding or subtracting nozzles.

(b) Organo-phosphate spraying

Flying speed 156 m.p.h.

Swath 440 ft.

Application rate 0.2 U.S.G./ac.

i. For "coarse" spray equip boom as in (a) above.

ii. For "fine" spray equip boom as in Newfoundland above.

iii. For "very fine" spray equip boom by substituting flat fan tips No. 8006 for No. 8010 tips, and increase the number of nozzles from 24 to 40. Pressure remains unchanged.

APPENDIX III

AIRCRAFT SAFE LOADS

F.P.Ltd. tries to keep loads safe for the pilots as well as the loading safe for ground crew. In order to keep aircraft from being overloaded the number of U.S. gallons per load which shall not be exceeded is calculated for the material being carried. Several examples are listed below -

a) Stearman, Ontario '68. Load not to exceed 1,200 pounds. The heavier of two formulations used weighs slightly more than 8.75 pounds/U.S. gallon. Top safe load is 135 U.S.G. For the sake of simplicity this load was used throughout the project.

b) T.B.M. Newfoundland '68. Load not to exceed 5,600 pounds. The heavier of two formulations used weighs slightly less than 8.5 lbs./U.S. gallon. Top safe load is 660 U.S.G. and this was not exceeded during the project.

c) T.B.M. New Brunswick '68. A safe load for the heaviest formulation (0.5 fenitrothion applied at 0.29 p.a.c.) is approx. 625 U.S.G. There was no need to use this limit because the standard load (600 U.S.G.) was determined by the trial block size.

d) D.D.T. in oil solutions rarely exceeds 8 pounds per U.S. Gallon in weight and loads of 150 gallons for Stearman and 700 gallons for T.B.M. are the rule.

APPENDIX 8

Draft Report For November 20, 1968, Meeting of Interdepartmental Committee on Forest Spray Operations.

REPORT ON THE EFFECTS OF THE 1968 NEW BRUNSWICK AERIAL FOREST SPRAYING ON JUVENILE SALMON AND THEIR FOOD ORGANISMS

by

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and

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RESOURCE DEVELOPMENT BRANCH
DEPARTMENT OF FISHERIES OF CANADA

HALIFAX, N.S.

1968

CONTENTS

INTRODUCTION

Aerial forest spraying to control an outbreak of the spruce budworm (Choristoneura fumiferana) in the Province of New Brunswick began in 1952. Since 1952 operational forest spraying has been carried out in New Brunswick each year, with the exception of 1959. During the first ten years of spraying, DDT was the insecticide operationally used and the rates of application varied from one pound per acre to one-quarter pound per acre. In the early years of spraying, in order to afford some protection from the adverse effects of DDT to juvenile salmon and their food organisms, the spray was shut off over streams readily visible from the air.

In 1962 a new insecticide, Phosphamidon, was experimentally sprayed on a 640 acre plot. The use of Phosphamidon was extended to include 22,500 acres in 1963 at the rate of one-half pound per acre. Phosphamidon was found to be relatively non-toxic to juvenile Atlantic salmon (Salmo salar) and their food organisms so it was used extensively along salmon streams in 1964, as has been generally the case thereafter, with DDT being sprayed over the rest of the forests. In 1966 another insecticide, Sumithion, was experimentally sprayed on 7700 acres at the rate of one-half pound per acre. In 1967, extended use of Sumithion and various mixtures of Sumithion with Phosphamidon were applied on approximately 200,000 acres.

Results of previous studies have demonstrated the effects of DDT, Phosphamidon, Sumithion and mixtures of Phosphamidon with Sumithion, to salmonids and to fish food organisms. Early field investigations were carried out by the Fisheries Research Board of Canada. Since 1960, the Resource Development Branch of the Canadian Department of Fisheries has monitored the effects of forest spraying on stream-dwelling salmon in New Brunswick. Results of these field investigations and other reports have shown the detrimental effects of DDT to juvenile salmon and their food organisms. These studies have also shown that extensive use of Phosphamidon along salmon streams and their tributaries, in place of DDT, greatly reduces the adverse effects of spraying. Recent studies have shown that Sumithion causes significant depletion of aquatic invertebrate populations. The present spraying program has evolved whereby Phosphamidon was extensively sprayed along streams that can be readily seen from the air and where DDT is applied to adjacent areas. Sumithion and mixtures of Phosphamidon with Sumithion were sprayed along or directly over streams.

In 1968, approximately 540,000 acres of New Brunswick forests were sprayed. This included 57 spray blocks of approximately 9,350 acres each. Twenty of the spray blocks, totalling approximately 185,000 acres, involved the spraying of DDT in various applications as follows:

1. 0.1875 pounds per acre of DDT applied in one application. Sumithion mixed with Phosphamidon was used along streams.

2. 0.1875 pounds per acre of DDT applied in one application with Phosphamidon stream buffer zones in most cases.

3. 0.1875 pounds DDT per acre mixed with one-eighth pound Sumithion per acre and applied twice. No stream buffer protection was applied here.

4. One-tenth pound DDT per acre mixed with one-quarter pound Sumithion per acre and applied in one application. Phosphamidon stream safety zones were applied here.

5. One-tenth pound DDT per acre mixed with one-quarter pound Sumithion per acre applied twice. Sumithion mixed with Phosphamidon was sprayed along streams.

6. One-quarter pound DDT per acre applied in one application with Phcsphamidon stream buffer zones included.

7. One-quarter pound DDT per acre applied twice with Phosphamidon sprayed along streams.

8. Three-eighths pound DDT per acre applied in one application with Phosphamidon stream safety zones in most cases.

The remaining spray blocks received various treatments of Sumithion or Phosphamidon or as mixtures of the two, as follows:

1. One-eighth pound Sumithion per acre applied in one application.

2. One-quarter pound Sumithion per acre applied in one application.

3. Three-eighths pound Sumithion per acre applied in one application.

4. One-half pound Sumithion per acre applied in one application.

5. One-quarter pound Sumithion per acre applied twice.

6. Three-eighths pound Phosphamidon per acre applied in one application.

7. One-quarter pound Phosphamidon per acre applied in one application.

8. One-eighth pound Sumithion per acre mixed with one-eighth pound Phosphamidon per acre and applied in one application.

9. One-eighth pound Sumithion per acre mixed with one-quarter pound Phosphamidon per acre and applied in one application.

10. One-quarter pound Sumithion per acre mixed with one-eighth pound Phosphamidon per acre and applied in one application.

An outline of the general spray area for 1968 is shown in Figure 1.

In addition to the operational spray area, the Chemical Control Research Institute of the Department of Forestry and Rural Development, Ottawa, experimentally sprayed several small blocks apart from the general spray area.

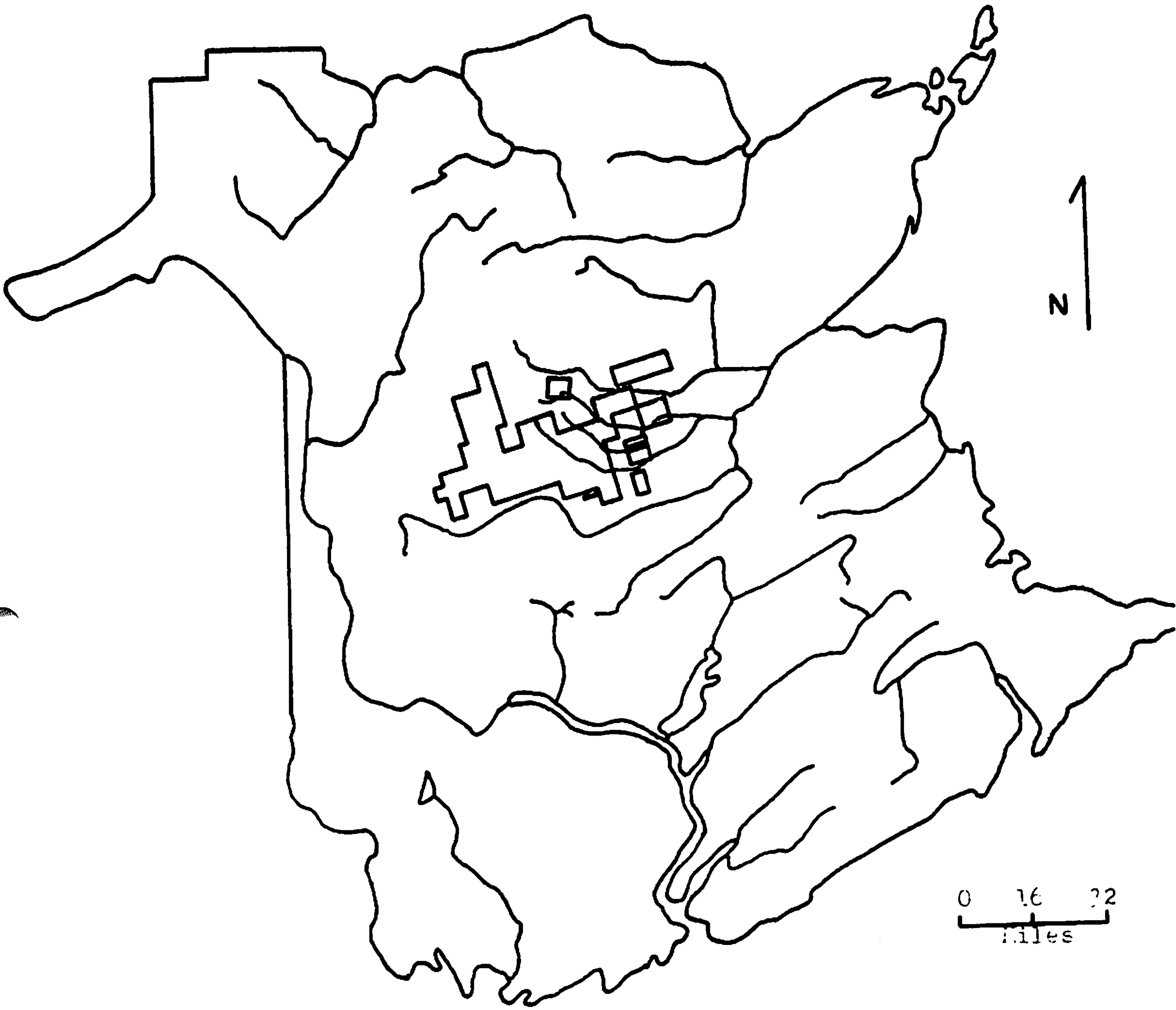

Figure 1 - Forest lands sprayed in New Brunswick in 1968 as shown by enclosed areas.

This is the latest of a series of assessments made each year to monitor the effects of forest insecticide spraying on the salmon resource of New Brunswick. This report is a preliminary analysis of the data collected during 1968 by the Resource Development Branch of the Canadian Department of Fisheries and presents four groups of data.

First, the toxicity of Sumithion to juvenile Atlantic salmon was checked by observing the mortality rate of caged native salmon parr as compared to a control. To obtain an indication of the relative toxicity of Baygon to salmonids, a bioassay test was carried out using eastern brook trout (*Salvelinus fontinalis*).

Second, a late summer population census on juvenile salmon was conducted on spray area and control streams. The population densities of underyearling salmon found in this study give an indication of the effects of the 1968 forest spray to fish of the year, while the population densities of juvenile salmon parr show survival rates of populations that may have been exposed to previous spraying as well.

Third, the effects of different rates of Sumithion applications on the fish food organisms of the stream bottom were examined. Recovery of fish food organisms in a stream sprayed with one-half pound per acre of Novathion (Sumithion) in 1967 was also checked. The effects on fish food organisms of Baygon sprayed on a small plot was spot checked.

Fourth, a preliminary study was conducted to determine the effects on growth of native salmon parr in relation to quantitative changes in fish food organisms in relation to spraying.

METHODS

Caged Fish Studies:

Native salmon parr were collected and held in cages at a stream sprayed with Sumithion at the rate of 3/8 pound per acre, and at an unsprayed control stream. Twenty (20) parr were placed in each cage ten days prior to spraying and periodic inspections were made to the tenth day following spraying. Records were kept of parr survival, water temperatures and water level fluctuations. The test stream was the South Renous River and the control stream was the Morse Brook.

Toxicity Tests on Baygon:

The method used for these tests and the calculation of results were conducted as described in Standard Methods for the Examination of Water and Wastewater (1965). The tests were conducted at Cardigan Fish Culture Station in Prince Edward Island. The test fish, yearling speckled trout, were exposed to various concentrations of Baygon in water. Observations were made on mortality, water temperature, pH of the solution and dissolved oxygen concentrations, for 96 hours. Preliminary tests were conducted over a broad range of concentrations and a final series of tests was conducted within a narrow range of concentrations to determine the lethal limits (median tolerance limit) of Baygon to speckled trout. The final tests were repeated to confirm the results.

Summer Census of Juvenile Salmon:

A census of juvenile salmon was made at eight spray area streams and at five control streams in the late summer and early fall. Sampling of populations was done by electro-fishing and population estimates were arrived at by the method of Delury (1951). Population densities were compared in order to assess the effects of insecticide spraying on stocks of juvenile salmon.

Effects on Aquatic Invertebrates:

In order to assess the comparative effects of various spray applications on fish food organisms, bottom fauna sampling was carried out before and after spraying, at spray area streams and at control streams. A one-foot square surber sampler fitted with silk bolting (38 meshes to the inch) was used to collect the invertebrates. Organisms were identified to order, counted, and wet weights were determined. Each station was sampled before spray application, and six times following spraying, at intervals of 3 days, one week, two weeks, three weeks, four weeks and six weeks. Each individual sampling consisted of five one-square-foot samples collected and analyzed separately.

Sampling was conducted at the following streams:

1. South Sevogle River (Clearwater Crossing) - control stream.

2. Burnthill Brook - sprayed Sumithion 1/4 pound/acre.

3. South Renous River - sprayed Sumithion 3/8 pound/acre.

4. Morse Brook - sampled to monitor recovery of insect populations from 1967 Sumithion spraying at rate of 1/2 pound/acre.

Spot checks were conducted on survival of caddis larvae in a stream where C.C.R.I. personnel had sprayed Baygon.

<u>Growth of Parr in a Sumithion-Sprayed Stream:</u>

This study was conducted in an attempt to detect changes in growth rate or body condition when food supply (invertebrates) had been reduced after Sumithion spraying, from a spray area stream, the South Renous River, and from a control stream, the South Sevogle River. These parr were weighed and measured and the length-weight relationship was calculated and expressed as a coefficient of condition. Seven weeks after spraying, 25 parr were again collected from each stream and were measured and weighed and condition factors were again calculated. Changes in bottom fauna populations had also been monitored in these streams as described in the preceding section.

RESULTS

Caged Fish Studies:

No mortalities were observed in the groups of caged parr at the stream in the area sprayed with three-eighths of a pound of Sumithion per acre, nor were there any parr mortalities at the unsprayed control station.

Tolerance of Speckled Trout to Baygon:

Figure 1 A. shows a plot of the time (to 50 percent mortality) - concentration (parts per million) curve derived from a final series of tests on the toxicity of Baygon to yearling speckled trout. Extrapolation from this curve gives median tolerance limits of yearling speckled trout to aqueous solutions of Baygon, as follows:

Tlm	-	24 hours	-	52 ppm
Tlm	-	48 hours	-	40 ppm
Tlm	-	72 hours	-	35 ppm
Tlm	-	96 hours	-	31 ppm

Summer Census of Juvenile Salmon:

Populations of the underyearling salmon fry, the year old small parr, and the larger parr, are presented in Table 1. Population densities are expressed as numbers of fish per 100 square yards.

The abundance of underyearlings in the spray area streams was only 56 percent of the population density

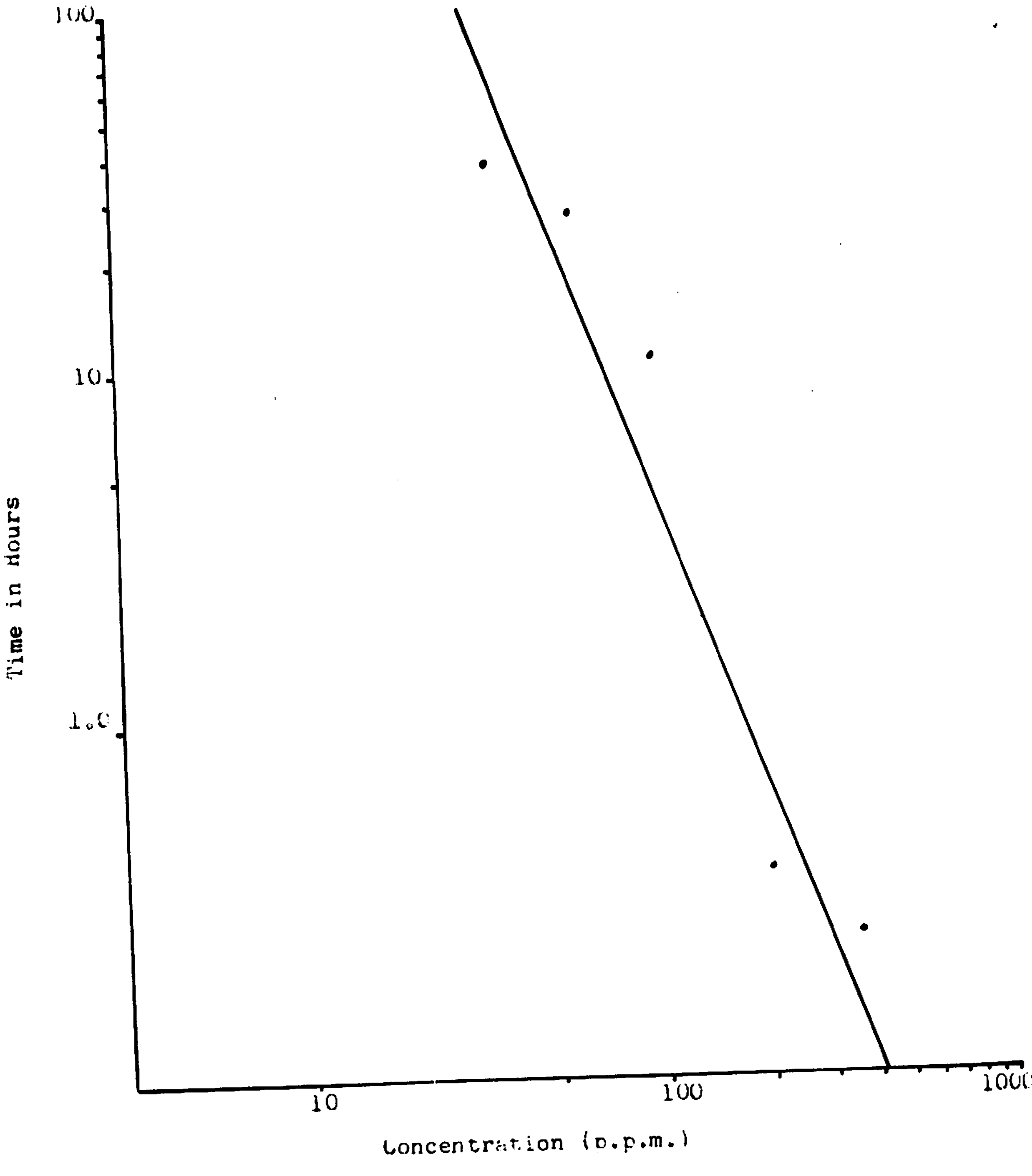

Figure 1 A. Time-concentration curve to 50 percent mortality of speckled trout in aqueous solutions of Baygon.

at control streams. The average density of underyearlings at spray area streams was about 26 per 100 square yards, while at control streams there was an average of 47 fry per 100 square yards. This difference may be indicative of some losses due to pesticide spraying. However, the remaining populations (averaging 26 fry per 100 square yards) are about equal to the long-term average density for unsprayed streams as reported by Elson. (1967).

Small parr were scarcer at spray area streams (average about 7 per 100 square yards) than at control streams which averaged 25 per 100 square yards. This is the second year that these fish have been exposed to aerial spraying; pesticide spraying may be the reason for low populations.

	Fry	Mean	Small Parr	Mean	Large Parr	Mean
SPRAYED IN 1968						
S. Renous R. - Plaster Rock Hwy.	40		41		15	
S. Renous R. - R. Swimm Road	32		4		4	
N. Renous R. - Richard Mill	32		3		5	
Dungarvon R. - Holtville	15		13		10	
Dungarvon R. - Ledgy Landing	16		11		13	
Dungarvon R. - 3 Miles below Ledgy Landing	24		7		4	
		26		7		9
SPRAYED IN (1966 DDT + Phos. (1967 Phos., Sumith.						
Main S.W. Miramichi - Ansel Brook	30		43		10	
Main S.W. Miramichi - Duff Pond	22		28		3	
UNSPRAYED CONTROLS						
Taxis R. - Maple Grove	28		56		11	
Taxis R. - Mile 4	42		32		4	
Cains R. - Estey Brook	60		8		2	
Cains R. - 6 Mile Brook	79		11		5	
S. Sevogle R. - Clearwater Crossing	26		17		9	
		47		25		6

TABLE 1. Post spray populations of juvenile salmon, given as number of fish per 100 square yards of stream bottom.

Populations of large parr were more dense at the spray area streams (average about 9) compared to 6 per 100 square yards at the control stations. This spray area density is about 75% of Elson's unsprayed index of 12 large parr per 100 square yards. Density differences are not of such magnitude as to reflect any losses attributable to pesticide spraying.

Two stations on the Main South West Miramichi which have not been influenced by DDT spraying in 1967 nor in 1968 had good populations of fry and small parr.

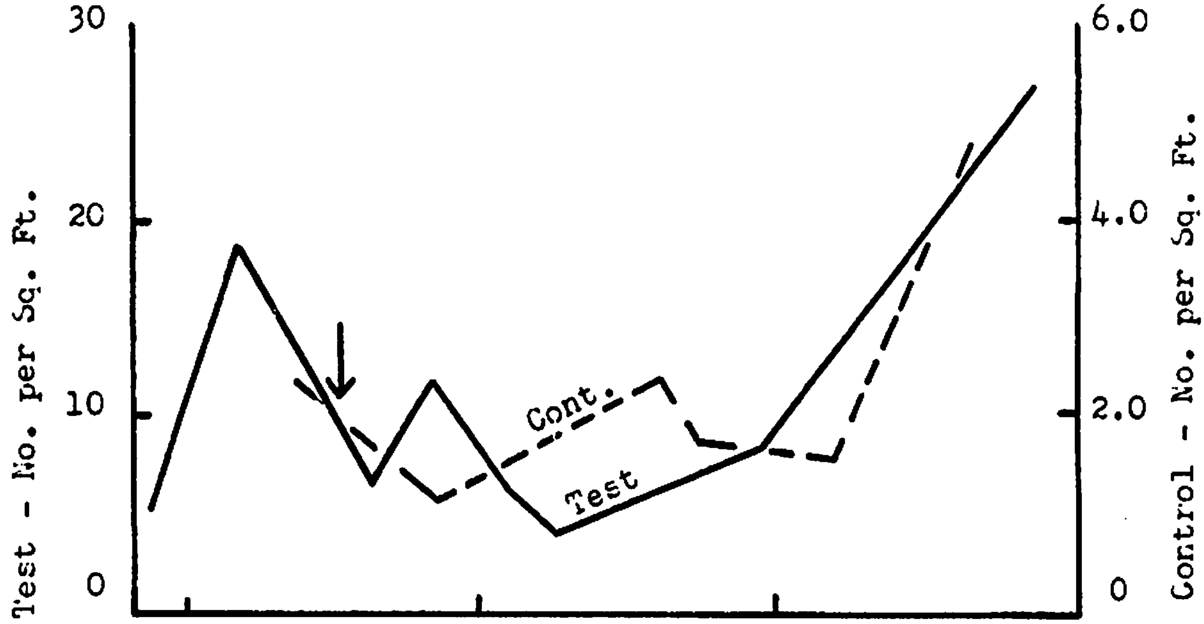

Fig. 2 - Trichoptera - Sum. 3/8 lb./Ac.

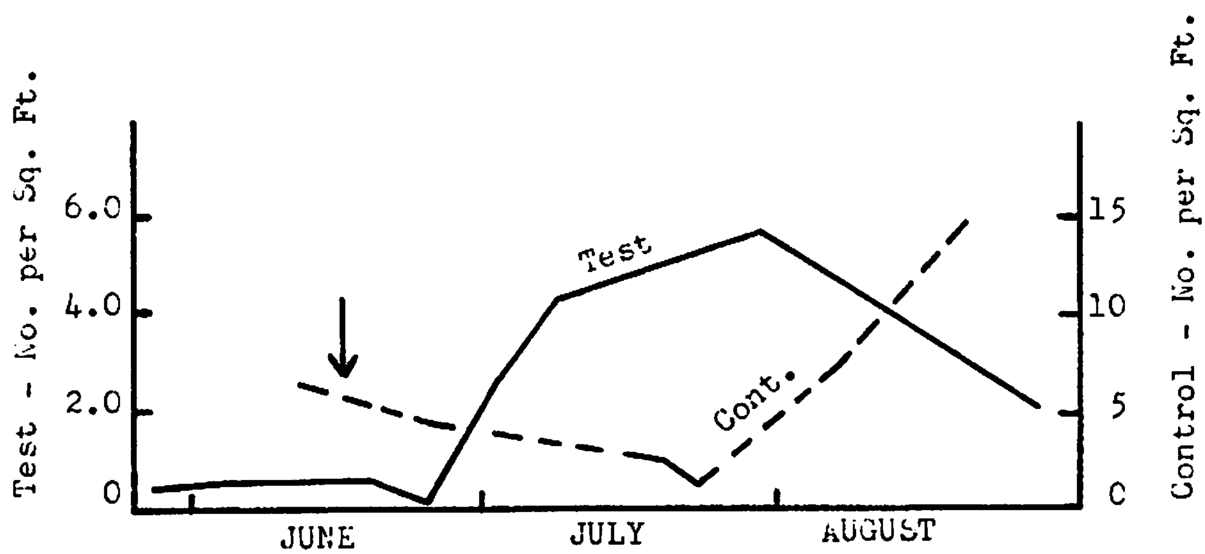

Fig. 3 - Plecoptera - Sum. 3/8 lb./Ac.

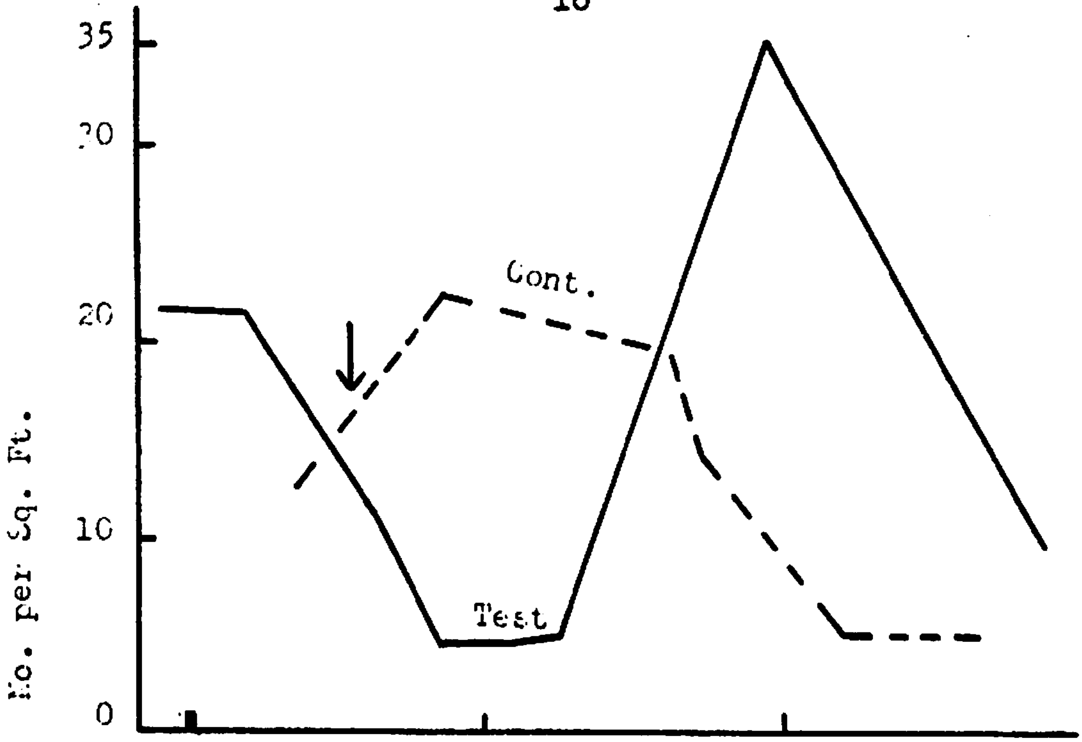

Fig. 4 - Ephemeroptera - Sum. 3/8 lb./Ac.

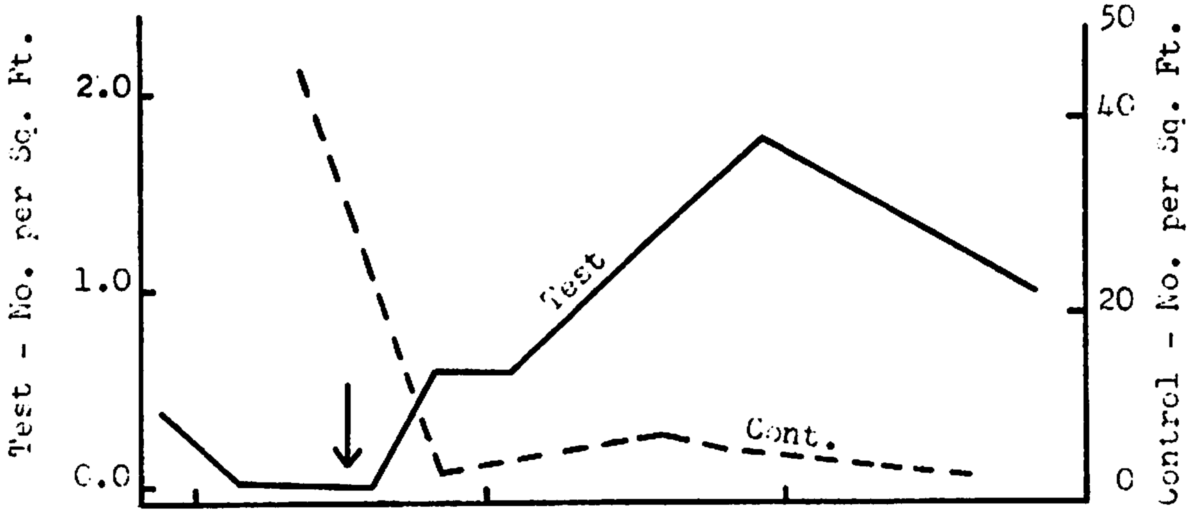

Fig. 5 - Diptera - Sum. 3/8 lb./Ac.

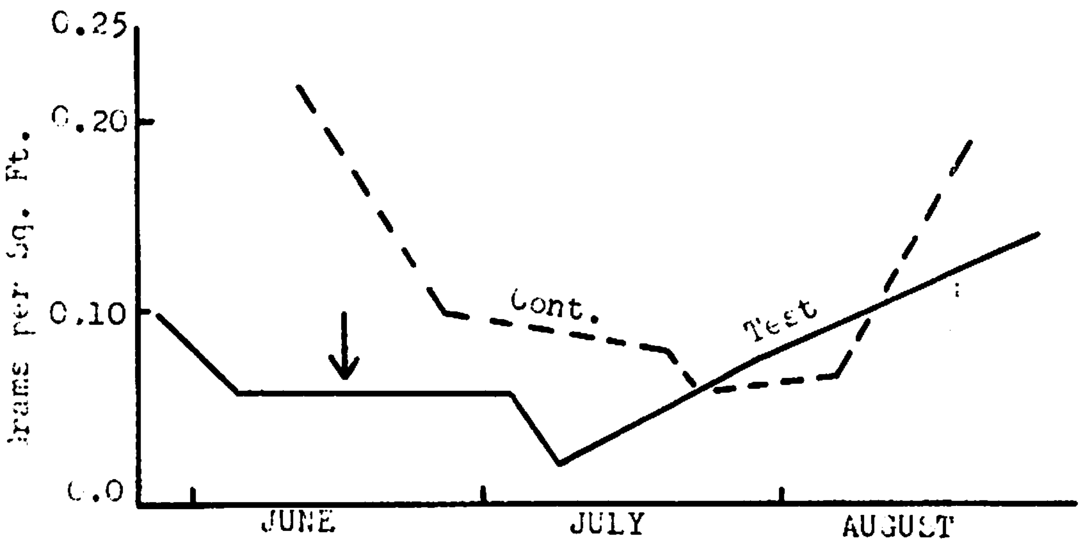

Fig. 6 - Wet Weights - Sum. 3/8 lb./Ac.

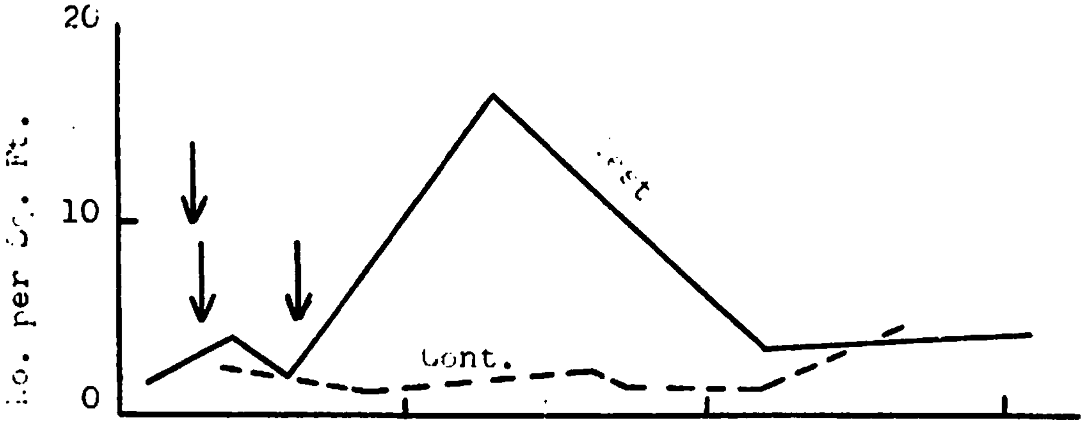

Fig. 7 - Trichoptera - Cum. 1/4 lb./Ac.

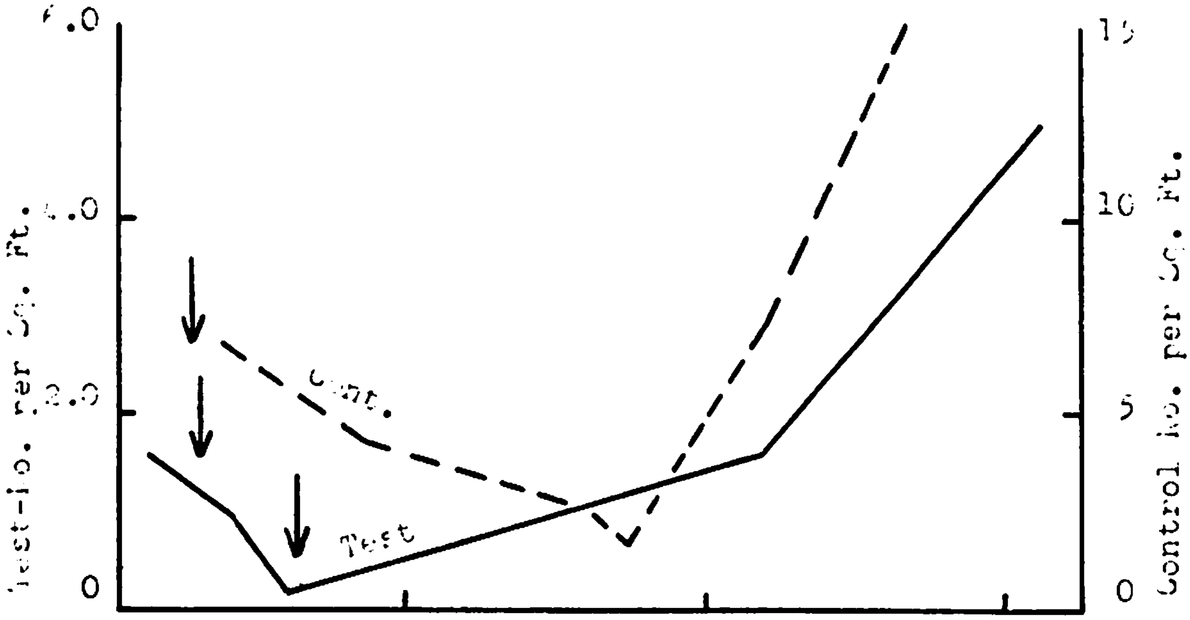

Fig. 8 - Plecoptera - Cum. 1/4 lb./Ac.

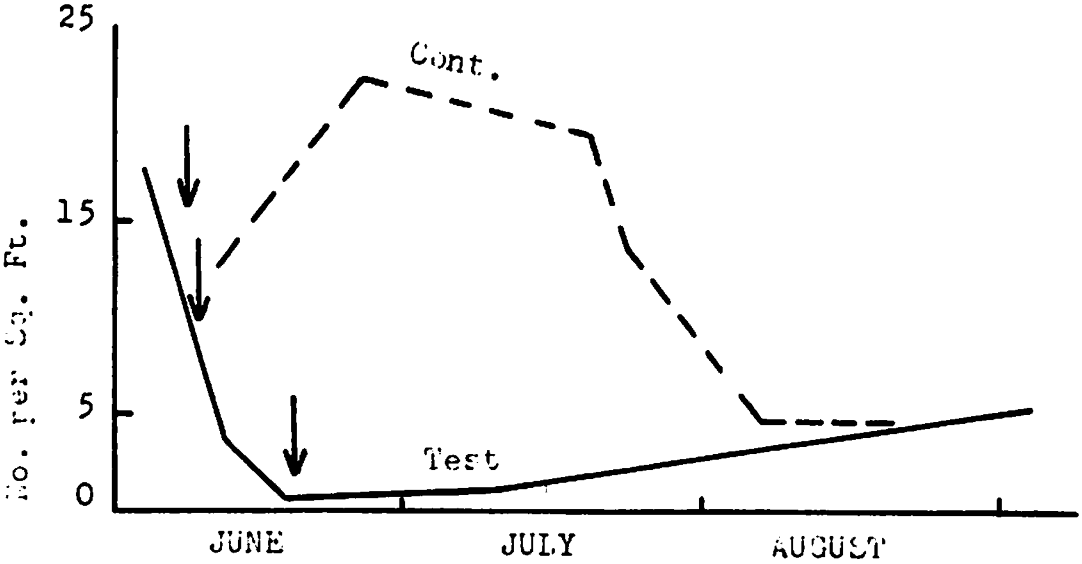

Fig. 9 - Ephemeroptera - Cum. 1/4 lb./Ac.

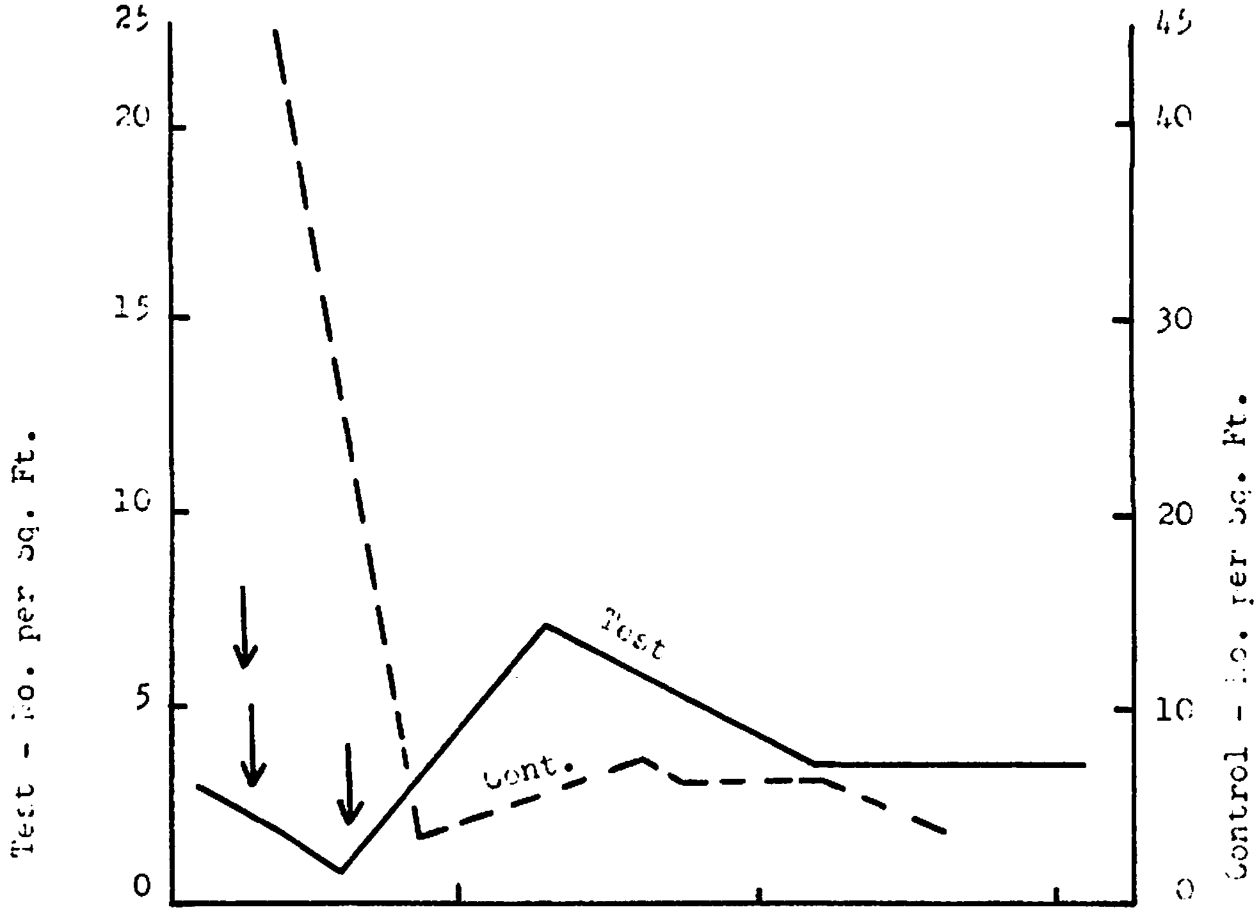

Fig. 10 - Diptera - Sum. 1/4 lb./Ac.

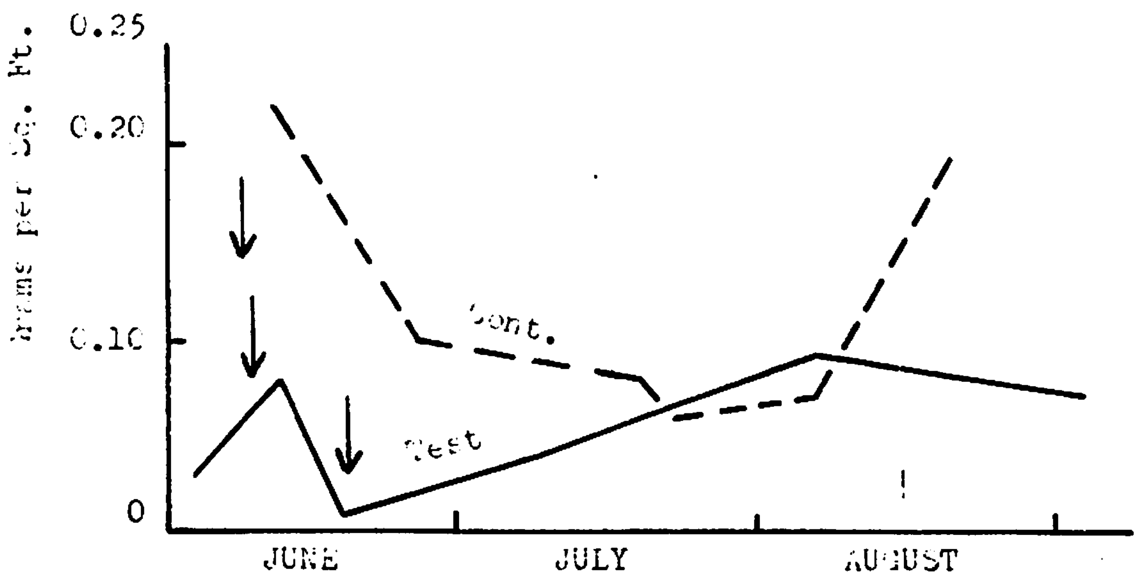

Fig. 11 - Wet Weights - Sum. 1/4 lb./Ac.

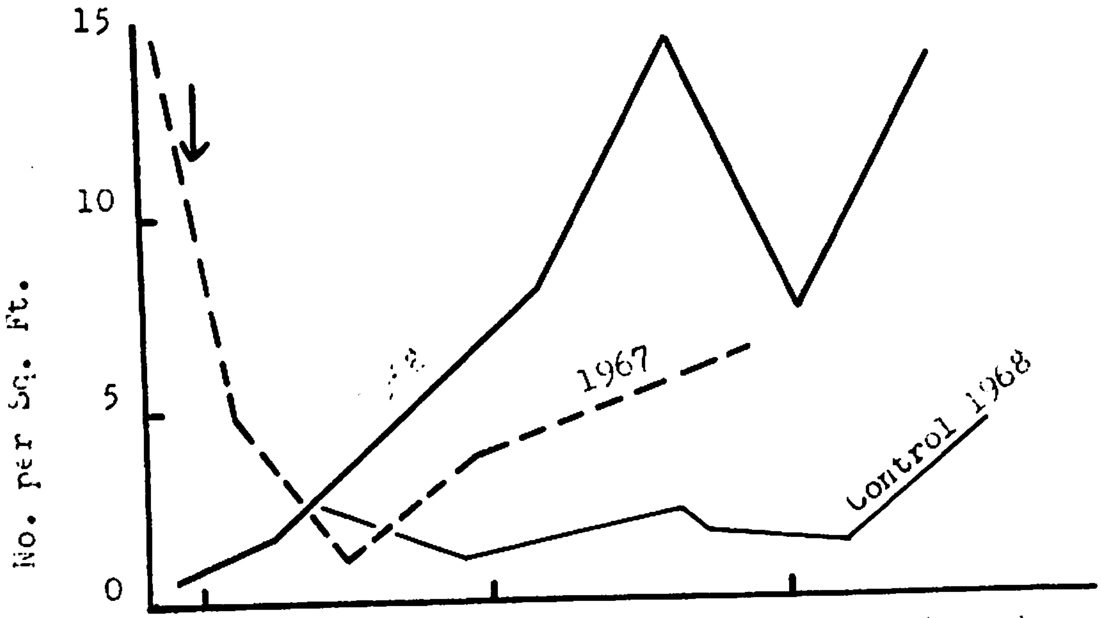

Fig. 12 - Trichoptera - Morse Bk. Nov. (Sum.)
½ lb./Ac. in 1967.

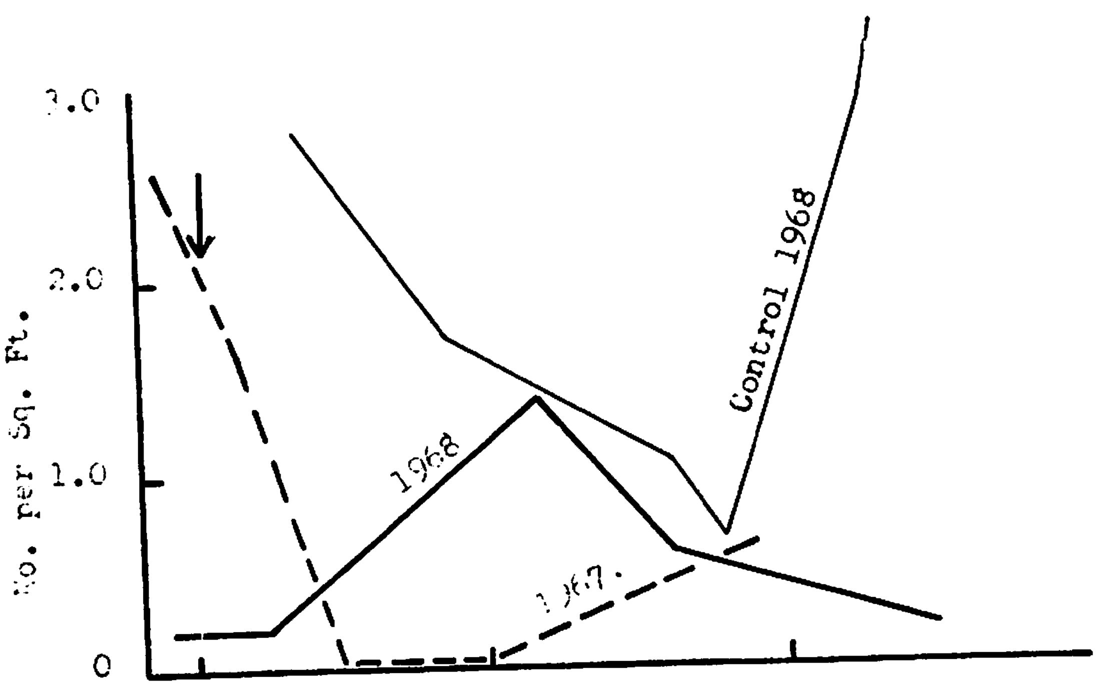

Fig. 13 - Plecoptera - Morse Bk. Nov. (Sum.)
½ lb./Ac. in 1967.

JUNE JULY AUGUST

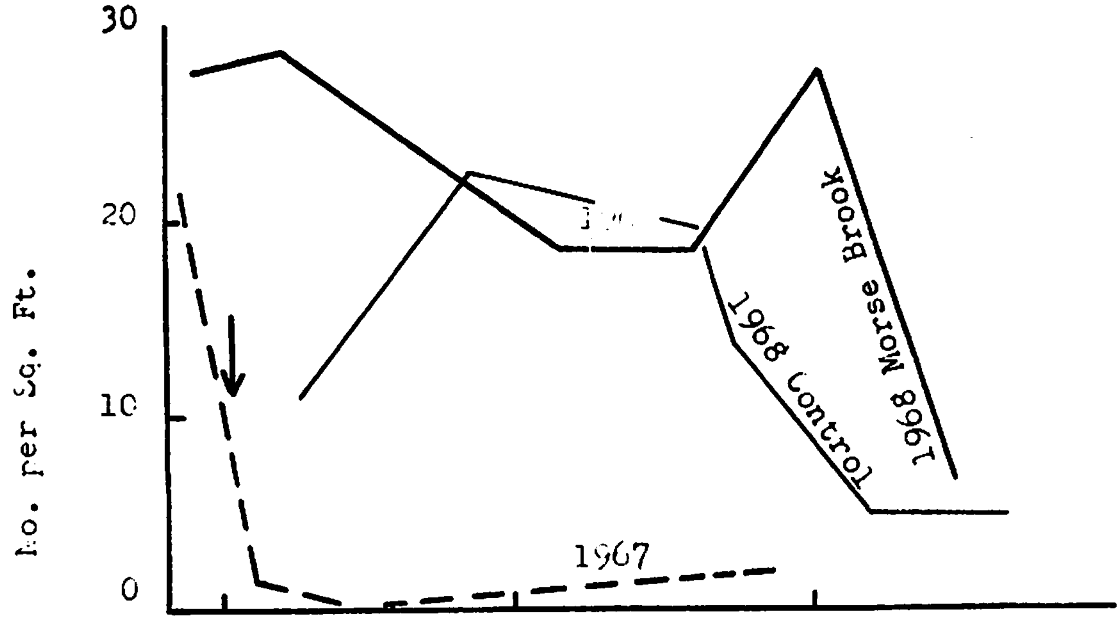

Fig. 14 - Ephemeroptera - Morse Bk. Nov. (Sum.) ½ lb./Ac in 1967.

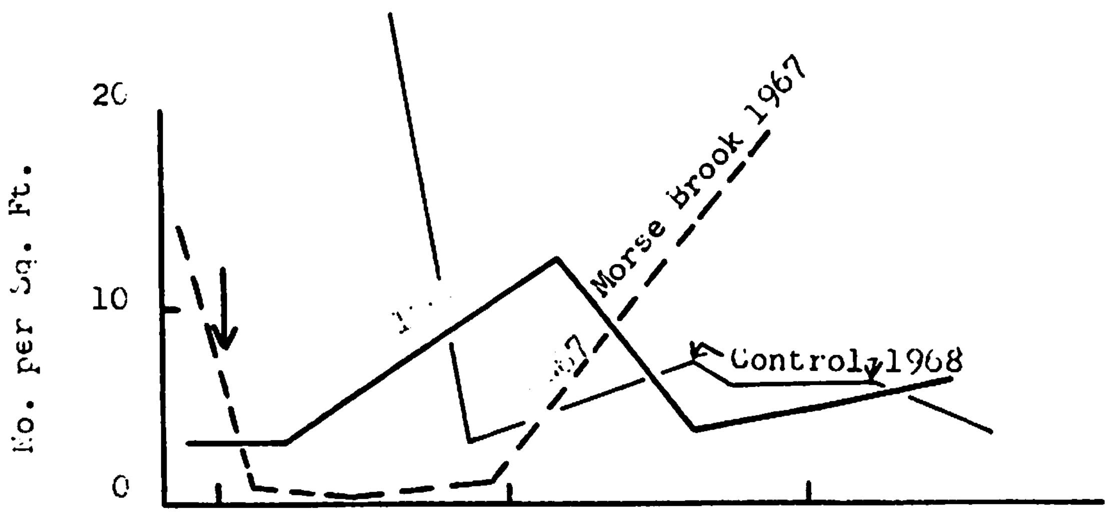

Fig. 15 - Diptera - Morse Bk. Nov. (Sum.) ½ lb./Ac in 1967

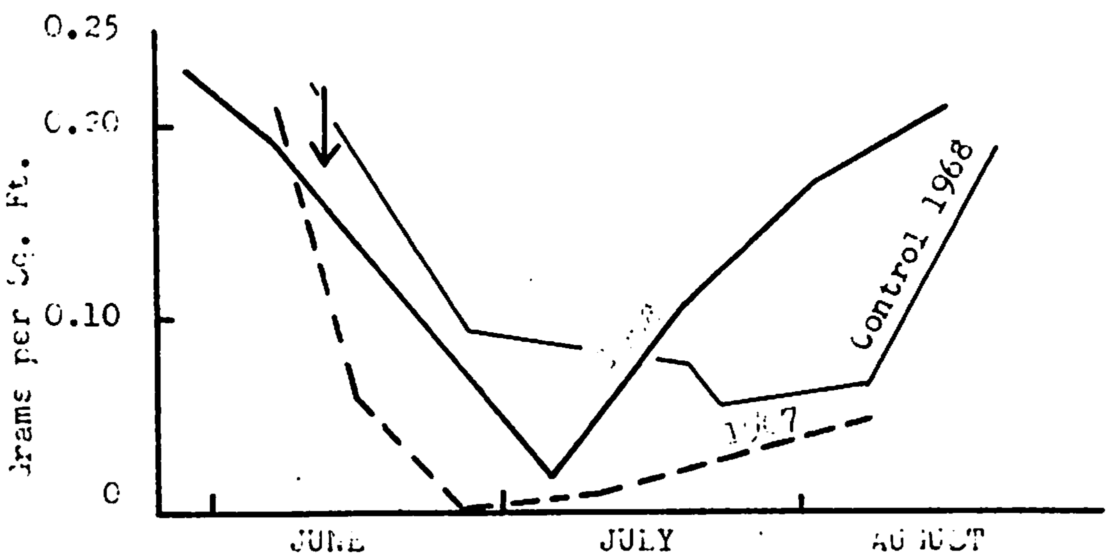

Fig. 16 - Wet Weights - Morse Bk. Nov. (Sum.) ½ lb./Ac. in 1967.

Effects on Aquatic Insects:

Figures 2 to 6 show the effects of Sumithion (3/8 pound per acre) spraying on aquatic insects at the South Renous River. Trichoptera (Fig. 2), Plecoptera (Fig. 3), and Diptera (Fig. 5), showed no significant decreases in numbers following spraying. The Ephemeroptera (Fig. 4) decreased rapidly but about three weeks later numbers increased above control levels. Fig. 6 shows that bulk of fish food organisms decreased slightly about 3 weeks after Sumithion spraying but soon increased to near control levels.

Figures 7 to 11 show effects of Sumithion spraying, at 1/4 pound per acre, on numbers and bulk of bottom organisms. Again only the mayflies (Ephemeroptera) showed significant reduction in numbers following this Sumithion spraying (Fig. 9). A reduction in wet weight is also noted in Figure 11, but recovery occurred in July and August.

Figures 12 to 16 show the numbers of, and wet weight of, aquatic insects at Morse Brook one year after it had been sprayed with Novathion (another trade name for Sumithion) at the rate of one-half pound per acre. The broken curve on these graphs shows the severe losses in numbers and wet weight which had occurred in 1967 following spray application. This brook was not sprayed in 1968. In 1968 the four major groups of aquatic insects (Fig. 12 to Fig. 15) were well represented in all samples, indicating reasonably good recovery from losses of the previous year. The wet weight curve for aquatic insects (Fig. 16) follows somewhat the general pattern of the 1968 control, again indicating recovery to reasonable levels of abundance.

The Chemical Control Research Institute experimentally sprayed a small plot with Baygon. A small stream in this plot was checked for the presence of insects a few days before spraying and two days following spraying. The majority of insects found here consisted of Ephemeroptera and Trichoptera. Their numbers did not appear to have decreased following spraying. Several caddis cases were opened before and after spraying and their pupae were found alive at both times.

Fish Growth in a Sumithion-Sprayed Stream:

Coefficients of condition were calculated from the formula $K = \frac{10^5 \times W}{L^3}$ where W is the weight in grams and L the length in millimeters. The average condition factor for 25 parr at the test stream (3/8 pound Sumithion per acre) one week before spraying was 0.908, and at control steam was 0.844. Seven weeks after spraying the average condition factor had increased 13% at the spray area stream to 1.027 and had also increased 13% to 0.955 at the control stream. This failure to detect differences in growth rate is probably related to the fact that, despite the Sumithion spraying, bottom fauna losses were slight at this station (Figure 6).

DISCUSSION

Caged fish tests again indicated that Sumithion was non-toxic to juvenile salmon at the concentrations used in the New Brunswick aerial spraying programme. This confirms results of similar tests in 1966 and 1967 when both salmon fry and salmon parr were unaffected by Sumithion spraying. However, despite the results of these tests, large numbers of dead salmon parr were reported from Rocky Brook following spraying. The Rocky Brook drainage area was sprayed with Sumithion at rates of ¼ or ½ pound per acre, as a fine spray. It may be that spraying of Sumithion in a fine dispersion is toxic to juvenile salmon OR it may be that some other insecticide such as DDT found its way onto the Rocky Brook watershed either by drift or by other means. A test for the toxicity of finely dispersed Sumithion to juvenile salmon is indicated for 1969.

Baygon (O- Isopropoxphenyl methylcarbamate) is relatively non-toxic to juvenile salmonids when compared to DDT. The tolerance limit for Baygon in 48 hours was 40 parts per million. Keenleyside (1958) reported a Tlm 48 for young salmon in a DDT solution to be .047 ppm. While juvenile salmon and juvenile trout may have different tolerances to different insecticides, the relatively high tolerance of young trout to Baygon probably means that young salmon will not be affected by concentrations normally expected from aerial spraying.

Atlantic salmon underyearlings were not as plentiful at spray area streams as at unsprayed streams. There is no clear reason to attribute population differences to insecticide spraying but the possibility cannot be entirely precluded as some DDT was sprayed over upper drainage areas of the Dungarvon River. Fry populations averaged 26 per 100 square yards at spray area streams, a healthy population density based on Elson's findings. Therefore, if spray damage did occur the losses were moderate.

Populations of small parr (average 7 per 100 square yards) were far below the control average of 25 and below Elson's index of 20 for unsprayed streams. These low population densities probably reflect effects of the use of DDT spray on the Dungarvon and Renous watershed in 1967. The result of such low density populations will be to limit smolt production from these streams.

Populations of large parr in spray area streams average 9 per 100 square yards compared to 6 for control streams. Most of the large parr of control streams, with the exception of the Sevogle, had been subjected to DDT and Phosphamidon spraying as underyearlings in 1966. This may account at least in part for the relatively low densities at control streams. However, stocks of large parr compared favourably with Elson's index of 12 per 100 square yards.

The two stations on the Main Southwest Miramichi have good populations of fry and of small parr, suggesting that absence of DDT in 1967 and 1968 allowed for good survival. The large parr are less abundant than normal, and again, as at the control streams, may be reflecting damage from use of DDT on the watershed in previous years.

In spite of a lack of complete consistency in the results of sampling, there are indications that smolt production will continue to be limited whenever DDT is used even though Phosphamidon safety zones are also used.

Sumithion applied at the rate of 3/8 pound per acre caused moderate decrease in abundance of aquatic invertebrates but recovery was rapid. These fish-food organisms were not affected to the degree observed in tests of previous years when severe losses had been observed. The Ephemeroptera (mayflies) appeared to have been the most severely affected and accounted for most of the loss. A similar situation was observed when Sumithion was sprayed at the rate of 1/4 pound per acre. Some reduction in bulk of insects was observed following spraying with the Ephemeroptera accounting for most of it. Recovery to near normal levels occurred during the summer. The difference between effects of Sumithion on bottom organisms in 1966, 1967 and 1968 is not understood.

The Morse Brook observations indicate that following the extensive insect kill in 1967, recovery proceeded rapidly.

The other 1968 tests also indicated rapid recovery of aquatic insect populations following initial post-spray kill.

A brief check on aquatic insects in a stream sprayed over with Baygon suggests that little or no damage occurred. However, should Baygon receive consideration for operational use, tests will be conducted to determine the effects on aquatic insects.

Forest insecticide spraying in 1968 is known to have caused some losses to juvenile salmon stocks and to fish food organisms but these losses appear to be moderate in comparison to losses observed in earlier years of spraying. The use of DDT in previous years continues to be reflected by population densities of salmon parr. In general, stocks of the smaller salmon parr are poor but underyearlings and large parr stocks appear to be in good condition.

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Appendix 9

CANADIAN PULP AND PAPER ASSOCIATION

WOODLANDS SECTION 2280 SUN LIFE BUILDING, MONTREAL 2, CAN.

A Fish Story — Anadromous, i.e.

B. W. FLIEGER

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A Fish Story — Anadromous, i.e.

B. W. FLIEGER, Forest Protection Ltd.

WS Index 2460 (F-3) ODC 453:414

Silent Spring, *the late Rachel Carson shocker of 1962, has a chapter all about effect of pesticide on aquatic life called Rivers of Death. On pages 129-135, the author weaves a Miramichi story of salmon life in fresh water — water that, in 1954 suddenly turned "hot" because of forest spraying. The documentation for these pages served her book theme to a tee but does not square with the record. In this paper, the purpose is to outline the changing impact of forest spraying on salmon to better understand the delicate relation between management of the tree resource and of other related so called renewable resources. You may decide that the impact was bad or good, serious or slight, depending on how you feel and think. It is now safe to say that the Atlantic salmon should he go the way of the dodo — will not go because of forest spraying. Miss Carson was not so optimistic.*

This is part of a story about an "unaim" in forest spraying — some of it is known only to the fish!

The locale is New Brunswick's budworm-infested forests of firs and spruces and the network of rivers that snake through the land on their way to the Gulf of Fundy.

The time is from 1952. Here for the past 16 years about 10,000,000 acres of forest growing-stocks, in various stages of maturity, have been protected by large-scale aerial spraying programs in which a very modest dose of DDT insecticide has been used to reduce numbers of needle-destroying budworm larvae — and with much success too! While the insect threat remains after several entomological attempts to count it out, the forest in general is in the best shape since before 1950.

DEFINITIONS

Spawning — depositing of eggs in water by female salmon and the fertilizing of these by male salmon.

Fry — fish freshly hatched from the egg in spring.

Small Parr — usually salmon in the second year of life.

Large Parr — usually salmon in their third year.

Smolt — the next older stage of salmon developing over winter from large parr and going to sea the following spring or early summer.

Grilse — a salmon which returns to its river after only one year at sea.

Salmon — an adult fish which returns to spawn after two or more years at sea, or returns the second time from the sea.

Generation — life for salmon is six or more years the first 3½ of which are usually spent in fresh water.

Spraying — emission of fine divided particles of liquid insecticide, in this instance DDT from low flying aircraft, many of which are intercepted by tree crowns but some reaching the ground level.

Dose — pounds of toxic material per acre.

Anadromous — running back to a river to spawn.

River systems in this region of continuous and precious forest include some of the best producers of Atlantic salmon remaining on either side of the ocean. All salmon interests are aware of the importance of these streams which will become even more important as salmon growers for tomorrow.

We are concerned here with the effect of pesticides on these waters and on their salmon production.

Gourmet Fish

The anadromous salmon of the Atlantic is not a world food fish as is its western brother, but is sought after by the gourmet — and who isn't one especially in fiddlehead time?

"Salmo Salar" affords a chancey living to a limited number of commercial fishermen, who use set or drift nets to take 80% or more of the total catch and it provides a world of fun for all anglers — the poachers, the legitimates and the fanatics who together take the remaining 20% or less on rod and fly.

Most salmon get to be big enough to eat in six years having passed from the egg through fry and parr stages, and having reached the smolt stage in fresh water, put to sea where they grow rapidly in size and weight and then as adult fish return, for the most part, to the river of their origin to spawn eggs.

We shall be concerned mainly with fry and parr, the age-size classes

Paper presented at the 50th Annual Meeting of the Woodlands Section, Canadian Pulp and Paper Association, held in Montreal, Que., March 18 - 21, 1968.

Although the authorities said one pound of DDT per acre would not upset wildlife seriously, it became obvious that the spray was getting into the rivers and killing some young salmon. However, surprises were in store.

present in fresh water at spraying time.

There have been great extremes in salmon populations if one can judge from the recorded commercial catches of the past 100 years. A steady decline in these from 1930 so alarmed fishing interests that they met in April, 1949, to discuss it. Those attending were from Ottawa and from the eastern provinces and they agreed that the trend in salmon numbers should be looked into. The Fisheries Research Board was invited to study the decline and make suggestions for improvements in salmon resource management which might arrest or reverse the trend. The board responded by expanding its salmon studies program. The Miramichi drainage basin and estuary was selected as the study area because it represented both angling and commercial fishing interests and was a well-known principal producer of salmon. By 1950, a counting fence for in-run adults and for outrun smolts was built and was operating on the Northwest Miramichi branch. In addition, statistics on catches were now being augmented by data from the board's estuarial traps. Population numbers of freshwater size classes of young salmon and other fish species were being obtained by electroseining on several streams. This, roughly, was the salmon fisheries study position in 1952 when forest spraying began.

DDT Harmless

In the winter of 1952, those responsible for the initial spray plan checked with available authorities and were assured that DDT, at one pound per acre, as used in the U.S. against the same spruce budworm, would cause no serious upset to plants, animals or fish. So, to make sure this advice was right, the project asked for and got a monitoring team of observers to keep an eye on the streams most likely to be contaminated. The observers saw some slight signs of DDT effect on fish but reported nothing of a serious nature in 1952 nor again in 1953 when the dose was halved.

By 1954, the spraying scene had moved south and east. A very large part of the Northwest Miramichi drainage was sprayed. Today it would be difficult to explain why sprayers (since 1952, Forest Protection Ltd.) knew nothing of the research board and its studies or that the board had no knowledge of the spray plan. But at that time, no conflict of interest had brought them together. This was soon to change. When the electroseining results were made known in the winter of 1953, these more than took the shine off a good forest spray effort which had just saved a whole young forest from certain impending death. According to his record, fry of the year were missing — well, almost. Small parr had been reduced to one-sixth and large parr to two-thirds their former numbers.

The Record

At first, few were inclined to believe the record, some because they thought it inconceivable that DDT could go this long without its ability to kill small fish having been established. Others, and FPL were of this mind, thought the mortalities indicated were much too high and that errors in censusing might be greater for the very small fry. Also it was felt that the almost total spray coverage of the stream drainage area in one season was not a typical case. But no matter how viewed, it was plain that DDT was getting into the rivers and killing some young salmon.

Fisheries scientists were concerned too for the fate of surviving parr. A large portion of their regular food supply now was missing because of the near elimination by DDT of several orders of their favourite heavy-bodied insects.

Because of this sudden turn of events, perhaps, the research board revised its study program which of course initially was not designed to cope with forest spraying. Canada Department of Fisheries, at the board's suggestion, extended merganser control to the entire Miramichi river system. This was a well-timed use of a proven management tool and made it possible for many a survivor of spraying to reach the sea safely.

Further surprises for the scientists came from the electroseining data of 1955. In contrast to the fry blank file of 1954, more than twice the usual number was recorded and parr survivors from the spraying of the year before did not starve to death or die from stress, as was feared, but survived surprisingly well on other than customary diet. Many insects came back — the smaller ones first — mainly the black flies, midges, etc., which provided ideal food for fry.

Not A Good Year

1956 was not a good year for sprayers nor a very lucky one. Late in the operation, the drainage area which supplied water to a fish hatchery was sprayed with a subsequent loss in salmon fry of 25% of the total stock. This carefully recorded effect makes the understanding of the elimination of native fry from a great stretch of stream by spraying a bit difficult when the same poison acting over a much shorter distance is seen to take but one in four at the hatchery.

In this same year, some of the Northwest drainage was sprayed again and the very numerous fish of the 1955 generation were reduced somewhat, but these were still plentiful and remained so until they went to sea.

A puzzling anomaly in 1958 was the large in-run of grilse through the counting fence. These were not due until the following year. Scientists, after a study of scales taken from the fish, finally concluded that the 1955 fry class split in two. Those which thrived best in surroundings very unusual for young salmon made the voyage to sea after only two years and the remainder went in the usual way a year later. Here is an example of the extent to which nature really abhors a vacuum and of an attempt by salmon to close the generation gap by a year. It had an important bearing on the angling success on this stream.

In 1957, New Brunswick and the Fisheries Research Board agreed to reserve the headwaters of the Northwest Miramichi for studies. This, by good chance, did not seriously affect the forest or subsequent spraying plans because the trees in the reserved area did not require further protection.

Was Not To Be

It now appeared that on this river a fairly complete story of the effect of DDT on young salmon might be available by 1960 or 1961. But this was not to be. A base metal mine shaft was pumped dry to make it ready for use. The effluent pumped out was weak acid of copper and

TABLE I — Angling catches of salmon in 1960, 1961, 1962 and 1963. C-Catch E-Effort rod days S-Sprayed P-Pollution D-Power U-Unaffected by spray.

		1960			1961			1962			1963		
		C	E	C/E x 10	C	E	C/E x 10	C	E	C/E x 10	C	E	C/E x 10
	Maritime region total	23,495	109,502	2.1	26,487	126,761	2.1	31,925	163,296	1.9	75,980	125,420	6.1
	Gulf area total	18,748	46,427	4.0	21,526	43,569	4.9	25,943	63,038	4.1	68,451	70,442	9.7
S	Miramichi system	14,064	34,142	4.1	16,571	32,364	5.1	19,784	48,706	4.0	58,182	57,060	10.2
S	S.W. Miramichi	10,445	24,351	4.3	11,647	22,798	5.1	13,633	28,187	4.8	45,556	42,275	10.7
PS	N.W. Miramichi	1,707	3,987	4.3	1,269	2,580	4.9	2,039	6,990	4.9	2,545	3,875	6.6
S	Little S.W. Miramichi	1,385	4,195	3.3	1,617	4,254	3.8	2,209	8,020	2.8	4,710	5,180	9.1
S	Renous	230	1,049	2.2	489	1,260	3.9	1,120	4,910	2.3	1,642	2,725	6.0
S	Cains	297	560	5.3	1,549	1,472	10.5	783	1,599	4.9	3,729	3,005	12.4
S	Restigouche system	3,102	4,991	6.2	3,432	5,480	6.3	3,620	5,232	6.9	7,446	5,807	12.9
S	Restigouche	2,278	3,555	6.4	2,405	3,750	6.4	2,575	3,704	7.0	4,917	3,651	13.5
S	Kedgwick	151	406	3.7	257	562	4.6	263	384	6.9	782	541	1.44
S	Upsalquitch	673	1,030	6.5	770	1,168	6.6	782	1,144	7.0	1,747	1,615	10.8
DS	Nipisiquit	243	905	2.7	338	1,360	2.5	516	1,570	3.3	334	878	3.9
S	Tabusintac	717	1,730	4.1	752	1,260	6.0	820	1,210	6.8	1,265	1,089	12.6
U	Margaree	140	1,050	1.3	147	1,035	1.4	505	1,240	4.1	335	1,190	2.8
	Atlantic area total	1,909	46,039	0.4	3,445	60,868	0.6	4,318	71,917	0.6	2,426	33,047	0.7
U	St. Marys	278	2,284	1.2	451	2,749	1.6	869	4,930	1.8	480	4,445	1.3
U	Moser	207	7,635	0.3	250	11,090	0.2	263	9,525	0.3	245	4,050	0.6
U	Sheet Harbour	167	9,715	0.2	333	14,605	0.2	449	21,495	0.3	304	3,161	1.0
U	LaHave	81	1,347	0.6	646	4,695	1.4	546	5,582	1.0	200	4,917	0.4
U	Medway	551	8,468	0.7	819	10,314	0.8	830	9,636	0.9	426	3,842	1.1
	Fundy area total	2,838	17,036	1.7	1,516	22,324	0.7	1,664	28,341	0.6	5,103	21,931	2.3
DS	Saint John (main) and Nashwaak	1,915	8,962	2.1	970	5,692	1.7	680	6,420	1.1	3,839	9,477	4.1
DS	Tobique	377	1,190	3.2	170	1,151	1.5	21	142	1.5	183	1,300	1.4
U	Petitcodiac system	166	1,110	1.5	82	606	1.4	423	1,382	3.1	170	626	2.7
U	Big Salmon	238	1,476	1.6	53	12,421	0.1	293	13,027	0.2	447	3,710	1.2

zinc and it eventually found its way to the main Northwest Miramichi above the counting fence. It so interfered with the faculties of in-run spawners in 1960 that many of these gave up the ascent of the main stream and backed off to several of the lower-down branch streams. This situation could not be corrected easily or in a short time. Kerswill, in July, 1961, said, "This additional and local change in the environment of salmon confused the research situation on the Northwest Miramichi insofar as getting further evidence of effects of earlier DDT spraying on runs of 'adults'."

Study Confounded

Such confounding of a study must have hurt more than superimposing spraying on the original study. In the short run, the sprayers gained — because some of the criticism over interference with salmon was now being directed at others — but what was lost was the total minus-and-plus effect of the spraying and this was most unfortunate.

The board did not have reliable statistics on spraying effects apart from the Northwest Miramichi river and was now forced to use this one stream. Anytime effects of spraying on other streams were "guesstimated."

Very large spray programs in 1957 and 1958 probably had, in total, more effect on stream fish-life than all others combined, because the river systems involved were heavily involved.

Before these took place, warnings of the devastating effect spraying would have on salmon stocks were sounded by scientists. There was not much favourable reaction to these — not by the sprayers, nor by angling outfitters who were not really interested in fishing futures, especially poor ones.

A great cooling out of the budworm outbreak was observed in the Gaspé peninsula in 1957 in sprayed and unsprayed forest alike. In 1958, it continued southward and by the

TABLE II — Comparison of catches of salmon in the Miramichi system for the years 1961-1967.

Year	Angling catch of grilse and salmon, numbers of fish	Commercial catch salmon only, in pounds of fish
1961	16,600	267,000
1962	19,800	365,000
1963	58,200	369,000
1964	31,100	596,000
1965	43,000	597,000
1966	57,500	651,000
1967	51,900	869,000

TABLE III — Commercial landings of Atlantic salmon in the Atlantic provinces and Quebec in recent years in thousands pounds.

	1961	1962	1963	1964
Nfld.	2093	2239	2677	2462
N.S.	279	312	301	266
N.B.	584	723	640	1039
Que.	509	501	432	590

Spraying should get two credits — it has helped replace any losses it created initially and it has the ability to make a stream ready for growing a very high-population generation without in any way destroying the habitat.

end of the season there was only a hard core of infestation left in the Miramichi region. Forest Protection Ltd. had been hoping for such an event to bring spraying to an end. Sprayers were happy also to find out that the insect could subside in spite of spraying.

Spraying In 1959

It was decided in the fall of 1958 to await the full eclipse and do no spraying in 1959. The pest set up somewhat the same spraying sequence as on the Northwest Miramichi in 1954; widespread large-scale spraying programs for two years followed by a year of respite. This time there were no counting fence records nor much electroseining. One must postulate from the evidence contained in angling and commercial catch returns what happened.

Spawners in 1957 found the rivers still to their liking and the fry hatching in 1958 were extremely high in number. Their enemies were practically non-existent and the food, while it came only in small mouthfuels, was plentiful for the small mouths. Where the spraying was repeated in 1958, fish of this large generation were reduced in numbers, but they still greatly outnumbered their older brothers and as for the numbers of fry in 1959, it was like 1958 all over again. This was possible because suckers and eels were gone, mergansers had either been shot or had starved or had been poisoned, competing fish were scarce and aquatic insect food gradually became available to the very large numbers of small fish as these continued to grow from one size class to the next.

The sprays hurt the 1957 parr population too and this caused at least some of the drop noted in the 1959 angling catch, and smolts should have been scarce from 1958 through 1961. Thus far the board's predictions have held up. Then a corner was turned. A great smolt out-run in 1962 went practically unnoticed. The grilse and salmon from the 1958-59-60 generations came in from the sea for the most part in 1962, 1963, and 1964.

Angling Loss

How great was the angling loss from spraying? It's difficult to say. The catch in the region went down by one half but only for a short time. A notable case of a much more serious nature occurred in 1955 when the entire Maritime commercial catch took a 60% drop and didn't recover for several years. In this instance, for which no real satisfactory explanation has been or can be made, spraying was not involved, and fortunately so, as witness a later report in *Trade News* — "In 1961, the Maritime commercial catch totalled 1,200,000 pounds or 7% below the 1960 level and continued the decline predicted as a result of DDT spraying on survival of young salmon in the Gulf area"!!!

Let's assume spraying was responsible for all the decline in the angling catch from 1959 to 1962 in sprayed regions and that is giving a lot because the trend was down in neighbouring regions as well. As noted, it was a short-lived decline and instead of going to 25% of average and then lower and lower, it stayed above 50% and then jumped up well over 100%. The dramatic upturn as evidenced by the catch statistics is difficult to argue down. The sprayed rivers show the great improvement especially the powerless ones. Attempts to explain this as anything but a plus value from spraying are not convincing, though they can be found in print. Forest Protection Limited believes these extra fish result from the 1957 and 1958 spraying operations (Table I).

Dose Halved

By now, most of the effect of the 1960 and 1961 spraying operations has made itself felt. In these sprayings the DDT dose was halved once more to ¼ pound per acre because of pressure from Canada Department of Fisheries, but more spray could have gotten to the streams, so the total gain to salmon may not be real. But if one judges from the angling and commercial catches in the Miramichi for the past few years, the reduced rate helped salmon to some extent, even if it contributed nothing to the main purpose of the spraying.

In 1963, the sprayers began to buffer salmon streams against direct contamination by DDT. A zone about ¼-mile wide on either side of the larger streams in the spray plan was kept almost free of DDT and the infested forest in the zone was sprayed with another insecticide which, in the dosage used, does not affect fish or aquatic insects. This is a complicated spray exercise but seems to have paid off well — better than expected by the sprayers who were sure that the unwanted contamination influx of DDT from small undetected streams which now on the evidence does not seem to be so. Fisheries scientists would like to see all streams so treated, which is not possible without spraying all areas with the zone insecticide. It has not been feasible to do this because there has been no adequate all-over substitute for DDT available.

Already Reflected

This change in technique, expanded and improved since 1963, is already reflected in the salmon statistics. It is a fact that where the two insecticides are used in this complementary fashion with due care, it has become most difficult for fisheries officers to show statistically that spraying has taken place.

A further corroboration of the

FISHERIES BOARD ANALYSIS

Steps in FRB analysis of spraying effects on certain salmon rivers. Results are expressed in percent of "normal." Here "normal" means the total annual catch without any effect of DDT on it.

(1) measure on a map the total areas of watershed available to salmon;
(2) measure the proportion of each area affected by DDT in each year since 1952;
(3) calculate the percentage kill of each of the three different size groups of young salmon on the basis of Northwest Miramichi observations, and thus obtain the percentage survival to large (pre-smolt) parr in the various years;
(4) convert these indices for large parr to adult grilse and large salmon, on the basis of trap records for the Miramichi and Tobique, and angling records for the Restigouche and upper main Saint John River.

success in keeping DDT out of main streams appeared in a press report of a meeting of a county council which said, "There should be an investigation to find out what was the matter with spraying for it wasn't even killing the black flies." DDT *does* and the zone insecticide *does not* kill black flies.

Spectacular Gain

After a spectacular gain in 1963, the salmon catch in the Miramichi has remained high. The five-year angling catch, for example, is very much higher than for the prespray effect period 1949-1958. This seems to hold for all spray area rivers. There is no evidence that salmon streams outside the influence of spraying have increased production in the same manner. Now if this is correct there are two credits which should be given spraying. First is the replacement, with some to spare, of any losses in salmon which spraying may have caused. This happened on the Northwest Miramichi before the confusion was further compounded. It is not automatic however, for reasons already given, that fish losses due to spray will be made up in the spraying years. Perhaps in most cases where DDT is the chemical used, this will take place only at the end of a continuous spraying activity. In the case of New Brunswick rivers, it is the good fortune that replacement began five years ago out of spraying actions 10 years ago.

The second, and perhaps in the long run more important gain, is in the ability which the poison has, without in any way destroying habitat, to make a stream ready for the growing of a very high-population generation. It appears that this has done more to bring about the present excellent condition of the salmon resource in the Gulf region than any event since the research board studies began.

Never A Good Thing

Overall the gain from spraying probably far outweighs the loss. Fisheries scientists readily admit that replacements due to spraying occur but perhaps would not say that poisoning such as caused by spraying followed by free restocking by the anadromous adult salmon is ever a good thing.

At the time of the Resource Minister's Conference in 1961, Kerswill said the future aim in angling catch should be 75,000 fish for the Maritimes, Quebec and Newfoundland. The angling catch on the Miramichi

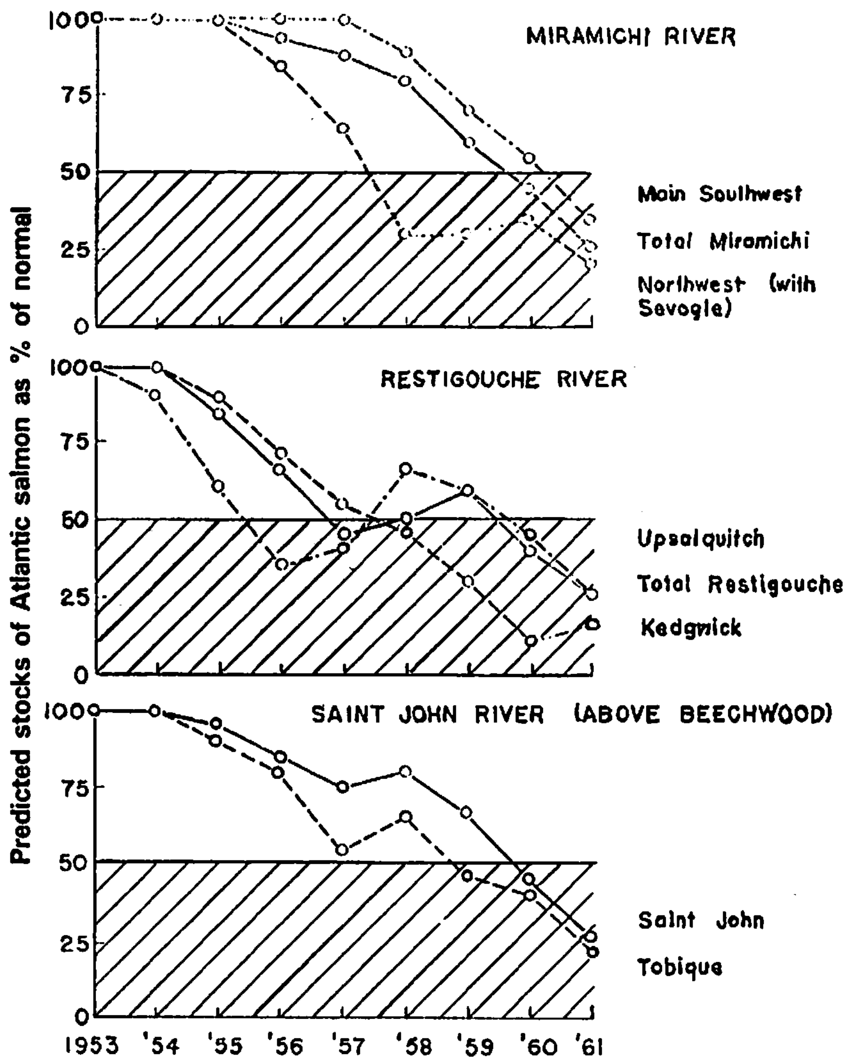

FIG. 1. From Trade News, June, 1958, Dept. of Fisheries of Canada.

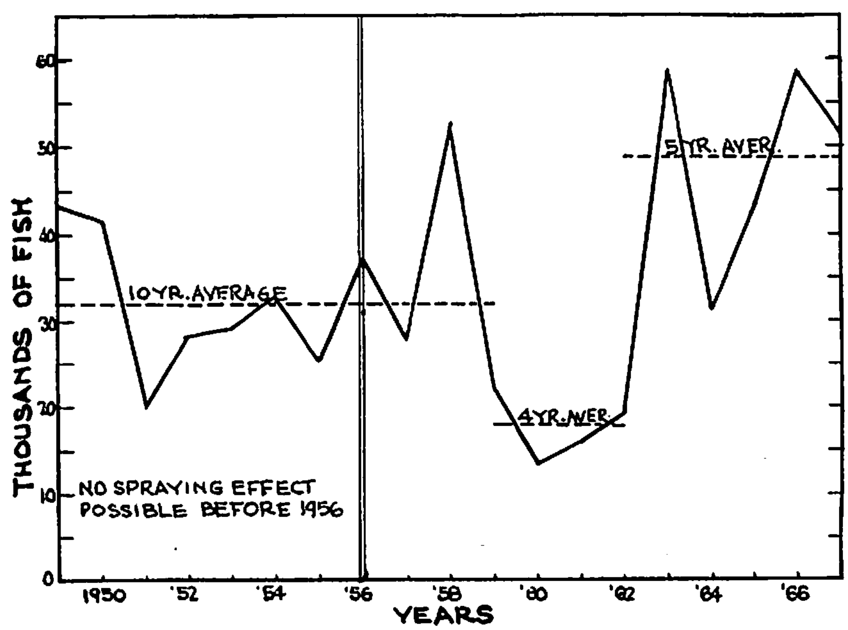

FIG. 2. Angling catch, Miramichi River system, 1949-1967.

DDT, dammed up and down the western world, has done a good job in New Brunswick, but there are signs that it lacks some of the old-time punch for spruce budworms. Experience with DDT gives guidelines for future use of pesticides.

for the past few years has exceeded this rate (Table II).

The commercial catch in 1964 jumped upward over 200,000 lb. and has increased substantially since. The 1964 salmon in most cases date from the 1958 spray year in which they were eggs spawned in the late fall (Tables II and III).

Better Now

These statistics indicate that the salmon resource is much better off in the sprayed part of New Brunswick now than in 1949 and 1950 which were pretty good years.

Effects of spraying are impossible to isolate in the case of salmon exposed also to outside influences other than spraying. A classic case is the Tobique branch of the Saint John River. The Saint John is the greatest river system between the St. Lawrence and the Hudson. It is not the largest salmon producer in New Brunswick, but it has been an important one on that part of the system, below Grand Falls above which there are no salmon. Since studies began in 1949, there have been three power developments on the river — Tobique narrows, Beechwood and Mactacquac, chronologically in a down-river direction. All these have affected salmon in years when forest spraying of parts of this river system took place. In the six to seven construction years, there was of course much serious dislocation of in-runs. Fishing became fabulous in places where fishing did not exist before, just down stream from construction. Then there followed certain difficulties in attracting salmon to fishways after construction and finally the salmon problem of finding the top of the flowages in time to meet the anglers. The Tobique branch suffered a great decline in angling and became so poor that it was given up entirely by one salmon club.

Not Producing

Although the habitat on the main river was changed out of all recognition by the dams and their operation, the upper Tobique is unchanged but is not producing what it should in young salmon.

The spraying effect on the Saint John is unknown but must be somewhat like that on other rivers with the same spraying history. Since the salmon situation on the Tobique is quite unlike that of the Restigouche and Miramichi systems, the difference must be attributed to some force other than spraying. Ironically it is only on this river that the 1957 prediction of future salmon runs have held up well.

Salmon production on the Saint John, as a result of the building of the giant Mactacquac Dam, is to be a completely managed business, new for the region. The Department of Fisheries has embarked on a program which will raise 500,000 salmon to smolt size at Mactacquac each year. The in-run adults in excess of those required for stripping will be transferred to angling water. In this way it is hoped to put the commercial fishing on a sound footing and help anglers as well. If it works out, it will be an outstanding example of salmon water lost without loss of salmon.

Effects Mixed

Effects of DDT on the salmon resource have been mixed. For some fish, it has meant an early death, for others a better life than otherwise they would have enjoyed. For the local fisheries of both kinds it caused some dislocations which could have been worse and which were of the kind that sometimes occur and for which there is no explanation. As the experts have said, "Until a point below 50% of average is reached, it is difficult for a fisherman of any description to see trends in fish populations." The dislocations of short duration have been followed by excellent fishing.

As to the resource itself, spraying has most probably had a big plus effect but perhaps because of a great assist from above-water predator control.

About the unfolding of the spray program and its side-effect brush with salmon, there is an air of serendipity. Let's say there was a fully-qualified ignorance in all directions at first and only now are we realizing how much worse it might have been for the forest and the fish.

It would be a good thing if the Tobique and the Northwest Miramichi were brought back to growing their full complement of salmon again and to find out why the Nashwaak river does not provide more. Since the first named is going to be part of a new game in fish management and the second seems to be suffering unnecessarily because of a few miles of acid water and its accompanying studies in pollution, perhaps they could be coaxed into a vibrant condition once more by a judicious use of poison and a bit of adult fish transfer so that angling, such as it is, for a short time would not suffer.

Never Again

We shall not experience spraying of this kind again, i.e. the kind from which we can draw some leads in growing salmon. Future spraying will have less effect for bad and for good on all life in water. DDT, which is being damned up and down the western world, has done a good job in New Brunswick but there are signs now that it lacks some of the old-time punch for budworms. Forest Protection Ltd. is ready to replace it when the time comes and effects associated with its use on off-target organisms will then take on an historical aura. The DDT experience should help to develop guidelines for future use of pesticides in forest protection.

In these days of data processing and brain bending, we must hold fast to the idea of managing the biological complex, of which the forest is a part, in a natural way through understanding natural processes and to resist the temptation to impose a gross management will on nature. This is a hard road but the only one in the long run.

It is what Rachel Carson meant when she wrote *Silent Spring* — and she could hurt with words!

It is what first Forest Protection Limited president V. E. Johnson, a noted salmon angler and forest user and the leader in the decision to spray to protect a business enterprise, meant when he said years ago — "Let's give nature a hand."

P&P

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The North Shore Leader. *Published weekly in Newcastle, N.B. for catch statistics in the Miramichi River system.*

Appendix 10

FISHERIES RESEARCH BOARD OF CANADA

BIOLOGICAL STATION

ST. ANDREWS, N.B.

REPORT ON ACTIVITIES TO INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

1. Insecticide Toxicity: In the summer of 1968, laboratory tests were made on the toxicity of the non-DDT insecticides listed below. The threshold values shown are for concentrations lethal to 50% of the population. Atlantic salmon parr was the test animal.

Insecticide	Lethal threshold (mg/litre)
Phosphamidon	1.10
Sumithion	0.75
Baygon	2.40
Matacil	1.35

The toxicity of a 1:1 mixture (by weight) of Phosphamidon and Sumithion appears to be somewhat less than the additive toxicities of each insecticide separately.

The toxicities of potentially-useful insecticides labelled C-8353 [2-(1,3-dioxolane-2-yl)-phenyl-N-methylcarbamate] and C-9491 [O,O-dimethyl-O-(2,5-dichloro-4-iodophenyl)phosphorothioate] will be tested shortly.

2. Laboratory Studies on Physiological Effects of Sublethal DDT: While the following unpublished results come from laboratory work, and their ecological significance, if any, is far from understood, it was nevertheless thought that the Committee might be interested in them.

Note: "Sublethal" refers to exposure of the test organism for 24 hours to DDT ranging from 10 to 300 parts per billion.

Lethal Temperature: Sublethal DDT markedly raises the lower lethal temperature of brook trout and salmon. This might account for the field observations, reported on several occasions, that following the onset of cold water temperature (5°C or less) in the autumn, dead salmon parr are seen in large numbers in streams which had been exposed to aerial spraying by DDT in the spring.

Lateral Line Function: A paper entitled EFFECT OF SUBLETHAL DDT ON LATERAL LINE OF BROOK TROUT, *Salvelinus fontinalis*, (by J. M. Anderson) will appear in the December issue of the Board's Journal. The abstract is as follows:

The lateral line nerve of brook trout responds to an abrupt low frequency pressure wave, generated by a falling drop of water hitting the water surface, by a relatively short high-frequency burst of large spikes. The burst duration has a negative temperature coefficient. Twenty-four hour exposure of trout to DDT, ranging from 0.1 to 0.3 ppm, renders the lateral line nerve hypersensitive to the experimental stimulus; in particular there is a marked increase, especially at the colder temperatures, in the negativity of the temperature coefficient of the burst durations. The results are discussed in general terms, as well as specifically in relation to other laboratory work which shows that sublethal DDT affects behavioural responses of fish to temperature.

Central Nervous System: A paper entitled DDT: SUBLETHAL EFFECTS ON NERVOUS SYSTEM FUNCTION IN BROOK TROUT, *Salvelinus fontinalis*, (by J. M. Anderson and R. H. Peterson), was this week submitted to SCIENCE for publication. The impairment of learning in fish by DDT is new and has interesting research possibilities. The abstract is as follows:

When brook trout are exposed for 24 hours to sublethal doses of DDT, the cold-blocking temperature for a simple reflex, which shows lability related to thermal history, is altered in a way suggesting that DDT is affecting the thermal acclimation mechanism. Sublethal DDT also prevents the establishment of a visual conditioned avoidance response.

Propeller Tail Reflex: DDT prevents brook trout from being conditioned to show the propeller tail reflex (light is the conditioning stimulus; electric shock the unconditioned stimulus.) This work is currently being written up.

Temperature Selection: New results on the effects of DDT on the temperature selection of brook trout, Atlantic salmon, and rainbow trout, are in hand which considerably up-dates our earlier work in this field. These data are also being written up for publication.

3. Popular Articles on the Effect of Forest Spraying

I would like to bring to the attention of the Committee an article by B. W. Flieger, "A FISH STORY - ANADROMOUS, i.e.", which appeared in the September 20, 1968, issue of WOODLANDS PULP AND PAPER MAGAZINE OF CANADA. The intended message, certainly the main theme, of this paper was that DDT spraying is good for salmon....e.g. page 95, "....in the long run (the) more important gain (of DDT spraying) is in the ability which the poison has, without in any way destroying habitat, to make a stream ready for the growing of very high-population generation". This hypothesis is clearly not a trivial one. It is one of enormous importance and significance, if true. In my view, however, the evidence for it is highly questionable.

In fact the hypothesis put forward by Mr. Flieger is so revolutionary that in my opinion it should first appear in a primary-publication scientific journal where it would be subjected to the rigorous and scientifically impartial scrutiny normally associated with good scientific reporting. With that sort of back-up support, then a popular article would be very much in order.

As one of the laboratories charged with the responsibility of assisting in the difficult task of the sound management of the fisheries resources in the Maritime area, popular articles of Mr. Fleiger's kind serve as a potential source of great difficulty in our dealings with the public.

I realize, of course, that Mr. Flieger's publishing activities are not the responsibility of the Interdepartmental Committee. Perhaps, however, it should be their concern.

Dr. P. F. Elson, in charge of our Anadromous Investigaion, has prepared a few notes on Mr. Flieger's article. They are attached.

J. M. Anderson,
November 16, 1968.

COMMENTS ON "A FISH STORY - ANADROMOUS, I.E." BY B. W. FLIEGER

PULP & PAPER MAGAZINE OF CANADA, SEPTEMBER 20, 1968,

WOODLANDS SECTION, WS INDEX 2460 (F-3) ODC 453:414

(pp. 91-96)

1. In introductory paragraph there is implication that Rachel Carson's documentation of salmon--DDT relationships in Miramichi, appearing in "Silent Spring", pp. 129-135, is inaccurate. This is unfounded: Carson's information was supplied by direct correspondence with C. J. Kerswill. If my recollection is correct, Dr. Kerswill checked this section of Carson's chapter before publication. The documentation <u>does</u> "Square with the record" up to time information was supplied (about 1957 or 1958, I think).

   Had forest spraying with DDT continued at the 1954-58 level there is little doubt in my mind that DDT would have contributed the largest portion to extreme reduction and quite possibly elimination of salmon from sprayed rivers.

2. The author's assessment of salmon values is somewhat inept. Salmon do not afford a chancey living to a limited number of commercial fishermen, plus some sport for others. They provide an important, if not large, seasonal income for professional fishermen which the fishermen claim is a very important item in keeping them in the fishing business. The sport fishery may take a comparatively small segment of the total salmon harvest, but is none the less the basis of an industry variously estimated by economists as a 2 million to 10 million dollar annual business for New Brunswick (Grasberg, 1956); Tuomi, draft in 1968).

3. The author is correct that the Federal Fisheries Ministry was informed of early spray plans for New Brunswick and invited to send observers or set up other associated studies. The Ministry's response was not sufficiently vigorous to bring out actual effects of DDT on salmon.

4. The FRB was certainly notified of spray plans for the Northwest Miramichi in 1954 and it is my recollection that FRB proposals to monitor effects on this stream, which had been selected for salmon studies beginning in 1950, did involve advance contact with Forest Protection Limited.

5. The electroseining results referred to were part of my responsibilities. They are given in some detail in my article in J. FRB, 24(4). In 1954, the year of first spraying, a total of 2 or 3 underyearlings were taken in the same areas that previously yielded over 1000; in years after spraying ceased, numbers again approached the high value.

Unquestionably there are errors, sometimes quite large, in estimating small fry, but the development of 95% confidence limits for many of the estimates indicates the errors do not even approximate the 1:300 ratio Flieger seems to imply; at most they indicate about 1:2 ratio and seldom that.

6. Although numbers of insects for parr food were rapidly restored, the balance of faunal types was swung to small insects. These were among most suitable types for under-yearlings and were utilized by larger fish. But total biomass was reduced to below one-half unsprayed values for several years. Hence total growth potential for young salmon populations was also reduced.

7. The statement that the fry class of the first post-spray year was about double earlier abundance is factual. This is discussed in Elson, 1967 (J.FRB, 24(4)). Similar increased abundance was observed in the unsprayed Pollett River in southern New Brunswick, in a Prince Edward Island stream, and apparently in the Margaree River of Cape Breton. It was apparently a general feature of Atlantic salmon reproduction in 1955 and cannot properly be attributed to any effect of forest spraying.

8. When the Northwest Miramichi was sprayed for the second time, in 1956, young salmon in the lower, sprayed reaches were reduced as in other sprayed streams. The unsprayed headwaters, normally producing more salmon per unit area than the lower reaches, apparently supplied most of the smolt output in succeeding years.

9. It is true that base metal mine effluent has reduced production in lower reaches since 1960, and this obscures some effects of DDT, particularly those after spraying stopped, i.e., masks full impact of recovery from spraying.

10. Reference to "guesstimating" effects on other streams is untrue. Electroseining was carried out on several other tributaries of the Miramichi than the Northwest (Main Southwest, Dungarvon, Renous, Cains) and on several main branches of the Tobique system. Similar population patterns were obtained to those for the Northwest Miramichi in relation to time of spraying.

11. Reference to removal of competitors and predators is correct for immediate post-spray years, but by 1960 eels (both competitors and predators on young salmon) were almost twice as abundant as before spraying. Most Northwest Miramichi eels in the lower reaches are now affected by base metal mine effluent. Above the effluent they have, beginning

2-4 years after spraying, regained pre-spray levels. Downstream from the mine effluent they show a decrease below pre-spray numbers down to the Sevogle inflow. However, farther downstream (attributable to dilution of copper-zinc), they are moderately abundant (several times pre-spray incidence above the Sevogle).

For other species of coarse fish the history of abundance is similar to that for eels. The author's statements, inasmuch as they concern other fish, must be based on data only to 1957, (Keenleyside, 1959 - Can. Fish Culturist, No. 24)--none has been published since.

12. Statements about reduced predation as far as they concern mergansers are probably correct. Control operations were stopped about 1960, because there were so few mergansers that FRB information did not indicate continued control was warranted. Continued sampling of merganser incidence by Department of Fisheries patrols does not indicate recovery of merganser populations on the Miramichi by 1968 to anything approaching pre-spray abundance. Such a reduction would be in accord with published information on sublethal effects of DDT on birds by reducing viable young. This type of merganser control might be expected to continue as long as substantial amounts of DDT are used in local forest spray programs. It should be noted that a systematic and intensive merganser control program on the Margaree River from 1962-68 has not produced rising angling catches--why should such benefits be as conspicuous on the Miramichi as the author implies?

13. The author's choice of catch statistics involves limitation to periods and places which can be misused to support his contention that DDT increases salmon stocks. He ignores past work on fluctuations and cycles. He ignores that the mid-fifties were a generally low period in nearly all Atlantic salmon areas, and that the late fifties and early sixties saw a generally rising trend in all areas, including those, e.g., Newfoundland, never subjected to spray. In my opinion the 1959-62 slump shown on his Fig. 2 would probably have been an especially high period had it not been for spraying--particularly for angling since it apparently involved a change from a moderately good proportion of large salmon to predominantly grilse populations in some streams (grilse have one less year of sea mortality).

Recently the Northwest Miramichi has had 10% or less of large salmon, whereas previously to 1958 it had up to one third or more large salmon. For this stream, copper-zinc pollution has doubtless contributed as much to the continuing change as DDT, probably more.

14. Use of catch statistics (Tables I-III) ignores probable effect of environmental factors on catches. The year 1962 was comparatively good for angling in many unsprayed streams because of suitable river discharge patterns. Yet the Miramichi had to await 1963 for such improved angling-- the year corresponding to first returns from an unsprayed year-class hatched in 1959. All three tables show data only for the recent period of increase, starting with, for N.B., the recognized nadir of depression which can be associated with DDT. This could be construed as an attempt to array data to support the author's fallacious argument that DDT is beneficial to salmon!

15. The Tobique system was yielding some good data on salmon-DDT and salmon parent-progeny relationships when new hydro-electric developments upset continuity of observations in 1967, especially. After depression from spraying, populations were recovering normally until recent construction interfered (see Elson and Kerswill, 1966, Munich Conference paper, and Elson, 1967).

Most of the author's argument must be classed as either inept or spurious. The only idea which, in my opinion, has any merit at all is that unintentional merganser reduction, which seems to me to still be a reality, may give some benefits via survival of parr populations. This is an idea I have several times expressed verbally. But much as the idea may appeal, it is difficult to support it on the basis of current Margaree results.

P. F. Elson

St. Andrews, N.B.
November 15, 1968.

Appendix 11

Summary of

Canadian Wildlife Service Projects

directed by C. David Fowle

-1968-

(1) <u>Ecological investigations</u>

(a) Habitat selection of forest birds in Central New Brunswick.
by W. G. Wilson

(b) Habitat selection and food of wood warblers.
by Miss Joanna MacLean

(2) <u>Residues</u>

(a) Transmission of residues in the food chain and life cycle of yellow-bellied sapsuckers.
by R. S. Gibbon

(b) DDT residues in small mammals.
by C. D. Fowle

(3) <u>Toxicity</u>

(a) Comparative study of the effects of five pesticides on forest birds.
by C. D. Fowle

For Interdepartmental
Committee on Forest
Spraying Operation

November, 1968

In addition to the monitoring of operational application of pesticides, reported by Mr. Peter Pearce, the Canadian Wildlife Service carried out several other investigations related to the spruce budworm control program in New Brunswick which were conducted under the direction of Dr. David Fowle, Department of Biology, York University.

1. ECOLOGICAL INVESTIGATIONS

(a) Habitat selection of forest birds in Central New Brunswick

.... by W. G. Wilson

The field work has been completed and a report in the form of an M.Sc. thesis at York University accepted. It is now being prepared for publication. It contains the first estimates of population density and discusses factors affecting distributions of the more common species. From limited observations it appears that operational application of DDT in the budworm control program has no obvious immediate effects on population or behaviour. The work will be useful in developing improved census methods and in predicting hazards to birds in spray operations in various forest types.

(b) Habitat selection and food of wood warblers

...... by Miss Joanna MacLean

Several species of wood warblers (genus: Dendroica) share the habitat provided by the forest canopy and are thus among the birds most likely to be effected by forest spraying. They also include species which change in abundance in relation to the abundance of budworm.

This study concerns the details of behaviour relating to habitat selection and ecological separation of species seemingly occupying the same habitat. Field work near Boisetown in central New Brunswick in 1967 showed that the model proposed by MacArther (1958)[1] for ecological separation did not apply is well in the mixed forest as it seemed to in the more purely coniferous stand he studied. In 1968 field work was started in the Fredericton region and then was moved to the Green River Forestry Station in northwestern New Brunswick. Here work in a more boreal forest type was continued and experiments working with caged birds were undertaken. Preliminary analysis suggests that habitat selection is in fact more clear-cut than had been thought before. Moreover, behavioural differences as well as differences in food preferences may keep the species apart.

Experimental work shows differences in preferences for perching surfaces and sizes of perches. These preferences and variations in feeding behaviour are being related to morphological characteristics such as the length of tarsus and type of bill and to the habitat occupied.

2. RESIDUES

(a) Transmission of residues in the food chains and life cycle of the yellow-bellied sapsucker

.... by R. S. Gibbon

Sapsuckers are common, widely distributed woodpeckers in the forests being sprayed. They feed on sap and insects, are conspicuous, and

[1] MacArthur, R. H.
Population ecology of some warblers of northeastern coniferous forests. Ecology 39 : 599-619

nest in cavities which are relatively easy to find. They are, therefore, particularly useful for following the transfer of DDT residues in the forest ecosystem.

The field work for this program was carried out on the Priceville Study Area in 1967-1968 where there is a 12-year history of spraying with DDT. Other investigations have shown that there is a substantial accumulation here of DDT and its residues in the upper soil layers and elsewhere in the forest.

In 1968 the investigation of behaviour and breeding cycle were continued and extended to answer questions raised by the work the previous year. Additional specimens for a residue analysis were collected.

The specimens from 1967, analyzed by Dr. L. Reynolds of the Ontario Research Foundation, yielded the following results. The brains of adult birds, nestlings, eggs and several food items all contained DDT or breakdown products showing that the material is being transmitted through food chains and from one generation to the next. Data for some whole body analysis and organs are available and additional information will be forthcoming from the 1968 collections.

(b) DDT residues in small mammals

..... by C. D. Fowle

Analysis of shrews and rodents collected in the Priceville Area in 1967 showed unexpectedly high levels of DDT and breakdown products in the brains of shrews and substantial levels in some rodents. Additional specimens collected in 1968 are being prepared for analysis now.

3. TOXICITY

(a) Comparative study of the effects of five pesticides on forest birds

.... by C. D. Fowle

The effects of the operational application of phosphamidon was monitored in 1968 and all data on phosphamidon collected since 1964 has now been brought together and is ready for review prior to publication.

In July, 1968, a series of tests were carried out on 22 species of freshly caught birds using five pesticides: Baygon, Matacil, Zectran, Phosphamidon and Sumithion. Most of the tests involved oral dosing but some tests of dermal toxicity and several inhalation experiments were done. In general there seem to be striking differences in the response of the same species to the several pesticides as well as considerable variation among species when one compound is tested. The results throw some light on the variations in response among species that we have observed in monitoring operational spraying.

ACKNOWLEDGEMENTS

As usual I am indebted to Mr. J. A. Keith of the Canadian Wildlife Service and others in the Service for advice and encouragement. All the staff of the Green River Forestry Station were very helpful but special thanks are due to Mr. Stewart Gage.

My thanks also to my associates in the field party, including Peter Pearce and Stanley Teeple of the Canadian Wildlife Service, Miss Joanna MacLean, Messrs. W. G. Wilson and R. S. Gibbon, my graduate students; Miss Joanne Cordingley, my technical assistant, and student assistants, Stewart Robinson and Simon Lunn.

Again, as in years past, we are grateful to the officers and staff of Forest Protection Limited for facilities, assistance and encouragement.

C. D. Fowle
November, 1968.

Environmental Contamination - Pesticides

By

W.N. Yule

Chemical Control Research Institute

Forestry Branch

Department of Fisheries and Forestry

Ottawa, Ontario

November, 1968

Environmental Contamination - Pesticides

By

W.N. Yule

Summary of Progress

Research has been concentrated on the distribution of DDT forms in the forest environment resulting from long-term aerial spray programmes for controlling the spruce budworm in New Brunswick. Sampling and analysis of DDT have been carried out on soil, water and air, which are considered to be the main media of transport or storage in the physical environment of the forest. Preliminary results of exploratory experiments are given in this report, and ecological interpretations are begun, with particular reference to the Priceville study area (see Macdonald, D.R. and J.R. Duffy, Forestry Branch Internal Report M-27, March 1968). A considerable amount of methods-development has been undertaken for the sampling and the analysis of DDT's in soil, water and air.

Soil

The profile and surface samples of soil that were collected from the Priceville area in 1967 have been analysed, and the following results obtained. (1) Approximately 25-40 per cent of the total DDT reported to have been sprayed over the area since 1956 (70 oz./acre) was found persisting in the forest soil in September, 1967. (2) Of this total amount, an average of 1 oz./acre fell directly on the surface of the soil from the aerial spraying of 8 oz./acre in June, 1967. Presumably, the remainder of the emitted dosage, less the amount lost to the atmosphere, deposited on the foliage. Analysis of cast foliage and plant debris collected from the surface of snow drifts, and of still-attached dead beech leaves collected before the 1967 spraying, indicated that foliage drop is a major route of DDT increment to the soil. (3) The DDT persists in the soil mainly as the pp' form, with only a small increase in DDE compared to the original formulation applied. (4) Almost all of the DDT residue occurs in the surface organic layer of the soil profile, and all of it is contained in the top 6 inches. Consequently, very little leaching or breakdown of DDT appears to have occurred during its long exposure in the forest soil. (5) Soil bioassay with Drosophila flies demonstrated that, although the DDT persists mainly as the most toxic isomer, in considerable quantities, and in a position where it is readily available for uptake by plants and terrestrial animals, the sour, highly-organic topsoils appear to have bound, physically and/or chemically, the DDT molecules to a large degree. Consequently, the biological availability (and ecological significance) of the toxic residue is very much less (eg. 50-200 times depending on forest and soil type) than purely chemical analysis would indicate.

The results on forms of DDT found persisting in Priceville soils were quite different from those published by G.M. Woodwell, (Forest Science, 7, 194-6, 1961; Science, 145, 481-3, 1964) for soils collected at Budworm

City in Northern, N.B. To resolve this question, soils were collected in 1967 from Woodwell's original sampling site, and the results on DDT forms found at Priceville were confirmed for the Budworm City locality. Our identification of DDT forms was made very thoroughly by comparison of gas chromatograms (GC) of soil extracts on three different columns against pure standards of pp' DDT, DDE, DDD and op' DDT. Qualitative confirmation was obtained with thin-layer chromatography (TLC). Thus, the results on DDT forms given by Woodwell are in error, possibly due to the less discriminating colorimetric method of analysis used for his analysis, and his hypothesis of differential weathering and preferential retention of the op' DDT form by forest soils is mistaken.

The collection and analysis of biological systems originating in the forest soil have begun, and it is hoped that ecological pathways and plant-animal food chain transfers can be determined in future work. Intensive surface-soil sampling of three 1/5 acre study plots, as well as three parallel transect sample lines of the whole 1000 acre Priceville study area, have been made during the summer of 1968 to obtain a statistically-reliable residue survey of a relatively small area with a common spray history, as a contribution to the overall ecological study that is being made there. If residue-variability within and between different forest and soil-type portions of the Priceville area is acceptably small, the DDT survey will be extended to areas of Northern N.B. and Gaspé, comprising a variety of forest and soil types with a combination of known spray histories. Background information on the forest soils found in these areas is being sought this winter.

Water

The water samples taken from Crooked Bridge Brook below its exit from the Priceville study area in 1967 have been analysed by GC, with the help of A.D. Tomlin. A selection of the results for various time intervals after the 1967 operational DDT spraying are given in Table I. It appears that a low, relatively steady residual concentration of approximately 0.5 ppb. of pp' DDT occurs in the waters of Crooked Bridge Brook. A dramatic increase in DDT concentration occurred during and for a few hours after spraying, existing mainly as a floating surface oil film, and returning to the steady low level within 12 hours. These same general orders of concentration and time occurred also in the main river systems into which this small brook flows ie. Big Hole Brook and the S.W. Miramichi River, according to samples taken near Doaktown. Another interesting preliminary result which will have to be investigated more thoroughly is that samples of these river sediments were found not only to store DDT residues as does soil, but some chemical changes appear to have occurred in isomer composition of the residue (detoxification?) in this environment (anaerobic?). A series of sediment samples was taken from the Miramichi Rivers during the summer of 1968 in order to investigate this situation more fully.

Air

Research on methods for measuring amount, form and significance of spray drift and atmospheric pollution with pesticides from forest pest control operations were continued in 1968, in collaboration with A.F.W. Cole of the Dept. of National Health and Welfare.

The various air samplers tested in experimental spraying of DDT in oil at Taxes, N.B. in 1967 were analysed. Of the 6 types of apparatus used, it was found that two, a bubbler containing xylene, and a dry sampler containing Florisil, were the most efficient air samplers for collecting drift particles at a point 1000 yards downwind from the aircraft emission track. These analyses were not made until after our return to Ottawa, and for the operational DDT spray-sampling a choice was made of a frequently-used combination (for industrial air pollution work) of a Millipore monitor (for particles) backed by a bubbler containing xylene (for vapour). However, some difficulty was experienced in extracting old Millipore filters for GC analysis, and no DDT was found in the xylene when analysed without concentrating the intermediate grade solvent that was used.

It was decided that a smaller scale of sampling would be used in the 1968 operational DDT spraying in N.B. to test and refine techniques and to utilise our limited resources (apparatus and personnel) more efficiently. Accordingly, two accessible operational DDT spray blocks comprising 18,000 acres, and a 400 acre experimental DDT plot were checked for drift in June (common dosage ½ lb. DDT/acre). Three types of apparatus were used independently: (1) a Millipore monitor case filled with activated Florisil (magnesium silicate); (2) a 250 ml. gas washing bottle with coarse centre frit (bubbler) containing 100 ml. redistilled dimethylformamide, (an efficient solvent for chlorinated insecticides, of low volatility, and readily cleaned-up for GC analysis by water-washing and partition to n-hexane; see D.C. Abbott et al., Nature 211, 259-61, 1966). These two units were operated from a battery suction pump at a rate of up to 12 litres air/minute. (3) A high-volume glass fibre filter operated by a portable generator at a rate of approx. 60 cubic feet air/minute.

The samplers were analysed by GC this summer and some very interesting results were obtained. (1) Nearly all the air samplers that were exposed in N.B. contained a trace of pp' DDT. From our soils work we suspect that contaminated dust is present in the air in the drier seasons when surface soil is exposed to air streams. (2) The order of decreasing efficiency of the samplers was glass wool, florisil, bubbler. From the results of later work on drift (see below), this indicates that most of the direct DDT drift was in a particulate form. (3) The farthest distance that drift was detected was 9 miles from the nearest edge of a spray block, and the maximum air concentration of pp' DDT that was found was approx. 500 nanograms (1×10^{-9}g) per cubic metre. (4) Although all three spray operations were begun very early on cold, still mornings, drift direction, as determined by sampler location, was found to be directly related to the light winds (0-4 mph) which began during and after the spraying.

Having established that a field situation exists where off-target loss of pesticide and environmental contamination (drift), as well as a possible human health hazard (air pollution with toxic chemicals) does occur in the aerial application of pesticides to the forest, it was decided to undertake more basic investigations on sampling methods and spray behaviour. Two spray-sampling trials were made around Ottawa this autumn (when weather conditions are similar to budworm spray time) using a non-toxic simulant formulation of the non-persistent fluorescent dye uranine with ethylene glycol, glycerol and water.

The first series of trials was made at the Experimental Farm, Ottawa, using a ground sprayer (standardised emission) which together with the excellent meteorological facilities and open fields found there, enabled us to measure weather effects on sprays and to determine sampler performance (the same three sampler systems were used as in the N.B. field trials). The second series of trials was made at Carp airport, near Ottawa (laboratories) using a rented aircraft to reproduce typical operational conditions, spraying height and speed, emission spectrum, and spray equipment (boom and nozzle, ULV Micronair - see report of A.P. Randall). Formulation composition was altered to change properties such as viscosity, specific gravity and volatility; and droplet deposit and drift were measured with the different spray equipment and formulations.

The results of these latest trials are not yet complete; however, plans for next year's field trials can be proposed. If a large-scale budworm spray operation is undertaken in N.B. in 1969 using mainly organophosphorus insecticides, we shall use the same air-monitoring system that was attempted in 1967. Four air-sampling stations will be operated on a systematic time plan outside and around the whole operational spray zone. Low-volume portable samplers comprising a Florisil filter backed by a bubbler containing a suitable non-volatile solvent will be used to collect particulate and vapour forms of pesticide from the air.

Table I

Time of sampling	pp' DDT content, ppb.	
	Surface water	18" deep water
Average laboratory background with blanks (distilled water and solvents)	0.30	0.30
Pre-spray, 1967	0.64	0.63
During spraying	17.57	1.69
Post-spray + 4 hours	8.62	0.74
" + 12 hours	0.90	0.78
" + 1 day	0.98	0.58
" + 3 months	0.92	0.94
" + 1 year	-	0.75

Concentrations of DDT in oil found on and in stream water from Crooked Bridge Brook at its exit from the Priceville study area, in relation to time of DDT spraying.

APPENDIX 13

Effects on Bird Populations of Phosphamidon and Sumithion used for Spruce Budworm Control in New Brunswick and Hemlock Looper Control in Newfoundland in 1968: A Summary Statement

by

P. A. Pearce
Canadian Wildlife Service
Fredericton, N. B.

For Interdepartmental Committee on Forest Spraying Operations, November 1968.

INTRODUCTION

Chemicals were first used for control of spruce budworm in New Brunswick in the northwest of the province in 1952. With the exception of 1959, operations have been conducted each year since. In 1960 the scene of activities shifted to central parts of the province. For several years DDT was used exclusively. In 1962 an organophosphate (phosphamidon) was first employed, on a trial basis, as a potential DDT-replacement insecticide. In 1964 the Canadian Wildlife Service, fulfilling its responsibilities under the Migratory Birds Convention Act, became involved in studies of the side effects on forest birds. Studies have mostly been conducted within a framework in which operational considerations, dictated by larval development, have assumed paramount importance. Wildlife monitoring has also been conducted in plots experimentally sprayed with a variety of chemicals by the Chemical Control Research Institute. "Operational experiments" have been concerned with variations of dosage, concentration, and timing of application. In 1966 a second organophosphate, sumithion (fenitrothion), was first used. A new factor, finer droplet size (fine calibration), was introduced for the first time in 1968. This year also, the areas treated with organophosphates exceeded for the first time those sprayed with DDT. A chemical control operation was launched against the hemlock looper in Newfoundland in 1968.

The following report summarizes the results of monitoring the effects on bird populations of phosphamidon and sumithion used for spruce budworm control in New Brunswick in June, and for hemlock looper control in Newfoundland in July, 1968. The latter operation is covered more fully in a separate report to this committee.

METHOD

The 1968 field season was to have been partly devoted to refining our census methods so that small post-spray depressions of bird populations might be more meaningfully assessed than has so far been possible in our monitoring program. This plan was disrupted when two treatments made early in this year's spray operation caused an unexpectedly high hazard to birds. Thereafter, and largely at our request, frequent changes were made to the schedule of block treatments as originally planned. Day-to-day decisions were made as to where and how we might best direct our monitoring activities and a great amount of time was spent travelling to spray blocks to search for sick birds.

Bird counting in the manner previously described to this committee was carried out in three areas (Block 25, Block 29, and control) in New Brunswick, and in two areas in Newfoundland (Area 24-25, and control). Two straight, parallel lines one-quarter of one mile apart and one mile in length were marked in the centre of Block 25 (Dungarvon River). They were oriented in an east-west direction, that is at right angles to flight lines of spray aircraft, to minimize the effect of overlapping of or gaps between spray swaths. The lines were designated as "A" and "B". Two straight, parallel lines one-third of one mile apart and one mile long were marked in the northeast corner of Block 29 (Big Hole Lake). They were oriented in a northeast-southwest direction, straddled the lake, and were designated as "A" and "B". This part of the block was the only area which we believed would contain a sufficiently varied avifauna. These two blocks were scheduled for treatments in which we were most interested and were chosen for reasons of accessibility and relative proximity to field camp. A similar route, composed of two legs each one mile in length, was marked in a very homogeneous stand on the Grand Lake road south of Doaktown, and used as a control. In Newfoundland, a route two miles long was marked in the middle of Area 24-25 and followed a logging road. A route of the same length was flagged along a logging road near Black Duck and used as a control.

An observer walked slowly along the "A" and "B" lines keeping a tally of all birds seen and heard. A count was made of the number of songs heard. Rough population indices were obtained by dividing the time (in minutes) taken to cover the route into the total number of songs heard and the total number of individual birds noted, respectively. Counts were made early in the morning when birds are most active. One observer was assigned the route in Block 25, another the route in Block 29. Both observers were assigned to cover the control route, thus obviating the "human factor" of any identification ability or hearing differentials. "A" and "B" tallies were kept separate. We felt that, with uniform spray coverage, any significant population depression should mainfest itself equally on each leg.

On either side of the "A" line, parallel lines were marked at a distance of two and one-half chains from it. Trees at each chain interval were labelled. An attenuated, 40-acre plot (80 x 5 chains) was thus demarcated. Within this plot, two observers in radio contact plotted the location of singing males and other birds seen. Territories were defined and later mapped. This kind of census taking was abandoned in Block 25 because of an insufficiency of time and suitably-qualified observers. In the New Brunswick control area, territory-mapping was conducted in three superimposed 40-acre plots of different configuration. The dimensions of these plots were as follows: 80 x 5 chains (as in Blocks 25 and 29), 40 x 10 chains, and 20 x 20 chains. Within the plots, lines two chains apart were flagged and trees were numbered at each chain mark. Work in the 40 x 10 and 20 x 20 chain plots was done by a biologist in pursuit of a separate project with different objectives. Our aim was to measure breeding populations in terms of the number of territorial males per 100 acres and to be able to pin-point territories vacated as the result of spraying. Another goal was to equate an estimation of the number of breeding pairs on a long, attenuated plot (containing many fractional territories) with an estimate of the number on a plot of more square configuration (perhaps embracing more whole territories). This phase of the study is not yet complete and is not reported on here.

Spraying was followed by searching for evidence of "bird effect" in 22 of the New Brunswick and three of the Newfoundland spray blocks. The following phenomena were considered to be indicative of poisoning to a greater or lesser degree:

(a) dead birds found;

(b) sick birds captured by hand;

(c) birds seen to be incapacitated to a lesser extent but poisoning evidenced by tremoring, loss of equilibium, erratic flight (e.g. ruffed grouse crashing into bole of tree), constant blinking and bill wiping (we have noted captive birds experimentally dosed with organophosphates to indulge in this activity. Increased lachrymation and salivation are reported to be symptoms of anticholinesterase poisoning in man);

(d) abnormally tame birds seen;

(e) birds seen out of their normal habitat (e.g. Cape May warblers on the ground, bay-breasted warblers foraging in slash);

(f) depression of population indices in areas where bird counts were made (in this regard, counts in control, or unsprayed areas are important as apparent population fluctuations occur from day to day which can be attributed to factors other than the application of poisons); and sprayed areas).

RESULTS

The results of census and search activities are presented under four headings—phosphamidon, sumithion, mixtures, and others. Within the first three categories, findings are presented block by block in order of decreasing dosage.

A Phosphamidon Blocks

Block 2

Treatment: phosphamidon, 3/8 lb., 1/5 USG, coarse calibration. June 11, morning.

Searched by 4 observers, 4:00 to 5:30 p.m., 8:15 to 8:45 p.m.,

sick birds captured	sick birds seen
1 eastern wood pewee	3 Tennessee warbler
1 magnolia warbler	2 myrtle warbler
1 myrtle warbler	1 purple finch
	1 chipping sparrow
	4 white-throated sparrow

During both search periods, all observers noted that birds had been virtually silenced. One observer heard only two partial songs from white-throated sparrows during a 30-minute period in an area of heavy slash which should have supported a large number of this species. During two hours of searching, another observer heard occasional songs from 11 birds of eight species scattered through the block. Song counts were made at six stations in an unsprayed area outside but near the block from 7:30 to 7:45 p.m. These counts gave 6, 7, 15, 18, 22, and 23 songs/minute, contrasting strongly with the silence inside the block. The two warblers died during the evening of the same day. The flycatcher was released.

Searched by 3 observers (1 inexperienced), 9:30 to 10:30 a.m., June 12

sick birds captured	sick birds seen
none	none

Song counts were 17/minute (mostly thrushes and Tennessee warblers), 2/minute (from 1 bay-breasted warbler), 4/minute (from 1 Blackburnian warbler), 4/minute (from 1 mourning warbler), and 3/minute (from 1 white-throated sparrow). A count made in a nearby unsprayed area gave 33 songs/minute from a variety of species, but mostly Tennessee warblers and purple finches.

<u>Block 25</u>

Treatment: phosphamidon, 3/8 lb., 1/5 USG, fine calibration.
June 7, morning.

Searched by 3 observers, 4:00 to 5:30 p.m., June 7.
2 observers, 7:00 to 8:15 p.m., June 7.

sick birds captured	sick birds seen
1 yellow-bellied flycatcher	1 sparrow hawk
1 robin	4 *Empidonax* flycatcher
1 Swainson's thrush	2 robin
2 Tennessee warbler (one dead)	1 Swainson's thrush
2 Cape May warbler	1 *Hylocichla* thrush
1 myrtle warbler	1 Cape May warbler
1 Blackburnian warbler	1 myrtle warbler
1 bay-breasted warbler	1 bay-breasted warbler
1 American redstart	1 white-throated sparrow
2 shipping sparrow	

The yellow-bellied flycatcher was found motionless on a road carrying light motor traffic. One dead Tennessee warbler was also found in such a location. Both birds could have been traffic victims but appeared to be uninjured. All observers reported that the forest was virtually silent at all locations. Song counts varied from nil to 1.3/minute (3 individuals of 3 species), to 1.7/minute (1 thrush). Counts were made at two stations in an unsprayed area to the south of the block and gave 32 songs/minute (10 individuals of 5 species), and 41/minute (13 individuals of 8 species). The first sick birds were picked up at 4:30 p.m. The first one (a Cape May warbler) died in captivity at 6:00 p.m. Most died during the evening or during the following night. A Blackburnian warbler survived until the next morning and a chipping sparrow survived until 4:00 p.m. of June 8. One observer reported that sick birds became progressively more difficult to find, as they were on the ground and moved very little.

Searched by 2 observers, 9:30 to 11:00 a.m., June 8.

sick birds captured	sick birds seen
1 yellow-bellied flycatcher	1 yellow-bellied flycatcher
1 robin	1 robin
1 hermit thrush	2 Swainson's thrush
2 Swainson's thrush	1 bay-breasted warbler
1 Tennessee warbler	2 evening grosbeak
1 myrtle warbler	3 slate-colored junco
2 bay-breasted warbler	1 unidentified
1 evening grosbeak	

Eleven species were heard singing while a bird count was being made prior to the search period. Both observers reported the near absence of bird songs at most places within the block. At one station, however, a high song count was obtained, possibly in an area that spray had not reached. Most of the captured birds died in captivity. The thrushes were released in the middle of a field during the afternoon. Both Swainson's thrushes flew strongly to the nearest cover about 100 yards away; the hermit thrush flew uncertainly, with one stop, to the same cover; the robin was able to fly only a few yards.

Searched by 1 observer while bird count was being made, June 9 a.m.

Sick birds captured	sick birds seen
2 Swainson's thrush	1 ruffed grouse
2 evening grosbeak	1 Swainson's thrush
	1 bay-breasted warbler
	1 white-throated sparrow

Vocal activity was very low. The observer reported that most of the singing on the "A" leg of the census route was by winter wrens, and by Tennessee warblers, ovenbirds, and slate-colored juncos on the "B" line.

Seven bird counts were made before spraying and another seven after spraying. Results are shown in Table 1. Population indices are shown in Table 2. Nearly all species were reduced in numbers. Ruby-crowned kinglets and most warblers were virtually eliminated. Ovenbirds, followed by Tennessee warblers, seemed less hard hit than other warblers. The spray effect was equally great on both legs of the census route. There was apparently little recovery of the most severely depleted species even 25 days later.

Table 1. - Bird count results, Line A, Block 25, N.B.

Species*	Number of birds recorded														
	May					June									July
	22	24	25	27	31	3	5	Sprayed on morning of June 7	8	9	13	19	24	27	2
Yellow-bellied sapsucker	8	10	12	11	8	6	8		9	4	6	9	6	10	10
Winter wren	8	9	9	10	7	6	9		6	5	5	6	4	4	4
Robin	8	2	3	4	4	0	3		2	0	3	3	1	2	0
Swainson's thrush	0	7	4	4	7	5	6		3	1	3	4	2	8	9
Ruby-crowned kinglet	4	5	1	3	2	3	2		0	0	0	0	0	0	0
Tennessee warbler	1	8	12	3	21	9	10		1	0	2	2	2	3	6
Parula warbler	1	0	1	1	3	2	2		0	0	0	0	1	0	1
Magnolia warbler	1	10	10	11	8	7	10		1	1	1	2	1	3	4
Cape May warbler	8	7	5	3	7	4	4		0	0	0	0	0	0	0
Black-throated blue warbler	3	4	4	3	7	4	4		0	0	0	0	0	0	1
Myrtle warbler	4	5	6	9	4	1	2		0	0	0	0	0	1	0
Black-throated green warbler	3	5	5	4	6	5	6		0	0	0	0	0	0	0
Blackburnian warbler	0	6	5	4	7	6	4		0	0	1	1	1	1	2
Bay-breasted warbler	2	9	9	11	13	9	13		2	2	2	5	1	4	3
Ovenbird	9	10	11	16	14	9	11		3	1	2	4	5	5	3
Canada warbler	0	2	3	3	7	1	3		0	0	0	0	0	0	0
American redstart	0	0	2	1	2	4	4		0	0	0	0	0	0	0
Rose-breasted grosbeak	2	8	5	5	4	4	7		0	1	0	0	0	0	1
Purple finch	7	6	3	6	5	4	4		2	1	3	3	5	6	2
Pine grosbeak	1	2	4	5	8	2	4		4	0	2	4	2	4	2
Slate-colored junco	5	8	5	0	2	1	3		1	2	1	1	0	1	2
White-throated sparrow	15	17	15	20	20	18	15		8	8	4	8	5	8	7

Line B, Block 25, N.B.

Ruffed grouse	2	4	2	3	1	0	1	0	1	0	0	0	0	0
Yellow-bellied spasucker	7	11	5	13	6	2	5	6	2	1	8	7	6	6

Table 1. — Cont'd.

Species*	Number of birds recorded														
	May					June									July
	22	24	25	27	31	3	5		8	9	13	19	24	27	2
Yellow-bellied flycatcher	0	0	0	0	0	2	3	Sprayed on morning of June 7	0	0	1	1	0	0	1
Red-breasted nuthatch	1	3	0	1	4	2	5		0	0	3	3	2	7	2
Winter wren	7	9	6	10	7	3	5		2	1	3	3	2	3	5
Robin	3	5	4	2	5	1	2		2	2	0	5	3	2	3
Swainson's thrush	0	3	2	3	2	2	4		2	1	1	6	5	5	8
Ruby-crowned kinglet	2	1	2	7	1	4	2		0	0	0	0	0	0	0
Solitary vireo	1	3	3	2	1	0	1		0	0	0	0	0	0	0
Tennessee warbler	1	11	7	2	11	2	12		0	3	3	4	4	5	7
Parula warbler	2	3	1	3	1	2	0		0	0	0	0	0	0	0
Magnolia warbler	0	3	3	6	3	5	4		0	0	0	1	1	1	2
Cape May warbler	8	8	3	4	1	1	3		0	0	0	2	0	0	0
Black-throated blue warbler	2	2	1	3	1	0	1		0	0	1	1	0	0	1
Myrtle warbler	6	4	6	4	5	2	4		0	0	0	1	0	0	0
Black-throated green warbler	0	6	4	5	1	3	3		0	0	0	0	0	0	0
Blackburnian warbler	0	5	1	1	5	2	4		0	0	1	0	2	1	1
Bay-breasted warbler	5	10	10	14	12	9	13		1	2	1	2	3	4	1
Ovenbird	5	14	12	17	13	7	10		4	5	3	7	3	3	5
American redstart	0	2	1	2	3	1	3		0	0	0	0	0	0	0
Rose-breasted grosbeak	2	5	4	4	4	1	4		0	1	0	0	0	1	0
Purple finch	5	6	5	7	3	0	3		1	1	0	2	4	3	1
Pine grosbeak	5	6	1	1	6	2	4		1	1	2	4	4	4	1
White-throated sparrow	11	19	12	19	15	15	14		5	4	7	7	7	7	6

* Includes only those species seen or heard, after first arrival on the block, on at least six of the seven pre-spray counts. Evening grosbeak has been excluded.

Table 2. - Count totals and population indices, Line A, Block 25, N.B.

Count number	Date	Total birds recorded	Time (minutes)	Birds/ minute	Total songs recorded	Songs/ minute	Total species
1	May 22	129	63	2.0	719	11.4	32
2	May 24	183	67	2.7	915	13.6	38
3	May 25	168	63	2.7	768	12.2	38
4	May 27	157	60	2.6	617	10.3	30
5	May 31	186	69	2.7	1037	15.0	31
6	June 3	128	61	2.1	552	9.0	27
7	June 5	165	60	2.8	818	13.6	31
		Sprayed on morning of June 7					
8	June 8	50	53	0.9	139	2.6	17
9	June 9	33	49	0.7	98	2.0	14
10	June 13	44	45	1.0	187	4.2	20
11	June 19	74	47	1.6	331	7.0	24
12	June 24	66	44	1.5	250	5.7	27
13	June 27	89	47	1.9	354	7.5	24
14	July 2	75	41	1.8	400	9.8	24
					Line B, Block 25, N.B.		
1	May 22	102	54	1.9	475	8.8	30
2	May 24	181	63	2.9	740	11.8	37
3	May 25	116	53	2.2	498	9.4	32
4	May 27	155	62	2.5	672	10.8	35
5	May 31	124	52	2.4	511	9.8	28
6	June 3	75	39	1.9	218	5.6	22
7	June 5	122	54	2.3	500	9.3	30
		Sprayed on morning of June 7					
8	June 8	31	47	0.7	72	1.5	13
9	June 9	41	45	0.9	76	1.7	22
10	June 13	37	34	1.1	224	6.6	19
11	June 19	76	45	1.7	309	6.9	24
12	June 24	62	38	1.6	257	6.8	25
13	June 27	77	43	1.8	321	7.5	26
14	July 2	58	35	1.7	235	6.7	21

The elimination of birds is reflected in the depression of the population indices. A slow recovery is suggested. Tables 1 and 2 are to be compared with Tables 7 and 8. Counts made in the control area show no significant decline of the numbers of any species, though they do of course indicate the small day-to-day changes which we expect and which we attribute to the influence of several weather variables on bird behaviour. Birds/minute indices in the control area remain remarkably constant.

Block 45

Treatment: phosphamidon, 1/4 lb., 1/5 USG, fine calibration.

June 27, morning.

Searched by 1 observer, 6:45 to 8:45 p.m., June 27.

sick birds captured	sick birds seen
none	none

No evidence of birds in distress was detected. Vocal activity was thought to be normal.

Searched by 3 observers (1 inexperienced), 9:45 to 12:00 a.m. June 28.

1 observer, 12:00 a.m. to 2:00 p.m., June 28.

sick birds captured	sick birds seen
2 Swainson's thrush	1 Tennessee warbler
2 Tennessee warbler	1 blackpoll warbler
1 Cape May warbler	1 American redstart
1 myrtle warbler	1 slate-colored junco
1 bay-breasted warbler	
1 blackpoll warbler	
1 pine siskin	
1 white-throated sparrow	

Observers ranged throughout the central parts of the block. Old logging roads were few: it was along such a road that most of the incapacitated birds were seen and captured. Although this was grown up in bracken and spruce in places it probably represented the best searching "habitat". Song counts were made at several stations in the block. They were as follows: nil (in open coniferous stand), 1/minute (from 1 bay-breasted warbler along a stream edge), 16/minute (from 4 individuals of 3 species, in open conifers), 17/minute (in open conifers), 32/minute (along a road edge), and 33 (along a stream edge). All counts were made in the middle of the morning. None was made in an unsprayed area. A swamp sparrow's nest containing three apparently healthy nestlings was also found.

Plot 1 (CCRI program)

Treatment: phosphamidon, 1/4 lb. average dosage, graduated across plot, east to west light to heavy, boom and nozzle application. June 3, evening.

The plot was searched for short periods during the two days following treatment. There was little evidence of birds in distress. A dead white-throated sparrow was found at station B4 at 3:00 p.m. on June 5. Song counts were made at several stations inside and outside the plot. Counts were low 48 hours after spraying, but were made in rather windy conditions.

Plot 2 (CCRI program)

Treatment: phosphamidon, 1/4 lb. average dosage, graduated across plot, east to west light to heavy, ULV application. May 23, evening.

Searched by 2 observers, 2:20 to 4:20 p.m., May 24.

sick birds captured	sick birds seen
1 myrtle warbler	2 white-throated sparrow

The myrtle warbler died about 7:00 p.m. of the same day, approximately 24 hours after spraying. All three birds were found near the road forming the western boundary of the plot. Very little song was heard.

Searched by 3 observers, 7:10 to 8:00 p.m., May 24.

sick birds captured	sick birds seen
1 hermit thrush	1 slate-colored uunco
	2 white-throated sparrow

The junco was seen to constantly twitch its tail and wipe its bill. The whitethroat was constantly bill wiping and flew erratically. Song counts were nil in 7 minutes, and 3 in 17 minutes (all from 1 bay-breasted warbler). Counts in a control area to the west of the road forming the western boundary of the plot were 18, 21, 20, and 17 songs/minute.

Searched by 2 observers from 8:45 a.m. on, May 25.

sick birds captured	sick birds seen
none	1 bay-breasted warbler
	2 ovenbird
	1 white-throated sparrow

The whitethroat was nearly caught, the two ovenbirds allowed very close approach, and the bay-breasted warbler was nearly touched. Song counts were 2, 1, and 1/minute. In a nearby control area they were 18, 16, and 19/minute.

Searched by 3 observers from 9:25 a.m. on May 26. Song counts were 1, 0, and 0/minute. In a control area they were 9, 11, and 26/minute. An observer walked along the "A" line as far as the 22-chain mark during the early afternoon of May 27 and in 34 minutes heard 22 songs, 10 of which were from one black-throated green warbler. The same observer then walked along the "B" line of Plot 1 being used as a control and in 29 minutes heard 115 songs.

Block 32

Treatment: phosphamidon, 1/8 lb., 1/5 USG, fine calibration.
June 16, evening.

Searched by 2 observers, 3:30 to 5:00 p.m., 6:30 to 7:30 p.m.
June 17.

sick birds captured	sick birds seen
none	1 myrtle warbler
	1 American redstart
	1 white-throated sparrow

During the afternoon search, three song counts were made. These were 5, 10, and 20/minute, mostly from Swainson's thrushes and white-throated sparrows. A Canada warbler and a white-throated sparrow were found incubating. A dragonfly was picked quivering from a twig. There was little bird song in the evening. At one station only 3 songs/minute were heard--from two distant white-throated sparrows. In one dense coniferous area no ruby-crowned kinglets or bay-breasted warblers were heard. In another similar area, however, bay-breasts were singing normally. Two purple finches and several whitethroats were seen to be constantly bill wiping.

Area 32 (Newfoundland)

Treatment: phosphamidon, 1/8 lb., 1/5 USG, fine calibration.
July 14, morning.

Searched by 1 observer, 1:45 to 3:15 p.m., July 14.

The observer was flown by helicopter into this remote area, During a five-minute period in a stand of black spruce and balsam fir, one pine grosbeak was heard singing and a small flock of crossbills was heard flying over. There was no other vocal activity. In another stand of balsam fir no bird song was heard. In a third location, a bog surrounded by alders, one Tennessee warbler sang once and several Lincoln's sparrows were busy wiping their bills. In places sheltered from the breeze, there were clouds of mosquitoes--much to the discomfort of the observer. Along the bank of the river (Lloyd's) a spotted sandpiper, two greater yellowlegs, and a northern waterthrush all behaved normally. An active osprey nest was found.

B. Sumithion Blocks

Block 9

Treatment: sumithion, 1/2 lb., 1/5 USG, fine calibration.
June 16, evening.

Searched by 4 observers (3 inexperienced), 4 different parts of the block, 5:00 to 7:45 p.m., June 17.

sick birds captured	sick birds seen
1 magnolia warbler	1 myrtle warbler
1 black-throated green warbler	1 slate-colored junco
1 Blackburnina warbler	
1 chipping sparrow	

All of the sick birds were seen on roadsides. Song counts were made in three of the locations searched and were as follows: 17/minute (mostly thrushes, no warblers), 30/minute (all expected species, thrushes particularly vocal), and 8/minute (no warblers). The song count was 27/minute in a nearby unsprayed area. Several dead dragonflies were found at one station. A redwinged blackbird's nest containing four active nestlings was also found. The latter part of the search was conducted in rain, at times heavy.

Block 16

Treatment: sumithion, 1/2 lb., 1/2 USG, coarse calibration.
June 5, morning (eastern three-quarters).
June 6, morning (western quarter).

Searched by 4 observers (1 inexperienced), 4:00 to 6:00 p.m., June 5.

sick birds captured	sick birds seen
1 Blackburnian warbler	(see below)

Searching was confined to the central and eastern parts of the block. Most of the area had been cut over and was laced with a network of wood roads which greatly facilitated search operations. For a hot, windy afternoon birds were thought to be quite vocal, particularly Swainson's thrushes and white-throated sparrows. Many bay-breasted warblers were seen on the ground or near the ground foraging in the omnipresent slash.

Searched by 4 observers, 9:30 to 11:00 a.m., June 6.

sick birds captured	sick birds seen
2 bay-breasted warbler	1 purple finch

No song counts were made, but song intensity was felt to be normal. Several bay-breasts were again seen near the ground foraging in slash piles. Several barn swallow nests were found in old camp buildings. Adult birds were behaving normally.

<u>Block 28</u>

Treatment: sumithion, 1/2 lb., 1/5 USG, fine calibration.

June 4, evening.

Searched by 3 observers (1 inexperienced), 10:30 to 12:00 a.m.

June 5.

sick birds captured	sick birds seen
none	none

Song counts at different stations gave 12, 6, and 10 songs/minute from a variety of species. There was nothing to suggest any serious effect on birds.

<u>Block 6</u>

Treatment: sumithion, 3/8 lb., 1/5 USG, coarse calibration.

June 16, morning.

Searched by 2 observers (1 inexperienced), 3:40 to 6:05 p.m.

June 16.

sick birds captured	sick birds seen
none	2 American redstart

Singing activity was thought to be normal although there were noticeably quiet areas. Few ruby-crowned kinglets were heard.

Searched by 2 observers (1 inexperienced), 7:20 to 8:30 p.m.

June 16.

sick birds captured	sick birds seen
1 American redstart	1 white-throated sparrow

Three nests were found (2 white-throated sparrow and 1 Tennessee warbler), all with adults incubating.

Searched by 2 observers, 2:00 to 3:00 p.m., June 17.

sick birds captured	sick birds seen
1 chipping sparrow	none

A white-throated sparrow was found incubating. Vocal activity seemed normal, and there were no noticeably quiet areas. The area searched was the same as on the preceding day. More ruby-crowned kinglets were heard singing.

Block 7

Treatment: sumithion, 3/8 lb., 1/5 USG, fine calibration.

June 6, morning.

Searched by 1 observer, 8:30 to 11:30 a.m., June 8.

sick birds captured	sick birds seen
none	1 magnolia warbler
	1 myrtle warbler
	1 American redstart

Due to a communications breakdown this block was searched 48 hours after treatment instead of one day later as planned. The sick birds were found in central and western parts of the block where no warbler or kinglet songs were heard. In eastern parts of the block there was no evidence of birds in distress and kinglet and warbler song was thought to be normal. The observer reported as follows: "At about 9:50 spray planes were finishing Block 8, immediately to the west, and they appeared to overlap Block 7 by as much as 1/4 mile. This resulted in Forestry sampling station #15 (and presumably #16) receiving a second treatment. This overlap included the area where sick birds were found."

Block 8

Treatment: sumithion, 3/8 lb., 1/5 USG, fine calibration.

June 8, morning.

Searched by 1 observer (inexperienced), 3:30 to 4:50 p.m., June 9.

sick birds captured	sick birds seen
1 magnolia warbler	none
2 Blackburnian warbler	

Searching was done in fine weather. Apart from the incapacitated birds which he caught, the observer saw only a few rose-breasted grosbeaks and white-throated sparrows. He was particularly struck by the silence in the block.

<u>Block 29</u>

Treatment: sumithion, 3/8 lb., 1/5 USG, fine calibration.

June 9, morning.

Searched by 3 observers, 6:10 to 8:10 p.m., June 9.

sick birds captured	sick birds seen
1 yellow-bellied flycatcher	1 ruffed grouse
2 Swainson's thrush	1 yellow-bellied flycatcher
2 Tennessee warbler	1 *Empidonax* flycatcher
2 magnolia warbler	1 robin
2 Cape May warbler	4 Swainson's thrush
1 chipping sparrow	1 Tennessee warbler
	1 parula warbler
	1 Cape May warbler
	2 myrtle warbler
	2 black-throated green warbler
	3 bay-breasted warbler
	1 yellowthroat
	1 scarlet tanager
	3 slate-colored junco
	7 white-throated sparrow
	1 unidentified

Song counts were made at various places in the block. They were as follows: nil, nil, 1/minute (1 ovenbird), 3/minute (3 individuals of 3 species), 25/minute (25 individuals of 15 species), and 30/minute (many individuals of 12 species). Quiet areas seemed to alternate with active areas in fairly well marked zones. The sick grouse was approached very closely. When it flushed it crashed into the trunk of a tree, fell to the ground, and then continued its flight. Casual searching was continued the following morning while the bird count was being made. No birds were captured but the following sick ones were seen: 1 ruffed grouse, 2 Swainson's thrush, 1 yellowthroat, 4 white-throated sparrow. A dead Blackburnian warbler was found near the census line 19 days after spraying.

Six pre- and five post-spray bird counts were made. Results are shown in Tables 3 and 4. All the warbler species apparently suffered a decline in numbers, particularly black-throated greens, Blackburnians, and bay-breasts. Unaccountably, ruby-crowned kinglets were reduced in number on the "B" line but not on the "A". Two flycatcher species were heard for the first time on the first post-spray count. Winter wrens were apparently unaffected on both lines as were yellow-bellied sapsuckers. Swainson's thrushes sustained a loss. Thirteen days after spraying, there had been a noticeable recovery or replacement. This is reflected in near pre-spray levels of the population indices. Tables 3 and 4 are to be compared with Tables 9 and 10. Counts made in the control area show no significant decreases in the numbers of any species and population indices remained constant.

Chignecto campground, Fundy National Park

Treatment: sumithion, 3/8 lb., 1/3 USG, medium calibration.
June 7, evening.

Three bird counts were made by the park naturalist. Results are shown in Tables 5 and 6. Unfortunately, the only post-spray count

Table 3. - Bird count results, Line A, Block 29, N.B.

Species*	Number of birds recorded										
	May				June						July
	22	23	26	28	29	5		10	13	22	28	3
Yellow-shafted flicker	2	1	1	1	1	0		0	0	1	1	0
Yellow-bellied sapsucker	11	7	11	10	6	9		7	5	7	10	10
Yellow-bellied flycatcher	0	0	0	0	0	3		0	1	2	1	0
Least flycatcher	0	0	0	0	1	0		0	0	0	0	0
Eastern wood pewee	0	0	0	0	0	0		2	2	2	2	2
Olive-sided flycatcher	0	0	0	0	0	2		1	0	2	0	0
Barn swallow	1	5	2	3	3	2		0	2	0	0	1
Blue jay	1	3	2	4	2	0	Sprayed on morning of June 9	2	0	1	0	0
Boreal chickadee	3	3	3	2	2	0		0	1	0	1	1
Red-breasted nuthatch	3	3	1	2	4	4		3	3	6	5	8
Winter wren	4	3	4	2	2	4		4	4	4	3	3
Robin	6	6	4	3	2	3		5	2	3	2	5
Swainson's thrush	1	8	7	4	8	10		3	3	11	11	8
Ruby-crowned kinglet	4	5	3	5	3	3		3	4	1	2	0
Solitary vireo	0	1	1	1	2	1		0	0	1	0	0
Tennessee warbler	0	5	8	8	17	17		2	9	13	14	10
Magnolia warbler	0	2	2	4	3	2		1	0	0	0	1
Cape May warbler	10	11	8	9	6	3		2	2	1	3	2
Myrtle warbler	12	7	3	4	2	5		1	1	3	4	1
Blackburnian warbler	0	2	7	7	5	2		0	0	0	0	0
Bay-breasted warbler	1	3	10	12	12	11		0	0	2	4	5
Ovenbird	4	11	8	7	11	9		2	3	5	3	5
Yellowthroat	1	1	2	1	0	1		0	1	0	0	0
Redwinged blackbird	1	2	3	1	0	1		2	1	1	1	3
Rose-breasted grosbeak	0	0	5	2	6	2		1	0	1	0	0
Purple finch	10	8	9	10	7	7		4	3	8	7	6
Pine grosbeak	4	2	1	1	2	2		1	1	0	2	0
Slate-colored junco	1	2	1	1	2	2		2	3	3	3	5
White-throated sparrow	10	6	7	7	7	4		1	2	4	3	6

Table 3. — Cont'd. Line B, Block 29, N.B.

Species*	Number of birds recorded											
	May					June						July
	22	23	26	28	29	5	Sprayed on morning of June 9	10	13	22	28	3
Yellow-bellied sapsucker	7	6	4	8	6	6		7	4	7	6	10
Eastern wood pewee	0	0	0	0	0	0		2	0	2	1	2
Olive-sided flycatcher	0	0	0	0	0	0		2	1	0	0	1
Blue jay	1	2	2	2	3	1		1	0	1	2	1
Winter wren	3	4	3	4	3	4		3	6	5	3	4
Robin	3	6	3	4	2	3		2	3	4	4	1
Swainson's thrush	1	4	4	7	11	4		2	3	11	9	8
Ruby-crowned kinglet	9	7	7	8	6	3		2	0	2	0	1
Solitary vireo	1	2	1	1	3	6		1	1	0	0	0
Tennessee warbler	0	4	10	15	20	14		4	4	11	8	5
Parula warbler	0	1	2	1	0	1		0	0	0	0	0
Magnolia warbler	1	7	3	11	4	7		1	0	1	1	2
Cape May warbler	9	10	9	7	6	7		1	1	0	1	1
Myrtle warbler	8	7	8	8	5	3		0	0	1	0	1
Black-throated green warbler	0	2	5	4	2	2		0	0	0	0	0
Blackburnian warbler	0	2	3	4	2	3		0	0	1	2	1
Bay-breasted warbler	0	3	11	6	6	8		0	0	2	2	5
Ovenbird	2	7	8	7	4	5		0	0	2	1	2
Yellowthroat	2	0	1	1	2	2		0	0	1	2	1
Redwinged blackbird	1	3	1	2	2	1		1	1	2	2	1
Purple finch	6	7	8	10	5	7		3	2	5	5	2
Slate-colored junco	2	1	2	3	3	2		1	0	1	2	4
White-throated sparrow	7	6	9	13	9	9		4	1	9	8	4

* Includes only those species seen or heard, after first arrival on the block, on at least five of the six pre-spray counts. Evening grosbeak has been excluded.

Table 4. - Count totals and population indices, Line A, Block 29, N.B.

Count number	Date	Total birds recorded	Time (minutes)	Birds/ minute	Total songs recorded	Songs/ minute	Total species
1	May 22	103	80	1.3	757	9.5	28
2	May 23	129	84	1.5	1126	13.4	36
3	May 26	130	75	1.7	968	12.9	32
4	May 28	117	64	1.8	954	14.9	29
5	May 29	128	61	2.1	990	16.2	35
6	June 5	121	61	2.0	982	16.1	32
		Sprayed on morning of June 9					
7	June 10	52	52	1.0	165	3.2	24
8	June 13	60	49	1.2	401	8.2	26
9	June 22	92	56	1.6	762	13.6	27
10	June 28	96	60	1.6	706	11.8	27
11	July 3	95	50	1.9	483	9.7	25
					Line B, Block 29, N.B.		
1	May 22	83	64	1.3	387	6.0	24
2	May 23	114	60	1.9	735	12.2	31
3	May 26	118	60	2.0	730	12.2	31
4	May 28	139	65	2.1	1010	15.5	31
5	May 29	119	54	2.2	909	16.8	31
6	June 5	120	60	2.0	883	14.7	34
		Sprayed on morning of June 9					
7	June 10	48	47	1.0	161	3.4	23
8	June 13	37	40	0.9	216	5.4	20
9	June 22	89	47	1.9	759	16.1	28
10	June 28	80	53	1.5	611	11.5	26
11	July 3	76	40	1.9	509	12.7	27

was made several days after treatment. Results indicate no substantial population changes. A C.W.S. observer made several three-minute song counts both within and well outside the campground on June 8.

	Station	Time	Songs/minute	Time	Songs/minute
Control	1	6:30 a.m.	23	1:00 p.m.	25
Control	2	6:45 a.m.	19		21
Control	3	6:55 a.m.	19		24
Campground	4	7:20 a.m.	13		15
Campground	5	7:45 a.m.	25		
Campground	6	8:00 a.m.	25		
Campground	7	8:15 a.m.	17	2:00 p.m.	17
Campground	8	8:30 a.m.	18	2:10 p.m.	15
Campground	9	8:45 a.m.	19	2:20 p.m.	8

At 2:30 p.m. the observer found a Cape May warbler perching on a branch about six feet from the ground. It allowed very close approach, its feathers were ruffled and it was closing its eyes periodically. When he reached out for it, it flew to a higher branch a few yards away. A few minutes later a black-throated green warbler was seen low down in a spruce and allowed the observer to approach within 10 feet before it flew off strongly. The observer reported "It seems likely that if there is to be any effect on birds it is just beginning to show up."

<u>Block 14</u>

Treatment: sumithion, 1/4 lb., 1/5 USG, extra fine calibration. June 19 morning.

Searched by 2 observers (1 inexperienced), 4:00 to 6:30 p.m., June 19.

Searched again by the same observers, 10:30 a.m. to 1:30 p.m. June 20.

Table 5. - Bird count results, Fundy National Park

Species	June 5	June 6		June 11
	Number of individuals noted			
Yellow-shafted flicker	1	0		0
Yellow-bellied sapsucker	3	1		1
Yellow-bellied flycatcher	0	1		1
Eastern wood pewee	0	4		1
Olive-sided flycatcher	1	0		0
Barn swallow	6	0		1
Gay jay	0	1		0
Common crow	2	1		1
Boreal chickadee	1	2		2
Red-breasted nuthatch	1	1		1
Winter wren	1	0		0
Robin	15	13		16
Hermit thrush	2	1	Sprayed on evening of June 7	0
Swainson's thrush	5	2		5
Ruby-crowned kinglet	3	3		3
Red-eyed vireo	4	0		2
Tennessee warbler	8	5		9
Nashville warbler	1	0		1
Magnolia warbler	7	11		10
Cape May warbler	4	5		2
Myrtle warbler	5	2		5
Black-throated green warbler	8	4		4
Bay-breasted warbler	20	18		17
Ovenbird	5	2		3
Mourning warbler	0	1		0
Yellowthroat	2	2		1
Canada warbler	0	1		0
American redstart	6	12		4
Brown-headed cowbird	4	1		1
Evening grosbeak	11	13		7
Purple finch	5	1		2
Pine siskin	8	2		6
American goldfinch	2	1		0
Slate-colored junco	10	8		12
Chipping sparrow	7	3		6
White-throated sparrow	21	18		16
Song sparrow	1	1		1
Unidentified	9	6		2

Table 6. - Count totals and population indices, Fundy National Park, N.B.

Count number	Date	Total birds recorded	Time (minutes)	Birds/minute	Total species
1	June 5	189	65	2.9	32
2	June 6	147	65	2.3	31
		Sprayed on evening of June 7			
3	June 11	143	60	2.4	29

Both searches were repeatedly interrupted by heavy rain. There was no evidence of bird intoxication.

Block 15

Treatment: sumithion 1/4 lb., 1/5 USG, fine calibration.

June 11, morning.

Searched by 2 observers (1 inexperienced), 5:30 to 8:00 p.m.,

June 11.

sick birds captured	sick birds seen (some only slightly affected--see below)
none	1 ruffed grouse
	1 magnolia warbler
	1 bay-breasted warbler
	1 yellowthroat
	1 pine grosbeak
	2 pine siskin

The ruffed grouse was seen at the roadside and allowed the observer to approach to within a few feet. It then jumped into a dtich and the observer followed. The bird then flew off through the woods, crashing into the branches of several trees before it was lost from view. The magnolia warbler was on the ground and very slow to move, as were the bay-breasted warbler and the yellowthroat. The pine grosbeak was seen to have difficulty maintaining its balance while perching. The two siskins were feeding at the roadside and when approached flew up into a nearby shrub where they obviously experienced difficulty retaining their balance. The observer was able to approach to three feet. In one very quiet area juncos and whitethroats were perching quietly in trees and constantly wiping their bills.

Song counts were made at a few forestry sampling stations as follows:

N10	2 songs/minute	(from 1 distant white-throated sparrow)
N8	4 songs/minute	(from 1 myrtle warbler, 2 Tennessee warblers, 1 white-throated sparrow)
N12	25 songs/minute	(several thrush and warbler species)

A control count gave 30 songs/minute (10 individuals of 6 species).

Most of the searching was done along and from a road bisecting the block and running roughly northeast to southwest. There was an apparent zonation of bird activity along this road.

Searched by 2 observers (1 inexperienced), 9:30 to 10:30 a.m.

June 12.

sick birds captured	sick birds seen
none	none

Song counts were again made at forestry sampling stations and were as follows:

N10	21 songs minute	(8 individuals of 5 species)
N8	33 songs/minute	(9 species)
N 12	10 songs/minute	(5 species)

A control count gave 36 songs/minute (10 individuals of 8 species).

Block 20

Treatment: sumithion, 1/4 lb., 1/5 USG, fine calibration.

2 applications. June 16, morning.

Searched by 2 observers 2:45 to 3:45 p.m., by 1 observer 4:30 to 5:00 p.m., by 2 observers 6:15 to 7:15 p.m., and by 1 observer 7:30 to 8:00 p.m., June 16.

sick birds captured	sick birds seen
2 American redstart	4 American redstart

Song counts were made at four widely separated points in the block:

(a) 38, 31, and 34 songs/minute.

(b) 9 songs/minute (mostly thrushes).

(c) 19, 23 songs/minute (most expected species but no warblers: it was in this vicinity that the six sick redstarts were encountered).

(d) 21, 23 songs/minute (second count consisting mostly of warbler song).

Searched by 4 observers (3 inexperienced), 2:30 to 4:30 p.m.

June 17.

sick birds captured	sick birds seen
1 Blackburnian warbler (found dead on road)	none
3 American redstart	

All four birds were found on logging roads. A few dead and dying dragonflies were found at several locations. Many individuals of an unidentified fly species were found to be in distress throughout the block.

<u>Block 30</u>

Treatment: fenitrothion (CIBA), 1/4 lb., 1/5 USG, fine calibration.

June 16, a.m.

Searched by 1 observer (inexperienced), 3:00 to 8:00 p.m.

June 16.

sick birds captured	sick birds seen
none	none

The observer reported no evidence of birds in difficulties. Two broods of ruffed grouse looked healthy and behaved normally. Song level was thought to be normal.

Block 34

Treatment: sumithion, 1/8 lb., 1/5 USG, fine calibration.

2 applications: noon and evening, June 23.

Searched by 3 observers, 3:00 to 5:00 p.m., 6:00 to 6:20 p.m.

June 24.

sick birds captured	sick birds seen
1 American redstart	1 myrtle warbler
1 American redstart found dead	3 American redstart
	2 White-throated sparrow

We had hoped this block treatment would have been a "dress rehearsal" of one of the treatments proposed for the hemlock looper control program in Newfoundland in which sumithion was to be applied twice, at 1/8 lb./acre, with a four or six day interval. Song counts were made at several stations in the block. In one hardwood area on the flanks of and at the crown of a hill birds had been silenced. One ovenbird sang once in five minutes. There was no other bird song. It was in this vicinity that three of the five redstarts were found. An employee of Forest Protection Limited was in the block during the afternoon of June 25. He reported seeing several birds (of unknown species) "wobbling on their perches." The redstarts were held in captivity and fed readily enough on insects that were presented to them but died during the night of June 25/26.

Area 24-25 (Newfoundland)

Treatment: sumithion, 1/8 lb., 1/5 USG, fine calibration.

Two applications: on morning of July 9 and on morning of July 15.

Searched by 2 observers, 3:30 to 6:30 p.m., July 9.

sick birds captured	sick birds seen
none	none

A few birds were seen to be constantly wiping their bills. A yellow-bellied flycatcher flew down to within a few feet of one observer. It retained its equilibrium and appeared to be in no distress. Searching was continued for a short while the following day but nothing untoward was noted.

Searched by 2 observers, 3:30 to 6:30 p.m., July 15.

sick birds captured	sick birds seen
none	(see below)

At the brow of a hill near the end of the census route, several birds were seen constantly bill wiping. While the bird count was being made on July 16, two incapacitated adult slate-colored juncos were seen, one of which was nearly taken in the hand. On the morning of July 18, one ruby-crowned kinglet, one junco and one whitethroat were very tame. All were on the ground and reacted very slowly when approached. Vocal utterances of young birds were not to be considerably diminished over the preceding days.

It was not known until a very late hour if the looper population in this area was of sufficient size to warrant chemical control. Consequently there was time to make only one pre-spray bird count. A total of eight counts was made. Results are shown in Table 1 and population indices are shown in Table 2 of a separate report to this committee. The results of counts in a control area at Black Duck are shown in Table 3 and control population indices are shown in Table 4 of the same report. There was apparently no population depression after the first treatment. After the second treatment, however, there was a decrease in the numbers of black-throated green and blackpoll warblers. The number of the latter species remained low three days later.

Block 26

Treatment: sumithion, 1/8 lb., 1/5 USG, fine calibration.
June 16, morning.

Searched by 2 observers (1 inexperienced), 3:15 to 6:15 p.m.
June 16.

sick birds captured	sick birds seen
none	none

No evidence of birds in distress.

Block 31

Treatment: sumithion, 1/8 lb., 1/5 USG, fine calibration.
June 14, evening.

Searched by 3 observers (1 inexperienced), 4:00 to 5:00 p.m., 6:15 to 7:15 p.m., June 15.

sick birds captured	sick birds seen
none	none

Area 14 (Newfoundland)

Treatment: sumithion, 1/8 lb., 1/5 USG, fine calibration.
Two applications, morning of July 7 and 14.

The area was searched by one observer from 5:15 to 8:15 p.m. on July 14 during which time nothing untoward was noted.

C. Mixtures

Block 1

Treatment: phosphamidon, 1/4 lb., + sumithion, 1/8 lb., 1/5 USG, fine calibration. June 11, a.m.

Searched by 4 observers (1 inexperienced), 7:00 to 7:30 p.m., June 11.

sick birds captured	sick birds seen
1 myrtle warbler	1 robin
1 bay-breasted warbler	2 bay-breasted warbler
1 slate-colored junco	1 slate-colored junco
2 chipping sparrow	1 white-throated sparrow
	1 unidentified

Birds were almost completely silenced in the areas searched. One of the chipping sparrows died at 9:00 p.m. The myrtle warbler appeared to have revived and was released.

Searched by 3 observers (1 inexperienced), 10:45 to 11:15 a.m., June 12.

sick birds captured	sick birds seen
1 rose-breasted grosbeak	1 robin
1 chipping sparrow	1 Tennessee warbler
	1 slate-colored junco
	1 chipping sparrow

Two song counts were made, at two widely separated locations. They were nil and 0.3 songs/minute (from 1 ovenbird). A control count was made at Catamaran Brook about a mile outside the block and gave 33 songs/minute (mostly Tennessee warblers and purple finches).

Block 33

Treatment: sumithion, 1/8 lb., + DDT, 1/10 lb., 1/5 USG, fine calibration. Two applications. June 22, morning.

Searched by 1 observer, 4:30 to 6:30 p.m., June 22.

No evidence of any effect on birds.

D. Others

Plot 3 (CCRI Program)

Part of the plot was sprayed with DDT during the evening of June 1, treatment being interrupted by problems of a mechanical nature. The rest of the plot was sprayed early the following morning. Average dosage was 1/4 lb./acre. At 5:00 a.m. on June 2 a robin was found at the side of the highway forming the southern boundary of the plot. Although it displayed some of the symptoms of poisoning (tremoring and loss of balance) it doubtless had been struck by a passing car, though no injury was apparent. An observer ranged widely through the plot for about one hour late in the morning of June 2. There was no evidence of bird poisoning.

Plot 8 (CCRI Program)

Bird census taking by a rolling-station method was begun in this plot but was discontinued owing to the demands of other commitments. The plot was sprayed with baygon at an unknown dosage on the morning of June 22. Three observers searched for evidence of bird poisoning from 2:30 to 4:00 p.m. of the same day. They found none.

Table 7. — Bird count results, Line A, Control, N.B. (Observer X)

Species*	May 24	May 25	May 27	June 2	June 4	June 8	June 27	July 2
Ruffed grouse	1	1	2	1	0	0	0	0
Yellow-bellied sapsucker	11	9	9	12	10	11	16	13
Yellow-bellied flycatcher	0	0	0	10	10	10	8	3
Red-breasted nuthatch	6	3	3	3	4	4	8	2
Winter wren	1	2	2	1	1	1	2	1
Robin	3	1	2	1	3	2	5	3
Swainson's thrush	8	11	9	5	8	10	15	15
Ruby-crowned kinglet	8	7	8	8	6	5	3	1
Solitary vireo	0	0	1	1	1	1	1	1
Tennessee warbler	15	15	10	16	15	14	19	12
Parula warbler	1	1	1	0	1	2	1	1
Magnolia warbler	5	5	12	8	6	6	9	3
Cape May warbler	5	4	4	2	1	2	4	0
Black-throated blue warbler	3	1	1	2	0	1	2	1
Myrtle warbler	5	9	5	4	3	4	2	4
Black-throated green warbler	7	2	4	3	3	1	2	1
Blackburnian warbler	1	3	3	5	4	2	4	4
Bay-breasted warbler	6	3	7	6	5	10	7	8
Ovenbird	14	13	14	12	13	16	13	16
Canada warbler	1	0	0	2	2	1	1	1
American redstart	0	0	0	1	0	0	0	0
Rose-breasted grosbeak	2	1	1	1	0	1	1	0
Purple finch	7	9	10	5	7	7	6	11
Pine grosbeak	0	0	0	0	0	0	1	4
Slate-colored junco	2	2	3	3	2	3	5	2
White-throated sparrow	11	8	12	10	9	8	16	13

Line B, Control, N.B. (Observer X)

Species*	May 24	May 25	May 27	June 2	June 4	June 8	June 27	July 2
Ruffed grouse	1	1	1	0	0	0	0	0
Yellow-bellied sapsucker	8	8	6	7	6	6	11	7
Yellow-bellied flycatcher	0	0	1	5	4	3	4	0
Red-breasted nuthatch	0	2	1	0	5	3	3	5
Winter wren	2	0	2	0	3	1	0	2

Table 7. — Cont'd.

Species*	Number of birds recorded							
	May			June				July
	24	25	27	2	4	8	27	2
Robin	7	9	4	6	6	6	6	5
Swainson's thrush	2	6	5	7	4	5	8	11
Ruby-crowned kinglet	7	7	13	6	8	6	7	3
Solitary vireo	0	1	0	0	0	0	0	0
Tennessee warbler	16	14	11	13	10	15	12	14
Parula warbler	2	1	2	2	1	0	1	1
Magnolia warbler	8	8	7	9	5	5	5	0
Cape May warbler	0	2	5	1	4	3	0	3
Black-throated blue warbler	1	0	0	0	0	0	0	0
Myrtle warbler	6	7	4	5	3	3	5	1
Black-throated green warbler	4	5	2	0	0	0	1	0
Blackburnian warbler	1	0	0	0	0	1	1	0
Bay-breasted warbler	3	4	10	6	6	6	8	4
Ovenbird	9	9	10	11	13	8	9	11
Canada warbler	0	0	0	2	2	3	2	0
American redstart	0	0	0	0	1	1	0	0
Rose-breasted grosbeak	1	0	0	0	1	0	2	1
Purple finch	6	5	9	8	9	2	8	7
Pine grosbeak	0	0	0	0	1	2	3	0
Slate-colored junco	1	1	0	0	1	1	1	0
White-throated sparrow	8	9	9	11	10	9	11	16

Table 8. - Count totals and population indices, Line A, Control, N.B. (Observer X)

Count number	Date	Total birds recorded	Time (minutes)	Birds/ minute	Total songs recorded	Songs/ minute	Total species
1	May 24	157	89	1.8	1317	14.8	39
2	May 25	131	62	2.1	1076	17.4	31
4	May 27	136	68	2.0	1148	16.9	29
7	June 2	137	58	2.4	1042	18.0	34
8	June 4	131	59	2.2	1060	18.0	31
10	June 8	142	60	2.4	1213	20.2	37
14	June 27	172	55	3.1	1029	18.7	37
15	July 2	141	59	2.4	1166	19.8	33
Line B, Control, N.B. (Observer X)							
1	May 24	117	57	2.0	624	10.9	31
2	May 25	117	61	1.9	826	13.5	27
4	May 27	118	64	1.8	836	13.1	28
7	June 2	114	50	2.3	703	14.1	27
8	June 4	125	56	2.2	710	12.7	36
10	June 8	104	50	2.1	922	18.4	29
14	June 27	126	56	2.2	894	16.0	32
15	July 2	108	52	2.1	887	17.0	29

Table 9. - Bird count results, Line A, Control, N.B. (Observer Y)

Species*	Number of birds recorded								
	May			June				July	
	26	28	29	6	10	14	21	3	10
Yellow-shafted flicker	1	1	0	0	0	0	1	0	0
Yellow-bellied sapsucker	14	13	13	6	9	3	8	16	10
Yellow-bellied flycatcher	3	3	4	3	4	4	5	6	3
Least flycatcher	2	2	2	0	0	1	1	0	0
Eastern wood pewee	0	0	0	1	3	1	1	2	1
Olive-sided flycatcher	0	0	0	0	0	0	0	0	0
Barn swallow	0	0	0	0	0	0	0	0	0
Blue jay	3	4	1	1	1	0	0	0	2
Boreal chickadee	0	1	3	1	0	0	3	1	5
Red-breasted nuthatch	1	4	2	4	6	2	3	2	3
Winter wren	1	1	1	1	0	2	1	2	0
Robin	5	8	4	1	5	1	2	3	3
Swainson's thrush	6	6	7	10	9	10	9	10	11
Ruby-crowned kinglet	7	8	8	5	5	4	4	1	1
Solitary vireo	0	1	0	1	1	0	0	2	0
Tennessee warbler	12	17	14	16	17	17	17	16	8
Parula warbler	2	1	2	1	1	0	0	0	2
Magnolia warbler	7	12	10	7	4	7	5	6	6
Cape May warbler	5	4	1	2	2	1	2	1	0
Myrtle warbler	4	7	6	4	2	1	3	1	3
Black-throated green warbler	3	5	4	3	2	2	2	2	1
Blackburnian warbler	1	2	2	3	1	3	3	1	0
Bay-breasted warbler	9	5	9	7	11	9	8	11	7
Ovenbird	13	13	11	16	16	9	11	13	14
Yellowthroat	0	0	0	0	0	0	0	0	0
Redwinged blackbird	0	0	0	0	0	0	0	0	0
Rose-breasted grosbeak	2	0	0	0	0	0	0	0	0
Purple finch	7	7	7	3	6	2	4	5	0
Pine grosbeak	0	0	0	0	0	2	0	1	1
Slate-colored junco	7	4	3	4	3	1	2	3	2
White-throated sparrow	24	19	21	19	21	14	16	16	17
	Line B, Control, N.B. (Observer Y)								
Yellow-shafted flicker	0	0	0	2	1	1		1	2
Yellow-bellied sapsucker	13	11	12	3	11	2		14	11

Table 9. — Cont'd.

Species*	Number of birds recorded								
	May			June				July	
	26	28	29	6	10	14	21	3	10
Yellow-bellied flycatcher	3	3	3	1	2	3		0	2
Least flycatcher	2	2	2	1	2	1		0	0
Eastern wood pewee	0	0	0	0	0	0		1	0
Olive-sided flycatcher	0	0	1	1	1	0		0	0
Barn swallow	0	0	0	0	0	0		0	0
Blue jay	1	3	1	1	3	2		0	0
Boreal chickadee	0	3	1	3	1	0		0	6
Red-breasted nuthatch	1	2	4	0	5	2		5	4
Winter wren	1	2	1	1	1	0		1	0
Robin	6	6	8	2	7	4		4	3
Swainson's thrush	7	5	4	1	6	9		12	16
Ruby-crowned kinglet	14	12	12	8	9	5		5	2
Solitary vireo	0	0	1	0	1	1		1	0
Tennessee warbler	15	17	16	14	14	13	rained out	9	7
Parula warbler	0	2	2	0	0	0		1	1
Magnolia warbler	7	8	10	6	8	7		4	6
Cape May warbler	4	3	1	4	2	5		1	0
Myrtle warbler	11	8	8	3	3	1		7	4
Black-throated green warbler	2	3	0	0	0	0		1	1
Blackburnian warbler	1	2	1	1	1	0		0	1
Bay-breasted warbler	14	10	9	8	13	6		7	7
Ovenbird	10	11	11	14	13	7		12	14
Yellowthroat	0	1	1	0	1	1		0	0
Redwinged blackbird	0	0	0	0	0	0		0	0
Rose-breasted grosbeak	0	0	0	0	2	0		3	0
Purple finch	8	7	5	5	4	3		5	3
Pine grosbeak	0	2	0	1	2	0		2	0
Slate-colored junco	0	0	4	0	3	0		0	3
White-throated sparrow	20	17	22	18	27	15		18	16

* Those species listed in Table 2.

Table 10. - Count totals and population indices, Line A, Control, N.B. (Observer Y)

Count number	Date	Total birds recorded	Time (minutes)	Birds/ minute	Total songs recorded	Songs/ minute	Total species
3	May 26	160	52	3.1	833	16.0	34
5	May 28	173	61	2.8	786	12.9	33
6	May 29	167	51	3.3	701	13.7	38
9	June 6	140	47	3.0	675	14.3	34
11	June 10	162	57	2.8	956	16.8	33
12	June 14	105	40	2.6	748	18.7	27
13	June 21	126	39	3.2	574	14.7	30
16	July 3	147	42	3.5	661	15.7	34
17	July 10	136	49	2.8	379	7.7	34

Line B, Control, N.B. (Observer Y)

Count number	Date	Total birds recorded	Time (minutes)	Birds/ minute	Total songs recorded	Songs/ minute	Total species
3	May 26	156	59	2.6	605	10.2	30
5	May 28	161	60	2.7	817	13.6	35
6	May 29	165	61	2.7	742	12.2	35
9	June 6	113	49	2.3	555	11.3	29
11	June 10	154	55	2.8	683	12.4	31
12*	June 14	98	33	3.0	433	13.1	26
13	June 21		(count not made because of rain)				
16	July 3	136	46	3.0	407	8.8	32
17	July 10	139	51	2.7	430	8.4	31

* Only three-quarters of route covered because of rain.

DISCUSSION

It is important to re-state at the outset that in 1968, as in previous years, our work has involved the monitoring of a control operation. We have not been able to establish hazard levels precisely and the effects of a given treatment must always be qualified by the words "as operationally made." It would be impossible to apply insecticide from the air uniformly over a wide area even though the operator was very experienced and used the best available equipment and aircraft-guidance systems. An uneven insecticide application, or a treatment that was not quite what was intended, could result from the influence of several variables of an "operational" nature. Some of these are interacting and are as follows:

(a) Human. Pilots may be inexperienced. Aircraft may not be flown at the correct speed and altitude. Correct spacing may not be maintained. Block boundaries may be incorrectly located by the guiding aircraft. Aircraft may be improperly calibrated. Formulations may be incorrectly prepared.

(b) Physical—Chemical. Emulsions may be unstable. Chemical properties of formulations may change if the water used in mixing is too acid or too alkaline. Properties of technical materials may change after prolonged storage.

(c) Physiographic. Spraying over rugged terrain imposes special difficulties for pilots. Operation over relatively featureless terrain may make block boundary location difficult.

(d) Meteorological. Excessive wind or air temperature may prevent the spray from reaching target areas. Drift spraying may be impossible in calm air conditions. Problems of this sort may be compounded by those caused by physiographic factors.

In operational spraying against spruce budworm, compressed as it must be into a short time span geared to larval development, some operational variables, singly or in combination, are very difficult to avoid. Their importance and effects are virtually impossible to assess.

Post-spray searching of treated areas occupied more of our time than in other years. Several factors, the following of which are important, determine whether a real effect will be detected by post-spray searching.

(a) The size of the population and the degree to which birds are poisoned.

(b) The experience of the searchers—an observer with little ability to identify birds and with no knowledge of bird behaviour will be severely handicapped.

(c) The number of persons employed searching.

(d) The time lapse between spraying and initiation of searching. The time for which searching is prolonged—it may be a considerable time before the effect of a slow-acting toxicant manifests itself.

(e) The weather during searching—rain or wind may inhibit bird activity and obscure any effect.

(f) The floristic nature of areas being searched—dense forests restrict vision, thick ground and shrub vegetation may conceal sick birds.

(g) The number of roads and trails in the search area—a good network will facilitate the finding of dead and incapacitated birds, as previous experience has shown.

(h) The extent to which sick birds are removed by predators.

For purposes of comparison it would be useful to systematize search operations and to quantify results. The above-mentioned factors point up the difficulty of such an exercise and for these reasons searches in two areas treated identically may produce markedly different results and assessment of total effect. Our experience has shown that carcasses are extremely difficult to find. Sick birds are relatively more easily found, depending on the degree of incapacitation. We may safely assume that the sick birds that are captured or seen actually represent only a small fraction of the total number affected in a given sprayed area.

A word of caution should be said concerning the usefulness of the population indices. These are based largely on the number of birds heard singing. Normally an observer will hear only those birds singing relatively close by, more distant songs being "drowned out". Following a population reduction, an observer will hear a disproportionately greater number of the birds that are singing within range. For these reasons a population depression may actually be greater than is suggested by the birds/minute and songs/minute indices. Furthermore, surviving birds may seek to expand their territories to fill the vacuum created by the removal of others. Increased competition may stimulate more vocal activity. Arrival of immigrants from outside the sprayed area may have a similar effect.

Before discussing the effects of the 1968 spray programs it would be useful briefly to review the conclusions drawn from the results of the last four years' operations in New Brunswick and to examine this year's findings in their light.

In 1964 phosphamidon applied at 1/2 lb. in 3/4 USG per acre caused substantial avian mortality in some areas. A half-strength mixture applied in the evening apparently had little effect on birds: it was not known if this could be attributed to the decreased dosage, to the relative inactivity of birds at the time of application, or to other factors. The effect of the addition of a penetrating agent was obscured by factors of an imponderable nature. Experiments with captive birds showed that it was possible for them to pick up lethal dosages through their feet from sprayed branches.

In 1965 varying degrees of population reduction and mortality were observed in all areas where 1/2 lb. of phosphamidon per acre was applied. A double application of 1/4 lb. in 4/5 USG caused some mortality. On all plots where 1/4 lb. phosphamidon per acre was applied, effects were relatively slight and it was concluded that this dosage was below the lethal level for most species except for those whose feeding habitats and behaviour made them particularly vulnerable. No effects could be attributed to dilutions of 1/5, 2/5, and 4/5 USG. Experiments with captive birds confirmed earlier observations on dermal toxicity.

Further monitoring of field applications of phosphamidon in 1966 were difficult to assess as they were made early in the season when migrants were arriving in the study areas where censuses were being taken. There was a suggestion that 1/4 lb. in 1/5 USG caused a slight reduction in the number of birds. A low volume application of technical material (1/3 lb. per acre) caused a decrease in numbers of birds and song activity, and several incapacitated birds were found.

In 1966 bird observations were made in several plots sprayed with sumithion. Cold weather, accompanied by rain and snow during post-spray censusing, made assessment of effect difficult. Navigational errors compounded the problem. It was concluded that doses of less than 1 lb. per acre of sumithion probably do not depress bird populations. Experiments with captive birds demonstrated the lower toxicity of sumithion compared with phosphamidon and that birds could pick up lethal doses of sumithion through contact with sprayed perching surfaces.

Operational experimentation with sumithion was expanded in 1967 and the effect on forest birds was monitored in 11 treatment areas. For the first time, sumithion-phosphamidon mixtures were used. All applications were made at the rate of 1/2 USG emulsion per acre. The effects on birds may be summarized as follows:

1. Sumithion applied very late in the evening at 1 lb. per acre apparently had no effect on birds, though monitoring was restricted to post-spray searching only;
2. Sumithion applied early in the evening at 1/2 lb. per acre caused incapacitation of some birds, a few of which were readily captured;
3. Sumithion applied in the morning at 1/2 lb. per acre caused a noticeable population depression, particularly of warblers. Fifteen birds were captured and many more were seen to be in distress. The effect was much more marked than in areas similarly treated in the evening. The same treatment in another spray block failed to cause any detectable effect and was ascribed to the inhibition of bird activity by excessive

wind at the time of spraying;

4. Sumithion applied in the morning at 3/8 lb. per acre failed to cause any population depression, though the area was sprayed during windy conditions and rain hindered post-spray searching;
5. Two evening applications of sumithion, three days apart, at 1/4 lb. per acre caused very little effect. Three warblers were captured in areas where it was suspected overlapping swaths had caused an increased dosage; and
6. Application of phosphamidon-sumithion mixtures (1/4 + 1/4, 1/8 + 1/4, 1/8 + 3/8 lb. per acre) caused no detectable bird-population depressions and no evidence of birds in distress was noted.

Effects of Phosphamidon, 1968

The most marked and widespread effect was in Block 25. Ruby-crowned kinglets and several of the high-foraging warbler species were apparently eliminated, there being no recovery or replacement 25 days after treatment. (Data for the control area do indicate a gradual decline in the numbers of ruby-crowns, early migrants, which may reflect a decline in breeding activity). Large birds, such as a sparrow hawk and a ruffed grouse, were also affected. Some avian mortality in Block 25 was not totally unexpected. We had had no previous experience with a 3/8 lb. dosage of phosphamidon, but this amount is 50 percent higher than the 1/4 lb. treatments made in 1965 and 1966 when, although some birds were killed, the effect was relatively slight. Total effect was probably as great as in some (Bettsburg, Nashwaak) 1/2 lb. blocks sprayed in 1964 although, for reasons already outlined, it is impossible to assess quantitatively. If dosage alone was the critical factor, the hazard level was lower than we had thought. A new variable, fine calibration, was introduced for the first time in the 1968 experiments. The same dosage (3/8 lb.) at the same dilution (1/5 USG) was applied in Block 2, treatment being made at a coarse calibration. About the same search effort was directed here as in Block 25, three sick birds being captured and another 11 seen. Birds were silenced but the effect appears not to have been as great as in Block 25. In Block 45 ten sick birds were captured and another four seen, the search effort being about the same, in man-hours, as in Block 25 and 2. Here again phosphamidon was applied at a fine calibration: mortality was greater than in areas treated with 1/4 lb. in previous years. A ULV application silenced birds throughout the plot during the two days we were active there, but only two sick birds were captured and another nine were incapacitated to a greater or lesser degree. In one of the 1/8 lb. blocks (32) sprayed during the evening, a few sick birds were seen and there was some song suppression in localized areas. In the other 1/8 lb. block (32, Newfoundland) sprayed during the morning, birds were silenced and several were noted to be constantly bill wiping. Probably the effects were just beginning to be manifested but it was not possible for us to return to the area. The possible implications for nestlings and other young birds resulting from spraying relatively late in the season have been treated more fully in a separate report concerning monitoring of the hemlock looper operation in Newfoundland.

Only one block (1) was visited that had been sprayed with a mixture of organophosphates (1/4 lb. + 1/8 lb. phosphamidon + sumithion at a fine calibration). In a little over three man-hours of searching, seven distressed birds were picked up and ten more seen. Birds had been silenced in the areas that were searched. There was no 1967 block with which to compare results but intensive censusing and post-spray searching in two blocks (I and L) treated that year with 1/4 lb. + 1/4 lb. mixture at a coarse calibration failed to reveal any effects on birds.

On the basis of experience in previous years we would not have expected such a marked effect in some of these blocks. This leads us to the conclusion that, in 1968, dosage was not the sole critical factor.

Effects of Sumithion, 1968

The Block 16 treatment was the same as in Blocks A, B, D, and J sprayed in 1967—1/2 lb. in 1/2 USG at a coarse calibration. It was included in the 1968 program in the expectation that some of the conflicting evidence arising from last year's monitoring might be resolved. Three sick birds were captured and a few more seen. Bay-breasted warblers were noted to be on or near the ground feeding but otherwise appeared normal. It is not known if this was an indication of slight intoxication or if the birds' natural food source had been eliminated and they were seeking an alternative one. The effect of spraying was very similar to that in Block A and B most parts of which, however, were sprayed in the evening. The effect was much slighter than in Block D but greater than in Block J (where birds were apparently unaffected). We are really no nearer establishing the hazard level for birds of sumithion sprayed at a coarse calibration but, under certain circumstances, 1/2 lb./ acre can kill birds.

Two blocks were sprayed with sumithion at 1/2 lb. in 1/5 USG at a fine calibration. Block 9 was sprayed in the evening and six birds were readily captured and others seen by inexperienced searchers in unfavourable searching conditions 24 hours later. This was the first time we had found sick birds after an evening spray. (A 1 lb. dosage applied coarse in Block M in 1967 apparently did not affect birds). Block 28 received exactly the same treatment but no evidence of bird intoxication was found. Observers encountered difficulty locating this block and some doubt was expressed at the time that they were within its bounds while searching.

We monitored five areas which were sprayed with 3/8 lb./acre. Birds were apparently most affected in Block 29, where the most intensive monitoring was carried out. Eleven sick birds were captured and another 38 seen. The results of searching throughout the block and a comparison of the census figures for both legs of the census route suggest that spray coverage was not very uniform. There were striking reductions in the numbers of many warblers. Winter wrens were apparently not affected but some ruffed grouse were. There had been a substantial recovery 13 days after treatment. Total effect was much less than in Block 25, confirming our belief that sumithion is less toxic to birds than phosphamidon. Effect was much greater than in Block D in 1967, suggesting that another factor, possibly calibration, was important.

The Block 29 treatment was replicated in Blocks 7 and 8. Birds were silenced in Block 8 and one inexperienced observer was able to capture three sick warblers easily about nine hours after spraying. The treatment in Block 6 differed only in that the calibration was coarse. Here a more intensive and prolonged search revealed only five sick birds, two of which were taken in the hand. The Fundy National Park campground was sprayed by a different type of aircraft, during the evening. Dosage was again 3/8 lb. but in 1/3 USG at a medium calibration. The limited census data suggest there was no significant population depression. Some birds were apparently slightly affected but probably soon recovered. The effects of these five 3/8 lb. treatments, compared with the 1/2 lb. treatments, indicate that a factor other than dosage was important and that it was probably droplet size.

A double application of sumithion at 1/4 lb./acre in Block 20 inexplicably failed to produce the extensive mortality that was anticipated. It is difficult also to interpret our findings in the five 1/4 lb. blocks that we searched. Some sick birds were seen. Song counts made at several points in these blocks suggest that spray coverage was far from uniform. Sumithion sprayed extra fine in Block 14 produced no effect that we could detect though rain impeded our searching. In Block 34 where sumithion was sprayed twice at 1/8 lb. some sick birds were captured and others seen. Effect on birds was again quite localized. Searching in five 1/8 lb. sumithion blocks revealed little or no effect on birds. The evidence suggests that the hazard level for sumithion at a fine calibration is between 1/4 lb. and 3/8 lb./acre. Acute poisoning of birds at dosages of or below 1/4 lb. can probably be attributed to local concentration resulting from overlapping swaths or peculiarities of drift.

In summary, then, we can state that apparent inconsistencies in the effects of duplicated treatments at lower dosage levels can probably be attributed to the influence of operational variables. Assuming that these factors do not account for all the relatively greater and more widespread effects as compared with the effects of comparable dosages in previous years, which seem likely, our findings best fit the hypothesis that the finer spray is more toxic to birds than the coarser calibration. Dr. Fowle has demonstrated the ability of birds to pick up lethal amounts of insecticide through contact of the feet with sprayed plant surfaces. It is possible that birds are able to pick up relatively greater amounts when the material is distributed in a greater number of smaller droplets, though smaller droplets would probably be absorbed much faster by the plants. The possibility of entry into the bird through the respiratory system has, in the past, not been excluded. Birds may be able to inhale smaller droplets more readily than larger ones. Smaller droplets would take longer to settle and would be more easily carried about by small air currents within the forest and could prove hazardous to birds in the lower levels. More work will be needed to determine the extent to which the bird hazard is augmented by the smaller droplet size and to define the mechanism by which birds are able to pick up toxic dosages.

SUMMARY

During the 1968 control programs in New Brunswick and Newfoundland we conducted searches for evidence of harmful effects on forest birds in 24 spray areas. Intensive monitoring by censusing was carried out in

Table 11. Summary of block treatments and assessment of effect.

Block	Treatment	Effect
2	Phos. 3/8 lb., 1/5 USG, coarse, a.m.	Suppression of song. 1.4 sick birds/man-hour* searching.
25	Phos. 3/8 lb., 1/5 USG, fine, a.m.	Suppression of song, population indices. Little recovery of some species, especially warblers, 3 weeks later. 5.8 sick birds/man-hour searching.
45	Phos. 1/4 lb., 1/5 USG, fine, a.m.	Effect variable. 1.8 sick birds/man-hour searching.
32	Phos. 1/8 lb., 1/5 USG, fine, p.m.	Effect variable, slight. 0.6 sick birds/man-hour searching.
32 (Nfld.)	Phos. 1/8 lb., 1/5 USG, fine, a.m.	Birds silenced. Some bill wiping. No sick birds found.
1	Phos. + Sum. 1/4 lb. + 1/8 lb., 1/5 USG, fine a.m.	Birds silenced. 4.8 sick birds/man-hour searching.
9	Sum. 1/2 lb., 1/5 USG, fine, p.m.	Rain impeded search. Song counts suggest variable effect. 0.9 sick birds/man-hour searching.
16	Sum. 1/2 lb., 1/2 USG, coarse, a.m.	Some warblers grounded. No apparent song suppression. 0.3 sick birds/man-hour searching.
28	Sum. 1/2 lb., 1/5 USG, fine, p.m.	No apparent effect. Searched early. Some doubt as to whether correct area.
6	Sum. 3/8 lb., 1/5 USG, coarse, a.m.	Singing normal. 0.6 sick birds/man-hour searching.
7	Sum. 3/8 lb., 1/5 USG, fine, a.m.	Searching initiated over 48 hours after spray. Effect variable. 1.0 sick birds/man-hour searching.
8	Sum. 3/8 lb., 1/5 USG, fine, a.m.	Birds silenced, little activity. 2.6 sick birds/man-hour searching.
29	Sum. 3/8 lb., 1/5 USG, fine, a.m.	Marked population depression, some recovery 6.8 sick birds/man-hour searching.

Table 11. Summary of block treatments and assessment of effect—Cont'd.

Block	Treatment	Effect
14	Sum. 1/4 lb., 1/5 USG, extra fine, a.m.	Rain impeded search but no apparent effect.
15	Sum. 1/4 lb., 1/5 USG, fine, a.m.	Localized. Some birds slightly affected.
20	Sum. 1/4 lb., 1/5 USG, fine, a.m., x 2, second treatment immediately following first.	Localized. 1.2 sick birds/man-hour searching.
30	Fen. 1/4 lb., 1/5 USG, fine, a.m.	None apparent.
34	Sum. 1/8 lb., 1/5 USG, fine, x 2, noon and evening same day.	Effect localized. 1.2 sick birds/man-hour searching.
24-25 (Nfld.)	Sum. 1/8 lb., 1/5 USG, fine, a.m., x 2, 6 days apart.	Slight effect, localized.
26	Sum. 1/8 lb., 1/5 USG, fine, a.m.	None apparent.
14 (Nfld.)	Sum. 1/8 lb., 1/5 USG, fine, a.m.	None apparent.
31	Sum. 1/8 lb., 1/5 USG, fine, a.m.	None apparent.
33	Sum. + DDT, 1/8 + 1/10 lb. 1/5 USG, fine, a.m., x 2 second treatment immediately following first.	None apparent.

* Number of sick birds includes those found dead, those captured, but not those only slightly affected. Searches by inexperienced observers abitrarily assumed to be half as effective as those by experienced ones.

only four of these as well as in two control areas which were not sprayed. Most of our work was concerned with two insecticides, phosphamidon and sumithion, applied at different dosages and calibrations. Some evidence of bird poisoning was detected in 15 of the areas sprayed. Table 11 gives a brief summary of our findings, which have been examined in the light of our experience in the past four years. Some previous conclusions have been strengthened but others remain unverified. From the effects of the 1968 programs we have drawn the following conclusions.

1. Evening spraying offers definite advantages to birds over morning spraying.
2. Phosphamidon is more toxic to birds than sumithion.
3. A fine spray-droplet spectrum augments the hazard to birds.
4. Phosphamidon probably begins to cause acute effects at a dosage of about 1/8 lb./acre when sprayed at a fine calibration.
5. Sumithion begins to cause acute effects at a dosage between 1/4 lb. and 3/8 lb./acre when sprayed at a fine calibration.
6. Phosphamidon kills birds at a 3/8 lb./acre dosage when applied at a coarse calibration. Hazard level is probably near 1/4 lb./acre.
7. Sumithion can kill birds when applied at 1/2 lb./acre at a coarse calibration.
8. Some anomalous results are ascribed to the effect of imponderable operational variables.

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Appendix 14

Spruce Budworm Aerial Spraying Operation, Northwestern Ontario, 1968

by

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Introduction

Beginning in 1965, a perceptible but gradual increase in numbers of spruce budworm was noted throughout Ontario. In July of 1967, a pocket of moderate to severe defoliation covering 40,000 acres was found near Burchell Lake in the Port Arthur District of northwestern Ontario (Figure 1). An egg survey conducted in the fall of 1967 indicated that this infestation covered some 200,000 acres. An area of some 4.5 million acres stretching to the north and east of Burchell Lake and comprising extensive stands of spruce-fir type was endangered by this infestation. These stands had not been budwormed since about 1925, having escaped two previous northwestern Ontario outbreaks, namely the Nipigon outbreak of the 1940's and the Sioux Lookout-Fort Frances outbreak which ended in 1962.

The existence of this infestation and the threat it posed were brought to the attention of the Ontario Department of Lands and Forests during 1967. It was suggested that two alternatives lay open to the Province for direct action against this infestation; (a) the mounting of a spraying operation in 1968 with the objective of suppressing populations sufficiently to "knock out" the relatively small infestation before it had a chance to spread; or (b) using aerial spraying to protect valuable forest stands in imminent danger of suffering heavy losses from further budworm feeding. It was pointed out that if alternative (a) failed to work, the second course of action remained open. The provincial department, after evaluating the forest resources endangered, decided to undertake an aerial spraying operation in 1968 with the objective of eliminating the infestation by the aerial application of chemical insecticide in the spring of 1968.

Operational control of the project was exercised by the Ontario Department of Lands and Forests. The Forest Research Laboratory, Sault Ste. Marie, provided technical guidance in the timing of the sprays, and undertook all insect population determinations necessary to define the infestation area and assess the effectiveness of the operation. Forest Protection Limited, Campbellton, New Brunswick was engaged by the Ontario Department of Lands & Forests to handle the application of insecticides.

This report outlines the main features relating to the progress of the project and results obtained, based on a very general and preliminary analysis of the data collected.

Insect Development and Pre-spray Surveys

Larval emergence from foliage which was collected in April, 1968 around Burchell Lake and then incubated, indicated no excessive winter mortality. On May 1 field work began for the timing of natural larval emergence. This occurred between May 9 and 12. Series of periodic samples were begun to follow budworm development through the six larval instars and the pupal stage until moths emerged.

Following larval emergence, crews began sampling budworm larval densities as a basis for establishing spray boundaries. The results of larval counts made at 170 locations over a 2-week period revealed that an additional 55,000 acres were infested beyond that indicated by the egg surveys of 1967 (Figures 1 and 2).

These and all subsequent quantitative entomological samples apply to balsam fir. Standard techniques were used for budworm population and defoliation measurement using as the sampling unit six 18" tips from mid-crown branches for larval and pupal counts and six whole branches for defoliation and egg-mass surveys.

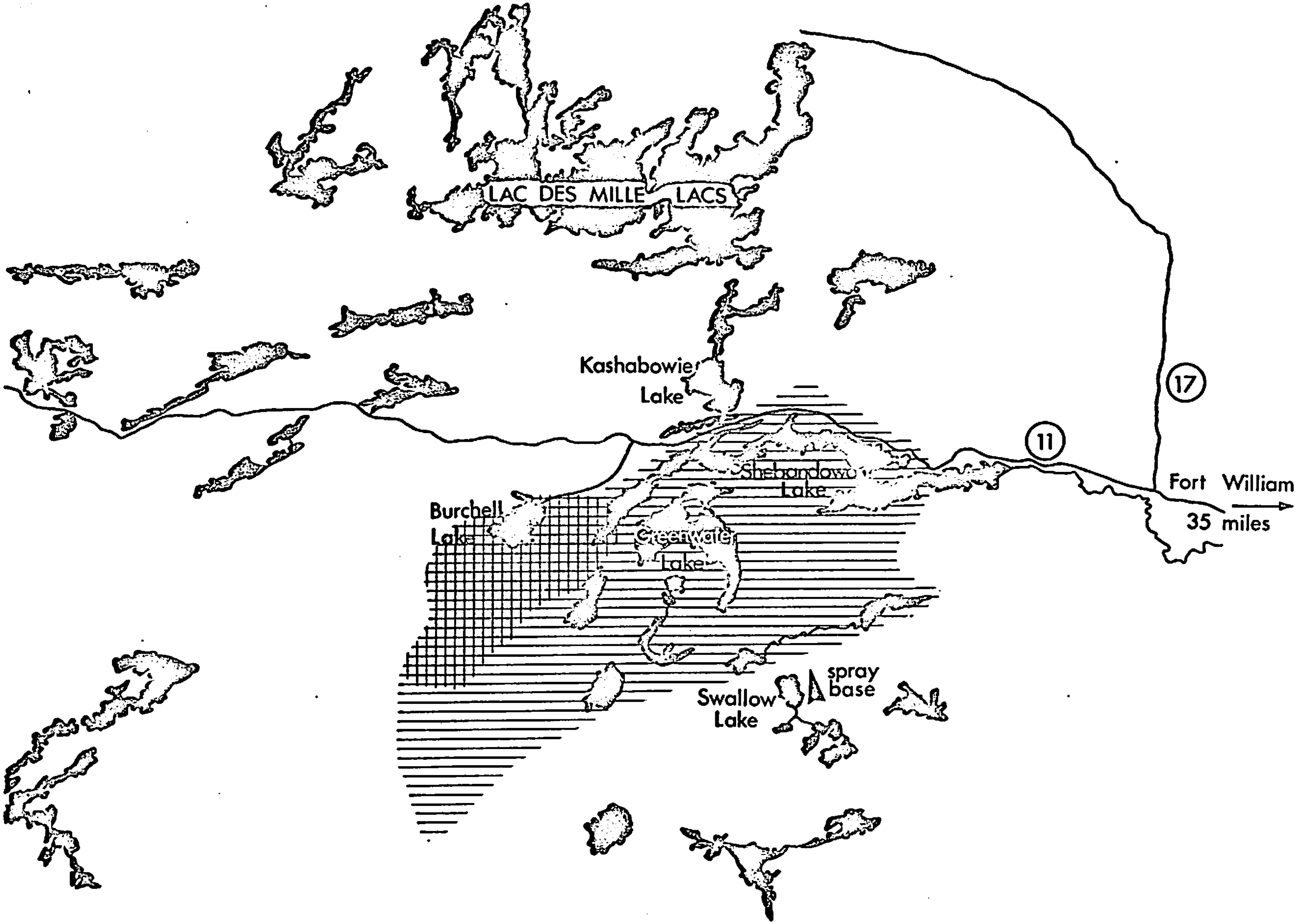
Spraying Operations

The operational plan called for the application of two organo-phosphate insecticides, which was a modified recommendation of the Chemical Control Research Institute in Ottawa. The materials were Sumithion, to be applied at the rate of 6 ounces per acre when the larvae were in 3rd or 4th instars, and Phosphamidon to be applied as a second spray at the rate of 4 ounces per acre at the peak of 5th instar.

Spraying commenced on June 5, but owing to continuously poor flying conditions, operations were then forced to shut down until June 12 when spraying resumed. All spraying was completed by June 20. The areas sprayed are shown in Figure 3 with acreages listed in Table I.

INFESTED AREAS – 1967

Figure 1

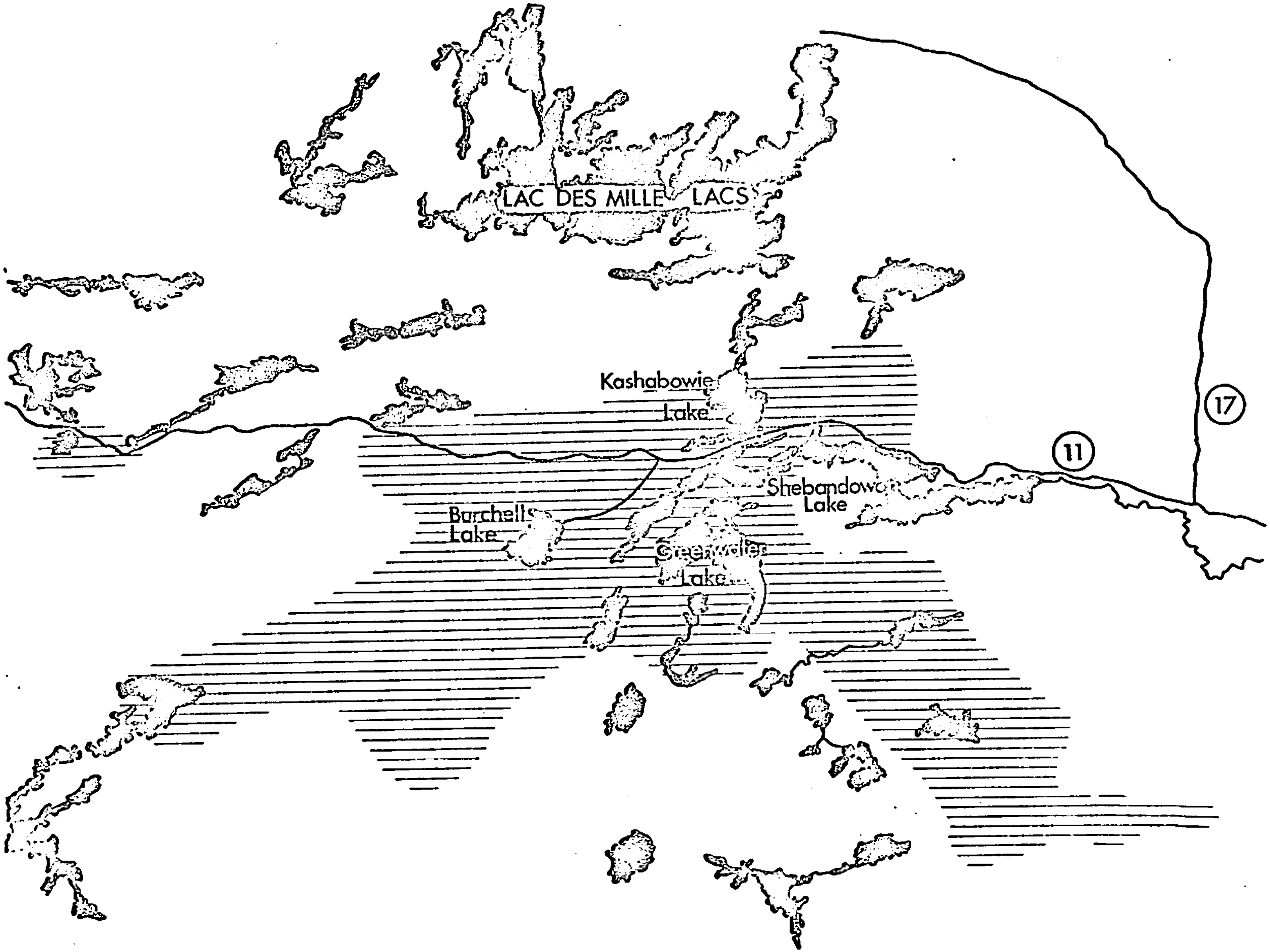


Area of severe defoliation, caused by 1966 generation – detected July, 1967

Area infested – 1967 fall egg survey

0 ——— 8

SPRAY BOUNDARY SURVEY

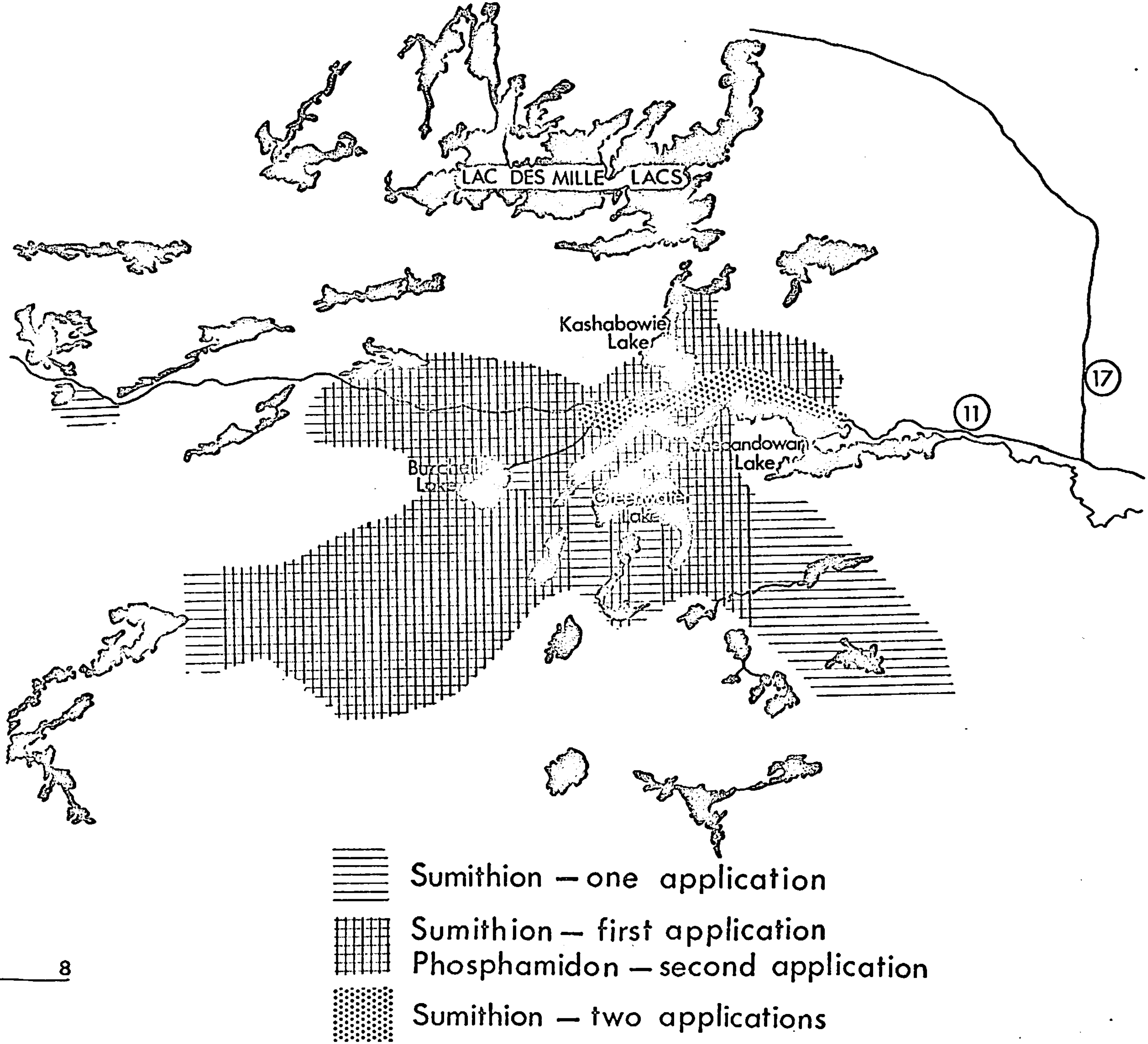


0 8

Area infested as determined by spray boundary survey May, 1968

Figure 2

AREA SPRAYED



0 8

Figure 3

TABLE I

Areas Sprayed in the 1968 Burchell Lake Control Operation in Northwestern Ontario

(Data obtained from maps supplied by Forest Protection Limited)

	Acres: One application	Acres: Two applications	Total
Sumithion			
Original plan	220,000	5,000	
Added to plan	55,000	—	
	275,000	5,000	280,000
Phosphamidon			
Original plan	200,000	—	
Added to plan	—	—	
	200,000	—	200,000

The Lakehead region had the wettest July since 1905 with thunderstorms being particularly frequent during the first 21 days. Major storms occurring between midnight and dawn on July 15 and 16 dropped 1.73 and 1.66 inches of rain respectively. These storms undoubtedly resulted in severe disturbance of the insects and foliage in the weeks following spraying.

Biological Assessments

The objective of this operation made direct population reduction assessment impossible. Because all check areas that were used were treated on the final day of spraying, a critical assessment of the reduction brought about by the two applications of insecticide was impossible. Some reliable determinations were made for the first spray application but these are of limited value in an overall assessment.

In spite of this, pupal surveys were carried out both within and outside the spray area to assess population levels at the end of the 1968 feeding season. The counts indicated very low populations both within the sprayed area and around it, except for a few areas east of Burchell Lake. As determined later by the egg survey, larger populations of pupae must have survived in some areas than were indicated by this sampling. One possible explanation is that some budworm were removed from host trees during the severe thunderstorms of July 15 and 16 and were thus not sampled, and that some of these gave rise to moths that laid eggs.

An aerial survey to detect defoliation in sprayed and adjoining areas was flown in early July. Four pockets of light to moderate defoliation totalling 1350 acres and two of heavy defoliation totalling 1300 acres were mapped in the spray zone. The total of 2650 acres is a relatively small area compared with the 40,000 acres of heavy defoliation in 1967, or with the forecast of even more extensive defoliation for 1968 based on egg surveys in the fall of 1967. Detailed estimates of defoliation were made from foliage collected at the time of the fall egg survey described below. These estimates also showed that defoliation in 1968 was much less severe than in 1967 (Table II).

The major assessment of this operation must be based on a comparison of egg populations present in late summer 1968 with those of late summer 1967. Egg surveys were conducted in August and early September 1968 throughout the spray area and adjoining areas. Samples were taken from 140 locations, 22 of which coincided with 1967 collection locations. Results from these 22 locations --

TABLE II

Comparison of 1967 and 1968 Egg Cluster Counts and Defoliation Estimates for Burchell Lake Region

Location	% Defoliation	Egg clusters per 100 ft.^{2} of foliage	% Defoliation	Egg clusters per 100 ft.^{2} of foliage
Burchell Lake	97	826	43	97
McGinnis Lake	82	725	25	18
Upper Shebandowan L.	74	293	37	34
Squeers Lake	48	136	6	58
Moss Lake	36	195	7	28
Hoof Lake	17	38	12	18
Greenwater L.	15	39	6	6
Huronian L.	11	0	6	14
Haines Twp.	9	25	6	3
HW 11 - 5 mi.	8	60	13	14
Shelter Island	8	41	2	8
Athelstane L. Rd.	7	0	10	3
Drift Lake Rd.	7	0	4	0
Hagey Twp.	6	8	5	0
Hood L.	6	11	5	15
Kekekaub L.	5	7	8	26
Plummes L.	3	3	5	0
Greenwood L.	nil	4	2	3
Titmarsh L.	nil	0	5	7
Bolton Bay	nil	0	6	0
Crayfish L.	nil	3	5	0
Blackwell Twp.	nil	0	2	3

mostly located within the spray area -- show a dramatic reduction in egg populations from 1967 to 1968 (Table II). Results from the balance of the 1968 egg sampling points indicate appreciable populations in only some 35,000 acres, located at the heart of the 1967 infestation area (to the east of Burchell Lake). Within this area, numbers of hatched egg-clusters were sufficiently high to produce populations that could cause moderate to heavy defoliation in 1969.

Conclusions

While a direct measure of larval population reduction resulting from spraying was not possible, it is clear that there was a very great reduction from 1967 to 1968 in the budworm populations, and the area infested, within the spray area.

It is impossible to assess how much of this reduction should be attributed to the spraying operation and how much to the clearly adverse weather that prevailed during budworm larval development in 1968. However, the result is a greatly improved spruce budworm situation in the susceptible spruce-fir forests west of the Lakehead.

Statement prepared for
Interdepartmental Committee
on Forest Spraying Operations
November 15, 1968

Appendix 15

SPRAYING FOR CONTROL OF SPRUCE BUDWORM

NORTHWESTERN ONTARIO, 1968

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Ontario Department of Lands and Forests

An infestation of the spruce budworm developed suddenly during 1967 in the Shebandowan Lake area of northwestern Ontario, about 50 miles west of Port Arthur. From an area of some 30,000 acres in 1967, it was found that the area likely to be infested in 1968 would be well over 200,000 acres. The over-all potential area for infestation, totalling at least 4.5 million acres and containing an inventory of 2.5 million merchantable cords of balsam and white spruce, represents the only significant area of susceptible forest in northern Ontario which has not been damaged by budworm epidemics during the past 40 years.

Two major pulp and paper companies, Abitibi and Great Lakes, have large operations in the area, and Shebandowan Lake in particular is also the major tourist and recreational area in that portion of the province. Therefore, in view of the forest values at stake in terms of possible direct kill of vital timber resources, the subsequent extreme fire hazard, and effects on tourism and recreation, and because the infestation appeared to be relatively well-defined, there was little choice but to attempt to confine the outbreak and if possible, to suppress it completely.

On the recommendation of the Chemical Control Research Institute, Ottawa, the chemicals selected were fenitrothion (Sumithion) applied at 6 oz. per acre when larvae were in the 3rd and 4th instars, and phosphamidon at 4 oz. per acre applied at the peak of the 5th instar. These materials were applied separately in one-fifth of a gallon water per acre. The chemicals, rates and operational procedures were chosen to give maximum kill of budworms with minimum risk to fish and wildlife. In order to avoid any unnecessary problems in public relations, the purple-dyed phosphamidon was not used in the area adjacent to Highway 11, and in the main cottage area along the north shore of Shebandowan Lake. In these areas both sprayings were with fenitrothion. As a result, 275,000 acres were sprayed with fenitrothion, and within this area 200,000 acres also received one application of phosphamidon.

Forest Protection Limited was engaged to act as an agent of the Ontario Government in developing a contract with the spray operator and in providing a guide system. FPL also assisted in planning and conducting the operation, and in locating a suitable airstrip site. The company provided the necessary equipment for mixing insecticide and loading aircraft, for purifying and loading fuel, and the experienced key personnel connected with these phases of the ground operations.

All construction and servicing was conducted through the Port Arthur District of the Department. Despite a late spring and much wet weather, the airstrip and 60-man camp were completed by mid-May. The rough terrain precluded the use of TBM aircraft. The spray fleet of 18 Stearman and the guide system of 5 Cessna planes were assembled at the site about June 2.

The Occupational Health Service of the Ontario Department of Health, Toronto, reviewed the use and handling of the insecticides, and made arrangements with the hospital staff, Fort William, to take the necessary blood cholinesterase samples from those persons in close contact with the chemicals. A helicopter was stationed at the spray site at all times during the operations. Spraying commenced on June 5, but was curtailed by wet weather until June 12. The operation was completed on June 20.

Because of current misunderstanding and suspicion of large-scale aerial spraying on the part of many segments of the public, it was particularly important to make a clear presentation of the objectives and methods of the project to interested groups in advance of the spraying. Consequently, through the Fish and Wildlife Branch of the Department, a meeting was held in Toronto with the Federation of Ontario Naturalists, the Audubon Society, and the Ontario Federation of Anglers and Hunters. A meeting in Port Arthur was held with the local press, cottage associations, Tourist operators, fish and game clubs, and naturalists. As a result, the project received full support from all agencies.

Under the supervision of the Fish and Wildlife Branch of the Department, a special study was made of the effects of spraying on wildlife populations. Since studies in the Maritimes had indicated that the effects of the chemicals used are not likely to be significant in the water environment, most of the effort was focused on song-bird populations. A team of four field observers determined bird populations over a period of two weeks prior to spraying, and followed results for two weeks after spraying. In summary, the results confirmed earlier observations in New Brunswick, that is, that neither chemical has a measurable effect on bird populations within a week or two after spraying. The effect of fenitrothion is particularly slight, with only two dead birds found on the 14 miles of census routes. Twelve dead birds and one jumping mouse were found on the census routes following the application of phosphamidon. This did not result in a measurable effect on the population as a whole. Caged minnows at three sites within the sprayed area did not suffer any mortality from either chemical. The results of an additional study on aquatic fauna were inconclusive.

In assessing the effectiveness of the project in controlling the budworm, the Forest Insect and Disease Survey, Sault Ste. Marie, has indicated that the core area of about 35,000 acres will require spraying again in 1969 if a resurgence of the infestation is to be avoided.

Prepared for meeting of the
Interdepartmental Committee
on Forest Spraying Operations,
Ottawa, November 20-21, 1968.

Appendix 16

Experimental Airspray for Control of Balsam Woolly Aphid in Newfoundland 1968

By

W.W. Hopewell and D.G. Bryant

Chemical Control Research Institute

Forestry Branch

Department of Fisheries and Forestry

Ottawa, Ontario

November, 1968

Experimental Airspray for Control of Balsam Woolly Aphid in Newfoundland 1968

W.W. Hopewell and D.G. Bryant

Screening of 27 insecticides over the past five years by application from the ground to individual trees infested with Balsam Woolly Aphid, and by laboratory tests (Hopewell and Bryant, 1966, Randall et al., 1967; Hopewell and Bryant 1968) led to the selection of four insecticides which showed activity in control of the aphid Adelges piceae Ratz. These were tested in August 1968 by aircraft application to small plots of aphid infested balsam fir near Deer Lake, Newfoundland.

Method:-

The plots were 20 chains square (ca. 40 acres) and each was bisected by a road. Two plots were at Goose Arm on the west side of Deer Lake and the other two on the east side near Pynn's Brook.

Two parallel lines of test trees were selected in each plot, one on each side of the road at a distance of 1 to 2 chains. The trees were spaced at approximately 2 chain intervals in the lines giving 20 per plot. Spray deposit samples were taken at each test tree and at one chain intervals along the road between the lines. Samples for deposit density were taken on petri dishes and on Kromekote cards for drops/cm^2.

Biological assessment was according to the method described by Hopewell and Bryant, with two prespray and three postspray sampling of nodes. Postspray samples were taken at 4, 8 and 14 days.

The spray solutions were applied by Stearman aircraft on emission runs at right angles to the road and timed to give an approximate emission run of 20 chains. Emission rate was 20 U.S. gals/minute.

Results and Discussion:-

It was planned that all materials would be applied at a nominal rate of 1 lb. active per acre in 2 gallons of solution (5%). However, due to unforeseen circumstances modifications were necessary for all insecticides. Baygon required a special solvent for dilution of the concentrate and there was not enough available to make up the 80 gallons; this material was applied as a 10% solution at a nominal rate of 1 gal/acre. Dursban, through an error in shipping in which one of the 2 containers of concentrate was found to contain a material other than Dursban, was applied at one half the intended concentrate, i.e., one half lb. in 2 gal/acre. The special formulation of Furadan made up for the tests contained 0.25 lb/gal. and this was diluted to 0.125 lb/gal. for use, i.e., 0.125 lb. in 2 gal. per acre. The amount of diazinon available was 25 lb. active which was made up to 80 gals (U.S.) and applied at 2 gal/acre.

The deposit density in U.S. gal/acre found at all sampling points is given in Table I. The amount of active material deposited is calculated from the data in Table I and is given in Table II. The number of drops/cm^2 at all sampling points is given in Table III. Table IV gives aphid mortality observed on all test trees of control and treated plots.

The very light deposit at most of the sampling positions indicates little likelihood of giving significant mortality, since previous tests using 12 to 25 lb/acre rates applied to individual trees did not always result in complete mortality of the aphid. The data have been grouped in dosage ranges of active ingredient and drops/cm^2 (Table V) to see if any correlation of mortality to dosage is apparent.

It is evident from the results that none of the materials was applied at a deposit high enough to give any significant mortality of the aphid. In fact there is a suggestion that the dosages used may have protected the aphid in some way since overall mortality on treated plots was less than mortality in control plots.

There was good distribution of spray deposit throughout the plots despite their small size for aircraft application. The average per cent recovery of emitted spray on the basis of 40 acre plots was 67, 25, and 71 on Plots 2, 3 and 7 respectively. Recovery could not be calculated for Plot 8 as 2 emission runs were made parallel to sample lines and thus samples were not representative cross sectional deposits.

Acknowledgements:-

Thanks are due to M.J. Hildebrand of Chemical Control Research Institute who took charge of the preparation and sampling of the plots with the aid of four summer students; also to Mr. Claude Marcoux, pilot for Wheeler Northland Airways Ltd. who did a very good job of application under difficult conditions.

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TABLE I

Deposit Density at all Sampling Points
for Each Plot (U.S. gal/acre)

	diazinon Plot 2			Furadan Plot 3			Dursban Plot 7			Baygon Plot 8		
Position	Line A	Road	Line B	Line A	Road	Line B	Line A	Road	Line B	Line A	Road	Line B
0		.16	.06		.10	.18		.72	.20		.90	.34
1	.12	.38		.20	.21		.62	.46		.83	1.14	
2		.19	.14		.05	-		.64	.62		.88	.19
3	.09	.09		.10	.12		.26	.37		1.47	1.15	
4		.32	.08		.13	.04		.59	.18		.98	.65
5	.08	-		.07	.09		.20	.38		.70	1.38	
6		.64			.05	.15		.44	.03		1.25	-
7	.39	.44		.13	.31		.37	.52		.50	1.57	
8		.30	.30		.16	.06		.46	.20		1.41	.61
9	.39	.39		.27	.24		.67	.44		.66	1.19	
10		.84	1.01		.06	.09		.49	.56		.62	.70
11	.82	.41		.09	.09		.52	.31		.53	.62	
12		.31	.49		.10	.02		.24	.46		.60	.29
13	.42	.49		.12	.22		.37	.55		.56	1.28	
14		.34	.31		.03	.05		.11	.13		.53	.32
15	.34	.36		.21	.07		-	.16		.15	.72	
16		.20	.18		.05	.04		.44	.36		.37	.42
17	.44	.28		.35	.12		.85	.31		.03	.48	
18		.38	.50		.21	.13		.59	.22		.42	.18
19	.20	.49		.14	.10		.31	.59		.48	.65	
20		.08			.16	.26		.77	.11		.26	.37
21	.03	.02		.09	.12		.16	.44		.46	.35	
22		.02			.09			.05			.13	
23	.04	-			.26		.03				.10	
24		.01			.03			.03			.05	
25		.03			.03		0				.06	
Ave.	.28	.30	.36	.16	.12	.10	.36	.42	.28	.58	.73	.41

TABLE II

Deposit of Active Ingredient per acre at all Sampling Points
(ounces/acre)

	diazinon Plot 2			Furadan Plot 3			Dursban Plot 7			Baygon Plot 8		
Position	A Line	Road	B Line	A Line	Road	B Line	A Line	Road	B Line	A Line	Road	B Line
0		.80	.30		.22	.40		2.88	.80		12.8	4.8
1	.60	1.90		.45	.47		2.48	1.84		11.8	16.2	
2		.95	.70		.11	-		2.56	2.48		12.5	2.7
3	.45	.45		.22	.27		1.04	1.48		20.9	16.4	
4		1.60	.40		.29	.90		2.36	.72		13.9	9.2
5	.40	-		.16	.20		.80	1.52		10.0	19.6	
6		3.20	-		.11	.34		1.76	.12		17.8	-
7	1.95	2.20		.29	.70		1.48	2.08		7.1	22.3	
8		1.50	1.50		.36	.14		1.84	..80		20.0	8.7
9	1.95	1.95		.61	.54		2.68	1.76		9.4	16.9	
10		4.20	5.05		.14	.20		1.96	2.24		8.8	10.0
11	4.10	2.05		.20	.20		2.08	1.24		7.5	8.8	
12		1.55	2.45		.22	.04		.96	1.84		8.5	4.1
13	2.10	2.45		.27	.50		1.48	2.20		8.0	18.2	
14		1.70	1.55		.07	.11		.44	.52		7.5	4.6
15	1.70	1.80		.47	.16		-	.64		2.1	10.2	
16		1.00	.90		.11	.09		1.76	1.44		5.3	6.0
17	2.20	1.40		.79	.27		3.40	1.24		0.4	6.8	
18		1.90	2.50		.47	.29		2.36	.88		6.0	2.6
19	1.00	2.45		.32	.22		1.24	2.36		6.8	9.2	
20		0.40			.36	.58		3.08	.44		3.7	5.3
21	0.15	0.10		.20	.27		.64	1.76		6.5	5.0	
22		0.10			.20			.20			1.8	
23	0.20	-			.58		.12	-			1.4	
24		0.05			.07			.12			0.7	
25		0.15			.07		0				0.8	
Ave.	1.40	1.50	1.80	0.36	0.27	0.22	1.44	1.68	1.12	8.25	10.38	5.83

TABLE III

Number of Drops/cm^2 at all Sampling Points

	diazinon Plot 2			Furadan Plot 3			Dursban Plot 7			Baygon Plot 8		
Position	Line A	Road	Line B	Line A	Road	Line B	Line A	Road	Line B	Line A	Road	Line B
0			3.2			3.2			3.4			21.7
1	4.7			7.7			14.4			20.1		
2			4.9			6.1			16.2			14.8
3	4.7			7.5			11.8			27.4		
4			1.8			1.0			3.2			24.8
5	5.8			1.6			7.1			17.9		
6			26.6			2.4			1.0			81.0
7	17.6			7.7			10.8			16.4		
8			11.6			1.4			3.4			34.7
9	13.7			8.7			20.0			29.0		
10			21.4			1.4			23.3			50.5
11	25.7			5.7			11.2			13.8		
12			8.5			0.4			7.5			20.5
13	8.7			1.8			14.4			10.8		
14			6.1			0.4			1.6			25.6
15	6.8			7.1			10.6			11.0		
16			3.9			0.2			19.9			31.5
17	7.9			35.7			18.3			0		
18			8.9			2.2			5.7			11.6
19	3.2			3.4			8.9			28.2		
20			0			9.7			2.8			10.4
21	0			2.4			3.0			21.9		
22						14.6			1.0			8.3
23	0			5.1			0.2			5.1		
24						0.2			0			0.6
25				0			0			0.6		

TABLE IV

Aphid Mortality (%) on Nodes of Trees in Treated and Control Plots

Tree No.	Plot 2 diazinon	Control A	Plot 3 Furadan	Plot 7 Dursban	Control B	Plot 8 Baygon
0	20		50	0		22
1*	4	26	0	22	23	41
2	17	37	-	8	25	35
3	-	52	29	15	-	21
4	13	48	30	12	7	20
5	0	30	18	24	47	31
6	-	29	39	20	29	-
7	-	-	32	12	-	18
8	18	23	29	29	56	24
9	13	16	22	35	23	36
10	5	28	41	31	-	40
11	22	50	6	33	-	32
12	10	38	30	14	-	32
13	12	45	20	25	-	14
14	5	24	31	50	31	40
15	24	63	43	-	-	35
16	16	37	35	12	-	39
17	19	31	28	60	40	14
18	7	27	8	17	-	21
19	8	40	35	18	-	8
20	-	43	0	11		17
21	18	40	17	26		15
22	-	50	-	-		-
23	-	50	-	-		-
24		28				
	12.8	37.2	25.6	22.6	31.2	26.4

* Odd numbers Line A - even Line B.

TABLE V

Summary of Results Grouped in Ascending Order of Deposit (oz./ac.) and Drops/cm^2 with Corresponding Mortalities

	diazinon		Furadan		Dursban		Baygon	
oz./acre	oz./ac.	Mort. (%)	oz./ac.	Mort. (%)	oz./ac.	Mort. (%)	oz./ac.	Mort. (%)
0-1	0.56 (8)*	12.0	0.34 (21)	25.9	0.64 (9)	21.0	0.4 (1)	14
1.1-2	1.68 (4)	15.0			1.42 (6)	16.0	-	
2.1-3	2.31 (4)	12.0			2.39 (5)	25.8	2.5 (3)	30.3
3.1-4	-	-			3.40 (1)	60.0	-	
4.1-5	4.10 (1)	5					4.5 (3)	31.3
5.1-10	5.05 (1)	5					7.9 (12)	23.8
> 10							16.3 (2)	31.0
Control Mort.		37.2		37.2		31.2		31.2

Drops/cm^2	Drops/cm^2	Mort. (%)	Drops/cm^2	Mort. (%)	Drops/cm^2	Mort. (%)	Drops/cm^2	Mort. (%)
0-5	3.6 (6)	13.0	1.68 (13)	29.5	2.63 (7)	21.1	0 (1)	14
5-10	7.5 (7)	11.0	7.7 (7)	32.7	7.3 (4)	18.2	-	-
10-15	12.6 (2)	15.5	-	-	12.5 (5)	21.4	12.3 (5)	23.8
15-20	-	-	-	-	18.6 (4)	28.8	17.2 (2)	24.5
20-30	23.6 (2)	13.5	35.7 (1)	28	23.3 (1)	31	24.4 (9)	26.1
30-40	-	-	-	-	-	-	33.1 (2)	31.5
> 40	-	-	-	-	-	-	50.5 (1)	40

* Number of samples given in brackets.

Appendix 17

INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

DEVELOPMENTS IN THE CHEMICAL CONTROL OF AMBROSIA BEETLES IN BRITISH COLUMBIA

by
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Council of the Forest Industries of British Columbia

Historical

For the past seven years a large volume of winter-cut high value sawlogs and peelers have been sprayed each spring for their protection from ambrosia beetle attack, Trypodendron lineatum (Oliv.) and Gnathotrichus sulcatus (Lec.). The insecticide used was Benzene Hexachloride (BHC) applied as an oil concentrate by helicopter to logs floating in water. Spraying of log booms by helicopter was first developed by the B.C. Loggers' Division of the Council of the Forest Industries of B.C. in 1960 (then known as the B.C. Loggers' Association). Since logging practices in the coastal areas of British Columbia involve the transport or the storage of logs in water, the spraying of logs in this manner was the cheapest and most effective. Spraying logs by helicopter in the woods has not been satisfactory because of inadequate coverage by spray of logs on the ground or in decks and because of the protective coverage of slash to felled-and-bucked. Added to these disadvantages of woods spraying is the high hazard to aircraft operation in such areas. Spraying logs in water circumvents all these problems and in addition permits a rapid application with a corresponding saving in costs.

Because of the widespread interest in the use of BHC in this manner on the B.C. coast, the Federal Department of Fisheries were closely associated with the Forest Industry throughout this development.

Problems in the Use of BHC

From the standpoint of beetle control with minimum danger to salmon, certain restrictive measures were necessary. These included a cut-off or zero date of April 15th, when spraying had to cease because of the commencement of the seaward migration of young salmon from the streams and rivers and the prohibition of spraying in the vicinity of river estuaries or in water less than an approved minimum depth. The most onerous of these requirements was the cut-off date of April 15th. Only a fraction of the winter-cut logs were in the water by that date and it was thus necessary to complete the spraying some two weeks before the first beetle flight occurred.

Added to these disadvantages in the use of BHC is the problem of water pollution through the accumulation of spray residue as indicated by recent surveys of the British Columbia Fish & Wildlife Branch of the Department of Conservation and Recreation. The presence of the Gamma Isomer of Benzene Hexachloride was detected in the tissues of trout in fresh water and in oysters of tidal flats affected by the spray operations. Accompanying these unfavourable features was the general concern of the public, particularly where it affected the domestic water supply.

The necessity for the development of a more compatible means for the protection of logs from ambrosia beetle attack had been evident to the Industry for the past several years and a search for a substitute for BHC had been underway by the B.C. Loggers' Division since 1965.

Injury to logs results from blackened tunnels drilled into the wood. In a heavy attack holes produced by this beetle may exceed one hundred per square foot of log surface. Damage in Douglas fir is restricted to the sapwood but in hemlock and balsam tunnels may penetrate several inches. Losses result from the degrade of both lumber and veneer cut from infested logs. Additional loss comes from the outright refusal of some overseas markets to accept lumber showing any signs of beetle attack.

Search for a Replacement for BHC

For an acceptable degree of protection an insecticide for this purpose must possess the following qualities:

(a) Non-toxic to fish and other aquatic life.

(b) Non-accumulative in its environment or in the animal food chain.

(c) A residual effectiveness against the ambrosia beetle for a minimum of four weeks.

(d) Low hazard to operator and a low level of mammalian toxicity.

For test purposes only insecticides were considered that seemed to qualify by these specifications. Five insecticides were selected for preliminary screening against the ambrosia beetle. These were Baytex, Baygon, Abate, Dimethoate, and Methyl Trithion. In all cases BHC was used as a check. From preliminary tests made in 1966 and '67 Methyl Trithion was selected as the most promising substitute for BHC. In 1968 further tests were undertaken under more natural conditions.

Methyl Trithion

LD 50 (Rats) Acute oral dosage

Methyl Trithion	200
BHC	200

96-hour Median Tolerance Limit (TLm)

Methyl Trithion	0.9 ppm.
BHC	0.05 ppm.

On this basis, therefore BHC is eighteen times more toxic to fish than Methyl Trithion.

(a) 1968 Tests

Three booms of logs were procured for the tests, all logs being from the same area, felled at the same time in December 1967, hauled from the woods, floated and made into three separate booms at the same time. One boom was sprayed with Methyl Trithion, one with BHC and one retained as an untreated check. They were all tied side by side on Cowichan Lake and periodic examinations were made to ascertain the degree of attack that might occur during the first half of summer.

Specifications of these booms were:

Boom No. 1 (unsprayed check)

Balsam 3; Cedar 42; Fir 129; Hemlock 115; Pine 1.

Total volume 174,089 fbm.

Number of pieces 290.

Boom No. 2 (Methyl Trithion)

Cedar 26; Fir 119; Hemlock 129; Spruce 3.

Total volume 165,398 fbm.

Number of pieces 277.

Boom No. 3 (Benzene Hexachloride)

Cedar 2; Balsam 5; Fir 143; Hemlock 162; Pine 5.

Total volume 201,722 fbm.

Number of pieces 317.

Periodic examinations were made of these logs from mid May to early July with the following results:

Number of logs infested (accumulated totals in brackets).

Boom No.	Treatment	Date Sprayed	May 13	May 16	May 21	June 6	July 5
1	Check	-	38	6 (44)	2 (46)	5 (51)	5 (56)
2	Mt	May 1	0	8	1 (9)	2 (11)	6 (17)
3	BHC	April 27	0	2	3 (5)	1 (6)	4 (10)

Under these conditions Methyl Trithion seems closely comparable to BHC for a two-week period. Shortly thereafter its effectiveness appeared to diminish although even as late as July 5th, a two-month period, there was a pronounced difference between the logs sprayed with Methyl Trithion and the unsprayed check.

(b) Use of Methyl Trithion in Control Operations

A total of 3,476 gallons of Methyl Trithion was applied during 1968 at a concentration of one pound active ingredient per Imperial gallon at a rate of 10 gallons per acre of log surface. Application was by helicopter at an average overall cost of 34 cents per thousand feet board measure. This compares to 24 cents per thousand feet board measure for BHC.

Methyl Trithion was used on Cowichan Lake, Nanaimo Lake and in certain salt water locations after the appearance of young migrating salmon. These locations were Valdez Island, Menzies Bay, Teakerne Arm and Alberni Inlet.

Since Methyl Trithion appears to be the best substitute for BHC at the present time and as the use of BHC is prohibited over fresh water and in certain salt water locations, Methyl Trithion will likely be the principal insecticide used for ambrosia beetle control in 1969. Its recommended use, however, is not without reservation. Its value under different conditions, dates of application, dosages, etc., has yet to be further explored. In the meantime, however, results in protecting logs from beetle attack, its safety to fish and freedom from water pollution would seem to justify its selection as a replacement for BHC until a better material is found. It is presently planned to phase out the use of BHC as an insecticide for ambrosia beetle control by 1970.

H.A. Richmond
Entomologist.

HAR:gh

November 1968

Appendix 18

Jack-pine Budworm Aerial Spraying Operation, Ontario, 1968

by

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Introduction

Extensive infestations of the jack-pine budworm have persisted on jack pine in northwestern Ontario for the past 3 years. Stands affected for more than 2 years, particularly those on poor sites, are in serious condition with considerable top-killing in evidence in 1968.

In central and southeastern Ontario, numerous infestations, some of them extremely heavy, were reported in 1968. Approximately 3500 acres of red and jack pine plantation showed severe defoliation in the Kirkwood Management Unit near Sault Ste. Marie. North of Parry Sound District, severe defoliation of natural stands of jack pine occurred within an area of 500 square miles, and in the Pembroke area two extremely heavy infestations were mapped, one southeast of Deep River and the other in the Lake Traverse area. In some instances, trees were stripped of their needles by a single year's feeding and some tree mortality is expected.

Measurement of Prespray Populations

In May, 1968, aerial spraying against the jack pine budworm was contemplated by the Ontario Dept. of Lands & Forests in five areas of northwestern Ontario. Three were small provincial parks (Rushing River, Blue Lake and Aaron) with a total area of 1300 acres; the fourth was Pipestone

Lake Provincial Park with an area of 3,500 acres; and the fifth was a 40-acre experimental area of high value on the Limits of the Dryden Paper Company near Dryden.

Owing to difficulties in predicting the intensity of attack from egg counts made the previous fall, population determinations were made in June by the Forest Research Laboratory in all five areas. Based on the results of these surveys (Table 1) spraying was confined to three areas, namely, the Rushing River and Blue Lake Provincial Parks and the 40-acre experimental area.

TABLE I

Prespray Measurements of Jack-pine Budworm Populations,
Northwestern Ontario, 1968

Location	Area in acres	Average number of 3rd and 4th instar larvae per 24-inch branch tip
Provincial Parks:		
Rushing River	430	17.0
Blue Lake	750	13.8
Pipestone Lake	3,500	3.8
Aaron	120	0.7
Experimental Area		
Dryden	40	6.6

Spraying Operation

On June 22, following the spraying of spruce budworm in the Burchell Lake area, one Stearman aircraft applied Sumithion to the 3 areas at the rate of 6 oz. per acre when jack-pine budworm larval development was at the peak of the 3rd instar.

The nature of this operation, which involved the spraying of widely-separated areas in a single morning, made critical assessment impossible. However, observations made in the weeks following spraying indicated that little foliage protection resulted. For example, the estimate of defoliation in the sprayed Dryden Paper Co. plot was 46%, while 49% defoliation was recorded immediately to the west and 50% to the east of it.

Infestation Status, Fall of 1968

Egg surveys conducted in the fall of 1968 revealed that overwintering populations sufficient to cause severe defoliation in 1969 are present in northwestern Ontario but over a greatly reduced area compared to 1968. In central Ontario, the surveys are still in progress and results are imcomplete. The first series of egg-cluster counts from the Pembroke area were lower than anticipated, based on the number of empty pupal cases present on host trees. This indicates a reduced level of infestation within areas seriously damaged in 1968 but suggest the possibility of infestation in other parts of the Ottawa Valley resulting from moth migration.

Aerial spraying is likely to be considered by the Department of Lands & Forests for the Kirkwood Management Unit and by the Petawawa Forest Experiment Station in 1969, each for a different reason. In the Kirkwood area many plantations are so badly damaged that a second year of defoliation could result in permanent injury. At Petawawa, most stands of jack pine were only lightly infested but because they are the subject of intensive study and long-term trails, any appreciable amount of defoliation cannot be tolerated.

It is anticipated that some aerial spraying will be carried out against the jack-pine budworm in 1969. The amount will depend on the complete results of egg sampling this fall and substantiated by larval counts in the spring of 1969. The maximum total amount is unlikely to exceed 7000 acres.

Statement prepared for
Interdepartmental Committee
on Forest Spraying Operations
November 15, 1968

APPENDIX 19

Statement for November 1968 Meeting of the Interdepartmental Committee on Forest Spraying Operations

Manitoba-Saskatchewan Region

Department of Forestry and Rural Development

by V. Hildahl

Contents

A. FOREST INSECT OUTBREAKS THAT MAY REQUIRE CHEMICAL CONTROL IN MANITOBA AND SASKATCHEWAN IN 1969

There are currently no serious outbreaks or infestations of major forest insect pests in Manitoba that may require operational control in 1969. Previous recorded outbreaks of the jack-pine budworm commenced declining in 1967 and were restricted to small patches of heavy infestation in 1968. Further decreases in population levels are expected to occur throughout these areas next year, thus eliminating the need for large scale control operations.

Other important forest insect pests such as the larch sawfly (*Pristiphora erichsonii* (Htg.)) and the spruce budworm (*Choristoneura fumiferana* (Clem.)) occur in outbreak proportions, but operational control is not proposed. Infestations of the former are scattered, and the major outbreak area of the latter is limited to more or less in accessible spruce-balsam stands in northern Manitoba and Saskatchewan.

1. CHEMICAL CONTROL INVESTIGATIONS AGAINST THE JACK-PINE BUDWORM IN MANITOBA--1968

by

R.F. DeBoo

Experimental spraying with insecticides using ground application techniques to control jack-pine budworm (Choristoneura pinus pinus Free.) outbreaks in pine (Pinus sp.) stands was continued in Manitoba in 1968. The objectives of the spray program were two-fold: (1) to develop application techniques adaptable to various types of spray equipment that are readily available to Provincial Parks and Forestry personnel; and (2) to determine the feasability of controlling larval populations while they are emerging from their hibernaculae.

Methods of Application

Conventional hydraulic power sprayer and mist blower applications (which were timed for control of 4th instar larvae) were made June 20-24. Matacil ULV was applied using a John Bean Rotomist Model 51 sprayer. All other treatments were applied with a hydraulic power sprayer utilizing a 500 gal. mixing tank. Treatment areas included both jack pine plantations and recreation areas in the Whiteshell Provincial Park of Manitoba where severe defoliation had occurred in 1967. A block treatment design was employed with one or more untreated check plots per treatment area.

Experimental applications for early control (vs 2nd and 3rd instar larvae) were applied June 5 to plantation jack pine ranging from 4 to 9.5 feet in height. The treatment area was located in the Whiteshell Provincial Park. A randomized completed block design having three replicates of 25 trees each was utilized for each experimental treatment. The insecticides were applied with five gallon knapsack-type compressed air sprayers. Population sampling to determine percentage of budworm larval mortality was conducted on July 5. A complete tally of the number of budworm larvae on 40% of the trees in each replicate was made on that date.

Results

All insecticides tested employing conventional hydraulic power sprayer and mist blower equipment provided adequate larval control to prevent serious injury to the foliage of infested pine trees. Similarly, adequate control was achieved with most of the compounds when applied against 2nd and 3rd instar larvae. Only 50% larval mortality was achieved with Malathion 57% emulsion concentrate, indicating that this material is not suitable for early budworm control.

The results of the experimental spraying against the jack-pine budworm are tabulated in tables 1 and 2.

TABLE 1

Control Achieved Using Hydraulic Power Sprayer and Mist Blower Applications (Timed for control of 4th instar larvae)

Compound	Formulation	Tree Ht. (ft.) + No. Acres Treated	Approx. No. gal. mixture/ acre	x No. budworm/ 36" branch 8-15 days after trtmt. Trtmt.	Check	% Mortality
Matacil ULV in Panasol	15 gal/25 gal	2-8 / 22	2	0	4.3	100
Phosphamidon 90% EC	1 L/100 gal	35-70 / 5	20	0	1.8	100
Phosphamidon 90 EC	1 L/100 gal	10-25 / 5	20	0.2	4.3	95
Phosphamidon 90 EC	1 L/100 gal	45-70 / 40	50	0.8	6.7	88
Cygon 2 E	2 qt/100 gal	25-70 / 20	20	0.1	21.8	99
Cygon 2 E	2 qt/100 gal	35-65 / 2	50	0.5	8.2	94
Accothion 80 EC	1 qt/100 gal	35-50 / 10	40	0.4	7.4	94
Sevin 4 Flow	1 qt/100 gal	3-20 / 15	47	2.2	15.8	89
Baygon 17 EC	1 gal/100 gal	3-20 / 10	10	1.3	11.7	86
Phosphamidon 90 EC + Accothion 80 EC	1 L + 1 qt/ 100 gal	3-15 / 95		0.9	4.3	85

TABLE 2

Experimental Applications for Early Control
(vs 2nd and 3rd instar larvae)

Compound	Conc. used	$\bar{x}$ No. budworm 30 days after treatment	% Mortality
Matacil 80% WP	0.2%	0	100
Phosphamidon 90% EC	0.1%	0	100
Cygon 2E	0.6%	0.33	98
Dylox 40% EC	0.5%	0.33	98
Phosphamidon 30% EC/ Fenitrothion 20% EC	0.1%	1.37	91
Malathion 57% EC	0.1%	7.17	50
CHECK (Untreated)	-	15.60	-

Note on above listed trade names:

Cygon = dimethoate

Fenitrothion (CIBA) = Accothion (Cyanamid) = Sumithion

Sevin = carbaryl

2. CHEMICAL CONTROL STUDIES OF THE YELLOW-HEADED SPRUCE SAWFLY IN MANITOBA--1968

by

H.C. Phillips and R.F. DeBoo

Results of preliminary experiments to test the potential effectiveness of some insecticides against the yellow-headed spruce sawfly (Pikonema alaskensis Roh.) indicate that there are several chemicals that induce almost immediate mortality of larvae. Of the chemicals tested, dimethoate, Sevin and phosphamidon produced almost immediate cessation of feeding following application while Accothion and DDT were less effective.

Methods of Application

The insecticides were applied to the treatment trees (Colorado spruce, Picea pungens Engelm.) between June 27-29 using a household sprayer with 96 oz. capacity tank. Treatment trees ranged from 15-18 feet in height. Five replicates consisting of two branches per replicate were used for each treatment. Branches were free of larvae before insecticide was applied then 10 larvae were placed on each branch after the spray had dried.

Results

The effectiveness of the various chemicals tested against the yellow-headed spruce sawfly are tabulated in the following table:

TABLE 3

Efficacy of six insecticides for control of mid-instar larvae

Treatment	Conc. used	% Mortality after				Defoliation/100 larvae*	
		1 hr.	24 hr.	120 hr.	240 hr.	cm	% of CK
Dimethoate	0.45%	98	100	100	100	15	6.8
Sevin (=carbaryl)	0.25	98	100	100	100	23	11.1
Phosphamidon	0.32	88	100	100	100	31	14.3
Malathion	0.14	68	100	100	100	57	25.9
Accothion	0.20	56	100	100	100	122	55.4
DDT	0.06	2	74	100	100	172	78.4
CHECK (Untreated)	-	0	4	8	36	202	-

* after 240 hrs.

3. CHEMICAL CONTROL OF THE POPLAR BUD-GALL MITE IN SASKATCHEWAN--1968

by

R.F. DeBoo and L.M. Campbell

Experimental testing with chemicals to control the poplar bud-gall mite (Aceria parapopuli (Keifer)) was continued for the second year on hybrid poplar (Populus sp.) plantings in western Saskatchewan. Treatment areas were located at Elrose and Mortlach, Saskatchewan, and at Hays, Alberta. Selected plantings contained primarily Northwest poplar.

Materials Used

Soil Drench	Granular	Foliar	Paint
dimethoate (0.1%) N/A 10242 (0.1%) (series of 1, 2, 3, 4 treatments)	Temik 10G @ 1/4 and 1/2 oz/in tree diam. (series of 1 + 2 applications)	1. Thiodan 4E @ 1/2 pt/gal 2. Cygon 4E @ 1/2 pt/gal 3. GS 13005 @ 1/2 pt/gal 4. Galecron @ 1/2 pt/gal 5. Phosphamidon @ 1/4 pt/gal 6. Phosphamidon-fenitrothion mixture (CIBA) --1/4 pt/gal 7. NIA 10242--1/2 lb 50% Wp/gal	Dimethoate (band around trunk @ 23% + 45% conc. (series of 1, 2, 3, 4 applications)

Methods of Application

1 -- soil drench using 8' spray boom
2 -- granular applications using cyclone seed spreader
3 -- foliar applications using Kiehers Mist Blower
4 -- bark painting of trunk (paint brush)

(Treatments repeated at 3-5 week intervals May to August)

Results

Results were generally negative. Mite populations were reduced by as much as 95% +, but they rebounded to pre-treatment levels 1-3 months following application of the chemicals. The following observations were noted: (1) there was no decrease in the numbers of galls per 18" sample branch; (2) there was no decrease in the numbers of mites per gall; and (3) the size of the galls remained essentially the same despite the chemical treatments applied.

C. PROPOSED EXPERIMENTAL SPRAYING TO CONTROL FOREST INSECTS IN MANITOBA AND SASKATCHEWAN IN 1969

1. A repetition of applications of materials listed in Table 1 to verify results.
2. Continued studies of comparative efficacy of new insecticides for control of yellow-headed spruce sawfly.
3. Continuation of control investigations of the poplar bud-gall mite in southwestern Saskatchewan.