C O N T E N T S

32804

MEETING OF INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

TENTATIVE AGENDA

1. Spruce Budworm Aerial Spraying Operations

   1.1 New Brunswick

      1.1.1 1972 Program
      - Operations
      - Surveys and Services - Forestry
      - Environmental Monitoring - Wildlife
        - Fisheries
        - Forestry
        - Environmental Protection Service
        - Health

      1.1.2 Prospects for 1973
      - Insect and Forest Conditions - Forestry
      - Proposed Aerial Spray Operations
      - Environmental Monitoring - Wildlife
        - Fisheries
        - Forestry
        - Environmental Protection Service

   1.2 Quebec)
   1.3 Ontario) Agenda items will follow the same sequence as for New Brunswick above.

   1.4 Research 1972 and Proposed 1973

2. Hemlock Looper Aerial Spraying Operations in Quebec.

   - Survey and Services
   - Operations
   - Prospects for 1973

3. Other Problems

   3.1 Black-headed budworm - British Columbia

   3.2 White pine weevil - Ontario

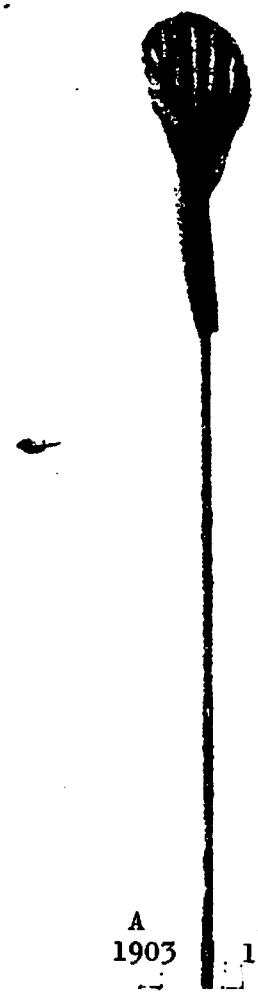
   3.3 Other species

4. Discussion of Future Plans for Review of Forest Spray Operations by Federal, Provincial and Industrial Agencies.

OPERATIONS OF

FOREST PROTECTION LTD.

1 9 7 2



ETENIM-NEMO-IGNAVIA
IMMORTALIS-FACTUS-EST

DECEMBER 1972

INTRODUCTION

In 1972 Forest Protection Ltd. staged a number of forest spraying programmes aimed at a variety of forest insect pests.

Large scale projects directed against spruce budworm in New Brunswick and in Quebec were, of course, the principal works.

Highlights of operations are reported here and some mention is made of certain other related activities of the Company.

Flow sheets of spraying operations are presented and interpreted to show the importance of the forces which affect the course of operations.

December, 1972
B.W. Flieger
/jm

FOREST PROTECTION LTD.

REPORT ON SPRAYING OPERATIONS

1 9 7 2

This brief account of spraying is in two parts, viz. I. New Brunswick, and II. Quebec Operations.

I. NEW BRUNSWICK

During winter the tentative November 1971 approved spray plan (basis for the 1972 spray programme) went unchanged. On maps made for spraying guidance, approximate areas totalled 4.2 million acres (1 applic.) and 0.5 million acres (2 applics.). These shrunk slightly later on and as sprayed are now listed as approximately 4,110,000 and 465,000 acres respectively for a total of 4,575,000 approx. map acres.

The spray plan was based on all available information and was considered to contain that portion of the total infested softwood forest most in need of protection from immediate further feeding pressure by the budworm pest (about 1/2).

A total sprayer fleet of T.B.M.'s (44) for work in both Provinces were calibrated at Dunphy Airstrip. Aircraft were then dispatched to various airstrip locations. (May 10 - 20)

Twenty-four sprayers began work from 5 fields in N.B. concentrated in the early days at Sussex and Blissville and gradually moving into Juniper and Sevogle where most were working during the last week. Dunphy had a small work pile and a small number of sprayer aircraft throughout the operation. Spraying began May 17 and ended June 9.

An oil solution of Fenitrothion in two strengths for dosages of 2 and 3 oz./ac. was used almost entirely at Sussex and to a lesser extent at Blissville. Elsewhere the regular emulsion (90% water) formulation was the rule.

Very minor changes in plan boundaries were made in the short time between insect emergence and onset of spraying.

This Spring which had been very backward began to catch up to 1971 for even date and spraying got under way about ten days after emergence was complete.

Weather and Spraying Progress

In 1972 the weather was unusual as usual. For the second consecutive year there was little or no frost at night during the second half of May. This in effect robbed the project of a real opportunity to test the value of the oil solution formulation. However, a good comparison of the relative merits of the two formulations as insecticides is available this year. (See Kettela)

Perhaps in part due to relatively high night temperatures in May the spray periods averaged short in duration for the first half of the project and by early June, in spite of a very healthy air power - work pile ratio from the beginning, there was still much left to do before heavy feeding would take its toll of new foliage. Fortunately, June weather continued fairly cool until the end which came four days earlier than the earliest previous finish. How fortunate this was can be estimated from the weather which followed. There was very little weather for flying, to say nothing of weather for spraying in the last third of the month.

Defoliation Picture as of early July '72

An aerial survey conducted jointly by the Company and Environment Canada (Forestry) indicated that the insect had been feeding heavily as was expected, and evidence was not observable until the sun dried out the severed needles. Only the county of Restigouche is completely free of severe defoliation. It is estimated that in the entire Province there is 1.75 million acres of severe defoliation about 1.0 million of which lies outside the confines of the 1972 spray plan - an improvement over the picture of a year ago, but still the needle loss was disappointly prominent in spots.

Monitoring of Operations and Side Effects

Apart from the routine monitoring by Environment Canada (Forestry) and Health and Welfare (Occupational Hazards) the Company, as in 1971, monitored effects of spraying on pollinators in areas of blueberry culture and in addition this year sponsored a study of fruit eating bird behaviour under direction of Dr. Fowle of York University. The purpose of the birds and bees studies is to provide the Company with material which may be used to defend against the action brought against the Company by Bridges Bros. Ltd.

2) Experimental Programme

In the Spring of '72 the Maritime Regional Forest Research Laboratory (Environment Canada) dusted off a 1969 field trial, carried out by the Company on the Tobique drainage against adult budworms, and became interested in further trials. The result was a cooperative arrangement between Environment Canada and the Company and the spraying of blocks of infested forest during the period of moth activity (July 2nd and 3rd weeks). Spraying was from Dunphy Airstrip employing a formation of 4 Stearman aircraft. Two chemicals which had been laboratory tested for their ability to kill moths (Phosphamidon and Fenitrothion) were used in the trial. Dosage was a theoretical 2 oz. a.i./ac. and there were two applications.

3) Tour Service for Visitors

Sponsors and others interested in the budworm threat to the forest were given an opportunity to see the work of the Company first hand. Of those who availed themselves of the service, some saw spraying from the air. One aircraft was used entirely for this purpose under the direction of the pilot and tour guide, E.W. Roberts.

II. QUEBEC

The Company again, as in 1971, acted as agent for the Government of Quebec, Department of Lands and Forests, and in this capacity organized and carried out several forest spraying operations.

Government-Industry Supported

1. Spruce Budworm spraying in Western Quebec (Gatineau Drainage mainly). This project in its final form was a much smaller spray project than originally planned by entomologists. The Company was allotted* some 1.5 million acres to be sprayed twice at dosages of 3 and 2 oz. Fenitrothion/ac.

For this program the Company assembled a fleet of 18 T.B.M. sprayers and guidance system to match, i.e. some 15 Cessna aircraft, pilots, navigators, supervision and ground personnel.

The spraying operations which were from Maniwaki and Lac des Loups airfields were in all respects pretty much the same as those running concurrently in N.B.

This project was carried out successfully beginning May 18 and ending June 15. It was marred by a pilot fatality and loss of plane. (June 9).

Based on cursory ground checks since spraying, the forst treated, which was not helped much by spraying in 1971, now seems to be making an extraordinarily good recovery - retaining a large fraction of the 1972 needles.

---

* The Government contracted with Midair Canada Ltd. of Norwich, Ontario, to spray about 300,000 acres of budworm infested forest, as above, and also to do large scale trials of Zectran and Matacil insecticides, all of which spraying would be done by DC-7 aircraft equipped with an electronic navigating system. The Company agreed to provide back-up for spraying of these areas in case of non performance. It was not called upon to do so.

2. Federal & Provincial Government Cooperative Baccilus Trials:

One unit (3 sprayers and 2 Cessna a/c) was deployed from Western Quebec to Rivière du Loup airport where the Company set up the necessary equipment for the mixing of insecticide and the loading of aircraft with insecticide and fuel. A special formulation of Bacillus Thuringiensis designed by Dr. Smirnoff was sprayed on 10,000 acres at a rate of 2 gallons/ac. This was applied in four lifts of ½ gallon each between June 4 and 7. According to Dr. Smirnoff the application was carried out perfectly. One June 8 a small block (300 ac.) nearby was treated with "Dipel" another Bacillus strain at the same application rate.

3. Province and Industry sponsored Jack pine budworm spraying. A limited area of Jack pine budworm infestation near Basketong Lake (Gatineau) was sprayed by one unit from Lac des Loups airstrip. Spraying was essentially the same as above described for Spruce budworm. The work was done between June 28 and July 3.

4. Province & Industry sponsored spray project - Hemlock Looper - Anticosti Island and North Shore St. Lawrence near the Natashquan River.

In 1971 an explosion of the dreaded Hemlock Looper caused severe mortality in the fir complement of the stands in the Eastern half of Anticosti. The purpose of the project was to contain looper damage in the Western part of the Island.

The Company, during June, made ready to work from Port Menier on Anticosti and Havre St. Pierre on the mainland.

Areas nominated for spraying at the last moment reduced the anticipated workpile by over 25% on the Island and on the mainland the plan washed out completely - because outbreak activity was absent. As a result all aircraft worked from the Port Menier airfield spraying some 400,000 acres twice around at dosages of 2 ozs. active fenitrothion per application/ac. The action took place July 3 - 12 incl.

5. Province and Industry sponsored Jack Pine Sawfly. A small area was sprayed from Lac des Loups spray project August 13. The Company had good luck with weather in all parts of the programs in Quebec which is remarkable, especially was this so on Anticosti.

III. OTHER

1. Spruce budworm spraying in Maine. Some 500,000 acres (a Federal-State-Owner sponsored programme) were sprayed with Zectran (2.4 Oz./ac.) at an application rate of one gallon/ac. The spraying which was done by a fleet made up of 10 P.V.2's (and a spare) plus 3 T.B.M.'s began much later than the work in N.B. (about June 8 and was completed later - about June 25). Results will be watched with interest. The project unit cost is high in the vicinity of $2.75-$3.00/ac. The total area of infestation was not treated - only those acres of high hazard rating.

The Company assisted the Maine project by providing certain aircraft servicing and insecticide mixing equipment, and in providing the guide system with trained navigators.

2. Flying Incidents

May 17 - T.B.M. lost on ferry from Dunphy to Maniwaki. Location - Northern Maine. Plane washed out; pilot O.K., rescued at day later.
June 6 - T.B.M. landinggear let go while loading at Dunphy; some spillage. Plane damage serious enough to write it off the project.
June 9 - T.B.M. lost while spraying out of Lac des Loups. Plane burned up. Pilot lost.
June 12 - T.B.M. went out of control on take off - did not get airborne but was washed out. Pilot O.K. Location - Sevogle.

3. In New Brunswick 1972 less than 1/4 of the area sprayed was treated in the evening, over 3/4 in early morning.

4. The top humorists and cartoonists have let us down this year. The collection of humor having to do with the environment has shrunk.

There must be a new band wagon!

Anyhow these pulse fellers have made lift more difficult for reporters which is perhaps just as well if one remembers that establishments, coporations, etc., have no sense of humor.

APPENDIX SHEET Nº 1

WESTERN QUEBEC 1971 FOREST SPRAYING PROJ.

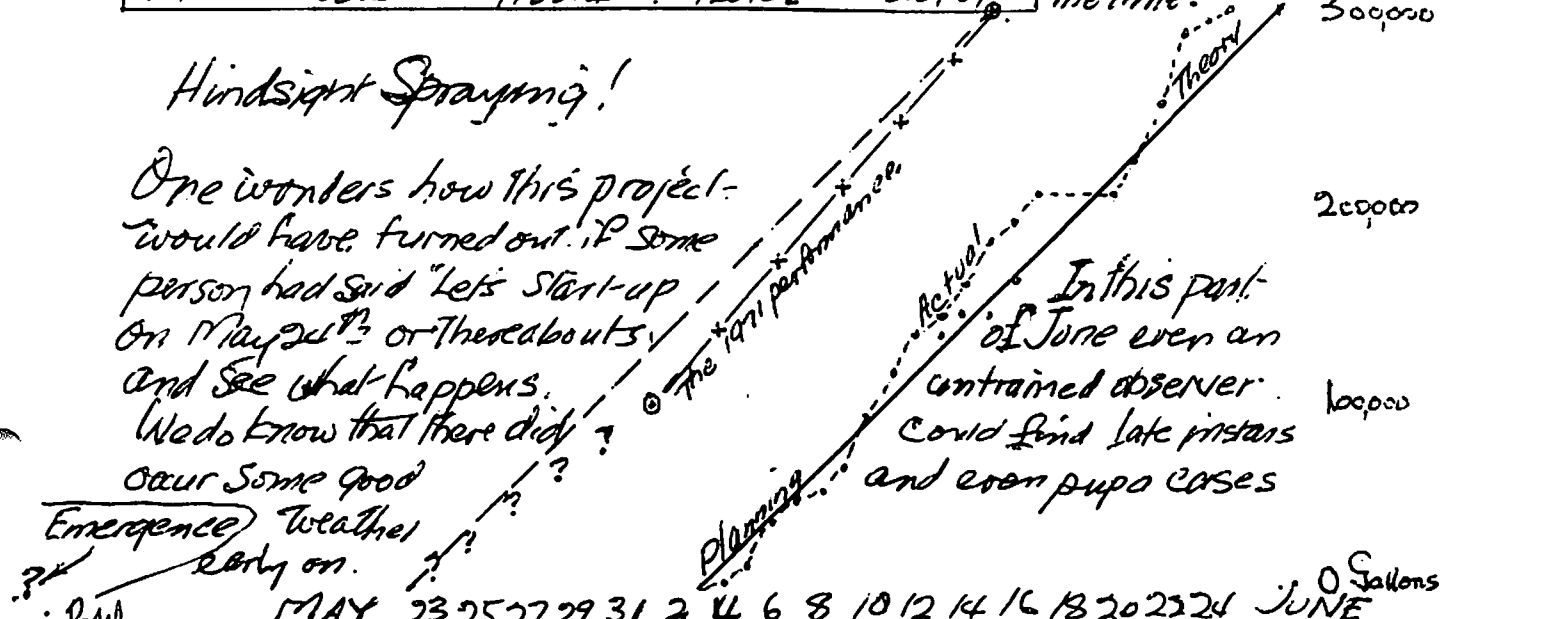
F.P.LTD. STATISTICS - GALLONS SPRAYED BY DATE.

June	Maniwaki	Lac des Loups	Lac Nilgard	Cumul.
4	1875			1875
5	7500	3750		13125
6	8750	9371	3750	34996
7	3750	5625	3125	47496
8	1875			49371
9	3750	3750	7500	64371
10	6511	13078	7604	91564
11	7500	9375	5000	113439
12	3750	11250	3750	132189
13	1875	1875	3750	139689
14	7500	5625	6250	159064
15	7500	6250	7500	180314
16	Comp! 3125	3750	3750	190939
17		5625	9375	205939
18	Haze			
19		Humid		
20			Hot	
21		1875	10625	218439
22		11250	23125	252814
23		11250	Comp! 24998	289062
24		5000		294062
25		Comp! 6875		300937
Totals	65261	115514	120102	300937

This project was planned to extend over three or more weeks
The work pile was about right for 3 teams TBM. % (See N.B. 1971 - work pile 1150,000 $ - 33%.)
Reference to the ops. flow sheet indicates a close conformity between planning and spraying
Unfortunately several important things were overlooked or unknown and the action did not protect needles of the year.
As spent for the customer the Company considers the Experience nothing short of Calamitous - and what is worse - unnecessary in the light of conditions and knowledge Existing at the time.

Hindsight Spraying!

One wonders how this project would have turned out if some person had said "Let's start-up on May 20th or Thereabouts" and See what happens.
We do know that there did occur some good Emergence Weather early on.



B.M.

APPENDIX SHEET Nº 2

NB. FOREST SPRAY PROJ. 1971

FOREST PROTECTION LTD. GALLONS BY DATE BY FIELD

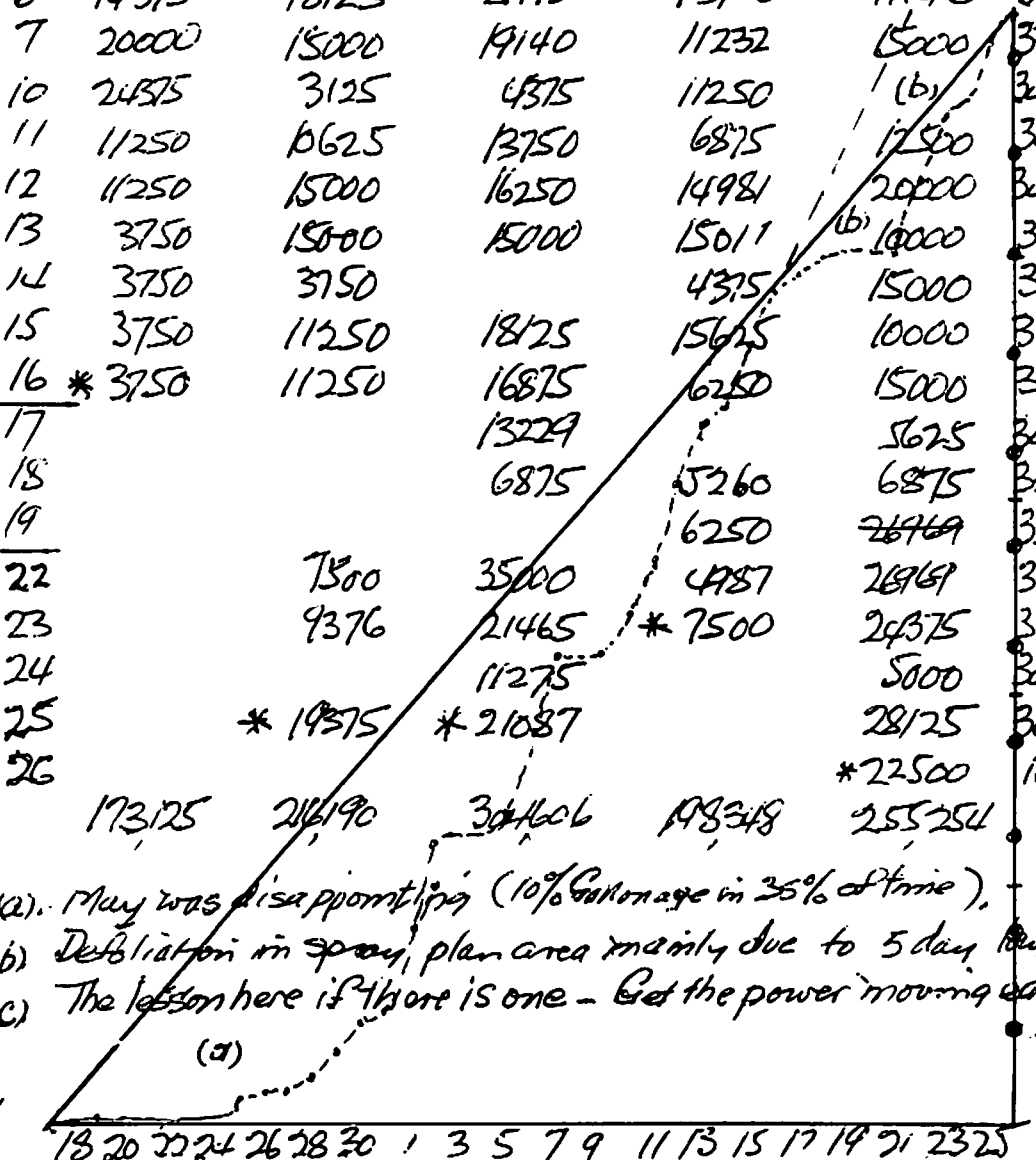
MAY	CHIPMAN	SUSSEX	DUNPHY	BLISSVILLE	JUNIPER	%	DAY TOTAL.	CUMUL.
18	1875					4 -	1875	1875
19	1875					4 -	1875	3750
25	5625	15625				10 ✓	21250	25000
26	3750			1250	✓ 13	14 -	5000	30000
27				3750	0 7	19 -	3750	33750
28	3750	7500	1875	7499	- 9	22 ○	20624	54374
29	5625	3125	3750	8749	× 11	25 ○	21249	75623
30	10625	7500	4900	13128	Total 40	29 ○	36153	111776
31		3687	4375			33 -	8064 (a)	119840
JUNE 1	20625	15000	16250	22499	12768	39 ✓	87142	206982
2	16875	13125	27460	11251	14371	41 ✓	83082 1/4	290064
5	6250	11250	12375	7500		36 ○	37375	327439
6	14375	18125	21175	13126	11146	33 ✓	77417	405386
7	20000	15000	19140	11232	15000 (b)	33 ✓	80372	485758
10	24375	3125	4375	11250	12500	34 ○	43125	528883
11	11250	10625	13750	6875	20000	34 ○	55000 1/2	583883
12	11250	15000	16250	14981	10000 (b)	34 ✓	77481	661364
13	3750	15000	15000	15011	15000	31 ✓	58761	720125
14	3750	3750		4375	10000	31 ○	26875	747000
15	3750	11250	18125	15625	15000	31 ✓	58750	805750
16 *	3750	11250	16875	6250	5625	31 ✓	53125 3/4	858875
17			13229		6875	34 -	18854	877729
18			6875	5260	26469	33 -	19010 (b)	896739
19				6250	26469	33 -	6250	902989
22		7500	35000	4487	26969	31 ✓	74456	977445
23		9376	21465	* 7500	24375	31 ✓	62716	1040161
24			11275		5000	30 -	16275	1056436
25		* 19375	* 21087		28125	30 ✓	68587	1125023
26					* 22500	10 ✓	22500	1147523
	173125	216190	304606	198348	255254		1147523	

* Completion date.

(a). May was disappointing (10% Gallonage in 36% of time).

(b) Defoliation in spray plan area mainly due to 5 day layoff June 17-21 incl.

(c) The lesson here if there is one - Get the power moving early

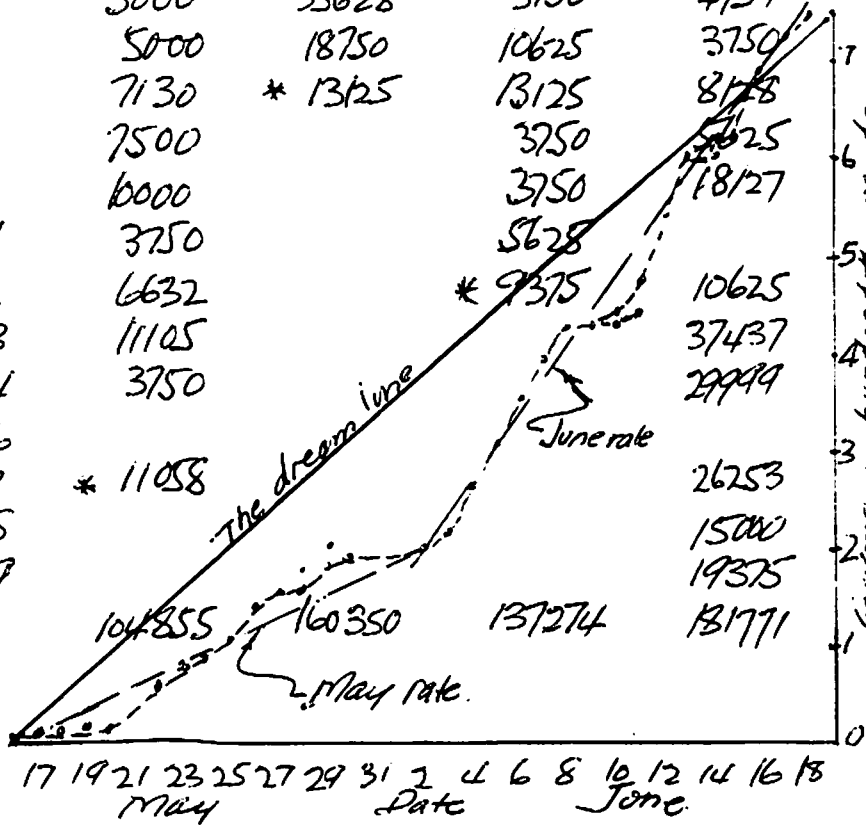


APPENDIX SHEET Nº 3

OPERATION FLOW IN GALLONS BY DATE & FIELD

NEW BRUNSWICK 1972

		DUNPHY	BLISSVILLE	SUSSEX				
M.	17			5000			- 5000	5000
	19		1875	5310	As in '71 May weather		- 7185	12185
	20		1800		was not good. Two days		- 1880	14065
	21	1875	1711		rate more than average.		- 3586	17651
	22	5400	14372	17589	However the 1/4 took pile		◦ 37361	55012
	23	1875	15632	5625	picked up in May made		◦ 23132	78144
	24	5625		5625	for the earliest closing		- 11250	89394
	25	6875	6875	3750	out date in 20 years		- 17500	106894
	26	3480	13952	16875			◦ 34307	141201
	27	1875	9370	5625			- 16870	158071
	28	1250					- 1250	159321
	29		8429	11250			◦ 19679	179000
	30	1250	15001	3125	JUNIPER	SEVOGLE	◦ 19376	198376 1/4
J	3	1875			1251		- 3126	201502
	4	2550	3750	7500	1250		- 15050	216552
	5	5000	35628	3750	4957	1875	✓ 51210	267762
	6	5000	18750	10625	3750	5100	✓ 45225	313987
	7	7130	* 13125	13125	8128	7477	✓ 49005	362992 1/2
	8	7500		3750	5625	21875	◦ 38750	401742 1/2
	9	6000		3750	18127		◦ 31877	433619
	11	3750		5628		7566	- 16941	450560
	12	6632		* 9375	10625	3750	◦ 30882	481442
	13	11105			37437	22498	✓ 71040	552482 3/4
	14	3750			29999	21925	✓ 55624	608106
	16					14375	- 14575	622681
	17	* 11058			26253	33900	✓ 71211	693892
	15				15000	25625	✓ 40625	734517
	19				19375		✓ 19375	753892 C
		104855	160350	137274	181771	165986	753892	



APPENDIX SHEET No 4

W. P.Q Spruce Budworm Forest Spray Project-1972 (F.P.Ltd. portion)

Flow sheet of Gallons sprayed by date & by Airfield

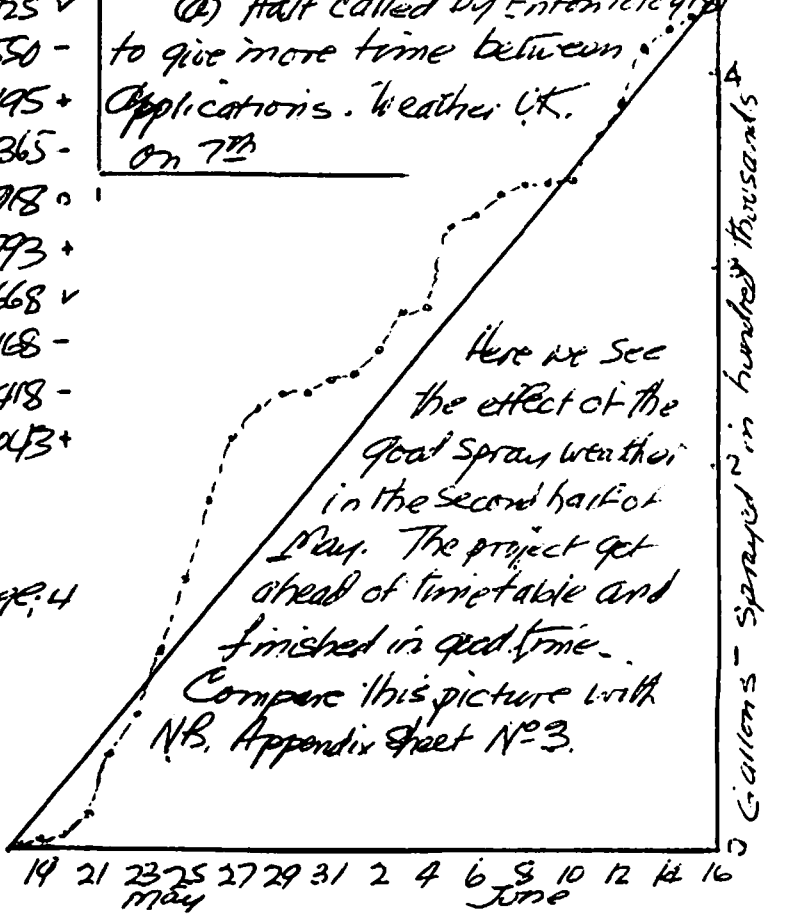
	Maniwaki	Lac des Loops	Day Total	Cumul.
M. 18	1250		1250	1250 -
19	3750		3750	5000 -
20		1875	1875	6875 -
21	5625	5000	10625	17500 +
22	10625	21875	32500	50000 v
23	15625	5625	21250	71250 o
24	11250	18645	29875	101145 o
25	16875	23875	40700	141845 v
26	14375	24063	38438	180283 v
27	13773	21875	35648	215931 v
28	6250	7500	13750	229681 +
29	8750		8750	238431 -
31		7500	7500	245931 -
J. 1	1875		1875	247806 -
2	1875	8294	10169	257975 +
3	2500	17800	20300	277675 o
4	1875		1875	279550 -
5	9375	35000	44375	323925 v
6	5625		5625	329550 -
7	3145	7500	10645	340195 +
8	3750	1420	5170	345365 -
11	3750	22803	26553	371918 o
12	3750	8125	11875	383793 +
13 *	7500	24375	31825	415668 v
14		7500	7500	423168 -
15		6250	6250	429418 -
16		* 10625	10625	440043 +
	157568	282475	440043	v

Spray day quality - Extra good; 6 Above average; 4
Fair; 6, Poor; 11. Washout 3 - Total 30.

Hemlock Looper Project-'72
400000 acres 2 applics.
Fenitrothion 202 + 202.
15 Canadian T.B.M. % worked.
Port Menier: Anticosti

July 3	3750	3750	Applic.
4			
5	22500	26250	(1)
6	34375	60625	
7	(a)		
8	3750	64375	
9	18750	83125	
10	9375	92500	(2)
11	9375	101875	
* 12	18750	120625	

(a) Halt called by Entomologist to give more time between applications. Weather O.K. on 7th



APPENDIX SHEET NO. 5

Each year the Company keeps records which enable those interested to keep track of just how insecticide sprayed on various projects conforms to the plans and specifications and the actual tally of areas treated.

For example, on this sheet are listed figures from these Records for the major Company projects of the last two years.

PROJECT	DOSAGE	APPLIC. RATE /AC.	TREATED	CALC. GALLONS NEEDED	ACTUAL GALLONS SPRAYED
	oz.a.i.	U.S.Gal.			
N.B. 1971	3 oz.	0.15	4,284,727	642,750	
Budworm	2oz.+2oz.	0.30	1,718,750	515,625	1,147,523
Sub-Total			6,003,477	1,158,375	1,147,523
Budworm P.Q. West 1971	3 oz.	0.15	2,030,404	304,560	
Temiscouata	3 oz.	0.15	116,376	17,456	
Sub-Total			2,146,780	322,016	300,937
N.B.	3 oz.	0.15	4,070,800)		
1972	2 oz.	0.15	25,000)	616,245	
Budworm	4 oz.	0.15	12,500)		
	2oz.+2oz.	0.30	462,500	138,750	
Sub-Total			4,570,800	754,995	750,242
P.Q. West	3 oz.	0.15	25,000	3,750	
1972 Budworm	3+2oz.	0.30	1,450,000	435,000	
Sub-Total			1,475,000	438,750	440,043
1972 P.Q. Bacillus (Smirnoff)	?oz.	2.00	10,000	20,000	
Bacillus (Dipel)	?oz.	2.00	300	600	
				20,600	20,600
P.Q. Looper 1972	2oz.+2oz.	0.30	400,000	120,000	120,625
TOTAL				2,814,136	2,779,970

Overall difference is approx. 1.2% on the light side.

AERIAL SPRAYING AGAINST THE SPRUCE BUDWORM IN 1972 AND A FORECAST OF CONDITIONS IN THE MARITIMES REGION IN 1973

E. G. Kettela

December 1972

INTRODUCTION

The 1972 aerial spraying operation in New Brunswick was the twentieth conducted by Forest Protection Limited to prevent continued massive budworm damage in high hazard areas. The results of studies and surveys to assess the efficacy of the spray program and to forecast conditions for 1973 are summarized. In 1972, no new poisons were tested against larvae, but an oil solution of fenitrothion was used over a large portion of the spray plan and operational spraying was started as soon as possible after larval emergence. In addition, experimental spraying, was conducted against the adult stage of the budworm. The results of these trials are summarized in a separate report.

SPRAYING IN 1972

General

In 1971, surveys for defoliation delineated 4.6 million acres of damage (Table 1) and surveys for egg masses predicted 9.0 million acres of high and 0.9 million acres of moderate infestation (Table 2). Hazard to trees was extreme on 0.6 million acres and high on 4.1 million acres (Table 3). Primarily on the basis of this information, Forest Protection Limited decided to treat 4.4 million acres in 1972. As a result of additional information collected during the winter of 1971-72 with the aid of a survey for overwintering larvae, an additional 175,000 acres were added to the plan in February of 1972.

Fenitrothion, an organophosphate, was the only poison used in the spray operation. A synopsis of the acres sprayed is shown in Table 4 and Figure 1. The two basic formulations used were an emulsion (poison, water, solvent oil, and emulsifier) and an oil solution (poison in Aerotex

oil). The method of application and rate of application was the same as in the previous 3 years (Kettela and Varty 1972).

The spring of 1972 was generally cold and as a result budworm emergence started on 10 May, as compared to 26 April for 1971. As May and June progressed, however, conditions for budworm development improved and the peak of the sixth instar in the Fredericton area was reached on 23 June as compared to 20 June for 1971. In an attempt to (a) take advantage of the usually favorable spray conditions in the latter half of May, (b) try and circumvent a conflict of interest with other land users, and (c) complete the program before the budworm reached the very destructive sixth instar stage, spraying was started as soon as possible after emergence (on 17 May). In addition, an oil solution of fenitrothion was used in much of this early spraying to try and circumvent the use of water emulsions on cold mornings. Spraying operations ceased in the afternoon of 18 June.

Efficacy of Spraying

The effect of spraying on budworms was estimated (using a version of Abbott's Formula) from pre-spray and post-spray counts on 20 plots in each of 28 spray blocks, and from a similar set of counts from 160 unsprayed plots. The data were grouped by spray treatment and insect development (Table 5). "Foliage saved" was estimated from ground measurements of defoliation in the sprayed and unsprayed plots and from the results of an aerial survey conducted by F.P.L. and the C.F.S.

The weighted mean reduction in survival of spruce budworm was 78% on balsam fir and 65% on spruce (red/black) (Table 6) while the mean for balsam fir foliage saved was 35%. The figure for foliage saved

is lower than but comparable with results achieved in previous operations, However, the reductions in survival are lower than in previous years, particularly on balsam fir. This is due, I believe, to two factors: (1) the spraying of second-instar larvae, and (2) the generally poorer results obtained with the oil solution spray (Table 5). Both these factors were indicated in similar trials conducted in 1971. Since the saving of foliage was the primary objective of spraying the decision to spray early was warranted because slightly more foliage was saved by spraying early (10%) rather than spraying late (3%) (Kettela and Varty 1972).

The best results in terms of foliage protection were obtained with the emulsion formulation, either one application during the third and fourth instar period of development, or with two applications during the second to fourth instar periods.

The oil formulation of fenitrothion gave poorer results at both one and two applications (Table 5).

REGIONAL SURVEYS FOR DEFOLIATION

New Brunswick

Forest Protection Limited and the C.F.S. conducted a joint survey to map the nature and extent of budworm defoliation. The results of this survey (Fig. 2, Table 1) show that most of the severe defoliation was limited to three areas of the Province: (1) in northern N.B. from Grand Falls northeast to Bathurst, (2) in southwest N.B. mostly in Charlotte County, and (3) in southeast N.B. in Kent, Albert, and Westmorland counties.

Some difficulty was experienced in mapping because of the very patchy nature of the defoliation. In all 1.9 million acres of severe, 2.4 of moderate and 0.5 of light defoliation were mapped as compared to 1.6, 1.9 and 1.0 million acres respectively for 1971. About 30% of the severe defoliation recorded in 1972 was inside the sprayed area.

Nova Scotia

Western Nova Scotia was surveyed by the C.F.S. concurrently with the New Brunswick Survey. The results (Fig. 3) show that the defoliation was limited to the Annapolis Valley area and to Cumberland County. However, some small patches of light defoliation were detected in northern Lunenburg County. A total of 386,500 acres of defoliation was mapped of which 285,700 were severe or severe in patches, 61,400 were moderate, and 39,400 were light. About 132,000 acres of severe defoliation were in Cumberland County, 76,500 in Kings County, and 77,200 in Annapolis County. The pattern of defoliation in Kings and Annapolis counties was very patchy and similar to the situation in southern New Brunswick.

Prince Edward Island

In late July, the Forest Insect and Disease Survey made a brief survey of P.E.I. The results of this survey indicated an extremely patchy pattern to the defoliation. Most of the damage noted was scattered throughout Prince County. Smaller affected areas were noted west of Charlottetown in Queens County, and in eastern Kings County north of Souris.

EGG-MASS SURVEYS AND A FORECAST OF INFESTATIONS FOR 1973

New Brunswick

Counts of budworm egg-masses at 1,065 locations indicate a decrease in the area of high infestation from 9.0 million acres in 1971 to 4.8 million acres in 1972 (Table 2). The total infestation area dropped from 14.8 million acres in 1971 to 13.3 in 1972. This reduction has been a reversal of the upward trend in the previous 4 years. The drop was greatest in Kent, Westmorland, Albert, Queens, and Kings counties. Lesser reductions of high infestation were noted in west-central New Brunswick. In conjunction with this reduction in high infestation area, the egg-mass count averaged less than half that of 1971. The most significant reductions in density were in the east coast and southern areas, and generally throughout the sprayed area (Table 7). Egg-mass infestations did not increase anywhere in New Brunswick. However, the 4.8 million acres of high infestation extends in a more or less continuous band from Bathurst and Grand Falls in the north, south to the Bay of Fundy (Fig. 4). In addition, there are 2.7 million acres of moderate infestation associated with this high infestation area.

Nova Scotia

A downward trend of infestation level was also recorded in Nova Scotia. The 185 egg-mass samples taken in Nova Scotia indicate that the high infestation area in Annapolis and Kings counties has receded to a small patch on the South Mountain on the border between the two counties (61,000 acres). In Cumberland County, the high infestation area has shrunk to a number of patches, mostly on the west coast of the Cumberland

Peninsula (90,000 acres). The highest egg-mass counts were recorded, in the area about Joggins. Elsewhere in Nova Scotia, egg-mass counts were low to nil.

Prince Edward Island

The 32 egg-mass samples taken in Prince Edward Island suggest that the infestation has decreased slightly from 1971. The infestation appears to be very patchy which is probably a function of the nature of the forest cover. However, there are a number of high infestation patches notably in northwestern Prince County, central Queens County, and eastern Kings County. Patches of severe defoliation will probably occur in these areas in 1973.

HAZARD TO TREES IN 1973

New Brunswick

As in previous years, the hazard rating for 1973 is based on the results of the egg-mass survey, ground and aerial surveys for defoliation, and defoliation history. Hazard is classified into three categories -- high to extreme, high, and variable. A comparison between 1972 and 1973 for these three categories is shown in Table 3. The acreage of high to extreme has increased to 2.9 million acres for 1973 as compared to 0.6 million acres for 1972. However, there has been a reduction in total hazard area from 8.7 million acres for 1972 to 7.7 million acres for 1973. The nature and extent of the hazard forecast for 1973 is shown in Figure 5.

Nova Scotia and Prince Edward Island

In Nova Scotia, hazard to balsam fir is high generally throughout the remaining high infestation area but the hazard to spruce is low to moderate. Because of the predominance of spruce throughout the infested area, the hazard rates no more than moderate.

In Prince Edward Island, the hazard rates no more than moderate because of the predominance of white spruce in the affected stands and the patchiness of the infestation and the forest.

SOME ADDITIONAL COMMENTS

In the region of New Brunswick between the Dungarvon and Gaspereaux rivers and Boiestown and Newcastle, the apparent vigor of a large number of spruce (red/black) stands has declined noticeably in the past few years. Investigations indicate that Dioryctria reniculella has become prominent in the fauna inhabiting these spruce trees. Generally this insect outnumbers the spruce budworm by 1.5:1 in the larval stage. In some stands, the ratio is as high as 14:1. This insect is occasionally found on balsam fir. D. reniculella has been responsible for defoliation of many red spruce stands during the past 3 years which would account for the phenomenon of defoliated spruce and green balsam fir in some stands. Cursory examination of a number of these stands suggests that D. reniculella is most destructive in the older, slow growing spruce trees (120 years) that show less than 1.0 inch of radial growth in the past 25 years. They have been damaged by the budworm on and off for the past 15 years and have been subject to varying spray regimes. Dr. Varty has suggested that D. reniculella may have been released by spraying. It might also be assumed that this insect acts as a 'secondary' type, feeding on trees

of low vigor brought on by poor site quality and previous attacks by the spruce budworm. The whole question points to the need for a serious study of red spruce since it is an important component of the softwood stands of central New Brunswick.

REFERENCES

Kettela, E. G. and I. W. Varty. 1972. Assessment of the 1971 spruce budworm aerial spraying program in New Brunswick and Forecast for 1972. Can. Forest. Serv., Inform. Rep. M-X-29.

Macdonald, D. R., D. G. Cameron and M. B. Craig. 1963. Studies of aerial spraying against the spruce budworm in New Brunswick. XVIII. Operational summaries and assessments of immediate results. Inform. Rep.

Macdonald, D. R., D. G. Cameron and M. B. Craig. 1968. Studies of aerial spraying against the spruce budworm in New Brunswick. XXII - Operational summaries and assessment of immediate and long-term results, 1963-1967. Can. Dep. Forest. & Rural Develop., Fredericton, N.B. Intern. Rep. M-25.

Webb, F. E., J. R. Blais and R. W. Nash. 1961. A cartographic history of spruce budworm outbreaks and aerial forest spraying in the Atlantic region of North America, 1949-1959. Can. Entomol. 93(5).

Table 1. Areas (thousand acres) by categories of defoliation caused by the spruce budworm and by counties in New Brunswick, 1971 and 1972

County	1971			1972		
	Light	Moderate	Severe	Light	Moderate	Severe
Saint John	127.5	42.8	70.7	5.0	4.0	85.7
Albert	40.8	44.8	93.6	8.0	35.9	98.6
Westmorland	58.8	145.4	52.8	76.7	95.6	77.7
Kings	105.6	150.4	115.5	9.9	48.8	198.2
Queens	51.8	136.5	44.8	25.9	141.4	128.5
Charlotte	53.8	110.6	102.6	4.0	71.7	196.2
Sunbury	30.9	112.5	52.8	8.0	105.6	72.7
Kent	31.9	190.2	101.6	24.9	167.3	80.7
York	51.8	210.3	314.7	57.8	378.5	151.4
Northumberland	256.0	454.2	344.6	127.5	652.4	339.6
Carleton	19.9	55.8	90.6	17.9	81.7	78.7
Victoria	82.7	196.2	181.2	28.9	211.2	319.7
Madawaska	46.8	4.0	.0	16.9	27.9	8.0
Restigouche	5.0	.0	.0	35.9	104.6	36.9
Gloucester	83.7	91.6	3.0	17.0	268.9	20.9
TOTALS	1047.0	1945.3	1568.6	465.2	2395.5	1893.5

Total acreage showing some defoliation - 1969 - 3,395,500
1970 - 3,408,800
1971 - 4,560,900
1972 - 4,754,200

Table 2. Areas (million acres) by categories of spruce budworm egg-mass infestations in New Brunswick, 1960-1972

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

Table 3. Area (thousand acres) of forest in New Brunswick by hazard categories, 1971 and 1972

Hazard category[a]	Year	
	1971	1972
High to extreme	575	2,856
High	4,120	1,857
Variable	4,000	3,000
Total	8,695	7,713

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

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

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

Table 4. Synopsis of the 1972 operational spray program[a] with fenitrothion to minimize damage by the spruce budworm in New Brunswick.

Applications	Poison/acre[b] (oz.)	Formulation	Acres
1	3	emulsion[c]	2,904,134
1	3	oil solution[d]	1,166,666
1	2	emulsion	25,000
1	4	oil solution	12,500
2	2 2	emulsion emulsion	325,000
2	2 2	oil solution oil solution	100,000
2	2 2	emulsion oil solution	37,500
		TOTAL	4,570,800

a. This was the twentieth program conducted by Forest Protection Limited in New Brunswick.

b. Each application of the insecticide was in 0.15 U.S. gallons of formulation per acre.

c. The emulsion ingredients were fenitrothion, water, solvent oil (Aerotex), and emulsifier.

d. Aerotex.

Table 5. Percentage reduction in survival of budworms and percentage of balsam fir foliage saved due to spraying with fenitrothion in New Brunswick, 1972

Treatment[a]	Blocks sampled	Main larval instar at treatment		Insects per 18-inch tip				% reduction in larval survival		% fir foliage saved
				On fir		On spruce				
		On fir	On spruce	Pre-spray	Post-spray	Pre-spray	Post-spray	On fir	On spruce	
1x3[b]	1	L2	L2	14.3	5.07	18.3	0.54	8	73	10
	1	L3	L2	21.9	.73	16.4	.26	90	83	30
	8	L4	L3	23.6	2.35	23.4	.87	68	56	37
	6	L5	L4	22.7	2.04	12.9	.98	70	43	22
1x3[c]	3	L2	L2	18.0	3.97	20.8	.97	31	50	8
	1	L3	L2	8.7	2.15	15.6	.12	48	94	27
	1	L4	L3	38.1	2.63	20.9	1.44	65	26	20
2x2[b]	2	L2	L2	21.0	2.06	26.8	.64	69	63	40
	4	L4	L3	26.1	1.34	17.8	.84	82	55	30
2x2[c]	1	L2	L2	44.8	2.30	60.4	1.57	44	39	20

a. Applications x ounces of poison.

b. Poison in emulsion.

c. Poison in oil solution.

Table 6. Percentage reduction in survival of population, and percentage of balsam fir foliage saved by spraying, 1952-1972

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

a. Data for 1952-58 (Webb *et al.* 1961).

b. - denotes no data.

c. Data for 1960-67 (Macdonald *et al.* 1963, 1968).

Table 7. Trends in spruce budworm populations by sector from 1968 to 1972
(Number of sample points in brackets)

Area	Mean egg masses per 100 ft^2 of foliage					Egg-mass ratios			
	1968	1969	1970	1971	1972	$^{69}/_{68}$	$^{70}/_{69}$	$^{71}/_{70}$	$^{72}/_{71}$
Sprayed in 1972									
Sprayed once	293(230)	392(255)	481(272)	515(276)	216(286	1.34	1.23	1.07	0.42
Sprayed twice	180(21)	447(26)	882(27)	508(28)	219(28)	2.48	1.97	.58	.43
Unsprayed in 1972									
Northwest	3(100)	4(103)	18(130)	110(143)	100(157)	1.33	4.50	6.11	.91
Northeast	64(57)	102(69)	251(82)	373(86)	316(91)	1.59	2.46	1.48	.85
Central-west	283(130)	200(137)	231(150)	200(154)	177(156)	.71	1.16	.87	.89
Central	488(124)	596(126)	612(139)	471(138)	302(146)	1.22	1.03	.77	.64
Southwest	29(30)	87(31)	162(41)	198(47)	158(49)	3.00	1.86	1.22	.80
South	251(28)	912(30)	1143(34)	546(36)	238(36)	3.63	1.25	.48	.44
East Coast	113(44)	210(44)	421(49)	392(54)	116(55)	1.85	2.48	.75	.30

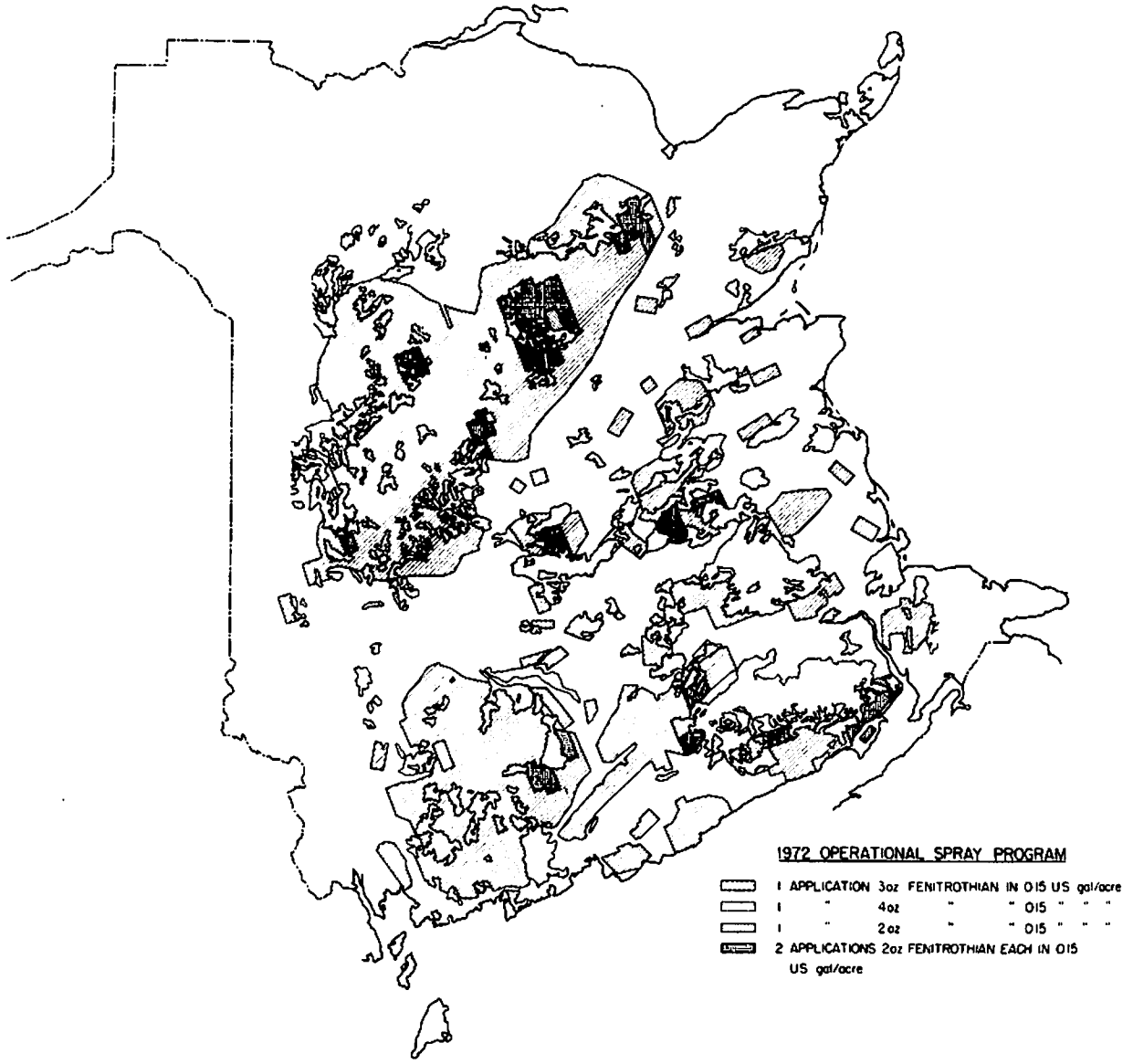


Fig. 1. Area sprayed in New Brunswick in 1972.

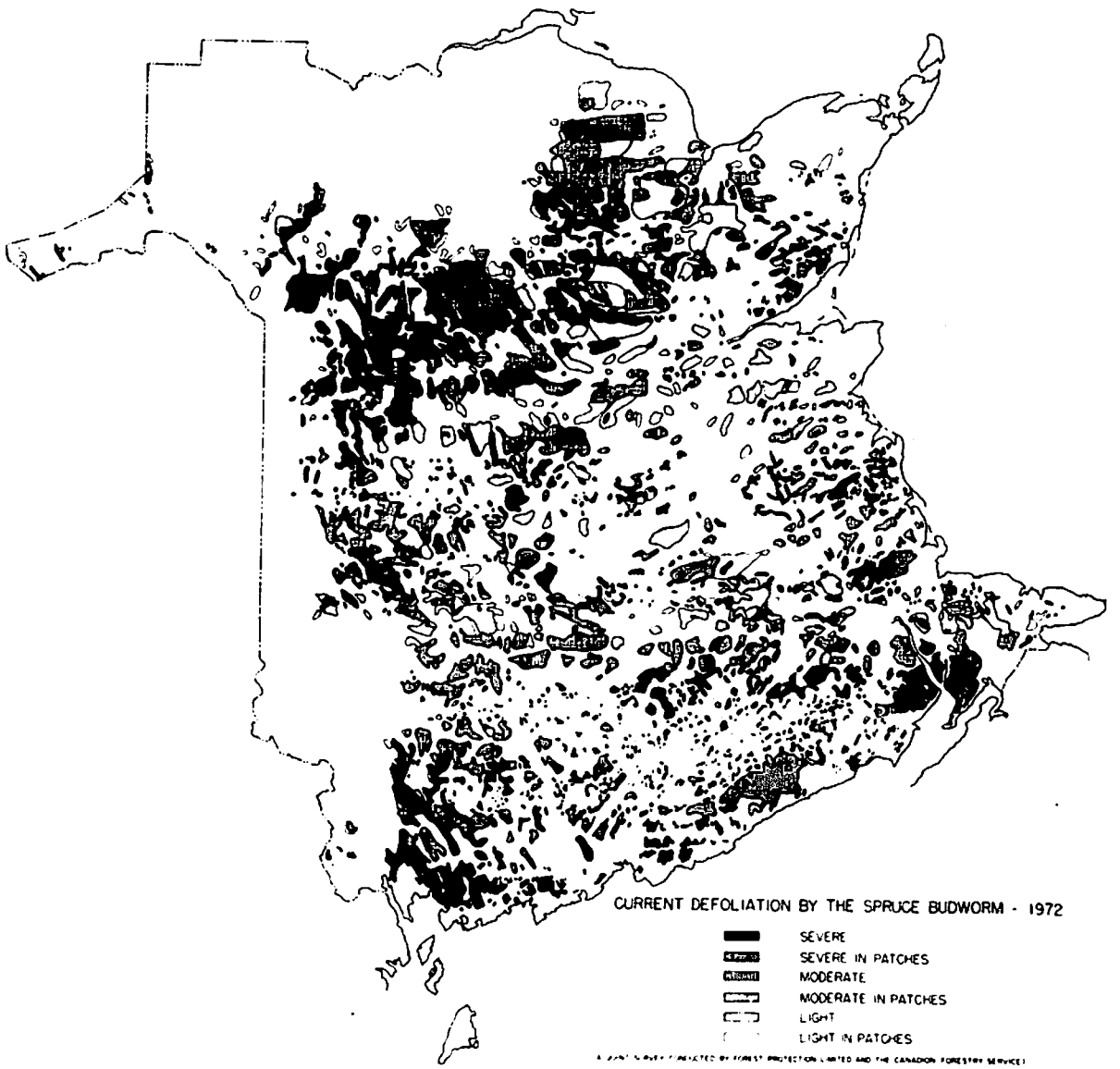


Fig. 2. Results of the 1972 aerial survey of defoliation in New Brunswick

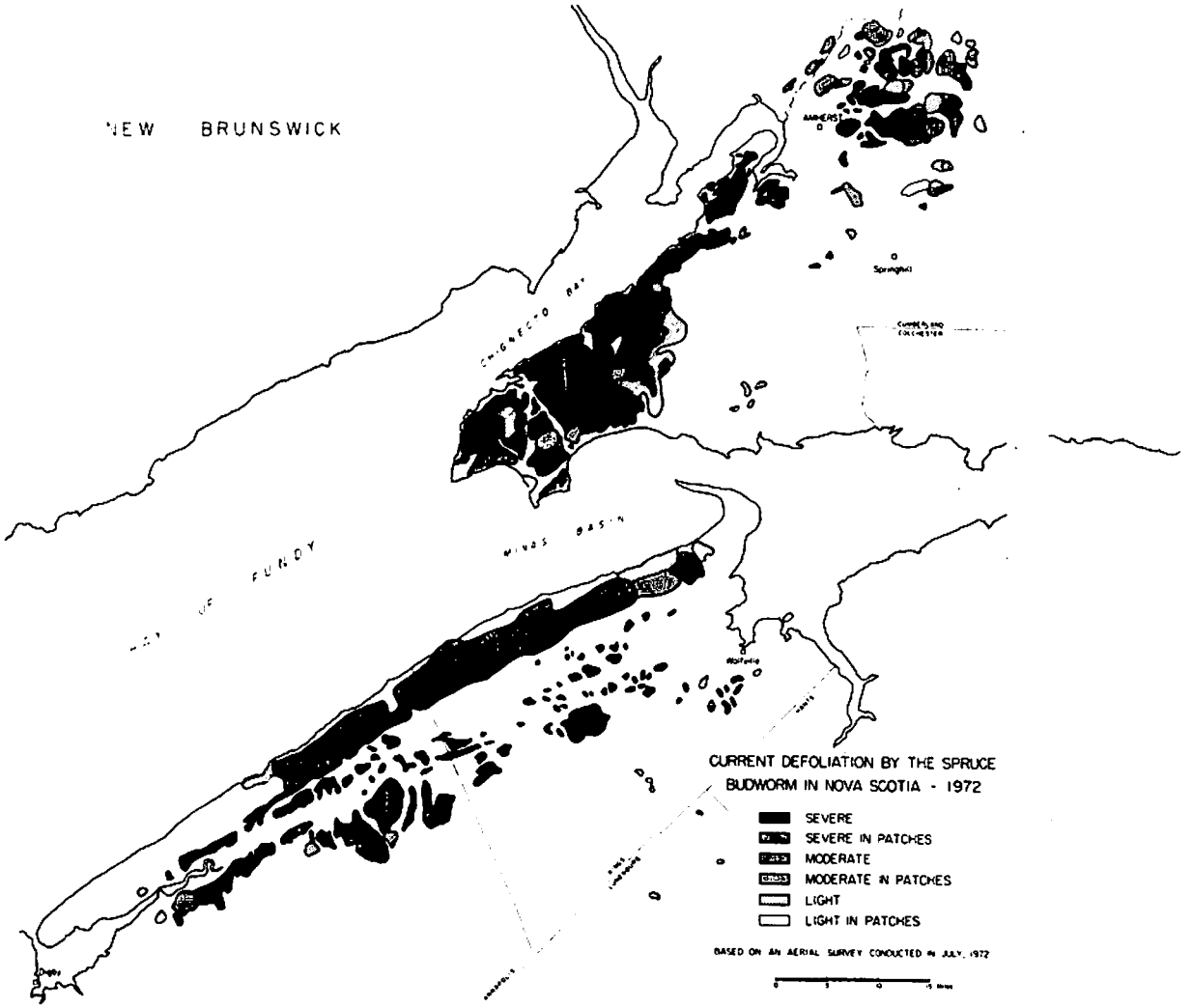


Fig. 3. Defoliation in Nova Scotia in 1972.

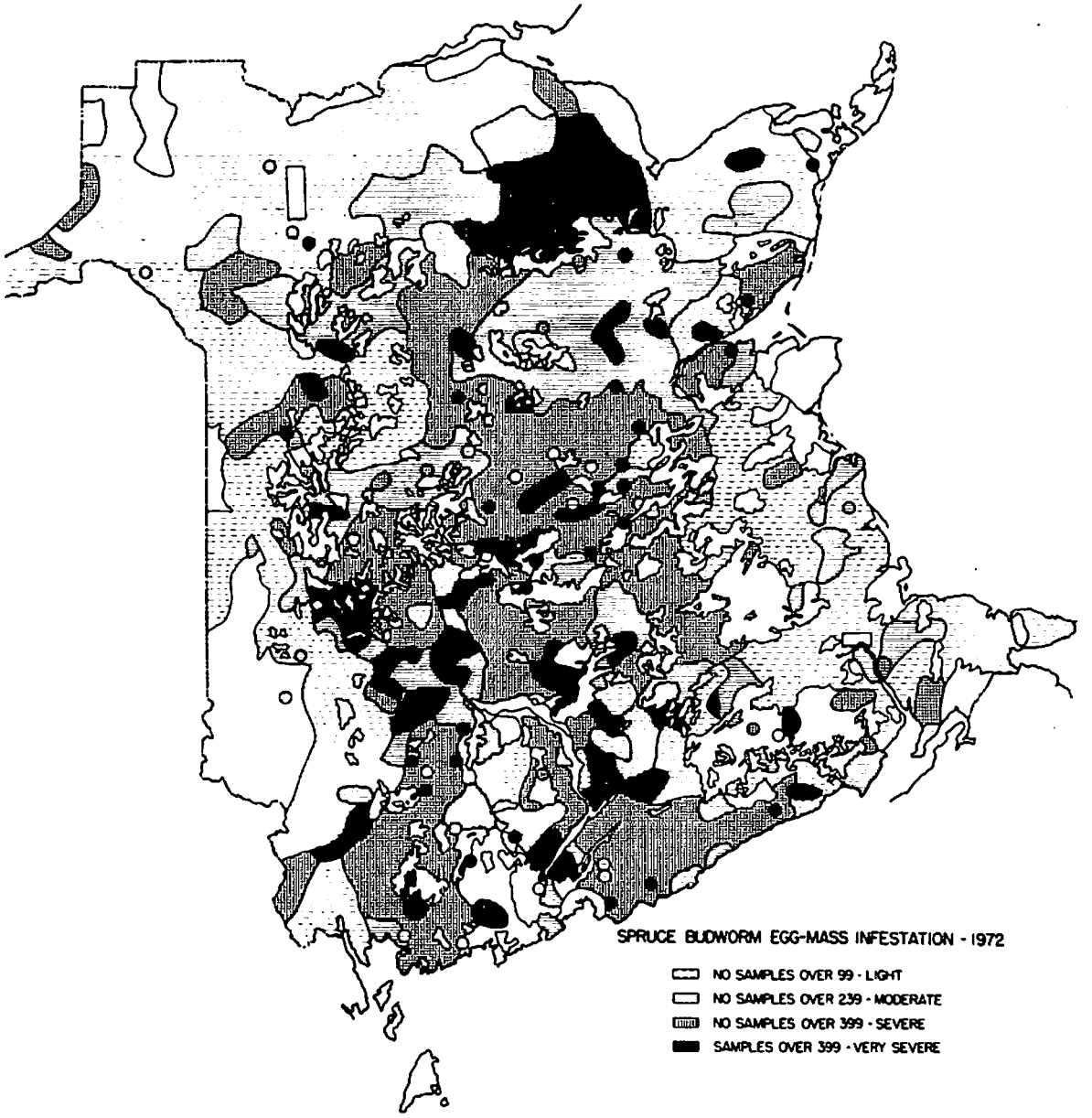


Fig. 4. Spruce budworm egg-mass infestations in New Brunswick in 1972.

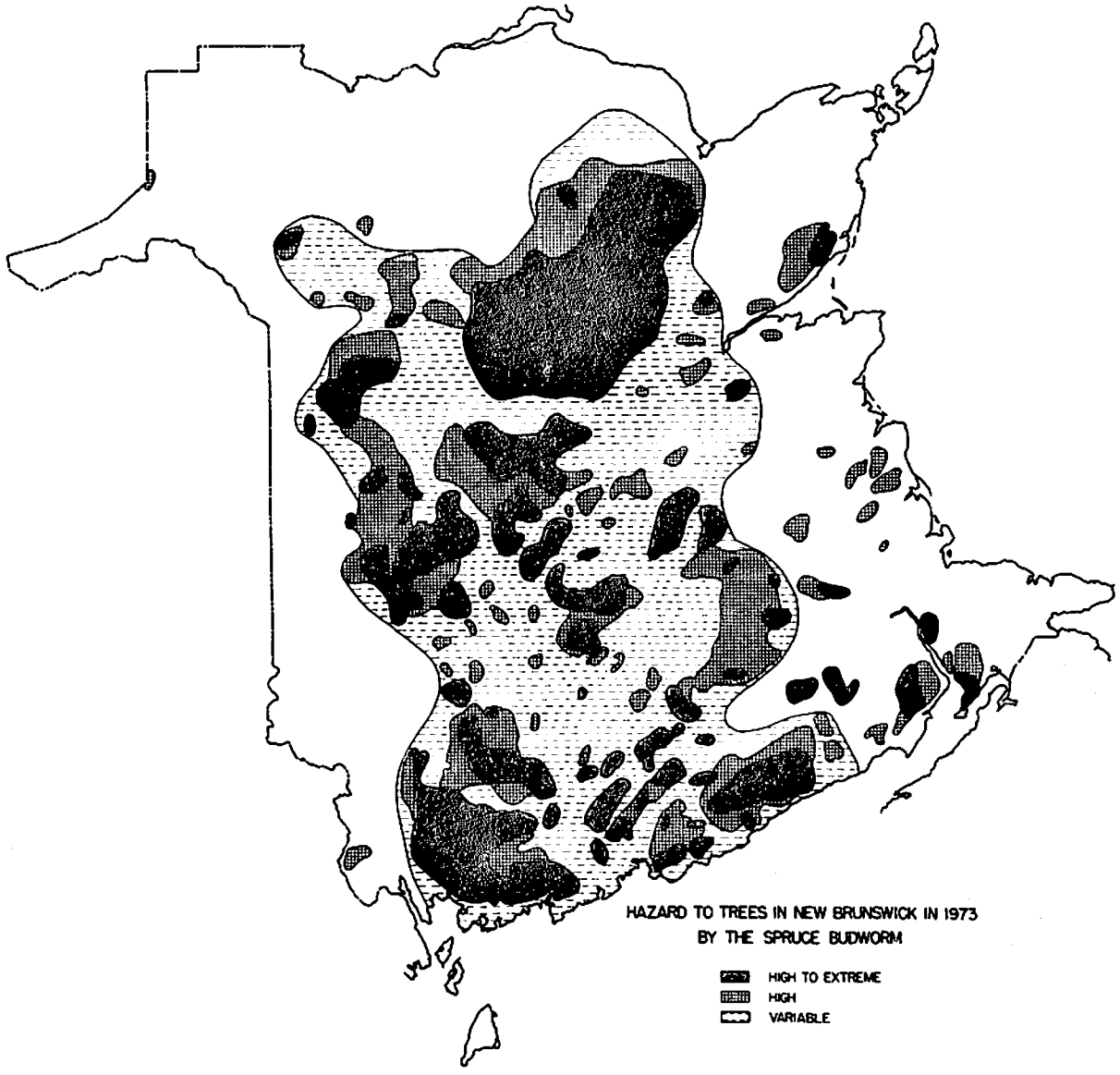


Fig. 5. Hazard posed by the spruce budworm in New Brunswick in 1973.

ENVIRONMENT CANADA - FISHERIES SERVICE

BIOLOGICAL STATION
ST. ANDREWS, N. B.

REPORT ON ACTIVITIES TO INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

Residual Effects of DDT. Pollution of stream environments with DDT remains 5 years after last application as a forest spray. Wild smolts given a sublethal treatment of DDT yielded only about 60% as many adult returns as control smolts. Wild Miramichi parr collected in 1971 had a DDT residue content (0.5-0.7 ppm) intermediate between that of the experimental smolts (0.9-2.8 ppm) and the control smolts (0.3 ppm) at their liberation. Wild parr from the headwaters also had PCB residues as high as 1.2 ppm in addition to their DDT residues.

P. F. Elson

Effects of Various Pesticides on Selected Temperature of Juvenile Atlantic Salmon and Brook Trout. Most metabolites and derivatives of p,p'-DDT had a similar effect to p,p'-DDT on selected temperature of young Atlantic salmon in a horizontal temperature gradient, namely a distributional shift to a temperature range 5-7°C higher than that of control fish (16°C). The order of effectiveness is p,p'-DDT $\geq$ p,p'-DDD > methyoxychlor > o,p'-DDT > p,p'-DDE. DDA, the most water soluble metabolite tested, had no effect at concentrations up to 8 ppm.

Exposure to progressively higher concentrations of aldrin, a chlorinated hydrocarbon insecticide of quite different molecular structure from p,p'-DDT, resulted in a progressively greater decrease in selected temperature (to a maximum of 4°C) coupled with a decrease in the precision of temperature selection.

The effect of p,p'-DDT on selected temperature of young brook trout in a vertical temperature gradient was similar to the effects obtained with young Atlantic salmon in the horizontal gradient.

R. H. Peterson

Ecological Studies. In four consecutive years (1969-72) the organophosphate insecticide fenitrothion (= Sumithion) was sprayed over the drainage basin of Trout Brook, Miramichi system, in spring to control the spruce budworm. Following spraying, the densities of aquatic stages of insects important

as food for young salmon and trout were below the levels established in 1966 after DDT spraying.

There was no evidence of immediate post-spray mortalities among fish following fenitrothion spraying but there were aberrant downstream movements of fish in spray years, particularly salmon parr in autumn.

Brook trout were greatly depleted as a result of DDT spraying in 1966 and they have not recovered; a contributing factor could be pesticides either acting directly on the fish or indirectly by reducing available food organisms.

J. W. Saunders

Side Effects of Aerial Spraying with Fenitrothion. Experimental investigations of possible side effects of aerial spraying with fenitrothion in the freshwater ecosystem show that aquatic insects (excluding Diptera) may be killed following spraying. Fish which eat fenitrothion-contaminated insects do not reach an acutely toxic dose because of regurgitation. At 10 mg fenitrothion/g food, fish eating rations up to 3 g/day significantly alter social hierarchies. Whether these "sublethal" effects significantly alter production of salmonids must be determined in the field.

D. J. Wildish

Compiled by H.H.V. Hord
St. Andrews, N.B.
November 20, 1972

SUMMARY REPORT ON THE EFFECTS OF THE 1972 FOREST SPRAY PROGRAM IN NEW BRUNSWICK ON AQUATIC INVERTEBRATES

PREPARED FOR

THE INTERDEPARTMENTAL COMMITTEE

ON FOREST SPRAY OPERATIONS

OTTAWA

December 12, 1972

by

D. B. Banks
Acadia University

and

H. A. Hall
Environmental Protection Service

Surveillance and Analysis Division
Environmental Protection Service
Dept. of the Environment
Halifax, N.S.

INTRODUCTION

Despite the large scale application of the organophosphorous insecticide fenitrothion for control of forest defoliants in New Brunswick, Newfoundland, the State of Maine, and elsewhere, very little data are available on the effects of this chemical on stream dwelling insects. In April of 1971 a two year program to determine the effects of the aerial application of this insecticide on aquatic invertebrates was initiated in New Brunswick. Originally, the study was under the auspices of the Department of the Environment, Fisheries Service, but responsibility has since been shifted to the Environmental Protection Service. Of primary concern during the study were the four orders of insects (Ephemeroptera, Plecoptera, Tricoptera, Diptera) that are the major food organisms of juvenile Atlantic Salmon and Brook Trout. The final report of the study, which will be a synthesis of relevant published material plus data from the field studies of the past two years, will be available in April of 1973. The information summarized in this report is that gathered during the 1972 field season only.

STUDY AREA

The nature of the study necessitated that the test stream fulfill several requirements. It had to be near the airstrip from which it would be sprayed. This would enable the field workers to be in close contact with the spray operations while being only minutes away from the stream. It had to be scheduled to receive a double application of insecticide, allowing for a comparison of results between the first and the second spray application. Other considerations were that it should be easily accessible and that it have a high salmonid population. Cove Brook, a small stream near Sussex, New Brunswick (Figure 1), fulfilled these requirements.

METHODS

The approach to the study was both biological and chemical in nature. After obtaining basic limnological data on the stream, a series of pre and post-spray water samples were collected and sent to the Water Management Service laboratory in Moncton and to Dr. J.R. Duffy at the University of Prince Edward Island for determination of insecticide concentrations in these organisms.

Three sampling methods were used in the biological studies carried out in 1972. In the first method, nine

one-foot-square Surber samples were collected (Figure I) twice weekly throughout the study period (mid May to mid June). The Surber method enables the investigator to determine the total population of invertebrates occupying one square foot of stream bottom at any given time. In the second method, twenty-stone counts, the investigator removes twenty stones one at a time from a selected area and counts the insects found on each were made twice weekly (Figure I). The third method was the collection of drift samples (Figure I). The phenomenon of a diurnal or diel drift pattern of aquatic insects is well known to aquatic biologists. It was hoped that by establishing the pattern and magnitude of the drift previous to spray, any spray-induced deviation could be detected. The drift nets were constructed by attaching a two-foot long bag net of 34 mesh Nitex netting to a one foot nylon collar. The collar was then attached to a one foot square steel frame which had "0" rings welded to the sides, allowing the frame to be slipped over stakes driven into the stream bed. Three nets were placed at one collecting station and three more were placed one-half mile down stream. Samples were collected for fifteen minutes every third hour in two nets and continuously in one net for 24-hour periods. Sampling began on May 15th and ended on June 16th.

In addition to the field work, some laboratory bioassay studies were carried out in the E. P. S. labs in Halifax.

RESULTS

Pre-spray insecticide levels in Cove Brook water samples were all less than 0.02 ppb (below detectable levels). The highest post-spray level detected was 7.4 ppb according to the Moncton laboratory and 14.3 ppb according to Dr. Duffy. Detectable amounts of the insecticide in the water disappeared after four or five days (Figure II). No insecticide was detected in the pre-spray mayfly samples. A high post-spray level of 0.916 ppb was recorded following spray (Figure III). It appears that the insects were taking up quantities of the chemical from the water, although retention time seemed to be short as fenitrothion concentrations in the mayflies were reduced to trace amounts in only two days.

In order to better evaluate these findings, the Environmental Protection Service conducted some bioassay tests using the emulsified concentrate with Atlantic salmon as the test organism. Tests were also carried out on the Aerotex solvent. With emulsified concentrate at a concentration of 0.00001% (0.07 ppm fenitrothion), a 50% mortality occurred during a 120 hour exposure test. A 5% Aerotex solution resulted in 100% mortality in 1.25 hours.

Data from the 20-stone counts and Surber samples appeared contradictory. The 20-stone counts seemed to indicate a large population drop immediately after the first spray application but Surber samples did not confirm this. Whether in fact there was a population decrease, and if so, whether its cause was natural or spray induced, is a subject which is still under analysis. Study of the drift data clearly shows an abnormal behavioral pattern following spray application in all instances. FigureIV represents the total insect drift based on a 15 minute sample collected every third hour for 24-hour periods. It is readily apparent that the amount of drift occurring immediately post-spray was substantially greater than during pre-spray conditions.

MUZROLL BROOK STUDY

In addition to the work at Cove Brook, the Environmental Protection Service was also involved in studying the effects of an experimental fenitrothion application near Doaktown, New Brunswick, in mid July of 1972. The purpose of this spray program was to determine the effectiveness of a 2 x 2 ounce application

of fenitrothion against the adult of spruce budworm. The Environmental Protection Service was interested in this program because the lower water levels and warmer temperatures that would be found in a mid July spray program might cause the fenitrothion spray to have more adverse effects on stream fauna. Muzroll Brook, a small stream running through the fenitrothion spray block was chosen as the test stream (Figure V). The methods used were basically similar to those used in Cove Brook: chemical analysis of water, Surber samples, drift samples.

Results of insecticide analysis of water were similar to the results obtained at Cove Brook, except that the fenitrothion appeared to disappear more rapidly in Muzroll Brook. Surber data indicated a steadily increasing insect density throughout the six day study period. Drift data did not indicate any significant change in drift behavior that could be attributed to the spray applications.

ACKNOWLEDGEMENTS

We would like to take this opportunity to thank Forest Protection Ltd., The Canadian Forestry Service and Dr. Duffy for their assistance during the 1972 field season.

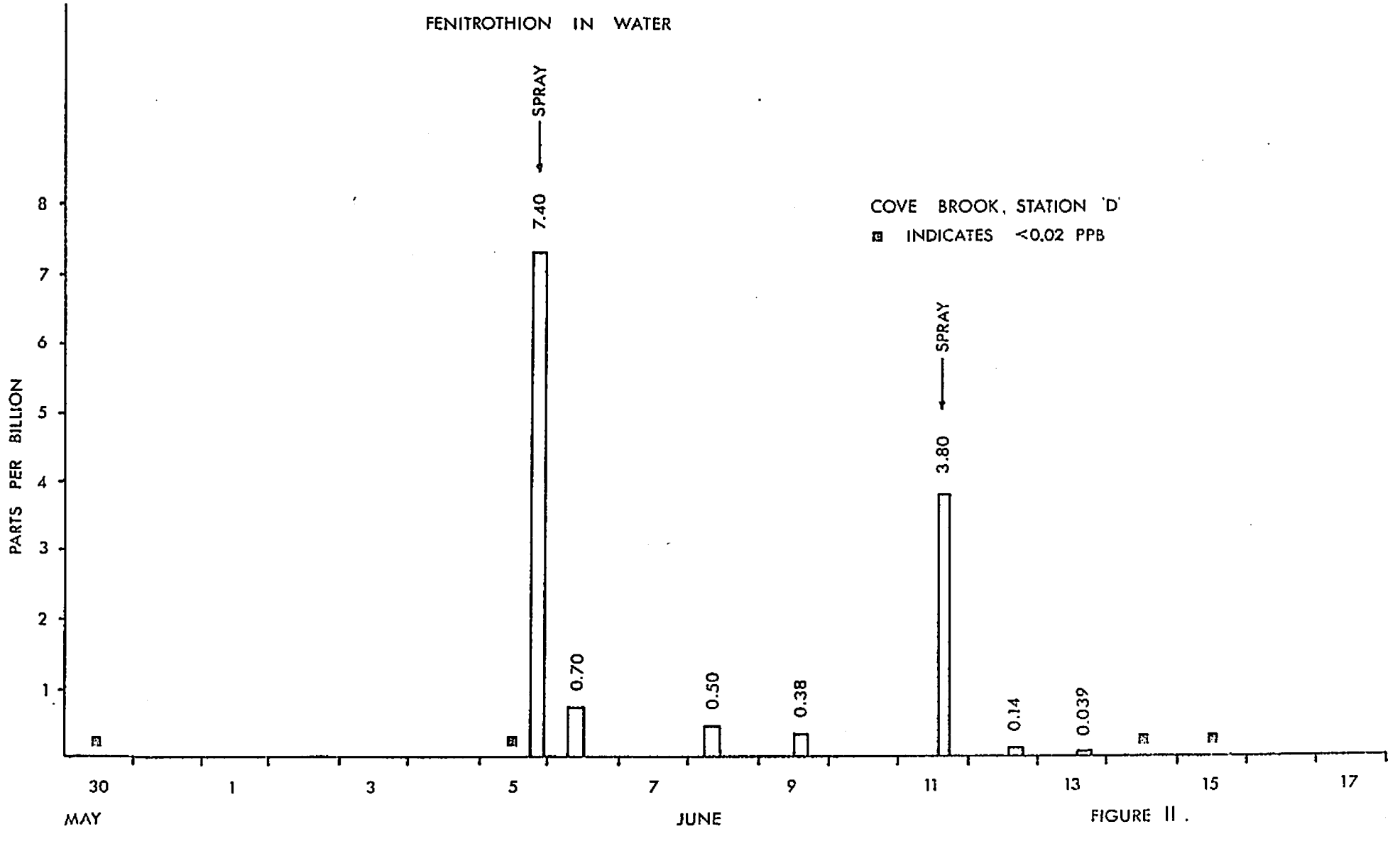

FENITROTHION IN WATER
COVE BROOK, STATION 'D'
INDICATES <0.02 PPB
SPRAY
SPRAY
7.40
0.70
0.50
0.38
3.80
0.14
0.039
PARTS PER BILLION
1
2
3
4
5
6
7
8
30
1
3
5
7
9
11
13
15
17
MAY
JUNE

FIGURE II.

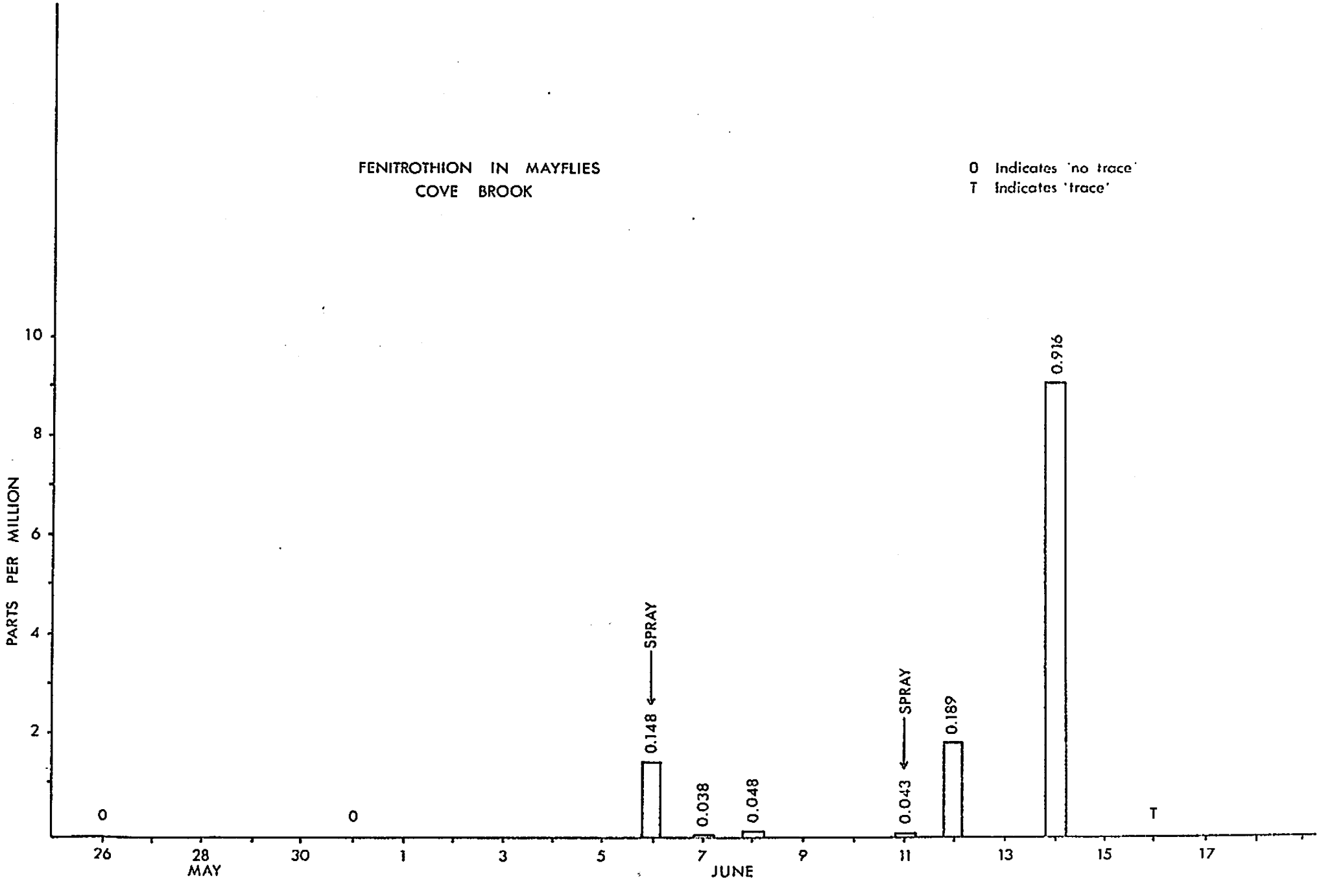

FENITROTHION IN MAYFLIES
COVE BROOK
0 Indicates 'no trace'
T Indicates 'trace'
PARTS PER MILLION
10
8
6
4
2
0
0
SPRAY
0.148
0.038
0.048
SPRAY
0.043
0.189
0.916
T
26
28
MAY
30
1
3
5
7
JUNE
9
11
13
15
17

FIGURE III

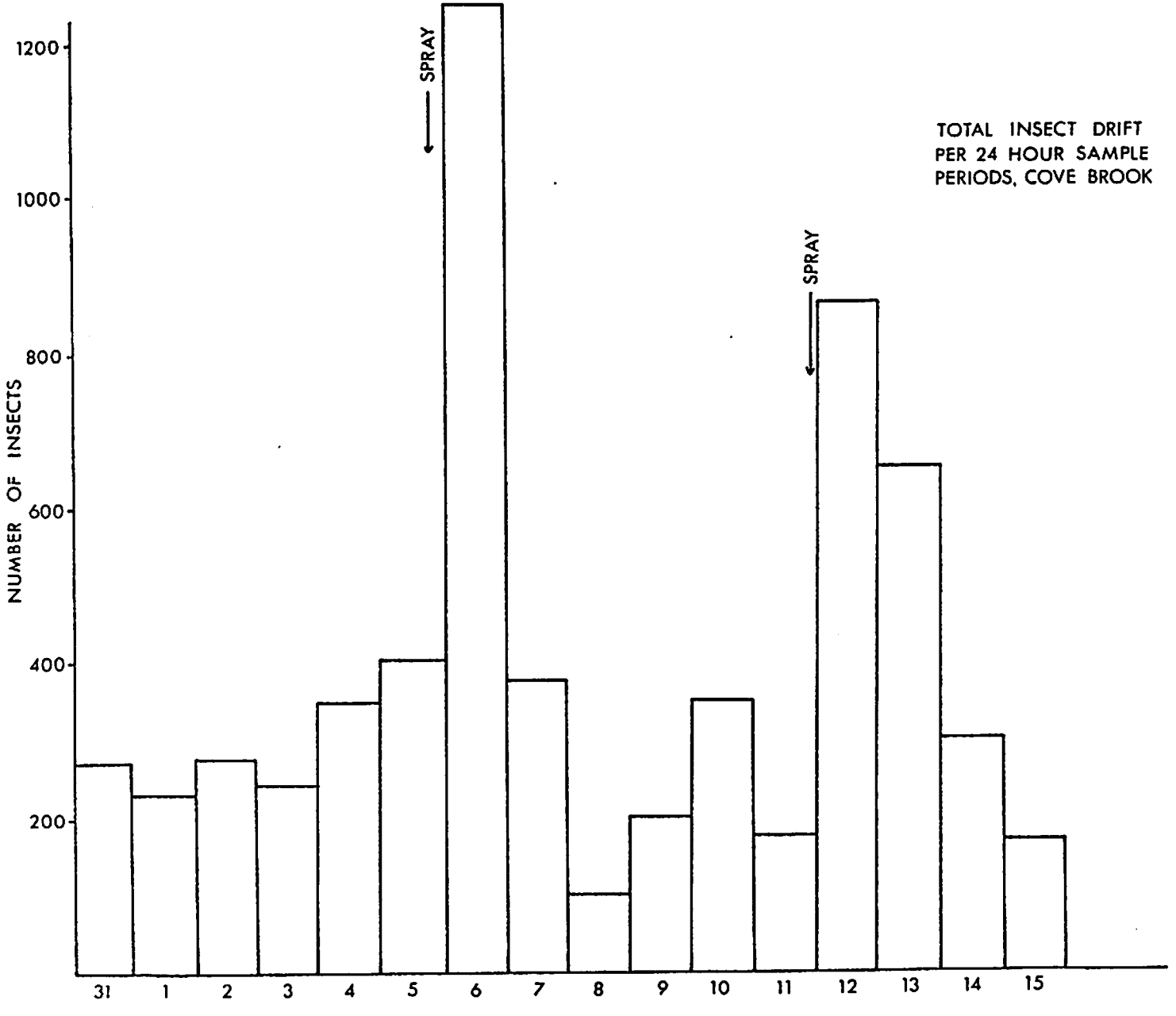

TOTAL INSECT DRIFT
PER 24 HOUR SAMPLE
PERIODS, COVE BROOK
SPRAY
SPRAY
NUMBER OF INSECTS
1200
1000
800
600
400
200
31
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
MAY
JUNE

FIGURE IV

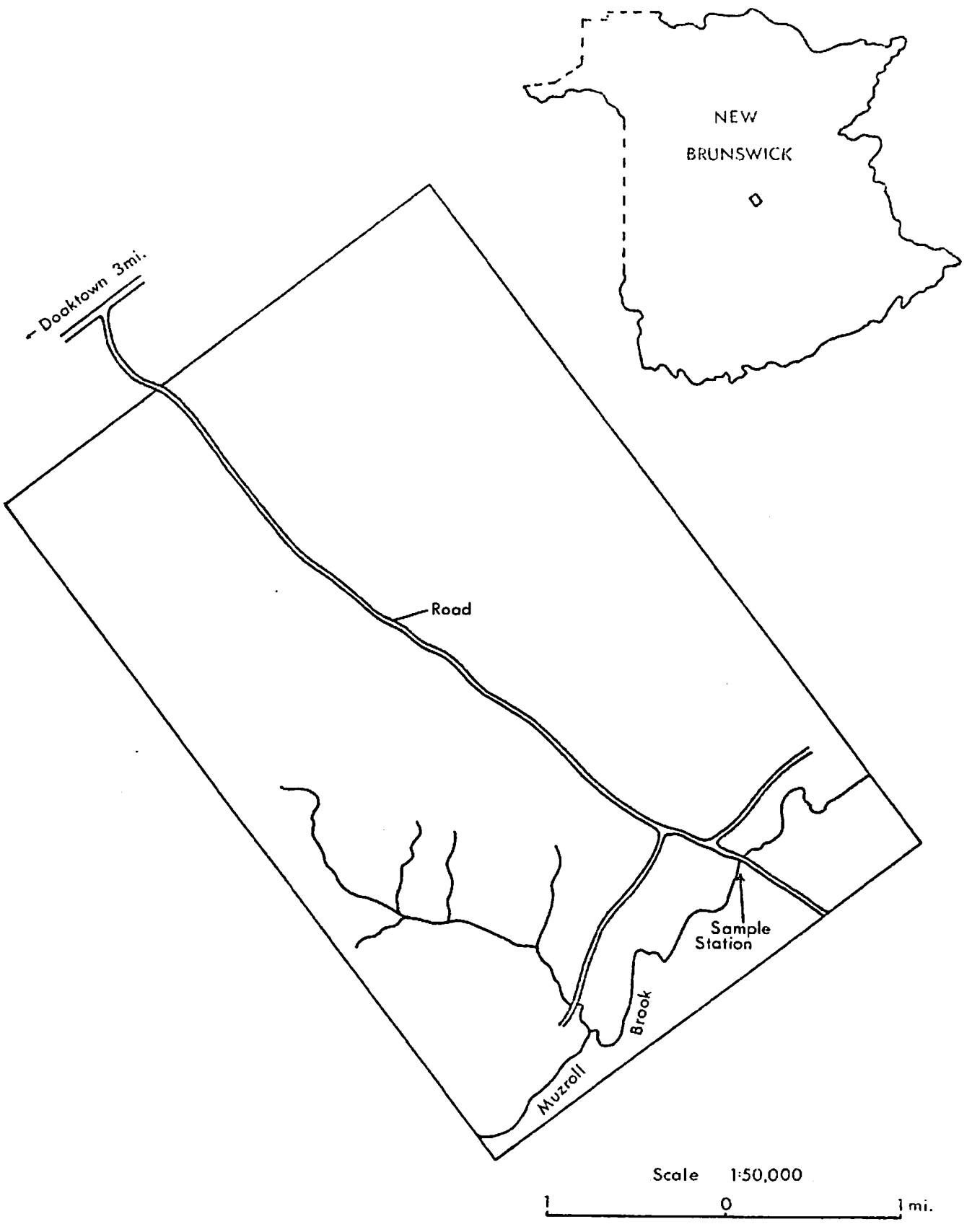


FIGURE V. MUZROLL BROOK STUDY PLOT AND SAMPLE LOCATION

File No. 454-7-3

Department of National Health and Welfare

Environmental Health Directorate

Occupational Health Division

Report No. OH 72-101

SPRUCE BUD WORM PESTICIDE SPRAYING

New Brunswick - 1972

Ottawa

August 1972

The primary objectives of the Occupational Health Division are to promote and preserve the highest degree of physical, mental and social well-being of workers in all occupations in Canada. The Division's activities include the development of occupational health standards and guidelines; formulation and distribution of informational materials; investigation of occupational environments and diseases; development and evaluation of assessment, surveillance and monitoring services; and the provision of consultation, training and advice.

HEALTH ASPECTS

SPRUCE BUD WORM SPRAYING OPERATION

New Brunswick - 1972

O.H. File 454-7-3
O.H. No. 72-101

1.	SERVICE REQUESTED:	Overseeing of health of persons exposed to spraying during annual spraying operation
2.	REQUESTED BY:	Dr. E.A. Watkinson, Deputy Minister of Health, Department of Health, Fredericton, N.B.
3.	PERSONS CONSULTED:	Dr. E.A. Watkinson, Deputy Minister of Health, Department of Health, Fredericton, N.B. Dr. H.W. Wyile, Department of Health, Fredericton, N.B. Mr. B.W. Flieger, Canadian International Paper Co., Sun Life Bldg. - Rm. 1540, Montreal, 2, Que. Mr. B.A. McDougall, Forest Protection Ltd., P.O. Box 130, Fredericton, N.B.
4.	SURVEY CONDUCTED BY:	Dr. T.F. McCarthy, Clinical Consultant, Dept. of National Health and Welfare.

5. At the request of Dr. E.A. Watkinson, Deputy Minister of Health for the Province of New Brunswick, the health aspects of the annual spruce bud worm spraying operation were monitored by personnel of the Environmental Health Directorate of the Department of National Health and Welfare,

6. The observations to be described were carried out during the period from June 1st to June 15th, 1972.

7. Previous experience indicated that in order to fairly assess the adequacy of the health and safety measures most effort should be directed towards observing and commenting on the following items:

(1) Measures for preventing pesticide poisoning in operating personnel;

(2) Plans, and resource available, for on site treatment of accident and/or injury;

(3) Techniques developed for the disposal of pesticide residues and decontamination of spills;

(4) Immediate measures taken to decontaminate empty drums and final disposal of them.

A. MEASURES FOR PREVENTING PESTICIDE POISONING IN OPERATING PERSONNEL

8. The pesticide "Fenitrothion", at present being used operationally by Forest Protection Limited, has been so used for four to five years. It is moderately toxic to humans.

9. Most of the personnel likely to have significant exposure to the pesticide, i.e., loaders, mixers, pilots and mechanics are, for the most part, experienced workers. All have access to adequate protective gear and experience has demonstrated that some of the more stringent measures, insisted upon when "Fenitrothion" was first used operationally can, with safety, be relaxed. An attempt is made to maintain and encourage a healthy respect for the chemical and the consequences of significant exposure have been explained to all concerned. There are adequate supplies of soap and water available on each site and the workmen are encouraged to make use of them.

10. Mixing and loading are carried out in the open air in a closed system with drip-free couplings. The mixing and loading operations are closely supervised and improvements in the system are being developed continuously.

11. The mechanics service aircraft in the open and ventilation is consequently a minor problem. Skin absorption, via the bare hands contaminated in the process of adjusting spraying nozzles, has not proven to be a major health hazard. Mechanics' hands usually have a coating of grease and/or oil that perhaps acts as a mechanical barrier to skin penetration. In addition their contact is with the dilute pesticide. Of the operating personnel the mechanics are probably the group

most at risk. However in four years of observation there has not been among them a single instance of illness that could reasonably be attributed to "Fenitrothion" exposure. None have been hospitalized and none have been treated for pesticide poisoning.

12. As has been mentioned the pilots are all experienced and some have been returning annually for the spruce bud worm spraying operation for many years. Most pilots are equipped with forced air supplied helmets, the breathing air coming from outside the cockpit and having been passed through an activated charcoal filter. Because of the special hazards of their work pilot's health is monitored very carefully and what would, in other situations, be minor complaints are accorded great significance. Being experienced in the use of toxic pesticides, they are able to recognize early symptoms of poisoning. Some minor departures from good health have been reported among pilots none of which were sufficiently specific to enable one to diagnose pesticide poisoning. It is probable that some, if not all, of these minor complaints were insignificant or psychologically induced.

13. In previous years spraying systems were checked immediately prior to take-off and there was considerable drift of pesticide into the working area. This procedure has been discontinued.

14. Good liaison has been established with the New Brunswick Department of Health. All hospitals in the spraying areas have information on the nature of the pesticide and recommended treatment of poisoning incidents.

B. PLANS AND RESOURCES AVAILABLE FOR ON SITE TREATMENT OF ACCIDENT AND/OR INJURY

15. A physician, usually a senior resident from a St. John hospital, is permanently on site at the headquarters of the operation, Dumphy air strip at Upper Blackville. Ground and air transportation are available to move him quickly to the site of any accident. Constant radio communication is maintained with all operating units.

16. Adequate supplies of first aid material is on hand as well as supplies of atropine and other antidote.

17. The Armed Forces search and rescue team stationed at Chatham have, in other years, assisted in locating downed air craft and rescuing injured personnel.

18. Some of the remote locations could be difficult to reach by air in poor flying weather and could require considerable time to reach by road. The time of most danger is of course when actual spraying is occurring. In practice this has not been a major problem.

19. Because the physician's time is not fully engaged he has opportunity and is encouraged to visit operating sites and to inspect health and safety measures operations at the various sites.

20 Supplies of oral atropine could be located at each site and could be an added safety provision. The temptation to diagnose and treat should be strenuously resisted and self medication discouraged. If supplies are made available they should be used only on advice of the physician at headquarters.

C. TECHNIQUES DEVELOPED FOR THE DISPOSAL OF PESTICIDE RESIDUES AND DECONTAMINATION OF SPILLS

21. Residues of formulated pesticide remaining in aircraft at the completion of an operation or in the loading system are dumped in a lagoon located on the side of the main runway and rendered innocuous by the addition of caustic and water. Experience has shown that holding over winter renders these residues non toxic and they can then be disposed of in sandy soil without danger of contaminating the area surrounding the dumping site.

22. Generally the information available from the suppliers is inadequate and impractical. At the present time reliance is placed on adequate washing of the site with caustic and water. The run-off is held in a secure location and aging renders it innocuous.

23. On occasion emergencies require the dumping of a load from an aircraft. Every attempt is made to make such disposal in a remote location removed from habitation and drinking water supplies. No such emergency occurred this year.

D. IMMEDIATE MEASURES TAKEN TO DECONTAMINATE "EMPTY" DRUMS AND FINAL DISPOSAL OF THEM

24. After the pesticide concentrate has been removed from the drum it is charged with caustic soda detergent and water, the bungs reinserted and the drum is inverted in order to rinse the interior of the drum. After a holding period of a few days the residues are emptied into the lagoon, as mentioned previously, and the drum stored in a secure location at the headquarters side of Dumphy Air strip. Periodically these drums are disposed of to a private agency for cleaning and re-use. The recommendation that drums be punctured, crushed and buried is impractical because of the large number of drums requiring disposal.

25. It appears reasonable to suggest that pesticide suppliers should be required to give practical advice on storage and disposal of containers.

26. Labelling has improved greatly over the past nine years. Most drum labels are now of adequate size and are stencilled on the drum or are waterproof, weatherproof and secure attachments. The skull and crossbones warning symbol is prominently displayed.

CONCLUSIONS:

27. The techniques developed for preserving the health of operating personnel using the pesticide "Fenitrothion" are adequate.

28. If changes in techniques are contemplated or if formulations are changed a fresh look should be taken at the safety measures.

29. Constant vigilance is necessary to ensure that the present excellent safety record is maintained.

30. Although, as has been mentioned, it has been possible to relax some of the more stringent safety measures, the temptation to discard the essential measures must be vigorously resisted.

31. Liaison already established with the New Brunswick Department of Health should be maintained and strengthened in order that sound advice on health and safety is readily available if and when needed.

32. Although safety precautions are of the utmost importance in preventing pesticide poisoning, there are other functions which favour the potentially exposed workman in this particular operation.

33. Spraying, because of weather conditions, is intermittent in character and exposure time during a week may amount to only a few hours. This permits recovery from minor exposure.

34. It is possible that minor exposures, that do not produce symptoms, may stimulate natural resistance.

35. The whole operation is completed in about one month's time so that adequate time is available for regeneration of any depressed enzyme system.

36. The very high protein diet available to workers probably assists in any detoxification process.

37. Distribution:

E.A. Watkinson, M.D., Deputy Minister of Health, Dept. of Health, Fredericton, N.B.
H.W. Wyile, M.D., Department of Health, Fredericton, N.B.
Mr. B.W. Flieger, Can. Inter. Paper Co., Sun Life Bldg., Room 1540, Montreal-2, Que.
Mr. B.A. McDougall, Forest Protection Ltd., P.O. Box 130, Fredericton, N.B.
Mr. Bancroft, Dept. of Labour, Fredericton, N.B.
F.H. Hicks, M.D., Medical Services Branch, NH&W
Regional Director, Medical Services, NH&W, New Brunswick
A.H. Booth, Ph.D., A/Director General, Environmental Health Directorate, NH&W
T.H. Patterson, M.D., Chief, Occupational Health Div., NH&W
C.R. Ross, P. Eng., Senior Engineer, NH&W
W.A. Prowse, M.D., Consultant, Environmental Health and Aerospace Medicine
M.L. Prebble, Ph.D., Chairman, Federal Interdepartmental Committee on Forest Spraying
J.J. Fettes, Ph.D., C.C.R.I., Ottawa
J. Woodward; Ph.D., Chairman, Federal Interdepartmental Committee on Pesticides
I.H. Anderson, M.D., Adviser, Civil Aviation Medicine.

AERIAL SPRAYING AGAINST INSECTS IN QUEBEC IN 1972

1 - Against the Spruce Budworm

1.1 - Fenitrothion treatment

1.11 - Gatineau River watershed

1.111 - Area sprayed	1,560,276 acres
1.112 - Type of aircraft	TBM Avenger
1.113 - Agent	Forest Protection Limited
1.114 - Bases of operation	Maniwaki and Lac des Loups
1.115 - Type of treatment	Two applications of water based insecticide, one of 3 ounces per acre and the other of 2 ounces
1.116 - Cost distribution	Quebec government: 2/3 of the cost per acre on timber limits and large private forests and 100% of the cost on vacant Crown lands and small private lands Participating pulp and paper companies: 1/3 of the cost per acre

1.12 - Dumoine River watershed

1.121 - Area sprayed	234,955 acres (plus an experimental block of 84,111 acres where a single 3 ounce application of insecticide per acre was made)
1.122 - Type of aircraft	DC-7B
1.123 - Operator	Midair (Canada) Limited
1.124 - Base of operation	Lac des Loups
1.125 - Type of treatment	Two applications of water based insecticide, one of 3 ounces per acre and the other 2 ounces
1.126 - Cost distribution	Same as 1.116

1.2 - Experimental treatment with Matacil

1.21 - Area concerned	Lievre River watershed
1.22 - Area sprayed	75,341 acres
1.23 - Type of aircraft	DC-7B
1.24 - Operator	Midair (Canada) Limited
1.25 - Base of operation	Lac des Loups
1.26 - Type of treatment	A single oil based application of 3/4 ounce per acre

1.3 - Experimental treatment with Zectran

1.31 - Area concerned	Gatineau River watershed
1.32 - Area sprayed	73,193 acres
1.33 - Type of aircraft	DC-7B
1.34 - Operator	Midair (Canada) Limited
1.35 - Base of operation	Lac des Loups
1.36 - Type of treatment	Same as 1.26

1.4 - Experimental of treatment with Bacillus thuringiensis

1.41 - Area concerned	Lake Temiscouata
1.42 - Area sprayed	10,152 acres
1.43 - Type of aircraft	TBM Avenger
1.44 - Agent	Forest Protection Limited
1.45 - Base of operation	Rivière du Loup
1.46 - Type of treatment	A 2 gallons per acre application of a Bacillus thuringiensis suspension with a chitinase enzyme addition
1.47 - Participating organizations	The Quebec government and the Canadian Forestry Service (Laurentian Forest Research Centre)

2 - Against the Jack Pine Budworm

2.1 - Area concerned	Gatineau River watershed
2.2 - Area sprayed	19,557 acres
2.3 - Type of aircraft	TBM Avenger
2.4 - Agent	Forest Protection Limited
2.5 - Base of operation	Lac des Loups
2.6 - Type of treatment	Same as 1.115
2.7 - Cost distribution	Quebec government: 2/3 of the cost per acre Participating pulp and paper company: 1/3 of the cost per acre

3 - Against the Hemlock Looper

3.1 - Area concerned	Anticosti Island
3.2 - Area sprayed	424,391 acres
3.3 - Type of aircraft	TBM Avenger
3.4 - Agent	Forest Protection Limited
3.5 - Base of operation	Port Menier
3.6 - Type of treatment	Two applications of 2 ounces per acre of water based fenitrothion
3.7 - Cost distribution	Same as 2.7

4 - Against the Swaine Jack Pine Sawfly

4.1 - Area concerned	Ottawa River watershed
4.2 - Area treated	17,585 acres
4.3 - Type of aircraft	TBM Avenger

4.4 - Agent	Forest Protection Limited
4.5 - Base of operation	Lac des Loups
4.6 - Type of treatment	A single application of water based fenitrothion at the rate of 4, 2, 1 and 0.5 ounces per acre on each quarter of the area treated
4.7 - Cost distribution	Same as 2.7

SUMMARY RESULTS OF THE 1972 SPRAYING OPERATIONS IN QUEBEC

Insect	Area	Aircraft	Dosage	Period of application	Total mortality	Residual population	Foliage protected	Eggs	
								1972	72/71
Spruce Budworm	1,560,276	TBM	3oz.+ 2oz.	May 18–June 16	88%	3.2	55%	479	0.411
Spruce Budworm	234,955	DC-7B	3oz.+ 2oz.	May 28–June 17	84%	3.2	4%	517	0.328
Jack Pine Budworm	19,557	TBM	3oz.+ 2oz.	June 28–July 3	68%	0.9	-	-	-
Hemlock Looper	424,391	TBM	2oz.+ 2oz.	July 3–July 12	79.8%	5.6	94%	-	-
Swaine Jack Pine Sawfly	4,396	TBM	4 oz.	August 13	100%	0.0	-	-	-
	4,396	TBM	2 oz.	August 13	100%	0.0	-	-	-
	4,396	TBM	1 oz.	August 13	100%	0.0	-	-	-
	4,396	TBM	0.5 oz.	August 13	99%	0.46	-	-	-

ARROSAGES AERIENS CONTRE LES INSECTES

AU QUEBEC EN 1972

1 - Contre la tordeuse des bourgeons de l'épinette

1.1 - Traitement au fenitrothion

1.11 - Dans le bassin de la rivière Gatineau

1.111 - Superficie traitée	1,560,276 acres
1.112 - Type d'avions utilisés	TBM Avenger
1.113 - Opérateur	Forest Protection Limited
1.114 - Bases d'opération	Maniwaki et Lac des Loups
1.115 - Mode de traitement	Deux applications d'insecticide à base d'eau, l'une de 3 onces l'acre et l'autre de 2 onces
1.116 - Répartition du coût	Gouvernement du Québec: 2/3 du coût à l'acre sur les concessions forestières et les grandes forêts privées et 100% du coût sur les terrains vacants du domaine public et sur les petits terrains privés Compagnies forestières participantes: 1/3 du coût à l'acre

1.12 - Dans le bassin de la rivière Dumoine

1.121 - Superficie traitée	234,955 acres (plus un bloc expérimental de 84,111 acres où une seule application de 3 onces d'insecticide l'acre a été effectuée)
1.122 - Type d'avion utilisé	DC-7B
1.123 - Opérateur	Midair (Canada) Limited
1.124 - Base d'opération	Lac des Loups

1.125 - Mode de traitement	Deux applications d'insecticide à base d'huile, l'une de 3 onces l'acre et l'autre de 2 onces
1.126 - Répartition du coût	Même que 1.116

1.2 - Traitement expérimental au Matacil

1.21 - Région concernée	Bassin de rivière du Lièvre
1.22 - Superficie traitée	75,341 acres
1.23 - Type d'avion utilisé	DC-7B
1.24 - Opérateur	Midair (Canada) Limited
1.25 - Base d'opération	Lac des Loups
1.26 - Mode de traitement	Une application de 3/4 once l'acre à base d'huile

1.3 - Traitement expérimental au Zectran

1.31 - Région concernée	Bassin de rivière Gatineau
1.32 - Superficie traitée	73,193 acres
1.33 - Type d'avion utilisé	DC-7B
1.34 - Opérateur	Midair (Canada) Limited
1.35 - Base d'opération	Lac des Loups
1.36 - Mode de traitement	Même que 1.26

1.4 - Traitement expérimental au Bacillus thuringiensis

1.41 - Région concernée	Lac Témiscouata
1.42 - Superficie traitée	10,152 acres
1.43 - Type d'avions utilisés	TBM Avenger

1.44 - Opérateur	Forest Protection Limited
1.45 - Base d'opération	Rivière du Loup
1.46 - Mode de traitement	Application de 2 gallons l'acre d'une suspension de Bacillus thuringiensis additionnée de l'enzyme chitinase
1.47 - Organismes participants	Le gouvernement du Québec et le Service canadien des Forêts (Centre de Recherches Forestières des Laurentides)

2 - Contre la tordeuse des bourgeons du pin gris

2.1 - Région concernée	Bassin de rivière Gatineau
2.2 - Superficie traitée	19,557 acres
2.3 - Type d'avions utilisés	TBM Avenger
2.4 - Opérateur	Forest Protection Limited
2.5 - Base d'opération	Lac des Loups
2.6 - Mode de traitement	Même que 1.115
2.7 - Répartition du coût	Gouvernement du Québec: 2/3 du coût à l'acre Compagnie forestière participante: 1/3 du coût à l'acre

3 - Contre l'arpenteuse de la pruche

3.1 - Région concernée	Ile d'Anticosti
3.2 - Superficie traitée	424,391 acres
3.3 - Type d'avions utilisés	TBM Avenger
3.4 - Opérateur	Forest Protection Limited
3.5 - Base d'opération	Port Menier

3.6 - Mode de traitement	Deux applications de 2 onces l'acre de fenitrothion à base d'eau
3.7 - Répartition du coût	Même que 2.7

4 - Contre la mouche à scie du pin gris de Swaine

4.1 - Région concernée	Bassin de rivière Ottawa
4.2 - Superficie traitée	17,585 acres
4.3 - Type d'avions utilisés	TBM Avenger
4.4 - Opérateur	Forest Protection Limited
4.5 - Base d'opération	Lac des Loups
4.6 - Mode de traitement	Une application de fenitrothion à base d'eau à raison de 4, 2, 1 et 0.5 onces l'acre sur respectivement un quart de la superficie
4.7 - Répartition du coût	Même que 2.7

RESULTATS SOMMAIRES DES ARROSAGES REALISES AU QUEBEC EN 1972

Insecte	Super-ficie	Avion	Dosage	Période d'application	Mortalité totale	Population résiduelle	Feuillage protégé	Oeufs	
								1972	72/71
Tordeuse des bourgeons de l'épinette	1,560,276	TBM	3 oz. + 2 oz.	18 mai - 16 juin	88%	3.2	55%	479	0.411
Tordeuse des bourgeons de l'épinette	234,955	DC-7B	3 oz. + 2 oz.	28 mai - 17 juin	84%	3.2	4%	517	0.328
Tordeuse des bourgeons du pin gris	19,557	TBM	3 oz. + 2 oz.	28 juin-3 juillet	68%	0.9	-	-	-
Arpenteuse de la pruche	424,391	TBM	2 oz. + 2 oz.	3-12 juillet	79.8%	5.6	94%	-	-
Mouche à scie du pin gris de Swaine	4,396	TBM	4 oz.	August 13	100%	0.0	-	-	-
	4,396	TBM	2 oz.	August 13	100%	0.0	-	-	-
	4,396	TBM	1 oz.	August 13	100%	0.0	-	-	-
	4,396	TBM	0.5 oz.	August 13	99%	0.46	-	-	-

Spruce Budworm Aerial Spraying Operations Ontario, 1972

by

G. M. Howse and W. L. Sippell
Canadian Forestry Service
Great Lakes Forest Research Centre, Sault Ste. Marie

and

K. B. Turner
Ontario Ministry of Natural Resources, Toronto

INTRODUCTION

Aerial spraying operations covering some 46,500 acres were carried out against spruce budworm in 1972 by the Ministry of Natural Resources in Ontario. The Canadian Forestry Service participated in planning the operations and were responsible for timing the spray applications and assessing the results.

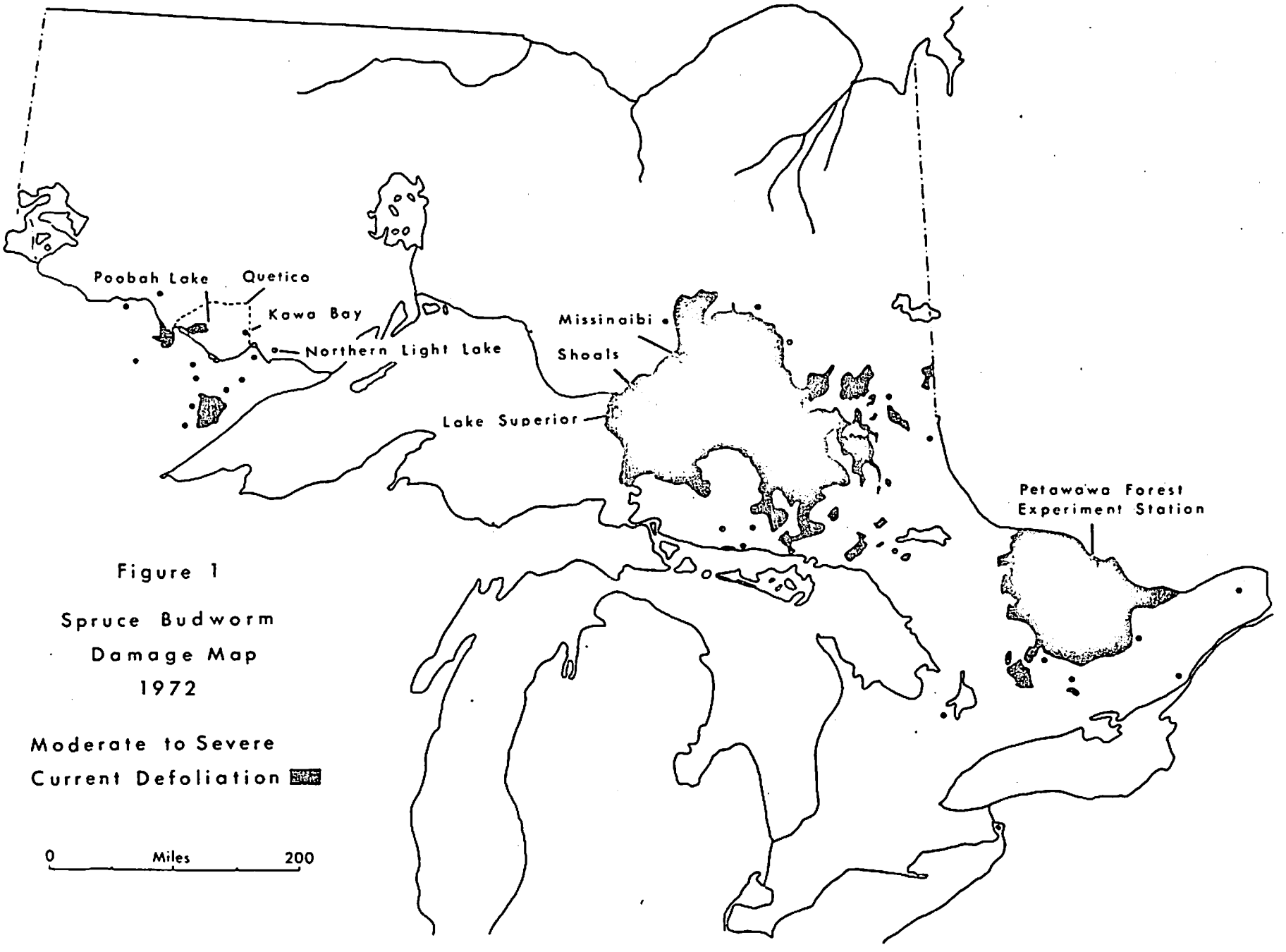
Two major changes were introduced into provincial aerial spraying operations in 1972. The first involved the use of Zectran (in place of fenitrothion) at a rate of 1.2 ounces of active ingredient in .15 U .S. gallons of spray mixture per acre. The diluent used was Arotex. The second change involved the installation of four Micronair units on each of three Stearman and on one Agcat aircraft used on the operations by the contractor General Airspray Ltd. of St. Thomas.

NORTHWESTERN ONTARIO

1972 Operations

The largest operation was in northwestern Ontario with spray headquarters and the airstrip located at Atikokan.

The purpose of this operation was to continue the program of abatement spraying begun in 1971 to prevent the spread of budworm into highly susceptible and valuable forests in the vicinity of Burchell Lake and Lac des Mille Lacs. Most of the acreage sprayed in 1972 was located in


Poobah Lake
Quetico
Kawa Bay
Northern Light Lake
Missinaibi
Shoals
Lake Superior
Petawawa Forest
Experiment Station
Figure 1
Spruce Budworm
Damage Map
1972
Moderate to Severe
Current Defoliation
0
Miles
200

Quetico Provincial Park where 9,000 acres lying south of Kawa Bay on Kawnipi Lake and another 26,000 acres lying between Allan Lake and Poohbah Lake in central Quetico were treated in June using 3 Stearman spray planes. The spraying started at the peak of 4th instar. It had originally been planned to spray a total of some 70,000 acres in Quetico but poor weather conditions throughout June forced the termination of this operation when a large proportion of the budworm reached the pupal stage. An additional 1,900 acres were sprayed at Northern Light Lake and Granite Lake in the southwestern part of the Thunder Bay District.

Generally speaking, the results appear to be good. A few small pockets of defoliation appeared within the sprayed areas but pupal counts and egg-mass counts show that in the sprayed areas budworm populations are much reduced from 1971.

Infestation Forecasts for 1973

The spruce budworm situation in northwestern Ontario appears brighter now than at any time in the last five years. Damage within unsprayed areas in Quetico Park amounted to only 70,000 acres in 1972. One major infestation of about 55,000 acres was located between Poohbah Lake westward to Lac la Croix at the Ontario-Minnesota border. The remaining infestations consisted of many pockets of varying size and occurred from Namakan Lake in the east to Bayley Bay in the west, mainly along the International Border.

Based on egg-mass surveys little change is forecast in infestation boundaries for 1973. In addition, the areas surrounding Burchell Lake and Lac des Mille Lacs appear to be virtually free of infestation.

Proposed Aerial Spraying Operations for 1973

The province is expected to continue its present policy of abatement and to spray as much of the main infestation in Quetico Park as resources will permit. It is also anticipated that chronic infestations at Northern Light Lake and Granite Lake will be checked for budworm abundance in the spring of 1973 after emergence has occurred, and that these areas will be sprayed again if necessary. The area south of Kawa Bay in Quetico Park that was sprayed in 1972 will also be checked in the spring of 1973 and sprayed if necessary.

NORTHEASTERN ONTARIO

1972 Operations

A total of 9,600 acres was sprayed using an Agcat fitted with Micronairs. Applications were timed to start at the peak of 4th instar. The sprayed acreage was located in the Lake Superior Provincial Park (3,600 acres) of the White River District and Missinaibi Provincial Park (6,000 acres) of the Chapleau District. The purpose of spraying in northeastern

Ontario was again to reduce the intensity of damage caused by budworm feeding on balsam fir and white spruce within selected high value recreational areas. It was originally planned to spray an additional 2,500 acres in the Shoals Provincial Park but severe damage to host trees caused by frost in this area during late May resulted in the cancellation of this part of the operation.

An assessment was conducted in Lake Superior Provincial Park to obtain detailed information about the effects on budworm of 1.2 ounces of Zectran per acre when applied to balsam fir and white spruce. Unfortunately, the occurrence of frost after the spraying complicated what would normally have been a straightforward assessment of the operation. However, if it is assumed that the effects of frost were similar in the sprayed and unsprayed areas, then the application rate of 1.2 ounces of Zectran in Arotex in .15 gal. (U.S.) of spray per acre causes a population reduction of 80% on balsam fir and 35% on white spruce. Damage to current foliage due to both frost and budworm was very severe in both sprayed and unsprayed areas for both host species. However, there was little backfeeding present in the sprayed area compared to heavy backfeeding in the unsprayed area.

Infestation Forecasts for 1973

In 1972, approximately 13 million acres were moderately to severely damaged in northeastern Ontario. This included a sizeable area of heavy frost damage to 1972 shoots on fir and to a lesser degree on white spruce within the general budworm outbreak area which now extends from Lake Superior Provincial Park in the west, in a broad band extending eastward through Chapleau District to the Quebec border. Other noticeable changes in 1972 were, a further expansion of the outbreak to the south in the Sault Ste. Marie District, the first appearance of defoliation on Manitoulin and Cockburn islands, new infestations in the southwestern part of the Sudbury District in the vicinity of Espanola, enlargement of other infestations in the western part of Sudbury District and in Swastika District and the appearance of new, small infestations in North Bay District. The greatest enlargement of the outbreak occurred where the Chapleau infestation merged with the Onaping outbreak.

Despite high egg-mass counts throughout all areas described, forecasts for 1973 must be treated with caution. Population collapses could possibly occur in the heart of the Chapleau outbreak where the effects of frost were particularly severe, depending on the amount of new foliage produced by host trees in 1973 and on the amount of balsam fir tree mortality. In any case, the outbreak will likely continue to expand into adjacent susceptible stands on the outer edges particularly to the south and east.

Proposed Aerial Spraying Operations for 1973

If the policy to minimize defoliation and to prevent mortality in the highly susceptible and highly valued areas of provincial parks in northeastern Ontario is to be maintained, spraying in the following parks will be considered: Missinaibi, Shoals, Lake Superior, Ivanhoe, Wakami and 5-Mile.

This could amount to as much as 50,000 - 60,000 acres if current budworm management plans, particularly for Lake Superior Park, are adhered to.

SOUTHEASTERN ONTARIO

1972 Operations

There were no provincial spraying operations in southeastern Ontario in 1972. Aerial spraying to protect white spruce plantations and high value research stands at the Petawawa Forest Experiment Station was carried out by the Canadian Forestry Service. A brief summary of the results of this operation is presented in a separate report pertaining to research.

Infestation Forecasts for 1973

The outbreak in southeastern Ontario expanded to approximately 6.5 million acres in 1972. Major extensions occurred in westerly and southerly directions in the Pembroke District and northern parts of Tweed and Lindsay districts.

It is expected that budworm populations will remain high in 1973 and that modest extensions may occur in a southerly or southeasterly direction into adjacent susceptible stands. A further westward extension towards the Parry Sound District is currently not expected because of a broad belt of hardwood forest that intervenes.

Proposed Aerial Spraying Operations for 1973

Based on high egg-mass counts and unusually severe defoliation over the past two years, spraying will be considered in parts of Algonquin Provincial Park, particularly along Highway 60. The question of spraying in this area raises many issues, but if plans do proceed, spraying is not likely to exceed 3-4,000 acres.

Report prepared for the Interdepartmental Committee on Forest Spraying Operations

November 22, 1972

EXPERIMENTAL SPRAYING OF SPRUCE BUDWORM ADULTS IN 1972

In the search for a technique to significantly reduce budworm abundance and to influence the course of an infestation, Forest Protection Limited proposed spraying of adult budworms. In 1969, Forest Protection Limited conducted an *ad hoc* adult spray trial in the vicinity of Trouser and Long Lakes in north-central New Brunswick which showed that a significant reduction in the infestation could be achieved with the poison Phosphamidon. In 1972, two areas of about 8,000 acres each in the Miramichi valley near Upper Blackville were selected for treatment. Each area received two applications of poison each consisting of 2 oz. of poison in 0.15 U.S. gal. of formulation per acre. The organophosphate poisons Phosphamidon and Fenitrothion were tested. Phosphamidon was formulated in solution with water and Fenitrothion was formulated as an emulsion. Application was made with a team of four Stearman aircraft equipped with Minonair nozzles.

The tests were monitored by a team from the Department of The Environment: C.F.S. - Kettela, Varty, Greenbank; E.P.S. - Hall, Banks; and C.W.S. - Pearce.

Spraying started on 11 July (pm) and ended on 16 July (pm). At the start of spraying, emergence of adults was males 100%, females 80%. Of the C.F.S. team, Kettela investigated mortality of budworm and effect on egg-mass infestations, Greenbank looked at adult behavior in the treated area, and Varty investigated the side-effects on non-target arthropods.

Mortality of budworms was determined from drop cloths at 10 plots in each spray block and from 12 unsprayed plots. Effect of spraying

on egg-mass infestations was determined by an intensive survey for egg-masses in sprayed and unsprayed areas.

The basic results of these two trials are as follows:

(1) Phosphamidon is superior to Fenitrothion both in killing budworm moths and preventing the laying of eggs (Table 1, Fig. 1). This was not a surprise as similar results in mortality were obtained in laboratory trials conducted during the winter of 1971-72.

(2) The first treatment in the Phosphamidon block was applied in the morning. The results from this block suggest that spraying can be done whenever there is good weather during the early adult period and should not be limited to evening spraying.

(3) Greenbank's data on behavior patterns and abundance of active moths following spraying in the Phosphamidon block indicates that most of the effect on the moths was achieved by the first application. This means that it may be possible to achieve the desired results with one application.

(4) Undoubtedly some egg-masses were laid before spraying, but Greenbank's information indicates that the area was invaded by females from unsprayed areas.

(5) Varty's studies show that both Phosphamidon and Fenitrothion killed parasitic and predatory insects in large numbers. The full impact of this finding will be checked in the spring of 1973.

The 1972 trials were successful enough to warrant a further series of trials in 1973. Any future trials, however, should be large enough to minimize the problems of invasion from untreated areas. A screening program to select potentially economic adulticides that are less harmful to predatory and parasitic types of arthropods should be established.

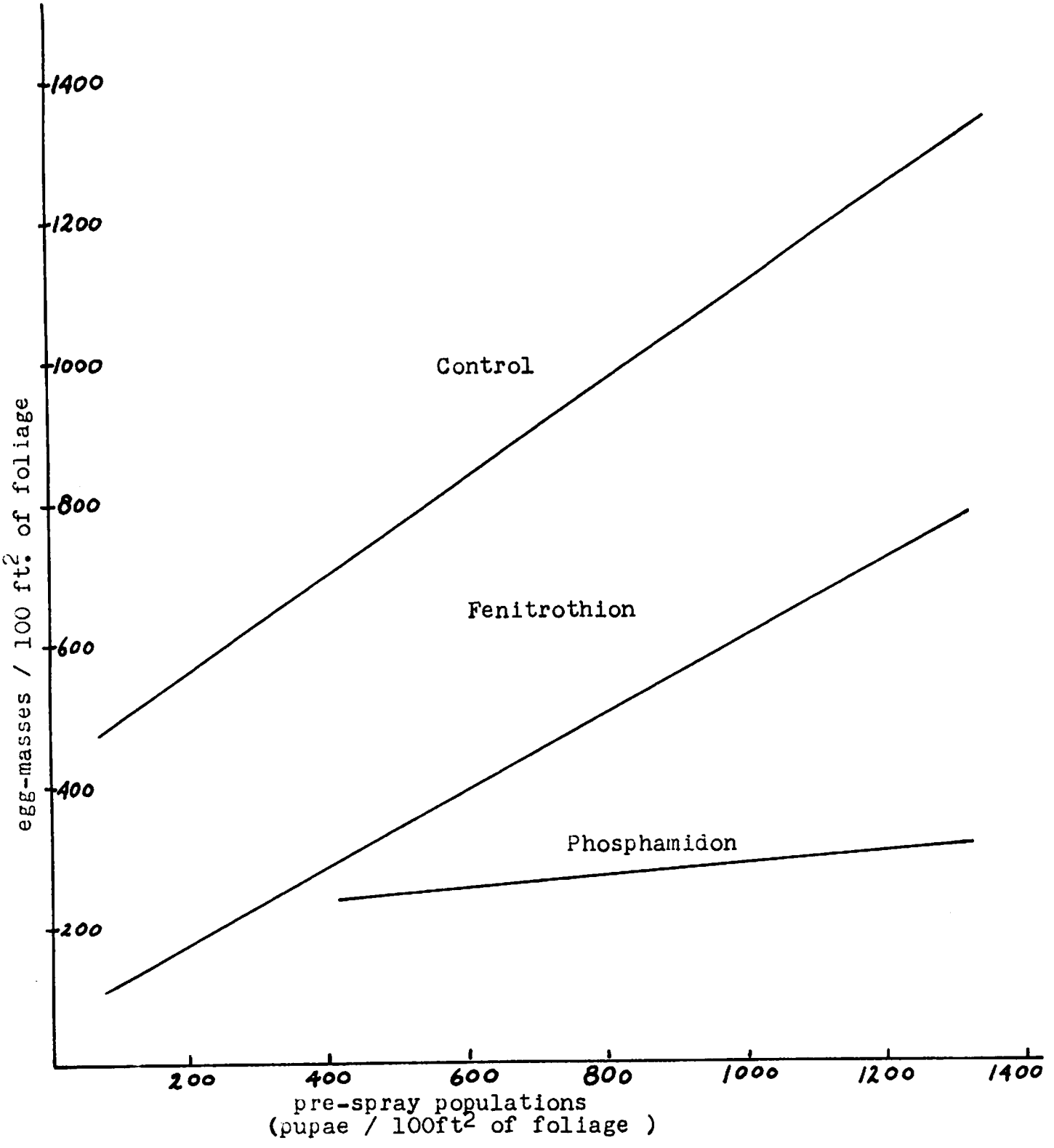
E. G. Kettela
December 1972

Table 1. Effect of spraying adult budworm and egg-mass populations

Treatment[a]	Adults/acre before spraying	Dead adults/ acre after spraying	% mortality due to spraying	Egg-mass/100 ft^2	
				Fir	Spruce
Phosphamidon	444,000	442,000	95	293	315
Fenitrothion	290,000	127,000	36	316	338
Control	214,000	22,000		683	550

a. Two applications of poison each of 2 oz. in 0.15 gal. (U.S.) of formulation.

Figure 1. The relationship between pupae and egg-masses in sprayed and control plots.



Effects on birds of fenitrothion and phosphamidon used as adulticides against spruce budworm in N. B.

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

For Interdepartmental Committee on Forest Spraying Operations
December 1972

Introduction

Operations to protect the forest against spruce budworm have been conducted in New Brunswick for two decades. Currently available evidence indicates that insecticides probably will continue to be used for many more years. Three chemicals have to date been operationally employed namely DDT, phosphamidon and fenitrothion. Application techniques have remained essentially unchanged since initiation of the program in 1952.

In 1972 a conceptually different approach to the use of insecticides was investigated by the Canadian Forestry Service and Forest Protection Limited. Two areas were experimentally sprayed with fenitrothion and phosphamidon at a time when adult budworm had emerged from pupation.

Post-spray searches conducted to determine whether birds were adversely affected by the spray are reported here.

Location of spray blocks and timing of sprays

The locations of the fenitrothion and phosphamidon spray blocks and the timing of the sprays are shown in Figures 1 and 2. Neither area had been sprayed in 1972 for budworm larva control. Sprays were intended to be made at the time of maximum moth activity before, for obvious reasons, eggs had been laid. Application during the evening, as opposed to the morning, was considered likely to be more effective. It was hoped that the interval between the two applications on a given block would not be more

than one day. In the event, theoretically optimum timing was not achieved because of excessive wind and temperature.

Spray application

Two applications of fenitrothion, as an emulsion, were made at an emitted dosage of 2 oz active ingredient in 0.15 US gallons formulation per acre. On a second block two applications of phosphamidon, in water solution, were made at an emitted dosage of 2 oz active ingredient in 0.15 US gallons formulation per acre. Sprays were delivered by a team of four Stearman aircraft fitted with "micronair" devices to achieve a theoretical mass median spray droplet diameter of 50 microns.

Monitoring

No bird censuses were conducted in the spray zones. Monitoring consisted only of post-spray searches for bird casualties. Eastern parts of the fenitrothion block were searched by one observer from 0730 to 1100 on July 12. A count of 23 songs per minute was made during the first hour. The phosphamidon block was searched from 1300 to 1630 on that day. The eastern third of the fenitrothion block was searched from 1730 to 1100 on July 13. A count of 20 songs per minute was made during the first hour. The northern third of the phosphamidon block was searched from 0720 to 1115 on July 15. A count of 20 songs per minute was obtained during the first hour of that search. No bird carcasses were found in either of the spray blocks. No symptoms indicating acute poisoning of birds were detected in

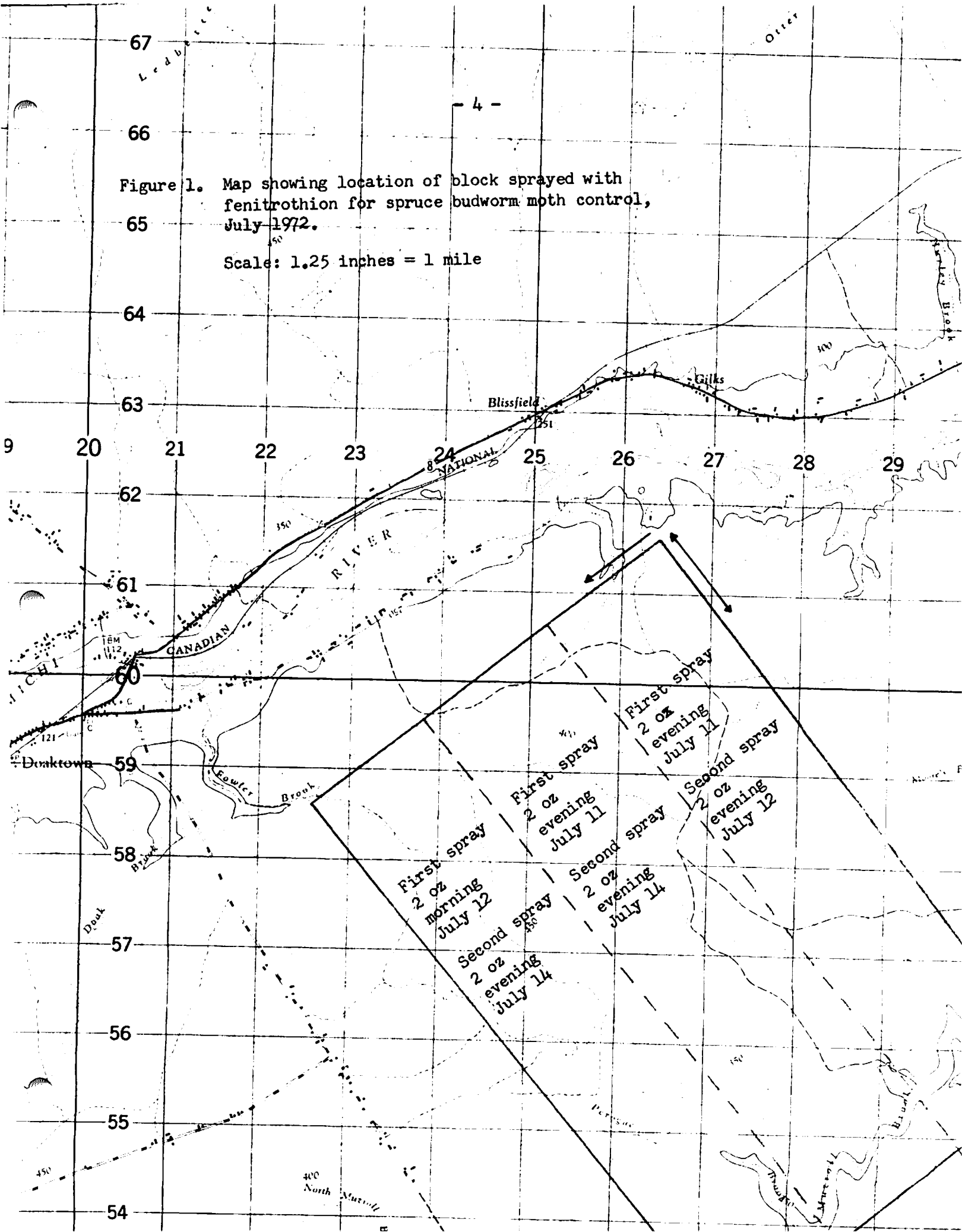
either block. Song counts appeared to be rather high for that time of year. There was abundant evidence of budworm moth knock-down after each spray application in both blocks. Birds were frequently seen carrying food which did not appear to be budworm. No birds were seen to pick up moribund or dead moths from the ground. Time did not permit the finding of many nests but the frequency of alarm calls by adult birds indicated the presence of many young of many species. Tadpoles remained active in roadside ditches in both blocks after both sprays.

Discussion

Adult birds did not appear to be adversely affected by the sprays. This is in general agreement with previous experience with both phosphamidon and fenitrothion at the low application rates used. In July, bird populations are temporarily swelled by considerable numbers of nestlings and fledglings which may be more vulnerable to the spray. It has not in the past been possible adequately to determine the importance of secondary poisoning to the survival of young birds. Should large-scale spraying in July prove to be logistically feasible and biologically desirable (in the forest protection sense) an opportunity to make such an assessment could present itself, since nests are more easily found then than in late May and in June when spraying normally takes place in New Brunswick.

Figure 1. Map showing location of block sprayed with fenitrothion for spruce budworm moth control, July 1972.

Scale: 1.25 inches = 1 mile



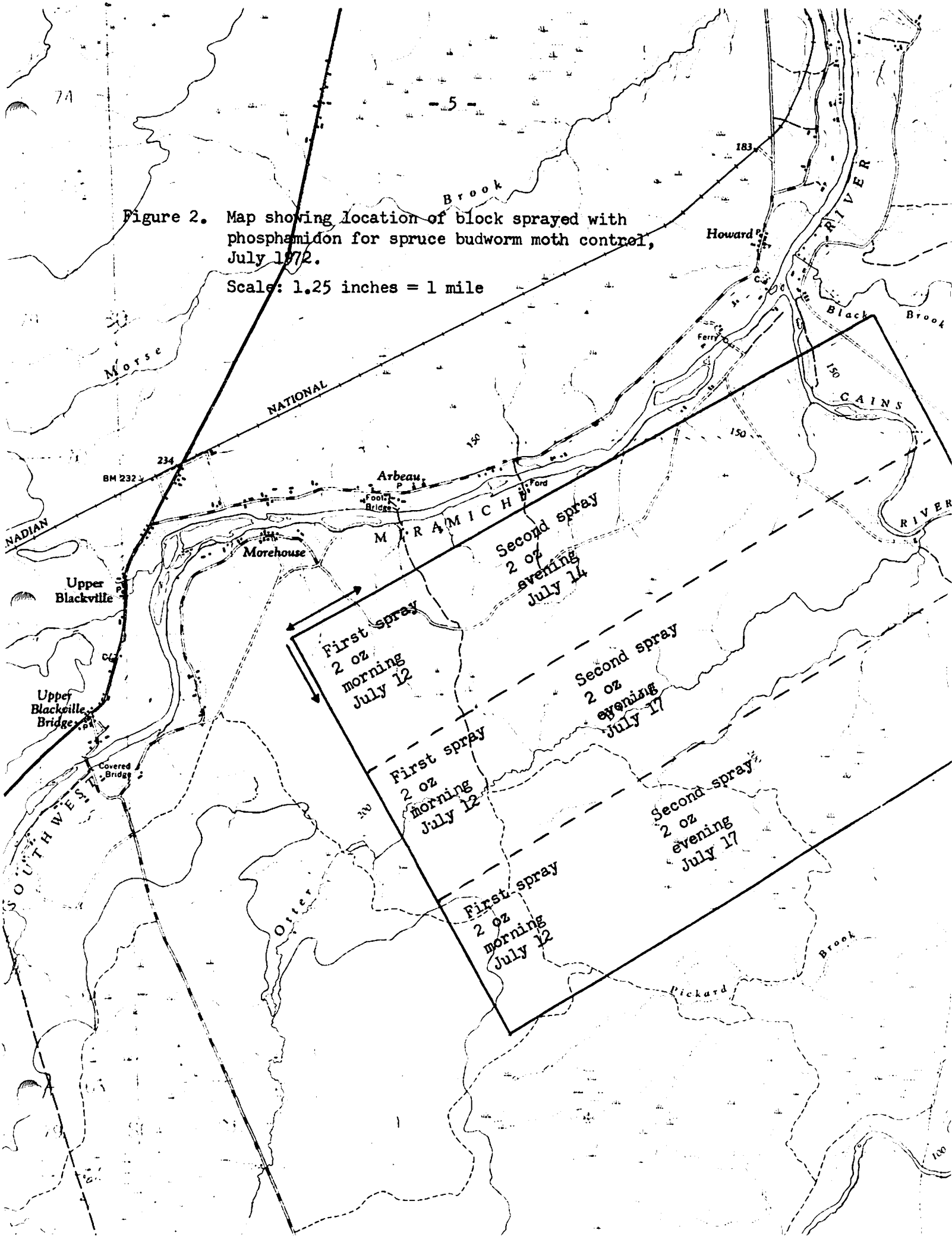


Figure 2. Map showing location of block sprayed with phosphamidon for spruce budworm moth control, July 1972.

Scale: 1.25 inches = 1 mile

AERIAL SPRAYING OF A *BACILLUS THURINGIENSIS* - CHITINASE FORMULATION FOR THE CONTROL OF SPRUCE BUDWORM

Work conducted with the cooperation of:

Laurentian Forest Research Centre,
Canadian Forestry Service,
Department of the Environment
Ste. Foy, Quebec.

Chemical Control Research Institute,
Canadian Forestry Service,
Department of the Environment,
Ottawa, Ontario.

Conservation Branch,
Department of Lands and Forests,
Quebec.

SUMMARY:

1) A 10,000 acre forest of mature balsam fir containing approximately 15 cords of pulpwood per acre was chosen in the Temiscouata county for the experiment.

2) This forest was severely infested by *Choristoneura fumiferana* for the third consecutive year. The budworm population was in an excellent *physiological* state. Microscopic analyses showed no infection by microsporidia, virus or other microorganisms. Populations averaged 21 larvae per 18" branch.

3) Aerial spraying was carried out between June 4-7, 1972. Insect development during that period was: 2nd instar, 5.2%; 3rd, 75.5%; 4th, 18.6% and 5th, 0.7%.

4) Spraying was performed with 3 TBM (Avenger) aircrafts having each a capacity of 625 gallons and equipped with a conventional boom and nozzle system; guidance was provided by 2 Cesna pointer planes. A total of 20,000 gallons was applied (2 gals/acre)

5) B.t. formulation was:

Thuricide HPC concentrate	0.5 gal (US)
Polyglycol 400	0.5 gal (US)
Chevron spray sticker (alkyl polymer)	0.16 oz (US)
Water	1 gal (US)
Chitinase (activity 950 nephelometric units)	10 mg

The chitinase use was obtained by our semi-industrial method. The Chevron sticker was low priced and proved most efficient.

6) Deposit ranged from 0.005 to 1.33 gals/acre with an average of 0.37 gal/acre. The treatment was effective when sprays were above 0.4 gals/acre; only 70% of the forest received this quantity. The average size of droplets was from 80 to 450 um. The average quantity of B.t. colonies on the exposed culture medium was 21 per cm^2. When the quantity of colonies per cm^2 was more than 77, and spray deposit higher than 0.4 gal/acre, larval mortality reached 84 to 93%. Mortality in the control plot was from 39 to 53%.

7) Strong metabolic perturbations occurred in the hemolymph of infected larvae as compared to control larvae. Dehydrogenase activity was greatly reduced (ICDH from 603 to 186 mμ/ml), phosphatase increased (alkaline phosphatase 200 to 450 mμ/ml) while transaminases did not vary. On the other hand the infection provoked a strong decrease in lipid reserves (from 4.8 to 2.7%) and a strong increase in the amount of chloride in hemolymph (36.0 to 100.5 mEq/l).

8) Visual observations showed a 70% foliage protection in B.t. + chitinase treated area while only 10% of the foliage remained in control. Foliage protection determined by a special statistical method was 47% in the treated area and 12% in control. The same method used to determine the efficacy of two treatments with fenitrothion showed a 44% foliage protection.

9) Safety: Laboratory experiments in 1970-71-72 showed that the B.t. + chitinase had no effects on mice and fish. Chitinase is always present in the digestive tract of insectivorous animals (birds, fish, mammals).

This formula has no effect on parasites and predators of C. fumiferana. There were no indications of pollution.

The quantity and size of particles in the air was unchanged.

RECOMMENDATIONS: Use of the B.t. + chitinase is recommended in all areas where the use of chemical insecticides is hazardous.

In the future, gradual replacement of chemical insecticides by this B.t. + chitinase formulation will be possible.

The conventional boom and nozzle system should be replaced on TBM or larger aircrafts by the Micronair system, which permits a 2 to 3 times (100 to 200 mμ) smaller droplets dispersion and a more uniform spray. Use of a larger aircraft (DC7) should be considered.

Sprayed liquid evaporation in the atmosphere should be reduced to minimum by modifying the formulation (particularly the adjuvant) so as to obtain effective deposit above 0.5 gal/acre. Aerosol and cold smoke applications of B.t. should be considered.

Industrial production of chitinase should be undertaken for reducing application cost.

Dr. W.A. Smirnoff
Laurentian Forest Research Centre
Canadian Forestry Service
Ste.Foy, Quebec.

December 7, 1972.

RESULTS OF THE AERIAL APPLICATION OF THURICIDE HPC + CHITINASE OVER 10,000 ACRES

OF SPRUCE BUDWORM INFESTED BALSAM FIR FOREST - TEMISCOUATA 1972

	% larval mortality		% foliage protected	Weight and length of larvae				Metabolic perturbations			
				6/15/72		6/22/72		Enzyme activities		Chloride	Total lipids
				W (mg)	L (mm)	W (mg)	L (mm)	Dehydrogenase mU/ml	Phosphatase mU/ml	mEq/l	% Wet organism
Sprayed area 0.0045 - 1.3237 GPA	70% of the area 0.4037-1.3237 GPA	30% of the area 0.0045-.3477 GPA									
	88.2 (84-93)	64.0 (51-76)	70	5.4	6.5	17.6	10.2	186.0	490.0	100.5	2.70
Controls	48.5 (39-53)		10	7.3	6.9	47.6	13.9	603.0	200.0	36.0	4.80

10

Revised version

Spruce Budworm Aerial Spraying Operations Ontario, 1972

Research 1972 and Proposed 1973

by

G. M. Howse and W. L. Sippell
Canadian Forestry Service
Great Lakes Forest Research Centre, Sault Ste. Marie

INTRODUCTION

During 1972, the Great Lakes Forest Research Centre cooperated with the Chemical Control Research Institute and the Insect Pathology Research Institute in four studies involving the aerial application of chemicals and viruses against spruce budworm in Ontario. The GLFRC involvement was, basically, to make population reduction and damage assessments similar to those used to evaluate operational trials and operational spraying carried out in Ontario over 4 previous years. It should be stressed, however, that the methods employed simply constitute one way of measuring the effectiveness of a particular treatment. Most of the trials will also be assessed, and reported on, by other individuals using different evaluation techniques.

The following is a brief outline of the results obtained, based for the most part on incomplete analyses. Detail has been omitted in the interest of brevity. Complete and detailed reports will eventually be issued.

A. PETAWAWA FOREST EXPERIMENT STATION - Protection of Forest Research Plots

Spraying, for the purpose of protecting white spruce research plantations and high-value natural stands, had been carried out at PFES by GLFRC with technical advice provided by CCRI in 1970 and 1971. The results demonstrated clearly a previously unrecognized problem in obtaining adequate protection of white spruce using the conventional equipment and dosage that have proven successful in Ontario and elsewhere against the spruce budworm on balsam fir. It was proposed jointly that in 1972 the Chemical Control Research Institute attempt to resolve this problem of protecting spruce by applying more highly developed application techniques (Micronairs) to obtain finer spray break-up (for operational details, refer to report by J.A. Armstrong, CCRI). GLFRC was responsible for timing the spray applications and assessing the results.

Budworm emergence started on May 11. Pre- and post-emergence counts confirmed the presence of high larval populations throughout the station. Spraying started on the morning of May 26 on which date the budworm were primarily fourth instar on white spruce and 40% thirds and 60% fourths on balsam fir.

Pre-spray larval counts were made from branch samples collected from the mid-crowns of trees throughout the various white spruce plantations and from balsam fir in the natural stands. Final post-spray counts were made during the pupal stage in the same locations as the pre-spray counts and the degree of defoliation of each sample branch was estimated.

In general, the data showed that good results were obtained for the sprayed balsam fir in natural stands. The overall population reduction was at least 65% (attributable to spraying) and the average degree of defoliation was limited to 20% compared to 70% in the controls. In the white spruce plantations, an overall population reduction of about 50% was achieved with an average degree of defoliation of 50% compared to 90% in the controls. These results are from 9 oz. fenitrothion per acre applied in three applications of 3 oz. each, using a Stearman equipped with Micronairs.

An aerial survey of the station made on June 27 by experienced observers revealed that many of the treated white spruce plantations showed light to moderate defoliation with streaks and/or patches of heavy to severe defoliation. By comparison the natural stands with a high balsam fir content that were sprayed appeared green, or at most, suffered light defoliation. The white spruce trees within these areas, particularly along roads, appeared moderately to heavily defoliated.

Although these results represent an improvement over 1970 and 1971, it remains doubtful that the level of protection achieved in the white spruce plantations, is sufficiently satisfactory to prevent either leader and branch tip mortality or increment loss.

Egg-mass counts from throughout the station forecast high levels of spruce budworm larval populations in 1973. Proposals for protecting up to 10,000 acres on the station and for finding ways of improving the degree of protection of the white spruce plantations are being formulated by CCRI and GLFRC, in consultation with PFES.

B. VIRUS-INSECTICIDE TRIALS, 1972 - Rankin

During 1972, nuclear polyhedrosis (NPV) and entomopox virus were applied, in combination with a low dosage of fenitrothion, to natural stands near Pembroke containing balsam fir and white spruce. The project was a cooperative one involving CCRI, GLFRC and IPRI. The GLFRC involvement was to provide larval development information for timing the spray applications and to determine the population reduction and reduced degree of defoliation due to each treatment. For operational details and other assessments of the operation, refer to reports by O.N. Morris of CCRI and J.C. Cunningham of IPRI.

Sprays were applied May 28 and 29. On these dates, the budworms were primarily in fourth instar on both host trees although some fifth instars were present on white spruce.

Highlights of the GLFRC assessment work from preliminary analyses (at time of writing) are as follows: The NPV + fenitrothion was the most effective treatment with population reductions of 80-85% being achieved for both balsam fir and white spruce. This treatment also resulted in the saving of foliage, i.e. treated white spruce and balsam fir showed 45% and 15% defoliation respectively compared to 75-80% defoliation of both species in the untreated controls. NPV alone also effected a high population reduction on white spruce (about 85%) but was much lower on balsam fir. Entomopox virus + fenitrothion seemed effective in saving foliage when compared to the controls, i.e. 50% defoliation for treated white spruce and 20% for treated balsam fir compared to the 75-80% defoliation of both species in the controls. However, this saving of foliage was not reflected in population reduction figures.

The percentage of successfully emerged pupae (those that gave rise to moths as a % of the total pupae collected) appeared normal for all treatments except the two treatments involving the entomopox virus where successful emergence was considerably lower.

Recommendations for the virus work in 1973 from GLFRC point of view would be to continue the investigation of carry-over effects on subsequent generations.

C. VIRUS CARRY-OVER - Follow-up of 1971 Virus Trials

Areas sprayed with NPV and entomopox virus in 1971 were re-examined in 1972 in a cooperative endeavour between IPRI and GLFRC, see report by J.C. Cunningham (IPRI) for results of infectivity studies. GLFRC assessed the population reductions and the degree of foliage protection attributable to virus carry-over, and provided sufficient numbers of insects for diagnosis by IPRI.

In 1971, two white spruce plantations on the Deluthier Rd. (PFES) were sprayed with high dosages of NPV using a helicopter. One plantation was sprayed during second instar (Plot G) and the other plantation was sprayed during fourth instar (Plot H). Other sprays of entomopox virus were applied at Achray in Algonquin Park. The immediate results were reported at the 1971 meeting of this committee.

The areas sprayed in 1971 were heavily reinfested by budworm moth influx and early larval counts in 1972 confirmed the presence of high population densities at both Deluthier and Achray. Based on preliminary analyses the average population reduction on white spruce was 65% in plots A, B and C at Achray and H at Deluthier and 48% on balsam fir in plots A, B and C at Achray. The average defoliation in the white spruce follow-up plots was

only 37% compared to 80% in the controls and 43% on balsam fir in follow-up plots compared to 73% in the controls. NPV was essentially the only virus found (by IPRI diagnosis procedures) in this carry-over work. This would be expected at Deluthier since NPV was sprayed there but not at Achray where entomopox virus slightly contaminated with NPV and CPV was applied. NPV was also found by IPRI in insects collected from Plot G (early spray) although GLFRC could not demonstrate any population reduction in this plantation.

An aerial survey, during which photographs were obtained, showed a difference in the degree of defoliation between the two white spruce plantations G & H. Defoliation percentages for G were about 80% (white spruce) and 30% or less for H (white spruce).

It is concluded that NPV is capable of persisting in the forest environment for at least one year and that NPV possesses the capability of effecting a measure of protection against the sprayed-plus-one generation, i.e. in the first year of carry-over. Also, it would appear that minute amounts of NPV, in this case as a contaminant of the entomopox virus sprayed at Achray, can be carried over in appreciable amounts as shown in 1972 by the pronounced effect on budworm populations on both host tree species.

It is recommended that these 1971 sprayed areas be re-examined in 1973 by IPRI and GLFRC for virus incidence and effectiveness. 1972 egg-mass counts for these plots forecast high populations again in 1973.

D. CHAPLEAU VIRUS TRIALS, 1972

In 1972, IPRI conducted an extensive series of aerial spray applications of virus near Chapleau. GLFRC, with the concurrence of IPRI, decided to evaluate two of the several trials from the standpoint of population reduction and defoliation differences. Unfortunately, a late spring frost following budworm emergence seriously interfered with the GLFRC assessments. This factor (frost) cast considerable doubt on the validity of our survival data, yet all of the work may not be useless, if certain assumptions can be made. This study has received a lower priority and analyses have not been completed at this time.

It is hoped that the areas sprayed with virus near Chapleau in 1972 can be studied in 1973 in a collaborative effort by IPRI and GLFRC to ascertain carry-over effects.

Statement prepared for the Interdepartmental Committee on Forest Spraying Operations

November 27, 1972

Original version

Spruce Budworm Aerial Spraying Operations Ontario, 1972

Research 1972 and Proposed 1973

by

G. M. Howse and W. L. Sippell
Canadian Forestry Service
Great Lakes Forest Research Centre, Sault Ste. Marie

INTRODUCTION

During 1972, the Great Lakes Forest Research Centre cooperated with the Chemical Control Research Institute and the Insect Pathology Research Institute in four studies involving the aerial application of chemicals and viruses against spruce budworm in Ontario. The GLFRC involvement was, basically, to make population reduction and damage assessments similar to those used to evaluate operational trials and operational spraying carried out in Ontario over 4 previous years. It should be stressed, however, that the methods employed simply constitute one way of measuring the effectiveness of a particular treatment. Most of the trials will also be assessed, and reported on, by other individuals using different evaluation techniques.

The following is a brief outline of the results obtained, based for the most part on incomplete analyses. Detail has been omitted in the interest of brevity. Complete and detailed reports will eventually be issued.

A. PETAWAWA FOREST EXPERIMENT STATION - Protection of Forest Research Plots

Spraying, for the purpose of protecting white spruce research plantations and high-value natural stands, had been carried out at PFES by GLFRC with technical advice provided by CCRI in 1970 and 1971. The results were not satisfactory, particularly in the case of the white spruce plantations, and consequently it was agreed within the CFS that operations at PFES in 1972 would be conducted by CCRI using improved application techniques over earlier years (for operational details, refer to report by J.A. Armstrong, CCRI). GLFRC was responsible for timing the spray applications and assessing the results.

Budworm emergence started on May 11. Pre- and post-emergence counts confirmed the presence of high larval populations throughout the station. Spraying started on the morning of May 26 on which date the budworm were primarily fourth instar on white spruce and 40% thirds and 60% fourths on balsam fir.

Pre-spray larval counts were made from branch samples collected from the mid-crowns of trees throughout the various white spruce plantations and from balsam fir in the natural stands. Final post-spray counts were made during the pupal stage in the same locations as the pre-spray counts and the degree of defoliation of each sample branch was estimated.

In general, the data showed that good results were obtained for the sprayed balsam fir in natural stands. The overall population reduction was at least 65% (attributable to spraying) and the average degree of defoliation was limited to 20% compared to 70% in the controls. In the white spruce plantations, an overall population reduction of about 50% was achieved with an average degree of defoliation of 50% compared to 90% in the controls applied in three applications of 3 oz. each, using a Stearman equipped with Micronairs.

An aerial survey of the station made on June 27 by experienced observers revealed that many of the treated white spruce plantations showed light to moderate defoliation with streaks and/or patches of heavy to severe defoliation. By comparison the natural stands with a high balsam fir content that were sprayed appeared green, or at most, suffered light defoliation. The white spruce trees within these areas, particularly along roads, appeared moderately to heavily defoliated.

Although these results represent an improvement over 1970 and 1971, it remains doubtful that the level of protection achieved in the white spruce plantations, is sufficiently satisfactory to prevent either leader and branch tip mortality or increment loss.

Egg-mass counts from throughout the station forecast high levels of spruce budworm larval populations in 1973. Proposals for protecting up to 10,000 acres on the station and for finding ways of improving the degree of protection of the white spruce plantations are being formulated by CCRI and GLFRC, in consultation with PFES.

B. VIRUS-INSECTICIDE TRIALS, 1972 - Rankin

During 1972, nuclear polyhedrosis (NPV) and entomopox viruses were applied by an aircraft to natural stands near Pembroke containing balsam fir and white spruce in combination with a low dosage of fenitrothion. The project was a cooperative one involving CCRI, GLFRC and IPRI. The GLFRC involvement was to provide larval development information for timing the spray applications and to determine the population reduction and reduced degree of defoliation due to each treatment. For operational details and other assessments of the operation, refer to reports by O.N. Morris of CCRI and J.C. Cunningham of IPRI.

Sprays were applied May 28 and 29. On these dates, the budworms were primarily in fourth instar on both host trees although some fifth instars were present on white spruce.

Highlights of the GLFRC assessment work from preliminary analyses (at time of writing) are as follows: The NPV + fenitrothion was the most effective treatment with population reductions of 80-85% being achieved for both balsam fir and white spruce. This treatment also resulted in the saving of foliage, i.e. treated white spruce and balsam fir showed 45% and 15% defoliation respectively compared to 75-80% defoliation of both species in the untreated controls. NPV alone also effected a high population reduction on white spruce (about 85%) but was much lower on balsam fir. Entomopox virus + fenitrothion seemed effective in saving foliage when compared to the controls, i.e. 50% defoliation for treated white spruce and 20% for treated balsam fir compared to the 75-80% defoliation of both species in the controls. However, this saving of foliage was not reflected in population reduction figures.

The percentage of successfully emerged pupae (those that gave rise to moths as a % of the total pupae collected) appeared normal for all treatments except the two treatments involving the entomopox virus where successful emergence was considerably lower.

Recommendations for the virus work in 1973 from GLFRC point of view would be to continue the investigation of carry-over effects on subsequent generations.

C. VIRUS CARRY-OVER - Follow-up of 1971 Virus Trials

Areas sprayed with NPV and entomopox virus in 1971 were re-examined in 1972 in a cooperative endeavour between IPRI and GLFRC, see report by J.C. Cunningham (IPRI) for results of infectivity studies. GLFRC assessed the population reductions and the degree of foliage protection attributable to virus carry-over, and provided sufficient numbers of insects for diagnosis by IPRI.

In 1971, two white spruce plantations on the Deluthier Rd. (PFES) were sprayed with high dosages of NPV using a helicopter. One plantation was sprayed during second instar (Plot G) and the other plantation was sprayed during fourth instar (Plot H). Other sprays of entomopox virus were applied at Achray in Algonquin Park. The immediate results were reported at the 1971 meeting of this committee.

The areas sprayed in 1971 were heavily reinfested by budworm moth influx and early larval counts in 1972 confirmed the presence of high population densities at both Deluthier and Achray. Based on preliminary analyses the average population reduction on white spruce was 65% in plots A, B and C at Achray and H at Deluthier and 48% on balsam fir in plots A, B and C at Achray. The average defoliation in the white spruce follow-up plots was

only 37% compared to 80% in the controls and 43% on balsam fir in follow-up plots compared to 73% in the controls. NPV was essentially the only virus found (by IPRI diagnosis procedures) in this carry-over work. This would be expected at Deluthier since NPV was sprayed there but not at Achray where entomopox virus slightly contaminated with NPV and CPV was applied. NPV was also found by IPRI in insects collected from Plot G (early spray) although GLFRC could not demonstrate any population reduction in this plantation.

An aerial survey, during which photographs were obtained, showed a difference in the degree of defoliation between the two white spruce plantations G & H. Defoliation percentages for G were about 80% (white spruce) and 30% or less for H (white spruce).

It is concluded that NPV is capable of persisting in the forest environment for at least one year and that NPV possesses the capability of effecting a measure of protection against the sprayed-plus-one generation, i.e. in the first year of carry-over. Also, it would appear that minute amounts of NPV, in this case as a contaminant of the entomopox virus sprayed at Achray, can be carried over in appreciable amounts as shown in 1972 by the pronounced effect on budworm populations on both host tree species.

It is recommended that these 1971 sprayed areas be re-examined in 1973 by IPRI and GLFRC for virus incidence and effectiveness. 1972 egg-mass counts for these plots forecast high populations again in 1973.

D. CHAPLEAU VIRUS TRIALS, 1972

In 1972, IPRI conducted an extensive series of aerial spray applications of virus near Chapleau. GLFRC, with the concurrence of IPRI, decided to evaluate two of the several trials from the standpoint of population reduction and defoliation differences. Unfortunately, a late spring frost following budworm emergence seriously interfered with the GLFRC assessments. This factor (frost) cast considerable doubt on the validity of our survival data, yet all of the work may not be useless, if certain assumptions can be made. This study has received a lower priority and analyses have not been completed at this time.

It is hoped that the areas sprayed with virus near Chapleau in 1972 can be studied in 1973 in a collaborative effort by IPRI and GLFRC to ascertain carry-over effects.

Statement prepared for the Interdepartmental Committee on Forest Spraying Operations

November 27, 1972

Interdepartmental
Committee

INSECT PATHOLOGY RESEARCH INSTITUTE

Summary of trials with biological insecticides 1972

By J. M. Cameron

Viruses

Preliminary trials in 1971 with aerial application of nuclear polyhedrosis (NPV) and entomopox viruses against the spruce budworm yielded encouraging results. It was therefore decided to attempt a series of tests in 1972 that would more nearly approach an operational spray, and to compare some formulations and rates of application. A suitable area near Chapleau was chosen, and plots totalling three square miles were laid out. Use of a Grumman Agcat biplane fitted with four Micronaire units was contracted. Based on 1971 results a dosage of approximately 4×10^{10} (forty billion) inclusion bodies per acre was selected as being reasonable for testing. This is the amount of virus in 10 grams of virus-killed sixth instar larvae, about 800 individuals for the nuclear polyhedrosis virus and about 500 individuals for the poxvirus. Details of the plots, treatments and results are shown in Table I. Distribution of spray was monitored by the standard Krome Kote cards, and an excellent deposit was obtained.

Spraying began on May 18th when all larvae were in the needle-mining second instar. The poxvirus was applied first as it develops more slowly, and the plots were all treated by May 23rd. All NPV plots were sprayed May 24th. At this time 17% of the larvae were still in the second instar and 83% in the third instar. The weather was unusually warm (75-85°F) throughout the spray period, and evening humidity was quite low until after dark.

On June 1st the temperature dropped, and reached about 26°F, accompanied by a snowfall of 4 to 6 inches. As a result practically all the buds and current year's growth on both the balsam fir and the white spruce were killed, and there was heavy mortality (estimated as high as 70%) among the budworm larvae. It was difficult to collect enough larvae to constitute a reliable sample for diagnosis of infection, and the results in Table I must be taken as indicative rather than absolute.

Table I suggests the following conclusions:-

1. The budworm population in the Chapleau area has a low natural infection by cytoplasmic polyhedrosis virus (CPV).

2. The additives did not improve the effectiveness of the ento-

mopoxvirus, and may actually have reduced it somewhat.

3. The rate of application (1vs.2 gal/acre) had no apparent effect.

4. More infection occurred on white spruce than on balsam fir.

The plots will be examined again in 1973 to assess any carryover effect.

The plots near Pembroke that were sprayed with viruses in 1971 were examined in 1972. The rates of application had been much heavier than was used in this year's spray - 30 gm/acre for the entomopoxvirus and 75 gm/acre for the NPV. In both cases there was some contamination of the virus material by CPV. The results of both 1971 and 1972 examinations are presented together in Table II, for comparison and to show the carryover effect.

Examination of Table II suggests that NPV persists in a treated area over at least one winter, and the incidence may actually increase in the second season. The entomopoxvirus declines almost to the point of disappearance.

These results from two year's work, despite the complication of bad weather in 1972, encourage the continuation of the research program and plans are being made for additional test spraying in 1973. Accumulation of information from an additional year of testing should give a fairly clear indication whether the results are valid. It does appear that, contrary to earlier expectations, the NPV is more likely than the entomopoxvirus to be of immediate value.

Bacillus thuringiensis preparations

Insecticide formulations based on the bacterium Bacillus thuringiensis are now being produced and marketed by several companies. Two brands, Dipel wettable powder and Thuricide liquid concentrate, were tested against the spruce budworm on three 160-acre plots in the Chapleau area. The same aircraft was used and the spraying was done on May 28th, following completion of the virus sprays, when the larvae were about half third and half fourth instar. The application rate was one gallon per acre, and the concentration was constant at a nominal 4×10^{10} (four billion) international units per acre. (The international unit is an arbitrary quantity determined by a standard bioassay procedure and now used by all workers doing comparative studies of bacterial insecticides). Various additives were used to assess their value in overcoming the difficulty of obtaining proper coverage of and sticking to conifer foliage by a water spray. Again the frost damage prevented a proper assessment

especially of foliage protection, but enough larvae survived in the untreated area to permit an estimate of population reduction due to the sprays. Sampling was done at two periods following spraying. The treatments and results are shown in Table III.

It appears that good control was achieved by all treatments. Population reduction due to weather was such that the results are indicative rather than absolute, but they suggest that there is a continuing effect over a considerable period, especially on white spruce. However, the B.t. preparations appear to be more effective on fir than on spruce. The rate of application used appears to be adequate. Further studies will be directed to reducing the dosages and improving the formulation to bring it into a more economically competitive range.

Table I

Details of virus sprays against spruce budworm, Chapleau, Ontario, 1972.

Plot	Size Acres	Treatment	Concentration of virus (gm/gal)	Rate of application (gal./acre)	Results		
					Tree species	Percent virus infection Entomopoxvirus	CPV
P	640	Entomopox virus I*	5	2	Ws	20	2
					Bf	4	1
Q	420	Entomopox virus II**	5	2	Ws	2	0
					Bf	2	0
R	210	Entomopox virus II**	10	1	Ws	2	0
					Bf	3	0
Control					Ws	0	1
					Bf	0	1
						NPV	CPV
S	420	NPV II**	5	2	Ws	22	1
					Bf	13	0
T	210	NPV II**	10	1	Ws	23	1
					Bf	15	0
Control					Ws	0	1
					Bf	0	5

*Virus suspended in water with 2.5% by weight of IMC sunlight protectant

**As in I, but with 10% by volume of molasses and 0.2% by volume of Biofilm added to increase spreading and sticking.

Table II

Virus infection in 1971 and 1972 of budworm in plots near Pembroke, Ontario, sprayed with virus suspension in 1971.

Plot	Virus* applied	Time of application	Tree species	Year of sample	Percent virus infection		
					Entomopoxvirus	NPV	CPV
C	Poxvirus	Early	Ws	1971	38	10	7
				1972	5	19	5
			Bf	1971	9	1	0
					0	7	2
A	Poxvirus	Late	Ws	1971	5	7	1
				1972	0	20	4
			Bf	1971	6	4	0
				1972	0	17	10
G	NPV	Early		1971	-	21	21
				1972	-	30	8
H	NPV	Late		1971	-	41	22
				1972	-	24	3

*The entomopoxvirus preparations were contaminated with both NPV and CPV, and the NPV preparations with CPV. In addition natural infection (less than 5%) with CPV was found in the general area outside the treated plots.

Table III

Details of Bacillus thuringiensis sprays against spruce budworm, Chapleau, Ontario, 1972.

Plot	Formulation in 1 gal spray	Tree species	Results					
			10 days after treatment			33 days after treatment		
			No. of samples	Av. larvae per sample	Percent control	No. of samples	Av. larvae per sample	Percent control
	Untreated	Bf	20	14.05	-	20	4.75	-
		Ws	20	22.45	-	18	9.0	-
1	Thuricide 1 qt. Molasses 1 pt. Nufilm 6 oz.	Bf	40	0.50	96.4	20	0.05	98.9
		Ws	28	7.43	67.0	20	1.75	80.6
2.	Dipel 1/2 lb. Sunlight protectant 3 oz. Biofilm 1.5 g	Bf	40	1.20	91.5	20	0.20	95.8
		Ws	29	9.97	55.7	20	1.25	86.1
3.	Dipel 1/2 lb. C.I.B.* 1 qt.	Bf	40	0.98	93.1	20	0.20	95.8
		Ws	34	10.85	51.8	20	1.80	80.0

*C.I.B. is a propietary formula for mixing with insecticides to improve spreading and sticking characteristics.

THE ENVIRONMENTAL EFFECTS OF INSECTICIDES

(Study Reference No. CC-014)

A REPORT TO THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

By

C. H. BUCKNER

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

November, 1972

THE ENVIRONMENTAL EFFECTS OF INSECTICIDES

By

C. H. BUCKNER

Studies on the impact of chemical and biological insecticides on forest ecosystems continued in 1972, with a concentration of effort on the ecological side effects of fenitrothion. Populations and life history parameters of small forest birds and mammals were examined relative to aerial treatment of forest stands with fenitrothion, zectran, matacil, pox virus, and a nuclear polyhedral virus. Relationships between fenitrothion and domestic bees were also explored.

MONITORING OF OPERATIONAL SPRAYS

Treatments for the express purpose of the suppression of damage by spruce budworm were monitored in New Brunswick, Quebec, and Ontario. In New Brunswick, 22 plots were censused for small birds and mammals under the following categories: controls, early single application (2 oz fenitrothion in oil), early double application (2 oz fenitrothion in oil applied twice), late single application (2 oz fenitrothion in emulsion), late double application (2 oz fenitrothion in emulsion applied twice) and a treatment similar to the previous one but in oil. There were no detectable changes in populations or ecology of birds or mammals that could be attributable to the treatment. In Ontario, a plot was monitored at the Petawawa Forest Experiment Station that received approximately 18 oz fenitrothion in a single dose (see report by J. A. Armstrong). There were no yellow warbler adults and few chipping sparrow adults on the treated plot but there was an abundance of these on the control area. Reproduction failures were noted for most warbler species and the chipping sparrow population in the treated area. On the other hand other species were evident in normal numbers and reproduction of these appeared normal. It is concluded that most open area species were adversely affected whereas those frequenting densily foliated habitats remained unaffected. Populations of adult shrews and juvenile rodents were significantly reduced in the treated area but had returned to normal by mid summer.

In the Maniwaki area of Quebec, populations of small birds and mammals were scrutinized relative to the large block spraying of matacil and zectran. Population and reproduction of both birds and mammals were similar in every respect to those in the untreated control areas, and hence it was concluded that under the conditions of application there were no immediate adverse effects attributed to this treatment.

MONITORING OF VIRUS STUDY PLOTS

In cooperation with F. T. Bird and J. C. Cunningham, Insect Pathology Research Institute, Sault Ste Marie, bird populations were monitored in the pox virus and nuclear polyhedral virus treatment plots in the Chapleau, Ontario, vicinity. Rechecks were also made on bird and mammal populations in Algonquin Park, where pox virus trials were conducted in 1971. No effects of any virus treatment on populations or life history parameters could be detected either in the short- or long-term studies. It is concluded that under the conditions of application, the virus treatments had no detectable effects on small birds and mammals.

INTENSIVE STUDIES ON FENITROTHION

Intensive investigations on the short- and long-term effects of fenitrothion were continued in the Larose Forest. Applications of 4 oz of insecticide per acre were conducted on three study blocks: two applications were ULV, one on a two-square-mile tract, the other was a simulated boom and nozzle application. The effects of these treatments on birds, mammals and domestic bees were observed. Populations of birds and mammals remained unaffected by the treatment, although certain behavioral changes in some of the bird species were detected immediately after the spray. This was particularly noticeable with the yellow warbler complex: activity was greatly reduced after each spray and this gradually returned to normal a week after treatment. Treatments were remarkably uniform and no severe concentrations of insecticide were detected. Probably because of this, there were no records of avian or mammalian mortality attributable to the treatments. Chemical analysis of the persistence of the insecticide in the environment indicated a rapid disappearance in foliage, soil, and water. One month after treatment, the insecticide and its metabolites could not be detected in any of the components monitored.

Studies on domestic bees included observations on sprays only in the vicinity of the hives and on a spray encompassing the entire flight range. Mortality at the hive, pollen production, brood production, flight activity, and hive growth were measured relative to the treatment. Mortality was similar in all cases and was normal five days after treatment. Pollen and brood production were slightly lower on the flight range treatment compared to the hive treatment and the treated hives were slightly less vigorous than the control hives. Weight gains were somewhat greater in the control hives but the differences from the standpoint of apiculture were not important. Residues of the insecticide persisted longer in pollen than in any other component of the environment monitored, but concentrations after fhe first four days could not be considered high. It is concluded that the treatments did not seriously affect domestic bees, although there was slight but inconclusive evidence of slower weight gain in treated hives.

PLANTATION PEST CONTROL RESEARCH, 1972:

(A) WHITE PINE WEEVIL - HYDRAULIC SPRAYER APPLICATIONS
(B) WHITE PINE WEEVIL - AERIAL APPLICATIONS
(C) SPRUCE BUDWORM - MISTBLOWER APPLICATIONS
(D) PINE NEEDLE MIDGE (CONTARINIA N. SP.), A NEW PROBLEM ON SCOTS PINE

(Study Reference No. CC-012)

A REPORT TO THE INTERDEPARTMENTAL COMMITTEE ON

FOREST SPRAYING OPERATIONS

By

R. F. DEBOO

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

November, 1972

PLANTATION PEST CONTROL RESEARCH, 1972:

(A) WHITE PINE WEEVIL - HYDRAULIC SPRAYER APPLICATIONS
(B) WHITE PINE WEEVIL - AERIAL APPLICATIONS
(C) SPRUCE BUDWORM - MISTBLOWER APPLICATIONS
(D) PINE NEEDLE MIDGE (CONTARINIA N. SP.), A NEW PROBLEM ON SCOTS PINE

By

R. F. DEBOO

INTRODUCTION

Experimental applications of insecticides for the control of several important forest plantation pests were made during the period May 7 to July 5 at locations in Ontario and Quebec. The project was designed to:

(1) Evaluate several non-persistent compounds in the field (previously screened in laboratory toxicological tests at CCRI) for updating chemical control recommendations.

(2) Assist both federal and provincial agencies in the solution of spray application problems.

(3) Acquire information for planning and execution of small-scale chemical control operations.

Results of all spray applications during 1972 are briefly summarized in the four sections which follow. Specific details and discussions of results are (or soon will be) available in the reference literature cited at the end of this report.

WHITE PINE WEEVIL - HYDRAULIC SPRAYER APPLICATIONS

Water-based sprays of methoxychlor, Dursban, and Gardona were applied on May 7, alone or in various combinations with the adjuvants Nu-Film-17 and Target E as follow up treatments to those made in 1971 (CFS Information Report CC-X-11). Results (CC-X-24) indicated that either methoxychlor or Gardona applied by hydraulic sprayer at 1.0 lb active ingredient (a.i./acre) will effectively control weevil populations. Higher application rates (1.5, 2.0 lb a.i./acre) and/or the addition of either adjuvant gave 95-100% control. Dursban sprays at 1.0 lb did not provide satisfactory control.

WHITE PINE WEEVIL - AERIAL APPLICATIONS

Aerial applications of methoxychlor at 2.5 lb a.i./acre were designed specifically to determine the nature of operational spray problems in Ontario (Howse and Sippell 1971). Nine treatments (2 gal, 4 gal water/acre; 2 gal, 4 gal No. 2 fuel oil/acre; double applications (each of 1.25 lb a.i. in 2 gal water/acre) - same day and at 6-day intervals; 2 gal water with the adjuvants Fomark, Nu-Film-17, and Target E) were applied during the period May 11 to 20. Results (CC-X-25) indicated that coverage in terms of spray volume/acre rather than insecticide concentration/acre may be the key factor for satisfactory aerial sprays. Oil-based sprays were superior to water, and 4 gal/acre of either spray formulation gave better control than at the 2 gal rate. All adjuvants appeared to enhance applications at 2 gal water/acre, but did not provide levels of leader protection which could be considered satisfactory (e.g. 55-75% control). Double applications also did not provide satisfactory control.

Two options are apparent as a result of this preliminary study: (1) apply methoxychlor in fuel oil at 4 gal/acre, or (2) through continued experimentation, find a new (and environmentally acceptable) more potent compound for application in water sprays at 2 gal/acre.

SPRUCE BUDWORM - MISTBLOWER APPLICATIONS

Six insecticides (carbaryl, dimethoate, Gardona, Imidan, malathion, methomyl) were applied by mistblower as dilute (0.1 to 1.0%) water solutions June 3-7. Results (CC-X-21) indicated that carbaryl at 0.2%, dimethoate at 0.1%, or methomyl at 0.2% will reduce budworm populations by 90-95%. Gardona (0.5%) and Imidan (0.4%) reduced populations by about 80%, while malathion at the highest rate evaluated (1.0%) reduced populations by only 70%. The amounts of insecticides (a.i.) sprayed by mistblower suggested that common low-volume aerial application rates (i.e., 0.1 to 0.5 lb/acre) of certain insecticides may also be suitable for ground sprayers.

PINE NEEDLE MIDGE (*CONTARINIA* N. SP.), A NEW PROBLEM ON SCOTS PINE

Infestations of a defoliating midge, recently designated *Contarinia* n. sp., have cause serious damage to Scots pine Christmas trees and ornamentals in southwestern Quebec and eastern Ontario. The midge appears to be the same as that species which occurred in New Brunswick on red pine about twenty years ago (Reeks and Smith 1956). Preliminary evaluation of spray applications by knapsack mistblower and compressed-air sprayer have shown that malathion (2%) and dimethoate (1%) will prevent defoliation if applied about July 1. Aldicarb (Temik 10G) at approximately 2 lb a.i./acre was effective as a granular treatment.

LITERATURE

DeBoo, R.F., and L.M. Campbell. 1971. Plantation Research: IV. Field evaluation of insecticides for control of white-pine weevil (Pissodes strobi) in Ontario, 1971. Department of the Environment, Canadian Forestry Service Information Report CC-X-11, 22 pp.

———————————— 1972. Plantation Research: V. Mistblower applications of dilute insecticide solutions for control of Choristoneura fumiferana on white spruce in Quebec, 1972. Dept. Environ., Can. For. Serv. Inf. Rept. CC-X-21, 17 pp.

———————————— 1972. Plantation Research: VI. Hydraulic sprayer applications of insecticides for control of white pine weevil (Pissodes strobi) in Ontario, 1972. Dept. Environ., Can. For. Serv. Inf. Rept. CC-X-24, 15 pp.

———————————— 1972. Plantation Research: VII. Experimental aerial applications of methoxychlor for control of white pine weevil (Pissodes strobi) in Ontario, 1972. Dept. Environ., Can. For. Serv. Inf. Rept. CC-X- . (Manuscript in preparation).

———————————— 1972. Plantation Research: VIII. The pine needle midge, Contarinia n. sp., a new problem on Scots pine. Dept. Environ., Can. For. Serv. Inf. Rept. CC-X- . (Manuscript in preparation).

Howse, G.M., and W.L. Sippell. 1971. White pine weevil aerial spraying operations in Ontario, 1971. Rept. Interdept. Comm. on Forest Spraying Operations, Appen. 21, 3 pp.

Reeks, W.A., and C.C. Smith. 1956. Observations on a midge, Contarinia sp., attacking red pine in a New Brunswick plantation, 1951 to 1955. Canada Department of Agriculture, For. Biol. Lab., Fredericton, New Brunswick, Int. Rept. 1956-1, 22 pp. (unpublished).

AERIAL APPLICATIONS OF VIRUS-CHEMICAL INSECTICIDE COMBINATIONS AGAINST THE SPRUCE BUDWORM, CHORISTONEURA FUMIFERANA

(Study Reference No. CC-019)

A REPORT TO THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

By

O. N. MORRIS AND J. A. ARMSTRONG

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

November, 1972

AERIAL APPLICATIONS OF VIRUS-CHEMICAL INSECTICIDE COMBINATIONS AGAINST THE SPRUCE BUDWORM, CHORISTONEURA FUMIFERANA (Study Reference No. CC-019)

By

O. N. MORRIS AND J. A. ARMSTRONG

During 1972, nuclear polyhedrosis and pox viruses were aerially applied in combination with a low dosage of fenitrothion against the spruce budworm, Choristoneura fumiferana. The project was a cooperative one between the Chemical Control Research Institute, Great Lakes Forest Research Centre, and the Insect Pathology Research Institute.

Three-eighths-square mile of a mixed stand of mostly white spruce and balsam fir was sprayed with fenitrothion emitted from the aircraft at 0.25 oz/acre and reaching ground surface at 0.1 oz per acre as determined by spot card measurement (W. Haliburton). Gas chromatographic analyses of glass collected deposits is still in progress.

Quarter-square mile plots were also sprayed with NPV alone, pox virus alone, NPV + insecticide or pox + insecticide. NPV was applied at 25 gm and pox at 10 gms freeze-dried IPRI stock preparations per acre. Microscopic analysis of microbial deposits collected on millipore membrane filter surface is still in progress and will be reported later.

CCRI assumed responsibility for application, deposit analysis, meteorological monitoring, and intensive larval and post-larval biological assessment on a weekly basis. GLFRC was responsible for live population reduction studies by large scale infrequent samplings, adult population by pheromone trapping and defoliation estimation by sight. IPRI kindly supplied a diagnostic service for the project in conjunction with the GLFRC functions.

Data was recorded for the following studies:

1. Incidence of primary (introduced) and secondary pathogens among field collected larvae and pupae.

2. Weekly population changes on spruce and balsam.

3. Overall population (live insects) reduction on spruce and balsam (GLFRC).

4. Effects of treatments on pupation in the field (spruce and balsam).

5. Changes in population densities of associated or competing species.

6. Larval, pupal, and egg parasitism in the field.

7. Effect of treatments on adult emergence (lab. data from field collected pupae).

8. Effects of treatments on adult sex ratio.

9. Effects of treatments on egg viability (data from egg mass survey).

10. Egg deposition per female (laboratory data from field collected pupae).

11. Oviposition density by tree crown level (upper, middle, and lower crowns, egg mass survey).

12. Defoliation on spruce and balsam (bud examination method).

Results of the CCRI involvement are summarized in the following Table I.

Summary Effects of Treatments on Larval and Post-larval Stages of Spruce Budworm

Rankin, Insecticide-Virus Trials, 1972

	Pox Alone	Pox + I*	Insecticide Alone	NPV Alone	NPV + I
Larval Mortality (%)[1]	2.1	4.0	15.4	18.3	25.5
Defoliation Reduction (%)	22.0	44.0	19.0	20.0	34.0
Pupal Mortality (%)	14.7	33.3	0.0	45.8	31.5
Adult Emergence Reduction (%)	26.5	34.3	0.0	13.6	19.9
Oviposition Reduction (%) (Egg mass survey)	6.7	1.0	7.4	8.9	6.0
Progeny Reduction (%) (Egg hatch/female)	0.0	20.6	0.0	29.0	0.0
Adult Sex Ratio (female/male)	1/1	1/2	1/1	1/1	1/1

[1]Corrected for control mortality by Abbott's formula. Reductions indicate the difference between controls and test figures. Larvae and pupae from all trees combined.

*Insecticide

The following conclusions may be drawn from the data:

1. The treatments caused only relatively low larval mortality (maximum of 25% for NPV + fenitrothion) but reduction in defoliation was substantially reduced by both virus-insecticide combinations compared with untreated controls.

2. NPV alone and pox virus + fenitrothion reduced post-larval development by 68%, NPV + I and pox alone by 48-57, and fenitrothion alone by 7.4%.

3. The sex ratio (female/male) of emerging first generation adults was 1/2 for pox + insecticide treated populations, compared with 1/1 for all other test populations including controls.

4. NPV alone and pox + fenitrothion caused 21 and 29% reduction, respectively, in the number of second generation offspring, compared with no reduction by other treatments.

5. Viewed holistically, pox + insecticide and NPV alone, appeared to have produced considerable control of first and second generation populations.

A population check of test areas will be made next year to determine long-term effects of the treatments. The following aerial spray tests are recommended for 1973:

(A) B.T. + NPV + SBP
(B) NPV + fenitrothion simultaneously
(C) NPV + fenitrothion 8 days later
(D) NPV + pox + fenitrothion simultaneously
(E) NPV + pox + fenitrothion 8 days later
(F) B.T. + fenitrothion

All sprays to contain Benzyl cinnamate or other protectant and possibly proprietary nutrient acidifiers added to neutralize pH.

STUDIES ON THE CONTROL OF THE SPRUCE BUDWORM BY AERIAL APPLICATION OF CHEMICALS

(Study Reference No. CC-001)

A REPORT TO THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

By

A. P. RANDALL

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

November, 1972

STUDIES ON THE CONTROL OF THE SPRUCE BUDWORM BY AERIAL APPLICATION OF CHEMICALS

By

A. P. RANDALL

The original project proposal "Investigation on the efficacy of pyrethrin, pyrethroid, and combinations of these, with current systemic insecticides (fenitrothion, Matacil, and Zectran) on forest insect fauna" was temporarily shelved in favor of a request from the Quebec Government to assess the DC-7B aircraft as a potential platform for aerial spraying. The concept of a high spray volume capability aircraft with electronic guidance control for swath width orientation offered a solution to many of the current problems in operational spraying. If successful, large acreages of infested forest land could be sprayed rapidly and economically with a minimum of unsprayed or overlapped sprayed areas. The project was divided into three major components as follows:

(a) calibration of the DC-7 aircraft spray system and assessment of its potential as an aerial applicator of pesticides on forested areas;

(b) assessment of the Litton Inertial Guidance System under operational spraying conditions;

(c) assessment of fenitrothion, Matacil, and Zectran, formulations as applied by the DC-7 spray aircraft.

Calibration of the DC-7 aircraft spray system and assessment of its potential as an aerial applicator of pesticides on forested areas (CC-001-2)

The calibration trials of the DC-7 aircraft were undertaken at Barstow, California, U.S.A., during the latter part of February and early March, 1972. Spray simulants of dyed diesel oil and water were used to represent the two types of formulations in use under operational spraying conditions. Results of the trials indicated that the aircraft had the capacity to carry up to 4000 gallons of spray and be sufficiently maneuverable to operate at spray heights of 200 feet above ground level. Spray droplet spectrum analysis of a diesel oil formulation at 30 psi and air speeds of 200 kts showed a maximum drop size of 200-230 microns (μ), a mass median diameter (MMD) of 70-90 (μ) and a number median diameter (NMD) of 50-70 (μ). Upwind swath deposit values of 1200 yards and crosswind deposits in excess of 5 drops/cm^2 at 1.4 miles were achieved. Swath flight intervals

of 1000 yards could be expected on operational spray program, provided a crosswind component and diesel oil formulations were used. Trials under conditions using dyed water were unsuccessful since no spray reached the ground. An information report on these trials is presently in press.

Assessment of the Litton Inertial Guidance System for Flight Line Positioning of the DC-7 Aircraft During Spray Emission (CC-001-2)

Three 76,800 acre blocks of forest (8 x 15 miles) were established as the experimental test area, 60 to 90 miles from the DC-7 base of operations at Lac des Loups to assess the navigation and guidance capabilities of the Litton System. The longitudinal axis of each test block was established on different magnetic headings with none of the block boundaries on a true north/south bearing. Each block was segmented into 14 flight strips, 15 miles long and at 3000-foot intervals. Longitude and latitude coordinates of each flight line were established from aerial maps or calculated for each block. Prior to take-off for a spray mission the coordinates of the desired flight lines were programmed into the computer and the aircraft proceeded on its mission.

Since this was a prototype installation of a navigation system that was engineered, modified, installed, and accepted on principle, as a working model in less than six weeks, CCRI undertook to monitor the guidance systems' ability to fly the aircraft on parallel swaths of the correct spacing starting at the correct coordinate points of origin.

Aerial and ground monitoring methods were employed on each block as follows: to monitor each flight track the CCRI Cessna (CF-BZA) was used exclusively for visual and photographic studies; ground monitoring was undertaken by means of ground sample stations located at approximately 90-yard intervals across each test block to record spray deposits.

Preliminary assessment of the results show that the Litton System has the capabilities of locating a spray block and if all systems and crew are operative, maintain parallel swath tracks at 3000-foot intervals. Further analysis of the data is currently being undertaken to ascertain the degree of precision of the flight lines and the deposit density of spray recovered on the blocks since drop deposits were recorded two miles on either side of the target area.

Assessment of fenitrothion, Matacil, and Zectran formulations as applied by the DC-7B spray aircraft (CC-001)

As a result of the success of the Barstow, California calibration trials, it was decided to use the modified DC-7 aircraft to spray three experimental 76,800-acre blocks in Quebec against the spruce budworm, Choristoneura fumiferana (Clem.) using fenitrothion, Matacil, and Zectran.

Block 1, the fenitrothion block, showed a very heavy infestation of spruce budworm in 1972 as well as three previous years of heavy defoliation while Blocks 2 and 3 (Zectran and Matacil, respectively) although heavily infested, showed little sign of previous defoliation.

Each block received a single application of insecticide with an expected deposit of 3 oz/acre (active ingredient) for fenitrothion and 3/4 oz/ac (a.i.) for Zectran and Matacil.

Although the trials were initially delayed by two weeks, all three materials proved highly effective, offering a reasonable degree of foliage protection.

In Block 1 (fenitrothion), a mortality of 86% was obtained at 1.25 oz/ac (a.i.) with a resulting defoliation of 70% while the nearby control (with the same high population) was 100% defoliated.

Block 2 (Zectran), showed up to 90% mortality at 0.35 oz/ac (a.i.) and a defoliation of 40-50% while its control showed 80-100% defoliation.

Block 3 (Matacil), showed a mortality up to 91-99% at 0.14 oz/ac and a defoliation of 60% compared to its control which received 100% defoliation at the same initial high population density.

The above results are a preliminary analysis of the data and thus may be subject to revision as the full assessment is currently in progress.

Calibration of Grumman Avenger (TBM) Aircraft for Operational Spraying of Bacillus thuringiensis formulations (CC-001-2).

In 1971, a small scale aerial field experiment was undertaken at Notre Dame du Lac, under the direction of Dr. W. A. Smirnoff, to assess the efficacy of a Bacillus thuringiensis formulation with and without Chitinase additive. A Stearman aircraft equipped with Micronair AU-3000 units was used to apply the formulation. Spray droplet deposits of up to 400 drops/cm^2 were obtained in the experimental plot using ULV calibration settings. On the basis of the 1971 results, a pilot operational project was initiated by the Quebec Laboratory to spray 10,000 acres with the B.T./Chitinase formulation at 2 gpa at Rivière du Loup, Quebec. Since the area involved was much too large to use ULV equipment (i.e., Micronair) and Stearman aircraft, it was decided to have the area sprayed with three "TBM" Grumman Avengers. These aircraft required recalibration in order to place the droplet spectrum to the specification of the 1971 trials. Arrangements for transportation by commercial means and those provided by Forest Protection were not convenient as it would require days to complete the calibration and return to the DC-7 program. By

utilizing the CCRI Cessna aircraft it was possible to complete the calibration and return to Lac du Loup within 36 hours, thus both programs suffered a minimum of delay. Results of the B.T. trials indicated an excellent coverage over the operational area.

Study of the Deleterious Effects of Various Insecticide Formulations on the Spray Tank Gaskets and Sealants Used on Aircraft (CC-001-2)

This program was initiated during the early days of ULV experimentation in 1965-66 when the conversion of aircraft spray equipment from low concentrate formulation to technical grade insecticide resulted in serious corrosion and deterioration of metals, rubbers, and bonding cements used in the spray tanks, booms and nozzles. At present, studies are being undertaken on the seals, gaskets, spacers, etc., of TBM aircraft, the Navy Tracker aircraft and the CL-215 Water Bomber. Preliminary results to date show that the intended use of water bomber tanks in such aircraft as the Tracker and the CL-215 for a dual purpose role of holding water and insecticides is not feasible due to the adverse effects of the insecticide solvents on the various natural and synthetic liners and sealants of the tanks. Further investigations on material suitability is currently under study.

A STUDY OF THE EFFECT OF FOREST METEOROLOGICAL CONDITIONS ON SPRAY DROPLETS AND AN ANALYSIS OF THE SPRAY CLOUD

(Study Reference No. CC-011)

A REPORT TO THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

By

J. A. ARMSTRONG

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

November, 1972

A STUDY OF THE EFFECT OF FOREST METEOROLOGICAL CONDITIONS ON SPRAY DROPLETS AND AN ANALYSIS OF THE SPRAY CLOUD

By

J. A. ARMSTRONG

The meteorological equipment was used to provide information on the meteorological conditions at the time of application of (a) sprays for the protection of plantations at PFES, (b) experimental spray for an integrated control project (Study CC-019, Dr. O. N. Morris), and (c) experimental spray for an ecological study (Study CC-014, Dr. C. H. Buckner). Data collected at the time of these sprays was also used in the assessment of the effect of meteorological conditions on the spray cloud (Study CC-011).

A. PROTECTION OF PLANTATIONS AT PFES

In attempts to protect the plantations at PFES fenitrothion was applied aerially in 1970 and 1971. These sprays did not provide adequate protection and it was the opinion of the interested parties that part of the fault may have been due to the small acreages treated (a total of 400 acres of which many were treated as individual plots of only a few acres), and poor break-up of the spray (boom and nozzle system used). For the 1972 project the acreage was increased to 2000 acres, thus providing a good margin around all plantations; and an aircraft fitted with Micronairs was used to apply the insecticide. The treatment was 3 ounces (weight) of fenitrothion per acre formulated in an oil and applied at the rate of 6 fluid ounces per acre. Three applications were carried out with the initial treatment being made when the budworm were at peak IIIrd instar. Meteorological conditions were recorded at the time of spray application; biological assessment of the insect population and defoliation determinations were under the direction of Dr. G. Howse of GLFRC. At the time of spray application Kromekote cards and glass petri dishes were set out in one of the blocks. Chemical and physical assessment of the spray deposit was done at CCRI by Mr. W. Hopewell and Mr. W. Haliburton.

Results

1. Meteorological Observations at the Time of Spray Application

The sprays at PFES were carried out under strong inversion conditions with stability ratios between + 21.0 and + 31.5 at the times of application. The relative humidities were greater than 60 percent and the wind averaged 5 mph with the highest wind speed being 8 mph. These conditions ensured a good deposit.

2. Spray Application

Difficulties with the spray equipment at the time of the first application resulted in approximately 300 acres receiving an estimated 18 ounces (weight) of fenitrothion per acre. This area did not receive any further treatment and the remaining 1700 acres of the project were treated according to plan. Following the overdose, Dr. C. H. Buckner surveyed the area to assess the effect of the treatment on the bird population. He reported some species virtually eliminated, some with reduced reproduction and others unaffected. A detailed report is given by Dr. C. H. Buckner in the report on Study CC-014.

3. Insecticide Measurements

The average deposit on the area was 65 percent of the emitted dosage to give 2 ounces weight fer treatment or approximately 6 ounces of fenitrothion for the three treatments. Droplet densities averaged 12.36 drops per square centimeter.

4. Biological Assessment

This is discussed in detail by Dr. G. Howse of GLFRC. In summary he reports an improvement from 1970-71; however, with the very high budworm population this did not provide adequate protection. The 1972 spray, even though not attaining the desired standards, did provide slightly better protection using a much smaller volume of material (6 fluid ounces at each application as opposed to 1/2 gal per application in 1971). It is considered that the achievement of equal or slightly improved protection with the much smaller volume of spray indicates that one of the problems with previous sprays has been a poor break-up of the spray.

B. MONITORING OF EXPERIMENTAL APPLICATIONS

1. Aerial Application of Insect Pathogens-Insecticide Combinations (Study CC-019, Dr. O. N. Morris and J. A. Armstrong)

The applications of insecticide (fenitrothion) and two viruses were made with the Stearman aircraft fitted with Micronairs. The spray area was at Rankin near Pembroke. All sprays were carried out under inversion conditions. At the time of the morning sprays the relative humidities were between 61 and 75 percent; the evening spray was done with a relative humidity of 30 percent. The stability ratios ranged from + 3.9 to + 152.3 indicating conditions from good to excellent. Analysis of the deposit on cards and plates indicated that 40 percent of the insecticide emitted reached the target.

2. Environmental Effects of Insecticides (Study CC-014, Dr. C. H. Buckner)

This project was initiated by Dr. Buckner in 1971; at that time a single application of fenitrothion was made to a 40-acre block in the LaRose Forest. In 1972 three blocks were treated as follows:

(a) a 2500-acre block treated with fenitrothion at 4 oz(wt)/acre formulated in an oil and sprayed at 6 fluid oz/acre;

(b) a 40-acre block treated the same as the 2500-acre block;

(c) a 40-acre block treated with fenitrothion at 4 oz(wt)/acre formulated as en emulsion and sprayed at 20 fluid oz/acre.

All treatments were made with the Stearman fitted with Micronairs. Applications were made under inversion conditions with stability ratios ranging from neutral (S.R. = 0.21) to very strong (S.R. = 24.1). Sample plates and cards as well as air samplers were set out in the plots at the time of spray application. The percentage deposit ranged from 16.0 to 62.5.

C. CORRELATION OF METEOROLOGICAL CONDITIONS WITH SPRAY DEPOSITED (Study CC-011, Dr. J. A. Armstrong)

At the time of each spray application the following meteorological conditions were measured in the undisturbed air mass above the trees, and in the air mass just below the tree crown: wind speed, wind direction, turbulence, stability ratio, temperature and relative humidity. Temperature and relative humidity were also measured at 8 feet above ground level. Also, at the time of spray application sample cards, glass petri dishes and in some cases air sampling equipment was set out.

The following observations were made:

1. The stability ratio between 8 and 20 feet, in a large clearing (approx. 100 yards in diameter) was the same as that above the trees in the same area.

2. In the treed area the stability ratio measured below the trees was always much larger than that measured above the trees. This was due to the shading and screening effect of the trees resulting in a greater temperature differential and less wind speed below the trees.

3, The relative humidity measured below the height of the trees was only slightly greater than that above the trees. This slight difference was probably due to the fact that at the time the observations were made the weather was cool and the ambient relative humidity was fairly high (an average of more than 50 percent).

4. The turbulence of the air mass below the trees was affected by the type of tree. In a fir-spruce complex there was generally an increased turbulence below the crowns of the trees relative to that above the trees. In a hardwood stand the turbulence below the trees was less than that above the trees. The difference is due to the shape of the trees and the continuity of the tree tops which is presented to the air mass above the trees.

5. There was only a very slight correlation between percentage spray deposited and relative humidity. The best correlation between percentage of spray deposited was with the stability ratio. The graph in Figure 1 illustrates this correlation. The data used in the graph is from the sprays monitored in 1972, and observations on a single spray in 1970.

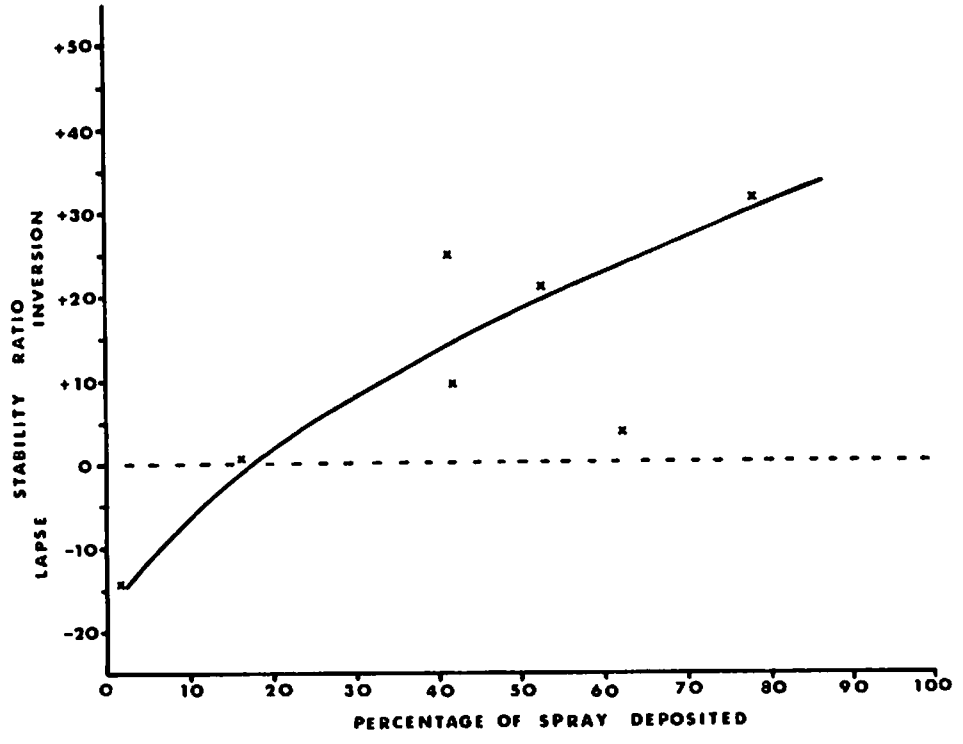


Figure 1. The correlation between the stability ratio and the percentage spray deposited.

MISTBLOWER APPLICATIONS OF MIXTURES OF VARIOUS PATHOGENS AND CHEMICAL INSECTICIDES AGAINST SOME FOREST INSECTS

(Study Reference No. CC-015)

A REPORT TO THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

By

OSWALD N. MORRIS

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

November, 1972

MISTBLOWER APPLICATIONS OF MIXTURES OF VARIOUS PATHOGENS AND CHEMICAL INSECTICIDES AGAINST SOME FOREST INSECTS

By

OSWALD N. MORRIS

During 1972, a series of experiments were conducted to determine larval mortality and post-larval effects resulting from field applications of pathogen-chemical insecticide combinations. A spray tower was used to simulate aerial application in the laboratory and field applications were done with mistblower on triplicate 20' - 30' white spruce trees in the Pembroke area.

Preliminary to the spray operations, extensive laboratory and field tests were carried out to find practical oil-emulsion formulations of Dipel (Bacillus thuringiensis) wettable powders and concentrated water suspensions of freeze dried virus.

Of 18 spray oils and emulsifiers tested, Stove oil and Biofilm proved to be the most suitable combination in terms of compatibility with insect pathogens. These as well as Span 85, Tween 80 and Triton B 1956 L 530 did not affect bacterial development. Fenitrothion at 0.01 oz/gallon did not affect bacterial growth.

A series of field trials were then conducted to determine the effect of weather on the pathogens sprayed on trees and exposed to the natural environment (in full sunlight) for varying time periods. Benzyl cinnamate, an ultra violet filter used commcercially in suntan lotions, was simultaneously tested for its protective effect on insect pathogens.

Results showed that Benzyl cinnamate protected B.T. from deactivation for up to 21 days and nuclear polyhedrosis virus for up to 7 days.

Dosage mortality tests with the spray tower gave an LD_{50} of 0.002 oz/US gallon fenitrothion against Choristoneura fumiferana and 0.045 oz/gallon of a synthetic pyrethroid SBP 1382XY against Hemerocampa leucostigmata. The former finding was used to determine the insecticide dosage in the aerial virus-chemical insecticide trials. (See report by Morris and Armstrong).

Following the above exploratory tests, the following mist-blower applications were made in the field against the spruce budworm.

(1) B.T. alone, (2) NPV alone, (3) B.T. + NPV, (4) B.T. + NPV + Benzyl Cinnamate, (5) Pox virus alone, (6) Pox virus + B.T., (7) Pox virus + B.T. + Benzyl Cinnamate, (8) SBP 1382 alone, (9) SBP + B.T., (10) Fenitrothion alone, (11) Fenitrothion + B.T., (12) Pox virus + fenitrothion 8 days later, (13) NPV + fenitrothion 3 days and (14) 8 days later, controls.

The results are summarized as follows:

(i) B.T. + NPV, B.T. + pox, NPV + fenitrothion 3 or 8 days later were the most effective in reducing larval and pupal populations. NPV + fenitrothion (8 days later) produced 20.5 percent larval control and 91.6 mortality among surviving pupae.

(ii) In nearly all treatments the proportion of females emerging were lower than that of males.

(iii) Benzyl cinnamate was effective as a sunlight protectant of the pathogens but the effect was evident during post-larval mortality.

The investigation points out the need to establish special criteria for evaluating mortality in microbial or integrated control procedures. It is a mistake to base mortality solely on immediate mortality and/or slopes of probit lines in a dosage mortality curve. The search is continuing for the best possible sunlight protectant.

SUMMARY OF LABORATORY EVALUATIONS OF INSECTICIDES AGAINST VARIOUS SPECIES OF FOREST INSECT PESTS DURING 1972

(Study Reference No. CC-006)

A REPORT TO THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

By

P. C. NIGAM

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

November, 1972

SUMMARY OF LABORATORY EVALUATION OF INSECTICIDES AGAINST VARIOUS SPECIES OF FOREST INSECT PESTS DURING 1972

By

P. C. NIGAM

Insecticides were tested for contact and residual toxicity using a modified Potter's tower. The results are summarized under contract and residual toxicity studies. Unless otherwise specified mortality counts were made at 72 hours after treatment.

CONTACT TOXICITY

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

BRITISH COLUMBIA

Ambrosia Beetle - *Trypodendron lineatum* (Olivier)

Five insecticides were tested against ambrosia beetle adults during 1972. The corrected percentage mortality ranged from 27% to 100%.

Dursban > B11163 > Dylox > Gardona > Phosvel

Western False Hemlock Looper - *Nepytia freemani* (Mun.)

Seven insecticides were tested against the larvae of this insect. The corrected percentage mortality ranged from 59% to 100%.

SBP1382 > phoxim > Zectran > Matacil > fenitrothion > Gardona > Orthene

Black-headed Budworm - *Acleris variana* (Fernald)

Four insecticides were tested against larvae of black-headed budworm. The corrected percentage mortality ranged from 0% to 100%.

Matacil > fenitrothion > DDT > Dipel

Western Hemlock Looper - Lambdina fiscellaria lugubrosa (Hulst)

Three insecticides were tested against third instar larvae of western hemlock looper. The corrected percentage mortality ranged from 17% to 100%.

SBP1382 > phoxim > Orthene

ONTARIO

European Pine Sawfly - Neodiprion sertifer (Geoffroy)

Eleven insecticides were tested against fourth instar larvae of European pine sawfly. The corrected percentage mortality ranged from 59% to 100%.

Supracide > Dibrom > Dowco 214 > PP511 > SBP1382 > Meobal > trithion > Bassa > R15396 > Galecron > allethrin

Black-headed Jack-pine Sawfly - Neodiprion pratti banksianae (Rohwer)

Eleven insecticides were tested against fourth instar larvae of black-headed jack-pine sawfly. The corrected percentage mortality ranged from 93% to 100%.

Supracide > methomyl > Dibrom > Dowco 214 > SBP1382 > PP511 > Fitios = Meobal > trithion > R15396 > Galecron

Larch Sawfly - Pristiphora erichsonii (Hartig)

Nine insecticides were tested against fourth instar larvae of larch sawfly. The corrected percentage mortality ranged from 93% to 100%.

Supracide > SBP1382 > Cygon = PP511 > Surecide > Meobal > Dylox > trithion > allethrin

Spruce Budworm - Choristoneura fumiferana (Clemens)

Six insecticides were tested against sixth instar larvae of spruce budworm collected in the Ottawa area. The corrected percentage mortality ranged from 88% to 100%.

Matacil > Zectran > F6957 > fenitrothion = SBP1382 > DDT

Spruce Budworm Adults - Choristoneura fumiferana (Clemens)

Five insecticides were tested against spruce budworm adults. The corrected percentage mortality was 100% for all five insecticides for 24 hours after treatment.

Phoxim > fenitrothion > SBP1382 > Gardona > malathion

European Snout Weevil - Phyllobius oblongus (Linnaeus)

Four insecticides were tested against the adults of European snout weevil. The insects were treated with Methoxychlor and malathion in the field before being collected for laboratory studies. The corrected percentage mortality was 100% for 48 hours after treatment.

fenitrothion > phoxim > Dursban > Gardona

QUEBEC

Red-headed Pine Sawfly - Neodiprion lecontei (Fitch)

Eighteen insecticides were tested against fourth instar larvae of red-headed pine sawfly. The corrected percentage mortality ranged from 0% to 100%.

Gardona > Supracide > Dowco 214 > Phosvel > Bay 78182 > Meobal > PP511 > Dibrom > SBP1382 > Dupont 1642 > Imidan = trithion > Dimetilan > R15396 > Bassa > Neopynamin > Galecron > R23680

Swaine Jack-pine Sawfly - Neodiprion swainei (Middleton)

Seven insecticides were tested against fourth instar larvae of swaine jack-pine sawfly. The corrected percentage mortality ranged from 69% to 100%.

Supracide > phoxim > Cygon > SBP1382 > PP511 > Dylox > allethrin

Gypsy Moth - Porthetria dispar (Linnaeus)

Nine insecticides were tested against third instar larvae of gypsy moth reared on artificial diet from eggs collected in 1971. The corrected percentage mortality ranged from 0% to 100%

SBP1382 > Matacil > Supracide > Sevin ULV_B > Meobal > Orthene = Imidan > malathion > Galecron

MARITIMES

Spruce Coneworm - Dioryctria reniculella (Grote)

The corrected percentage mortality for sixth instar spruce coneworm was 52% with 2% fenitrothion at the rate of 1 gpa.

RESIDUAL TOXICITY

The insecticides were tested for residual toxicity by spraying potted host plants in the spraying chamber. The sprayed plants were exposed to weathering conditions for 10 days. The insects used for bioassay of residues were collected from field and maintained in the laboratory until their release on the insecticide treated foliage. The residue of the insecticides bioassayed on the same day of spraying (i.e. 4±2 hours after spraying) are referred to as 0 day and these host trees were not exposed to weathering. The insecticides are arranged in descending order of residual toxicity at 0 and 10 days of residual life. The corrected percentage mortality is given in brackets and is that observed 72 hours after releasing of insects.

Spruce Budworm - Choristoneura fumiferana (Clemens)

Residual toxicity of eight insecticides was tested against fifth instar larvae of spruce budworm. Two percent Matacil, Zectran, fenitrothion, and 5% DDT at the rate of 1 gpa were repeated from previous year using white spruce and balsam fir as hosts (Series I). Two percent Orthene, Sevin 4 Oil, Imidan and SBP1382 at the rate of 1 gpa were tested this year using white spruce (Series II).

Series I

White Spruce	0 day	- Matacil(92) > Zectran(82) > fenitrothion(68) > DDT(42)
	10 days	- Matacil(50) > Zectran(40) > fenitrothion(27) = DDT(27)
Balsam Fir	0 day	- Matacil(100)> Zectran(98) > fenitrothion(95) > DDT(74)
	10 days	- Matacil(90)> Zectran(79) > DDT(46) > fenitrothion(24)

Series II

White Spruce	0 day	- Orthene(90) > Sevin 4 Oil(40) > Imidan(27) > SBP1382(7)
	10 days	- Orthene(16) > Imidan(12) > Sevin 4 Oil(2) > SBP1382(1)

Jack Pine Sawfly - Neodiprion pratti banksianae (Rohwer)

One percent concentration of five insecticides at the rate of 1 gpa were tested against fourth instar larvae of jack pine sawfly using jack pine plants.

0 day - Zectran = SD 8447 = Baygon = Matacil = Bayer 77488 all 100%
10 days - Zectran(84) > SD 8447(76) > Baygon(27) > Matacil(23) > Bayer 77488(0)

Larch Sawfly - Pristiphora erichsonii (Hartig)

Three insecticides were tested against fourth instar larvae of larch sawfly. Larch trees were sprayed with 1% concentration at the rate of 1 gpa.

0 day - Dimethoate = SD 8447(100) > Baygon(82)
10 days - Dimethoate(51) > SD 8447(50) > Baygon(15)

White Pine Weevil Aerial Spraying Operations Ontario, 1972

by

G. M. Howse and W. L. Sippell
Canadian Forestry Service
Great Lakes Forest Research Centre
Sault Ste. Marie, Ontario

INTRODUCTION

Approximately 1,900 acres of white pine plantations were sprayed with Methoxychlor in the Sault Ste. Marie District in 1972 for the purpose of protecting specific plantations from attack by the white pine weevil. As in previous years, this was a cooperative operation between the Ontario Ministry of Natural Resources, who were responsible for operational aspects, and the Canadian Forestry Service who assessed the effectiveness of the operation.

THE 1972 OPERATION

Pre-spray Infestation Levels

The incidence of 1971 weevilling was determined by CFS personnel with assistance from the MNR for numerous plantations in the Kirkwood and Peshu Lake Crown Management Units in the fall of 1971 and early spring of 1972 prior to adult weevil emergence. The level of weevilling and individual plantation management objectives were the factors used in selecting the areas to be treated. Three plantations in the Kirkwood C.M.U. totalling 390 acres were designated for spraying while 1,500 acres were selected in Township 2A of the Peshu Lake C.M.U.

The Spraying Operation

First weevil activity was noticed in open plantations in the vicinity of the Kirkwood C.M.U. on May 2 despite patches of snow on the ground. A few weevils were noticed on May 5 on open-grown trees immediately adjacent to plantations to be treated in the Kirkwood C.M.U. although there was still 2 - 3 feet of snow present in the plantations. By May 10, large numbers of

weevils were active in the Kirkwood C.M.U. area and spraying commenced on the morning of May 12. The 390 acres in the Kirkwood C.M.U. were sprayed on the morning of May 12 and the 1,500 acres in Township 2A on the morning and evening of May 13 and evening of May 14. The applications were made with a Grumman Super Agcat from General Air Spray Ltd., equipped with 4 Micronair AU 3000 units. All applications but one consisted of Methoxol 2.4 E.C. mixed in equal proportions with water and sprayed at a rate of 2.0 gallons per acre to provide a concentration of 2.4 pounds of Methoxychlor per acre. The one exception consisted of 50 acres treated with undiluted Methoxol at a rate of 1 gallon per acre, again providing 2.4 pounds of Methoxychlor per acre but with a lower spray volume. Dye was added to all spray emitted in the Kirkwood C.M.U. and spray card coverage showed that a variable but generally good deposit was obtained. The results of the spraying are shown in Table I.

Table I

Incidence of weevilling in sprayed and unsprayed areas in the Kirkwood C.M.U. and Peshu Lake C.M.U. before and after spraying.

		Per cent of trees weevilled	
		Pre-spray (1971)	Post-spray (1972)
Sprayed areas			
Kirkwood C.M.U.			
* Rose Twp. - Block 2	50 acres	27.1	13.7
** Rose Twp. - Block 6	110 acres	15.7	6.6
** Lefroy Twp. - Block 1	230 acres	14.8	8.6
Peshu Lake C.M.U.			
** Twp. 2A	1,500 acres	24.5	10.5
Unsprayed areas			
Kirkwood C.M.U.			
5 plantations (combined data)		9.1	14.9

* sprayed at 1 gal. per acre (2.4 pounds of Methoxychlor per acre - undiluted Methoxol)

** sprayed at 2 gal. per acre (2.4 pounds of Methoxychlor per acre - chemical mixed with water at a 1:1 ratio)

The level of weevilling in the unsprayed areas increased from 9.1% in 1971 to 14.9% in 1972, thus indicating an increase of 64% in population levels. However, reductions occurred in all sprayed areas. Using the formula,

$$\% \text{ reduction} = \frac{\text{Expected population} - \text{Observed population}}{\text{Expected population}} \times 100$$

it was calculated that a population reduction of 69% owing to spraying occurred in Rose Twp. - block 2, 74% in Rose Twp. - block 6, 65% in Lefroy Twp. block 1 and 74% in Twp. 2A.

FORECASTS FOR 1973

It is expected that white pine plantations not exceeding a total of 2000 - 2500 acres will be sprayed for white pine weevil in 1973 in the Sault Ste. Marie District.

CONCLUSIONS

Table II shows the results of aerial spraying operations against the white pine weevil using Methoxychlor for the past four years in Ontario.

Table II

Summary of white pine weevil spraying results, Ontario, 1969-72

Year	Rate and concentration of Methoxychlor application	% Reduction in incidence of weevilling	Incidence of weevilling in sprayed areas after spraying
1969	2.0 lbs. in 2 gal. per acre	67%	5.2%
1970	2.5 lbs. in 2 gal. per acre	74%	7.7%
1971	3.0 lbs. in 2 gal. per acre	56%	8.6%
1972	2.4 lbs. in 1 gal. per acre	69%	13.7%
	2.4 lbs. in 2 gal. per acre	71%	8.6%

Boom and nozzle systems were used in 1969, 1970 and 1971 whereas Micronairs were used in 1972. The poor results in 1971, despite the greatest amount of chemical, were attributed to unusually wet weather conditions that prevailed during and after the spraying.

It is concluded from the 1972 operations that Methoxychlor insecticide applied at the rate of 2.4 lb. per acre is as effective when applied at 1 gal. per acre as at 2 gallons per acre. In other words, doubling the volume of spray while maintaining the same amount of active ingredient does not appear to improve the effectiveness of Methoxychlor.

Secondly, it is concluded, after four years of aerial spraying against the white pine weevil using Methoxychlor at several different rates and concentrations, that it is realistic to expect a reduction of no more than 70-75% in the incidence of weevilling and a residual weevilling rate of not less than 8 or 9% in the year of spraying. Despite the fact that in the Sault Ste. Marie District infestations are severe and the conditions for plantation spraying less than ideal, these results, in consideration of an estimated cost of $5.00 an acre, indicate that more suitable alternatives are still urgently required.

Report prepared for the Interdepartmental
Committee on Forest Spraying Operations

November 22, 1972

WESTERN BLACKHEADED BUDWORM
ACLERIS GLOVERANA (WALS.)

D. A. Ross,

Pacific Forest Research Centre,
Canadian Forestry Service,
Victoria, B. C.

The blackheaded budworm epidemic persisted through 1972, the third year of budworm attack on the western hemlock forests of Vancouver Island. The cumulative area of defoliated forest reached some 410,000 acres (see map), of which 60,000 were heavily defoliated.

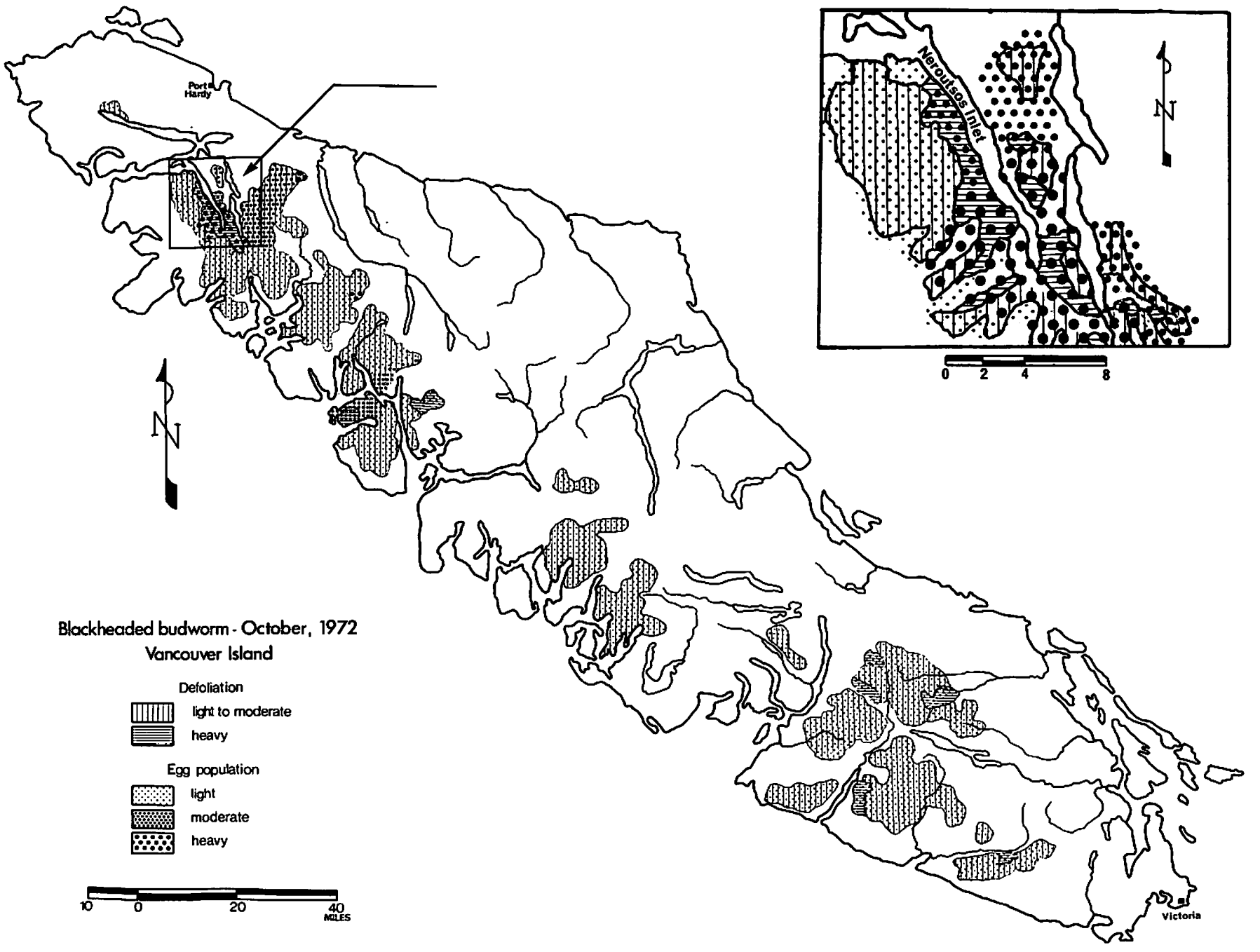
In 1972 defoliation declined in intensity in many of the hemlock stands on the southern third of Vancouver Island, and generally increased in intensity and area along the northwest coast, and about Neroutsos Inlet and Victoria Lake on the northerly end of the Island. New outbreaks appeared farther north on some of the Queen Charlotte Islands and on the mainland of Prince Rupert Forest District.

Canadian Forestry Service surveys, aided greatly by the forest industry and British Columbia Forest Service, showed that the current overwintering egg population is light on the southern third of Vancouver Island, moderate in the northwest coast forest and heavy in some 17,000 acres of hemlock forest about Neroutsos Inlet and Victoria Lake. Since defoliation in 1972 was also heavy in this region it is considered the high hazard area of the Island. Over half of this area involves regeneration and immature forest. This is the first blackheaded budworm epidemic where extensive areas of regeneration hemlock have been heavily defoliated. Past experience indicates that top-kill and tree mortality is likely to occur in the mature forests about Neroutsos Inlet and Victoria Lake.

To date neither disease organisms nor parasites have had much impact on the larval and pupal stages of the budworm, however some undetermined factor caused reduction of the population on the southern portion of Vancouver Island late in the summer or early in the fall of 1972.

The status of the outbreak and the forecast for 1973 was reviewed by the Pest Control Committee of the Council of Forest Industries of British Columbia on November 15. The areas forecasted to be heavily defoliated in 1973, and certain areas with moderate egg population which have been severely defoliated (in 1971 or 1972) are being examined by company foresters. Decisions regarding possible protection action in 1973 will be made at a later date.

Prepared for meeting of Interdepartmental Committee on Forest Spraying Operations, December 12, 1972.


Port Hardy
Nerouitsos Inlet
N
N
0 2 4 8
Victoria
Blackheaded budworm - October, 1972
Vancouver Island
Defoliation
light to moderate
heavy
Egg population
light
moderate
heavy
10 0 20 40
MILES

WESTERN FALSE HEMLOCK LOOPER

NEPYTIA FREEMANI MUNROE

D. A. Ross,

Pacific Forest Research Centre,
Canadian Forestry Service,
Victoria, B. C.

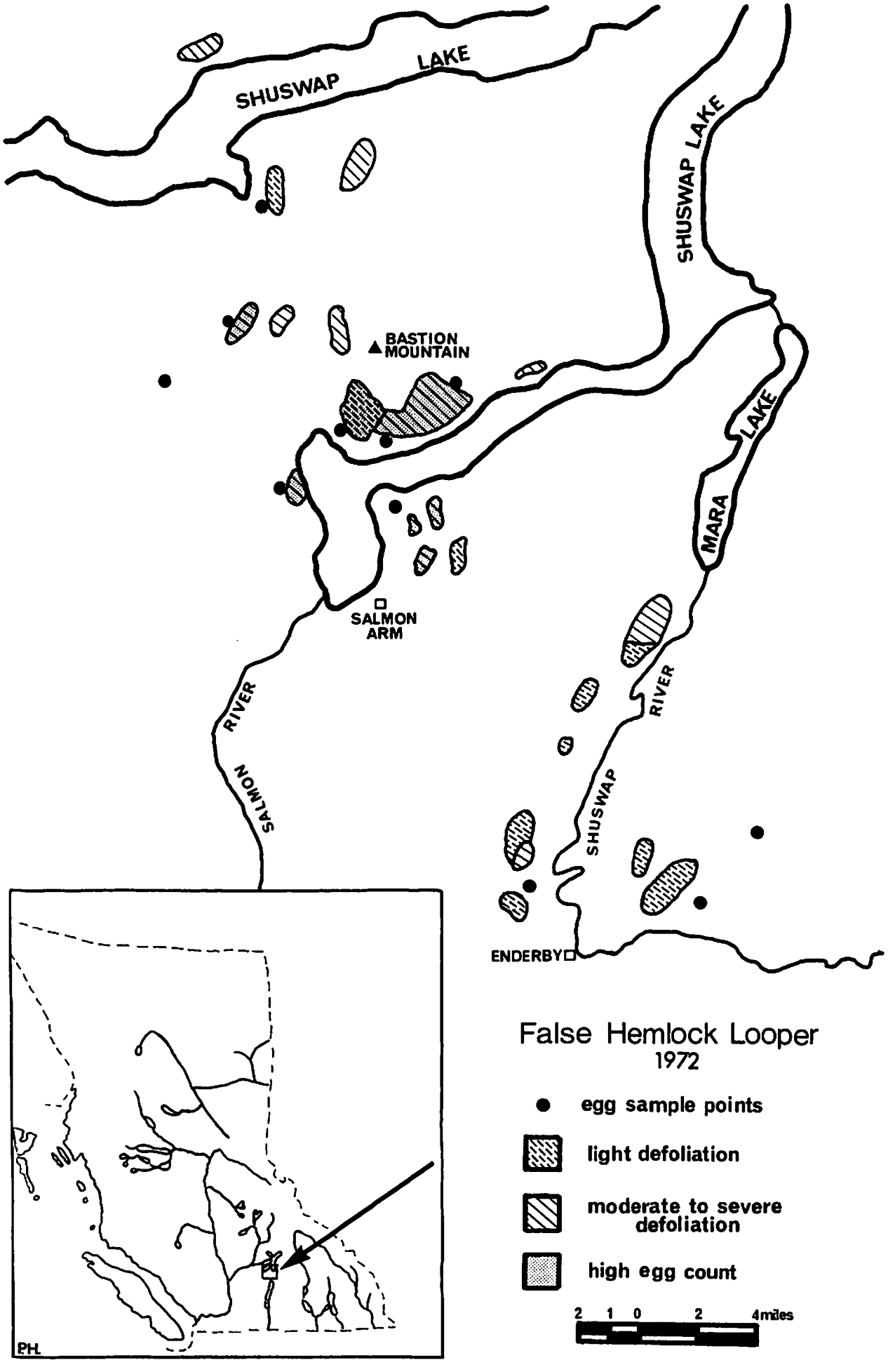
In 1972, this looper defoliated 3,200 acres of semi-mature Douglas-fir trees (20 woodlots or stands) near Salmon Arm and Enderby, British Columbia. Generally the infestations were in stands of trees below commercial size, on private property, near residential or recreational areas and close to important spawning waters for the Pacific Salmon. Twig and bud mortality was common on the 1,100 acres of Douglas-fir categorized as severely defoliated.

Virus disease was not found in the loopers; an insignificant amount of Verticillium and Beauvaria was present. Parasitism was of little significance. Some starvation of larvae occurred in the centers of the infestations where trees were completely denuded.

Moth emergence and oviposition was highly successful. An analysis of egg samples showed that moderate to severe defoliation is likely to recur in 1973 within and adjoining the areas defoliated in 1972. Significant tree mortality is predicted.

The public has expressed deep concern about the looper damage, to the point of presenting a petition to the British Columbia Forest Service requesting action, and some form of protection is anticipated in 1973 although a decision has not been confirmed.

Prepared for meeting of Interdepartmental Committee on Forest Spraying Operations, December 12, 1972.


SHUSWAP LAKE
SHUSWAP LAKE
BASTION MOUNTAIN
MARA LAKE
SALMON ARM
SALMON RIVER
SHUSWAP RIVER
ENDERBY
PH
False Hemlock Looper
1972
egg sample points
light defoliation
moderate to severe defoliation
high egg count
2 1 0 2 4miles