32776

1961
Meetings of the Interdepartmental Committee on Forest Spraying Operations

14-0-31

BRITISH COLUMBIA LOGGERS' ASSOCIATION
(INCORPORATED)
ROOM 401-550 BURRARD STREET
VANCOUVER 1, B.C.

Minutes of a meeting of the Pest Control Committee held on January 4th, 1961, at 2:00 p.m. in the Board Room - 550 Burrard Street, Vancouver, B.C.

PRESENT: Mr. G. Marples, Chairman.

Messrs. Forse, Graham, Kinghorn, Jackson, Lejeune, McLeod, McMullan, Patterson, Radcliffe, Richmond, Silver and Douglas.

INTER-DEPARTMENTAL MEETING: Mr. Richmomd reported on his trip to Ottawa and attendance at the Inter-Departmental Committee meeting on Forest Spraying. In addition to himself, Mr. Lejeune and Mr. Jackson, Department of Fisheries, were present from British Columbia. Representatives from eastern Canada were also present.

Spray Projects in both the East and West were reported upon. This included the work on the Queen Charlotte Islands, and log boom spraying on Cowichan Lake. Results of current research by the Forest Biology Division in connection with the development of forest spraying were reported. It was generally agreed that in our pest control projects much had been achieved in limiting the detrimental side effects of DDT when applied over forest lands. The Federal Department of Fisheries expressed appreciation of efforts being made in this direction by the Forest Industry.

1961 PROJECTS: Kitimat Area

Dr. Silver's reports on this and other projects had been mailed to members of the Committee.

With regard to the saddle-back looper in the vicinity of Kitimat, Dr. Silver reported 14,000 acres are regarded as a high hazard area, in which the understory of the forest is already badly damaged. If the infestation continues it is expected that the larvae will move into the remaining green overstory which would result in total defoliation and probably considerable timber mortality.

The spread of this pest into adjacent uninfested timber is a possibility. This could be checked in early spring by helicopter since the first spring activity will be the flight of the moth from its overwintering location. At the time of moth flight and egg laying, the location and possible spread of the 1961 population should be fairly apparent. At present only Alcan and Crown timber are affected but adjacent privately owned timber could be involved, depending upon its spread. Mr. Kinghorn will be in charge of the field work and it is expected that the Forest Biology Division staff will be adequate to handle the ground work. The spray project, if required, would probably take place in the third or fourth week of June, depending on development of the larvae.

It was agreed that since no definite plans can be made at this time, and since much depends on circumstances unpredictable at the present, that tentative arrangements be made for aircraft and spray materials subject to cancellation if control appears to be unwarranted or unnecessary.

Dr.Silver pointed out that the saddle backed looper may be harder to kill and that a heavier dosage of DDT may be necessary, particularly so since much of the early larval activities may be restricted to the lower foliage. If possible, preliminary tests on the susceptibility of this insect to DDT will be undertaken by the Chemical Control Section of the Forest Biology Division, Ottawa.

It was recommended that we check such proposals with the Department of Fisheries as they may affect important salmon waters in the Kitimat valley.

Vancouver Island

Discussions followed Dr.Silver's report on the green striped looper on the west coast of Vancouver Island. As with the saddle back looper, an early spring survey will be necessary to determine the 1961 status. The Federal Department expects to be able to handle this survey without assistance from the industry except for possibly a limited amount of flying time.

Okanagan Helicopter Company has indicated that they are interested in bidding on a spray project if this should be required. At the moment some 5,000 acres are heavily defoliated and it is feared that an outbreak of this infestation could cause serious tree mortality. From observations up to this time it is not possible to predict developments and it is not likely that this can be done with any degree of certainty until spring. Again it is assumed that the most opportune time for spraying would be June 20th, or shortly after. It may be necessary to use the Helicopter which could be operated from a scow.

Ambrosia Beetle

The matter of continuation of the study on susceptibility to attack by ambrosia beetle in various log storage areas in Howe Sound, Fraser and Pitt Rivers, was then discussed. It was suggested that this work as started in 1960, should be continued under the auspices of the Association and Member companies were requested to officially confirm to the Secretary if they are interested in participating in this project.

Mr.Richmond recommended a close check on the spray effectiveness in connection with the planned helicopter spraying of log booms this spring. Two sections of logs, known to be susceptible to ambrosia beetle attack would be required, one batch to be sprayed and one left unsprayed, stored together until after the main attack date of the insect.

It was regularly MOVED and SECONDED that this committee recommend to the Board of Directors that the study of susceptibility of log storage areas as outlined above and the study of protective measures of combatting Ambrosia beetle damage to log booms be continued by Mr. Richmond under the auspices of the Association.

CARRIED.

Mr.Richmond then requested members to inform him as soon as possible if they are in a position to make logs available for these purposes.

Balsam Woolly Aphid

Mr.LeJeune reported that the Forest Biology Division is continuing its surveys in connection with this insect. It would appear up to this time the infestation has not yet assumed the proportions to which it is capable, but having regard for the seriousness of this pest in the States, they are keeping a close check on developments. He explained that four species of predators had been introduced during 1960 and further liberations were hoped for in 1961. Results of these introductions could not be known for some time.

Mr.Marples suggested some form of illustrated literature that if available to field personnel, would help in the reporting of infested trees. Dr. Silver proposed the preparation of a small brochure containing descriptions and illustrations for this purpose, distribution of which would be through the Forest Service and this Association.

<u>ADJOURNMENT</u>: The meeting adjourned at 3:45 p.m.

Chairman.

AFD:gh

GOVERNMENT OF CANADA

ACTION REQUEST

CGSB 6-GP-12
P.P. & S. Cat. 3433

TO: J. [illegible]

LOCATION: [illegible]

FOR:

FILE NO. ......

☐	ACTION		
☐	APPROVAL	☐	NOTE & FORWARD
☐	COMMENTS	☐	NOTE & RETURN
☐	DRAFT REPLY	☐	REPLY, PLEASE
☐	INFORMATION	☐	SEE ME, PLEASE
☐	INVESTIGATION	☐	SIGNATURE
☐	MORE DETAILS	☐	TRANSLATION
☐	NOTE & FILE	☐	YOUR REQUEST

PREPARE MEMO TO: ......

REPLY FOR SIGNATURES OF: ......

REMARKS: (1) See note item 2(a), p. 5

FROM	PHONE	LOCATION	DATE
[signature]			Jan 6/[illegible]

FILE NO. 702-1-10

14 - 0 - 31

CANADA

DEPARTMENT OF FISHERIES

OTTAWA

902324

January 5, 1961.

Mr. H. W. Beall,
Administration Branch,
Department of Forestry,
238 Sparks Street,
O t t a w a.

Dear Mr. Beall:

Enclosed for your information please find a copy of the notes of the December 19 meeting of the Interdepartmental Committee on Forest Spraying Operations.

Yours very truly,

E. W. Burridge,
Chief,
Fish Culture Development.

Encl.
EWB/sh

NOTES OF A MEETING OF THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS HELD IN THE SIR CHARLES TUPPER BUILDING, OTTAWA, ON DECEMBER 19, 1960, AT 9:00 AM.

Present were:

Dr. M. L. Prebble (Chairman)	- Department of Forestry
Dr. J. J. Fettes	- Department of Forestry
Dr. R. M. Belyea	- Department of Forestry
Mr. H. W. Beall	- Department of Forestry
Dr. A. L. Pritchard	- Department of Fisheries
Mr. E. W. Burridge (Secretary)	- Department of Fisheries
Dr. J. L. Kask	- Fisheries Research Board
Dr. C. J. Kerswill	- Fisheries Research Board
Mr. J. P. Cuerrier	- Canadian Wildlife Service, Northern Affairs & National Resources
Mr. K. B. Brown	- Department of Lands & Mines, New Brunswick
Mr. B. W. Flieger	- Forest Protection Limited

The December 19 meeting of the Interdepartmental Committee on Forest Spraying Operations was in effect an extension of the October 31 meeting and of the meeting of December 16 of the Committee (including a small number of Departmental advisors) and was called primarily to consider features of the proposed 1961 Spray Project in New Brunswick.

Dr. Prebble introduced an Agenda for consideration. Mr. K. B. Brown suggested the insertion of item 2(a), shown below, otherwise the Agenda was adopted as presented.

AGENDA

1. Outline of proposed spray program, New Brunswick, 1961

    a. Division of infested area into two major zones

        Zone 1 (i) location; acreage; additions proposed by Forest Biology Laboratory, by Forest Operations Division, etc.; exclusions proposed by other agencies.

(ii) concentration of DDT in spray mixture; application rate; timing of spraying; factors governing repeat spraying.

Zone 2 - location; acreage; proposed action.

b. Possible extensions of area to be sprayed, based on new information in early summer of 1961.

c. Hazards to fish and wildlife, precautions, etc.

2. Investigations to be carried out in 1961.

a. Forest Research Division

b. Forest Biology Division

c. Fisheries Research Board and Fisheries Department

d. Canadian Wildlife Service, Northeastern Wildlife Station

e. Forest Protection Limited (with special reference to Zone 2)

3. Means of improving liaison among Fisheries Research Board, Fisheries Department, Forest Biology Laboratory and Forest Protection Limited during spraying operations, with particular reference to safeguarding investigational program.

4. Other matters.

The discussions are summarized below according to the appropriate sub-divisions of the Agenda.

1 (a) Dr. Prebble introduced a map showing the area proposed by the Government of New Brunswick and Forest Protection Limited for the 1961 spray operation (copies of this map were subsequently sent to members of the Committee). Zone 1, comprising about 1.7 million acres and located primarily in the western portion of the infested area with the notable exception of a tongue along the southwest Miramichi River, was scheduled for treatment at ½ strength DDT spray (¼ lb. in ½ gal. per acre).

The modifications to the originally proposed area for spraying are as follows:

(i) The Forest Biology Laboratory, Fredericton, recommended inclusion of small areas northeast and northwest of Juniper; filling of a gap north of Millville and Barton and east of Woodstock; spraying of three small isolated infestation areas near York Mills and north and northwest of Redbank; inclusion of an area east of Fredericton towards Grand Lake and including the Acadia Forest Experiment Station.

(ii) Dr. Belyea indicated that the Fredericton Laboratory placed rather low priorities for spraying in the area south of Oromocto and Burton, more extensive areas west of Renous, and in the general vicinity of Stanley to Durham Bridge westward towards Burtts Corner. In his view inclusion of these three areas of rather low priority in the 1961 spray program would hardly be justified if the extensions, referred to in (i) above, were not included in the spray program.

(iii) Mr. Beall stated that the Deputy Minister of Forestry was very anxious that the Acadia Forest Experiment Station be sprayed with the operational DDT concentration in 1961, but the Department of Forestry was not pressing for extension of spraying beyond the Acadia Forest Experiment Station toward Grand Lake. Mr. Beall also felt that complete spraying would not be necessary in the Camp Gagetown area, but only in certain heavily infested spots within the original program boundary.

(iv) Dr. Belyea reported that the Dean of Faculty of Forestry, University of New Brunswick, and the Director of the Fredericton Experimental Station of the Department of Agriculture would be requesting exemption of the U.N.B. woodlot and the Experimental Farm property from the spray program. On the other hand, the Fredericton Forest Biology Laboratory did not propose to ask exemption of plots used for studies of the biological control of *Adelges piceae*.

(v) In response to a question from Dr. Pritchard, Mr. Brown and Mr. Flieger pointed out that the boundaries of Zone 1, as shown on the map, were approximate only and would undoubtedly be changed by the time of spraying to take account of the distribution of forest land, agricultural land and related features. However, they felt that the area to be sprayed would not differ substantially from that within the boundaries of Zone 1. They did anticipate, however, that there might be minor extensions outside Zone 1, depending on information becoming available next June.

Mr. Flieger noted that the 1961 spraying would be timed as carefully as possible to effect protection of foliage, and the plan envisages repeat spraying, at an interval of ten days or more, of certain areas of persistent high populations. As a rough estimate Mr. Flieger thought that upwards of 500,000 acres might be involved in repeat spraying. Dr. Belyea pointed out that previous infestation and egg population maps are being studied at the present time to outline areas of high persistent populations. He also stated that the Forest Biology Laboratory would be involved in appraisals of the results of the first spraying before second spraying was undertaken.

In response to a question from Dr. Pritchard, Mr. Flieger indicated that the location of anticipated repeat spray areas would be made known to Fisheries Department as soon as the maps had been prepared at the Fredericton Laboratory.

Zone 2, comprising about 1.5 million acres, lying chiefly in the eastern part of the infestation area, is not included in the area for general spraying in 1961. Mr. Brown pointed out that in general the forest in Zone 2 is less valuable than that in Zone 1, contains higher proportions of other species, but in addition contains numerous privately owned woodlots representing relatively high value to the individual owners. It is possible that protective measures may be taken in reference to woodlots, and some experimental spray operations might be carried out in small portions of Zone 2. Detailed plans have not yet been worked out.

1 (b) It was recognized that some extensions to the proposed spray operations in 1961 might be necessary to treat heavy infestations not apparent when the map referred to above had been prepared. Normally such new information would become available in the course of flights over the area next June. Dr. Pritchard wished to be assured that Fisheries staff would be informed of any further extensions during the operational program. Although in the past such extensions had occasionally been sprayed almost at once when the heavy infestations were discovered, Mr. Flieger agreed that a lapse of one to two days between discovery and treatment would be quite feasible, thus allowing information to be transmitted to Fisheries representatives. (see No. 3 below).

1 (c) Dr. Pritchard noted that the northeastern boundary of Zone 1 came very close to the South Esk hatchery, and emphasized the importance of avoiding this area in the spraying operations. He also stated that spraying

operations should ~~not be carried out over certain areas in which control studies and other investigations will be conducted by Fisheries Research Board and Fisheries~~ Department staffs. When plans have been made for fisheries studies in 1961, the areas for exemption from spraying will be marked on maps submitted to Forest Protection Limited.

Dr. Belyea stated that Mr. Bruce Wright had shown him a map with the location of woodcock study areas, four of which fell within Zone 1 around Fredericton, scheduled for spraying in 1961. One study area is outside the proposed spraying operation. On instructions of the Committee, Dr. Prebble agreed to write to Mr. Wright informing him of the general spray program for 1961. Further details could be obtained by Mr. Wright in consultation with Dr. Belyea and Mr. Brown.

2 (a) Forest Research Division, Department of Forestry

Mr. Brown suggested that some useful studies in the areas sprayed since 1952 might be carried out by the Forest Research Division. No detailed discussions had been held with the Department of Forestry but he thought that certain aspects of forest inventory and forest ecology might bear investigation.

Jan 9/61

2 (b) Forest Biology Division

The Fredericton Laboratory would carry out the regular spray deposit assessments, and population and mortality studies of the budworm, including populations on spruce; and would, in addition, investigate the influence of spraying on predators of the balsam woolly aphid. If repeat spraying is undertaken, this will also be assessed. Dr. Belyea pointed out that studies by the Fredericton Laboratory would be somewhat complicated in 1961 by absence of representative check areas and also by the prospects of investigations in Zone 2, quite remote from some sections of Zone 1 near Fredericton.

Dr. Prebble recommended that an area of possibly 20 to 30 thousand acres or more be sprayed at full strength (½ lb. DDT per ½ gal. per acre) as an aid to interpretation of the operational results in 1961 when half strength spray is expected to be used throughout the operation. It was thought by Mr. Flieger and Dr. Belyea that 20 to 30 thousand acres for full-strength spraying might be located in Zone 2 in an accessible area containing no important salmon or trout streams. In the selection of such an area, care should be taken to avoid any areas used for study by Mr. Wright, or known by him to be important woodcock producing areas.

It was pointed out that the Forest Biology Division hoped to have additional studies of Bacillus thuringiensis in 1961, but no detailed arrangements have been made as yet. Mr. Flieger asked Dr. Fettes' opinion on the potential usefulness of Phosphamidon for budworm control and presented for Dr. Fettes' study a booklet prepared by D. A. Dever and D. L. Davis, dated November 10, 1960. He was also interested in knowing whether the Forest Biology Division felt that further trials of insecticides would be useful. Dr. Fettes stated that laboratory trials are conducted every season, using new promising materials, but that costly field trials would not be undertaken unless there was considerable information at hand through the manufacturer or through other experimental users on toxicity to insects, mammals and fish, and unless the material holds promise of being superior to DDT. If the Chemical Control Section proposed field trials of additional insecticides in 1961, Mr. Flieger stated that the Section could count on assistance from Forest Protection Limited.

The seasonal program of the Chemical Control Section has not yet been established, and Dr. Prebble urged that in any case some arrangement should be found to avoid the very extensive involvement of Mr. Hopewell in routine water analyses for DDT. Dr. Kask and Dr. Pritchard thought that some arrangement could be worked out whereby a technician assistant could be provided to work under Mr. Hopewell's direction on the analysis of DDT in streams where studies of fish and aquatic insects are conducted.

2 (c) Fisheries Research Board and Fisheries Department

Dr. Kask indicated that the 1961 fisheries assessment program would follow along similar lines to the field investigations in 1960; and he hoped that Dr. Ide would be available to carry out studies on aquatic insects. Dr. Kask hoped that the Fisheries Research Board would develop a program of more fundamental studies of the relationships between aquatic organisms and insecticides in streams as part of the broader problem of stream pollution. This should include studies of fish feeding behaviour, distribution of insecticide in the water, and longer-term effects of insecticide pollution. In connection with studies of aquatic insects, Dr. Kerswill noted that Dr. Ide had recommended that insect populations be investigated over the whole range of a stream about 20 miles in length rather than as essentially one-station sampling, as in previous years. In such a set-up the entire watershed of the study stream should fall within a uniform treatment zone.

Dr. Kask felt that the Forest Biology Division might well take a greater part in the studies of the effects of insecticides on aquatic insects. Dr. Prebble pointed out that no members of the Division at the present time were especially trained in aquatic insects. Dr. Belyea noted that a member of the Fredericton Laboratory had been carrying out broad sampling of aquatic insects as an extension of Dr. Ide's more detailed studies, but that the identifications were merely to family or order, not to genus or species.

2 (d) Canadian Wildlife Service, Northeastern Wildlife Station

Mr. Cuerrier stated that the Canadian Wildlife Service would not be conducting studies in the area to be sprayed in 1961. Details of studies to be undertaken by the Northeastern Wildlife Station had not been received from Mr. Bruce Wright.

2 (e) Forest Protection Limited

Messrs. Brown and Flieger expressed the opinion that additional study was needed to determine appropriate means of protecting budworm infested stands with high spruce content. Mr. Flieger felt that a part of Zone 2 might be used for experimental studies, but no detailed plans had been drawn up as yet. Close contact will be maintained with Dr. Belyea in working out any such plans.

3 With reference to extension of areas to be sprayed beyond the limits of Zone 1, and the exemption of study areas within Zone 1 that are of particular interest to the Fisheries Research Board and the Fisheries Department, it was agreed that improved liaison was needed among the four parties directly or indirectly involved in the spraying operations. It was agreed that means of improving liaison could be worked out in advance of spraying operations among representatives of the Fisheries Department, Fisheries Research Board, Forest Biology Division, and Forest Protection Limited. Mr. Flieger and Dr. Belyea should take the lead in contacting representatives of the Fisheries Department and Fisheries Research Board in this connection.

4 Owing to the fact that several members of the Interdepartmental Committee had not had the opportunity

to see the budworm infestation in New Brunswick, the spraying operations, effects on forests and on fish, Dr. Prebble suggested that the Committee, as a group, might be interested in visiting New Brunswick during the spraying operations in 1961. This idea was supported by the Committee and Mr. Flieger extended an invitation to the group. He suggested that the Committee assemble at the project headquarters (Taxis Airstrip) from which visits to the various parts of the infested area could easily be arranged. Details will need to be worked out later.

Dr. Pritchard wished to know if any further information had been received regarding proposals for spray operations against the saddle-backed looper near Kitimat. Dr. Prebble stated that he would write to Mr. Lejeune for information and that a further meeting of the Committee would be called when information was at hand.

E. W. Burridge, Secretary,
(Minutes prepared in consultation
with M. L. Prebble)
December 30, 1960.

702-1-10

FILE NO.

CANADA

DEPARTMENT OF FISHERIES

OTTAWA

902230

December 30, 1960.

Mr. H. W. Beall,
Administration Branch,
Department of Forestry,
238 Sparks Street,
Ottawa.

Dear Mr. Beall:

Enclosed please find a correction to the notes of the October 31 meeting of the Interdepartmental Committee for Forest Spraying Operations. Dr. Logie was misquoted in connection with this point and we would appreciate it if the erratum could be incorporated in your copy of the notes.

Yours very truly,

E. W. Burridge

E. W. Burridge,
Secretary,
I. C. F. S. O.

Correction made

Encl.

CANADA DEPARTMENT OF FORESTRY

902146

FOREST BIOLOGY DIVISION
K.W. NEATBY BUILDING
CENTRAL EXPERIMENTAL FARM

14-0-31

YOUR FILE No:

OUR FILE No: 7.9.14

OTTAWA, CANADA

December 27, 1960

MEMORANDUM TO:

Mr. H. W. Beall
Dr. R. Glen
Dr. H. Hurtig
Dr. R. M. Belyea
Dr. J. J. Fettes
Dr. F. E. Webb
Dr. L. Daviault
Mr. W. A. Reeks
Dr. G. P. Thomas
Mr. R. R. Lejeune

DEPARTMENT OF FORESTRY
DEC 29 1960
DEPUTY MINISTER

Herewith a copy of the Minutes of a special meeting of the Interdepartmental Committee on Forest Spraying Operations held in Ottawa December 16. The minutes, which are not signed, were prepared by Mr. Burridge in consultation with Dr. Fettes, Dr. Belyea and the undersigned.

M. L. Prebble,
Director,
Forest Biology Division.

MLP/kp

Mr. Beall

NOTES OF A MEETING OF THE INTERDEPARTMENTAL COMMITTEE FOR FOREST SPRAYING OPERATIONS HELD AT 9:30 AM ON DECEMBER 16, 1960, IN ROOM A-227 OF THE SIR CHARLES TUPPER BUILDING

Present were:

Dr. M. L. Prebble	Department of Forestry
Mr. H. W. Beall	Department of Forestry
Mr. W. W. Mair	Department of Northern Affairs & National Resources
Dr. J. L. Kask	Fisheries Research Board
Dr. A. L. Pritchard	Department of Fisheries
Dr. J. J. Fettes	Department of Forestry
Dr. R. M. Belyea	Department of Forestry
Dr. C. J. Kerswill	Fisheries Research Board
Mr. J. P. Cuerrier	Department of Northern Affairs and National Resources
Mr. E. W. Burridge	Department of Fisheries

The Committee met to continue appraisal of the results of experimental studies, 1958-1960, and to recommend the types of appraisal studies that might be carried out in 1961. It also considered proposals that should be advanced to the government of New Brunswick and Forest Protection Limited to safeguard fisheries and wildlife interests during the 1961 spray program.

Experimental Studies

Evidence as prepared by Mott and Fettes was re-examined. Consensus of the Committee was that the conclusions as outlined in the notes and appendices of the October 31 meeting were acceptable and there appears to be no justification for the continuation of intensive investigation of DDT concentration-droplet density-budworm mortality relationships.

Proposals for 1961 Spray Program

Dr. Belyea discussed the tentative spray program for 1961 based on a map that had been prepared by Forest Protection Limited taking account of hazard appraisal studies by the Forest Biology Laboratory in Fredericton. The hazard area was divided into two categories in the first of which spraying was considered to be justified by the New Brunswick Government on the basis of forest values. In this area, comprising of about 1.8 million acres, spraying with 6.25% DDT is proposed with certain areas, characterized by special hazard, to receive two applications if necessary. In the second category, general spraying was not considered by the New Brunswick Government to be justified owing to lesser forest values although certain parts of it might be proposed for experimental spraying. Mr. Beall pointed out that the Department of Forestry attached great importance to protection by spraying of the area containing the Acadia Forestry Experimental Station owing to the long-term research projects underway. Dr. Belyea indicated that the Acadia Station was included in the area of high hazard although falling in the second category of spraying. He believed that a request for inclusion of the Acadia Station in the spray program would be sympathetically received by Forest Protection Limited. This viewpoint had been transmitted to the District Forest officer at Fredericton.

Proposals for additional studies

It was agreed that since spraying operations are to be carried out in 1961, studies of the effects of such spraying on fish populations would have to be conducted. Dr. Kask insisted on the importance of establishing more satisfactory long-term arrangements for appraising the effects of insecticides on fish populations if it appeared likely that forest spraying operations were to continue indefinitely. Although future spraying against the budworm in New Brunswick could not be forecast accurately, the forest entomologists agreed that forest spraying for insect control would probably continue in one part of Canada or another for as long as can be foreseen. The Committee therefore supported Dr. Kask's proposal that long-term studies of pesticide-fish inter-relationships be set up. Mr. Mair indicated that the Canadian Wildlife Service had made a small start toward the same objective in connection with wildlife.

It was agreed that spray deposit assessment in New Brunswick in 1961 would have to be carried out by the Forest Biology Division to accompany the studies on fish populations and would also be an inherent part of budworm mortality studies on selected plots.

As a safeguard for the interpretation of results on the large operational area to be sprayed at 6.25% DDT in 1961, Dr. Prebble suggested that a selected area be sprayed at 12.5% DDT. After viewing the map it seemed that an area of 20-30,000 acres could be found free of streams carrying important fish populations. Dr. Belyea stressed the importance of accessibility so that the deposit density and budworm mortality studies could be carried out conveniently. The Committee agreed that such a recommendation should be made to Forest Protection Limited.

Safeguards for 1961 Spray Program.

The Committee agreed that arrangements should be made between Fisheries and Forest Protection Limited for close liaison during the spray program to avoid contamination of streams where controls were being maintained by fisheries personnel.

File: 14-0-31

DRR:EBC

Mr Beall ...
Mr. Fegar Dast

Forest Research Division

Ottawa, December 20th, 1960.

Mr. H. D. Heaney,
District Forest Officer,
P.O. Box 428,
Fredericton, N. B.

Sir:

Following the meeting of the Interdepartmental Committee on Forest Spraying Operations, Mr. Beall was advised by Mr. K.B. Brown, Deputy Minister of the Department of Lands and Mines in New Brunswick, that he and Mr. Fleiger, Manager of Forest Protection Limited, have agreed to the extension of the 1961 spray program to include the Acadia Forest Experiment Station.

With reference to the last paragraph of your letter of December 8th, I am pleased to authorise you to request Mr. Fleiger to have the Acadia Forest Experiment Station included in the area to be sprayed in 1961. Kindly forward a copy of your letter to Mr. Brown.

Yours faithfully,

DRR
D. R. Redmond,
Chief.

7.9.14

MEMORANDUM TO:

Dr. J. L. Kask
Dr. A. L. Pritchard
Mr. W. W. Mair
Mr. H. W. Beall

December 20, 1960

At the Meeting of the Interdepartmental Committee on Forest Spraying Operations December 16, I promised to let you have copies of the map showing the proposed spray project in New Brunswick in 1961. The area in question is enclosed by the solid irregular line, and the smaller patches with identifying numbers are referred to in the attached memorandum prepared by D. G. Mott and R. M. Belyea of the Forest Biology Laboratory, Fredericton.

M. L. Prebble,
Director,
Forest Biology Division.

MLP/kp

Mr. Beall - 2 copies

Suggested Modifications to F.P.L. Spray Plan for 1961

1. Areas marked "1" and coloured red should be included in Category 1.

   (a) Small area in southern York County (noted by Flieger as having been left out of Category 1 by accident).

   (b) Two areas west and northwest of Juniper. These areas are generally inaccessible and egg populations in 1960 could easily have been missed; they were not sprayed in 1960 and defoliation was heavy. Because of their location on the northern boundary of the infestation, they should be included for treatment in Category 1 for 1961.

2. Area marked "2" and coloured red should logically be included in Category 1, or at least marked for special watching in 1961. In this area, egg sampling was limited in 1960 and the heavy defoliation recorded in 1960 could represent fairly heavy residual budworm populations, rather than only a result of late spraying.

3. The extension of Category 1 into Camp Gagetown area (area marked "3" and coloured green) and at the same time the exclusion of the area around Acadia (area marked "4" and coloured red) do not seem logical. There is limited forest and generally low hazard at Gagetown, while egg numbers and hazard in area "4" were high.

4. The two small spots (marked "5" and coloured red) west of Chatham represent two small areas of heavy defoliation noted beyond the northern boundary of the 1960 spray. These, because of their location, should be considered for inclusion in Category 1, subject to ground or aerial inspection in early 1961.

5. The two fairly large areas marked "6" and coloured green are blocks of low hazard that might be considered for exclusion from Category 1.

D. G. Mott
R. M. Belyea
Forest Biology Laboratory
Fredericton, N.B.

December 5, 1960

Area 1 enclosed by solid white line is F.P. Ltd. proposal for spraying in 1961

Area 2 enclosed by broken white line may have portions within it sprayed, exact areas to be decided later. Considered to have some significance [illegible] economic value than Area 1 [illegible]

14-0-31

CANADA

DEPARTMENT OF FORESTRY

902007

Forestry Operations Division Maritimes District

P. O. Box 428,
Fredericton, N. B.

December 20, 1960.

Mr. H. W. Beall,
Chief, Forestry Operations Div.,
Department of Forestry,
Ottawa, Ontario.

Northern Affairs and National Resources
FORESTRY
DEC 22 1960
BRANCH

Sir:

This will acknowledge your letter of December 15 concerning forest insect spraying at Camp Gagetown.

When the Army was first advised of Mr. Mott's survey this summer, the matter was referred by them to their Headquarters and apparently was sent on to Eastern Command with the request that money be found to spray the area. More recently, and as mentioned in my letter of December 12, Mr. Boynton (I said Mr. Davis) saw the military authorities at the Camp again, and when informed the small area in the northwest portion of the Camp was in the spray program, they seemed quite satisfied that no further areas be sprayed. I do not know if the Camp authorities have made any further communications to Area Headquarters or to Central Command.

Yours faithfully,

H. D. ~~Heaney~~,
District Forest Officer.

14-0-31

CANADA DEPARTMENT OF FORESTRY

FOREST BIOLOGY DIVISION
K.W. NEATBY BUILDING
CENTRAL EXPERIMENTAL FARM

YOUR FILE No:

OUR FILE No: 7.9.14

OTTAWA, CANADA

January 25, 1961

MEMORANDUM TO:

Dr. A. L. Pritchard
Dr. J. L. Kask
Mr. H. W. Beall
Mr. W. W. Mair

CENTRAL REGISTRY
JAN ... 1961

Re : Progress Report - B. S. Wright

We have received the accompanying report and reprint from Bruce S. Wright, Director, Northeastern Wildlife Station, Fredericton, N.B., and these are being sent to members of the Interdepartmental Committee on Forest Spraying Operations as I thought they would be of interest.

M. L. Prebble (per ...)

M. L. Prebble,
Director,
Forest Biology Division.

MLP/kp

NORTHEASTERN WILDLIFE STATION

OPERATED COOPERATIVELY BY THE
WILDLIFE MANAGEMENT INSTITUTE OF WASHINGTON, D. C.

UNIVERSITY OF NEW BRUNSWICK, FREDERICTON, N. B.

BRUCE S. WRIGHT
DIRECTOR

December 20, 1960.

PROGRESS REPORT

PESTICIDE POISONING IN NEW BRUNSWICK WOODCOCK

Bruce S. Wright

A reduced reproductive rate in woodcock (*Philohela minor*) in the DDT sprayed area of northern New Brunswick has already been reported (Wright, 1960). A sample of 4 birds has now been analysed by the Section of Chemical, Physiological, and Pesticide-Wildlife Studies of the US Fish & Wildlife Service. They were taken in the Tobique valley in the spray zone between September 19 - 25, 1959. Two of the 4 contained DDT in amounts of 2.4 and 0.6 mcc/c, showing that this poison is carried by the birds during the fall season when they are used as human food.

A further and more serious case of pesticide poisoning in woodcock is to be reported for the chemical heptachlor. Ten specimens collected in May and June in central New Brunswick contained an average of 0.18 ppm heptachlor epoxide. It was assumed that it was acquired by the birds on their winter range in the southern States where the chemical is widely used for fire ant eradication. However the results of the analysis of 16 specimens collected between August 25 - September 26, 1959, in five widely scattered locations in New Brunswick showed that 10, or 62%, were infected with heptachlor epoxide in amounts ranging from 0 - 4.3 mcc/c. The upper limit is the highest ever recorded from a wild woodcock, and it is highly significant that this bird was an immature. Four of 7 immature birds collected contained the poison.

The age and sex class most heavily infected were the adult females, and it is not known if this chemical can be passed from the hen to the egg. The other possibility is that the young birds are acquiring the chemical from a local source. Heptachlor is used in New Brunswick in two ways. It is spread on sweet turnip fields as a dust to control wire worms at the time of planting in late May and early June, and later in the season it is used as a spray on the foliage of carrots and strawberries. The size and extent of the areas so treated are at present unknown, but they are a very small proportion of the habitat. If these areas are the source of the infestation it indicates a woodcock feeding habit that has not been observed here.

Wherever the poison is coming from it is present in New Brunswick woodcock at an average rate of 1.5 mcc/c in the fall when these birds are extensively used as human food. The Tolerance Level for this chemical in human food in the United States is Zero.

Future Plans

1. To determine the amount and distribution of heptachlor used in agriculture in New Brunswick.
2. To test the possibility that the poison is being passed from hen to chick by analysis of a small number of hens and their eggs, and a small number of hens and chicks.

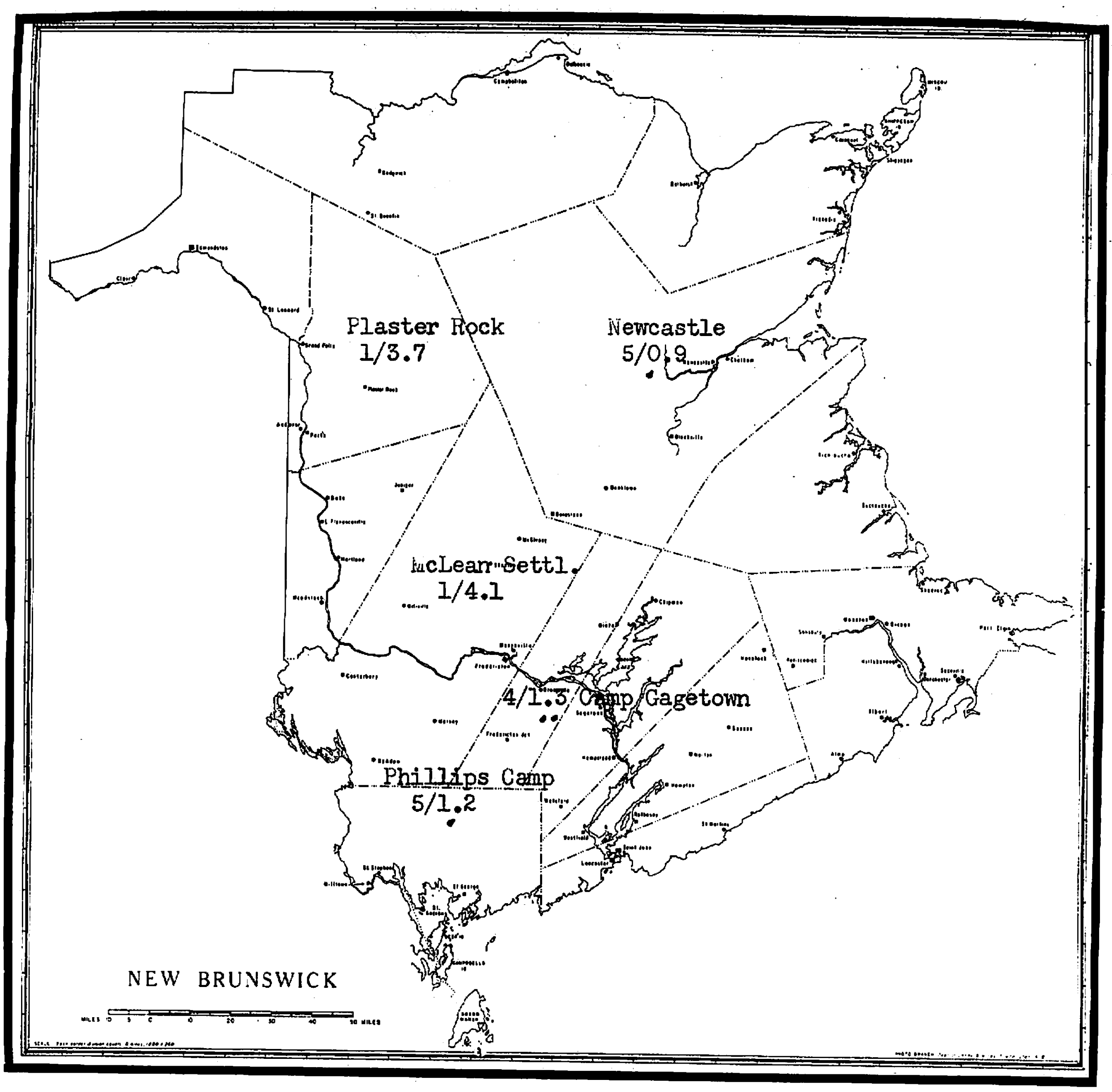
References

Wright, Bruce S. 1960. Woodcock reproduction in DDT-sprayed areas of New Brunswick. J. Wildl. Mgmt. 24 (4), October 1960. pp 419-420.

HEPTACHLOR INFECTED WOODCOCK FALL 1959

16 specimens
62% infected

Range of infection 0 - 4.3 mcc/c heptachlor epoxide
Average infection 1.5 mcc/c " "
Adult females most heavily infected



No. Birds analysed / average infection mcc/c

Immature bird infected •

Made in United States of America
Reprinted from THE JOURNAL OF WILDLIFE MANAGEMENT
Vol. 24, No. 4, October, 1960
pp. 419–420

WOODCOCK REPRODUCTION IN DDT-SPRAYED AREAS OF NEW BRUNSWICK

Bruce S. Wright

Northeastern Wildlife Station, University of New Brunswick, Fredericton, New Brunswick

Chlorinated hydrocarbon pesticides (and some others) have a drastic effect on the reproduction of quail and pheasants under laboratory conditions (DeWitt, 1955, 1956; DeWitt, *et al.*, 1955). Even minute quantities in the diet of adult birds reduced the number of chicks produced, and increased percentages of crippled and defective chicks. Young birds from these experimental groups were highly susceptible to the test compounds, and few, if any, survived when fed at levels which permitted survival of chicks from normal (undosed) parents.

This paper presents observations on the proportion of young woodcock (*Philohela minor*) in samples taken from sprayed and unsprayed areas of New Brunswick which indicate that similar toxic effects may have been caused in woodcock by the continued spraying of breeding grounds with DDT for spruce budworm control.

The sample birds were collected by cooperators and staff of the Northeastern Wildlife Station. Sex and age determinations of the 1959 birds were made by the Section of Population and Distribution Studies of the Bureau of Sport Fisheries and Wildlife of the U.S. Fish and Wildlife Service. Most of the collecting was done in the Tobique Valley, but birds were collected as opportunity afforded in all parts of the sprayed zone. This area covers the greater part of New Brunswick north of the Miramichi River.

SPRAY PROGRAM

The New Brunswick spruce budworm control program has been described in detail by Webb (1959). The spray program and the schedule of woodcock collecting are shown in Tables 1 and 2. The dosage used was usually ½ lb. of DDT per acre, but some areas received 1 lb. of DDT per acre in the first year of the operation. The whole area was sprayed once, but most of it was resprayed from one to five times from 1952 through 1958.

WOODCOCK SAMPLE

A total of 105 woodcock were collected in the sprayed area, and 660 were collected in the unsprayed areas in the period 1953 through 1958. All birds were collected between September 20 and November 4. They were aged by primary wear following Sheldon, *et al.* (1958), and sexed by primary width following Greeley (1953).

RESULTS

The proportion of young in the fall bag is shown in Table 2. The statistical significance of these results was tested by the chi-square test (Snedecor, 1956). The results showed a highly significant dif-

TABLE 1.—SPRAY PROGRAM FOR SPRUCE BUDWORM CONTROL IN NEW BRUNSWICK

Year	Area Sprayed or Resprayed (square miles)
1952	300
1953	2,800
1954	1,800
1955	1,800
1956	3,100
1957	8,100
1958	4,100
Total	22,000

TABLE 2.—COMPARISON OF YOUNG WOODCOCK IN THE FALL BAG IN THE SPRAYED AND UNSPRAYED AREAS OF NEW BRUNSWICK

Year	Sample		Percentage Immature	
	Sprayed	Unsprayed	Sprayed	Unsprayed
1953[1]	19	50	37	44
1954	12	62	17	50
1955	14	27	21	52
1958	60	512	20	45
Total	105	660		
Mean			23	45

[1] Since spraying took place in June 1953 after the hatch was off, this year can be taken as unsprayed for purposes of comparison.

ference between sprayed and unsprayed areas in 1958 after the area had been sprayed or resprayed up to five times. The totals of all years' spray on the ground also showed a highly significant difference between the sprayed and unsprayed areas.

All data indicated a decrease in the proportion of young in the sprayed area. The decrease was of a highly significant level in both comparisons made with the total sample of the areas for which a reasonably large sample of birds were available. The trend of every measurement was in the same direction.

In 1959, 65 of 856 woodcock collected were from the spray zone as it is the least hunted and most inaccessible. The remainder came from unsprayed areas to the south and southwest. No spraying was done in 1959, so that the area represented the condition 1 year after spraying and respraying for 6 years had ceased.

Table 3 compares the proportion of young in the fall bag in and out of the spray zone in 1959 with conditions in 1958, the last year of spraying. In 1958 there was only 20 percent young in the sprayed area. In 1959, a year after spraying ceased, there was 49 percent young in this area. This is an increase of 145 percent in a year when young in two unsprayed control areas increased only 31 and 33 percent respectively. This difference suggests that breeding success may have been materially affected

TABLE 3.—COMPARISON OF YOUNG WOODCOCK IN THE FALL BAGS FROM THE SPRAYED AND UNSPRAYED AREAS OF NEW BRUNSWICK, 1958–59

Zone	Year	Sample	Percentage Immature	Percentage Increase
Unsprayed				
Central	1958	521	45	
	1959	545	59	31
Southern	1958	115	48	
	1959	246	64	33
Sprayed				
Northern	1958	60	20	
	1959	65	49	145

by the successive sprayings the area had been subjected to, and as the 49 percent young in the sprayed area was still below the 59 percent and 64 percent in the unsprayed areas that year, it indicates that the sprayed area had not completely recovered from spray effects in one year.

DISCUSSION

This note describes observations of the proportion of young birds in a sample of the population, but does not represent a systematic determination of the effect of pesticides upon the reproduction of woodcock. It does not establish that these differences are typical of the populations, or that they are attributable to effects of the pesticide. It reports a phenomenon that has occurred and has been measured by the only method available. The 1960 plans for the budworm spray call for an additional 2½ million acres of the much more accessible central zone to be sprayed. This zone contains a much higher density of breeding woodcock than the northern zone, and it is heavily hunted. The study will be continued in this area.

In 1959, a further complication was added. A sample of 10 woodcock collected in New Brunswick in June was analyzed by the Section of Chemical, Physiological, and Pesticide–Wildlife Studies of the U.S. Fish and Wildlife Service. They were found to contain 0.18 p.p.m. of heptachlor epoxide, proving that they had been exposed to heptachlor during their stay on the winter range. This was presumably the heptachlor application of the U.S. Department of Agriculture's fire ant eradication program in the southeastern states where banding returns show birds from this region winter. Thus New Brunswick woodcock are now shown to be exposed to pesticide poisoning at both ends of their migratory range.

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Received for publication April 25, 1960.

14-0-31

CANADA DEPARTMENT OF FORESTRY

FOREST BIOLOGY DIVISION
K.W. NEATBY BUILDING
CENTRAL EXPERIMENTAL FARM

YOUR FILE No:

OUR FILE No: 7.9.14

OTTAWA, CANADA
February 1, 1961

MEMORANDUM TO:

Dr. A. L. Pritchard
Dr. J. L. Kask
Mr. H. W. Beall

Herewith copies of a report prepared by Mr. Corlett on work undertaken with Thuricide, sponsored by the Canadian Wildlife Service. These have just been supplied by Mr. Mair who presented a brief verbal summary of the main conclusions at the October 31 meeting of the Interdepartmental Committee.

Three copies are being sent to Dr. Pritchard and Dr. Kask so they can distribute copies to their field establishments, if they so desire.

M. L. Prebble,
Director,
Forest Biology Division.

MLP/kp

INVESTIGATIONS OF THE EFFECTS OF *Bacillus thuringiensis* ON MAMMALS

By

G.R. Corlett, B.Sc.

A Canadian Wildlife Service research project
carried out at the University of Ottawa

January 1961

INVESTIGATIONS OF THE EFFECTS OF *Bacillus thuringiensis* ON MAMMALS

By G.R. Corlett

Abstract

"Thuricide", the new live insecticide based on the viable spores of the micro-organism *Bacillus thuringiensis* Berliner is non-toxic for warm-blooded animals. This characteristic has been established in a series of tests, indicating that "Thuricide" can be used on agricultural crops as protection against leaf-eating insects without harm to mammals.

Introduction

"Thuricide" is a live biological insect control agent. The active principle is live spores of the micro-organism *Bacillus thuringiensis*, a bacterium first isolated in 1911 by Berliner from diseased larvae of the Mediterranean flour moth (2).

Bacillus thuringiensis and some vicinal species catabolize a protein-like substance found in crystal form in the cultures. The ingestion of this substance causes paralysis and death in larvae of Lepidoptera (1, 2, 5).

"Thuricide" has been used initially against leaf-eating insects. In Ontario and New Brunswick, "Thuricide" has been used in trials against spruce budworm and the hemlock looper with encouraging results (5).

"Thuricide" is unique in that it is a fatal, quick-acting disease for susceptible insects and yet is non-toxic for man, other mammals, birds, and fish.*

* In a recent internal mimeographed report from the Fisheries Research Board of Canada Biological Station, Nanaimo, B.C., dated October 1960, tests conducted in fresh water against young coho salmon (*Oncorhynchus kisutch*) averaging 5 cm. in length led to the following conclusion: "Although the Thuricide preparation is concluded to be toxic, its potency appears to be much lower as a piscicide than the "standard" material in use, DDT. Comparable 48-hour median tolerance limits of DDT- and Thuricide-oil preparations have been estimated at 0.08 mg/L. respectively. A promising departure from the high order of toxicity of DDT is indicated on the basis of these findings."

Experimental

The toxicological studies on "Thuricide" were as follows:

(1) Investigation of the concentration of live bacteria in "Thuricide".

(2) Estimation of virulence of "Thuricide".

(a) Oral administration of (i) a saline suspension of "Thuricide".

(ii) an emulsion of "Thuricide" in furnace oil.

(b) Oral administration of a broth culture of "Thuricide"

(3) Investigation of virulence increase by the "passage" method.

(1) Investigation of the concentration of live bacteria in "Thuricide".

The "Thuricide" concentrate (Bioferm sample SO-69) used in these tests contained approximately 45×10^9 viable spores of Bacillus thuringiensis Berliner per gram. In addition to the active spores, the product contained a diatomeaceous earth filler.

The spore count was determined by a plating method. "Thuricide" was diluted in saline (0.85%) to the following concentrations:

1:100; 1:1,000; 1:10,000; 1:100,000; 1:1,000,000; 1:10,000,000. One ml. of each dilution was inoculated into two petri dishes and nutrient agar added. The plates were incubated at room temperature for 40 hours. The number of colonies were counted, corrections made for the dilution factor, and the results averaged.

(2) Estimation of virulence of "Thuricide".

(a) (i) Ingestion of a 24% saline suspension of "Thuricide".

A 24% suspension of "Thuricide" in saline (0.85%) was made with carbomethoxyl cellulose (1%) added as support.

The suspension (dosage: 1 cc. per 100 grams body weight) was administered daily for one week to:

10 male white rats (160 - 180 grams),
10 male guinea pigs (300 - 350 grams, at least 5 days after weaning),
10 male white mice (17 - 20 grams).

Saline alone was administered to as many rats, guinea pigs, and mice serving as controls.

The suspension was placed directly in the stomach by means of a syringe fitted with a ball-tipped feeding needle.

The animals were weighed daily and observed for fifteen days following the last administration.*

No fatalities of mice, rats, or guinea pigs occurred due to "Thuricide" toxicity nor were any outward signs of toxicity observed. The animals remained healthy and continued to increase in body weight. Gross examination of tissues revealed no differences from the control groups. Bacteriological examinations of heart, blood, and liver on nutrient agar were negative.

(a) (ii) Ingestion of a 23.8% oil emulsion of "Thuricide".

Since in the field "Thuricide" is applied in an emulsion of furnace oil, it was decided to ascertain whether or not the oil would increase the toxicity of the organism. An emulsion of 23.8% "Thuricide" in furnace oil was prepared (3). The "Thuricide" emulsion was placed directly in the stomach by means of a syringe with a ball-tipped feeding needle. The emulsion was administered at the dose of 1 cc. per 100 grams body weight, to:

10 male white rats (240 - 278 grams),
10 male guinea pigs (270 - 425 grams, at least 5 days after weaning).

Here again the same number of animals, receiving only furnace oil, served as controls.

The animals were weighed at regular intervals and observed for fifteen days following the last administration.

Both experimental and control animals became very ill with vomiting and loss of appetite after one feeding. One rat of the experimental group died 24 hours after the first feeding. Gross examination of tissues revealed that the stomach and intestines were extensively ulcerated. Control animals exhibited the same lesions on examination. Due to the very weakened condition of the animals, the administration of the emulsion was discontinued after one day. Six days later the remaining rats began to gain weight. Gross examination of tissues after fifteen days revealed that the rats (experimental and control groups) had completely recovered from the effects of the oil - the tissues were healthy and no different from those of animals which were not given an emulsion.

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*(Because of initial poor technique, five guinea pigs died due to trauma and esophageal puncture. The test was repeated on a second group.)

The administration of the emulsion to the guinea pig group was discontinued after the second day. However, all the guinea pigs (experimental and control groups) died within seven days of the first administration. Gross examination of the tissues revealed that the stomach and intestines were extensively ulcerated.

Since both experimental and control animals exhibited the same symptoms (vomiting, progressive loss of weight, and extensive ulceration of the digestive tract), the effect must have been due to the furnace oil and not the "Thuricide" contained in the emulsion.

(b) Ingestion of a broth culture of "Thuricide".

A nutrient broth was inoculated with "Thuricide" and incubated for approximately 96 hours at room temperature, then checked for total sporulation. After it had been determined that sporulation was completed, a 96-hour broth culture was administered daily (dosage: 1 cc. per 100 grams body weight) for one week, to:

10 male white rats (160 - 190 grams)
10 male guinea pigs (335 - 416 grams, 5 days after weaning),
10 male white mice (17 - 20 grams),
and to an equal number of rats, guinea pigs, and mice receiving only the broth.

The dosage was placed directly in the stomach by means of a syringe fitted with a ball-tipped feeding needle. The animals were weighed regularly and observed for fifteen days after the last administration.

The animals showed no outward signs of toxicity and continued to increase in body weight. Gross examination of tissues revealed no differences from the control groups. Bacteriological examinations of heart, blood, and liver on nutrient agar were negative.

(3) Investigation of virulence increase by the "passage" method.

Ten male white rats were injected intraperitoneally with 1 ml. of a broth culture of "Thuricide" which had been incubated at room temperature for 72 hours. After 24 hours, each rat was injected intraperitoneally with 2 ml. of sterile broth, and 1 ml. of the drainage fluid was withdrawn from each rat. The withdrawn fluid was pooled, and each rat of a new group was injected intraperitoneally with 1 ml. This procedure was repeated on a third, fourth, and fifth group of ten rats each. The animals were observed for one week after the inoculation of the fifth group.

This investigation was repeated on five groups of five male guinea pigs each, and five groups of five male white mice each.

No fatalities occurred due to "Thuricide" toxicity nor were any outward signs of toxicity observed. Gross examination of tissues revealed no differences from the control groups (same number of animals receiving only the vehicle). Bacteriological examinations of heart, blood, and liver were negative.

Of the rats, three control animals of the second control group and four control animals of the third control group died several days after inoculation. Gross tissue examination revealed severe irritation of the peritoneum, possibly resulting from the injection puncture.

During these investigations the animals were caged individually, fed a standard laboratory diet and water ad libitum.

Conclusions

The tests which have been described above indicate that the microbial insecticide "Thuricide" and its active principle Bacillus thuringiensis Berliner are harmless for warm-blooded animals.

In addition, the harmlessness of "Thuricide" to humans, other animals, beneficial insects, and fish (see footnote on page 1) has been indicated in other laboratories in Canada and the United States (3, 6).

Oral toxicity tests have been conducted on wild pheasants, and the results indicated that "Thuricide" was harmless to the birds. (4).

There have been no reports of toxicity of any kind to man, other mammals, birds, or beneficial insects since field application began in 1957 in the United States.

Acknowledgments

The advice and assistance of many people are gratefully acknowledged; among them are Dr. L.P.E. Choquette and Dr. Genest.

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F.P.C. 14-0-31

CANADA

DEPARTMENT OF FORESTRY
Forest Biology Division

Our File: 7.9.14

Motor Building
238 Sparks St.
Ottawa, Ont.
February 16, 1961

FEB 17 1961

MEMORANDUM TO:

Dr. A. L. Pritchard
Dr. J. L. Kask
Mr. H. W. Beall ✓
Mr. W. W. Mair

Re : Correction - Progress Report of December 20/60
<u>Pesticide Poisoning in New Brunswick Woodcock</u>

The attached notice has been received from Mr. B. S. Wright regarding a correction in the above-mentioned Progress Report, which was sent to you through this office January 25, 1961.

M. K. Pearson

(Mrs.) M. K. Pearson
for M. L. Prebble
Director
Forest Biology Division

MKP

COPY/kp

NORTHEASTERN WILDLIFE STATION

BRUCE S. WRIGHT
DIRECTOR

Operated Cooperatively by the
Wildlife Management Institute of Washington
D.C.

University of New Brunswick, Fredericton, N.B.

February 7, 1961

CORRECTION TO PROGRESS REPORT OF December 20, 1960

PESTICIDE POISONING IN NEW BRUNSWICK WOODCOCK

Due to a misprint the units used for the amount of Heptachlor Epoxide present is shown as mcc/c. This should read mcg/g - micrograms/gram.

(sgd) B. S. Wright

B. S. Wright
Director

GOVERNMENT OF CANADA

ACTION REQUEST

CGSB 6-GP-12
P.P. & S. Cat. 3433

TO

LOCATION

FOR:

FILE NO.

- [ ] ACTION
- [ ] APPROVAL
- [ ] COMMENTS
- [ ] DRAFT REPLY
- [x] INFORMATION
- [ ] INVESTIGATION
- [ ] MORE DETAILS
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PREPARE MEMO TO:

REPLY FOR SIGNATURES OF:

REMARKS:

FROM | PHONE | LOCATION | DATE

MEMORANDUM TO:

Dr. A. L. Pritchard
Dr. J. L. Kask
Mr. W. W. Mair
Mr. H. W. Beall

DEPARTMENT OF FORESTRY
CENTRAL REGISTRY

7.9.14
FE-16(1961)

February 18, 1961

Subject: Operational Spray Program against the Spruce Budworm, 1961

At the last meeting of the Interdepartmental Committee December 19 it was indicated that certain areas within the proposed spray area of 1961 seemed to represent particular hazard because of the persistence of rather high egg populations and moderate to heavy defoliation in the period 1958 to 1960. Dr. Balyea indicated that the past records were being examined and that a map would be prepared to show such areas where a second spray might be carried out in 1961.

I attach a copy of a map of New Brunswick just received from Dr. Balyea in which the hazard areas are shown in red. Attention is also drawn to three small areas shown in blue, representing recommendations for slight extensions to the west of the operational area.

I believe it is the present intention that areas marked in red should be sprayed a second time even though it may be practically impossible to carry out biological sampling after the first spraying in any substantial part of the territories marked in red. Certain features of this proposal require further discussion with our Fredericton Laboratory. If you have any special views I would appreciate them within the next week or so because I hope to be in touch with Dr. Balyea and other members of the Fredericton staff by late February or early March.

... 2.

 Ottawa, February 10, 1961

A number of proposals have been made for experimental studies in the eastern part of Zone 2 but the details are far from complete at this time.

M. L. Prebble,
Director,
Forest Biology Division.

MLP/mp

HWB/mes

Dr. M.L. Prebble

H.W. Beall

14-0-31

Operational Spray Program Against The Spruce Budworm, 1961.

Feb. 22/61.

Thank you for your memorandum of February 10th on the above subject.

2. I have no particular comment to make on the latest map received from Dr. Belyea.

H.W.B.

Herb:

No particular comments except areas (2) broken line called "Experimental spray area" are areas in which some spraying may be carried out; exact areas to be determined at a later date. The area as a whole (2) considered to have lower infestation and/or less economic value than areas enclosed by solid line.

Acadia is in such an area (2) but see Note 1 (b) on map.

These comments arise from previous map showing proposed areas to be sprayed by F.P.L.

GOVERNMENT OF CANADA

ACTION REQUEST

CGSB 6-GP-12
P.P.&S. Cat. 3433

TO: Mr Beattie

LOCATION: Birks Bldg.

FOR:

FILE NO.

- [ ] ACTION
- [ ] APPROVAL
- [ ] COMMENTS
- [ ] DRAFT REPLY
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PREPARE MEMO TO:

REPLY FOR SIGNATURES OF:

REMARKS:

FROM	PHONE	LOCATION	DATE
[signature]			

GOVERNMENT OF CANADA

ACTION REQUEST

CGSB 6-GP-12
P.P. & S. Cat. 3433

TO: [illegible] Redmond ekk

LOCATION: Mr. [illegible] Dast

FOR:

FILE NO.

☐	ACTION		
☐	APPROVAL	☐	NOTE & FORWARD
☐	COMMENTS	☐	NOTE & RETURN
☐	DRAFT REPLY	☐	REPLY, PLEASE
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☐	MORE DETAILS	☐	TRANSLATION
☐	NOTE & FILE	☐	YOUR REQUEST

PREPARE MEMO TO:

REPLY FOR SIGNATURES OF:

REMARKS:

Have you any comments, pse ?

No comment ekk

FROM [illegible] PHONE LOCATION DATE Feb 14

14-0-31

BRITISH COLUMBIA LOGGERS' ASSOCIATION
(INCORPORATED)

ROOM 401 - 550 BURRARD STREET
VANCOUVER 1, B.C.

Circular No.61-63

April 13,1961

Henry

To Members,
Pest Control Committee

Re: Kitimat Project

We wish to refer to the minutes of the meeting of the Pest Control Committee held on March 22nd,1961.

As suggested we asked the Forest Service and Alcan whether or not they wished the Pest Control Committee to proceed with this work. In reply Mr.H.B.Forse expressed his appreciation of the work done by this Committee. The Forest Service feels, however, that since 70% of the timber affected belongs to the Crown, the B.C.Forest Service will handle this spray project.

In answer to Mr.Forse's letter we have written to Victoria and asked that our Pest Control Committee be kept informed of further developments so that immediate steps may be taken if the infestation should spread to our Members' timber.

A.F.Douglas
Secretary-Manager

AFD:gh

14-0-31

BRITISH COLUMBIA LOGGERS' ASSOCIATION
(INCORPORATED)

ROOM 401 - 550 BURRARD STREET
VANCOUVER 1, B.C.

Minutes of the meeting of the Pest Control Committee held on Wednesday, March 22nd, 1961, at 11:00 a.m. in the Board Room - 550 Burrard Street, Vancouver.

PRESENT: Mr. G. Marples, Chairman.

Messrs. Bonney, Cameron, Hepher, Jackson, Kinghorn, McGhee, Richmond and the Secretary.

KITIMAT PROJECT: The Chairman had called this meeting for the purpose of discussing the Kitimat Saddle-Backed Looper Project, and to determine the responsibilities of all parties concerned.

Up to this time the infestation is confined to timbered land owned by the Crown and the Aluminium Company of Canada. Member companies' holdings are not yet affected, but in spring the infestation could spread to the surrounding timber. It was, therefore, felt that the Pest Control Committee should handle this project.

FINANCIAL COMMITMENTS: The Chairman pointed out that since it is not possible to obtain a helicopter on short notice, it will be necessary to plan the project well ahead of time.

He suggested that the Government as well as ALCAN, make firm commitments to reimburse the Association and authorize the B.C.L.A. in writing to proceed with the necessary preparations for this project.

OWNERSHIP: Mr. Bonney reported that of the 14,000 acres of timberland infested, only 2,500 acres or 18% of the land is owned by ALCAN. The timber on that land is Crown property, and Mr. Bonney therefore, felt that the Provincial Government should pay the cost for the protection of that timber.

The Chairman pointed out that the ratio of equity should be determined by agreement between the Forest Service and ALCAN, and is not the responsibility of this Association.

Members also agreed on the principle that in any spray project the cost of spraying should be borne by the parties whose timber is affected, and that parties owning timber in adjacent areas which are not infested could not be expected to contribute to the cost of the spray project.

This principle would, of course, not apply to initial surveys conducted for the purpose of determining whether or not a reported infestation required coordinated action. Such surveys should be conducted on an Association basis and paid out of Association funds.

KITIMAT SURVEY: As regards to the situation in the Kitimat area, Mr. Kinghorn reported that the Federal Forestry Biological Department will have a three man crew in the Kitimat area to observe the developments. In the first week of May, a check will be made on the pupae population, followed by a study of the moth flight in order to determine the spread of the infestation. The cost of this survey will be borne by the Federal Government. The survey will require a few hours flying time, and Mr. Bonney reported that one of ALCAN's helicopters will be available for the purpose. Total cost of flying time and incidentals is not expected to exceed $500 for each participating party.

SPRAY PROJECT: It was agreed that the first week of June appears to be the best time for spraying, as the insect is then in the most vulnerable stage.

The total cost of the project is estimated at $2.00 per acre. - ca $28,000.

FISH MORTALITY: Mr. Jackson stated that the Fisheries Department will also have an observation crew in the area. The Department is deeply concerned about the spring salmon in the Kitimat River, particularly having regard to the heavy dosage of DDT which may be required to kill the saddle-backed looper. This insect feeds on the understory of the forest which makes it even more difficult to spray from the air. It would appear that the dosage necessary for this project would be ½ lb. of DDT per acre. This could be applied in a solution of one gallon per acre containing ½ lb. of DDT or in a solution of 2 gallons per acre, each containing ¼ lb. of DDT.

It was felt that a helicopter provides better control of the spray and should be used over areas bordering streams. Alternatively, it may prove necessary to leave a swath of a ¼ mile along the streams unsprayed to prevent fish mortality.

RESOLUTION: It was then resolved that the Secretary be instructed to write to the Chief Forester and to the Aluminium Company of Canada, asking for firm commitments of each party's responsibility and a written authorization for the B.C.L.A. to proceed with the project.

AMBROSIA SPRAY PROJECT: Mr. Richmond reported that the various contracts between participating parties, Okanagan Helicopters and the Association have been completed. The necessary chemicals have been ordered and are expected to be delivered at the various destinations during the week of March 27th. It is expected that the actual spray project will commence on April 3rd. The Fisheries Department will provide skin divers to observe results of the spray on fish.

ADJOURNMENT: The meeting then adjourned.

Chairman.

AFD:gh

Ps. B F.
April 25 AM.
[handwritten initials]

14-0-31

Canada
Department of Forestry
Forest Entomology and Pathology
Branch
Ottawa 2

Our file: 7.9.14

April 18, 1961

MEMORANDUM TO:

Dr. A. L. Pritchard,
Dr. J. L. Kask
Mr. W. W. Mair
Mr. H. W. Beall ✓

Subject: Meeting of Interdepartmental Committee on Forest Spraying Operations

In confirmation of my telephone conversations with members of the Committee yesterday, a meeting of the Committee is scheduled for Tuesday, April 25, 3:30 p.m. It will be held in the Tupper Building, Riverside Drive, and I suggest that we meet at Dr. Pritchard's office. The group will be small, consisting of not more than 7 or 8, so I suggest that Dr. Pritchard may decide whether to hold the meeting in his office or in a Board Room of the Tupper Building.

The chief point for discussion is the experimental program to be carried out in New Brunswick and Nova Scotia. Dr. Fettes will be able to report on this as result of a recent trip to Fredericton.

I have extended an invitation to Dr. Henry Hurtig of the Research Branch of the Department of Agriculture to attend owing to his interest in insecticide problems and hazards to other forms of life.

M. L. Prebble,
Director.

MLP/kp

cc: Dr. J. J. Fettes
Dr. H. Hurtig
Dr. R. M. Belyea

STATEMENT OF PLANS FOR AIRPLANE SPRAY EXPERIMENTS NEW BRUNSWICK 1961 FOR CONSIDERATION BY THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

The following plan was drawn up by members of the Forest Entomology and Pathology Branch at a meeting in Ottawa, February 23, 1961. A meeting in Fredericton, April 13th and 14th, comprising representatives of Fisheries Research Board, Forest Protection Limited, the Department of Fisheries and the Forest Entomology and Pathology Branch, confirmed the plan and agreed on a number of details (see below):

"BRIEF SUMMARY OF DISCUSSIONS IN OTTAWA, FEBRUARY 23, 1961

Present at Discussions: M. L. Prebble
J. J. Fettes
D. G. Mott
R. M. Belyea

1. Operational Testing of Spray Concentrations and Timing <u>with Respect to Budworm Control on Balsam Fir and Spruce</u>

(a) Experimental Spray Block Requirements

(i) Check block (no spray)
(ii) Block sprayed once with 12% DDT formulation
(iii) " " " " 6% " "
(iv) " " twice " 6% " "

It was agreed that the above represented the basic requirements for these tests, and that further timing regimes with 6% formulation might be added if resources prove sufficient to handle them adequately.

(b) Population Assessments (on check and all spray blocks)
(i) Pre-spray larval assessment
(ii) post first application larval assessment
(iii) post second " " "
(iv) pupal assessment
(v) egg mass "

(c) Spray Deposit Assessment

- in all sprayed blocks

(d) Responsibility

Forest Biology Laboratory, Fredericton, fully responsible for tests; Chemical Control Section to assist in deposit assessment as mutually agreed on by field supervisors.

2. Phosphamidon Testing, with Respect to Budworm Control on Balsam Fir and Spruce

a new promising insecticide - "systemates"

(a) Experimental Spray Block Requirements

(i) Check area (same area as in 1(a)(i) above)
(ii) 8 pray blocks necessary to test 2 formulations, 2 concentrations, and 2 volumes of spray
(iii) Single applications of spray only, timed as closely as possible to single applications in 1(a) above.
Note: These spray blocks need not be as large as those in 1(a) above.

(b) Population Assessments (on all spray blocks)

(i) pre-spray larval assessment
(ii) post-spray larval assessment
(iii) pupal assessment (possibly)

(c) Deposit Assessment

- in all sprayed blocks

(d) Responsibility

Chemical Control Section fully responsible for tests; Forest Biology Laboratory, Fredericton, to assist in population assessments as mutually agreed on by field supervisors.

3. Decca Navigational Aid Testing

It was agreed that tests should be located where most convenient for Decca installations and where deposit can be assessed in coniferous stand, but that effect of deposit on budworm need not be considered. It was thought that a suitable area might be found in the Truro, N. S. area, and that the tests would follow completion of operational spraying in New Brunswick.

(a) Responsibility

Chemical Control Section fully responsible for tests. Forest Biology Laboratory, Fredericton, agreed to look into question of suitable area (including accessibility and availability of airports) and to undertake necessary contact with Nova Scotia Government.

4. Studies of the Fate of DDT in Water

Studies of the mode of action and effects of DDT on aquatic fauna will continue in conjunction with Fisheries Research Board personnel.

(a) Responsibility

Chemical Control Section; Forest Biology Laboratory will assist in any way possible.

5. Thuricide Testing

If further Thuricide tests are decided on (if improvement in formulation warrants) it was agreed that they should be planned and conducted jointly by Chemical Control Section and Forest Biology Laboratory, Fredericton.

General

Forest Biology Laboratory will be making direct arrangements with Forest Protection Ltd. for 1, above; Chemical Control Section will be making similar direct arrangements for 2 and 3. Chemical Control Section will be making direct arrangements with Fisheries personnel for 4. No arrangements being made for 5 until decision made on whether aerial tests warranted in 1961.

Fredericton, N.B.
February 27, 1961.

Richard M. Belyea"

SUMMARY OF DISCUSSIONS IN FREDERICTON, APRIL 13th and 14th, ON EXPERIMENTAL AERIAL SPRAYING PROGRAM 1961

Present at discussions:

J. C. Kerswill, Fisheries Research Board
H. Edwards, Dept. of Fisheries
B. W. Flieger, Forest Protection Limited
D. G. Mott, Forest Entomology & Pathology Br.,
R. M. Belyea, " " "
J. J. Fettes, " " " .

Also present for specific points of discussion:

F. G. Cuming and R. G. Clark.

There was a general agreement on the experimental program as presented above. Mr. Flieger indicated that arrangements for the necessary aircraft service would be arranged through Wheeler Airways and Forest Protection Limited. The flying for all of the operation, with the exception of the Decca testing, would probably be from the Dunphy Airport.

Under heading 2 of the program it was agreed that observation on the effect of Phosphamidon on balsam woolly aphid would be made under the direction of R. G. Clark. It was not felt that a full-scale population check could be done within the present facilities but every attempt would be made to appraise the gross effects of Phosphamidon. If one of the Phosphamidon versus Budworm Plots could be located in an area in which balsam woolly aphid was active, no extra flying would be entailed. However, if it were to the convenience of Mr. Clark to have a portion of aphid-infested forest sprayed for his express purposes, arrangements could be made.

Under heading 3 of the program, it was suggested by Mr. Cuming that an area near Truro, N. S. would be suitable for the Decca navigational aid test and that he would confirm the area and arrange the necessary authority for its use.

Under heading 4 of the program, it was agreed by all concerned that the Molus river watershed would be the most suitable for a study of the fate of DDT in water and its effects on aquatic fauna. The watershed would be sprayed in an operational schedule and the Fisheries Research Board, Dr. Fred Ide and W.W.Hopewell would collaborate in the study. The final decision to use the Molus watershed will depend on Dr. Ide but it is not likely that the location will be changed.

Under heading 5, it has not been finally decided to test Bacillus thuringiensis in 1961. The decision is pending an improvement in formulation. The formulation which was used in 1960 had a tendency to flocculate and resulted in clogging of apparatus and caused an uneven distribution of Bacillus concentration within the plots. The manufacturers of B.t. are currently working on a new formulation which will be used in aerial spray testing if it is completed and satisfactory in time.

Negotiations have begun with Dr. Waldichuk of the Nanaimo Biological Station, Fisheries Research Board, to carry out tolerance tests of young salmon to Phosphamidon. The decision to initiate the tests depends on whether or not the personnel at Nanaimo can add to its present program.

The details of the program are being worked out by the persons involved.

Ottawa, Ont.
April 25, 1961.
JJF/M

James J.Fettes,
Head, Chemical Control Section.

COPY/kp

DEPARTMENT OF FISHERIES

Maritimes Area

Office of the Area Director

Halifax, N.S.

April 25, 1961

Dr. M. L. Prebble,
Chairman, Interdepartmental Committee,
Forest Spraying,
Department of Forestry,
Ottawa, Ontario.

Dear Dr. Prebble:

Enclosed herewith is a sample copy of the 1961 New Brunswick spray map. Attached to the map you will see arrows indicating Fish Hatchery and Rearing Pond sites as well as one area in which the Fisheries Research Board operates an experimental program.

In accordance with a decision reached at the Interdepartmental level, a map indicating areas which Fisheries and Research Board people wish to have exempted from spraying, will be sent to those concerned. Before this is to be done, however, it was felt that the map should have the approval of the Committee Chairman. When the necessary approbation is received, copies of the map will be sent to the following:

1. Mr. D. G. Mott
2. Mr. B. W. Flieger
3. Coordinator at Taxis Airstrip.

The map which will be sent to Mr. Mott will contain some additional information. The locations of sites where caged fish tests are to be held in 1961 will also be shown.

You may retain the enclosed map if you so desire. Further distributions will be delayed, however, pending advice from you.

Your comments and/or approval will be greatly appreciated.

Yours very truly,

(Sgd) H. E. Edwards
for Chief, Fish Culture Branch
Maritimes Area.

Administration Branch

14-0-31

HWB/BB

OTTAWA, April 26, 1961.

Dr. J.L. Kask,
Chairman,
Fisheries Research Board,
Sir Charles Tupper Building,
Ottawa, Ontario.

Dear Dr. Kask:

In accordance with your request at yesterday's meeting, I enclose herewith a chart showing the main organizational structure of the Department of Forestry.

Yours very truly,

H.W. Beall,
Director.

MEMORANDUM • GOVERNMENT OF CANADA

TO : FILE | YOUR FILE No:

FROM : H.W. Beall | OUR FILE No: 14-0-31

SUBJECT: Spraying for Mosquito Control - Camp Gagetown | DATE: April 26/61

Dr. H. Hurtig of the Research Branch, Department of Agriculture, said at a meeting of the Interdepartmental Committee on Forest Spraying Operations on April 25th that the R.C.A.F. has done small spraying operations with Dakota aircraft, in the vicinity of the main army headquarters at Camp Gagetown, for several years.

2. The usual dosage is 1 lb. per acre, and time of application about May 15th. It is expected that about 10 square miles will be done in 1961.

3. Further information re mosquito control spraying on military areas may be obtained from Mr. A.B. Windmill, Surgeon-General's Office, N.D.H.Q., Ottawa.

H.W.B.

CGSB Standard 6-GP-22; PP&S Cat. No. 3590 cc: Mr. H. W. Beall

14-0-31

Canada
Department of Forestry
Forest Entomology and Pathology
Branch
Ottawa 2

Our file: 7.9.14

April 28, 1961

Mr. H. E. Edwards,
Fish Culture Branch,
Canada Department of Fisheries,
Halifax, N.S.

Dear Mr. Edwards:

Thank you for your letter of April 25 and the accompanying map of the proposed budworm spray project of New Brunswick, 1961, on which are indicated the areas in which the Fisheries Department and the Fisheries Research Board wish to have exempted from spraying. All of the proposed exemptions are well separated from the indicated boundaries of the spray project area and should, therefore, be safely preserved from contamination, with the exception of the proposed exemption to the southwest of North West Bridge on the Miramichi River. I believe that Forest Protection Limited, the New Brunswick Government and our Forest Entomology and Pathology Laboratory in Fredericton are well aware of the importance of having this area exempted from spraying in 1961 with appropriate adjustment of the northeast boundary of the proposed spray project in that immediate area.

I think it would be appropriate, therefore, to distribute the map showing these areas to be exempted to Dr. R. M. Belyea, Officer-in-Charge of our laboratory at Fredericton, Attention: D. G. Mott; to Mr. Flieger; and to the Co-ordinator at the Taxis Airstrip. I note that the map going to Mr. Mott will contain information on the locations where caged fish tests are to be carried out in 1961.

I have checked the boundaries of the 1961 spray project with the map in my possession and found full agreement with the one that you have submitted. There is only one thing that you seem to have omitted in your copy, namely a small area proposed for re-spray on the west side of the Bantalor Game Refuge.

... 2.

Missing from your map, as well as from the one already in my possession, are the locations of blocks for experimental studies of different dosages of DDT and other insecticides between Chipman and Harcourt on the north side of the Salmon River. I believe these areas were recently outlined in joint discussions at Fredericton.

Yours sincerely,

M. L. Prebble,
Director.

MLP/kp

cc: Dr. A. L. Pritchard
Dr. J. L. Kask
Mr. W. W. Mair
Mr. H. W. Beall
Dr. R. M. Belyea

CANADA

DEPARTMENT OF FORESTRY

Birks Bldg. → 14-0-31

P. O. Box 428,
Fredericton, N. B.

905680

May 1, 1961.

DEPARTMENT OF FORESTRY
MAY 2 1961
CENTRAL REGISTRY

Mr. H. W. Beall,
Director, Administration Branch,
Department of Forestry,
Ottawa, Ontario.

Sir:

In response to your letter of April 26, I asked Mr. Doyle to get as much information as he could and he has prepared the enclosed memo.

I believe that if the area in question were in any other part of the Province, spraying would not be recommended. We will attempt to have more information for you later, as intimated in Mr. Doyle's memo.

Yours faithfully,

H. D. Heaney,
District Forest Officer.

Encl.

May 1, 1961.

Memo to H. D. Heaney, District Forest Officer

Re: Mr. H. W. Beall's April 26, 1961 letter, file 14-0-31

I obtained the following information relative to the deletion of the north part of the Camp Gagetown area from the aerial spraying map. Mr. Boynton hopes to obtain further details from Army authorities and Mr. Mott or I will discuss the matter with Mr. B. W. Flieger when he is in Fredericton again. Since I expect to be in Nova Scotia for the next few days, you may wish to let Mr. Beall know the situation at present.

Mr. Boynton believes that a separate spraying operation would not be justified from the management point of view. However, if spraying is being done to the Camp Gagetown boundary, then he believes that spraying of the north corner would be a worthwhile precaution.

Mr. Mott had just received a map showing the deletion of this area from the spray plan. Like Mr. Boynton he agrees that spraying is not justified from the management viewpoint. However, he explained that there are rather high egg populations in some of the screen areas between the artillery ranges. If these areas are not sprayed and there is much mortality, it could mean that a high fire hazard area would develop. Also, coalescence of these isolated spots could occur and in future years the facilities for spraying might not be available. Unofficially Mr. Mott believes that Forest Protection Limited may have made an arrangement with National Defence to spray a portion of the Camp for black flies and mosquitoes in the course of aircraft calibration being carried out from Blissville airport. However, the timing of this operation would be too early to do the budworm much harm.

While officials closer to the operation should make the recommendations, I believe that spraying will not take place in the north part of the Camp if the same yardstick is used to measure the need for spraying as is used elsewhere in the Province.

E. N. Doyle.

ACTION REQUEST

TO ~~[illegible]~~ [illegible] | DATE

LOCATION [illegible]

FROM [illegible] | RE FILE NO.

FOR:

[ ]	ACTION	[ ]	NOTE & FORWARD
[ ]	APPROVAL	[ ]	NOTE & RETURN
[ ]	COMMENTS	[ ]	P.A. ON FILE
[ ]	DRAFT REPLY	[ ]	REPLY DIRECTLY
[ ]	INFORMATION	[ ]	REPLY, PLEASE
[ ]	INVESTIGATE AND REPORT	[ ]	SEE ME, PLEASE
[ ]	INVESTIGATION	[ ]	SIGNATURE
[ ]	MAKE..................COPIES	[ ]	TRANSLATION
[ ]	MORE DETAILS	[ ]	YOUR REQUEST
[ ]	NOTE AND FILE	[ ]	....

PREPARE MEMO TO:..

REPLY FOR SIGNATURE OF:..

REMARKS Everyone seems to be sitting on the fence about this! Apparently it isn't a matter of major concern one way or the other. [illegible]

CGSB 6-GP-12 P.P.&S. CAT. 3433

Canada
Department of Forestry
Forest Entomology and Pathology
Branch
Ottawa 2

Our file: 7.9.14

May 2, 1961

MEMORANDUM TO:

Dr. A. L. Pritchard,
Dr. J. L. Kask,
Mr. W. W. Mair,
Mr. H. W. Beall. ✓

At the December 19 Meeting of the Interdepartmental Committee on Forest Spraying Operations members showed an interest in the possibility of visiting the spruce budworm spray project in 1961 and Mr. Flieger indicated that he could readily provide accommodation and transportation for seeing some of the operational phases of the work. I understand that Mr. Flieger still would be interested in having members of the Committee visit the operation. At the same time Dr. Belyea and Dr. Fettes could show the members some of the biological studies undertaken in connection with the operational project and also some of the experimental trials being carried out by the Forest Entomology and Pathology Branch.

It would probably be more satisfactory if the members visited the area jointly and the most suitable time would probably be in the early part of June. This is to prompt the members so that we may learn soon whether a joint visit is feasible so that necessary arrangements can be made with Mr. Flieger and others. Would you please let me know whether you are able to contemplate a trip to New Brunswick at the indicated time. I would think that about two or three days in the area would suffice.

M. L. Prebble,
Director.

MLP/kp

cc: Dr. R. M. Belyea
Dr. J. J. Fettes

c.c. sent Mr. Dyer.

HWB/BB

Dr. M.L. Prebble

H.W. Beall

14-0-42 -3/

Proposed Visit to Budworm Spraying Operation in New Brunswick

May 3, 1961.

Thank you for your memorandum of May 2nd on the above subject.

2. I am not planning to visit the New Brunswick spray operation this year, but Mr. D.A.S. Dyer will likely make the trip in connection with inspection of work done under the Federal Provincial Agreements. If a special trip for members of the interdepartmental committee is arranged, I would suggest that Mr. Dyer be included in the plans if agreeable to you.

3. Mr. D.R. Quirt, Secretary of the Air Transport Board, expressed an interest in visiting this operation some time ago and I understand that this would be quite acceptable to Mr. Flieger. It would, I think, be very helpful if arrangements could also be made for Mr. Quirt or his representative to join the interdepartmental committee's party.

H.W.B.

14-0-31

FISHERIES RESEARCH BOARD OF CANADA

(UNDER THE MINISTER OF FISHERIES)

769-67-2

Your file: 14-0-31

OFFICE OF THE CHAIRMAN
OTTAWA, CANADA

May 4, 1961.

905790

DEPARTMENT OF FORESTRY
MAY 5 1961
CENTRAL REGISTRY

Mr. H.W. Beall,
Department of Forestry,
Administration Branch,
Birks Building,
Ottawa, Canada.

Dear Mr. Beall,-

Many thanks for sending me an organizational chart of the Forestry Department. This is very useful. I shall watch you grow with interest.

Yours sincerely,

J.L. Kask,
Chairman.

14-0-31

CANADA

DEPARTMENT OF FORESTRY

Mr Dyer Beall

P. O. Box 428,
Fredericton, N. B.

May 9, 1961.

905905

Mr. H. W. Beall,
Director,
Administration Branch,
Department of Forestry,
OTTAWA, Ontario.

DEPARTMENT OF FORESTRY
MAY 10 1961
CENTRAL REGISTRY

Sir:

In your letter of April 26, 1961 you refer to the 1961 proposed spray area map which you saw at a recent meeting of the Inter-departmental Committee on Forest Spraying Operations. A copy of this map has been forwarded to you to-day under separate cover.

I have received no further information since my letter of May 1, 1961.

Map filed in Room 109 Norlite Bldg.

Yours faithfully,

H. D. Heaney
H. D. Heaney,
District Forest Officer.

CANADA

DEPARTMENT OF FORESTRY

Forest Entomology and Pathology Branch
Forest Entomology and Pathology Laboratory
College Hill, Fredericton, N. B.

May 11, 1961 File: 62.46

Director
Forest Entomology & Pathology Branch
Ottawa, Ont.

Herewith a map prepared by Mr. Mott from one provided by Forest Protection Ltd., showing the spruce budworm DDT aerial spraying plan for 1961 as laid out by spray blocks--only the outside boundaries of the spray blocks are indicated. You will note that spray blocks in 1961 will be rectangular in shape (for TBM aircraft) except in the Hartland area where old-style blocks (for Stearman aircraft) will be used--if the block layout this year is not clear to you, Dr. Fettes can bring you up to date on it. Incidentally, spray blocks designated for second treatment have been established independently of the initial spray blocks.

The experimental spray blocks are shown to the northeast of the check area, the area between the blocks and the check being reserved for Dr. Fettes' phosphomidon tests.

Richard M. Belyea
Officer-in-Charge

RMB:rmb
Encl.

c.c. Mr. H. D. Heaney

14-0-31

CANADA

DEPARTMENT OF FORESTRY

905997

P. O. Box 428,
Fredericton, N. B.

May 11, 1961.

Mr. H. W. Beall,
Director, Administration Branch,
Department of Forestry,
Ottawa, Ontario.

Sir:

I am forwarding under separate cover a map showing the spruce budworm DDT aerial spraying plan for 1961. Dr. Belyea supplied me with two copies of this map and requested that one be sent to you.

Attached is a copy of Dr. Belyea's letter which accompanied the map he sent to Dr. Prebble.

Yours faithfully,

H. D. Heaney,
District Forest Officer.

Att:

Done

14-0-31

CANADA

DEPARTMENT OF FORESTRY

906105

File Jan 19/61

P. O. Box 428,
Fredericton, N. B.

May 15, 1961.

Mr. H. W. Beall,
Director, Administration Branch,
Department of Forestry,
Ottawa, Ontario.

Sir:

Please refer to my letter of May 1 and the attached memo of Mr. Doyle. Further to this the deletion of the north end of Camp Gagetown from the 1961 proposed aerial spray area was discussed with Mr. B. W. Flieger of Forest Protection Limited. Mr. Flieger said that this area was deleted because officials of the Forest Entomology and Pathology Branch consider that spraying is unnecessary there at this time.

Yours faithfully,

C. H. D. Heaney

H. D. Heaney,
District Forest Officer.

14-0-31

CANADA
DEPARTMENT OF FORESTRY
Forest Entomology and Pathology
Branch
Ottawa 2

Our files: ~~7.9.14~~
VZ-1

May 18, 1961

MEMORANDUM TO:

Dr. A. L. Pritchard
Dr. J. L. Kask
Mr. W. W. Mair
Mr. H. W. Beall ✓

Subject: Saddle-backed looper infestation,
Kitimat, B.C.

To supplement brief remarks made at the last meeting of the Interdepartmental Committee on Forest Spraying Operations this will let you know that our Victoria staff have found evidence of only slight overwintering mortality of the looper pupae in the Kitimat area. During early May moths have been emerging and laying eggs and the B.C. Forest Service is making plans to spray about 10,500 acres of the infested area. It is expected that helicopter will be used for the aerial application and that the DDT formulation will be ½ lb. per gallon applied at the rate of 2 gallons per acre.

I am informed that mutually satisfactory arrangements have been worked out among the B.C.Forest Service, the Vancouver office of the Fisheries Department, and our Victoria Laboratory. It is expected that spraying should start about June 20.

M. L. Prebble,
Director.

MLP/kp

FILE No. ~~702-1-10~~

14-0-31

CANADA

DEPARTMENT OF FISHERIES
OTTAWA

file

906541

May 19, 1961.

Mr. H. W. Beall,
Director,
Administration Branch,
107 Sparks Street,
Ottawa, Ontario.

Dear Mr. Beall:

Enclosed please find a copy of the notes from the April 25 meeting of the Interdepartmental Committee on Forest Spraying Operations. Also enclosed is a copy of Appendix I referred to in these notes.

Yours very truly,

E. W. Burridge

E. W. Burridge,
Chief,
Fish Culture Development Branch.

Encl.

NOTES OF A MEETING OF THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS HELD IN THE SIR CHARLES TUPPER BUILDING, OTTAWA, ON APRIL 25, 1961, AT 3:30 PM.

In attendance were:-

Dr. M. L. Prebble (Chairman)	- Department of Forestry
Mr. H. W. Beall	- Department of Forestry
Dr. J. J. Fettes	- Department of Forestry
Dr. H. Hurtig	- Department of Agriculture
Dr. J. L. Kask	- Fisheries Research Board
Mr. W. W. Mair	- Canadian Wildlife Service Northern Affairs
Mr. E. W. Burridge (Secretary)	- Department of Fisheries

Dr. Prebble introduced Dr. Hurtig to the meeting as a specialist in the insecticide field who is interested in the development of methods of reducing hazards to fish and wildlife.

The Chairman referred to two earlier meetings held on February 23 and April 13-14 at which a plan was developed for the 1961 New Brunswick DDT spray program. Summaries of the discussions from the above meetings were circulated for the information of the Committee (copy attached as Appendix I) and during the meeting were reviewed by Drs. Fettes and Prebble.

Dr. Fettes explained that two applications of 6¼% DDT formulation were being applied in part of the 1961 project area because of forest characteristics, including considerable proportions of spruce and persistent budworm populations during recent years. It was stated that the first application would be limited to an 8 to 10 day period due to location of the spray area which is in one or two climatic zones. Dr. Fettes indicated that the Chemical Control Section would not participate in assessment of the DDT operational spray program apart from deposit assessment but would be involved in an experimental program to test the effectiveness of Phosphamidon in controlling budworm on balsam fir and spruce. The Fredericton laboratory would look after studies of spray effectiveness in the operational project.

Dr. Fettes referred to trials which are being set up to test the effectiveness of Decca Navigational Aid in forest spray programs. The increase in the total cost of an entire program of the magnitude of the 1961 New Brunswick operation would be approximately $30,000.00.

Dr. Prebble stated that aerial applications of Bacillus thuringiensis would be deferred until formulation problems have been overcome. If the difficulties are overcome by early summer of 1961, tests will be undertaken jointly by Chemical Control Section and Fredericton Forest Biology Laboratory.

Dr. Fettes referred to fisheries studies proposed for the Molus River. He added that Mr. Hopewell's work would be similar to that in previous years but would be confined to one area. Dr. Fettes stated that assistants would be available this year and if analyses are completed by the end of the season, aid will not be required from the Fisheries Research Board.

Mr. Beall expressed concern over the apparent omission of Camp Gagetown from the spray area. Dr. Hurtig indicated that this area is treated each year with DDT for mosquito control.

But this may not be [illegible] for fishermen

In referring to the spray area map it was indicated that the cross hatched area near the red "check area" will be used to test phosphamidon.

A brief explanation of systemic insecticides was given. Dr. Fettes suggested that it would be desirable to have tolerance tests run on phosphamidon at the Pacific Biological Station. No aquatic studies are planned for the present field tests of this compound.

The Chairman stated that the situation is unchanged from last fall at Kitimat in British Columbia where a saddle-back looper infestation is apparent. Extensive studies are to be undertaken this spring to assess the need for control measures. If required, they will be carried out by the B. C. Forest Service.

Dr. Kask stated that studies of delayed fish mortalities related to DDT exposure, to be undertaken at the University of New Brunswick, will be supported financially by Fisheries Research Board.

In reply to a question from Dr. Hurtig, Mr. Mair indicated that no study program on wildlife in DDT spray areas has been possible with the Service's present limited staff. He added that low concentration spray formulations applied in the Maritimes would have little effect on wildlife.

The meeting adjourned at 5:15 pm.

E. W. Burridge, Secretary.

APPENDIX I

STATEMENT OF PLANS FOR AIRPLANE SPRAY EXPERIMENTS NEW BRUNSWICK 1961 FOR CONSIDERATION BY THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS

The following plan was drawn up by members of the Forest Entomology and Pathology Branch at a meeting in Ottawa, February 23, 1961. A meeting in Fredericton, April 13th and 14th, comprising representatives of Fisheries Research Board, Forest Protection Limited, the Department of Fisheries and the Forest Entomology and Pathology Branch, confirmed the plan and agreed on a number of details (see below):

*BRIEF SUMMARY OF DISCUSSIONS IN OTTAWA, FEBRUARY 23, 1961

Present at Discussions: M. L. Prebble
J. J. Fettes
D. G. Mott
R. M. Belyea

1. Operational Testing of Spray Concentrations and Timing with Respect to Budworm Control on Balsam Fir and Spruce

(a) Experimental Spray Block Requirements

(i) Check block (no spray)
(ii) Block sprayed once with 12½% DDT formulation
(iii) " " " " 6¼% " "
(iv) " " twice " 6¼% " "

It was agreed that the above represented the basic requirements for these tests, and that further timing regimes with 6¼% formulation might be added if resources prove sufficient to handle them adequately.

(b) Population Assessments (on check and all spray blocks)

(i) Pre-spray larval assessment
(ii) Post first application larval assessment
(iii) Post second " " "
(iv) Pupal assessment
(v) Egg mass "

(c) Spray Deposit Assessment

- in all sprayed blocks

(d) Responsibility

Forest Biology Laboratory, Fredericton, fully responsible for tests; Chemical Control Section to assist in deposit assessment as mutually agreed on by field supervisors.

2. Phosphamidon Testing, with Respect to Budworm Control on Balsam Fir and Spruce

(a) Experimental Spray Block Requirements

(i) Check area (same area as in 1 (a) (i) above)
(ii) Spray blocks necessary to test 2 formulations, 2 concentrations, and 2 volumes of spray
(iii) Single applications of spray only, timed as closely as possible to single applications in 1 (a) above.

Note: These spray blocks need not be as large as those in 1 (a) above.

(b) Population Assessments (on all spray blocks)

(i) Pre-spray larval assessment
(ii) Post-spray larval assessment
(iii) Pupal assessment (possibly)

(c) Deposit Assessment

- in all sprayed blocks

(d) Responsibility

Chemical Control Section fully responsible for tests; Forest Biology Laboratory, Fredericton, to assist in population assessments as mutually agreed on by field supervisors.

3. Decca Navigational Aid Testing

It was agreed that tests should be located where most convenient for Decca installations and where deposit can be assessed in coniferous stand, but that effect of deposit on budworm need not be considered. It was thought that a suitable area might be found in the Truro, N.S. area, and that the tests would follow completion of operational spraying in New Brunswick.

(a) Responsibility

Chemical Control Section fully responsible for tests. Forest Biology Laboratory, Fredericton, agreed to look into question of suitable area (including accessibility and availability of airports) and to undertake necessary contact with Nova Scotia Government.

4. Studies of the Fate of DDT in Water

Studies of the mode of action and effects of DDT on aquatic fauna will continue in conjunction with Fisheries Research Board personnel.

(a) Responsibility

Chemical Control Section; Forest Biology Laboratory will assist in any way possible.

5. Thuricide Testing

If further Thuricide tests are decided on (if improvement in formulation warrants) it was agreed that they should be planned and conducted jointly by Chemical Control Section and Forest Biology Laboratory, Fredericton.

General

Forest Biology Laboratory will be making direct arrangements with Forest Protection Ltd. for 1, above; Chemical Control Section will be making similar direct arrangements for 2 and 3. Chemical Control Section will be making direct arrangements with Fisheries personnel for 4. No arrangements being made for 5 until decision made on whether aerial tests warranted in 1961.

Fredericton, N. B.
February 27, 1961.

Richard M. Belyea

SUMMARY OF DISCUSSIONS IN FREDERICTON, APRIL 13th and 14th, ON EXPERIMENTAL AERIAL SPRAYING PROGRAM 1961

Present at discussions: J.C. Kerswill, Fisheries Research Board
H. Edwards, Dept. of Fisheries
B. W. Flieger, Forest Protection Limited
D.G. Mott, Forest Entomology & Pathology Br.
R.M. Belyea, " " "
J.J. Fettes, " " "

Also present for specific points of discussion:

F.G. Cuming and R.C. Clark.

There was a general agreement on the experimental program as presented above, Mr. Flieger indicated that arrangements for the necessary aircraft service would be arranged through Wheeler Airways and Forest Protection Limited. The flying for all of the operation, with the exception of the Decca testing, would probably be from the Dumphy Airport.

Under heading 2 of the program it was agreed that observation on the effect of Phosphamidon on balsam woolly aphid would be made under the direction of R.C. Clark. It was not felt that a full-scale population check could be done within the present facilities but every attempt would be made to appraise the gross effects of Phosphamidon. If one of the Phosphamidon versus Budworm Plots could be located in an area in which balsam woolly aphid was active, no extra flying would be entailed. However, if it were to the convenience of Mr. Clark to have a portion of aphid-infested forest sprayed for his express purposes, arrangements could be made.

Under heading 3 of the program, it was suggested by Mr. Cuming that an area near Truro, N.S. would be suitable for the Decca navigational aid test and that he would confirm the area and arrange the necessary authority for its use.

Under heading 4 of the program, it was agreed by all concerned that the Molus river watershed would be the most suitable for a study of the fate of DDT in water and its effects on aquatic fauna. The watershed would be sprayed in an operational schedule and the Fisheries Research Board, Dr. Fred Ide and W.W. Hopewell would collaborate in the study. The final decision to use the Molus watershed will depend on Dr.

ıue but it is not likely that the location will be changed.

Under heading 5, it has not been finally decided to test Bacillus thuringiensis in 1961. The decision is pending an improvement in formulation. The formulation which was used in 1960 had a tendency to flocculate and resulted in clogging of apparatus and caused an uneven distribution of Bacillus concentration within the plots. The manufacturers of B.t. are currently working on a new formulation which will be used in aerial spray testing if it is completed and satisfactory in time.

Negotiations have begun with Dr. Waldichuck of the Nanaimo Biological Station, Fisheries Research Board, to carry out tolerance tests of young salmon to Phosphamidon. The decision to initiate the tests depends on whether or not the personnel at Nanaimo can add to its present program.

The details of the program are being worked out by the persons involved.

Ottawa, Ont.,
April 25, 1961.
JJF/M

James J. Fettes,
Head, Chemical Control Section.

ACTION REQUEST

TO Mr. [illegible]	DATE
LOCATION	
FROM	RE FILE NO.

FOR:

[ ]	ACTION	[ ]	NOTE & FORWARD
[ ]	APPROVAL	[ ]	NOTE & RETURN
[ ]	COMMENTS	[ ]	P.A. ON FILE
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[✓]	INFORMATION	[ ]	REPLY, PLEASE
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PREPARE MEMO TO: ....

REPLY FOR SIGNATURE OF: ....

REMARKS: Re page 2
Please look into [illegible] situation at Camp [illegible] during your visit.
[signature]

CGSB 6-GP-12 P.P.&S. CAT. 3433

Messrs. Dyer and Hay to note.

Administration Branch

c.c. sent Dr. Prebble.

14-0-31

OTTAWA, April 26, 1961.

Mr. H.D. Heaney,
District Forest Officer,
P.O. Box 428,
Fredericton, N.B.

Sir:

At a meeting of the Interdepartmental Committee on Forest Spraying Operations held yesterday, the Department of Fisheries had a map of the area planned for spraying in New Brunswick in 1961, which incorporated a number of changes from the last map I had seen. The Acadia Forest Experiment Station and the McGivney Ammunition Depot were retained in the spray area, but the small area of infestation at the north end of Camp Gagetown, which had previously been included in the program, has evidently been deleted.

It was reported at the meeting that the Department of National Defence is arranging a spraying operation for mosquito control in the vicinity of the main army camp. Possibly it is considered that this will take care of the budworm situation, or perhaps there have been other developments of which we are not aware here, which have resulted in this change in the program.

In view of Dr. Belyea's letter to you of December 7, 1960, indicating that there were certain areas in the northern part of the camp that warranted attention in the 1961 program, would you please look into this matter and advise whether the spraying program as now revised is considered adequate for purposes of forest management at Camp Gagetown.

Yours faithfully,

H.W. Beall,
Director.

14-0-91

CANADA DEPARTMENT OF FORESTRY
Forest Entomology and Pathology Branch
238 Sparks Street
Ottawa, Ontario

File: 7.9.14

July 7, 1961.

MEMO TO: Dr. J. L. Kask
Dr. A. L. Pritchard
Mr. W. W. Mair
Mr. H. W. Beall

The May-June, 1961 issue of our Bi-Monthly Progress Report contains a series of short articles on trials of a microbial insecticide against forest defoliators carried out in 1960. I think these articles will be of interest to members of the committee and five copies of the Bi-Monthly Progress Report are attached for each member of the committee.

M. L. Prebble,
Director.

MLP:RBH
ENCL.

CANADA

DEPARTMENT OF FORESTRY

FOREST ENTOMOLOGY AND PATHOLOGY BRANCH

Vol. 17
REPORT
Number 3

BI-MONTHLY PROGRESS REPORT

May-June
1961

Published by Authority of the Hon. Hugh John Flemming, Minister of Forestry, Ottawa

TESTS OF A MICROBIAL INSECTICIDE AGAINST FOREST DEFOLIATORS

During recent years, high toxicity of crystalliferous spore-forming bacteria of the genus *Bacillus* to a number of lepidopterous larvae has been demonstrated in laboratory experiments. Encouraging results have also been obtained in field trials utilizing commercial preparations of *Bacillus thuringiensis* and related species, applied as water suspensions of low density but high volumes per acre against agricultural pests.

The non-toxicity to aquatic fauna and wildlife of *Bacillus* "microbial insecticides" would be an outstanding advantage over the majority of chemical insecticides, in large aerial control projects against forest defoliators. One of the special problems in the aerial use of microbial insecticides is the development of satisfactory formulations for high-density low-volume application over large forested areas. Adequate dispersal and residual life are interrelated problems of equal importance.

As a continuation of the program sponsored by the Interdepartmental Committee on Forest Spraying Operations to reduce hazard from aerial spray projects to aquatic fauna and wildlife (see Bi-Monthly Progress Report Vol. 16, no. 1, 1960), co-operative tests of *Bacillus thuringiensis* "microbial insecticide" were undertaken in 1960 against the spruce budworm, *Choristoneura fumiferana*, and the black-headed budworm, *Acleris variana*. The product tested was "Thuricide concentrate SO-75", containing 60 billion spores of *Bacillus thuringiensis* per gram, manufactured by the Bioferm Corporation of Wasco, California, and donated in sufficient quantities for aerial trials in eastern and western Canada. Dr. R. A. Fisher of the Bioferm Corporation collaborated on questions relating to formulation with representatives of the Forest Entomology and Pathology Branch and participated in the field trials in New Brunswick and British Columbia. Thanks are also owing to Forest Protection Limited and to the B.C. Loggers' Association for providing the spray aircraft for trials in New Brunswick and British Columbia respectively.

The results of the 1960 trials, summarized in the following articles, while not demonstrating that *B. thuringiensis* preparations are at present an acceptable substitute for DDT sprays, justify further study of the potential usefulness of such preparations in the control of forest defoliators.—M. L. Prebble.

Spray Formulation, Toxicity, Diagnosis, and Bacteriological Assay of Spray Deposit.—Limited studies in 1959 indicated that the spruce budworm and possibly the black-headed budworm were susceptible, under laboratory conditions, to infection with highly purified preparations of a number of crystalliferous bacteria. The decision to include commercial preparations of *Bacillus thuringiensis* in the 1960 experimental field spray program made it necessary to develop methods (*a*) for preparing biologically active dispersions of microbial insecticides in an oil vehicle suitable for use in aircraft, (*b*) for diagnosing killed or moribund larvae, and (*c*) for performing a simple bacteriological assay of the spray deposit.

Although a number of entomogenous crystalliferous strains are known, manufacturers have tended to rely almost exclusively on the Mattes strain of *B. thuringiensis* as a basis for their products which are referred to in the literature as *B.t.*. Initially a number of commercial preparations of *B.t.* were considered and these comprised the spores, crystals, and vegetative debris of the bacterium together with fermentation solids and various extenders such as clays, starch, and other inert fillers. After an extended series of tests the product deemed most promising for our purposes was "Thuricide concentrate SO-75" manufactured by the Bioferm Corporation, and this is hereinafter referred to as Thuricide.

(*a*) Although water suspensions of *B.t.* are easily prepared and have been widely used, the only information available concerning its compatibility with fuel oil, suggested for use in aerial sprays, was a personal communication from a member of the U.S.D.A. who stated that simple mixing resulted in an unpromising viscous tarry precipitate that might clog spray nozzles. It was therefore decided to explore the suitability of water-in-oil emulsions. A number of commonly used emulsifiers and surface-active agents were considered and rejected for one or more reasons, viz; the toxic crystals in *B.t.* preparations are soluble in free alkali and the crystal protein is easily inactivated in the dissolved state; the wetting action of some compounds could adversely affect the viability of the bacterial spores; some compounds would inhibit ingestion of the insecticide which acts only as a stomach poison; or because of possible phytotoxicity. The most promising of the products tested were members of the Tween-Span series, which are widely used in the food and pharmaceutical industries as emulsifiers. By using a mixture of Tween 80 and Span 80 stable emulsions of water in fuel oil were prepared which were not markedly phytotoxic and would not inhibit the feeding of budworm larvae. Such preparations were tested periodically, and there was no detectable decrease of toxicity after 7 days storage. Even after several months storage, the suspensions were still toxic and viable spores were still present.

Thuricide, as all other *B.t.* preparations, is relatively bulky and comprised principally of insolubles so that is does not lend itself to the preparations of high concentration-low volume sprays. For practical reasons spray volume per acre in aerial applications should not exceed one or two gallons. The spray suspension should not be too concentrated in order to prevent clogging the nozzles of the aerial spray equipment. After a series of tests it was concluded that concentrations of 1-2 lb. of Thuricide per gallon of fuel oil would be feasible. The method finally adopted to make the suspension was developed by the Bioferm Corporation and is as follows: add 34 parts by weight of wetting agent no. 3 (mixture of Tween and Span) to 540 parts of no. 2 furnace oil and mix thoroughly; add 195 parts Thuricide concentrate SO-75 and mix thoroughly; mix with 50 parts water.

Suspensions prepared as above were used in the New Brunswick tests and it was found that the insecticide tended to aggregate into tiny clumps. In the British Columbia tests, the Thuricide concentrate was modified further in order to obviate this difficulty.

When small amounts of Thuricide were incorporated in oil-water emulsions and tested in the laboratory it was found that air-dried sprayed balsam fir buds were readily eaten by IV- and V-instar spruce budworm larvae and that death ensued within 72 hours. Preparations of Thuricide equal to 2 lb. per gallon of oil emulsion were sprayed on to single balsam fir buds, air-dried, and fed to larvae which were then reared individually at 70°F/40% R.H. After 6 hours there was no further feeding or frass drop; mortality was 25% at 24 hours, 50% at 44 hours and 99% at 78 hours. These results are typical for a number of similar experiments.

In another experiment a small number of larvae were allowed to ingest measured amounts of Thuricide in water from the tip of a microsyringe. It was found that as little as 1 micro-gram was a lethal dose. On this basis the homogeneous dispersion of Thuricide over one acre would yield at least 150 lethal doses (and probably more) per sq. in. of sprayed surface. In practice such a dispersion could not be achieved because of droplet formation and the tendency of the insecticide to clump.

(*b*) Larvae which had ingested Thuricide either on sprayed buds or as a droplet of water suspension became sluggish, moribund, and then displayed the blackened, soft appearance of *B. thuringiensis* infection. When these killed larvae were examined in nigrosin as whole body smears, or as preparations of exudate obtained by removing an abdominal leg, enormous numbers of the vegetative rods of *B. thuringiensis* were seen.

Larvae which had ingested a droplet of a suspension of Thuricide in water were dissected at hourly intervals and examined on the microscope. It was found that at about 6 hours a few vegetative rods could be seen in gut smears, massive numbers at 12 hours, and before 24 hours the organism could be found in the haemolymph of moribund larvae. This is taken to indicate that the organism does not grow simply as a saprophyte in killed larvae, but is capable of establishing itself in the gut of living larvae and invading the haemocoele prior to death.

The characteristic appearance of *B. thuringiensis*-killed larvae and the presence of vegetative rods formed the basis of the diagnostic method. Briefly, dead larvae collected in the field were immersed in a quaternary ammonium disinfectant (Hyamine) for one minute to surface-cleanse the cadaver, rinsed in distilled water, and then macerated on a microscope slide in a drop of 3% nigrosin. The dried smears were examined on the microscope and the presence of vegetative rods of *B. thuringiensis* was taken as presumptive evidence of infection.

(*c*) In laboratory tests, suspensions of Thuricide in oil-water emulsion were sprayed on to the surface of petri plates containing sterile Difco nutrient agar, and incubated at 30°C. In 18 hours, characteristic colonies of *B. thuringiensis* were visible indicating that the oil did not inhibit germination of the spores or multiplication of the vegetative rods. In the field test, disposable sterile plastic petri plates containing Difco nutrient agar were placed 12 inches above ground on small wooden platforms throughout the area to be sprayed and uncovered immediately prior to the application of the spray. Soon afterwards the lids were replaced, the plates removed to the laboratory for incubation and when the characteristic colonies were visible, they were counted. Areas of high and low spray density were thus indicated, and foliage samples were taken in the same areas and analysed by staff of the Bioferm Corporation.—T. A. Angus, A. M. Heimpel, R. A. Fisher.

Aerial Spraying of Thuricide Against the Spruce Budworm in New Brunswick.—Two formulations of Thuricide, 2 pounds in 1 U.S. gallon of furnace oil with an emulsifier, and 2 pounds in 1 U.S. gallon of water, were applied at 1 gallon per acre on two 30-acre plots of spruce budworm-infested balsam fir. Three types of check plots were employed: (*a*) sprayed with 12½ per cent DDT in oil at 1 gallon per acre; (*b*) sprayed with oil alone at the same dosage; and (*c*) untreated. A Stearman biplane fitted with boom and nozzles was used in the trials. The spray system was flushed with oil and with water and detergent before application of the different formulations.

Spray deposit and insect populations were measured at intervals along two lines at right angles to flight direction in each plot. Deposit was assessed as the number of bacterial colonies per 85 mm. diameter petri plate filled with nutrient agar. The plates were located about 12 inches above the ground in openings near the trees used for population sampling, and were exposed immediately before spraying. After spraying they were incubated for about 8 hours.

Insect populations were counted on 18-inch branch tips selected from the mid-crowns of dominant and co-dominant balsam fir trees at 100-foot intervals along the sampling lines.

At the time of spraying, the morning of May 30, 1960, the budworm population consisted of various instars as follows: III—1%; IV—49%; V—49%; VI—1%. Shoots were well extended and needle flare had taken place. A light shower had saturated the foliage immediately before spray application, but it was considered that this would aid dispersal and help to assure good contamination. Foliage was completely dry shortly after spraying. Application was followed by two days of weather favourable to rapid insect feeding, and absence of rain. A light drift of air from west to east occurred throughout the trials.

Counts of colonies on the petri plates revealed that deposit was almost uniformly higher than 500 colonies per plate throughout that portion of the plot tested directly with the oil formulation. Counts declined as distance from the swaths increased, but a few colonies still appeared about 2,000 feet downwind. Deposit was lighter on the plot treated with water formulation, probably due to the clogging of nozzles observed during application (a considerable residue of material was discovered in the spray system and all nozzles required cleaning). Counts of over 500 colonies per plate occurred over a smaller portion of the sample lines in the water-treated plot, and there was evidence that more easterly drift occurred.

Foliage samples from both plots were examined by the Bioferm Corporation for viable spores of *Bacillus thuringiensis*. Although spore counts are not necessarily indicative of insecticidal activity of *B.t.* sprays, the counts revealed that initial contamination above the level considered to be lethal occurred only on the day of treatment in those parts of the oil-treated plot on which plate counts were highest. In the remainder of the oil-treated plot, and in the plot treated with the water formulation, initial contamination was below the accepted lethal level. The counts revealed a rapid decrease of viable spores during the first five days, but spores were still present on the seventeenth day after treatment.

Larvae collected about 8 hours after spraying were reared in the laboratory at room temperature in sterile tubes. Mortality began June 3, and examination of nigros[illegible] smears established the presence of vegetative rods of *B. thu[illegible]ngiensis* in the dead insects.

Population sampling at intervals of three days, however, failed to establish a discernible effect on population density produced by Thuricide sprays, or by spraying with oil alone, whereas the DDT treatment was followed by a clearly defined decline in density yielding about 95 per cent control.

However, the living and dead insects were counted in these collections, and diagnosis established that most of the dead larvae in the treated plots were contaminated with *B. thuringiensis*. The numbers of dead larvae expressed as percentages of the total number of larvae in each collection are shown in Table I.

TABLE I

Date	Percentage of dead larvae in collections				Differences in percentages		
	Untreated check	Thuricide in oil	Thuricide in water	DDT	Thuricide in oil-check	Thuricide in water-check	DDT-check
May 23	7	6	7	—	−1	0	—
29	6	16	15	15	10	9	9
30	13	9	6	17	−4	−7	4
Sprays applied May 30							
June 2	3	13	12	10	10	9	7
6	30	35	29	83	5	−1	53
9	7	20	18	73	13	11	66
13	3	25	21	56	22	18	53
16	4	35	26	33	31	22	29
20	4	7	11	—	3	7	—
23	11	13	11	33	2	0	22
27	6	9	8	0	3	2	−6
July 4	3	1	8	0	−2	5	−3

A higher percentage of dead insects occurred in the Thuricide-treated plots than in the check plots. The maximum differences between the check and treated plots were: oil treated, 31% on June 16; the water-treated, 22% on June 16; and DDT-treated, 66% on June 9. Thus, the Thuricide produced a reduced and later insecticidal effect in comparison with DDT.

Defoliation patterns mapped aerially and from the ground after budworm pupation revealed no discernible difference between the Thuricide-treated plots and the untreated plot.

Development of the Thuricide-treated populations appeared to be retarded, possibly because the larger, more rapidly feeding larvae were killed.

It is clear from these trials that Thuricide as formulated and applied from aircraft against the spruce budworm in 1960 produced some insecticidal effect. This was not sufficiently high to consider its use in place of DDT. An oil formulation yielded easier passage through the spray apparatus, a better pattern and degree of deposition of material, and slightly higher insecticidal effect than a water formulation.—D. G. Mott, T. A. Angus, A. M. Heimpel, R. A. Fisher.

Susceptibility of the Black-Headed Budworm to Thuricide.—Trials of Thuricide against the black-headed budworm were conducted on the Queen Charlotte Islands, British Columbia in 1960. Prior to aerial spraying a pre-test was carried out in a field laboratory. The purpose was to test the general susceptibility of the Queen Charlotte Islands strain of black-headed budworm to the Thuricide to be used in the aerial trials. On July 10, 24 field-grown western hemlock seedlings, approximately 2 feet tall, were placed individually in pots and divided into four lots of six seedlings each. All insects were removed from the seedlings. The mouths of the pots were covered with cloth and the pots were placed on the floor of a shed above strips of light brown wrapping paper. Two days later, 30 field-collected black-headed budworm larvae (mostly third instars) from unsprayed areas were placed on each seedling.

Seven days after their first introduction and just prior to application of the pre-test sprays, it was observed that only about one-third of the larvae originally introduced had established themselves on the potted seedlings. The amount of frass that had accumulated during larval establishment showed that considerable feeding by the survivors had taken place during the 7-day period. Fifty-six larvae were established on Lot 1, 69 on Lot 2, 60 on Lot 3 and 90 on Lot 4. The reason for such poor establishment is not known with certainty. The author suspects that handling of the delicate third-instar larvae during collecting, sorting, and introducing them to the seedlings contributed to this mortality.

The four lots of seedlings were sprayed as follows:

Lot 1	Thuricide SO-75	234 grams
	Wetting agent #3	40.1 grams
	Furnace oil #2	646.0 grams
	Tap water	59.6 grams
Lot 2	Two lb. Thuricide per U.S. gallon of tap water.	
Lot 3	Oil alone.	
Lot 4	Tap water alone.	

The spray, applied with a pressure-type hand sprayer, was directed above the seedlings and allowed to fall on them and on oil and water cards placed beside the oil treated (Lots 1 and 3) and water treated (Lots 2 and 4) seedlings, respectively. The droplet sizes on these cards indicated a very heavy spray dosage. There was no way of calibrating the hand sprayer used and, consequently, the spray deposits, although heavy throughout, were rather unevenly distributed.

The larvae which died during the tests were examined microscopically for vegetative cells of *Bacillus thuringiensis*. The cadavers of heavily infected larvae were light to dark brown, soft, and disintegrated under slight pressure. The cadavers were macerated on microscope slides and stained with nigrosin. Slides showing five or fewer vegetative cells were scored as negative.

Peak mortality for oil-Thuricide treated plants occurred in 24 hours and for water-Thuricide treated plants in 48 hours. The largest number of larvae positive for *B. thuringiensis* were found on the second and sixth days in the oil-Thuricide treatment, and on the fourth and sixth days in the water-Thuricide treatment. These "double peaks", it is presumed, merely indicate that some larvae ingested the microbial insecticide earlier than others.

In the oil-Thuricide treatment, all larvae died, but in the water-Thuricide treatment two remained alive at the end of the test. Sixty-six per cent of the dead larvae in the former group were positive for vegetative cells, compared with 51 per cent in the latter group. In the oil-alone and the water-alone treatments, four and two larvae, respectively, died. None of these were positive for *B. thuringiensis*.

From each of the four lots of sprayed seedlings, 25 small branches were removed immediately after treatment and each placed in a glass rearing tube. One larva, collected from an unsprayed field area and starved for 24 hours, was then placed on each branch. The tubes were placed in the field laboratory. Over a 7-day period mortality counts were taken and dead larvae examined for vegetative cells daily. Both the oil-Thuricide and water-Thuricide treatments produced peak mortalities on the third day following spray application and 23 out of 25 (92 per cent) were positive for vegetative cells.

In both oil and water controls, 7 out of 25 larvae died by the fifth day. In the oil controls, 5 out of the 7 dead were positive for *B. thuringiensis* and in the water controls, 3 out of 7 were positive. Presumably, there was bacterial contamination of these two treatments during the course of the experiment. This is not surprising because of the difficulty of ensuring aseptic conditions in the field laboratory.

The amounts of frass which accumulated in the feeding tubes were considerably larger for the untreated than for the treated groups. On the bases of frass accumulation, larvae on treated foliage appeared to have stopped feeding entirely within 24 hours. This suggests interference with normal digestive functions soon after ingestion of the microbial insecticide. Frass accumulations in the seedling test paralleled those in the rearing-tube test.

The mortality rate appeared to be slightly faster with the oil-Thuricide than with the water-Thuricide formulation. In the former, approximately 50 per cent of the infected larvae had died 48 hours after application of the spray in both seedling and rearing-tube tests. In the seedling and rearing-tube tests of water-Thuricide trials, 50 per cent mortality occurred approximately 96 hours and 72 hours, respectively, after spraying.

On the basis of these observations it is concluded that the black-headed budworm is susceptible to *Bacillus thuringiensis* and that the disease symptoms are similar to those of other susceptible Lepidoptera.—O. N. Morris.

Aerial Spray Trials Against the Black-Headed Budworm in British Columbia.—Advantage was taken of a DDT control project against a black-headed budworm outbreak on the Queen Charlotte Islands in 1960 to test Thuricide against this insect. Three 30-acre plots were selected in dense stands of small western hemlock trees, varying in height from 5 to 25 feet, which could be readily sampled from the ground. The budworm population in these young stands was light at the beginning of the season. When the Thuricide spray was applied on July 24, most of the insects had reached the fourth instar, but parasitism and cool, wet weather caused such heavy mortality that only a sparse population remained. Eighteen-inch branch samples taken the day before spraying yielded an average of only 3.3 living larvae per 10 square feet of foliage; over three-quarters of the samples were without living budworms.

In view of the low population, it was recognized before the experiment was begun that it would not be possible to obtain an adequate population reduction assessment, but that information could be gained on formulation, deposit, and viability of the material.

The Thuricide was suspended in oil similar to one of the formulations in the New Brunswick experiment, but additives were incorporated to reduce the tendency for clumping and settling. The formulation per 100 U.S. gallons was:

Thuricide SO-75	150 lb.	Sodium nitrate	8 lb.
wetting agent no. 3	4.5 gal.	Diesel fuel oil	73 gal.
Microcel A	35 lb.	Water	8.5 gal.

The Thuricide contained 60 billion viable *B. thuringiensis* spores per gram, and 3.6 per cent Petro A.G., a wetting agent. Wetting agent no. 3 was a 1:1 blend of Atlas emulsifiers Span 80 and Tween 80.

The equipment of the Grumman Avenger spray aircraft was modified to include manual agitating apparatus to prevent settling of solids in the small volumes of spray used. The aircraft was flown at 160 m.p.h. and the spray emission rate was 112 U.S. gallons per minute. With each pass over the ⅛ mile centre lines of the plots about 16 gallons were released.

Two dosage levels were applied. On Plot 1, the aircraft sprayed two passes over the centre line, thus releasing 32 gallons containing 48 pounds of Thuricide. Three passes over the centre of Plot 3 gave a dosage of 48 gallons containing 72 pounds of Thuricide. If an effective swath width of 400 feet is assumed, the nominal dosages were 2.7 pounds of Thuricide in 1.8 gallons per acre on Plot 1, and 4 pounds in 2.7 gallons per acre on Plot 3.

Plot 2 was sprayed with 48 gallons of diesel oil containing all additives other than Thuricide.

In each plot, spray deposit assessment units were set on 4-foot stakes at 55 stations on five lines running at right angles to the line of flight. Oil-sensitive cards and 9 cm. petri plates containing nutrient agar were used to assess the deposits. Viable spores germinated quickly on the agar permitting colony counts within twelve hours after spraying, but deposits higher than 500 colonies per plate could not be estimated accurately.

The plots were almost twice as wide as the anticipated swath coverage to allow for lateral drift. As a consequence only about one-half of each plot was sprayed heavily. At stations where the colony counts exceeded 200 per plate, the average spray droplet density was 25.2 drops per square centimetre on Plot 1, and 29.0 on Plot 3. Both types of assessment units were in general agreement in delineating heavily sprayed portions of the plots. At most stations where more than 12 spray droplets per square centimetre were recorded, colony counts exceeded 500 per plate.

Where deposits were heavy, particles of solid material could be seen on rocks and foliage. On the oil-sensitive cards, clumps of spores and inert material could be seen in the centre of the oil stains with the unaided eye. The droplet counts indicate that not every oil droplet carried viable spores. The tendency for the material to agglomerate reduced the theoretical efficiency of the deposit.

Small samples of hemlock foliage were collected on July 24 and 27, and 12 and 80 hours after spraying, for residual spore analysis by the Bioferm Corporation. The first sample from Plot 1 yielded 1,390,000 viable spores per gram of fresh leaf, or about 6,040 spores per leaf. Corresponding values for samples from Plot 3 were 710,000 spores per gram (3,090 per leaf) on July 24, and 71,100 spores per gram (308 per leaf) on July 27. In comparison with Thuricide experiments on other insects, the initial deposits were high enough to cause budworm mortality, but by the third day after treatment the residues were at a presumed sub-lethal level. Apart from light overnight dews, the weather remained warm and dry for two weeks after the spray was applied.

On July 25, budworm larvae collected from an unsprayed area were placed on foliage from heavily sprayed trees in the spray plots. The insects were reared until either death or pupation at the Insect Pathology Research Institute at Sault Ste. Marie, Ontario. Diagnosis of the dead larvae revealed that 15 out of 20 larvae (75%) reared on Plot 1 foliage were infected with *B.t.* Of 77 larvae reared on Plot 3 foliage, 69 (90%) were infected with the bacterium.

Post-spray larval samples were taken on July 27, but only 41 living and 70 dead larvae were found on 412 samples from the two plots treated with Thuricide. Twenty-seven of 64 cadavers subsequently diagnosed at Sault Ste. Marie were infected. Nine of the infected larvae were from portions of the plots that received only light or trace deposits. The living larvae from this collection were reared on clean foliage until either pupation or death. Of 32 that died as larvae, 14 were infected.

A number of branch tips in Plot 1 were colonized with healthy larvae prior to spraying. Twenty-five per cent of the dead larvae found on these branches on July 29 and August 1 were positively diagnosed, although almost one-half were from lightly sprayed trees.

No general statement on population reduction can be drawn from the sparse population that was present. Nevertheless, the field trial indicated that the black-headed budworm is susceptible to commercially produced *Bacillus thuringiensis*, that the toxicity of the preparation is not destroyed by the oil carrier, and that it is possible to apply a lethal deposit from aircraft. If the residual life of the deposits can be extended, and if the clumping tendency can be overcome, one may expect an increase in the efficiency of aerial applications of *Bacillus thuringiensis* suspensions.—J. M. Kinghorn, R. A. Fisher, T. A. Angus, A. M. Heimpel.

CURRENT ACTIVITIES
ROCKY MOUNTAIN REGION

Miscellaneous New Records of Fungi Occurring on Pine in Alberta.—In the course of cull surveys made in Alberta, two new fungi were recorded. These fungi were isolated in culture from living, 110-year-old pine trees, believed to be natural hybrids between *Pinus banksiana* Lamb. and *Pinus contorta* Dougl. var. *latifolia* Engelm., near Whitecourt, Alberta (Ref. Moss, E. H., Natural Pine Hybrids in Alberta. C. Journ. Res., C, 27:218-229. Oct. 1949). Only single isolates were obtained in each case.

Poria asiatica (Pilát) Overh. was isolated from brown cubical rot at stump height occurring in lens-shaped pockets which often contained white mycelium. The fungus apparently entered through a fire scar and the volume of associated decay was about 0.2 cu. ft. *Poria asiatica* has been reported as the cause of a butt and trunk rot of jack pine in Ontario (Forest Resources Inventory, Div. of Timber, Ontario Dept. of Lands and Forests, 1958) but there seems to be no record of its occurrence on lodgepole pine from any part of the range for that tree species. It has not been previously reported on any tree species in Alberta.

Peniophora phlebioides Jackson and Dearden was isolated from a very pale brown, soft rot at stump height in the vicinity of a fire scar. The volume of associated decay was about 0.2 cu. ft. This fungus has been found quite commonly on lodgepole pine slash in Alberta but this is the first report of its occurrence on living pine.—Robena C. Robinson and Glen D. Paul.

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Greenidge, K. N. H. Studies in the physiology of forest trees. IV. Moisture movement in decapitated stems. Am. J. Bot. 47: 816-819. 1960.

Hedlin, A. F. Some aspects of the cone and seed insect problem in the Pacific Northwest. For. Chron. 37: 6-9. 1961.

McMinn, R. G. Water relations and forest distribution in the Douglas-fir region on Vancouver Island. Can. Dept. Agr. Pub. 1091, 1960.

Prebble, M. L. Review of economic entomology : 3, Forest entomology. *In* Rept. 7th. Commonwealth Ent. Conf. London. 1960, pp. 235-241.

Smirnoff, W. A. A virus disease of *Neodiprion swainei* Middleton. J. Ins. Path. 3: 29-46. 1961.

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Thomas, J. B. The life history of *Ips pini* (Say). Can. Ent. 93: 384-393. 1961.

Thomas, J. B. and H. Herdy. A note on the life history of *Cimberis elongatus* (Lec.). Can. Ent. 93: 406-408. 1961.

Vaartaja, O. Selectivity of fungicidal materials in agar cultures. Phytopathology 50: 870-873. 1960.

Vaartaja, O. Demonstration of photoperiodic ecotypes in *Liriodendron* and *Quercus*. Can. J. Bot. 39: 649-654. 1961.

Vaartaja, O., W. H. Cram, and G. A. Morgan. Damping-off etiology especially in forest nurseries. Phytopathology 51: 35-42. 1961.

Wallis, G. W. Survey of *Fomes annosus* in East Anglian pine plantations. Forestry 33 (2) 203-214. 1960.

Wallis, G. W. Infection of Scots pine roots by *Fomes annosus*. Can. J. Bot. 39: 109-121. 1961.

Watson, W. Y. and W. L. Sippell. Scolytid vectors of the Dutch elm disease in Ontario. Can. Ent. 93: 403-405. 1961.

Webb, F. E., J. R. Blais, and R. W. Nash. A cartographic history of spruce budworm outbreaks and aerial forest spraying in the Atlantic region of North America, 1949-1959. Can. Ent. 93: 360-379. 1961.

Ziller, W. G. Pear rust (*Gymnosporangium fuscum*) in North America. Plant Disease Reporter 45 (2) 90-94. 1961.

Ziller, W. G. Pine twist rust (*Melampsora pinitorqua*) in North America. Pl. Dis. Reporter 45: 327-329. 1961.

ROGER DUHAMEL, F.R.S.C., Queen's Printer and Controller of Stationery, Ottawa, 1961

O. H. M. S.

DEPARTMENT OF FORESTRY
OTTAWA

14-0-31

Dr. R. M. Belyea

M. L. Prebble

3.6.6
FZ-16

Aerial Spray Project - 1960

June 19/61

I have your memorandum of June 13 regarding acreages sprayed at different dosages and concentrations in 1960. Since Mott feels that the figures supplied to me earlier are more correct, I have not changed the portion of the Minister's Report dealing with the 1960 spray operation. I have inserted a qualifying phrase stating that the acreage figures are derived from planimetric measurements of maps of the sprayed area.

Mr. Beall agreed that this was a reasonable decision on my part and I believe he intends to eliminate the reference to the acreage sprayed in 1960 from the administrative section of the Minister's Report.

being done by Woomer by editing HB

M. L. P.

MLP: RBH

cc: Mr. H. W. Beall ✓

GOVERNMENT OF CANADA

ACTION REQUEST

CGSB 6-GP-12
P.P.&S. Cat. 3433

TO: ~~H. W. Beall~~

LOCATION: [illegible]

FOR:

FILE NO.

- [x] ACTION
- [ ] APPROVAL
- [ ] COMMENTS
- [ ] DRAFT REPLY
- [ ] INFORMATION
- [ ] INVESTIGATION
- [ ] MORE DETAILS
- [ ] NOTE & FILE
- [ ] NOTE & FORWARD
- [ ] NOTE & RETURN
- [ ] REPLY, PLEASE
- [ ] SEE ME, PLEASE
- [ ] SIGNATURE
- [ ] TRANSLATION
- [ ] YOUR REQUEST

PREPARE MEMO TO:

REPLY FOR SIGNATURES OF:

REMARKS:

FROM	PHONE	LOCATION	DATE
M. L. Prebble - Forest Ent. & Path.			19/6

EXCLUSIVE CONNECTION WITH WESTERN UNION CABLE SERVICE

Form 6102

CANADIAN NATIONAL TELEGRAPHS

J. R. WHITE, GENERAL MANAGER
TORONTO

CHECK FILE COPY

CHARGE ACCOUNT NO.

TIME AND DATE FILED

COMPANY Director, Administration Branch,
ADDRESS Department of Forestry,
CITY 107 Sparks Street, Ottawa.

14-0-31

Send the following message, subject to the terms on back hereof, which are hereby agreed to

OTTAWA, August 3, 1961.

Mr. H.D. Hensey,
District Forest Officer,
P.O. 428, Fredericton, N.B.

NDHQ HAVE RECEIVED SIGNAL FROM EASTERN COMMAND ENGINEER SAYING CAMP GAGETOWN FORESTRY STAFF WOULD BE AGREEABLE TO SUPERVISING HERBICIDE SPRAYING CONTRACT FOR ARMY BUT REQUIRE HIGHER AUTHORITY. WE HAVE NO OTHER INFORMATION. PLEASE SUPPLY DETAILS AND YOUR RECOMMENDATIONS.

H.W. Beall,
Director.

14-0-3

CANADA

DEPARTMENT OF FORESTRY

508047

P. O. Box 428,
Fredericton, N. B.

August 7, 1961.

Mr. H. W. Beall,
Director, Administration Branch,
Department of Forestry,
Ottawa, Ontario.

Sir:

Please refer to your telegram of August 4 and our telephone conversation of that same day, concerning supervision of the spraying contracts being let by the Army to inhibit tree growth on their ranges.

Further discussions have been held with officials at Camp Gagetown, and it is now apparent that what they require is the services of a man for about a month and a half to supervise the spot spraying in the general manoeuvre area. This will be a ground spray. In other words, this is a job of an operational nature and it would seem not too difficult for a man from ~~our~~ their own staff.

Glen Davis does not feel that he can spare a man for a month and a half, just when Boynton will be preparing his timber disposal operations for the coming winter. Also, for another two months we will continue having our fire hazard.

Davis, however, said that he did not wish to divorce himself entirely from the operation, but that he and Boynton should make periodic assessments to check on the efficacy of the various methods of spraying.

Yours faithfully,

H. D. Heaney,
District Forest Officer.

14-0-31
HWB/BB

August 10, 1961.

Mr. H.D. Heaney,
District Forest Officer,
P.O. Box 428,
Fredericton, N.B.

Sir:

The information contained in your letter of August 7th, regarding supervision of herbiside spraying contracts at Camp Gagetown, was passed by telephone to Col. Burgoyne of N.D.H.Q by me today. The latter said that he would advise Eastern Command of the arrangement you proposed, namely that the military authorities should provide the supervision but that our staff would be glad to assist in the technical aspects of assessment of various spraying methods.

I hope that this arrangement will dispose of the matter to everyones satisfaction.

Yours faithfully,

H.W. Beall,
Director.

YOUR FILE No. ~~7.9.14~~

OUR FILE NO. 14-0-31

DEPARTMENT OF FORESTRY

FOREST ENTOMOLOGY AND PATHOLOGY BRANCH

CANADA

September 13, 1961

OTTAWA.

MEMORANDUM TO:

Dr. A. L. Pritchard
Dr. J. L. Kask
Mr. W. W. Mair
Mr. H. W. Beall

Subject: Fall Meeting.- Interdepartmental Committee on Forest Spraying Operations

This is to let you know that I would like to have our first fall meeting of the Interdepartmental Committee on Forest Spraying Operations during the week of October 2, probably during the latter part of that week.

The feasibility of this will depend partly on the presence of members of the Committee in Ottawa, and partly on the feasibility of regional staff and the Chemical Control Section to digest 1961 data and submit synoptic statements for the Committee. Similarly I expect that Drs. Kask and Pritchard wish to be assured that members of their staffs can submit synoptic reports in time for the meeting.

This is therefore a rather tentative forecast of the meeting date in the first week of October. If found to be impossible, the meeting will, of course, be delayed, but if delayed may have to go into November because of several other commitments I have in the month of October.

M. L. Prebble
Director

MLP/kp
cc:
Dr. H. Hurtig

14-0-31

DEPARTMENT OF FORESTRY

Our file: 7.9.14

FOREST ENTOMOLOGY AND PATHOLOGY BRANCH

Ottawa, Ontario,
September 18, 1961.

MEMORANDUM TO:

Dr. A. L. Pritchard	- and -	Mr. W. J. Carroll	Dr. G. P. Thomas
Dr. J. L. Kask		Mr. F. G. Cuming	Mr. R. R. Lejeune
Mr. H. W. Mair		Dr. R. M. Belyea	Dr. D.A. Ross
Mr. H. W. Beall ✓		Dr. L. Daviault	Dr. J. J. Fettes
		Mr. W. A. Reeks	Dr. J. M. Cameron
		Dr. F. E. Webb	

Subject: Fall Meeting - Interdepartmental Committee on Forest Spraying Operations

In response to my circular letter of September 13 to other members of the Committee and to our regional establishments I have learned that at least two groups, one within and another outside the Forest Entomology and Pathology Branch, would have real difficulty in assembling material for a meeting in the first week of October. Furthermore, Dr. Kask is away until about the middle of October.

Therefore I propose that the required material be assembled not later than about October 20 and that we hold the first fall meeting of the Interdepartmental Committee as early as possible in November - the date to be fixed later.

M. L. Prebble,
Director.

MLP/kp

cc: Dr. M. Hurtig

14-0-31

HQ 5432-G2/2 TD 1139

DEPARTMENT OF NATIONAL DEFENCE

CANADA

OFFICE OF THE DEPUTY MINISTER
OTTAWA, Ontario.

22 September, 1961.

909025

DEPARTMENT OF FORESTRY
SEP 25 1961
CENTRAL REGISTRY

Deputy Minister
Department of Forestry.

Regrowth Control
Camp Gagetown, N.B.

1. The purpose of this letter is to request that Mr LG Davis, the Superintendent of your Forestry Station at Camp Gagetown, N.B., be authorized to make a technical assessment of the regrowth control program being carried out in the Camp Gagetown training areas.

2. The control program includes controlled burning, some cutting, and the application of herbicides by aerial and ground methods. The proposed work for 1962 includes the herbicide treatment of approximately 13,000 acres at a total estimated cost of $140,000.00.

3. Mr LG Davis has a first hand knowledge of the areas involved and it is considered that a technical assessment of the control program by him will provide valuable assistance in combatting the regrowth problem.

4. Enclosed are the following documents which it is suggested should be passed on to Mr Davis to provide some of the background to the program now being carried out:

a. copy of specifications and drawings for aerial herbicide project 1961,

b. copy of specifications and drawings for ground herbicide project 1961,

c. copy of report by Lt Col J Burgoin, ADW (Maint), D Works, dated 28 Jun 61,

d. copy of technical report on the regrowth problem dated 31 Dec 59 by Mr. HC Fisher, Grounds Specialist, Maint Div, D Works,

e. copy of project justification sheet outlining the work proposed in 1962.

5. It is suggested that if authority is granted to have Mr. Davis carry out this work, that Mr. Davis liaise directly with the Officer Commanding, 7 Works Company, RCE, at Camp Gagetown on all matters concerning this technical assessment.

(E B Armstrong)
Deputy Minister

DEPARTMENT OF FORESTRY
SEP 25 1961
DEPUTY MINISTER

14-0-3-1

CANADA

DEPARTMENT OF FORESTRY

Administration Branch

OTTAWA, September 27, 1961.

H. D. Heaney, Esq.,
District Forest Officer,
Department of Forestry,
P.O. Box 428,
FREDERICTON, N.B.

Sir:

Please refer to my letter of August 10th in which I gave you authority to assist in the technical aspects of the "regrowth control" program to be carried out by the Army at Camp Gagetown.

The letter has just been received from the Deputy Minister, Department of National Defence, asking for verification that you will make the technical assessment, presumably with Messrs. Davis and Boynton. Please have Mr. Davis keep in touch with the Officer Commanding, 7 Works Company, R.C.E., at Camp Gagetown on all matters concerning this technical assessment.

At the same time several documents were enclosed and these with a copy of the Deputy Minister's letter are going forward to you with this letter.

Please send three copies of your reports when you are ready to submit.

Yours faithfully,

for H. W. Beall,
Director.

'copy for Director, Administration Branch' RAY/hjr

14-0-3-1

OTTAWA, September 27, 1961.

E. B. Armstrong, Esq.,
Deputy Minister,
Department of National Defence,
OTTAWA, Ontario.

Dear Mr. Armstrong:

Regrowth Control, Camp Gagetown, N.B.

I have your letter of 22nd September, with enclosures pertaining to the contract for herbicide spraying at Camp Gagetown, and requesting authority for Mr. Davis to carry out a technical assessment of the project.

These documents, together with a copy of your letter, have been passed on to Mr. Heaney, District Forest Officer, with corroboration of the authority to have the technical assessment made which had been given previously by telephone.

I trust everything is in order now and I hope this method of treatment will prove to be successful. We are glad to make the technical assessment because the results will be interesting to us too, as for example, in certain areas where shrubs are a hindrance to natural regeneration.

Yours sincerely,

J. D. B. Harrison.
Deputy Minister.

1961

REPORT OF A MEETING OF THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS HELD IN THE SIR CHARLES TUPPER BUILDING, OTTAWA, ON NOVEMBER 22, 1961 AT 9:00 A.M.

REPORT OF A MEETING OF THE INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING OPERATIONS HELD IN THE SIR CHARLES TUPPER BUILDING, OTTAWA, ON NOVEMBER 22, 1961 AT 9:00 A.M.

---

1. Those present were:

M. L. Prebble, Chairman	Department of Forestry, Ottawa
H. W. Beall	Department of Forestry, Ottawa
W. E. Stevens	Canadian Wildlife Service - Northern Affairs, Ottawa
J. L. Kask	Fisheries Research Board, Ottawa
A. L. Pritchard	Department of Fisheries, Ottawa
E. W. Burridge, Secretary	Department of Fisheries, Ottawa
J. J. Fettes	Department of Forestry, Ottawa
R. M. Belyea	Department of Forestry, Fredericton
R. R. Lejeune	Forest Entomology and Pathology Laboratory, Victoria
B. M. McGugan	Department of Forestry, Ottawa
V. J. Nordin	Department of Forestry, Ottawa
L. Daviault	Department of Forestry, Quebec
C. J. Kerswill	Fisheries Research Board, St.Andrews
F. P. Ide	Department of Zoology, University of Toronto
L. Edgeworth	Department of Fisheries, Vancouver
R. R. Logie	Department of Fisheries, Halifax
B. W. Flieger	Forest Protection Limited
H. A. Richmond	B. C. Loggers Association, Vancouver

2. <u>Proposed Order of Business</u>

At the outset Dr. Prebble referred to the agenda which had been circulated prior to opening of the meeting. Following a brief discussion it was agreed that this agenda be accepted as outlined below:-

Introductions

Proposed order of business

Review of spruce budworm control in New Brunswick and Quebec 1961

a) Operational control program <u>New Brunswick</u>
Flieger, Belyea, Kerswill, Logie, others

Operational control program <u>Quebec</u>
Flieger, Daviault

b) Experimental spray program New Brunswick, Fredericton Laboratory
Belyea

Experimental spray program Quebec, Quebec Laboratory
Daviault

Chemical Control Section
Fettes

Aquatic fauna
Kerswill and Ide

c) Experimental trials of spray distribution utilizing Decca navigational system
Fettes

Status of budworm infestations in New Brunswick and Quebec, fall of 1961, forecast of hazard and probability of spray operations in 1962

New Brunswick - Belyea and Flieger
Quebec - Daviault and Flieger

Review of operational control programs British Columbia, 1961

a) saddle-back looper, Kitimat
Lejeune

b) pine butterfly, Vancouver Island
Lejeune

c) ambrosia beetle
Richmond

Status of saddle-back looper, pine butterfly and ambrosia beetle infestations in British Columbia in fall of 1961, forecast of hazard and probability of spray operations in 1962
Lejeune and Richmond

Review of infestations of other insect species in various provinces in the fall of 1961 and the possibility of control operations in 1962
Prebble, others

Proposals for experimental studies, 1962

3. *Review of Spruce Budworm Control in New Brunswick and Quebec 1961

(a) Operational Control program

*Item 3 was not dealt with at the opening of the meeting for the convenience of one committee member.

(i) Mr. Flieger spoke on the 1961 forest spray operation which involved a total of 2.2 million acres. The entire area was treated with ¼ pound of DDT per ½ gallon per acre and approximately one quarter of this area received a second application. A new improved spray technique, which had been developed by Mr. Flieger and his associates, was used throughout 97% of the area which was sprayed by Avengers, the remaining 3% being sprayed by Stearman aircraft flying under operational control as in earlier years. Details of the technique were outlined by Mr. Flieger and appear as Appendix I.

Mr. Flieger stated that their new techniques provided more efficient coverage of the area, however, ideal weather conditions had facilitated the operation by retarding larval development thus permitting the entire area to be treated at a critical stage of budworm development.

Dr. Kerswill asked what precautions were taken in the new spray technique to avoid spraying streams. Mr. Flieger replied that the new system was not designed to keep spray out of streams.

Dr. Logie complimented Mr. Flieger on the overall efficiency of the 1961 New Brunswick spray operation. He explained that he and Mr. Burridge had accepted Mr. Flieger's invitation to observe the spray program in the field and that they were both impressed by the size of the program and the operational difficulties experienced. Dr. Logie suggested that it should be possible to have spray planes "shut off" over observable bodies of water comparable to "shut offs" over settlements.

(ii) Dr. Belyea indicated that deposit patterns produced by the new spray technique were a considerable improvement to those produced in past programs. Surveys had revealed a more uniform deposit with fewer misses. As a result of surveys outside and within the spray area an additional ¼ million acres were added to and 10,000 acres were deleted from the original spray plan.

Areas scheduled for double application were given their first spraying at the beginning of the operation to facilitate field checks, which were undertaken about five days after spray application. Examination of these areas supported their need for a second spraying. It was again found that a higher per cent of budworm were killed in high population areas.

Indications are that mixed-species stands, i.e. balsam fir and red spruce, were in part responsible for persistence of high budworm populations in certain areas. It is now considered that the second spraying should reach the budworm in the red spruce foliage at a time when the foliage is exposed through sloughing of the bud-cap.

Further details on the large-scale and experimental spray operations in New Brunswick are included in D. G. Mott's report (Appendix II) and the reader is referred particularly to the 2-page Summary at the beginning of the Appendix.

(iii) Dr. Kerswill reviewed fish studies in the operational area undertaken by the Fisheries Research Board and the Department of Fisheries. Summaries are contained in the first four pages of Appendix III and further details are set forth in individual reports by H. E. Edwards, P. F. Elson, and F. P. Ide, identified as Appendices 1 - 3 of the Fisheries Report. Indications from caged fish studies were that a double application of the ¼ pound DDT per ½ gallon per acre is almost as injurious as one treatment at ½ pound DDT per ½ gallon per acre.

Fisheries Research Board electro-seining studies were continued to assess the native salmon populations in various streams outside and within the spray area.

Dr. Kerswill referred to Dr. Ide's work on the N. W. Miramichi which indicates a recovery of aquatic insects from previous years' sprayings.

Studies of late season mortalities are again being conducted this year. Undetermined numbers of dead juvenile salmon and trout have been picked up from various streams in the spray area. Dr. Kerswill stated that results of late season mortality studies will be available at a later date.

Dr. Kerswill referred to the forecast that 1960 and 1961 would have relatively low salmon runs. He stated that 1961 was 35% lower than 1960.

Dr. Belyea referred to stream sampling of aquatic fauna, which has been conducted by the Fredericton Laboratory since 1955. He expressed the hope that the results of these studies would soon be available.

Dr. Logie described a recent spray pollution problem experienced at one of the Department's New Brunswick hatcheries. Through carelessness and ignorance, potato farmers in the area had permitted quantities of toxic sprays to enter the hatchery supply stream. As a result all salmon and trout at the station were lost.

Operational Control Program, Quebec

(i) Mr. Flieger explained that Forest Protection Limited had been requested to spray a small area in Quebec just north of the New Brunswick border for budworm control. An area of approximately 50 square miles was sprayed in 1960 and 125 square miles in 1961.

Stearman aircraft were used in treating the area with ½ pound DDT per ½ gallon per acre. The spray technique formerly employed in New Brunswick programs was used during this operation.

(ii) Dr. Daviault explained that the area sprayed in Quebec was increased to about 120 square miles to include all known areas supporting budworm populations capable of causing severe defoliation in 1961. Later in August an inaccessible area of approximately 17 square miles was found with a heavy infestation which was not sprayed in 1961. In the areas which had been sprayed, control was comparable to that effected in previous years. Further details are included in Appendix IV.

(b) Experimental spray program New Brunswick, Fredericton Laboratory

(i) Fredericton Laboratory

Dr. Belyea referred to the four objects dealt with in the report prepared by D. G. Mott

1) to check spray coverage -

Spray droplet coverage in 1961 was much improved over that obtained in 1960.

2) to compare spray procedures i.e. single ¼ pound per ½ gallon per acre with single ½ pound per ½ gallon per acre -

Results that have not yet been completely analysed indicate no difference in degree of control that could not be explained by different droplet deposit density in the areas of full-strength and half-strength spraying.

3) to compare single application of ¼ pound per ½ gallon per acre with double application of ¼ pound per ½ gallon per acre -

The results of these experimental trials were confused by faulty spray application due to a defect in the equipment.

4) to study budworm control on balsam fir, white spruce, red spruce and black spruce -

In general, mortality of the budworm on balsam fir and white spruce increased later in the period of spraying owing to greater exposure of the larvae. In red spruce and black spruce there was a period of moderate mortality early in the spraying followed by greatly reduced mortality when the larvae were protected by the bud-caps on the expanding shoots. Later mortality of the budworm on black spruce and red spruce was very high when the protective bud-cap had been sloughed. In the last portion of the spraying period, budworm mortality was very similar on all four hosts.

Further details are to be found in pages 7 to 15 of Appendix II.

Mr. Flieger stated that the 1961 program was designed to treat all known "hot spots" which are now thought to be areas of mixed balsam fir and spruce.

(ii) <u>Chemical Control Section</u>

Dr. Fettes described work being done with systemic insecticides. These substances are taken up by plants rendering them toxic to feeding insect forms. Reference was made to field and lab trials with the systemic insecticide Phosphamidon. Where droplet deposit density was adequate Phosphamidon compared favourably with DDT in effectiveness. Evidence that Phosphamidon performed as a systemic is shown in the extended period of mortality (18 days). Further evidence of the systemic activity of Phosphamidon was shown in laboratory experiments where larvae feeding on untreated branches of treated trees were killed (Appendix V).

Dr. Pritchard urged that tests on Phosphamidon be extended. Dr. Fettes indicated that lab tests will be continued with this and other systemic insecticides.

(iii) <u>Aquatic Fauna</u>

Dr. Kerswill introduced the subject by referring to Dr. Ide's 1960 studies. These included the use of "drift screens" to determine the number of drifting organisms before and after spraying. 1961 studies using similar techniques were conducted in a test stream, Molus River (see report by F. P. Ide, Appendix III). Dr. Ide reviewed highlights of the 1961 program in which it was found that ¼ pound DDT per half gallon per acre was not completely destructive to aquatic forms. Bottom sampling indicated a survival of between 43% and 70%. Post spray surveys revealed the elimination of certain species. In the final report aquatic insect data will be correlated with water analysis which are now being completed.

(c) Experimental trials of spray distribution utilizing Decca navigational system

Dr. Fettes explained that Forest Protection Limited supplied guide and spray planes for these tests which were flown in Nova Scotia. Field trials with the Decca navigation system are dealt with in Appendix VI. Dr. Fettes then referred to figures in his report which illustrate clearly the accuracy possible with this device in guiding spray aircraft.

Dr. Fettes in reply to a question from Dr. Pritchard explained that costs would be between $75,000 and $100,000 for a program of the magnitude of the 1961 New Brunswick operation. The cost would depend on the number of aircraft equipped and the complexity of the Decca chain utilized. Dr. Kask expressed enthusiasm over the evidence of controlled operation of the spray aircraft.

4. Status of budworm infestations in New Brunswick and Quebec, fall of 1961, forecast of hazard and probability of spray operations in 1962

(i) New Brunswick

Dr. Belyea explained that the status of the New Brunswick budworm infestation was described in D. G. Mott's report (Appendix VII). He referred to the egg mass map for 1961 which is the best indicator of the 1962 population. Dr. Belyea reported that in east-central New Brunswick where hazard had been moderate or severe, egg mass surveys had indicated a reduction in population in spite of the absence of spraying in 1961.

Mr. Flieger outlined the 1962 spray plan for New Brunswick as developed at a recent meeting of Forest Protection Limited directors in Fredericton. In 1962 it has been decided to spray areas where budworm populations are still high in order to reduce these populations to as low a level as possible. It is expected that the area will amount to approximately 1 million acres. Certain sections will likely require two applications of the ¼ pound DDT per ½ gallon per acre.

Mr. Flieger gave three objectives for their approach to the 1962 program:

(1) to get populations down to a safe level generally

(2) to quench populations in high hazard and high population areas

(3) to attempt to reduce populations to a level that would remove the need for future spraying.

Mr. Flieger advised Dr. Logie that firm plans would be available early in the new year and at that time a meeting of interested agencies would be called.

(ii) Quebec

Dr. Daviault explained that egg mass surveys in Quebec show a population decline over preceding year (Appendix IV). A high infestation area amounting to 34 square miles was located. As a result plans are being made to spray 100 sq. miles in this area with ½ pound DDT per ½ gallon per acre in 1962 in an attempt to suppress the infestation.

Mr. Flieger stated that the Quebec Provincial Government has agreed with the request from the Quebec Forest Industries Association to carry out the proposed 1962 program.

5. Review of operational control program British Columbia

(a) Saddle-back looper, Kitimat

Mr. Lejeune described the 1961 program which involved spraying 10,500 acres with ½ pound DDT per 2 gallons per acre by helicopter (Appendix VIII). It is estimated that mortality produced by the spraying operation was approximately 90% and autumn surveys indicated that populations were generally down to low levels. Unsatisfactory results, partly attributable to unfavourable weather, were obtained in experimental application of Dibrom, Phosphamidon and Thuricide. Mr. Edgeworth reported that there had been no evidence of fish mortality to salmon fry found in isolated pools along the river's edge. He added that liaison in the field with persons responsible for the project had been excellent.

(b) Pine butterfly - Vancouver Island

Mr. Lejeune reviewed the highlights of this project which took place in Cathedral Grove, Vancouver Island (Appendix IX). Reports although incomplete in detail of overall mortality indicate the population was reduced to approximately the 1960 level. Mr. Lejeune was not satisfied that 1 gallon of the ½ pound DDT per acre was adequate. He suggested that further tests should be conducted to determine more accurately the concentration and volume of spray required to control this organism.

Mr. Edgeworth described tests conducted by the Department in the area at the time to determine the feasibility of removing spray solutions from streams using various types of baffles.

(c) Ambrosia beetle control

Mr. Richmond described the helicopter spray program undertaken annually by the B. C. Loggers Association's Pest Control Committee against Ambrosia beetles. Three hundred acres of boomed logs (75 million board feet) were sprayed in 1962 with benzene hexachloride. Details of this program may be found in Appendix X. Mr. Richmond pointed out that details of the program are made known in advance to the Department of Fisheries observers. Mr. Edgeworth agreed that co-operation with the Association had been excellent and as a result fish kill in the sprayed areas had been negligible. Indications are that the program may be expanded next year, however, Mr. Richmond stated that this would depend on the log inventory held by the various companies at the end of the winter season.

Mr. Lejeune pointed out that because of lumber grading regulations now enforced in the interior of British Columbia, these inland companies may spray to control ambrosia beetles. Control of spraying operations would be difficult in this area since the logging operators do not belong to the B. C. Loggers' Association. Mr. Lejeune stated that a meeting will be held in Vernon early in the New Year to describe to the operators methods of ambrosia beetle control. Dr. Pritchard suggested that a member of the Department of Fisheries should attend that meeting.

6. Status of saddle-back looper, pine butterfly and ambrosia beetle infestations in British Columbia in fall of 1961, forecast of hazard and probability of spray operations in 1962

Summing up the saddle-back looper infestation in the Kitimat Valley it was indicated that because of heavy parasitism and disease in a residual infestation of about 1500 acres, spraying will not be recommended during 1962. Salvage operations are now underway. There is no spraying forecast for pine butterfly control in 1962.

7. Review of infestations of other insect species in various provinces in the fall of 1961 and the possibility of control operations in 1962

Dr. Prebble referred to a number of control programs in various parts of Canada that may be undertaken in 1962.

(i) Ontario - small plantation spraying in the Kirkwood area against white pine wevil (Appendix XI).

(ii) Alberta - some top killing by spruce budworm has been reported from the Cypress Hills. Provincial Parks Committee may carry out control spraying in 1962 since this is an important tourist area (Appendix XII).

(iii) Interior British Columbia - There is some probability of control operations being undertaken against ambrosia beetles and the possibility that small spray operations may be undertaken against the Douglas fir tussock moth, and against the satin moth in poplar groves (Appendix XIII).

8. Proposals for experimental studies, 1962

(a) Fredericton Laboratory

Dr. Belyea stated that there are no plans for experimental programs by the Fredericton Laboratory for 1962 because of the staff situation and the lack of favourable opportunities.

(b) Chemical Control Section

Dr. Fettes indicated that -

(i) lab studies would be continued to determine whether other insecticides including additional systemics might be effective against the spruce budworm;
(ii) it is uncertain whether further purely experimental tests on the use of Decca navigational equipment as a spray program aid might be conducted;
(iii) field studies of promising systemics would be undertaken;
(iv) toxicological studies of inherent resistance of budworms to DDT are planned;
(v) liaison work would continue with the Nanaimo station in connection with tolerance tests with insecticides used by the Chemical Control Section.

(c) Fishery Agencies would continue the following -

(i) electroseining for assessment of previously sprayed area (C. J. Kerswill)
(ii) caged fish studies in spray area (R. R. Logie)

(iii) possible participation in co-operative program where systemics are being field tested (R. R. Logie)

(iv) investigate the use of chromatography for DDT analysis (C. J. Kerswill)

(v) late season mortality studies (as yet no future plans) (C. J. Kerswill).

(d) British Columbia

Mr. Lejeune reported that the B. C. Forest Service is considering tests with Phytoactin for control of white pine blister rust on an 80 acre area near Vernon. Low toxicity to fish and mammals of this antibiotic has been reported. Department of Fisheries personnel will participate holding caged fish in the spray area.

Mr. Richmond indicated that the B. C. Loggers' Association was interested in testing Thiodan as a fog against ambrosia beetles in felled and bucked timber in the woods.

Dr. Prebble explained that the *Bacillus thuringiensis* preparation from the Bioferm Corporation had arrived too late in 1961 to be used in field tests in New Brunswick. Dr. Fettes stated that this material would be used on an experimental program in New Brunswick if any are undertaken by the Chemical Control Section during the 1962 season.

Dr. Daviault reported that *Bacillus thuringiensis* and other Bacillus organisms had been used experimentally in Quebec for control of the spruce budworm, with some promising results. Applications had been made from the ground, not from aircraft.

The meeting adjourned at 5:40 p.m.

E. W. Burridge,
Ottawa, January 11, 1962.

Surviving Population Level

The objective of spraying spruce budworm populations should usually be the preservation of the foliage crop of the year on the important tree species, usually balsam fir. When operations have been designed to obtain the highest possible degree of control of insect population level (eg. 1960), it has sometimes been found that natural increases have compensated for the effect of insecticide and no improvement in foliage conditions has been obtained--thus, operations are necessary in the following year. If the foliage has been preserved, the succeeding operation can be omitted. In some cases, for example well-delineated small areas of infestations which threaten to spread to important areas of forest, high population control may be a valid objective, but this will usually require unusually high dosage levels.

Even though foliage preservation should be the main objective of an operation, a high degree of population control should be an important secondary objective. In a forest containing a mixture of host-tree species, this objective requires that the surviving population levels on all species be carefully considered.

Now, a proper discussion of surviving population level is very complex. It must include a consideration of initial differences in population between the four host tree species as a result of differences in oviposition, and differences in percentage control as a function of timing of spray application, and any migration from species to species which might take place when the species occur in mixture. For example, in one study plot in 1961, red spruce experienced very little decline in a low population level during a period when white spruce experienced a reduction to one-fifth of a high population level. This is the expected result of migration and natural mortality, but the degree to which it takes place will depend upon a variety of factors about which not enough is known. Accordingly, a somewhat theoretical consideration will be presented.

Population sampling within the check area in 1961 provided the following estimates of budworms per 10 square feet of branch surface area and natural survival rates during the period from the beginning of spraying until pupation:

	Balsam fir	Red spruce	White spruce	Black spruce
Initial population	57.2	27.5	62.0	15.9
Final population	36.6	26.1	11.7	8.2
Survival rate	0.64	0.95	0.19	0.52

Now, it is possible to compute the number of survivors which would be expected on each species under any given spray-timing regime using the data from Fig. 8. Three such regimes will be discussed: that employing only one spray about June 8, that employing one spray about June 16, and that employing one spray about June 8 and another about June 26. The results are presented in Table 6.

The survival rate from a spray treatment can be computed from the percentage control data as being:

$$\frac{100 - \text{Percentage control}}{100}$$

When two sprays are applied the two survival rates are multiplied to obtain the combined rate. Exact values have been read from the graph in Fig. 8 but it must be remembered that these are subject to sampling error.

Table 6.--Observed surviving budworm populations per 10 sq. ft. on four tree species with theoretical reductions from three spray regimes.

	Balsam fir	Red spruce	White spruce	Black spruce
Untreated surviving population	36.6	26.1	11.7	8.2
Survival rate, sprayed June 8	0.48	0.39	0.45	0.56
" " , " June 16	0.33	0.95	0.22	0.95
" " , " June 8, 26	0.11	0.09	.04	.03
Expected survivors, sprayed June 8	17.6	10.2	5.3	4.6
" " , " June 16	12.1	24.9	2.6	7.8
" " , " June 8, 26	4.0	2.3	0.5	.2
*Expected egg-masses/100 sq. ft., June 8	176	102	53	46
" " " , June 16	121	249	26	78
" " " , June 8, 26	40	23	5	2

*About 10 egg-masses per 100 sq. ft. of foliage would be expected from each surviving insect; 200 egg-masses per 100 sq. ft. of foliage would be expected to result in complete defoliation the following year.

Obviously, the results of this exercise disclose that two sprays, properly timed, yield very good control. However, in mixed stands of fir and red spruce, the June 8 spraying will tend to produce severe defoliation of fir in the next season because of high surviving populations on the fir, as will the June 16 spray since high populations, some of which will lay eggs on fir, are left on red spruce, and moderate populations survive on fir. The two-spray regime eliminates the hazard of reinfestation of fir from populations on the other species. The very good results in the 1961 operation can be attributed to the fact that in the two-spray areas, spraying took place roughly in accord with the two-spray regime considered here.

The data mentioned above in the section dealing with surveys of the number of surviving larvae per 18-inch branch tip five days following spraying, can now be presented (Table 7).

Table 7. Average number of budworms per 18-inch branch tip, five days after spraying, in specified conditions.

Condition		Balsam fir		Red spruce	
		No. samples	Average population	No. samples	Average populations
After one spray	Designated for one spray	292	5.6	245	9.2
	Designated for two sprays	85	9.2	78	6.5
Sample points with 'high' populations after one spray		52	19.4	49	23.9
Same category of points after two sprays		55	3.5	54	5.7

Timing regimes in the 1961 operation were dictated mainly by weather and intuition. Yet, the treatment in one-spray areas tended to be applied at a time comparable to the theoretical June 16 spray, and the first treatment in two-spray areas at a time comparable to the theoretical June 8 spray. Table 7 presents the results of sampling surviving populations five days after spray was applied in these 1961 spray areas. The sampling unit used and the time at which samples were taken yield different values in Table 7 than in Table 6. Nevertheless, surviving populations from the survey (Table 7), relative to one another, are comparable to those obtained from the theoretical results (Table 6). That is, the theoretical June 8 spray, which is comparable to the first spray in two-spray areas, yielded a higher number of survivors on balsam fir than on red spruce (17.6 is higher than 10.2), and in the survey this also was found (9.2 is higher than 6.5). Again, the theoretical June 16 spray, which is comparable to the spray applied in one-spray areas, yielded a higher number of survivors on red spruce than on balsam fir (24.9 is higher than 12.1), and this was also found in the survey (9.2 is higher than 5.6). Thus, there is some support in the surveys in 1961 for the theoretical considerations given above.

The remainder of Table 7 shows the results of re-visiting, five days after the second spray was applied, a number of sample plots which contained 'high' populations after the first spray. These plots contained an average of 19.4 and 23.9 budworms per 18-inch branch tip on balsam fir and red spruce, respectively, after the first spray, when they were visited after the second spray the counts were reduced to 3.5 and 5.7, again respectively.

New Brunswick Spraying Design

Using T.B.M. Sprayer Aircraft and Cessna Flag Aircraft

In the forest spraying operations which were carried on in New Brunswick and Quebec during the period 1952 - 1958 Stearman biplane aircraft were used almost exclusively. Beginning in 1958 the Gruman Avenger (in the U.S. called T.B.M.) began to displace the Stearman in New Brunswick forest spraying operations as it and other heavier aircraft had already largely succeeded in doing in the U.S.

For both these aircraft in their agricultural sprayer conformation the crew ratio is 1 : 1. Cost of surplus T.B.M. converted to sprayer : Stearman so modified is perhaps 1.5 : 1. All up weight, useful load of insecticide and power ratios are all about 4.5 : 1. Spraying speed ratio about 1.6 : 1. Rate of coverage of forest about 3 : 1. From these very approximate relationships between the two, T.B.M. and Stearman, it is easy to see how costs may be reduced by use of the T.B.M. in flat to rolling terrain. Where, depending on length of haul, a T.B.M. is worth two to six Stearmans.

Stearman spray blocks were about 4,500 acres in size (say 3½ miles long X 2 miles across), bounded by streams, wood roads or any convenient break easily recognizable on the ground at time of spraying from an air position as well as on maps or air photos. Spraying of these were by parallel passes or by contouring or a combination of the two, all from memory after familiarization with block location, size, bounds, nature of terrain, etc. Inspection consisted of sampling sprayer performance visually from light aircraft.

With the advent of T.B.M.s, blocks were made larger (about 12,000 acres - say 18-20 sq. miles - 6 to 7 miles long X 3 wide). Beyond increasing the length of a pass and intensifying inspection to give 100% visual coverage in 1958 and 1960, the method remained essentially the 1953 version of Stearman spraying in which now the pairs of sprayer aircraft fly at 150-160 miles an hour instead of 95 to 100 and cover about 800 feet laterally in a single pass instead of 400. Other things equal, errors in judgment by pilots are magnified in use of T.B.M.s as compared with Stearmans. Most of these are the direct result of increased speed and greater distances without corresponding compensating increases in pilot ability.

It was obvious after the 1960 operation that some change in method of spraying must be sought if the advantage of the T.B.M. aircraft, viz. its load carrying ability, high ferry speed, endurance and excellent swath width, etc., were to be made most of. With this incentive a completely new way of spraying was worked out and tested before the 1961 operation and then was used in this operation to give a much improved application of insecticide.

The new method is based on the assumption that the pilot has enough to do simply to fly the aircraft and that he should not have to determine where the pass is to be made or the direction in which it should be flown. Such assumptions are made in agricultural flying, where flagmen on the ground determine position and direction of pass. There is no operational terrestrial flag system possible for large scale elastic forest spray programs and so it was decided to try to develop an aerial one.

Early winter trials employing helicopters as flag aircraft for sprayers indicated that the helicopter was not the solution but did suggest trials using fixed wing aircraft as flags. It was sometime before the idea of the flag in motion in the direction of spraying was accepted not only as possible but necessary, to control the spraying. After much flying, testing and adjusting, it was found feasible to fly the course of a spray pass by using two flag aircraft as sighters for the simulated sprayer.

Always the chief difficulty with flyers is at the beginning when it is necessary to have sprayers and flag aircraft in their proper positions relative to each other, after which the system has little difficulty in providing the guides and controls necessary to the sprayer pilots for adequate coverage.

Changes did not stop at shifts in responsibility of pilots and aircraft. Spray blocks were designed to fit the aircraft and its load of insecticide. These were made square in shape and 14,000 acres in size, which can be covered in 10 plane loads of 700 gallons sprayed at a theoretical emission rate of about 63 gallons a minute from a plane travelling about 150 m.p.h. and having a theoretical swath width of 412 ft. approx.

The blocks, approximately 4.7 miles on a side, were laid out on 1 : 50,000 topographic maps instead of air photos and without any relation to the drainage. Only map cardinal directions were used in block orientation. Flying in pairs, 5 team loads of 6 passes each (823 ft. wide), covered such a block. The least count in area was a team load (equivalent of 2,800 acres - 4.7 mi. X 0.93 mi. - 0.2 Block).

In each position of responsibility was a person best fitted for the work. For example, flag pilots were required to have had 500 hours or more experience on light aircraft holding an instructor's rating and, in addition, were required to pass screenings by Company test pilots.

Pointers, who were in control of flag plane movements while spraying, were required to be good map readers and low level navigators and to have had some woods experience. These two, Flaggers and Pointers, took over for the first time responsibilities formerly accepted by the Sprayer pilot and ceased to be just bird watchers.

All aircraft carried two radio systems for regular and emergency communications air to air and air to ground. All aircraft were equipped with directional gyros and flag aircraft with rotating beacons which helped sprayers to pick them up in times of fair to poor visability.

... 3.

Example

In order to explain how this worked out in practice a typical block is selected for spraying. It is far enough away from the airfield to allow two teams of sprayers, staggered so that one is reloading while the other is spraying, to work under one team of flag planes.

Sprayers and flaggers are given names which cannot be confused on radio. In this instance sprayer teams Nylon and Jughead are assigned to the block by the field pilot. Sprayers in teams are lead and trail and in this instance would have the designations Nylon one and Nylon two or Jughead one and Jughead two. Ordinarily the radio portion of the drill involves the lead pilot only. His trail man follows him separated laterally about 410-15 feet.

Flag teams are given colors. In this case Red team is made up of two flag pilots and two pointers flying in two Cessna 172's. They are Red leader and Red two. Block 61 is shown in Fig. I and all points mentioned in the following account of the spraying of the first two passes are labelled.

The lead spray pilots have flown the boundaries with the flaggers. They not only know what it looks like and how to get there from the airfield but they also have agreed on a rendez-vous point C in Fig. I. Inability to find this point or to announce position at the time of arrival washes out the drill. All is ready.

Step 1: Red Flag team locates starting point A, in N.E. cor. of block. Red leader circles at Point A at an altitude of 700 feet above average ground elevation. Red 2 Flag extends the E-W line through A eastward 2½ miles to Point B and circles at 700 feet (see Fig. I).

Step 2: Spray team Nylon come out loaded from the airfield and upon reaching Point C, their pre-determined rendez-vous point 4½ miles East of starting Point A will then say "Nylon lining up". Red Flag Team will acknowledge and Red Leader will fly Westward on track maintaining an altitude of 700 feet and a speed of 75 miles an hour toward starting Point A.

Step 3: At Point D, ½ mile East of starting Point A, the spray team, flying at an altitude of 150-200 feet and at a speed of 150 miles an hour will have gone past Red Two who will then be in a position to see the spray team as they pass starting Point A, and will call "Nylon booms on". Nylon spray team will then proceed Westward maintaining their track and following Red Leader with Red Two bringing up the rear.

Step 4: When Red Leader reaches Point E, ½ mile East of ending Point F, the spray team will have gone past him putting Red Leader in position to give "Nylon booms off" as they cross Point F.

Step 5: Red Leader, after "booms off", will stay on track until he sees Nylon team bank left for turn. He will then do a 180 degree turn, moving over approx. 800 feet. Red Two, on hearing "booms off", will increase speed and maintain track until he sees Red Leader complete his turn. He will then do a 180 degree turn, moving over the required swath width of approx. 800 feet.

Step 6: Nylon spray team will, on completing turn, line up on Red Leader flying Eastward on track and will turn "booms on" as they cross starting Point G on the second swath using spray pattern from the first swath for guidance. The spray team will then continue Eastward on track passing Red Leader near Point G and follow Red Two who is now at Point H approximately 2 miles East of the spray team.

Step 7: When Red Two flag aircraft reaches Point I, ½ mile West of ending Point J on second swath, the Nylon spray team will have gone past him and he will be in position to say "booms off" when they cross said Point J.

Step 8: Red Two flag aircraft, after "booms off", will stay on track until he sees spray team bank left for turn. He will then do 180 degree turn moving over 800 feet. Red Leader will make his turn at the same time as Red Two, as it is only on the first swath of a spray load that the trail flag aircraft waits until the lead flag aircraft has completed the turn to make his. The flag team and spray team will continue in this manner until the spray aircraft has completed its load. The red flag team then locates starting point for the second spray load on the block and orbits awaiting the arrival of spray team "Jughead" which should be on the way out. Upon the arrival of this team, they continue in the same routine as they did with "Nylon" spray team on the first load.

The sprayer aircraft were calibrated so that a team carrying a full complement of insecticide would, on the average, run-out slightly beyond the end of the 6th pass.

B. W. Flieger
January 3, 1962

NORTH

Block 61

Load Team

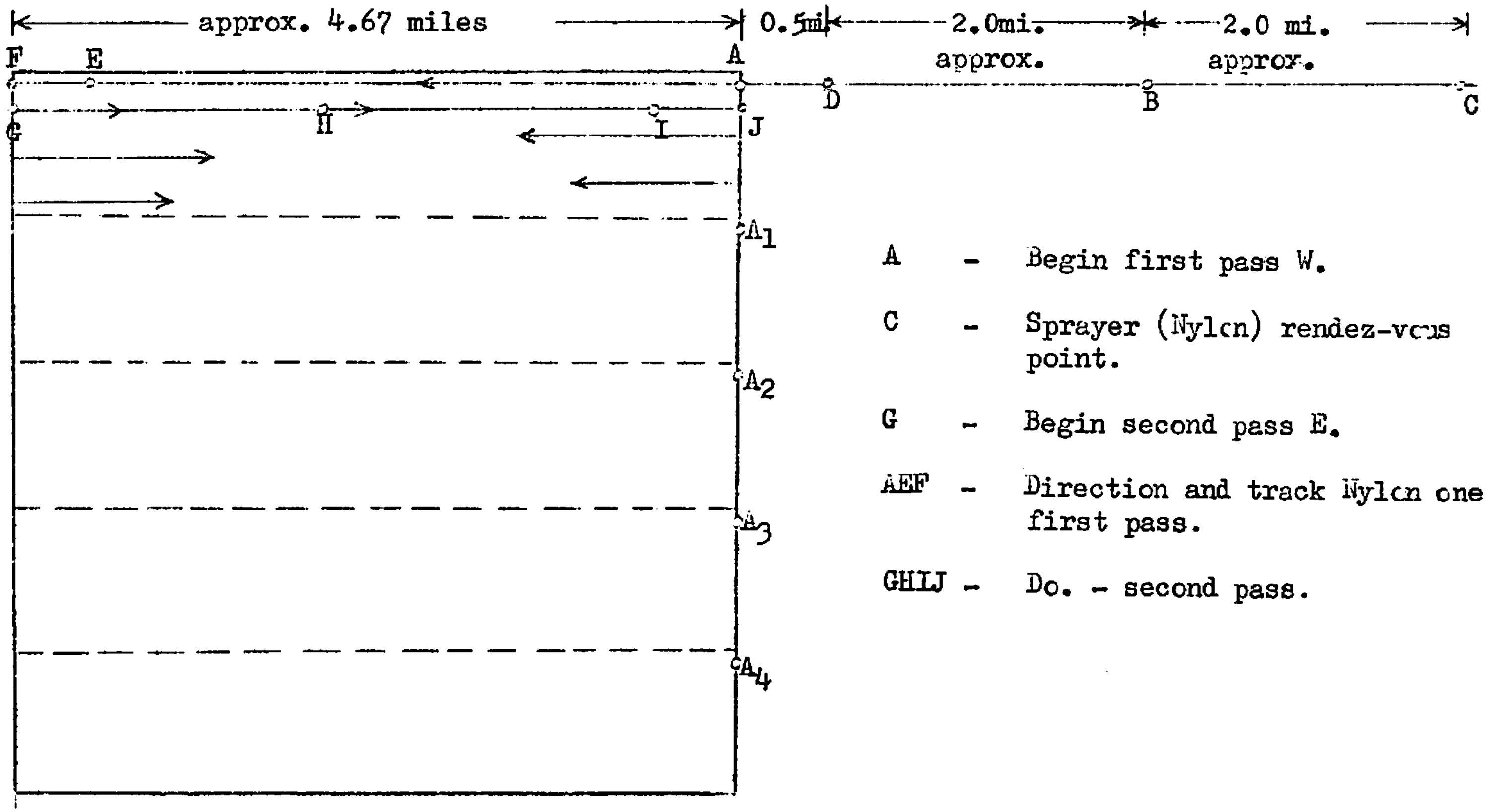
1. Nylon

2. Jughead

3. Nylon

4. Jughead

5. Nylon



A - Begin first pass W.

C - Sprayer (Nylon) rendez-vous point.

G - Begin second pass E.

AEF - Direction and track Nylon one-first pass.

GHIJ - Do. - second pass.

Theoretical Spraying Data -

(a) Swath width pair: 822 ft. X 30 passes = 24,660 ft. = 4.67 mi.
(b) Insecticide dosage: 0.5 U.S.G. / Acre = 7,000 U.S.G./14,000 ac. (4.67 mi. X 4.67 mi.)
(c) Coverage: 5 loads X 6 passes X 2 aircraft = 60 passes X 4.67 miles = 280.2 miles X 411 ft = 14,000 ac.
(d) Emission rate 280.2 miles @ 150 m.p.h. = 112.2 min. @ 62.3 G.P.M. = 7,000 G + 0.5 G.P.A. = 14,000 ac.
(e) Cessna speed: variable to maintain position - average 75 M.P.H. - ½ sprayer speed.

B. W. Flieger
January 3, 1962

Appendix II

PRELIMINARY ASSESSMENT OF OPERATIONAL AND EXPERIMENTAL AERIAL SPRAYING AGAINST SPRUCE BUDWORM IN NEW BRUNSWICK IN 1961

D. G. Mott

Forest Entomology and Pathology Laboratory
Department of Forestry
Fredericton, N. B.

November 6, 1961

Summary

1. In the 1961 aerial spraying program against spruce budworm, 1,648,150 acres were sprayed once, 523,100 acres were sprayed twice, and 2,800 acres were sprayed thrice with low-strength insecticide (1/4 lb. DDT in 1/2 U.S. gal. solvent oil per acre). 14,000 acres were sprayed once with high-strength insecticide (1/2 lb. DDT in 1/2 U.S. gal. solvent oil per acre). Experimental and operational spraying on these areas was carried out by Forest Protection Limited with technical assistance from the Laboratory.

2. Spraying began on June 4, a late date because of a late spring in 1961, and was completed on June 30. Second sprays were first applied on June 18.

3. Surveys, conducted during the early larval period before spraying, disclosed that 224,900 acres outside the original spray plan supported high populations, and that 8,400 acres within the spray plan supported low populations. These areas were added and deleted, respectively, from the spray plan.

4. Several areas, 424,500 acres in all, were designated in the original spray plan to receive two applications of insecticide because they had a persistent infestation history. Counts of the number of larvae surviving five days after the application of the first spray showed that these areas contained a greater number of high surviving populations than the areas designated for one spray. These counts were obtained from a survey which also disclosed that high surviving populations occurred in 98,600 acres of the area originally designated for one spray. These were treated a second time.

5. Higher percentage control was obtained in 1961 as in 1960, on both balsam fir and red spruce in areas where egg infestations were high than where they were low.

6. Higher percentage control was obtained on both balsam fir and red spruce in areas sprayed twice than in areas sprayed once.

7. New flying techniques were used by Forest Protection Limited in 1961. Spray deposit in 1961, assessed along a transect of spray swaths in two experimental blocks, disclosed that spray droplet coverage was much improved over that obtained in 1960, assessed at about the same number of locations scattered throughout the operation. Two sprays are thought to provide even more complete spray coverage.

8. Proper comparison of low- and high-strength insecticides requires more complete analysis. Preliminary results indicate that there is no difference in the effectiveness of the two insecticides which is not attributable to known relationships between droplet deposit and insect mortality.

9. Studies of shoot development, budworm feeding habits and experimentally applied sprays on June 5, 8, 11, 14, 19, 24 and 29 show that:

   (a) Percentage control on balsam fir and white spruce increased from about 50 per cent to about 90 per cent from June 5 to June 29. Larvae became progressively more likely to be contacted by spray at later dates.

(b) About 50 per cent control was obtained on red spruce and black spruce by spraying on June 5, 8 and 11. About 5 per cent was obtained on June 14 and 19, and spraying after June 24 produced progressively higher percentage control to about 90 per cent on June 29. Larvae were moderately well exposed on these species during the early period but became well protected during the mid-period as they entered the later-opening buds where they were protected by bud-caps. During the late period, the disappearance of bud-caps and increased size and movement of the larvae contributed to better control.

10. Populations of spruce budworm vary from species to species among the host tree species. When this is considered together with variations in the percentage control obtained from sprays applied at different times, it is concluded that:

(a) Single sprays applied early to protect balsam fir foliage will leave a sufficiently high population on either red spruce or balsam fir to reinfest balsam fir in stands containing a mixture of the two species.

(b) The application of an early spray and a late spray will both protect balsam fir foliage and yield high percentage control on all host tree species.

(c) Late spraying will produce high percentage control on all host tree species but will not protect balsam fir foliage.

PRELIMINARY ASSESSMENT OF OPERATIONAL AND EXPERIMENTAL AERIAL SPRAYING AGAINST SPRUCE BUDWORM IN NEW BRUNSWICK IN 1961

D. G. Mott

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Department of Forestry
Fredericton, N. B.

The 1961 spruce budworm aerial spraying program in New Brunswick comprised an operational spray area of some 2,084,450 acres and an experimental spray area of some 103,600 acres. Preliminary acreages sprayed were given in an earlier report[1]. Table 1 presents a final statement of areas involved in both operational and experimental spraying.

Table 1.--Acres sprayed in 1961 spruce budworm aerial spraying operation.

<u>Operational area</u>	
Sprayed once with (1/4 lb. DDT per 1/2 U.S. gal. solvent per acre)	1,572,550
" twice " " " "	509,100
" thrice " " " "	2,800
<u>Experimental area, Dept. Forestry</u>	
Sprayed once " " " "	33,600
" twice " " " "	14,000
" once " (1/2 lb. DDT per 1/2 U.S. gal. solvent per acre)	14,000
<u>Experimental area, Dept. Fisheries and Fisheries Research Board</u>	
Sprayed once with (1/4 lb. DDT per 1/2 U.S. gal. solvent per acre)	42,000
Total area sprayed once	1,662,150
" " " twice	523,100
" " " thrice	2,800
Total area sprayed (net area)	2,188,050

[1]Summary Report of 1961 Spruce Budworm Aerial Defoliation and Egg-Mass Surveys, and Forecast of Conditions for 1962. D. G. Mott, Forest Entomology and Pathology Laboratory, Department of Forestry, Fredericton, N. B. September 27, 1961.

In 1961 the Forest Entomology and Pathology Laboratory, Fredericton, N. B., Department of Forestry, again provided technical assistance to Forest Protection Limited in the conduct of the operational spray program, and conducted experimental studies in the experimental spray area in conjunction with Forest Protection Limited. The technical assistance rendered by the Laboratory was under the overall direction of D. G. Mott, assisted by D. G. Cameron who supervised experimental work at a field camp at Chipman, and M. B. Craig who supervised surveys of population level following spraying. During the year the Laboratory expended some 2,000 man-days and 54,000 vehicle-miles on the operational and experimental spray programs. Forest Protection Limited augmented the Laboratory staff and facilities by supplying some 3,000 man-days of labour and 20,000 vehicle-miles of transportation, and all flying services. The Laboratory undertook the following responsibilities in 1961:

1. Consultation with respect to development of the spraying plan. This required the conduct of surveys of population level in the late summer of 1960 and forecasts of hazard from attack for 1961.

2. The conduct of surveys of tree and insect development in 1961 as a basis for advising on timing of spray applications.

3. The conduct of surveys of population level in 1961 in the vicinity of the operational area and advising regarding the need for extensions to the area to be sprayed.

4. The conduct of surveys of surviving populations following spraying and advising regarding the need for respraying.

5. The assessment of the effectiveness of the spraying operation through population and defoliation surveys following spraying.

6. The conduct of experimental programs.

During May, June and July work was centered at Taxis Airstrip at Parker's Ridge, and at Chipman. Trailer facilities were provided by Forest Protection Limited at Taxis, and a field camp was established in local facilities at Chipman. The latter was established and operated by F.P.L. with costs borne by the Department of Forestry.

The extensive defoliation survey was conducted by Forest Protection Limited.

In the following report, results of operational and experimental spraying are considered separately.

Operational Spraying

The earlier report of this Laboratory already referred to, presented maps of the 1961 aerial spraying operation and these will not be repeated here.

In the autumn of 1960, the Laboratory drew attention to the fact that surviving populations on red spruce were remarkably high following spraying and the probability that these populations would reinfest balsam fir. It also pointed out that in certain limited areas, red spruce was beginning to suffer serious damage from defoliation by budworm. The Advisory Committee on Forest Spraying of

Forest Protection Limited at its Meeting of November 14, 1960, drew attention to the fact that there were areas of seemingly persistent infestation in spite of spraying in 1958 and 1960, and, with the hypothesis that this might be due to the survival of budworm on red spruce, recommended that such areas be delineated and treated with two sprays in 1961, one at the normal time for protection of balsam fir foliage and the second about ten days later when red spruce shoots were expected to be more developed. Such areas were delineated at the Laboratory from past records of egg-mass infestation and defoliation, and as a result 424,500 acres were included in the original 1961 spray plan for two spray applications. A visual assessment of stand conditions from the air in these areas suggested that red spruce was prevalent in most of the coniferous stands and was frequently an important component in mixedwood stands.

Timing of Spraying

The basis for timing spray applications in New Brunswick has been that devised by Webb (1955)[1]. Using Webb's work as a guide, the 1960 spray application was delayed to obtain high insect kill, and considerable defoliation of balsam fir resulted. Very favourable weather for the budworm prevailed during the 1960 season and most of the sprayed area, then seriously damaged, became reinfested. The 1961 operation, therefore, had to be timed to preserve as much foliage as possible on balsam fir.

In 1961, spring development of trees and the budworm were about three weeks later than normal. This was accompanied, and perhaps caused, by a predominant air flow from the east during the spring period, which carried inland cool air from the Gulf area. As a result, development was later in some easterly sections than in some westerly sections, and shifts in the timing of spraying had to be made to account for this.

Original planning for 1961 intended that first sprays in all areas be applied at the time when maximum foliage protection would be obtained on balsam fir, and second sprays where applicable, be applied about ten days later with the objective of obtaining better control on red spruce. Very little experience with budworm habits on red spruce was available when these plans were made. However, close observation of development in the early spring of 1961 suggested that in two-spray areas the first spray should be applied earlier than the normal time to protect balsam fir foliage because it was found that budworm larvae on red spruce were fairly well exposed on old foliage during the early period and it was suspected that they would become well protected under bud-caps at about the normal time of spraying. This was discovered in time to recommend earlier applications of the first spray in two-spray areas. Further discussion of timing is presented below in experimental results.

The timing schedule that was evolved for 1961 was followed remarkably well by Forest Protection Limited. Spraying began on June 4, second sprays were first applied on June 18, and spraying was completed on June 30.

Pre-spray Larval Population Surveys Outside the Spray Plan

A survey, using sequential counting techniques, was conducted in May and

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[1] Webb, F. E. 1955. Biological assessment of aerial forest spraying against the spruce budworm in New Brunswick. For. Chron. 31(4): 342-352.

early June for larval populations outside the operational spray plan along the perimeter from Fredericton clockwise to the lower Miramichi. This survey was intended to provide infestation information early enough that any extensions to the plan could be made while foliage could still be protected by spraying. It was also intended to determine the population level on two spray blocks containing a total of 8,400 acres which were suspected to contain low populations. It was particularly important to detect any infestations on the northern edge of the plan where the large areas of vulnerable, overmature timber lie. Previously undetected infestations were discovered at a number of locations: a large area south of Prince William running down to Brockway, areas near Meductic, Hartland, East Florenceville, Glassville, Juniper, Maple Grove, Napadogan, Hovey Brook, Parker's Ridge, Salmon Brook Lake, and along the lower Renous River. Low populations were discovered in the two blocks mentioned above that had been included in the plan. These were located along the lower Northwest Miramichi River.

As a result of these surveys, 224,900 acres were added to the original spray plan and 8,400 acres were deleted.

Surviving Populations After First Spray

In order to establish whether areas designated in the spray plan to receive two applications of spray warranted second treatment on the basis of population levels following the application of the first spray, and to establish where other areas of high surviving population were located, a survey of surviving larval populations, using sequential counting techniques, was conducted within all sprayed areas. Counts were obtained from balsam fir and red spruce at up to five locations in each accessible spray block five days following first spraying. In this survey, 'high' counts represent the number of larvae which would be expected to cause severe defoliation and severe reinfestation of eggs. 'Low' counts represent the number expected to cause light defoliation and light reinfestations. The results of this survey are presented in Table 2.

Table 2.--Percentage of sample points from sequential surveys conducted five days after first spraying, containing 'high' and 'low' infestation levels on balsam fir and red spruce. (Number of sample points in brackets.)

Sequential infestation category	Areas designated for one spray application		Areas designated for two spray applications	
	Balsam fir	Red spruce	Balsam fir	Red spruce
High	14 (42)	26 (63)	26 (22)	22 (17)
Low	86 (250)	74 (182)	74 (63)	78 (61)
Total	100.0 (292)	100.0 (245)	100.0 (85)	100.0 (78)

A larger proportion of balsam fir samples contained 'high' surviving populations following the first application of spray in areas designated for two sprays than in areas designated for one spray (26 per cent vs. 14 per cent). A fairly large proportion of red spruce samples contained 'high' populations in both treatment categories (26 per cent and 22 per cent), but it must be remembered that red spruce in stands in the areas designated for two applications is more prevalent than in those designated for one, and that 'high' surviving populations on this species in the areas designated for two sprays are therefore more likely to yield reinfestation of balsam fir.

Some 98,600 acres were discovered in the survey to support 'high' surviving populations after the application of the first spray, in the areas originally designated to receive one spray. These were therefore treated the second time. Some 2,800 acres were resprayed a third time, because 'high' populations were discovered after the second treatment.

After the second treatment, the percentage of 'high' samples in the whole operational area was reduced from 17 per cent to 1 per cent on balsam fir, and from 25 per cent to 3 per cent on red spruce.

A discussion of the average number of surviving insects in these different spraying regimes is presented later, following a consideration of the experimental results.

Population Reduction by Spraying in 1961

Percentage control is based on sampling pupal populations throughout sprayed and unsprayed areas. This is an extensive survey: in 1961, counts were made on balsam fir at 322 locations, and on red spruce at 185 locations. In Table 3, the results are broken into those obtained in one- and two-spray areas, and into two infestation categories.

Table 3.--Number of emerged pupae per 18-inch branch tip on balsam fir and red spruce in sprayed and unsprayed areas, divided into high and low infestation categories; and calculated percentage control by spraying. (Number of samples in brackets.)

			Pupae per 18-inch branch tip		Per cent
			Sprayed areas	Unsprayed areas	control
Balsam fir	Sprayed once	Low*	0.93 (140)	1.97	53
		High*	1.16 (98)	5.17	78
	Sprayed twice	Low	0.67 (16)	1.97	66
		High	0.86 (68)	5.17	84
Red spruce	Sprayed once	Low	0.42 (82)	0.90	53
		High	0.72 (42)	3.81	81
	Sprayed twice	Low	0.19 (11)	0.90	79
		High	0.52 (50)	3.81	86
Combined:	Balsam fir (weighted by number of samples)				73
Combined:	Red spruce (" " " " ")				79

*Infestation categories, based on egg-mass infestations from 1960 survey. High - above 175 egg-masses per 100 sq. ft. of foliage. Low - below 174 egg-masses per 100 sq. ft. of foliage.

The following conclusions may be drawn from Table 3:

(a) Better control was obtained on both balsam fir and spruce where larval populations were high than where they were low. This is consistent with results in 1960.

(b) Better control was obtained on both balsam fir and red spruce in areas sprayed twice than in those receiving only one spray. However, the remarkably good control suggested on red spruce in the one-spray areas as compared with that on balsam fir (81 and 53 per cent compared with 78 and 53 per cent) is not consistent with the more intensive experimental results to be presented later in this report. No firm explanation can be advanced; it may be due to an underestimate of unsprayed population levels due to sampling.

(c) Somewhat better overall control was obtained on red spruce than on balsam fir.

An indication of the influence of the spraying operation on population trends can be obtained from a comparison of egg populations in 1960 and 1961 (Table 4).

Table 4.--Comparison of number of egg-masses per 100 sq. ft. of foliage on plots sampled in 1960 and 1961 in sprayed and unsprayed areas.

Area	No. plots	Egg masses per 100 sq. ft. foliage		Ratio, 1961:1960
		1960	1961	
1961 operational and experimental areas - one application	173	156.5	64.0	0.41
1961 operational and experimental areas - two applications	73	202.2	52.9	0.26
1961 unsprayed check areas	10	401.3	216.7	0.54

Table 4 indicates a reduction in average population level occurred naturally in check areas from 1960 to 1961 with 1961 populations being about one-half those of 1960. In areas that were sprayed once in 1961, a slightly greater reduction took place, and in areas sprayed twice, populations in 1961 were about one-quarter their level in 1960.

On an area basis, however, the reduction in the infestation is much more marked. There was a reduction from 939,000 acres to 260,000 acres of moderate and severe infestation (more than 175 egg-masses per 100 sq. ft. of foliage) in the operational area from 1960 to 1961 following the 1961 operation. In the remaining infested area in 1960 (aside from the Tabusintac area), only part of which was sprayed in 1961 experimentally, 847,000 acres were moderately and severely infested in 1960 and 647,000 acres in 1961. Thus, in the operational area, the area of moderate and severe infestation was reduced in 1961 to 27 per cent of the area in 1960, while in the remaining area of 1960 infestation, the area infested in 1961 is equal to 76 per cent of that in 1960.

Experimental Spraying Program

Only the experimental program of the Forest Entomology and Pathology Laboratory, Fredericton, will be considered in this report. Those of the Chemical Control Section, Department of Forestry, and of the Fisheries Research Board and Department of Fisheries will be reported on separately.

The program of the Laboratory was carried out in the area illustrated in Fig. 1 from field headquarters at Chipman, and had as its objectives the following:

1. The comparison of spray droplet coverage in 1961 with that in 1960.

2. The comparison of the effectiveness of a single application of 1/4 lb. DDT per 1/2 U.S. gal. solvent oil per acre (low-strength insecticide) with that of a single application of 1/2 lb. DDT per 1/2 U.S. gal. solvent per acre (high-strength insecticide), as a supplement to more intensive testing of these two formulations in 1960.

3. The comparison of the effectiveness of one and two applications of 1/4 lb. DDT per 1/2 U.S. gal. solvent oil per acre as a check on performance of these two spraying regimes in the 1961 operational spray area.

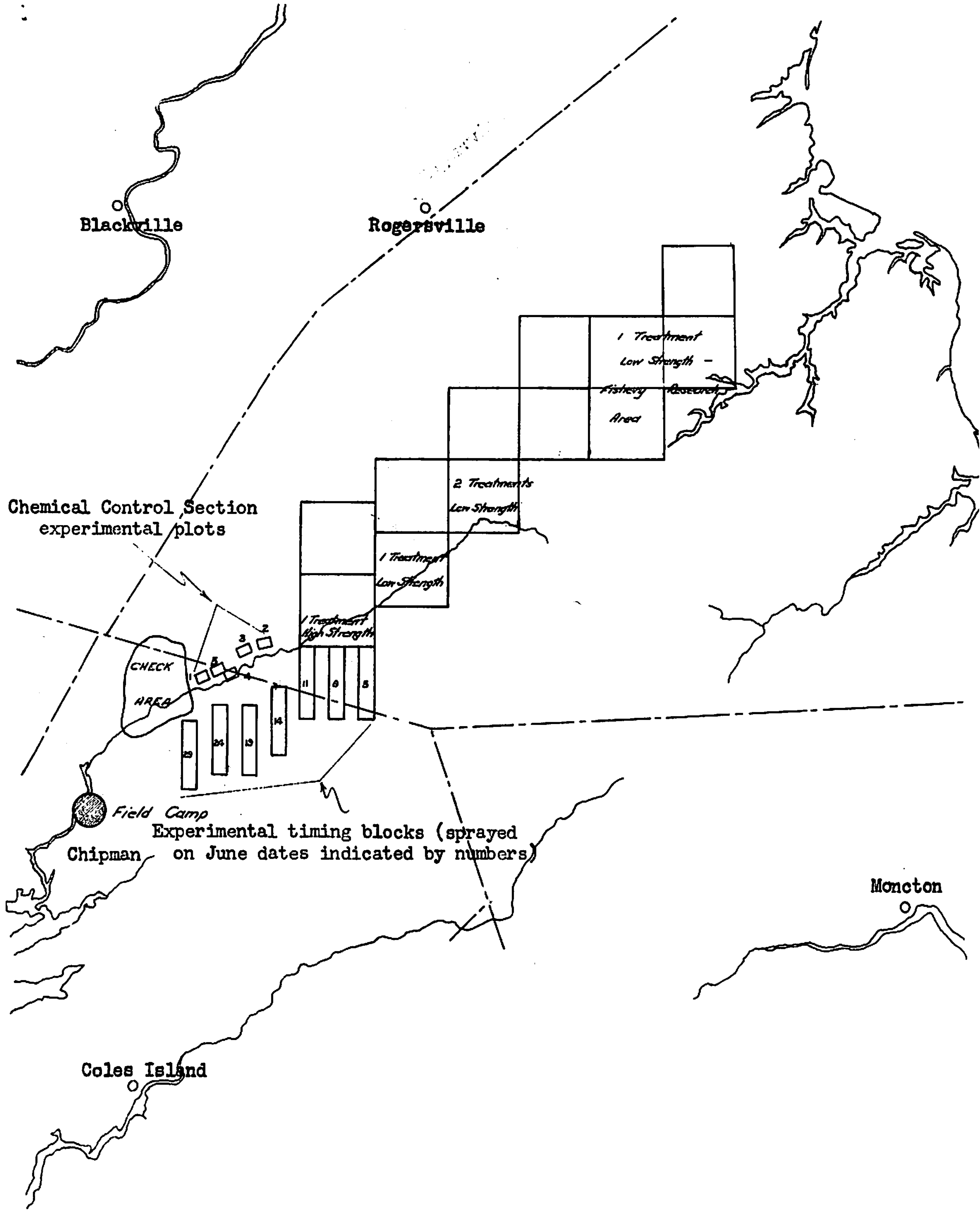
4. The study of means of obtaining good control of budworm on all four of its host tree species--balsam fir, red spruce, white spruce, and black spruce.

Spray Droplet Coverage

In previous studies the Chemical Control Section, Department of Forestry, has shown that when a deposit of at least 10 droplets of spray per sq. cm. is obtained, good control of budworm larvae can be expected from either the low-strength or high-strength spray formulations. At less than 10 droplets per sq. cm. of deposited spray, effectiveness of both formulations is reduced, and the effectiveness of the low-strength formulation is less than that of the high-strength formulation. Evaluation of droplet coverage in the 1960 operation disclosed that a large proportion of the area received deposits of less than 10 droplets per sq. cm. Forest Protection Limited modified its flying procedures in 1961 in an attempt to improve the uniformity of spray coverage. The improved technique provided for each pair of spray aircraft two light aircraft carrying navigators who directed their flight paths by referring to topographic maps and ground characteristics. These two navigating aircraft were separated along the flight path, thus permitting the spraying aircraft to become oriented by visually aligning the navigating craft. Square or rectangular spray blocks were used, which contained the area to be treated by five team-loads of spray or nearest fifth thereof (14,000 acres or nearest 2,800 acres).

The spray deposit obtained from this new flying technique was measured on two of the experimental spray blocks by measuring the deposit on cards placed at intervals along a transect across the two blocks. The blocks were sprayed by 8 of the 24 aircraft used in the operation. In 1960, dosage was measured in a large number of blocks at a small number of places within the block--that is, in

Fig. 1.--Map of experimental spray area in 1961.



Scale: - 1 inch = 7.89 miles

a different way. Nevertheless, a comparison of the results obtained in 1960 and 1961 is informative (Table 5).

Table 5.--Comparison of spray deposit, 1960 and 1961.

Deposit, drops per sq. cm.	Proportion of sampled points	
	1960	1961
Less than 5 drops	48	23
Between 5 and 9.9 drops	20	13
More than 10 drops	32	64

On the basis of the sampling represented in Table 5, and considering deposits of less than 10 droplets per sq. cm. as representing inadequate spray coverage, spray coverage in 1961 was considerably better than in 1960. In those areas receiving a second spray in 1961, the area which received an adequate dosage during either the first or second spray, can be calculated as 64 per cent, plus 64 per cent of the initially inadequately sprayed 36 per cent, or a total of 87 per cent. In addition, there would have been areas which received less than ten drops in each of the first and second sprays, but on which the cumulative dosage would have been greater than ten: it is not known whether this can be considered adequate spraying.

An over-all increase in effectiveness of the 1961 spray over what was obtained in past years when high-strength insecticide was used should not necessarily be expected from the improvement of spray coverage in 1961. At deposits of less than 10 droplets per sq. cm. the high-strength insecticide is more effective than the low strength, while above 10 droplets per sq. cm. they are equally effective. Therefore, in those areas receiving less than 10 droplets per sq. cm., effectiveness was probably higher in past years with high-strength insecticide than it was in 1961 when low-strength insecticide only was used in the operation.

A detailed assessment of the spray deposit can be obtained from an examination of deposits along the transect through the two experimental spray blocks (Figs. 2, 3, 4, and 5).

Figs. 2 and 5 present results of assessments at intervals of about 115 feet along about 7.5 miles of transect, or at about 346 locations. High and low deposits can be seen to occur in patterns which are interpreted to be derived from individual swaths or team-swaths of spray. In Figs. 3 and 4, deposit was measured at intervals of about 14 feet along about 1.9 miles of transect. Spraying was done by two different teams of aircraft, and each figure represents spraying results of a team. A marked difference occurred between the two teams. Obviously this is not because of differences in flying procedure since even the poorer results show that swaths were located in approximately correct positions, although the aircraft may have been flying too close together. Most probably it is due to differences in the droplet spectrum of emitted spray, a matter which is susceptible to manipulation during calibration, or to the presence of a light cross-wind where good results were obtained.

Fig. 2.--Spray deposit measured as number of droplets per sq. cm. on cards placed at 115-ft. intervals along a transect of spray swaths in an experimental block containing 11,200 acres. Each team-load represents 12 spray swaths. The location of the beginning and end of each team-load is the theoretical map location and is not necessarily where the aircraft began spraying.

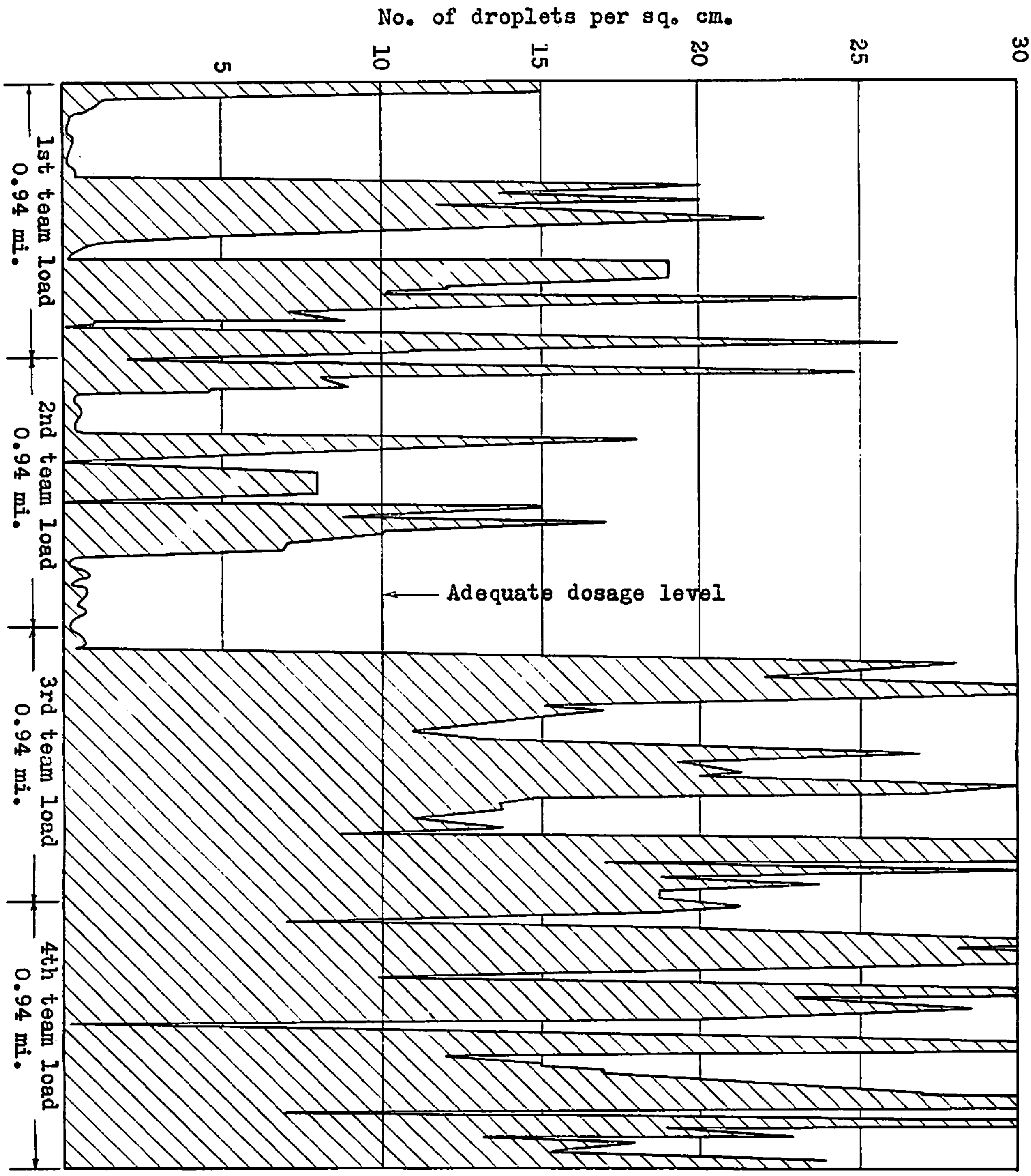

No. of droplets per sq. cm.
5
10
15
20
25
30
1st team load
0.94 mi.
2nd team load
0.94 mi.
3rd team load
0.94 mi.
4th team load
0.94 mi.
Adequate dosage level

Fig. 3.--Spray deposit measured as number of droplets per sq. cm. on cards placed at 15-ft. intervals along a transect of spray swaths in an experimental block containing 2,800 acres. Each team-load represents 12 spray swaths. The location of the beginning and end of each team-load is the theoretical map location and is not necessarily where the aircraft began spraying.

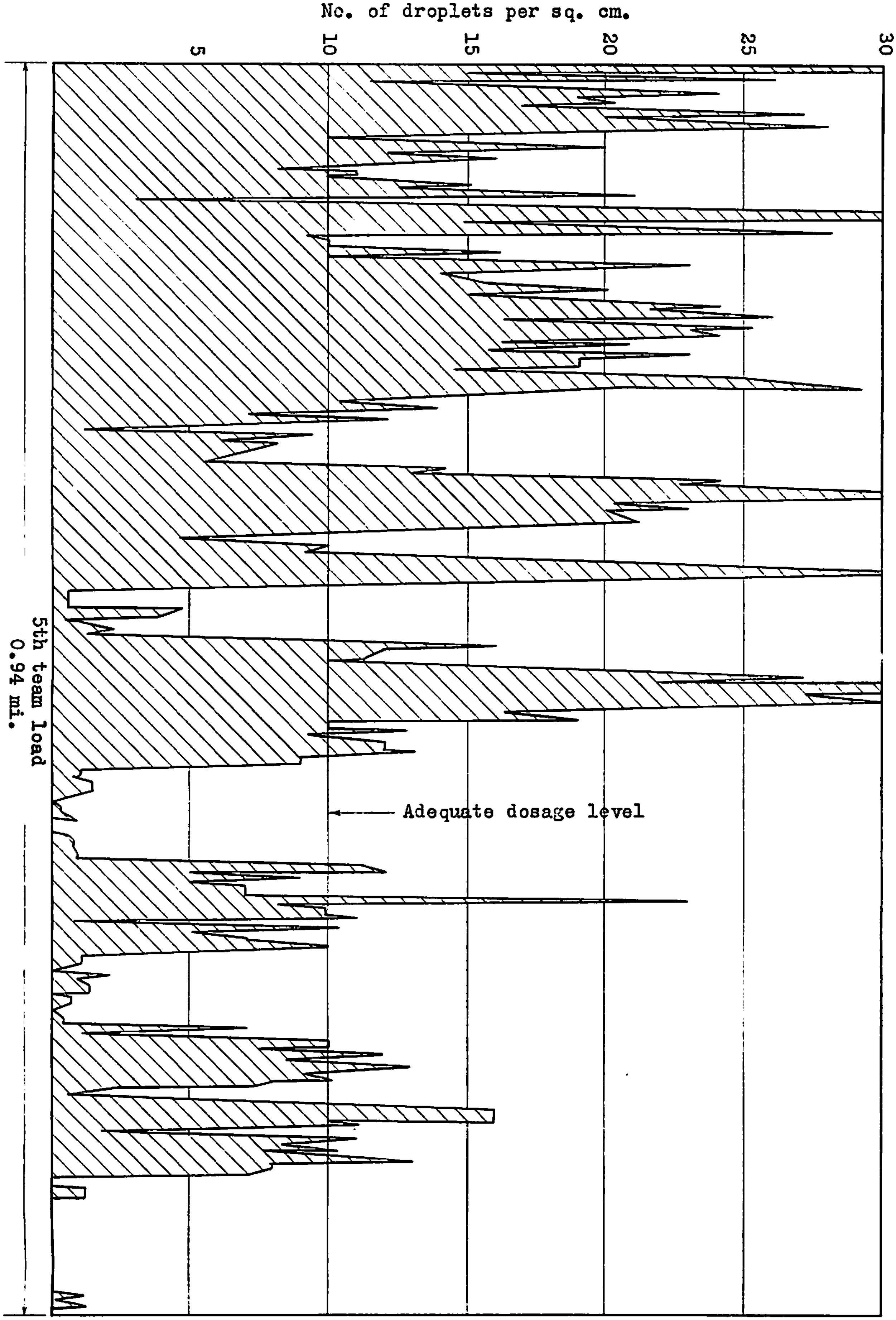
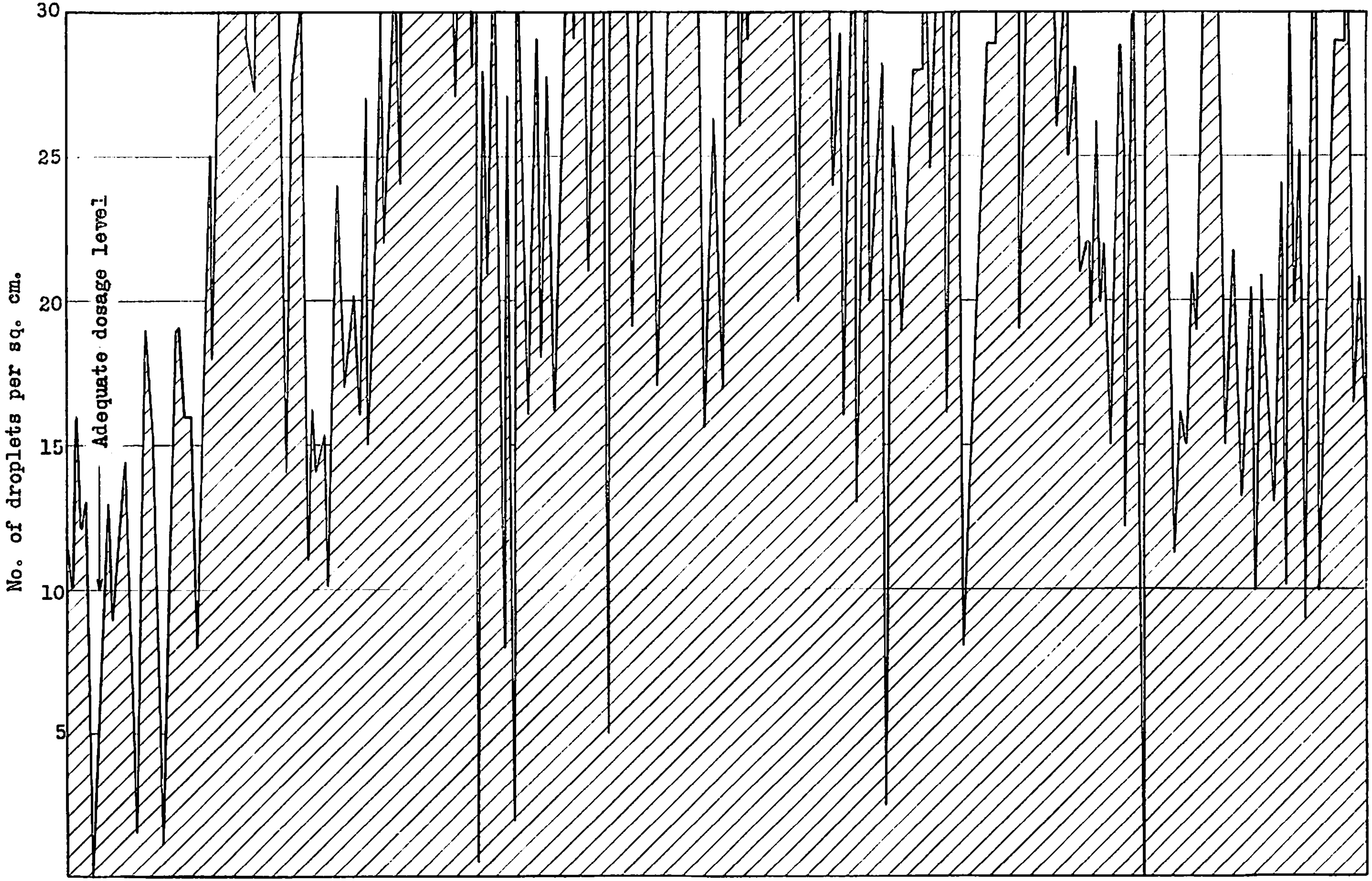
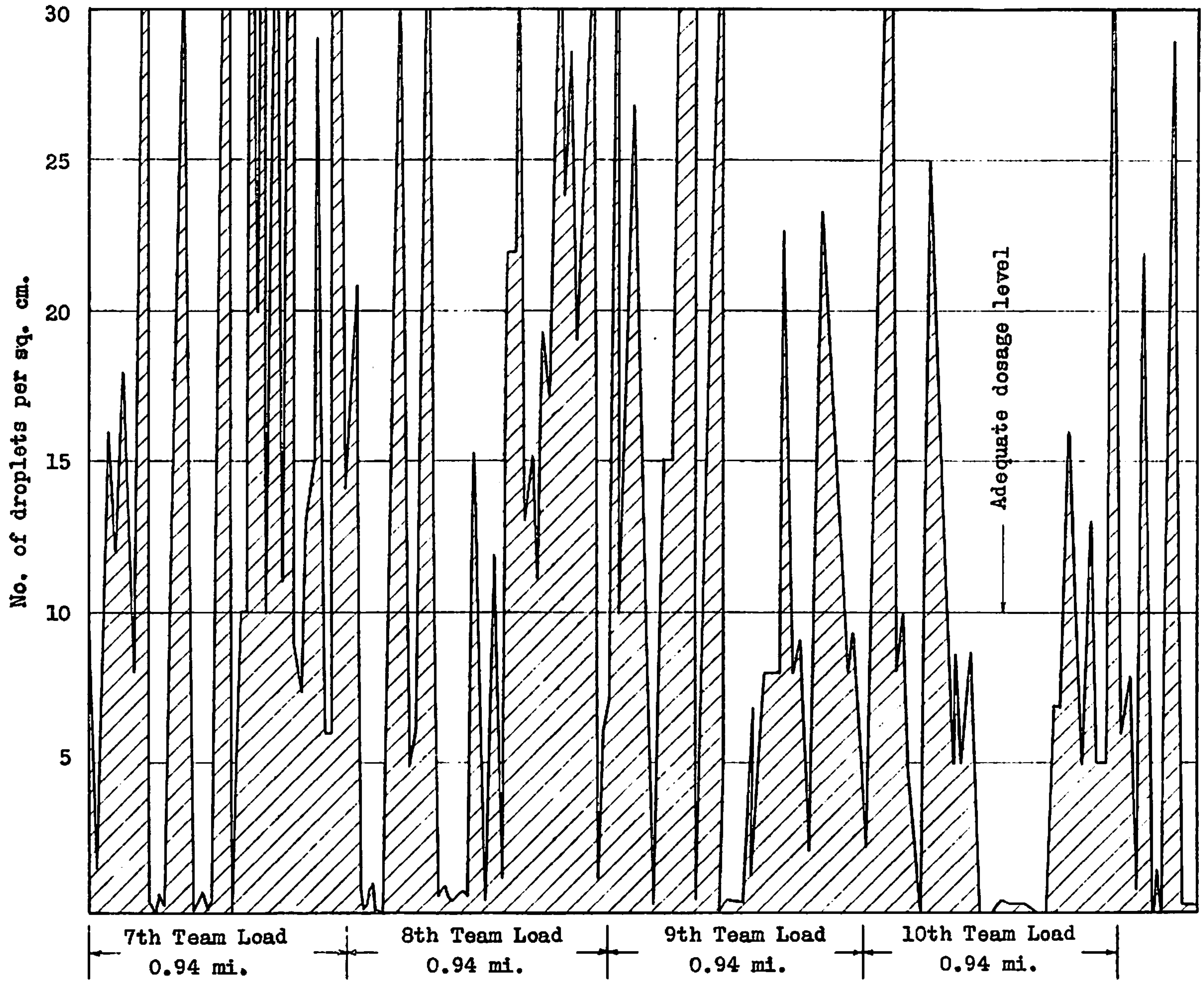

No. of droplets per sq. cm.
5
10
15
20
25
30
Adequate dosage level
5th team load
0.94 mi.

Fig. 4.--Spray deposit measured as number of droplets per sq. cm. on cards placed at 15-ft. intervals along a transect of spray swaths in an experimental block containing 2,800 acres. Each team-load represents 12 spray swaths. The location of the beginning and end of each team-load is the theoretical map location and is not necessarily where the aircraft began spraying.



6th Team Load
0.94 mi.

Fig. 5.--Spray deposit measured as number of droplets per sq. cm. on cards placed at 115-ft. intervals along a transect of spray swaths in an experimental block containing 11,200 acres. Each team-load represents 12 spray swaths. The location of the beginning and end of each team-load is the theoretical map location and is not necessarily where the aircraft began spraying.



No. of droplets per sq. cm.
5
10
15
20
25
30
Adequate dosage level
7th Team Load
0.94 mi.
8th Team Load
0.94 mi.
9th Team Load
0.94 mi.
10th Team Load
0.94 mi.

Pupal populations were measured at 38 locations which received in 1961 more than 10 drops per sq. cm., and at 24 locations which received less. There were 3.04 and 7.36 pupae per 10 sq. ft. of foliage, respectively, in these adequately- and inadequately treated locations.

Comparison of Low- and High-strength Insecticide

One 14,000-acre experimental spray block was treated with low-strength insecticide and one similar experimental spray block was treated with high-strength insecticide on the same days. Population sampling was carried on in an untreated check area and in the two spray blocks at intervals of about five days from May 25 to July 15. Twenty sample trees were distributed throughout each area. Spray was applied on June 14 p.m. and June 15 a.m. The degree of population reduction by spraying was computed as:

$$100 \times \frac{\text{Expected population (treated)} - \text{Observed population (treated)}}{\text{Expected populations (treated)}} \quad \ldots\ldots (1)$$

where:

$$\text{Expected population} = \text{Initial population (treated)} \times \frac{\text{Final population (check)}}{\text{Initial population (check)}}$$

Proper analysis of these data require a regression analysis of probit mortality and log droplet density in each treatment, together with a comparison of the resultant regression lines. At the time this report is written, such an analysis has not been performed and the results to be presented must be considered preliminary.

An average of 92 per cent control with high-strength insecticide and 78 per cent with low-strength was obtained on balsam fir. However, the sample trees in the area treated with high-strength received an average deposit of 9.6 droplets per sq. cm., while those in the low-strength area received only 6.7 droplets per sq. cm. The difference in percentage control is undoubtedly due to these differences in droplet dosage, and it is concluded that there were no differences in effectiveness of the two formulations when adequate dosage is obtained.

Comparison of One and Two Applications of Experimentally Applied Low-strength Insecticide

For this comparison, the 14,000-acre spray block treated with low-strength insecticide used in the preceding comparison was used as one experimental block, while a second 14,000-acre block was sprayed twice with the same formulation on June 7 a.m. and June 24 p.m. Population sampling was conducted in the same way as in the preceding comparison. The results of this test were inconclusive. During the first spray on the two-spray block, difficulty was experienced with the aircraft equipment in that portion of the block where most of the sample trees were located. A faulty dump valve permitted the load to be released much more rapidly than would have been the case through the regular nozzles. The resultant spray pattern showed large droplets beneath the aircraft with little lateral drift. Poor control was measured on the area--67 per cent in comparison with 78 per cent in the area treated with one application. However, the data collected from the operational area (see above) showing percentage control based on pupal populations leaves little doubt that better control was obtained in areas treated twice.

Spraying Balsam Fir, Red Spruce, White Spruce, and Black Spruce

Seven 2,800-acre blocks (Fig. 1) were sprayed on June 5, 8, 11, 14, 19, 24 and 29 with low-strength insecticide. The percentage control by spraying in each block was established by conducting an extensive survey of surviving pupal populations in early July. These counts were compared with the counts in the check area. Data on insect development and shoot development were obtained in the check area from the mid-crown of mature trees in the check area.

Figs. 6, 7, and 8 present the results of these studies. In Fig. 6, shoot growth during the spraying season is illustrated for each of the four tree species, while in Figs. 7 and 8 the persistence of bud-caps on the growing shoots and percent control resulting from spraying are shown in relation to date for each tree species.

Balsam fir growth proceeds at a rate intermediate between white spruce and red and black spruce (Fig. 6). This is the rate of growth with which budworm feeding is synchronized, such that serious defoliation results where populations are sufficiently high. The faster growth rate of white spruce results in more foliage being produced than can be consumed by budworm and thus only light or moderate defoliation. The slower growth rate of red and black spruce would result in more foliage being consumed than is produced if budworm larvae were able to feed in the shoots of these species. However, red and black spruce buds remain closed and protected from entry of the larvae by the bud-caps which persist for about 15 days after the balsam fir and white spruce bud-caps have begun to drop (Fig. 7). During this period old foliage must be consumed by the larvae. It is well known that small budworm larvae are not able to survive on the old foliage of black spruce and thus very little defoliation takes place on this species, except when it occurs in mixture with red spruce and balsam fir and becomes infested with budworm larvae from the former two species after the buds on black spruce have broken. However, it has been discovered that larvae can survive successfully on the old foliage of red spruce. At first, when they are very small, they mine the needles while later, as fourth-instar larvae, they construct open feeding sites among the old needles. Red spruce, however, is usually defoliated both by its own resident populations which survive in the above manner, and, when in mixture with balsam fir, by some larvae which become starved on fir and successfully move to red spruce.

When these four tree species are sprayed, the results depend very markedly on the timing of spray application. In 1961, within the experimental area, spraying between June 5 and June 11 obtained moderately good results on all species[1] (Fig. 8). After June 11, progressively better results were obtained on balsam fir and white spruce, but during the period from June 11 to June 20, very poor results were obtained on red and black spruce, followed by very good results after June 20. (It is convenient to discuss this in terms of dates, but it must be remembered that these dates might change radically from year to year, see below.)

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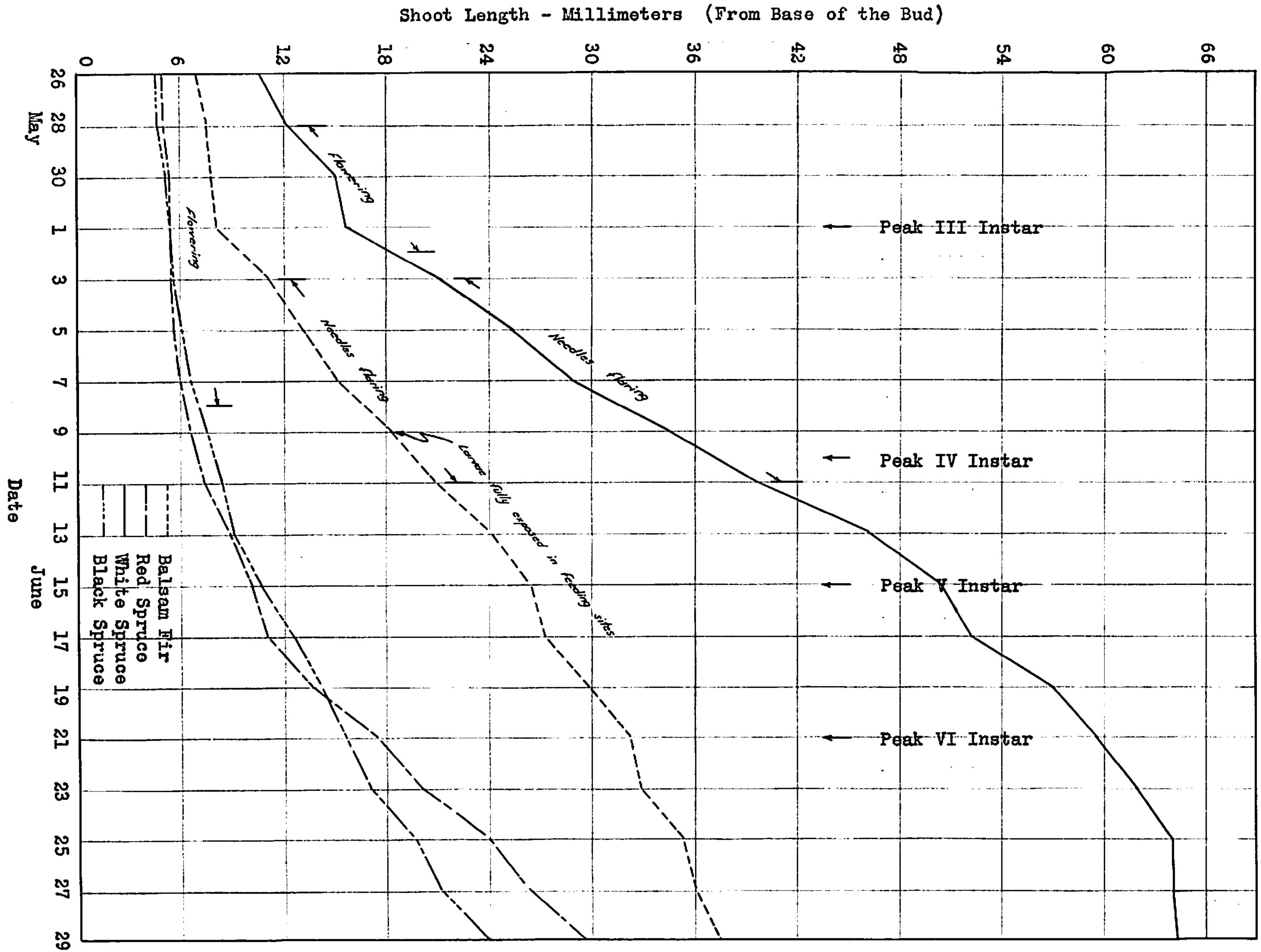
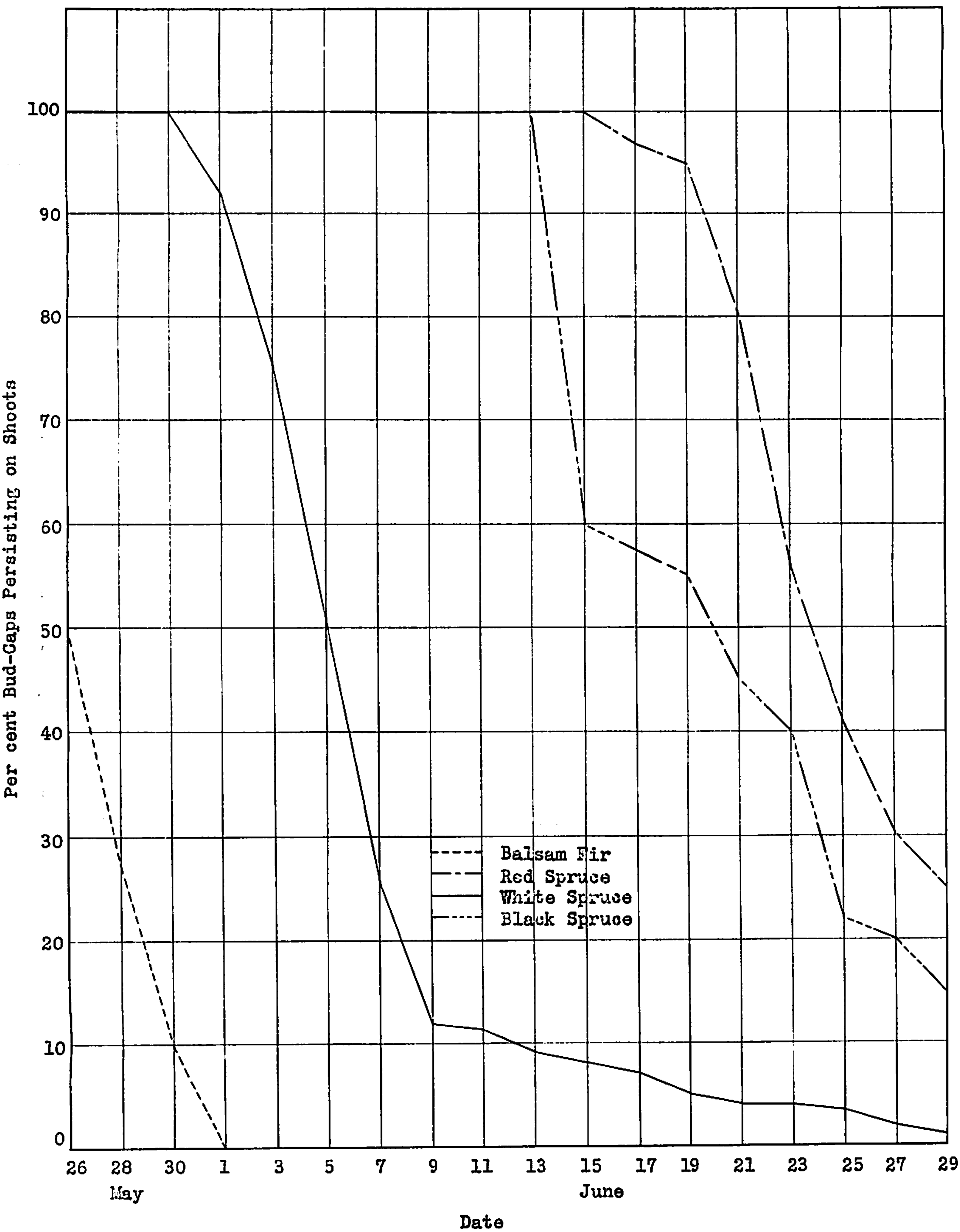
[1]Note that the data for white spruce have been extrapolated--during pupal surveys, few white spruce were found in these early experimental blocks.

Fig. 6.--Length (mm.) of shoots on mid-crown branches of dominant balsam fir, red spruce, white spruce, and black spruce at intervals of two days from May 26 to June 29. Data collected in Chipman Check Area, 1961. Dates of occurrence of maximum abundance of each instar of spruce budworm (peak - ... instar) on all species combined. A maximum difference between tree species of three days in the occurrence of maximum abundance of each instar was discovered.



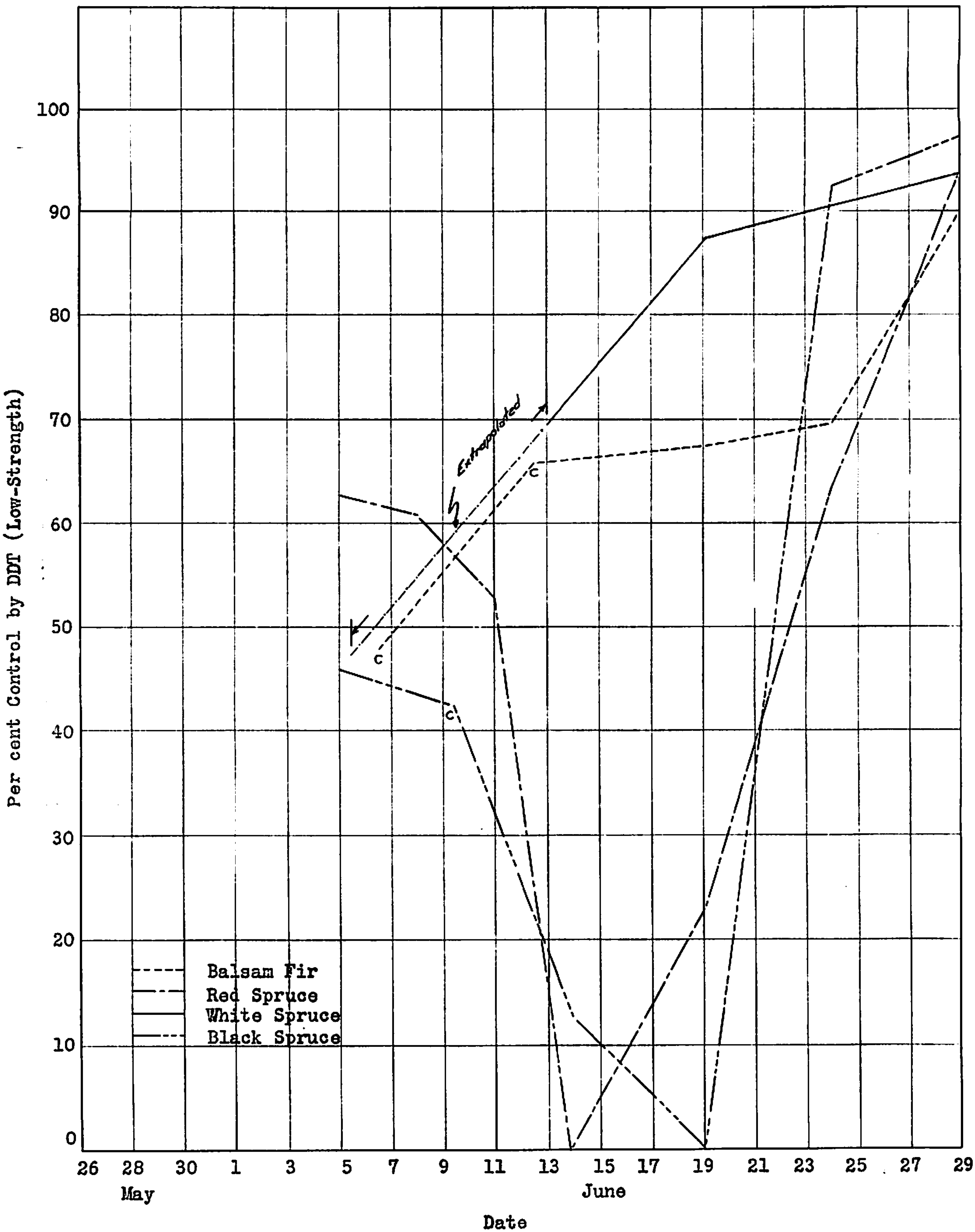
Shoot Length - Millimeters (From Base of the Bud)
0
6
12
18
24
30
36
42
48
54
60
66
Date
May
June
26
28
30
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
Peak III Instar
Peak IV Instar
Peak V Instar
Peak VI Instar
Flowering
Flowering
Needles flaring
Needles flaring
Larvae fully exposed in feeding sites
Balsam Fir
Red Spruce
White Spruce
Black Spruce

Fig. 7.--Percentage of shoots on mid-crown branches of dominant balsam fir, red spruce, white spruce, and black spruce on which bud-caps persist, at intervals of two days from May 26 to June 29.



Per cent Bud-Caps Persisting on Shoots
100
90
80
70
60
50
40
30
20
10
0
26
28
30
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
May
June
Date
Balsam Fir
Red Spruce
White Spruce
Black Spruce

Fig. 8.--Percentage control obtained in experimentally-sprayed 2,800-acre blocks on balsam fir, red spruce, white spruce, and black spruce by spraying with low-strength insecticide (1/4 lb. DDT per 1/2 U.S. gal. solvent oil per acre) on June 5, 8, 11, 14, 19, 24, and 29. Values obtained on adjacent dates were combined in three instances and plotted over the average date for purposes of smoothing the curves. These values are indicated with a 'C'. No data were collected on white spruce on the areas treated before June 14 because the species was not encountered in surveys through the areas treated on the early dates. The curve has been extrapolated in accord with what would have been expected on this species from data in Fig. 7.



Per cent Control by DDT (Low-Strength)
100
90
80
70
60
50
40
30
20
10
0
Extrapolated
c
c
c
Balsam Fir
Red Spruce
White Spruce
Black Spruce
26
28
30
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
May
June
Date

The explanation seems to be as follows. Balsam fir foliage was not fully flared until June 11, and larvae were not well exposed until June 9 (Fig. 6). As time progressed, larvae became bigger, moved about more and consumed more foliage; all of these factors would contribute to progressively better kill from later spray application.

Flaring on white spruce occurred at about the same time (Fig. 6) but before this date larvae were protected by bud-caps (Fig. 7). However, more bud-caps dropped as time went on, and the growth of larvae and increasing food consumption and movement made them more likely to be killed by later spraying.

On the other hand, on red and black spruce, small larvae were moderately well exposed on old foliage up to June 11. The data (Fig. 8) suggest that they were better exposed on black than on red spruce, but this difference is well within the variation expected in the data. Following this, as bud-caps began to loosen, they entered the buds where they were well protected from spray. Again, notice that some variation in spraying effectiveness occurred during this period between the species; this is undoubtedly due to natural sampling variation. Larvae are protected on these two spruces until the shoots become more exposed, both through elongation of the shoot and dropping of bud-caps. On black spruce, most buds split the bud-cap upon the initiation of rapid growth while the remainder carry a very small bud-cap on the tip of the expanding shoot. Thus, in Fig. 7, there is a rapid decline on black spruce in the percentage of shoots with persistent bud-caps shortly after June 13, followed by a less rapid decline as the remaining bud-caps are shed. Larvae become well exposed with a resulting rapid rise to a high level in percentage control obtained by later spraying (Fig. 8).

On red spruce, the bud-caps are carried on the tip of the growing shoots, and are so constructed that they expand to a remarkable degree, yielding ample protection to feeding larvae on those shoots on which they persist. Thus, the slower increase in the percentage control obtained from spraying red spruce during this late period may be significant[1].

Timing of Spraying

Obviously, from the previous section it would be concluded that spraying after June 20 would be more effective in stands containing fir and the three spruces. However, the effectiveness of spraying is not measured alone by the degree of control obtained. In most cases, it is more important to obtain adequate foliage protection on balsam fir, and it is known that this requires spraying in the period before larvae reach mid-fifth instar after which food

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[1]Note that following spraying subsequent growth on the shoots of all species is not contaminated. Thus, the exposed part of the shoot on white spruce and balsam fir would be contaminated during early spraying and would be toxic to larvae if they should feed there during the later instars when food consumption is high. On red and black spruce, however, the whole bud is protected until about June 15.

consumption is high, or before June 16. Yet, though populations can be sufficiently lowered by early spraying to protect the foliage of the year, about half the population survives to reinfest the stand, and operational considerations frequently require spraying during the period when low control is obtained on red and black spruce.

The solution must lie in the use of two spray applications, one before June 11 to protect fir foliage and obtain good early control on all species, and one after June 20, to obtain a high level of control on the population in the stand.

Absolute dates have been used in this discussion, and it has been pointed out that these are peculiar to this year, 1961, and to this area. In any other year, or in other areas, the date when itition of growth takes place can be expected to be earlier, for 1961 was a late year, and to vary from year to year. Indeed, the synchronization between insect development and shoot development, and the relationship between shoot growth on the four species can be expected to vary. Accordingly, it is useful to refer to the dates in terms of time following recognizable events in the development of the insect and the tree. Since the factors which are felt to influence the variations in effectiveness of spraying are felt to be more closely a function of shoot and bud-cap development, timing should be made more closely dependent upon these factors. Although it has not been included in this study, earlier studies indicate that spraying should not begin before balsam fir buds begin to flare, an event which took place this year when shoots at mid-crown of overstory trees were about 12 millimeters long. This could occur at a shorter shoot length in flowering years. The following timing descriptions are pertinent:

Balsam fir.--Spraying can begin when needles begin to flare when shoots at mid-crown of overstory trees are about 12 mm. long in non-flowering years. Increasing percentage control will be obtained up to the time of pupation, but spraying should be completed by the time of peak fifth instar in order to preserve the foliage crop. This period will usually consist of about 10 to 15 days.

White spruce.--Spraying can begin when needles begin to flare and after about half the bud-caps are off. In 1961, this occurred when shoots were about 25 mm. long. Spraying can continue to pupation, and there is no danger of serious defoliation. Increased percentage control is obtained with later spraying.

Red and black spruce.--Spraying can begin after budworm larvae have passed peak third instar, when they are generally feeding in open sites on old foliage. It can continue to the time when buds begin to open, an event which occurred in 1961 when shoots were about 7-8 mm. long. Spraying should then cease for about 13 days until bud-caps are well off, when shoots are 18 and 22 mm. long (black and red spruce, respectively). Higher percentage control is to be expected in later spraying. No serious defoliation is to be expected except on red spruce in mixture with balsam fir.

Appendix III

FOR INFORMATION ONLY

1961 INTERIM REPORT ON EFFECTS OF DDT SPRAYINGS ON NEW BRUNSWICK FISH AND AQUATIC INVERTEBRATES

(Prepared for Interdepartmental Committee on Forest Spraying Operations, Ottawa, November 22, 1961)

This is a brief outline of the projects undertaken recently by the Fisheries Research Board and Department of Fisheries to determine the effects on salmonid fishes and their food, of the 1961 and earlier DDT spraying operations in New Brunswick. Further details may be found as indicated in Appendices 1 to 3.

1. Short-term mortality tests with caged young salmon and trout, 1961

Hatchery-reared salmon parr, trout fingerlings and trout fry were held in cages in lower sections of four streams within the 1961 operational spray area in the Nashwaak and Miramichi drainages. Two of the streams received single half-strength ($\frac{1}{4}$ lb DDT/$\frac{1}{2}$ gal/acre) application, two received double application of the same spray with an interval of about 10 days. Similar lots were held near the lower end of the Molus River which received a single half-strength application for a special experiment with aquatic invertebrates, and in the upper Northwest Miramichi at Camp Adams, the unsprayed control. No streams suitable for fish holding tests were sprayed at full strength ($\frac{1}{2}$ lb DDT/$\frac{1}{2}$ gal/acre).

Results: Mortalities of salmon parr in single half-strength sprayed watersheds were of similar order to those receiving half-strength application in 1960, indicating less severe effects than with full-strength application regularly used previously. Double application at half strength appeared to have as severe effect on salmon parr survival as single full strength used previously. Data for trout were inconclusive.

(Report by H. E. Edwards, Appendix 1)

2. Relative effects on native young salmon populations of single full-strength, single half-strength and double half-strength applications of DDT insecticide

In 1961, autumn electroseining assessments of young salmon populations were continued at representative stations on tributaries of several river systems including the Miramichi and Nashwaak, having different spray histories. In addition assessments were made on the Molus, sprayed once at half-strength in 1961, and on adjacent unsprayed streams in Kent County. Data similarly obtained in 1960 on the unsprayed Margaree, N. S., were used in this analysis of data obtained over several years. Condition factors have been calculated indicating "fatness" of specimens taken during autumn electroseining to show possible effects of altered diets related to changes in invertebrate fauna.

Results: With single half-strength spraying, native populations of underyearling and yearling salmon are reduced to about half the normal populations for unsprayed streams. Older young salmon are less affected so that 3 months after spraying they represent about $\frac{3}{4}$ of the number needed for full smolt production. These effects of half-strength spraying have been much less serious than effects of earlier full-strength sprayings where underyearlings were practically eliminated.

Two half-strength applications at an interval of about 10 days appear to have had somewhat less serious effects on native young salmon than a single full-strength application, but are much more harmful than a single half-strength application for all year-classes, especially for underyearlings. Such double spraying may leave only 5% of the number of fry needed for full smolt production.

Young salmon in both half-strength and full-strength sprayed streams averaged shorter and thinner than those in unsprayed streams.

It seems possible that a single half-strength application of DDT insecticide, if not repeated during the 3 following years, would have scarcely noticeable effects on adult salmon catches resulting from the young salmon in the affected streams.

(Report by P. F. Elson, Appendix 2)

3. Effects of half-strength spraying on aquatic invertebrates, Molus River, 1961

On June 11-12, 1961, the whole 10-mile long Molus watershed, Kent County, was sprayed experimentally at half-strength ($\frac{1}{4}$ lb/$\frac{1}{2}$ gal/acre) to permit investigation of the effects on invertebrate fauna at several stations from source to mouth, in relation to distribution of insecticide as shown by water analyses. Seven stations were used, including three which were covered intensively--one well up the northwest branch, one just below the confluence of the two main branches and about halfway down the watershed, one just above head of tide.

Three sampling techniques were used: (a) Pre- and post-spray Surber square-foot bottom sampling; (b) collection of aquatic insects emerging from yard-square areas into cage-traps, from 2 to 3 days before until 10 days after spraying, with cages cleared hourly except during final week; (c) collection of downstream drifting insects and debris on 12 inch x 12 inch 25-mesh copper screens, cleared hourly from several hours before spraying until 48 hours after spraying, and then at increasingly longer intervals to 24-hourly by June 21.

Time-consuming analyses of water samples by Department of Forestry and working over of many samples for aquatic organisms have not yet been completed.

Results: At this stage of analysis it appears that: (a) From Surber sampling, half-strength spraying had less drastic effects than full-strength spraying used previously; yet reductions between pre- and post-spray aquatic invertebrate populations ranged from 72 to 43%. (b) Adult emergence cages were of little use during this short, cold, early-season period when few mayflies and stoneflies were emerging. They did indicate that pupal stages of Chironomidae were little affected. (c) The drift screens gave samples that should provide much valuable new information when fully analyzed. There is evidence of different degrees of susceptibility among the various groups of insects, based on the time and duration of their appearance on the screens in relation to the time of spraying. Among those showing high susceptibility to poisoning are blackfly larvae, mayfly nymphs *Heptagenia*, *Iron* and *Paraleptophlebia*, and hydropsychid caddisflies. More resistant forms are mayflies *Ephemerella* and *Stenonema carolina*, and stoneflies *Leuctra*.

(Report by F. P. Ide, Appendix 3)

4. Recovery of aquatic insects in branches of Northwest Miramichi River having different spray histories

In 1961 as previously, emerging insects were sampled from May through August by 24-hour, 5 times-per-week collections in series of yard-square cage-traps at (a) Camp 42, in area sprayed in 1954; (b) Camp Adams, in area sprayed in 1954 and 1956; (c) Trout Brook, in area sprayed in 1956. Daily collections have been analyzed qualitatively and quantitatively.

Results: Immediately after aerial DDT spraying the aquatic insect fauna in affected streams typically declines sharply and little emergence occurs for several weeks. Later in the summer of spraying, the total number of emerging insects per unit area of bottom rises above normal levels but the total volume per unit area is much below normal; there are fewer kinds then, particularly of larger-sized forms like caddisflies, but more individuals of smaller-sized forms like midges. The larger-sized insects, which are the preferred food of salmon parr, have been slow to return. After several years with no further spraying, however, the trend has been for total number per unit area to decrease and total volume per unit area to increase, as the species composition returns to normal. Extreme flooding in May 1961 disturbed stream bottoms and confused to some extent the analysis of insect recovery during the past season. F. P. Ide is prepared to discuss the general picture at the I.C.F.S.O. meeting.

5. Late-season mortality experiments, St. Andrews laboratory

Commonly as the water temperature approaches freezing, autumn mortalities of young salmon have been observed in streams sprayed that year with full-strength application of DDT, but not in unsprayed streams. Whether this is a direct effect of thinness or is associated with DDT content in body tissues is unknown. In fall and winter 1960-61, experiments by P. F. Elson compared survival of parr collected in October from streams sprayed in June 1960 at half strength and full strength, and from an unsprayed stream. Similar experiments are being started this fall with parr collected in November from five streams, including some sprayed singly and doubly at half strength in June 1961, and from the Pollett as an unsprayed control.

Results: The 1960-61 experiments brought out important differences between survival of fish subjected to half-strength and full-strength spraying. For example, subjecting fish of the three groups to gradual chilling to 1°C and holding at that temperature was followed by no losses among the unsprayed and half-strength sprayed fish within a month, but over 80% mortality among the full-strength sprayed fish within 8 days.

6. Recent Miramichi adult salmon runs in relation to forecasted effects of DDT sprayings

In 1958 on the basis of reduced populations of young salmon in recently sprayed Miramichi streams, particularly in the extensive Southwest Miramichi drainage sprayed in both 1956 and 1957, it was predicted that adult salmon returning to the Miramichi would be noticeably scarce in 1960 and 1961. Catches by estuarial trap-netters and Southwest Miramichi anglers have been low, as predicted. A better index of abundance is provided, however, by the F.R.B. estuarial sampling trap operated near Chatham through the whole open water season; it can register fish that may have been delayed by environmental conditions and are unavailable to the fishing public. From spring to October 31, 1961, the trap took 6,844 grilse (53% increase over 1960) but only 2,988 large salmon (35% decrease from 1960). The large salmon were mostly 2-sea-year fish from the 1959 smolt run, but some 15- to 20-pounders were taken, identified by scale-reading to be from the 1958 smolt run. The 1961 increase in grilse (1-sea-year adults) was expected because the estimated total Miramichi smolt run in 1960 was back to normal at around 2 million, as compared to under 1 million in 1959.

Recommendations

Considering all information provided by the fisheries investigations to November 1961, the following recommendations are made for serious consideration in planning future DDT spraying programs, in the hope of reducing to a minimum the harmful effects on young salmonid fish in affected streams:

1. That sprayings be restricted as far as possible to a single half-strength application ($\frac{1}{4}$ lb DDT/$\frac{1}{2}$ gal/acre) since it is the least injurious to fish of any DDT formulation and dosage used so far.

2. That all spray blocks covering an individual watershed be given the single half-strength DDT application within the shortest possible period of time; if watersheds receive the single application over periods exceeding a week as in 1961, the effect on fish might be as serious as double application at half strength.

3. That respraying of individual watersheds be limited to every fourth year; repetition of half-strength spraying within 2 years of first spraying could reduce salmon production by 50% or more.

4. That stricter precautions be taken to prevent direct spraying of salmon rearing waters that are sufficiently wide to be seen clearly from the air; in 1961 considerable mortality of young salmon was observed along the main Southwest Miramichi shortly after spraying over or very near the river, probably related to use of a new system of uniform spray blocks in 1961 instead of irregular blocks delimited by streams.

5. That further consideration be given to acquisition of staff and facilities for more extensive basic experimental studies of the effects of pesticides on fish and other fauna; the recent Molus River project and late-season mortality experiments are examples of studies that can provide necessary background information.

C. J. Kerswill
Fisheries Research Board of Canada
Biological Station, St. Andrews, N. B.

November 8, 1961.

EFFECTS OF DDT SPRAYING FOR BUDWORM CONTROL ON CAGED SALMONID FISH IN CENTRAL NEW BRUNSWICK, 1961

H. E. Edwards

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INTRODUCTION

In 1961 for the ninth time, the forests of Central New Brunswick were sprayed with a DDT-in-oil solution. As in the past, the 1961 effort was designed to control an outbreak of spruce budworm attack. The main or industrial spray area covered an area of 2,168,354 acres. Apart from the main spray area, a total of 103,600 acres of forest land were sprayed experimentally.

This year's formulation was ¼ lb. DDT per ½ U.S. gallon of oil per acre of forest sprayed. In the main spray area, 1,559,914 acres received one application, 502,040 acres two applications about 10 days apart, and 2,800 acres a third application.

Within the experimental area, 75,600 acres received a single application of the ¼ lb/½ gal/acre formulation and dosage. Here a joint study was undertaken involving analysis by the Department of Forestry of DDT content of the water following spraying, and by the Department of Fisheries and Fisheries Research Board of its effect on aquatic fauna.

Short-term mortality tests were carried out at strategic points in both the main spray and experimental areas using caged young salmon and trout.

METHODS

During the 1961 spraying, the observations on short-term mortalities in caged fish tested somewhat different conditions than those which existed in the 1960 spraying. Last year tests were run in three area types--one receiving a single application of DDT at the rate of ¼ lb/½ gal/acre; one receiving a single application of DDT at the rate of ½ lb/½ gal/acre; and one receiving about 5/8 lb DDT/½ gal/acre.

This year's tests were conducted in two area types--one receiving a single application of DDT at the rate of ¼ lb/½ gal/acre; the other receiving two applications of DDT, each at the rate of ¼ lb/½ gal/acre. No tests were run this year in areas receiving ½ lb/½ gal/acre.

In the main spray area four check points were established, two in zones receiving a single application and two in zones receiving a second application 10 days later. Single application check points were established at MacKenzie Brook tributary to the Nashwaak River, and Burntland Brook tributary to the Southwest Miramichi. In the double application zones, check points were established at Big Hole Brook and Betts Mill Brook, both tributary to the Southwest Miramichi. Three cages were placed at each of the check points. Two of the cages held approximately 50 salmon parr each and the third cage held 50 trout fingerlings and about 50 trout fry; the latter were encased in a smaller cage which was fitted into the larger cage.

In the experimental spray area, the Molus River was selected as the most suitable for joint studies of DDT-in-water content and its effects on aquatic fauna. Here the short-term effects of the DDT spraying on caged fish were also studied along the lines conducted in the main spray area. Similar numbers of young salmon and trout were held in three large cages and one small cage.

An experimental control point was set up at Camp Adams, site of the Fisheries Research Board's salmon counting fence on the Northwest Miramichi River, well outside the 1961 spray area and unsprayed since 1956.

Salmon fry were not used this year because past experience has shown that their delicate state at this early stage of development makes them extremely difficult to handle effectively for these tests. Trout fry, available at a slightly more advanced stage, were used but are also difficult to handle effectively in the field for tests such as these. Pre-spray impoundment time is an important factor. Impoundment for one week prior to spray commencement appears to be the optimum. This sometimes necessitates the transfer of fish under unfavourable conditions, over long distances, extending sometimes over 200 miles. The main hazards to be combatted are high temperatures and oxygen depletion.

RESULTS

The effects of the 1961 spraying in the single and double application zones of the main spray area are shown in two ways: (a) Tables I, II and III give the weekly mortalities as percentages of the numbers held in each cage at the start of spraying; the latter are shown by numbers placed below the stream names. Similar data for the Molus cages are given in Table IV. (b) Figure 1, comprising graphs of cumulative percentage mortalities for each area, i.e., for streams in the single and double application zones. It shows the trends of mortalities for salmon parr and trout fingerlings, including those for the Molus River. Arrows on the graphs indicate dates on which the areas were sprayed. Arrows complete with "tails" indicate initial spraying; arrows with no tails indicate repeat sprayings. Arrows are also designed to show roughly the amount of spraying on each date. For each 1/8 inch of each arrow an amount equal to one team load is allowed.

(a) Salmon parr

Within 7 days of the initial spraying in all areas, the highest salmon parr mortalities recorded were at MacKenzie Brook and Burntland Brook with 19 and 37% respectively. At Betts Mill Brook and Big Hole Brook, mortalities were much lower after the initial spraying--3% and 7%. However, within 5 days after Betts Mill and Big Hole Brook areas were sprayed the second time, the salmon parr mortalities jumped from 7% (7 days earlier) to 83% at Betts Mill and from 3% to 76% at Big Hole (Table I).

At the unsprayed control area during a similar period, mortalities reached 9%.

(b) Trout parr

Observations on caged trout parr or fingerlings during the period of the spray project were of little value in assessing the immediate results of the DDT spraying. This is obvious, of course, because there was no immediate effect of any value on them. The trout fingerlings, during the period of observations, showed little or no reaction which could be readily attributed to the DDT spraying. It would appear that fingerlings of the size used, average length 5¼ inches, are not as sensitive under these conditions as the smaller fish used in 1960 tests (Table II).

(c) Trout fry

The high sensitivity of young "fish of the year" is evident from the high mortalities in the small trout fry. Mortalities in the fry were high even following the single application of the "¼ lb" formulation, reaching 72% at Burntland Brook and 78% at MacKenzie Brook. Mortalities in the double spray zones, though relatively low following the initial spraying (9 and 21%), went from the 9% at Big Hole to 90% following re-spray and from 21 to 70% at Betts Mill Brook.

Control mortalities in trout fry, for a similar period, totalled 20% (Table III).

CONCLUSIONS

1. Mortalities in caged salmon parr during the 1961 operations appear to have roughly parallelled those in 1960, that is, half-strength application of DDT insecticide was followed by moderate losses.

2. Comparison of 1961 data with data of previous years indicates that caged fish suffer similarly heavy losses from forest sprayings with a single application of ½ lb/½ gal/acre and with two applications of ¼ lb/½ gal/acre about 10 days apart.

3. Total mortalities, in most cases, followed very quickly the second application of DDT at the rate of ¼ lb/½ gal/acre. The sharp rise in mortalities following the second spraying suggests that the two applications may be more injurious than the single application of the ½ lb formulation (full-strength). The following factors other than DDT deposit might have had a decisive influence, however, on the caged fish mortalities towards the end of the experiment: (a) rising water temperatures; (b) receding water levels; (c) stress on fish impounded for an additional 10 days without food.

RECOMMENDATIONS

It has been well established by now that the spraying of New Brunswick's forests with a DDT formulation of ¼ lb/½ gal/acre, sprayed once, is the least injurious to caged fish of any DDT spray formula used to date.

Therefore, should the necessity of continued sprayings be established, it must be recommended that these be done using a single application of DDT at the rate of ¼ lb/½ gal/acre of forest sprayed.

Halifax, N. S.
October 26, 1961.

Table I. Caged salmon parr mortalities, 1961 DDT spraying (1/4 lb/1/2 gal/acre). Parr average length 3½ inches. Placed in cages June 2, 3, 4.

Site	Dates watershed sprayed		Percent mortalities by weeks ending			
	First application	Second application	June 10	June 17	June 24	July 1
Control Camp Adams Northwest Miramichi 101	...	...	4	4	1	?
MacKenzie Brook 100	June 11, 12, 15, 16, 19	...	5	19	13	15
Burntland Brook 90	June 17, 18, 19	...	0	1	37	9
Betts Mill Brook 81	June 5, 8, 9	June 20, 21, 23	0	7	83[a]	6
Big Hole Brook 100	June 5, 7, 8	June 19, 20, 21	6	3	76[a]	15

[a]Following 2nd application of 1/4 lb/1/2 gal/acre.

Table II. Caged trout parr mortalities, 1961 DDT spraying (1/4 lb/1/2 gal/acre). Parr average length 5¼ inches. Placed in cages June 6.

Site	Dates watershed sprayed		Percent mortalities by weeks ending			
	First application	Second application	June 10	June 17	June 24	July 1
Control Camp Adams Northwest Miramichi 50	...	...	4	0	0	?
MacKenzie Brook 50	June 11, 12, 15, 16, 19	...	0	6	0	0
Burntland Brook 45	June 17, 18, 19	...	0	0	0	0
Betts Mill Brook 54	June 5, 8 9	June 20, 21, 23	0	0	1	6
Big Hole Brook 50	June 5, 7 8	June 19, 20, 21	0	0	0	0

Table III. Caged trout fry mortalities, 1961 DDT spraying (½ lb/½ gal/acre). Free swimming fry placed in cages June 4.

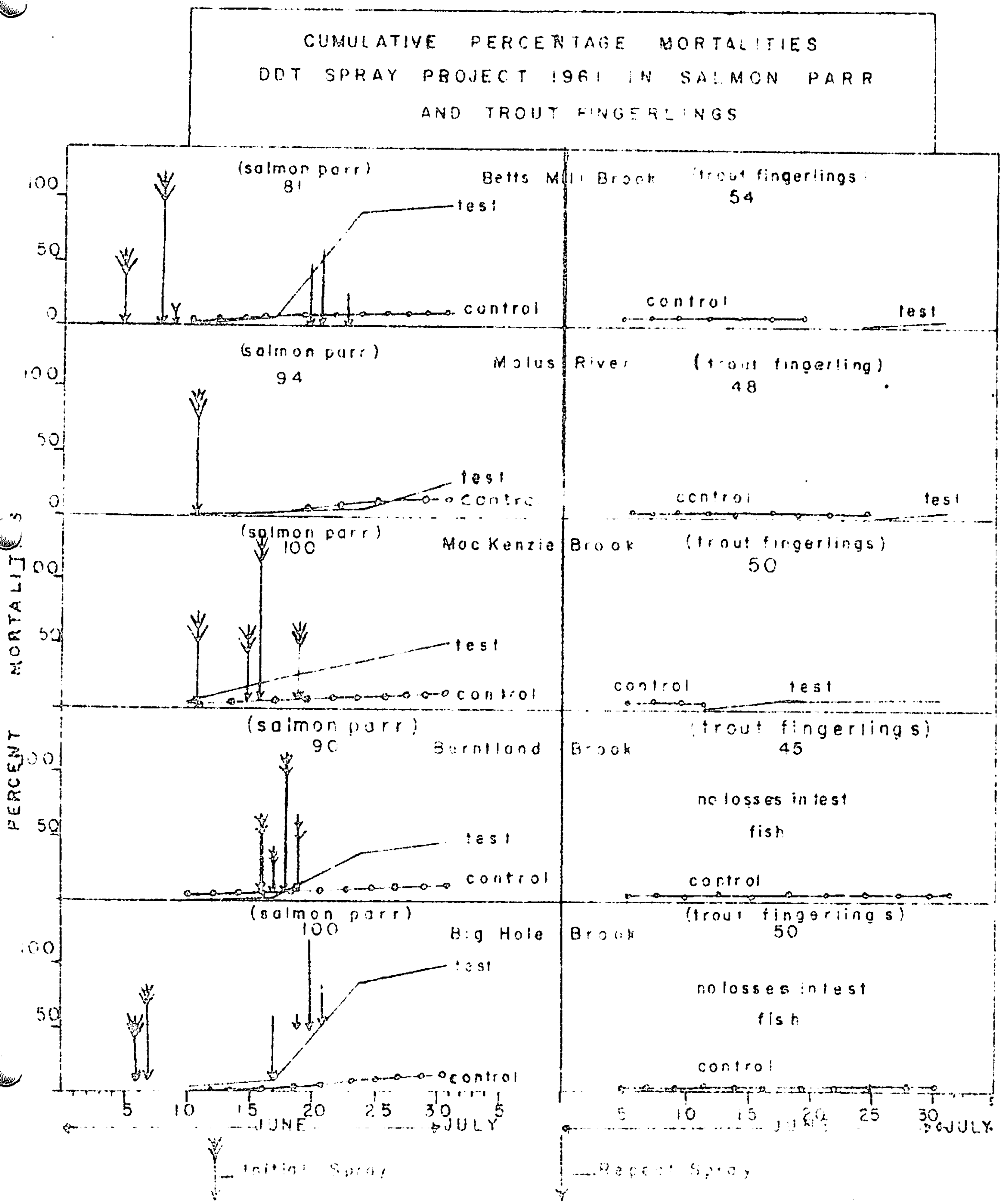
Site	Dates watershed sprayed: First application	Dates watershed sprayed: Second application	Percent mortalities by weeks ending: June 10	June 17	June 24	July 1
Control Camp Adams Northwest Miramichi 50	...	...	4	6	10	
MacKenzie Brook 50	June 11, 12, 15, 16, 19	...	0	78	18	4
Burntland Brook 33[c]	June 17, 18, 19	...	28[b]	0	72	0
Betts Mill Brook 47	June 5, 8, 9	June 20, 21 23	9	21	70[a]	...
Big Hole Brook 50	June 5, 7 8	June 19, 20 21	0	9	90[a]	0

[a]Following re-spraying.
[b]This loss suggests possibility that some spray did enter Burntland Brook from spraying of Single Block Number 79 on June 8, 1961.
[c]We think some escaped but losses totalled 33 when none left.

Table IV. Caged fish mortalities, Molus River, DDT experimental spraying 1961 ($\frac{1}{4}$ lb/$\frac{1}{2}$ gal/acre). Specimens placed in cages June 7.

	Number specimens	Date sprayed	Mortalities by weeks following spraying: Week ending	Numbers	Cumulative % mortalities
Salmon parr	94	June 11	June 10	0	0
			June 17	4	4
			June 24	5	9
			July 1	15	25
			July 5	4	30
Trout parr	48	June 11	June 10	0	0
			June 17	0	0
			June 24	0	0
			July 1	3	6
			July 5	0	6
Trout fry	23	June 11	June 10	0	0
			June 17	9	39
			June 24	0	39
			July 1	11	86
			July 5	3	100

FIGURE


CUMULATIVE PERCENTAGE MORTALITIES
DDT SPRAY PROJECT 1961 IN SALMON PARR
AND TROUT FINGERLINGS
PERCENT MORTALITIES
(salmon parr)
81
Betts Mill Brook
(trout fingerlings)
54
test
control
(salmon parr)
94
Molus River
(trout fingerling)
48
(salmon parr)
100
MacKenzie Brook
(trout fingerlings)
50
(salmon parr)
90
Burntland Brook
(trout fingerlings)
45
no losses in test fish
(salmon parr)
100
Big Hole Brook
(trout fingerlings)
50
JUNE
JULY
Initial Spray
Repeat Spray

RELATIVE EFFECTS OF SINGLE APPLICATIONS OF FULL-STRENGTH AND HALF-STRENGTH DDT FOREST SPRAY, AND TWO APPLICATIONS OF HALF-STRENGTH, ON NATIVE POPULATIONS OF YOUNG SALMON

P. F. Elson

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Partial amelioration of some harmful effects on salmon of DDT forest spraying, by reducing dosage from ½ lb DDT/½ gal/acre to ¼ lb DDT/½ gal/acre, was confirmed by 1960 autumn electroseining assessment of native young salmon in sprayed areas.

In 1961 similar electroseining observations on native young salmon in sprayed streams included some in areas exposed to a single application of the lighter, half-strength spray, and some given two applications, spaced some days apart, of the same spray.

Half-strength versus full-strength spray

As in 1960, greatly improved survival was observed in half-strength sprayed areas as compared to that in areas given full-strength spray in 1960 and earlier. Even with half-strength spray some loss is evident, but the effects have nowhere been observed to approach the elimination of an entire year-class, as they did with full-strength spraying. Table I summarizes data on numbers and

Table I. Populations of young salmon in unsprayed streams and streams sprayed with DDT, given as average numbers per 100 sq yd, together with mean lengths (cm), weights (g) and condition factor ($K = \frac{100W}{L^3}$) for underyearlings, small parr (10 cm total length and under) and large parr (over 10 cm). Unsprayed streams: West St. Nicholas and Coal Branch, Richibucto system in 1961; N. W. Miramichi above Tomogonops in 1953 and 1960; Margaree in 1960. Half-strength sprayed: Molus, Richibucto system in 1961; Cains and S. W. Miramichi, Miramichi system, in 1960. Full-strength sprayed: Nashwaak in 1960.

	Control No spray	Half-strength sprayed ¼ lb DDT/½ gal/acre	Full-strength sprayed ½ lb DDT/½ gal/acre
Underyearlings			
No./100 yd^2	25.3	13.9	0.1
Length	5.0	4.9	...
Weight	1.4	1.2	...
K	1.075	1.003	...
Small parr			
No./100 yd^2	31.3	16.8	10.9
Length	8.5	8.3	9.2
Weight	6.6	5.6	7.6
K	1.049	0.963	0.965
Large parr			
No./100 yd^2	13.2	8.4	9.0
Length	11.1	11.1	11.1
Weight	14.7	14.3	13.1
K	1.053	0.963	0.944

sizes of the three important pre-smolt year-classes of salmon normally important in our Maritime streams. The control data are average values from three streams never sprayed and one stream not sprayed for 5 years. Half-strength data are for three streams sprayed in 1960 and 1961, and full-strength data for a stream so sprayed in 1960. Considerably more data than represented in Table I have been gathered but are not yet fully analysed. Preliminary inspection of it indicates that Table I is a valid representation for all similar cases.

With a single half-strength spraying, underyearlings and yearlings appear to average about half as abundant as with no spraying, and larger fish a little more than half. The numbers of large parr present three summer months after half-strength spraying represent about 3/4 to 4/5 of the number apparently required to produce full smolt production from a stream. So it would appear that the effect of a single application of such spray repeated only every 4th year might scarcely be noticeable over natural variations in salmon catches. However if such spraying were repeated in the first and/or second years following, it might well reduce production to ½ or even less of what it would have been with no spraying.

The drastically harmful effects of full-strength spraying have been described in previous years. It is to be noted that populations indicated as surviving full-strength spraying in Table I would be further drastically attenuated--possibly to 20% of the numbers shown, by the characteristic cold weather mortality which has been shown to follow this kind of DDT poisoning. No such mortality has, up to now, been discovered for fish subjected to a single application of half-strength spray.

Single versus double application of half-strength spray

Four of the areas used for assessing native Maritime young salmon this year had been given a repeat dose of half-strength spray; 11 received one application of half-strength; 51 were unsprayed. As compared with areas given a single dosage, the twice-sprayed areas have only about half as many yearling and older fish and only about 1/8 to 1/10 as many underyearlings. The values found suggest that such double spraying may leave only about 5% of the number of fry required for full smolt production, possibly even less.

The 1960 spawning season, which yielded 1961 underyearlings, had unusually low autumn water in many streams. This in turn may have affected spawning success in headwater and other small streams. Two of the twice-sprayed stations were located on the Nashwaak. The upper three quarters of this stream, including all assessment stations, also received full-strength spray in 1960. Population assessments on the Nashwaak yielded no underyearlings in either 1960 or 1961. The 1960 condition is in keeping with that observed previously for full-strength spraying; the 1961 condition is not. It is not known whether this year's deficiency is a carry-over effect from 1960, a result of 1961 single half-strength application extending over several days on the long stretch of stream above, a result of (unrecognized) badly deficient spawning in 1960, or some other factor. Further observation is required.

The available evidence does, however, seem to indicate that two applications of half-strength spray, while probably not as serious as full-strength spray, are much more harmful than a single application for all year-classes, but especially for underyearlings. Widespread use of such technique over 2 or 3 successive years would be expected to reduce salmon production almost but not quite as low as full-strength spraying.

Starvation

It is to be noted that both length, and "fatness" as represented by condition factor, of fish in sprayed streams tend to be less than in unsprayed streams. This presumably represents the effects of severe food rationing resulting from removal of aquatic insects by the spray.

Winter mortality

Plans are under way to examine whether any special winter mortality may be associated with two applications of half-strength spray. As noted above, single application did not appear to be associated with special winter mortality in 1960. Field assessments in November 1961 appear to confirm this finding. Assessment on twice-sprayed areas has not been accomplished at this writing.

St. Andrews, N. B.
November 6, 1961

EFFECT OF DDT FOREST SPRAYING ON THE WATERSHED OF THE MOLUS RIVER IN KENT COUNTY, N. B., IN 1961

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This was an investigation to determine the effect of the toxicant on the fauna at several stations along the length of the stream for comparison with the corresponding distribution of the poison.

In June of 1961, Forest Protection Limited, a crown corporation, sprayed areas of southern and central New Brunswick with DDT at the rate of 1/4 pound of DDT per acre for control of the spruce budworm. The spraying was done from Avenger aircraft, marking and monitoring of the runs being by Cessna aircraft. Included in the area sprayed was the watershed of the Molus, a small tributary of the Richibucto River in the coastal section of Kent County, N. B.

As it was planned to spray the Molus watershed almost simultaneously so that all parts of the stream would be affected within a short interval, intensive sampling was planned of the distribution of the toxicant in the water and the corresponding effect on the fauna. This consisted of taking frequent, as far as possible hourly, samples of the water at several points in the stream for analysis for DDT and corresponding samples of the aquatic invertebrate fauna, mainly insects, and fish.

The water samples were taken and analysed by the Chemical Control Division, Forest Biology Section of the Department of Forestry of Canada, the samples of the aquatic insects and other

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invertebrates by the Fisheries Research Board and the fish tests by the Conservation and Development Branch of the Fisheries Department of Canada. An interdepartmental committee with membership from the Fisheries and Forestry Departments supervised the planning of the operation. Representatives of the committee were: Dr. J. J. Fettes for the Department of Forestry, Dr. C. J. Kerswill for the Fisheries Research Board and Dr. R. R. Logie for the Conservation and Development Branch, Department of Fisheries.

The carrying out of the aquatic insect part of the project, the subject of this report, was under the direction of the author who had the assistance of the following personnel of the Fisheries Research Board: R. H. Peterson assisted by C. D. Grant, student assistants, supervised the sampling at the stations near the source of the river and E. J. Schofield, technical officer, at the lowest stations. Other assistance was given during the three most crucial days by Drs. M.H.A. Keenleyside and R. L. Saunders of the scientific staff and E. Chambers and D. Mickle, student assistants. Sorting and preliminary analysis of data has been carried out during the summer by Peterson and Grant with some assistance from Mickle.

GENERAL DESCRIPTION OF RIVER

The Molus River is about 10 miles long with two main branches, a north and a south, and has a gradient which in most sections causes a rapid flow of the water. The lower third is tidal. Figure 1 shows the river and its relation to roads and to the spray Quadrants 157, 158 and 159, by which the area was sprayed.

The underlying rock is sandstone in the upper and middle sections at least, over which there is a layer, in many places only 3 or 4 inches deep, of flat angular rubble and gravel.

METHODS

Stations were selected and designated A, B, K, L, M, R and S as shown in Figure 1. Stations A, M and R were more intensively covered than were the others for some phases of the investigation and Station S was discontinued when it was found that it was in the intertidal range of levels. General features of the vicinity of the stations and of their physical features are given in Table I. The most noteworthy feature is the thermal gradient with higher temperature at the upper station which may be due to the extensive beaver pond above Station A.

Three sampling techniques were employed as follows:

(1) Pre- and post-spray determinations were made of the bottom organisms, the former about 4 days before and the other about 10 days after spraying. The Needham-Surber square foot bottom sampler was used and five samples were taken at each sampling at each place. The rapid method was employed, i.e., working over the bottom particles in the square foot area for 5 minutes. The organisms and debris were preserved in 70% ethyl alcohol and counts made of the organisms later under a binocular microscope.

(2) Emergence of the aquatic insects from the water was followed at Stations A, K, L, M and R for from 2 to 3 days before until approximately 10 days after spraying. The cages were cleared hourly when possible except for the last week when they were cleared at longer intervals increasing to 24-hourly. Similar emergence cages operated on the unsprayed Northwest Miramichi River and tributary Trout Brook through the same period give control data for the Molus project. Figure 3a illustrates the yard-square emergence or cage-trap.

(3) Screens of 25-mesh copper measuring 12 inches by 12 inches, shown in Figures 3b and 3c, were employed to catch the insects and other organisms drifting downstream. These were cleared of insects and debris at hourly intervals from several hours before spraying, to determine background numbers, to 48 hours after spraying and then at increasingly longer intervals to 24-hourly until the end of sampling on June 21. The accumulated debris and insects were scraped from the screens with a table knife, preserved in alcohol and later the insects were separated from the debris, counted and classified using a binocular microscope.

The object in these samplings was to determine if there was a difference in susceptibility to poison for different organisms as indicated by different times to death or incapacitation. Evidence of differential susceptibility was to be compared with those of survival into the next year as indicated by the post-spray bottom samples and the experience gained from other years regarding survival in different streams.

Most of the spraying which would have an effect on the Molus River (all but a small eastern part of Block 158) was done over a short period on the evening of Sunday, June 11. The remainder of Block 158 was sprayed the next morning, June 12. A section of the east side of Block 157, possibly affecting the upper section of the south branch, was sprayed early in the forenoon of June 11. At the present state of analysis of the data no effect of this early spraying has been detected. On the other hand the evidence of spray effect was pronounced at all stations for the Sunday evening spraying as reference to Figures 4-12 will show.

RESULTS

The results will be given under the three following headings: (1) Surber bottom samples, (2) emergence cages and (3) screens.

(1) Surber bottom samples

Results from bottom samples are shown in Table II. Since spraying was with 1/4 pound DDT to the acre, reduction of post-spray fauna was not as drastic as was the experience when spraying was with double this strength. The reductions, however, ranged from 72 to 43% with an actual increase of 37% at one station. Some groups of insects present in the pre-spray samples are absent in the post-spray ones, notably the black flies which were absent in the post-spray samples from all stations. The period between pre- and post-spray sampling is a season during which many insects are hatching from eggs in greater numbers than adults are emerging from the water so that an increase in numbers of bottom stages would be found in the absence of spray. The increase at Station K over this same period was almost entirely accounted for by one species of mayfly of the genus *Ephemerella* and case-making caddisflies, both associated with *Fontinalis* moss which was bulky in three of the samples taken at K at that time. This mayfly appears to be relatively resistant and is one which has been observed to survive spraying in other instances.

(2) Emergence cages

Results showed little change in the numbers emerging before spraying and those emerging in the early hours following spraying although the numbers were negligible several days after spraying. The pupal stages of Chironomidae were apparently little affected and these insects continued to emerge after spraying for some time. Insects emerging from nymphs, e.g., mayflies and stoneflies, were scarce in all cages before and after spraying mainly because emergence was low at this early season and in the unseasonably cold weather prevailing.

(3) Screens

The screens, collected at hourly intervals through 48 hours after spraying, showed large numbers of insects descending the stream as compared with the numbers taken under pre-spray conditions. Most of the histograms illustrating this phenomenon, see Figures 4-12, have the same general form with high ordinates initially, then reduction either rapidly or gradually with time. For some kinds the histograms have a relatively short base covering a few hours only and for others the base is much extended, in some cases over several days, implying greater tolerance in some individuals.

Black flies. At Station A the pre-spray background number for one hour's collecting per square foot of screen averaged 11 individuals for twelve samples, the largest number being 21. Of the total of 37,800 black fly larvae collected per square foot of screen during 5 days of collecting, 11,000 or nearly one third were collected during the first hour after spraying and half the total number were collected in the first 3 hours of post-spray collecting. In the 4th to 8th hours after spraying the numbers were still over 1,000 per square foot and from then on the number dropped rapidly to from 2 to 3 hundred per hour. In the third day following spraying numbers of black fly larvae higher than a hundred per square foot of screen were being caught but by the fifth day the numbers were negligible and these individuals showed signs of having been dead for some time as they were decayed.

At Station R the background count (pre-spray) averaged 3 black-fly larvae per hour per square foot of screen for eight collections with a maximum of 4. The increase in number coming on the screens with spraying is shown in Figure 4. Smaller numbers were taken by the screens at R than at A and the base of the histogram covers a shorter time.

At Station M, in the confluence of the two branches and approximately midway between A and R, the numbers of black-fly larvae were more comparable to those at R than A.

Caddisflies. Figure 5 shows the histogram illustrating the catch of Hydropsychidae, nearly all one species of *Cheumatopsyche*, one of the net-building caddis. These larvae are apparently extremely sensitive to DDT, appearing in large numbers on the screens only in the first hour following spraying. They appeared in a similar manner at Station M also. Belated individuals appearing on the screens after a longer interval were all rotten and badly disintegrated. This group of caddisflies have been found to be particularly adversely affected by spray in previous treatments of similar rivers. Some other caddis are equally susceptible but some, notably case-making types, appear to be more resistant than the Hydropsychidae.

Mayflies. See Figures 6-10. These insects, judging by the histograms, show different degrees of susceptibility to the DDT spray. Among the most susceptible would appear to be members of the genus *Heptagenia*, three species of which are plotted in Figure 6 and another H. hebe in Figure 7. In the same category is Iron humeralis (Fig. 8) and only slightly more tolerant the mayfly, Paraleptophlebia mollis, which was abundant at all stations except B.

More tolerant groups in the mayflies are species of Ephemerella for which histograms are more extended along the time axis with evidence also of a later mode and median for the histogram than in sensitive species. Further analysis will be necessary before these points are clear.

Stenonema carolina as shown in the histogram of Figure 9 illustrates another relatively resistant mayfly.

Some individuals of the resistant Ephemerella were taken in numbers in the post-spray Surber samples of June 20 and 21 and it has been observed that some of these insects have survived spraying in other years in other streams and have generally recovered to large populations rapidly.

One species of static water mayfly, Arthroplea bipunctata, occurred at Station B only and gave the data for Figure 10. This station was located on a small tributary of the south branch of the river and above the station was a beaver meadow with quiescent stream conditions and much water held back by a beaver dam. There is a noticeable lag between the time of spraying and the arrival of individuals in numbers on the screen. This may represent the time required to float downstream but more probably is a measure of the delayed effect of the DDT introduced into such a comparatively large reservoir.

Stoneflies. One genus only of the stoneflies has been treated so far in the analysis of results. This is the genus Leuctra with more than one species involved. Judging from the histogram the mode and median occur later than in sensitive forms and individuals survived and were taken in post-spray bottom samples on June 20 and 21. It has been observed that Leuctras have survived spraying and increased rapidly in the years following spraying in other streams sprayed in other years.

Cladocera. Figures 11 and 12 show the numbers of the cladoceran Simocephalus serrulatus taken per square foot of screen in the hours following spraying at Stations A and B respectively. Station B, as mentioned above, had static water conditions in a flooded beaver meadow immediately above it and Station A had two beaver ponds upstream from the station. The nearest of these, a small narrow pond formed by the secondary dam, was located approximately 1,350 feet above Station A. The pond further upstream was about 400 feet long with a maximum width at the dam of approximately 100 feet. The depth at the dam was 4 feet in the original stream bed, probably the maximum depth, and the dam was located approximately 1,600 feet above Station A. The delay of 11 hours between the application of spray and the collecting of the organisms against the screens cannot logically be attributed to the time involved in being carried 1,600 feet. It seems more probable that the lag was associated with either high resistance of these organisms or delay in the toxic material reaching them in the reservoir. Freshet, following heavy rain, may also have been a factor in bringing the Cladocera downstream.

DISCUSSION AND CONCLUSIONS

The results from the present project give some evidence of the time taken for the organisms to be killed (incapacitated) by the poison in this stream. There is evidence of different degrees of susceptibility for different groups of insects but this is partially masked by drift of organisms downstream.

The ultimate pattern of survival into the next year does not, however, parallel a scale of tolerance since other factors are controlling in many cases. Black flies, for example, although highly susceptible, are generally observed to appear in numbers again in a sprayed stream through immigration of ovipositing female flies into the area from unaffected streams. In some other groups, although the nymphs or larvae may be susceptible to poison the eggs and pupae of the same species appear to be highly resistant and if these insects are present in the streams in these stages with hatching or emergence delayed beyond the time when the poison is in the water in lethal amounts the species survive. Other special conditions of life cycle, diapause for instance, or of distribution in season or in the bottom, as well as differences in feeding habits may counteract the factor of susceptibility.

The present study has contributed some information on physiological as contrasted with ecological tolerance although this data is much less reliable than would be the results from rigidly controlled laboratory experiments.

SUMMARY OF RESULTS

1. Using as criteria the positions of the mode and median and length of the abscissal base of the histograms for well-preserved individuals, some of the organisms have been classified as susceptible to poisoning or relatively resistant. Among the former are black-fly larvae, nymphs of species of _Heptagenia_, _Iron_ and _Paraleptophlebia_. Hydropsychid caddisflies are also sensitive. More resistant forms among the insects are species of _Ephemerella_, _Stenonema carolina_ and stoneflies of the genus _Leuctra_.

2. More sensitive organisms came down on the screens for periods of from 1 to 3 hours for the most sensitive to about 48 hours for somewhat less sensitive ones from the time of spraying. Tolerant forms appeared on the screens for up to 4 days and even longer in some cases leaving a residual population sampled in the Surber bottom sampling approximately 10 days after spraying.

3. Organisms drifted downstream for considerable distances but very little evidence of the magnitude of this trend is available at the present stage of analysis of the data. One exception is provided by the cladoceran *Simocephalus serrulatus* at Station A. This organism, an inhabitant of static water, presumably came from beaver ponds located 1,350 and 1,600 feet upstream from Station A and appeared on the screens at this station only after an interval of 11 hours after spraying.

FOR INFORMATION ONLY
St. Andrews, N. B.,
September 28, 1961.

Table I. General descriptions of Molus River stations and surroundings.

Station	Width (ft)	Average depth (in)	Flow rate (ft/sec)	Flow volume (cu ft/sec)	Temperature of water June 10-15 Max.	Mean	Min.	Stream bottom	Notes on vegetation adjacent to station
A	5.1	5	1.9	2.8	61.0	56.8	52.6	Flat angular stones over bedrock	Mixed, birch, poplar, conifers. Alder border.
K	21	7.5	2.2	20.2				3-4" flat rubble fragments over bedrock. Sand.	Mixed hardwoods and conifers. Alder border.
L	20	7	2.3	18.8				3-4" flat rubble fragments over bedrock. Sand.	Mixed hardwood and conifers. Alder border.
M	29	11.7	2.0	39.6	59.7	55.1	50.5	Flat angular stones and sandstone.	Mixed hardwood and conifers. Alder border
R	31	11.4	1.9	39.2	57.6	53.0	48.5	Flat stones somewhat rounded by molar action.	Alder lined above station. Adjacent cleared agricultural land.

Table II. Pre- and post-spray sampling by Surber bottom samples, June 1961, Molus River. Five foot-square areas were sampled at each station on each visit, taken by working over the bottom for five minutes for each sample. The results are for 5 square feet.

Station	Date	Total numbers	Ephemeroptera	Plecoptera	Trichoptera	Diptera: Chironomidae	Diptera: Simuliidae	Diptera: Tipulidae Ceratopogonidae Empidae, etc.	Coleoptera	Misc. incl. Megaloptera	Mollusca	Crustacea and Hydracarina	Planaria Annelida Mematoda	Percentage reduction
A	June 7	155	25	16	32	15	20	4	36	0	2	3	2	68
	June 21	51	5	9	9	2	0	0	14	1	6	4	1	
K	June 7	123	29	0	25	20	7	2	8	0	27	2	3	-37
	June 20	169	84	1	30	2	0	4	3	1	34	3	7	
L	June 8	356	134	13	85	30	8	13	14	0	43	8	8	43
	June 20	203	4	1	66	3	0	4	14	2	90	6	13	
M	June 8	194	86	0	43	31	11	14	2	1	6	0	0	63
	June 20	71	16	3	20	12	0	8	1	0	5	4	2	
R	June 9	174	54	5	31	29	20	16	18	0	1	0	0	72
	June 20	49	17	0	11	7	0	0	10	0	0	3	1	

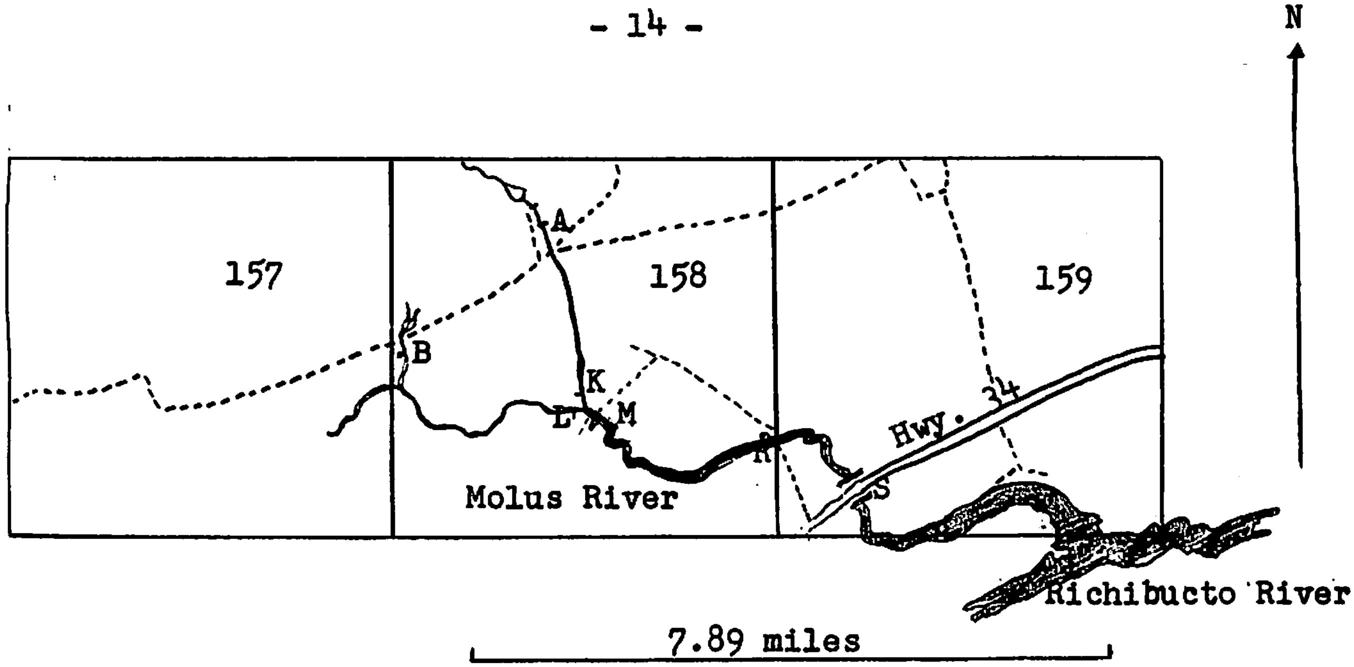


Figure 1. Map of the Molus River, N. B., showing position of stations and 1961 spray blocks 157, 158 and 159.

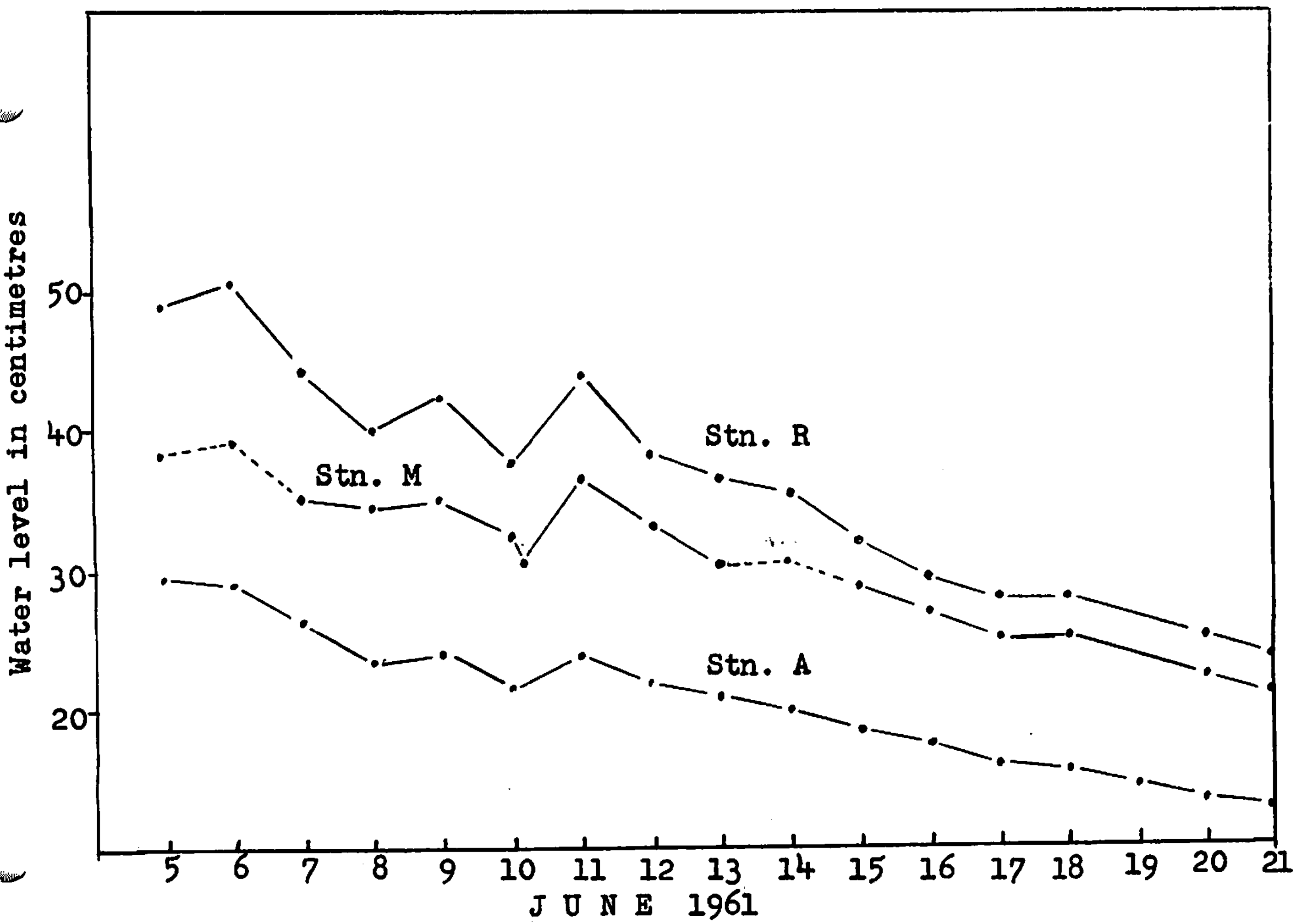
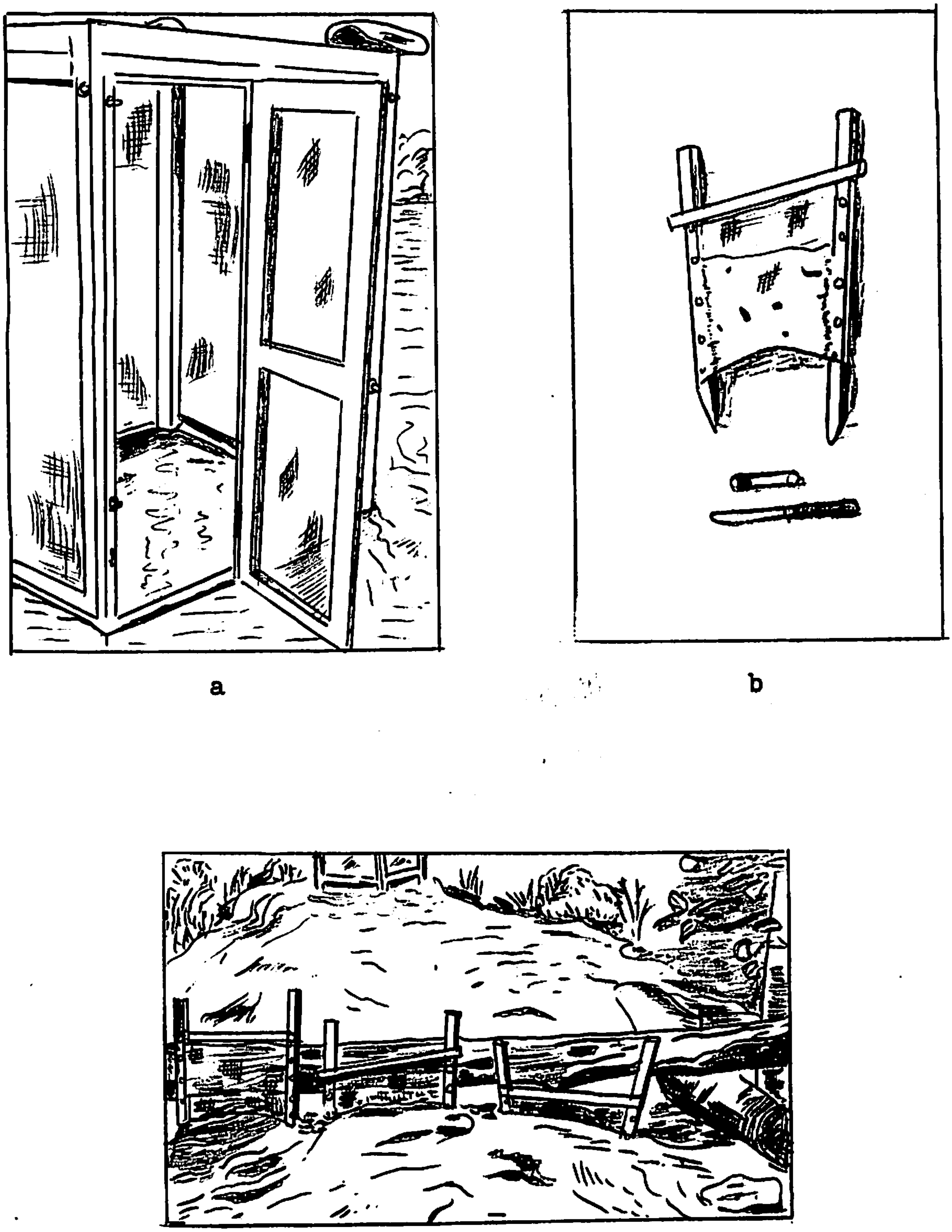


Figure 2. Water levels at Stations A, M and R, Molus River, 1961.



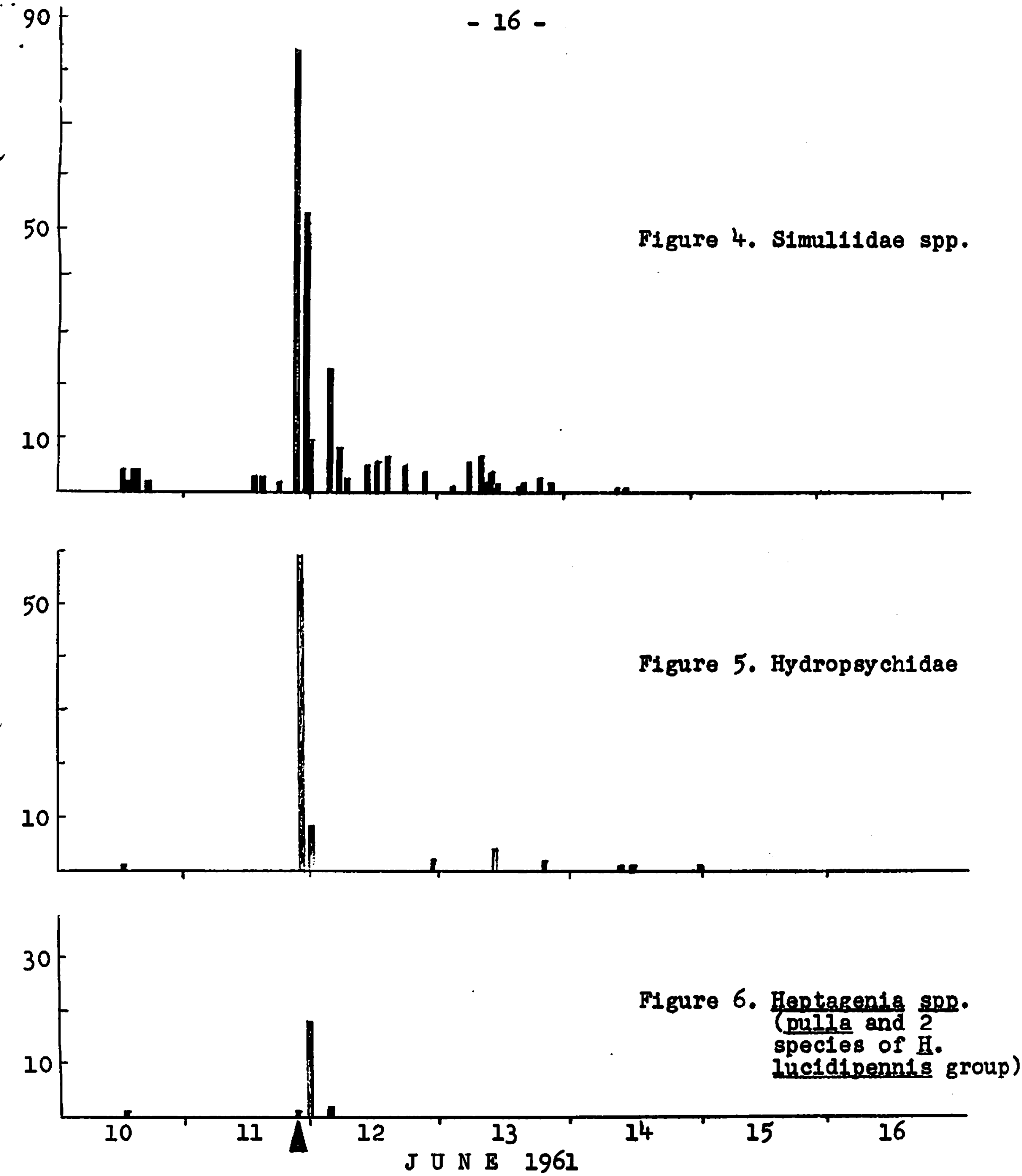
a b

c

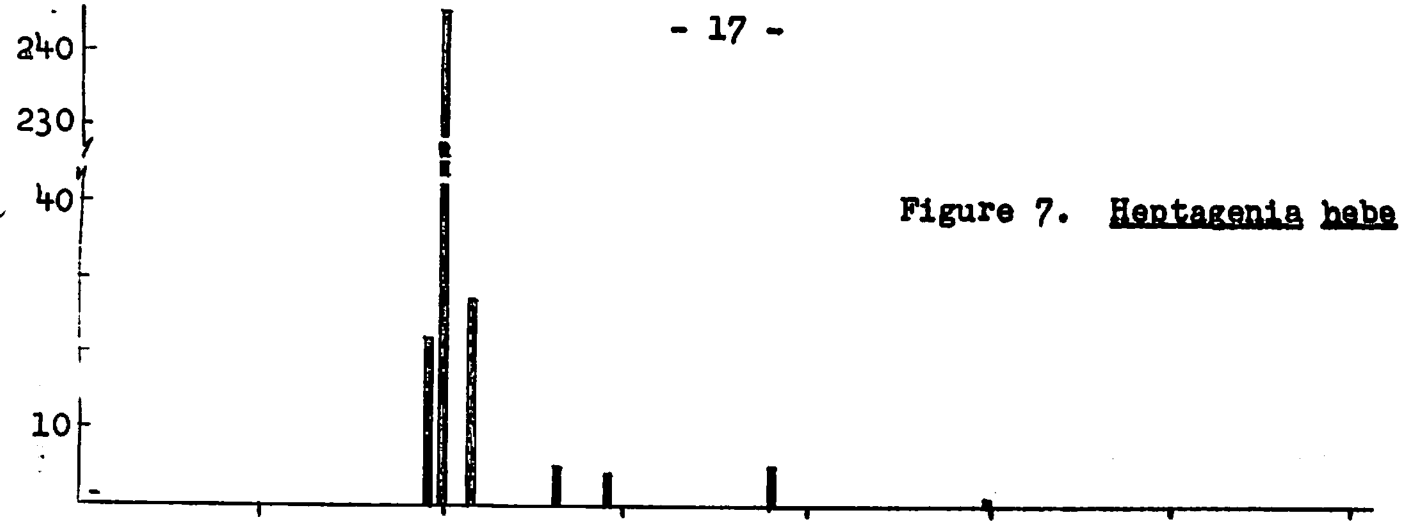
Figure 3. (a) Cage-trap in position for taking emerging insects.

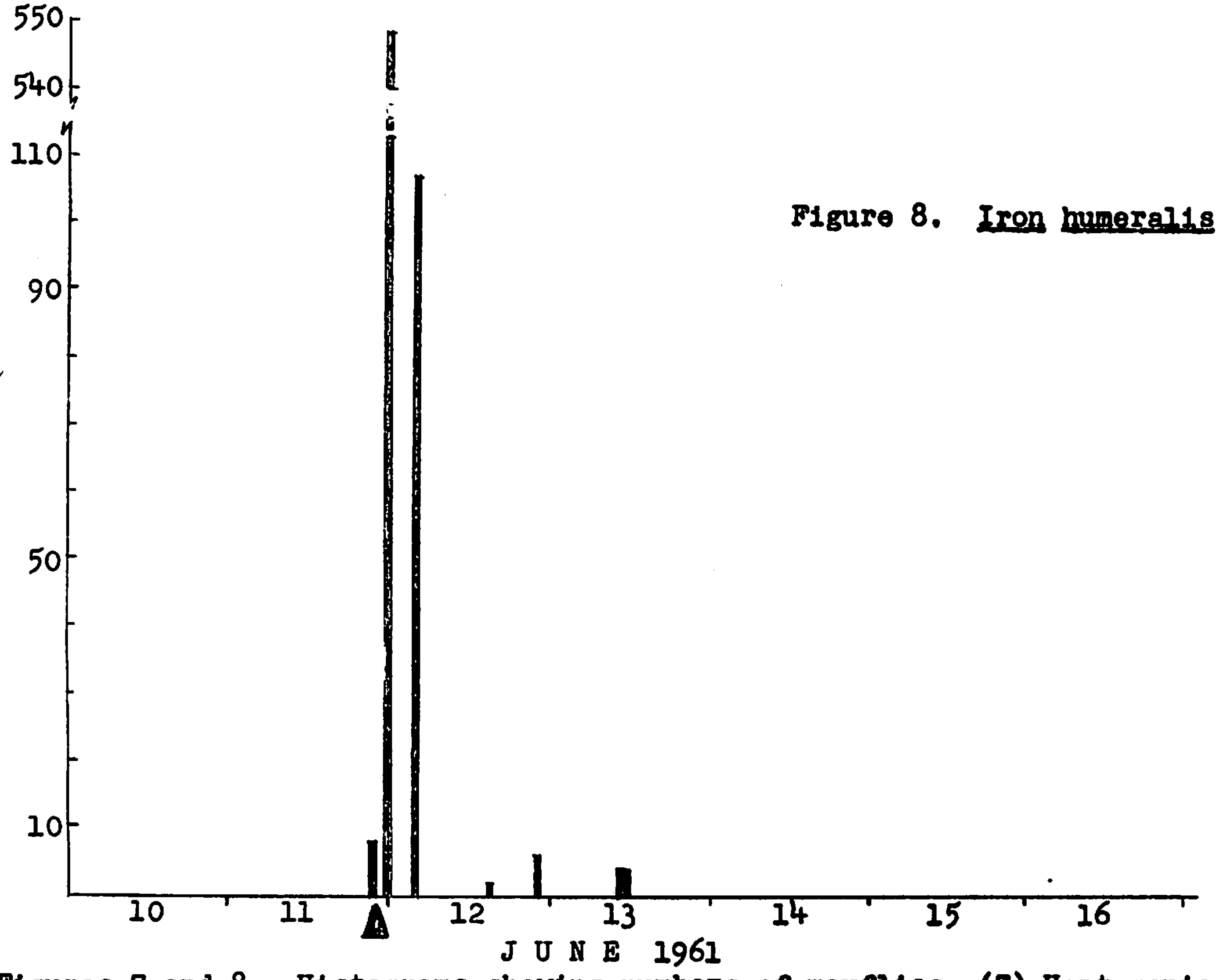
(b) Screen for catching drift.

(c) Screens in position at Station A, Molus River, 1961.



Figures 4, 5 and 6. Histograms showing numbers of (4) larvae of Simuliidae (black flies), (5) Hydropsychid caddisflies, (6) mayflies, Heptagenia spp., caught at Station R by a 12 inch by 12 inch area of screen during hourly intervals through pre-spray and post-spray periods. Spray was applied at time indicated by arrow on abscissa.





Figures 7 and 8. Histograms showing numbers of mayflies, (7) *Heptagenia hebe*, and (8) *Iron humeralis* caught at Station R by a 12 inch by 12 inch area of screen during hourly intervals through pre-spray and post-spray periods. Spray was applied at time indicated by arrow on abscissa.

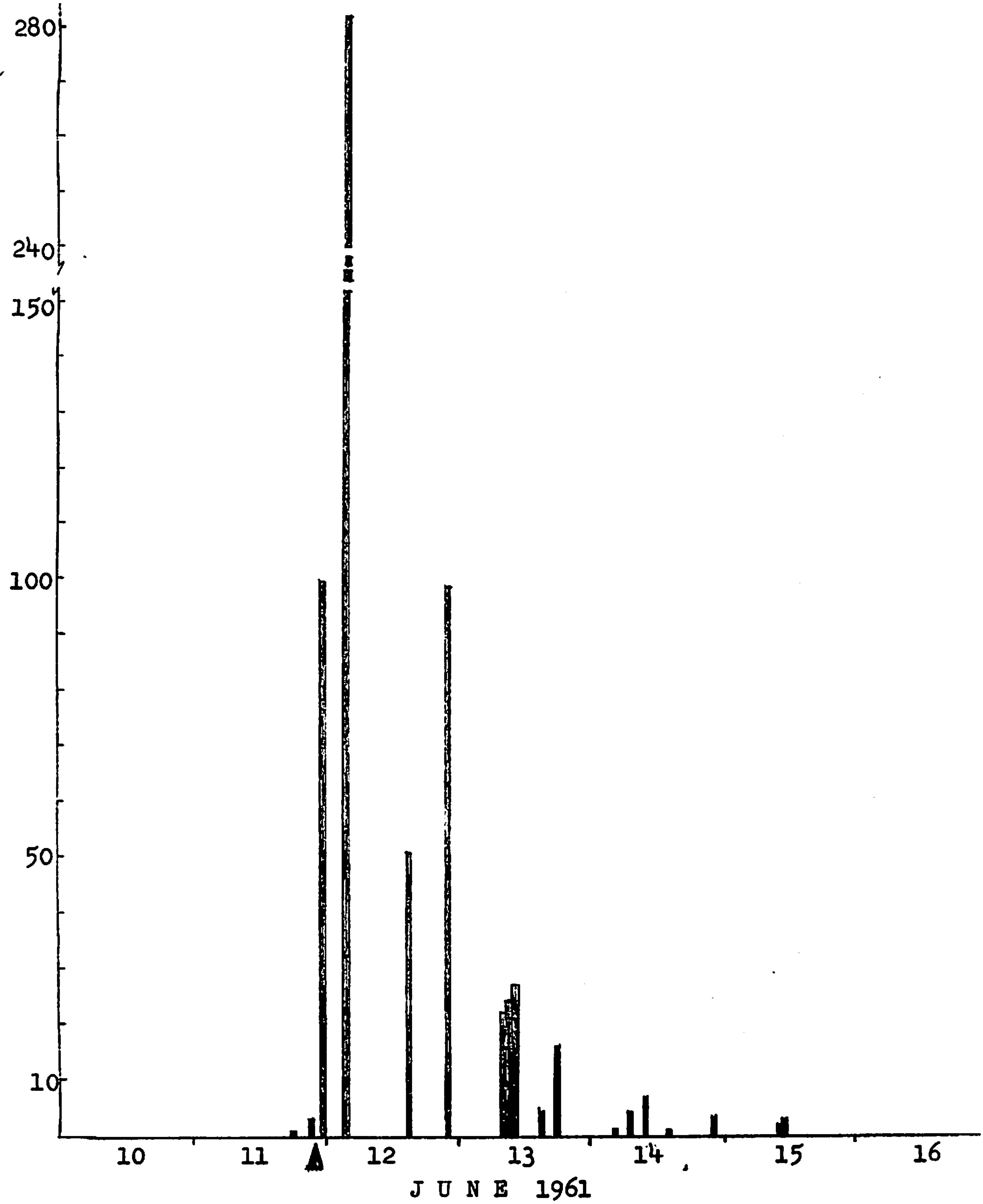


Figure 9. Histogram showing numbers of mayflies, Stenonema carolina, caught at Station R by a 12 inch by 12 inch area of screen during hourly intervals through pre-spray and post-spray periods. Spray was applied at time indicated by arrow on abscissa.

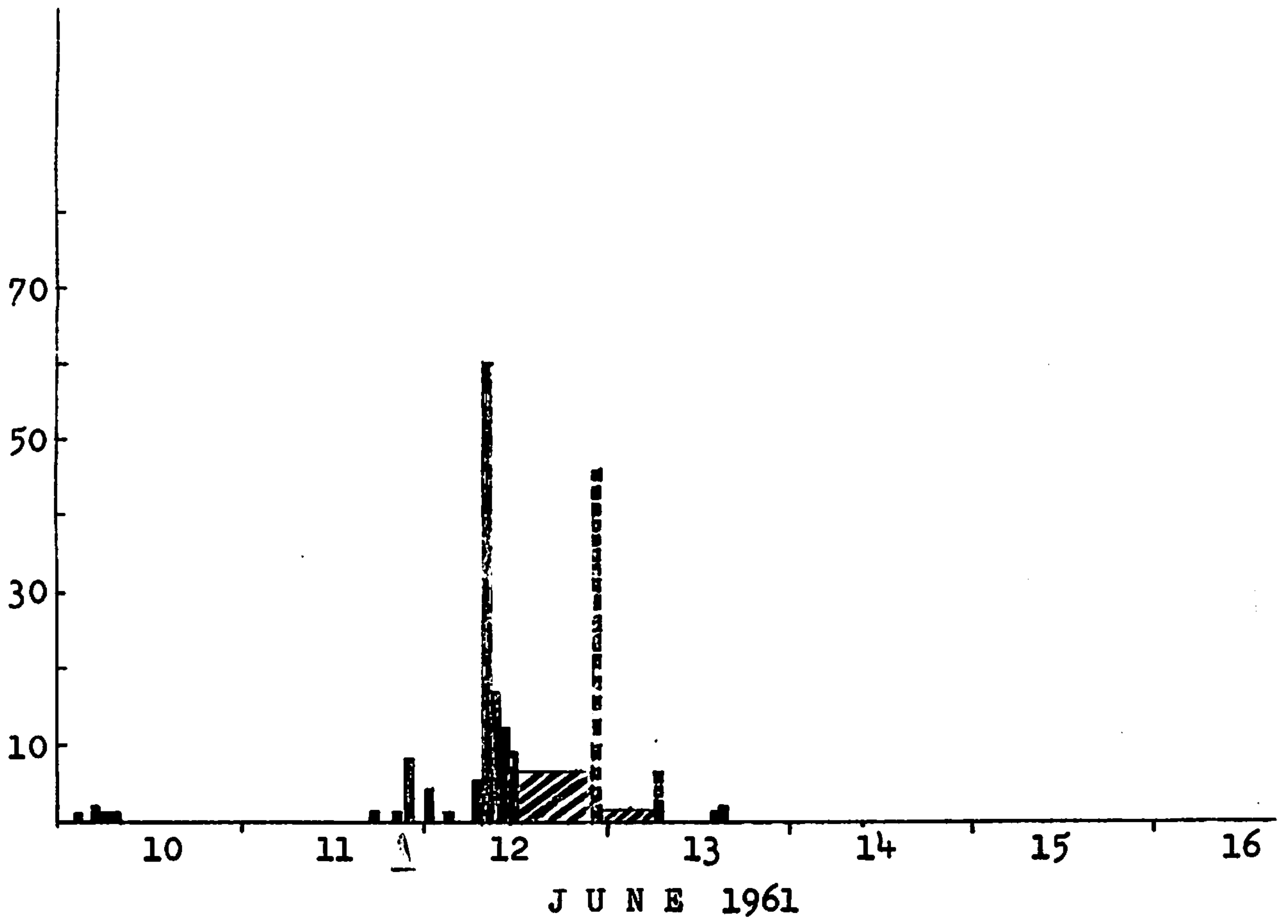
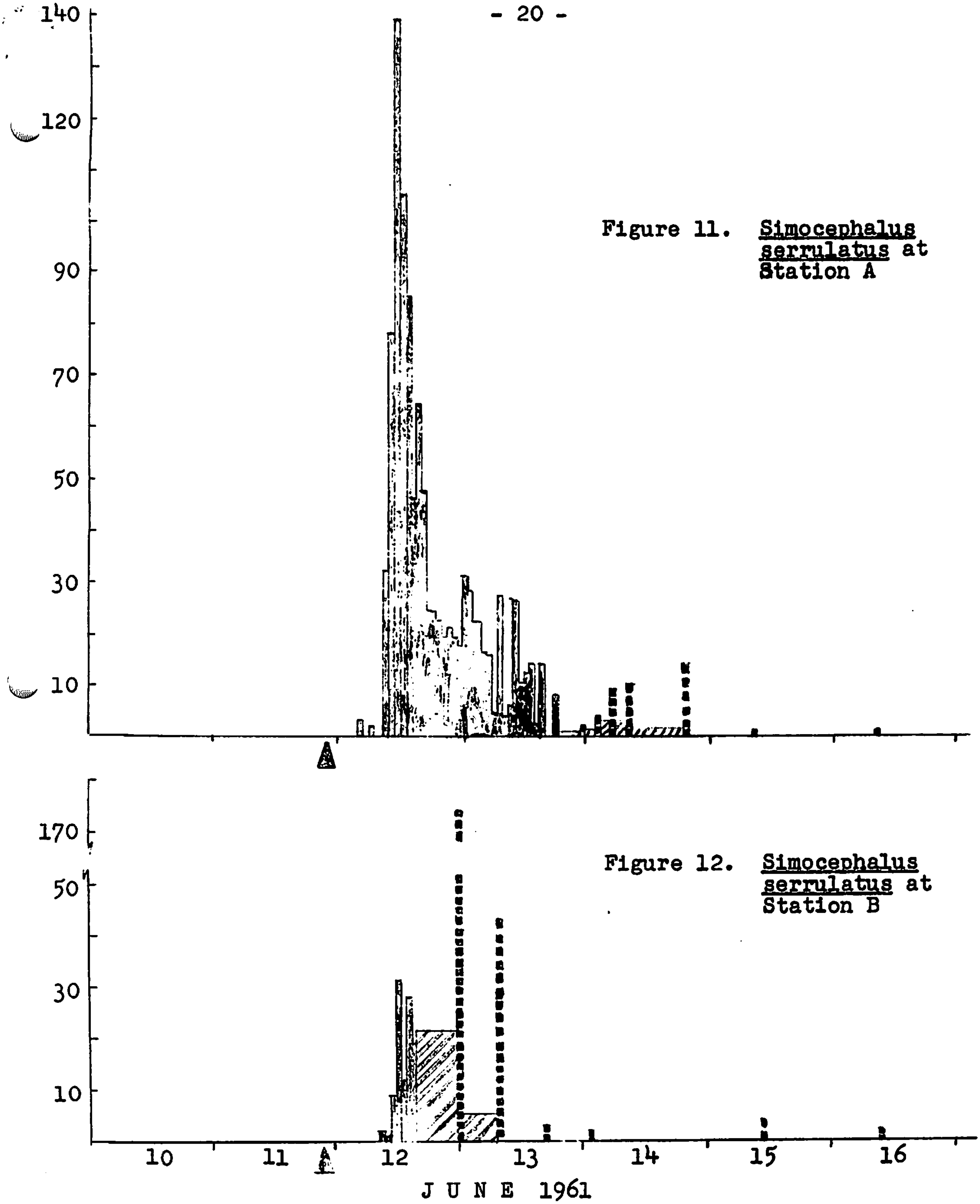


Figure 10. Histogram showing numbers of mayflies, *Arthroplea bipunctata*, caught at Station B below beaver pond by a 12 inch by 12 inch area of screen during hourly intervals through pre-spray and post-spray periods. Spray was applied at time indicated by arrow on abscissa. Dotted columns are for accumulated catch over periods longer than an hour; corresponding averages calculated for hourly catches are indicated by cross-hatched columns.



Figures 11 and 12. Histograms showing numbers of cladoceran, Simocephalus serrulatus, caught (11) at Station A below pond, and (12) at Station B below ponds, by a 12 inch by 12 inch area of screen during hourly intervals through pre-spray and post-spray periods. Spray was applied at the time indicated by arrow on abscissa. Dotted columns are for accumulated catch over periods longer than an hour; corresponding averages calculated for hourly catches indicated by cross-hatched columns.

Appendix IV

SPRUCE BUDWORM SPRAYING OPERATIONS IN QUEBEC IN 1961

AND PROSPECTS FOR 1962

J. R. BLAIS

In 1961, the aerial application of DDT against the spruce budworm was practised in the Rimouski River area of Quebec for the second consecutive year. These operations are being carried out with two purposes in mind: the prolongation of the life of trees, and the reduction of spruce budworm populations with the hope of preventing the spread of this incipient outbreak.

The egg survey conducted in the summer of 1960 had indicated that insect populations could be expected to cause severe defoliation in two separate areas on either side of the area treated in 1960. Plans were made to spray these two areas which totalled 95 square miles. Surveys carried out at the time of the early larval stage in the spring of 1961 indicated high populations in the areas recommended for treatment and in an additional 23 square miles adjacent to the two areas. The 23 square miles were added to the spray program to make a total of 118 square miles. This included nearly all areas supporting budworm populations capable of causing severe defoliation. Only light populations existed outside of the spray area except for a small sector of approximately 17 square miles which because of its inaccessibility was not detected until the time of the aerial defoliation survey in August.

The sprays were applied in late June when the larvae were nearly full grown. The formulation used was the same as in past years and consisted of one pound of DDT to one U.S. gallon of oil. The solution was applied at the rate of 1/2 gallon per acre. Favourable weather conditions permitted the completion of operations within five days.

In order to assess the efficacy of the sprays and the effects of natural control a post-spray population survey was conducted in the same localities sampled during the early larval stage. Results of the pre- and post-spray population assessments and the per cent reduction in population between the two surveys for sprayed and nearby unsprayed areas are shown in Table I; for purposes of comparison data for 1960 are also included.

Table I

Average population per 18-inch branch tip for sprayed and unsprayed localities during the early larval stage (pre-spray) and the pupal stage (post-spray) and per cent reduction in population between the two surveys for 1960 and 1961

Year	Treatment	No. of localities	Av. no. of insects per 18-inch branch: Early larval stage (pre-spray)	Av. no. of insects per 18-inch branch: Pupal stage (post-spray)	Per cent reduction in population
1960	Unsprayed	40	8.9	2.6	70.8
	Sprayed	27	18.2	0.6	96.7
1961	Unsprayed	30	1.4	0.13	90.7
	Sprayed	15	12.3	0.07	99.4

In unsprayed areas the reduction in population between the two surveys was due solely to natural control factors and was considerably greater in 1961 than in 1960. This was due, in part, to an increase in parasitism. In the sprayed areas the reduction in population was due to the combined effects of natural control and the sprays and was unusually high.

Populations were sampled for eggs in 61 localities in and around the outbreak area with the purpose of predicting the degree of defoliation expected in 1962 (Table II). Results indicate that the outbreak is at a low ebb within the areas treated as well as in those immediately outside. Only four localities gave a high egg count and these were situated in or near the sector of severe defoliation referred to earlier. Insect populations can be expected to be high in this area in 1962 and the area which covers approximately 30 square miles should be treated next year.

Table II

Degree of defoliation expected in 1962 in localities sampled for eggs in 1961

Treatment	No. of Localities sampled	Degree of defoliation expected/ No. and % of localities: Nil No.	Nil %	Light No.	Light %	Severe No.	Severe %
Unsprayed	34	23	68	7	20	4	12
Sprayed 1960	12	8	75	4	25	0	0
Sprayed 1961	15	9	60	6	40	0	0
Total	61	40	65	17	28	4	7

A serious effort to stamp out this outbreak might justify the inclusion in the spray program of the surrounding areas where light insect populations persist. This policy is contemplated although not yet decided upon; should it be adopted, the area to be treated would cover close to 100 square miles.

The sector being considered for treatment in 1962 is drained by two streams, the larger one forms part of the upper reaches of the Patapedia River, the other is a smaller stream that runs into Lake Mistigougeche. There are no lakes in the sector.

Results obtained to date in this relatively small area of operation are very encouraging. It can be concluded with some certainty that had it not been for spraying operations carried out in the past two years, the spruce budworm outbreak would now occupy an area of several hundred square miles, 300 square miles of which would be under severe attack. It appears that reducing spruce budworm populations through spraying is especially effective when the treatment is applied within one season over a large part of the outbreak area, and such procedure is quite feasible when the outbreak is still restricted. Should natural control factors be as effective in 1962 as in 1961, it is possible that the combined effects of chemical and natural control could bring this incipient outbreak to an end next year.

Quebec, 26 September 1961.

Appendix I

An Appraisal of the Systemic Insecticide

Phosphamidon Tested Against the Spruce Budworm

An Interim Report by James J. Fettes, Chemical Control Section,

Forest Entomology and Pathology Branch

A systemic insecticide effective against coniferous defoliators would solve many of the difficult problems encountered with contact or stomach poisons. Systemic insecticides taken into the living tissues render plants toxic to phytophagous insects at all locations of feeding. They have been notably effective against sucking insects on succulent plants and, more recently, have shown great promise in woody, broad-leaved plants. In 1960 a reported success of Phosphamidon against gypsy moth larvae feeding on white pine was the first indication that a systemic insecticide might be effective against a defoliator of conifers. Additionally, toxicological tests have indicated that Phosphamidon is virtually non-toxic to mammals and aquatic fauna at dosages anticipated for forest spraying. Two series of tests were planned by the Chemical Control Section to determine the efficacy of the systemic action of Phosphamidon against the spruce budworm on spruce and balsam, and tolerance tests on young salmon comparing Phosphamidon with DDT were performed by Mr. D. Alderdice of the Fisheries Research Board Biological Station, Nanaimo, B.C., and the following results reported:

Table I

Comparison - Tolerance of Young Salmon to Phosphamidon and DDT

Insecticide		48 hr. Median Tolerance Limit
Phosphamidon	-	10 ± 1 mg/L
DDT	-	0.03 ± 0.01 mg/L

These data indicate that young coho salmon can tolerate over 300 times more Phosphamidon than DDT.

Laboratory Tests

Several groups of small potted white spruce were treated in various ways with Phosphamidon, Dimethoate and several other candidate systemics. The two systemics mentioned by name showed definite and nearly equal effects when taken up by the roots of the plants and by the foliage. The most significant result was demonstrated by treating one portion of the foliage, enclosing that portion in a plastic bag, and observing the effects on spruce budworm larvae feeding on the untreated portions of the plants. The subsequent death of most of the larvae clearly indicated that these two systemics had been taken up by the plant and that the entire plant became toxic to the larvae. These results are the first indication that conifers may be successfully protected by a systemic insecticide.

Field Tests

A series of field tests in which Phosphamidon was applied to spruce budworm-infested spruce-balsam forests in New Brunswick in 1961 was designed to determine the effects of airplane application of Phosphamidon on the spruce budworm larval populations. Aircraft facilities were provided by Forest Protection Limited and the chemicals were provided by the California Chemical Company of Medina, N.Y. The gross results of these tests appear in Table II (see page 3).

The data for this series have been partially analyzed but provide a reasonably firm appraisal of the effects of Phosphamidon. Because of the high variability in the spruce budworm population samples and their spatial separation from the deposit samples a regression of dosage-mortality relationships is not meaningful. In earlier reports on other insecticides, the plots were divided into portions receiving various mean dosages to facilitate the appreciation of the dosage mortality relationships. The deposits recorded in the Phosphamidon plots were, for the most part, too uniform across the plot to allow clear-cut divisions of high, medium, and low dosage areas. The best exception to this pattern is noted in Plot 3 which was sprayed at 1 lb. Phosphamidon per gallon per acre, diluted in water. In this plot the heaviest spray was applied close to one side so that the dosage decreases from heavy to light along the sample lines. Plot 3 is even more interesting because it has a low overall dosage and shows the lowest overall larval decrease due to Phosphamidon. A further breakdown of data of Plot 3 (Table III) clearly demonstrates the effect of various deposits of the insecticide on the larval population. Over 10 drops per square centimetre results in control values in excess of 90% whereas the lower dosages show correspondingly lower effects on the insects. A most interesting observation is the similarity of the effects of Phosphamidon and the results of DDT trials reported earlier. The values shown for Plot 3 would fall within the confidence limits of the graph computed for the DDT data.

Table II

Phosphamidon Test Plots - New Brunswick 1961

Plot	Line	Concentration and Dosage	Spray Deposit Drops/cm^2	Pre-Spray Larval Density*	Expected Post-Spray Larval Density**	Observed Post-Spray Larval Density	Per Cent Larval Density Decline Due to Phosphamidon
1	A	½#/gal/Acre	4.7	.148	.107	.013	88
	B	in Water	3.6	.117	.082	.023	72
2	A	1#/gal/Acre	14.5	.105	.073	.009	88
	B	in Oil	12.9	.069	.048	.011	77
3	A	1#/gal/Acre	4.4	.157	.110	.039	65
	B	in Water	4.7	.179	.125	.046	63
4	A	2#/gal/Acre	10.0	.101	.071	.018	75
	B	in Water	8.3	.097	.068	.014	79

5 Balsam Woolly Aphid***

* Densities = the number of larvae per new shoot.

** Natural population decline averaged 25% between June 7 and 28. A factor of 30% was used for safety.

*** A plot was heavily sprayed to test for BWA control. No effect was observed. Predators were killed by contact poisoning.

Pre-spray population samples were taken one to two days before spraying.

Post-spray values are those from samples taken eighteen days after spraying.

Table III

Phosphamidon Test Plot 3

Line A Upper Crown Sample

Line Section	Spray Deposit Drops/cm^2	Pre-Spray Larval Density*	Expected Post-Spray Larval Density	Observed Post-Spray Larval** Density	Per Cent Larval Density Decrease due to Phosphamidon
1	10.3	.148	.104	.003	97
2	3.6	.149	.104	.056	46
3	0.7	.143	.100	.101	0

Line A Lower Crown Sample

Line Section	Spray Deposit Drops/cm^2	Pre-Spray Larval Density*	Expected Post-Spray Larval Density	Observed Post-Spray Larval** Density	Per Cent Larval Density Decrease due to Phosphamidon
1	10.3	.148	.104	.007	93
2	3.6	.184	.129	.028	78
3	0.7	.178	.125	.058	54

* Two days prior to application.
** Eighteen days after application.

There is an important difference between the action of Phosphamidon and DDT. DDT being a stomach and contact poison, produces its effect on the population within a few days of application. All of the data for DDT shows about 85% of mortality taking place within four days of application. With Phosphamidon however, the initial contact effect is not marked but the mortality continues to rise for a period of at least 18 days. Since the Phosphamidon is said to be not present on the outside of the plant for more than four days, the evidence is strong that the Phosphamidon is actually acting as a systemic poison. This observation is important as it is the first field evidence that a systemic would be taken up in sufficient quantities to render balsam foliage toxic to a defoliating insect.

The data presented in Table III are selected and represent the most clear-cut indication of effect. The conclusion which might be drawn is that Phosphamidon is quite promising and deserves further investigation. Because of considerable variation in the data, which may be due to many factors, including rain, it would not be wise to consider Phosphamidon "operationally" at this time but it is worthy of further testing. It is clear that Phosphamidon must be very carefully applied to be effective over a large area. The application of a systemic insecticide would indicate a change in application principle. As the material is taken up by the plant it would not be necessary to strive for a large number of small drops per unit area but rather a uniform deposit of larger drops. Phosphamidon is still an experimental insecticide and, therefore, it would be unreal to project cost figures at this time.

Chemical Control Section,
Ottawa, Ont.,
November 21, 1961.

Appendix VI

The Decca Navigator System as a Device for Positioning Spray Planes

An Interim Report by James J. Fettes, Chemical Control Section

Forest Entomology and Pathology Branch

One of the most serious difficulties encountered in large-scale airplane spray programs has been to guide the aircraft over predetermined points on the ground. Several techniques have been tried with varying success but the problem of sizeable "missed" areas persists. The Decca Navigator System was demonstrated for use in aircraft and its accuracy and reproducibility of positioning suggested that such a system might be used as an aid in airplane spray operations. In a co-operative project with Computing Devices of Canada, Forest Protection Limited and the Department of Forestry, the system was tested over a forested area in Nova Scotia in 1961. An area of forest on the limits of the Riversdale Lumber Co., near Truro, N.S., was selected for the tests because it was located within the existing Decca chain centred at Halifax. The Canadian Army Unit at Debert, N.S., provided airport facilities.

The Decca System equipment was installed in a Grumman T.B.M. spray plane and a Cessna 180. The T.B.M. was used as the spray plane and the Cessna for observation. The performance of the Decca System is explained in a Report by Computing Devices of Canada Limited, Appendix 1. The report contains a chart of the actual flying that was done for the tests and illustrated in Figure 3 of the Appendix.

The staff of the Chemical Control Section surveyed a one mile transect through the pre-selected rectangle of forest. Sensitized cards were used to determine the oil deposit, and a number of observers, spaced along the line, recorded the intersections of the flight lines with the transect. The flight path intersections on the flight log recorder charts corresponded closely to the observed ground points.

Trial Decca 1

The first trial was designed to lay a number of swaths across the sample transect at intervals of 740'. This interval was determined by the Decca Channel System at that geographic position (Figs. 5 & 6). The headings for the 740' positions were determined by the Computing Devices engineer, Mr. David Underwood, and the pilot was instructed to follow a pre-determined lead line on the chart to the area and lay down the spray swaths on the given headings. The plot layout was designed to give swath width characteristics of the T.B.M. Because of an undetermined miscalculation, the northbound swaths were begun after the transect had been crossed. Actually, the deposits on the transect were those of 1480' swaths rather than the planned 740'. Fig. 1 illustrates the deposit at 80 points at

1 chain intervals in terms of drops per square centimetre. The solid arrows indicate the flights from which spray was emitted over the transect while the other arrows indicate the flights from which no spray reached the transect. The trial was carried out under very light wind conditions so that the individual swath deposit measurements are separate and distinct.

Trial Decca 2

The second trial was planned to represent more closely an operational spray deposit with a 400' swath width. Again, the Decca Channel was more easily read by using a 370' interval. Fig. 2 illustrates the deposit measured along the transect for the portion of the 1 mile line covered by a single plane load. Spray was deposited from all flights over the transect. In trial 2 the swath overlaps raise the deposit density, generally, to an acceptable dosage of 10 drops per square centimetre. This trial was carried out at wind speeds of from 2 to 3 miles per hour across the plot resulting in more separation of swaths than is desirable. The aircraft performed exceptionally well when guided by Decca. (Figs. 5 & 6).

Fig. 3 compares the observed position of the spray plane track across the transect with the target position for both Decca trials. The data to illustrate the aircraft performance is presented in Table 1, in which the observed aircraft position is compared with the theoretical aircraft position and the swath width error determined. It is noted for trial 1 that the largest swath width error is 120', or about 2 widths of the aircraft, while in trial 2 the greatest swath width error is 70', somewhat more than 1 plane width. Such a small deviation from the target over an area entirely unfamiliar to the pilot after one day of familiarization with the System, shows an extraordinary accuracy possible with the Decca System (Table 1, see p.3).

Taking the data from Decca trial 1 and averaging 3 consecutive swaths, some appreciation of the effect of wind on swath width can be illustrated (Fig.4). Overlapping a series of deposit curves from 4 miles per hour crosswind swaths suggests that a continuous, acceptable deposit of 10 drops per square centimetre or more, can be achieved with a 400' swath interval. Transforming the data for a downwind drift of 6 miles per hour, a similar, acceptable deposit could be achieved with a 500' swath interval. At 10 miles per hour the acceptable deposit swath would not increase beyond 500' but the deposit would be more uniform. The same effect could be achieved by increasing the altitude of flight inversely with wind speed. A more uniform deposit for an operation could be achieved by determining a proper spray altitude for a given wind speed. This principle, demonstrated by the Defence Research Organization, Porton, England, is one to which we should pay more attention.

Table 1. Actual Aircraft Position when Guided by Decca compared with Theoretical Position

Trial 1	Pass No.	Actual Distance* from 0	Swath width	Theoretical Distance from 0	Deviation from Target	Swath width Error	Error Direction
	1	0	-	-	0	-	-
	2	760	760	740	20	20	Wide
	3	1520	760	1480	40	20	Wide
	4	2080	560	2220	180	120	Narrow
	5	2810	730	2960	150	10	Narrow
	6	3510	760	3700	130	20	Wide
	7	4295	725	4440	145	15	Narrow
	8	5115	820	5180	65	80	Wide
	9	5855	740	5920	35	0	Correct
	Average		732	740	93	36	
Trial 2							
	1	0	-	0	0	-	-
	2	420	420	370	50	50	Wide
	3	750	330	740	10	40	Narrow
	4	1170	420	1110	60	50	Wide
	5	1500	330	1480	20	40	Narrow
	6	1920	420	1850	120	50	Wide
	7	2220	300	2220	0	70	Narrow
	8	2650	430	2590	60	60	Wide
	Average		379	370	40	31	

* All distances in feet.

Conclusion

The Decca System was tested under conditions less than ideal. The installation was done rather hurriedly and a minimum of time was available for checking out the equipment and familiarizing the pilots with its operation. Nevertheless, after 3 or 4 hours of familiarization, the spray pilot was able to find a small area of forest some 25 miles from base, lay down a spray pattern with a high degree of precision, and return to base (See Figs. 5 & 6). The pilot, Mr. J. Holland, indicated that he had no difficulty navigating by Decca and was most enthusiastic about a device with which he could find himself at any time and be certain that he was spraying within a few feet of a pre-determined location.

Chemical Control Section,
Ottawa, Ont.,
November 17, 1961.

FIG. 1 Deposit Decca 1

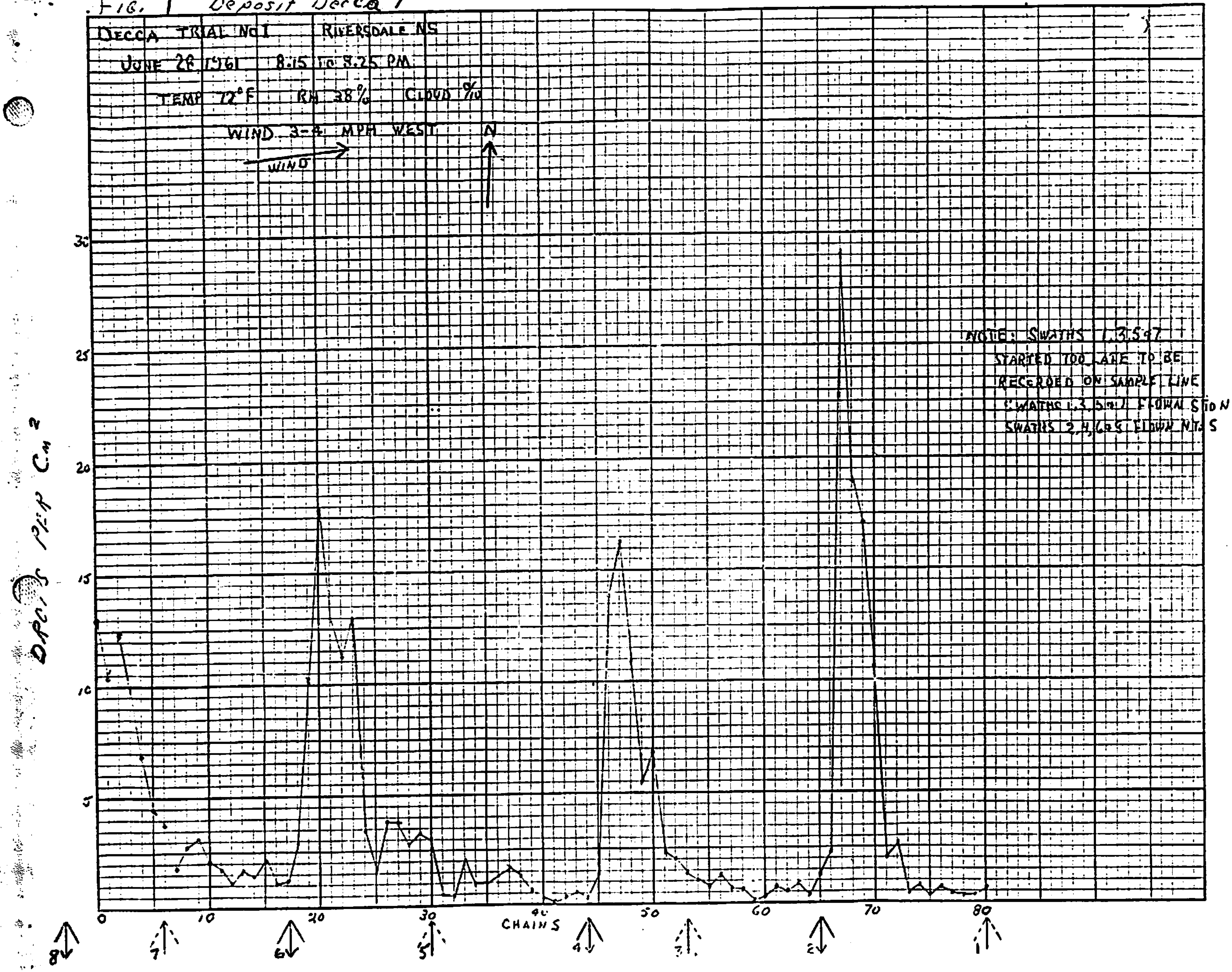
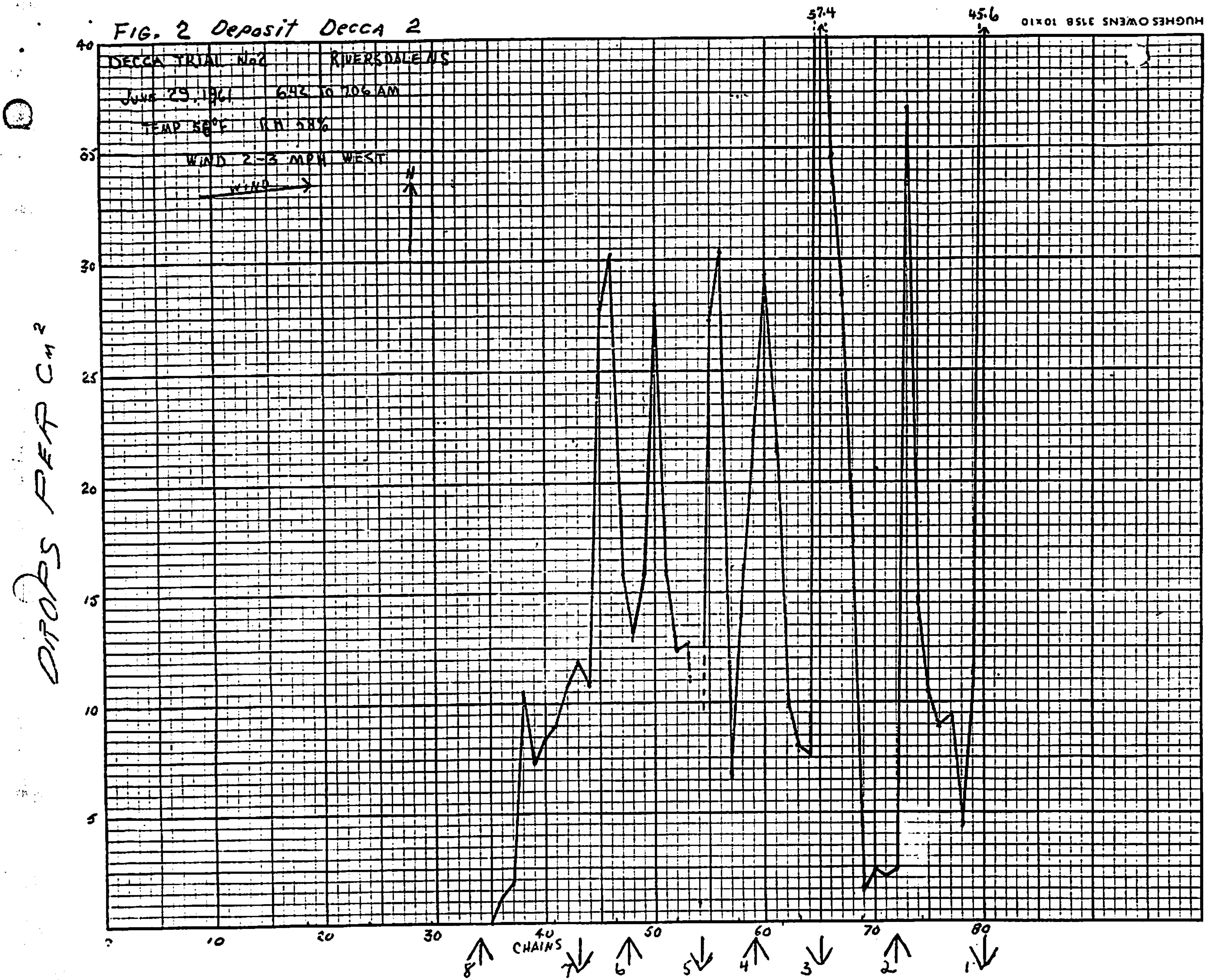


FIG. 2 Deposit Decca 2



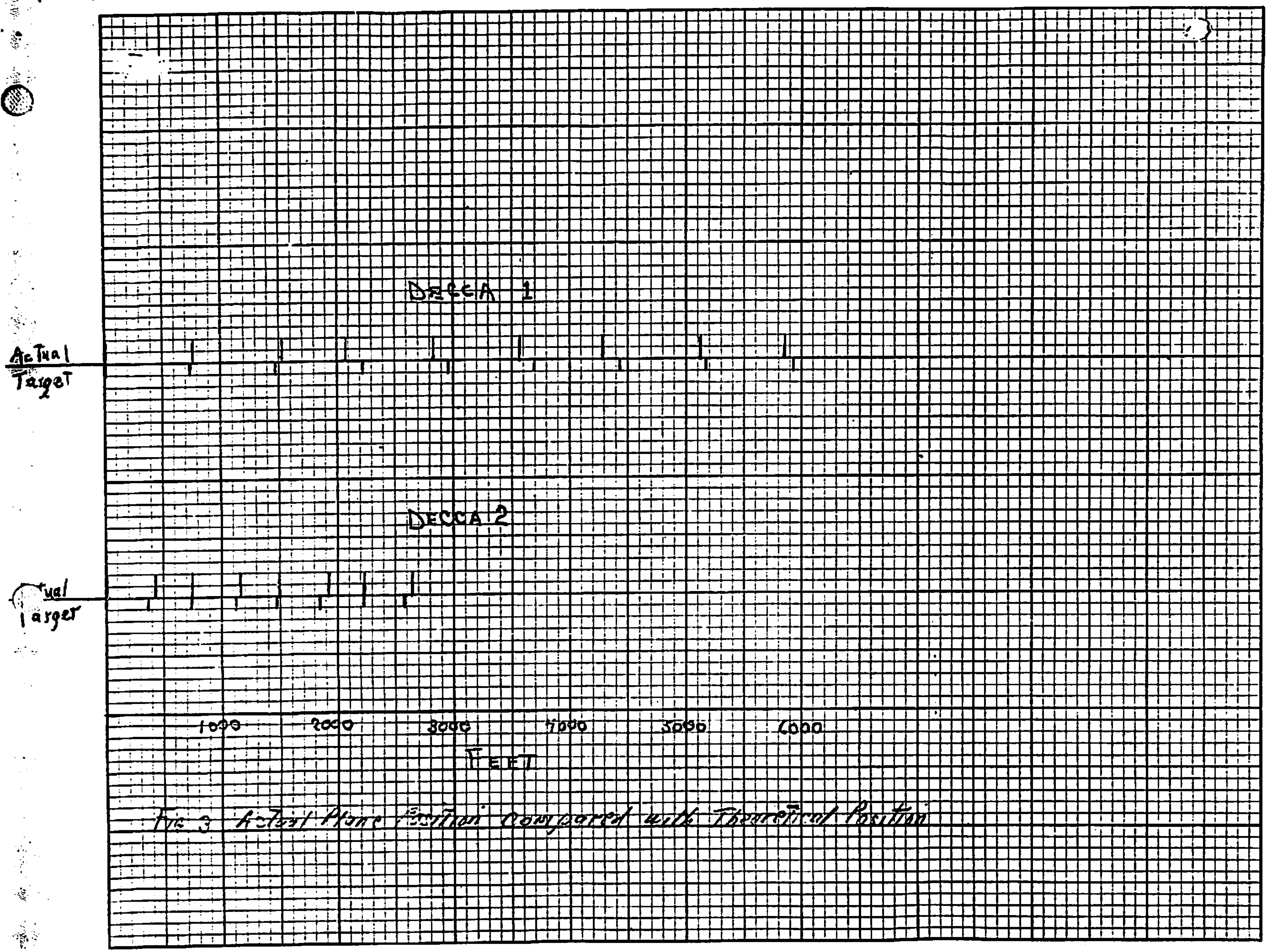


Fig 3 Actual Plane Position compared with Theoretical Position

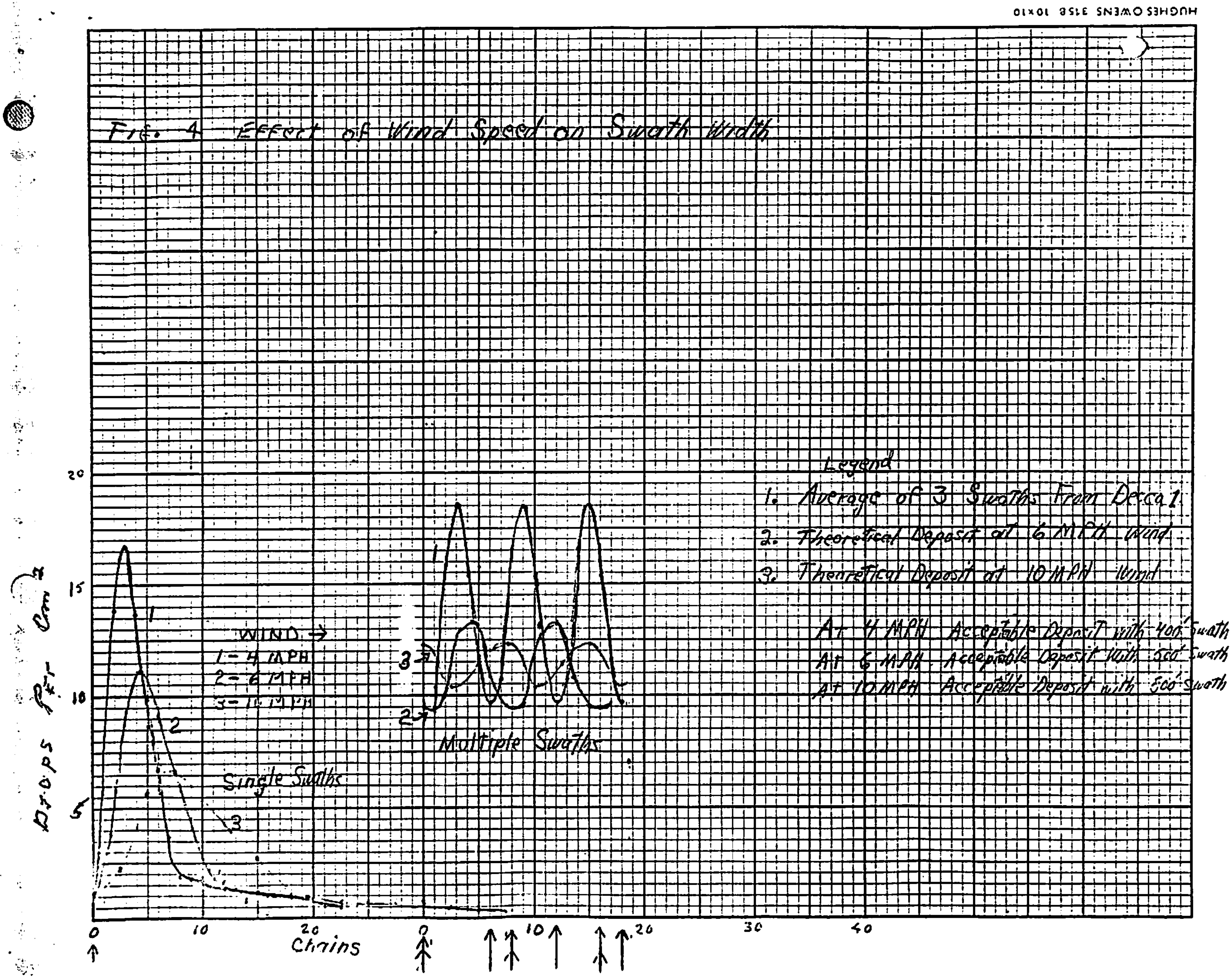
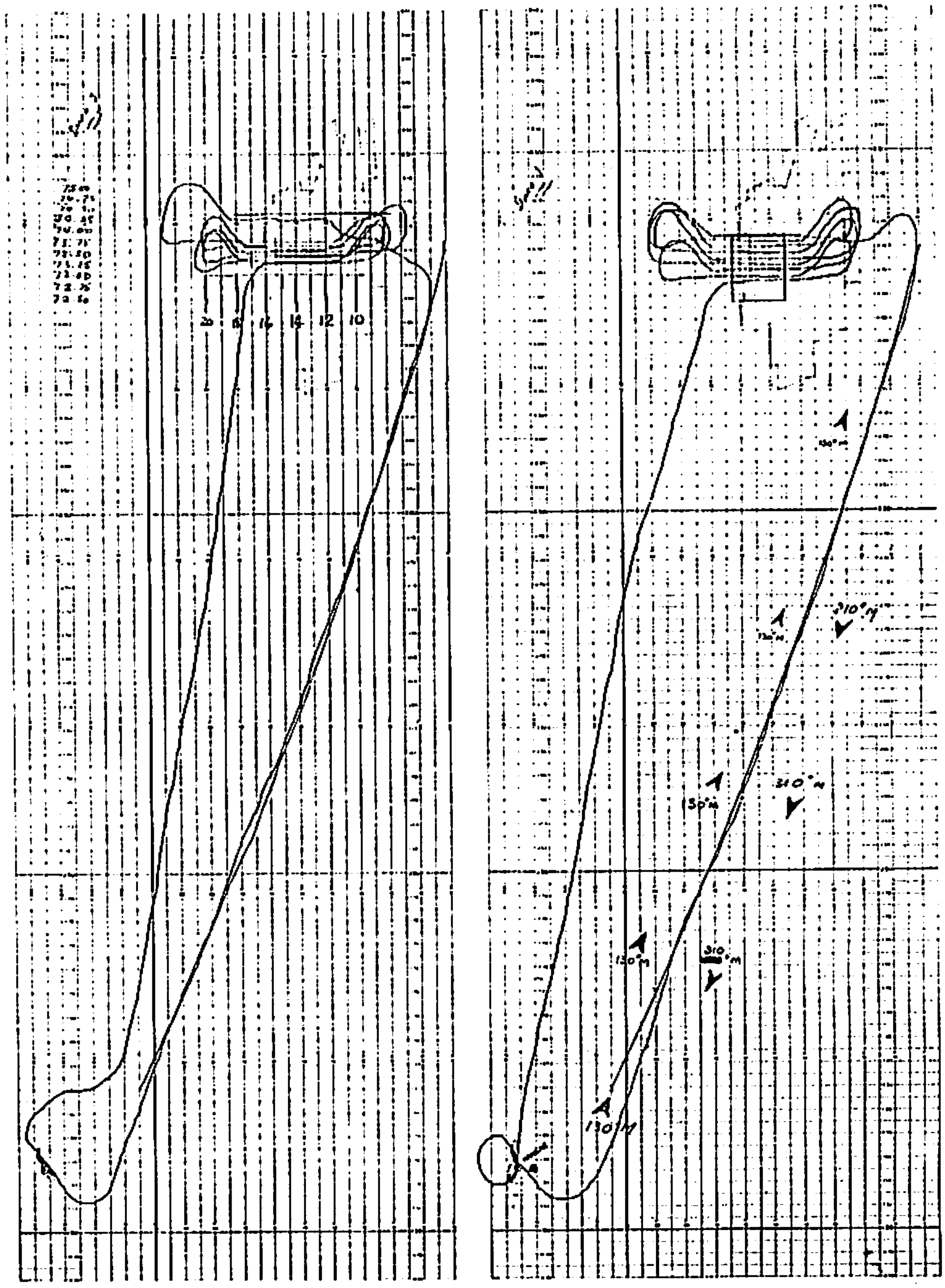


Fig. 4 Effect of Wind Speed on Swath Width



Figs. 5 + 6.

Appendix VII

SUMMARY REPORT OF 1961 SPRUCE BUDWORM AERIAL DEFOLIATION AND EGG-MASS SURVEYS, AND FORECAST OF CONDITIONS FOR 1962

D. G. Mott

Forest Entomology and Pathology Laboratory
Department of Forestry
Fredericton, N. B.

Introduction

This report records the results of the aerial defoliation and egg-mass surveys conducted in 1961. It also presents a forecast of spruce budworm hazard for 1962 based primarily on these two surveys. A later report will present an assessment of the 1961 spray operation and record the results of experimental spraying carried on in conjunction with the operation.

The 1961 spruce budworm aerial spraying operation in New Brunswick comprised the treatment of 2,168,354 acres in the central part of the Province. Of this total, 1,559,914 acres received one application, 502,040 acres two applications, and 2,800 acres three applications of 1/4 lb. DDT in 1/2 U.S. gal. solvent per acre; these constituted the main 1961 operational spray area. In addition, experimental spraying was carried out on 75,600 acres with one application and on 14,000 acres with two applications of the operational spray formulation and dosage, and on 14,000 acres with one application of 1/2 lb. DDT in 1/2 U.S. gal. solvent per acre.

The original spraying plan for 1961 proposed by Forest Protection Ltd. and the Province of New Brunswick during the winter 1960-61 was modified as a result of surveys conducted by the Laboratory before spraying began and during the operation. A survey in May and June, 1961, of budworm larval populations outside the proposed spray plan revealed that infestations were present in a number of localities not indicated by 1960 surveys. There is evidence that egg-mass surveys in 1960 were deficient in some of these areas, but in addition it seems clear that considerable long-distance dispersal of emerging larvae occurred in the spring of 1961. As a result of the surveys 193,128 acres were added to the 1961 operational area, and 5,600 acres were deleted from it because lower populations than were expected were found.

Certain blocks of the operational spray area were designated in advance of the operation to receive a second spray application because their infestation history suggested that they harboured persistent budworm infestations. Following the first spray application in 1961, a network of plots was established to discover if larval survival after spraying was high in the remaining blocks of the operational area so that they might be included in the area to receive the second treatment. As a result, an additional 92,400 acres were designated for second treatment. One area of 2,800 acres was found to support high populations after the second spray application and was treated a third time.

The spraying operation, as it was ultimately carried out, is illustrated in Figure 1. The large area mapped in the west-central part of the Province was the main operational spray area; the smaller separate area to the east included the experimental spray area.

Aerial Defoliation Survey

The aerial defoliation survey was conducted by Forest Protection Ltd. personnel and covered the whole Province except for the Camp Gagetown area. Results of the survey are illustrated in Figure 2. Current defoliation of balsam fir was assessed from the air as being severe, moderate, or light. Such assessment usually means the following:

Severe	- 80 to 100%	loss	of	current	foliage
Moderate	- 50 to 80%	"	"	"	"
Light	- 30 to 50%	"	"	"	"

However, for extensive areas to the southeast of the main 1961 operational area, defoliation was underestimated in the aerial survey because the trees had produced very little foliage in 1961.

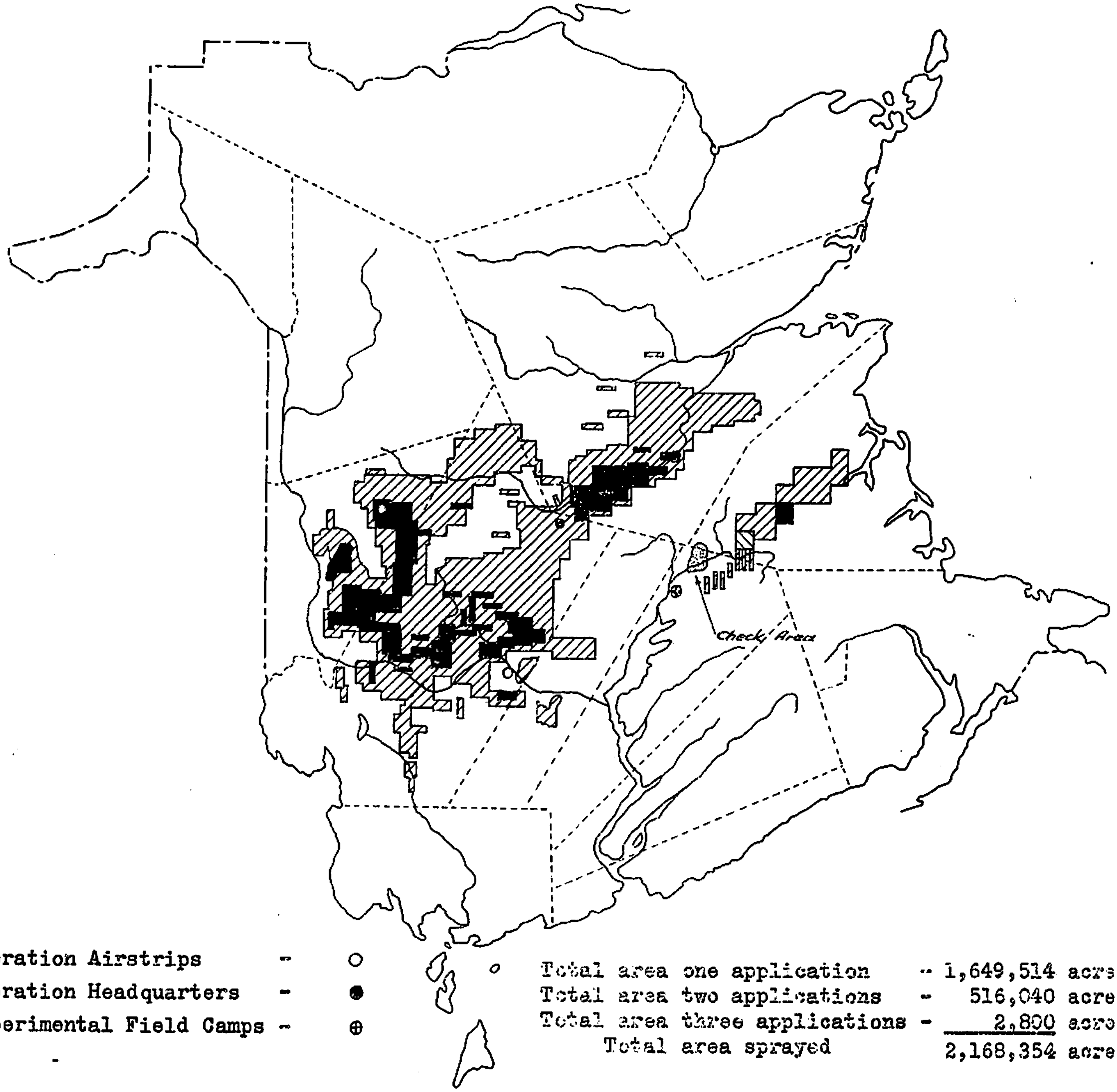
In general, the defoliation survey indicates a very successful spraying operation. In the operational spray area the 1961 foliage was generally preserved, and tree crowns that had been in seriously damaged condition a year ago are now thrifty. Areas of moderate and severe defoliation in the 1961 operational area are small and scattered, and very little defoliation was experienced beyond the sprayed area.

However, extensive defoliation occurred in the area to the east of the 1961 operational area, in general accord with forecasts made a year ago on the basis of 1960 egg-mass surveys. The defoliation pattern was, however, somewhat different than expected, particularly in the coastal parts of Kent County where a large area was defoliated to the north of the area of severe egg-mass infestation in 1960. This is believed to have resulted from a northward dispersal of emerging larvae which was observed in the spring. The infestation near the Gloucester-Northumberland county line, east of Highway 8, developed as predicted.

To the west and northwest of the 1961 operational area, several small areas of infestation that had not been detected earlier were found during the defoliation survey. These are located north of the lower parts of the Tobique River and on the west side of the St. John River between Grand Falls and Perth. Subsequent ground checks in these areas revealed high populations of adult moths and eggs.

Figure 1

1961 Aerial Spraying Operations Against Spruce Budworm



Operation Airstrips	-	○	
Operation Headquarters	-	●	
Experimental Field Camps	-	⊕	

Total area one application	-	1,649,514 acres
Total area two applications	-	516,040 acres
Total area three applications	-	2,800 acres
Total area sprayed		2,168,354 acres

Area sprayed with $\frac{1}{4}$ lb. DDT per $\frac{1}{2}$ U.S. gal. per acre -

Area sprayed with $\frac{1}{2}$ lb. DDT per $\frac{1}{2}$ U.S. gal. per acre -

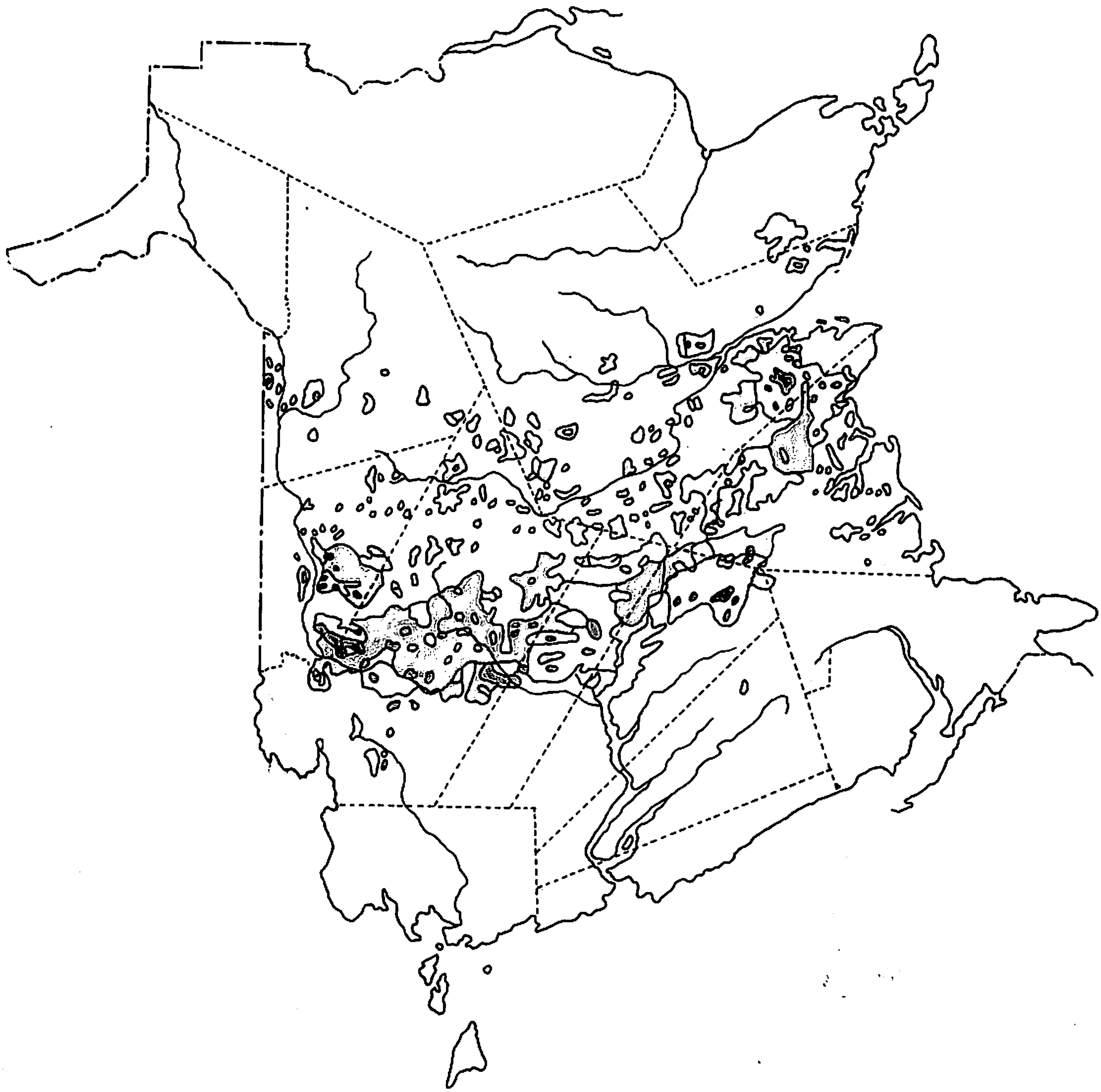
Area sprayed with two applications of $\frac{1}{4}$ lb. DDT per $\frac{1}{2}$ U.S. gal. per acre -

Area sprayed with three applications of $\frac{1}{4}$ lb. DDT per $\frac{1}{2}$ U.S. gal. per acre -

Operation began June 4 and finished June 30.
Second applications began June 18.

Scale: 1 inch = 34 miles (approx.)

Figure 2



<u>**Current Defoliation of Balsam Fir - 1961**</u>

(From aerial surveys by Forest Protection Limited. Camp Gagetown area not included.)

Scale: 1 inch = 34 miles (approx.)

Egg-Mass Survey

Figure 3 presents the results of the extensive egg-mass survey conducted throughout the Province during August and early September, 1961. This map is based on sequential counts made at some 1,020 separate points on balsam fir.

The survey reveals that the area of moderate and severe egg-mass infestation in 1961 is markedly reduced from what it was in 1960 and 1959, and that it is only slightly larger than it was in 1958. However, in 1961, egg-mass infestations were located mainly in the eastern part of the Province, downwind from the central forested area with respect to the normal winds that contribute to population dispersal, and therefore they do not constitute a major threat to the central forested area as they did in 1958.

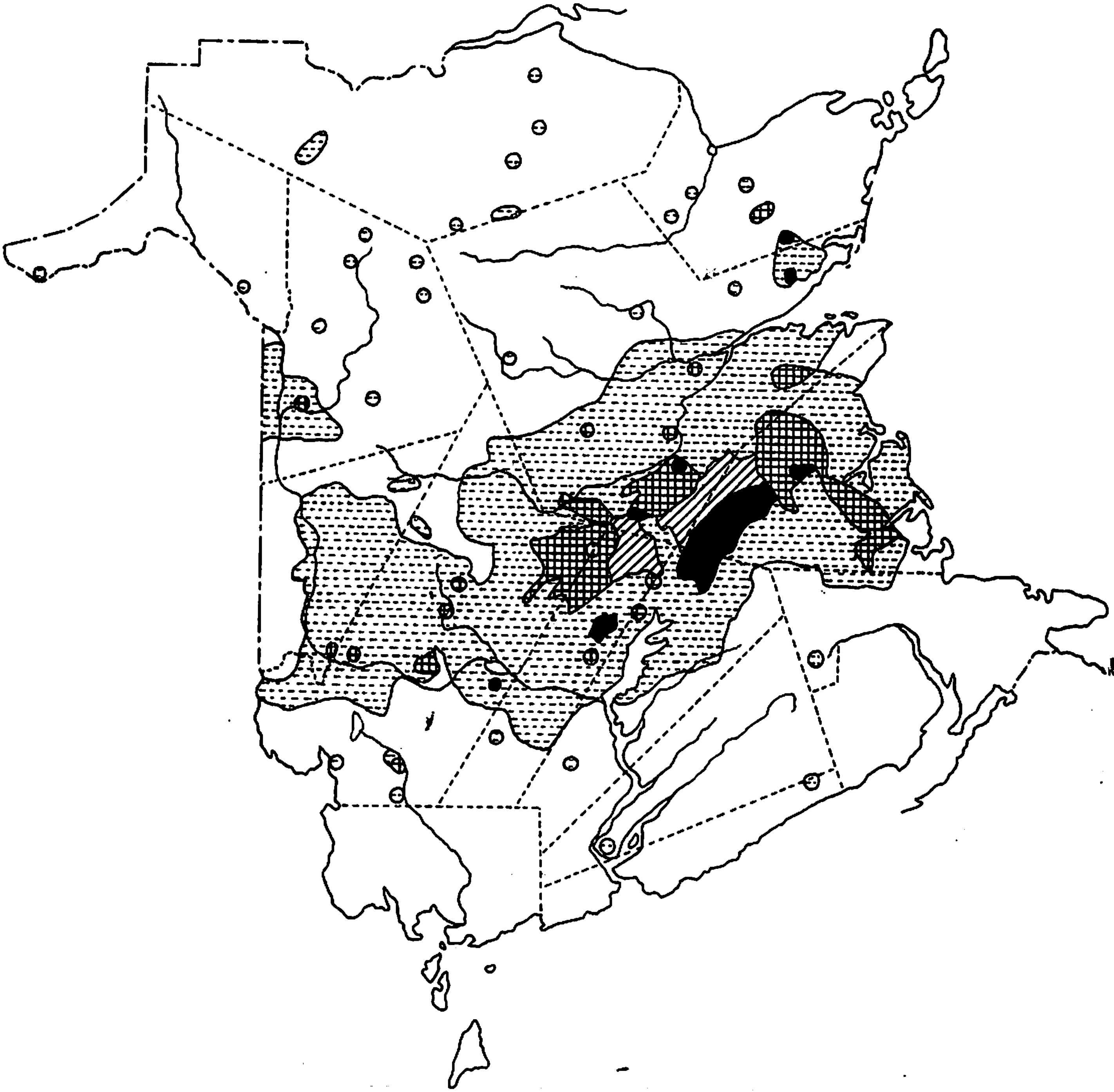
Scattered small areas of moderate and severe egg-mass infestations were found within the 1961 operational spray area. Two small areas of infestation near the junction of the Tobique and St. John Rivers are located upwind from extensive susceptible forests and should be carefully watched in 1962.

The trend in spruce budworm population throughout the Province between 1960 and 1961, as measured by changes in egg-mass numbers, and the effect of the 1961 spraying on this trend, are illustrated in the following table:

Area	No. plots	Av. No. egg masses per 100 sq. ft. foliage 1960	1961	Ratio, No. egg masses 1961/1960
Operational and experimental spray areas 1961, one application	173	156.5	64.0	0.41
Operational and experimental spray areas 1961, two applications	73	202.2	52.9	0.26
Northern N. B., unsprayed 1961	291	4.9	7.7	1.57
Southern N. B., unsprayed 1961	93	8.5	4.6	0.54
East-central N. B., unsprayed 1961	93	230.5	120.7	0.52

Within the 1961 operational spray area, egg-mass numbers were greatly reduced in 1961, particularly in the areas receiving two spray applications. This is a satisfactory result, particularly in the areas which received two

Figure 3



Spruce Budworm Egg-Mass Infestation

Autumn 1961

(Represents forecast of attack in 1962)

- No sample over 174 masses/100 sq. ft.
- No sample over 399 masses/100 sq. ft.
- Samples over 400 masses/100 sq. ft.
- No samples taken

Complete defoliation of current foliage is to be generally expected in the medium and heavy categories in 1962.

Scale: 1 inch = 34 miles (approx.)

spray applications, because these were areas of persistent population following treatment in 1958 and again in 1960.

The very low population in northern New Brunswick increased in 1961 by one and one-half fold, but is still at a very low level. Such an increase should not be regarded as remarkable since five- to eight-fold increases annually would normally be expected in years immediately before an outbreak.

The decrease in population that occurred in southern New Brunswick was unexpected. Natural control in this part of the Province is considered to be fairly low, and this, coupled with generally favorable weather in 1961, might have been expected to at least maintain populations at the 1960 level. However, strong winds prevailed in the south at the time of larval emergence in the spring of 1961 and these may have accounted for a wastage of larvae at this critical stage in the insect's development.

The decline in population in the east-central areas was, however, expected. This is an old infestation in which natural control is high and in which larvae are experiencing starvation because of tree mortality and decreased foliage production.

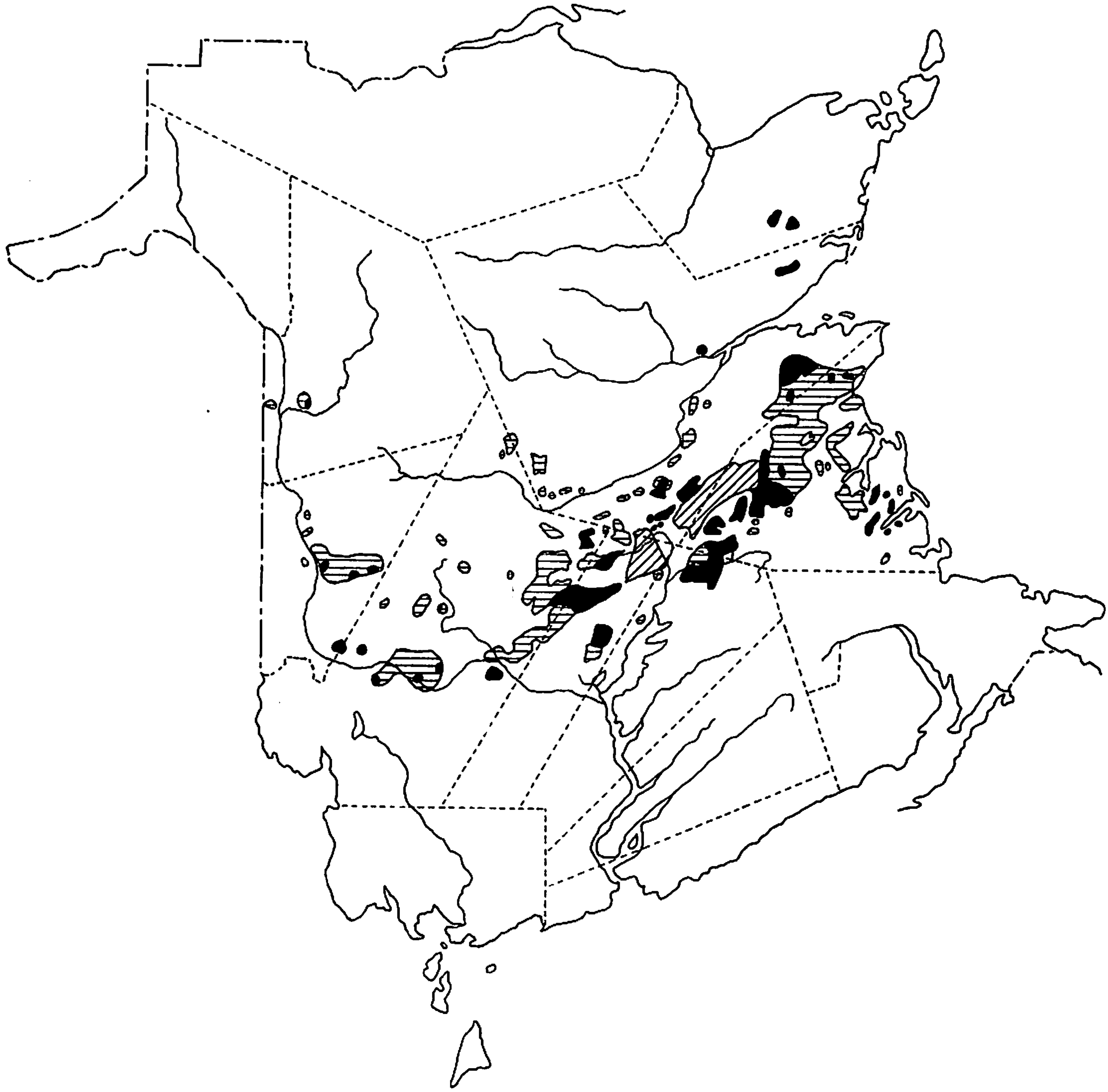
Forecast of Hazard for 1962

In previous years, hazard maps have been constructed by using a formula to derive a hazard rating for sample points and delineating areas of equivalent rating. The formula included a number of factors relevant to tree condition and expected insect attack which were given appropriate weights. Application of this formula and mapping technique to 1961 data was attempted but was found to produce unsatisfactory results because of the heterogeneous forest conditions that prevail in the east-central part of the Province, in contrast to the homogeneous forest conditions to the west and north for which the technique was originally devised.

Therefore, a new technique was developed for rating and mapping hazard for 1962, as follows. The 1961 aerial survey information was mapped, and the results of the egg-mass survey were superimposed on this map. Egg-mass infestation levels were divided into three categories: light--areas in which samples less than 174 egg masses per 100 sq. ft. were found; moderate--areas in which no sample over 399 egg masses per 100 sq. ft. were found; and severe, in which more than 400 egg masses per 100 sq. ft. were found. The combination of egg-mass and defoliation conditions which resulted were subdivided as follows to yield estimates of the degree of hazard:

Degree of egg-mass infestation 1961	Degree of defoliation, 1961			
	Nil	Light	Moderate	Severe
Light	Light	Light	Light	Light
Moderate	Light	Moderate	Moderate	Severe
Severe	Light	Moderate	Severe	Severe

Figure 4



Forest Hazard From Spruce Budworm Attack in 1962

Severe hazard	(solid black symbol)	295,000 acres
Moderate hazard	(horizontal hatching symbol)	507,000 acres
Areas where no information is available	(diagonal hatching symbol)	

Hazard is based on an evaluation of tree condition in 1961, and the degree of attack predicted for 1962 from 1961 egg mass surveys. See text.

Scale: 1 inch = 34 miles (approx.)

The 1962 hazard map, so constructed, is illustrated in Figure 4. In this map severe hazard means that severe attack by budworm may be expected in 1962 in trees that are presently seriously damaged. Moderate hazard means that severe attack may be expected in 1962 in trees that are only moderately damaged or moderate attack in trees that are severely damaged. Figure 4 includes 295,000 acres of severe hazard and 507,000 acres of moderate hazard.

In areas of moderate hazard delineated in Figure 4, balsam fir will be in serious condition by the fall of 1962 if foliage production in 1962 is not protected. Extensive tree mortality would be expected following a further year's feeding in 1963. Some mortality of suppressed and intermediate stems would be expected following attack in 1962.

Conditions within areas designated as severe hazard are complex. In some such areas, extensive mortality of balsam fir has already taken place and red spruce is beginning to die. Elsewhere, mortality of smaller stems will probably occur during the winter 1961-62 and more extensive mortality would be expected in 1962 without protection by spraying. Hazard to the living trees in these stands from further defoliation in 1962 is severe, but for an adequate appraisal of what this means in terms of forest values, more accurate information is required on the mortality that has already taken place and on the volumes of the timber involved. At the time of writing (late September) the N. B. Department of Lands and Mines is conducting surveys in western Kent County to obtain such information. When it is available it should be studied in conjunction with the information portrayed in Figure 4.

Summary

1. Within the 1961 operational spray area, 1961 foliage was generally preserved and trees came through the 1961 season in good condition. Egg-mass surveys revealed that fewer eggs were laid in this area than in 1960 and the hazard rating for 1962 is generally low.

2. In northern New Brunswick, egg-mass surveys indicated a slight increase over 1960, but populations remained very low.

3. In southern New Brunswick, egg-mass surveys indicated a reduction in 1961 in the very low populations in that part of the Province.

4. In east-central New Brunswick, where hazard for 1961 was designated as moderate or severe but where spraying was not undertaken in 1961, egg-mass surveys in 1961 revealed a reduction in population, but to a level still high enough to indicate moderate and severe hazard in 1962 to living trees over fairly extensive areas. In these areas it is known that tree mortality has already begun, and, therefore, an adequate appraisal of hazard in them must await the completion of surveys being conducted by the N. B. Department of Lands and Mines.

Fredericton, N. B.

September 27, 1961

Appendix VIII

CHEMICAL CONTROL OF THE SADDLE-BACKED LOOPER (ECTROPIS CREPUSCULARIA) AT KITIMAT, B.C. - 1961

I. Operational Project

During 1960, the saddle-backed looper caused severe defoliation of western hemlock and amabilis fir over 10,500 acres immediately west of Kitimat townsite and smeltersite. Almost all of the understory conifers, and a considerable portion of the overstory trees were killed by the 1960 damage. An autumn pupal survey showed that a dangerously high looper population survived the 1960 season. To avert further disaster, tentative plans were made during the winter to undertake chemical control in 1961. Spring checks showed that the population survived the winter. The final decision to spray was reached in early June.

The project, under the direction of the British Columbia Forest Service, called for treatment of 10,500 acres severely defoliated in 1960. Dosage was set at one-half pound of DDT in two U.S. gallons of fuel oil per acre. A concentrate of Standard Oil Company's W.T. Base oil containing 25% DDT was diluted with diesel fuel oil to the required 3 1/8% concentration at the site.

Okanagan Copter Sprays were awarded the contract for supplying and applying the insecticide. A Bell G2 helicopter sprayed the area between June 22 and July 12. The project area was divided into spray blocks in such a manner that stands at low elevation were sprayed before those at the higher levels. This procedure ensured that the whole area was sprayed after all eggs had hatched but well before larvae had reached full size.

Biological assessment of the spray was hampered by the almost total lack of small living trees from which larval samples could be collected. Instead, frass trays were placed beneath trees at several selected points just prior to treatment. Numbers of dead and dying larvae that fell to the trays were recorded in the days following treatment. Ten days after the initial spray, the helicopter applied a second, but heavier spray over the selected check points. It was assumed that insects that had survived the operational spray would be killed by the second spray and caught on the trays. Therefore, the total larval catch from both sprays approximated the whole population. Cessation of frass drop several days after the second spray was applied was reasonable evidence that the whole population over a tray had been destroyed. By expressing the numbers of larvae taken after the first spray, as a percentage of the total tray catch, mortality estimates were reached. By this method, the calculated mortality at eight check points averaged 91.6 per cent. As an average, the estimate errs slightly on the high side because small amounts of frass in some of the trays indicated that the whole population had not been killed by the two applications. Nevertheless, it is estimated that the true mortality was close to 90 per cent.

A survey of Ectropis pupae hibernating in the ground was carried out in September. In the operational spray area, only one pupa was found in 90 one-square-foot duff samples. Comparable samples examined on year earlier yielded an average of 7.8 pupae per square foot.

The drastic reduction in population cannot be wholly attributed to the spray. Parasitism and virus disease greatly reduced the numbers of insects that survived the spray. Evidence of virus disease was common among late instar larvae, and dipterous parasite cocoons were numerous in the duff samples.

Pupal populations were not high in most adjacent unsprayed areas that were known to be heavily infested. Three infested areas just outside the sprayed zones yielded averages of 0.8, 1.2 and 9.0 pupae per square foot.

The foregoing remarks apply to 9,800 acres sprayed in accordance with hazard areas prescribed by the 1960 pupal and damage survey. At the end of the project an additional 700 acres were sprayed. This area was at a low elevation and larvae were then approaching maturity. Control attributable to the spray was less favourable than in the bulk of the project area where larvae were sprayed while still small. An average of 1.3 pupae were taken from twelve samples collected in this area.

The principal object of the chemical control project was to avert almost certain death of most surviving hemlock and balsam seriously damaged in 1960 by preventing heavy feeding in 1961. By killing most of the larvae while they were still small, the spray successfully accomplished its purpose. Most tree mortality that has, or will occur, can be ascribed directly to, or as a consequence of 1960 defoliation.

As outlined by Dr. Silver in his summary of the whole pupal survey, chemical control of the remaining *Ectropis* during 1962 is not warranted. The relatively small population remaining should be destroyed by parasites and disease before any further serious feeding can occur.

II. Experimental Sprays

Advantage was taken of the opportunity presented by the main control project to compare the efficiency of the operational spray with a reduced DDT treatment and three other materials. Five contiguous 20-acre plots were reserved for the purpose immediately west of Kitimat Service Center. The treatments were:

(1) The operational spray - ½ lb. DDT in 2 U.S. gal./acre

(2) Half strength DDT - ¼ lb. DDT in 2 gal./acre

(3) Dibrom[1/] - ½ lb. in 2 gal. fuel oil/acre

(4) Phosphamidon[1/] - ½ lb. in 2 gal. fuel oil/acre

(5) Thuricide[2/] (*Bacillus thuringiensis*). Sufficient concentrate in 2 gal. of fuel oil per acre to give a nominal dosage of 70×10^{12} viable *B.t.* spores per acre.

1/ Donated by Ortho Agricultural Chemicals Limited

2/ Donated by Bioferm Corporation

The sprays were applied in the morning of June 28th, but by evening a storm began which dropped 0.8 inch of rain overnight. In all probability much of the Thuricide was washed off the foliage before it was ingested by most of the loopers.

Knockdown was very fast in the Dibrom plot. Most affected insects were down and dead less than two hours after the spray was applied. One day after the spray any dead and dying loopers were in all the frass trays except those in the Thuricide plot. A number of dead larvae were taken in the trays in the Thuricide plot five days later, and some of these were positively infected with B. thuringiensis. There is an indication from the spray assessment techniques used that part of the reason for failure of Thuricide to give good control lies not with the lack of viable spores per unit area, but rather with insufficient liquid carrier to disperse the spores efficiently.

Biological assessment was accomplished with the two-spray method outlined in Section I. The technique did not work as satisfactorily as it did for the operational spray because the second spray failed to kill all of the surviving insects. It was quite obvious, however, that the ½ lb. DDT per acre gave the best control. The half strength DDT ranked second in efficiency, although degree of control was more variable than for full strength DDT. Control achieved by Dibrom, Phosphamidon, and Thuricide was not satisfactory - mortality caused by any one of these three treatments was not greater than forty per cent.

J.M. Kinghorn,
Forest Entomology and
Pathology Laboratory,
Victoria, B.C.
October, 1961.

Appendix IX

CHEMICAL CONTROL OF THE PINE BUTTERFLY,

NEOPHASIA MENAPIA (F. & F.)

Populations of the pine butterfly increased to outbreak proportions in the lower Cameron River Valley in 1960. Although egg counts in the fall of 1960 indicated that defoliation in 1961 would not be sufficiently severe to cause tree mortality, a chemical control program was planned for June, 1961, to protect the aesthetic value of the trees and rule out the possibility of secondary insects attacking the overmature stand.

Okanagan Copter Sprays was awarded the contract. The spray was applied by a Bell 47G2 helicopter equipped with a 20 foot boom. Effective swath width was 100 feet at 60 to 75 feet above the tree tops at a speed of 30 mph. The insecticide used was Later's 25% DDT diluted on location to a dosage of ½ lb. DDT per gallon of Standard Oil furnace oil, and applied at the rate of 1 U.S. gallon per acre.

A total of 1,538 acres were included in the original spray area, although this area was reduced slightly to avoid the mouth of the Cameron River where the Dept. of Fisheries had fish traps located. Of the original area, 378 acres were in MacMillan Park under the jurisdiction of the B.C. Parks Division, and 1,160 acres were owned by MacMillan, Bloedel and Powell River Ltd. The latter company was responsible for the project, but the overall cost was divided proportionately with the Parks Division. Technical advice and assessment were the responsibility of the Forest Entomology and Pathology Branch.

The spray was applied on the mornings of June 16 and June 19. Thirty trips were required to complete the job.

Results

Because of the large size of the trees and the absence of suitable reproduction trees, assessment could not be done by normal branch sampling. Six small potted trees were infested with pine butterfly larvae and placed in the spray area, and three check trees were set up outside the park area. Frass trays were placed beneath all the experimental trees, and trays were also set out beneath 10 dominant Douglas-fir trees at selected localities. It is hoped that the amount of frass collected from a known number of larvae on the small trees eventually can be related to the amount of frass which was collected in the other trays. Because of the large amount of work involved in cleaning, drying, and weighing the frass samples, however, these data are not yet available. Meanwhile, the population level can be compared on the basis of egg counts made in the fall of 1960 and again in October, 1961 (Table 1).

Only one locality within the spray area (outside MacMillan Park) was sampled in 1960. This averaged 15.14 eggs per square foot of foliage surface in 1960, and only 0.34 eggs in 1961, a reduction of over 97 per cent. A second sample from within the spray area contained only 0.32 eggs per square foot. The sample point at Block 35, Cameron River, was just outside the spray area and could have been hit by drift.

Table 1

Pine Butterfly Egg Counts. Vancouver Island.

Locality	Average number of eggs per square foot of foliage		Per cent increase or decrease
	1960	1961	
Outside MacMillan Park (within spray area)	15.14	0.34	-97.7
Experimental area	-	0.32	-
Block 35, Cameron River	1.25	0.05	-96.0
Block 81, Cameron River	0.12	0.15	+25.0
Nanaimo River	2.14	0.16	-92.5
Nanaimo Lakes	-	0.15	-
Copper Canyon	-	0.23	-
Northwest Bay	-	0.12	-

The apparent reduction in population indicated by the egg counts cannot be wholly attributed to the spray. Egg counts at other localities were low, and the reduction in the number of eggs at Nanaimo River was very surprising, as frass drop was heavy and the butterfly flight was heavier than in the Cameron River. This suggests that for some reason, unknown as yet, the Vancouver Island populations developed normally until in the late larval, pupal, or adult stage, but produced very few eggs. Nevertheless the spray was beneficial in terms of the purpose for which it was originally intended. The population at MacMillan Park is still the heaviest of the Island populations, and the spray probably assisted in the large reduction in egg counts. This is also indicated by the sample at Block 81 in the Cameron River Valley, which is about four miles beyond the spray area. There, the number of eggs increased slightly. Because defoliation was light in the spray area, the primary objective of protecting the overmature stand was achieved.

Summary

The spray operation was successful in preventing heavy defoliation of the overmature Douglas-fir trees in the Cameron River Valley during the last year of abundant caterpillars. Now, the pine butterfly populations on Vancouver Island have decreased to a very low level and no serious defoliation is expected anywhere on the Island in 1962.

G.T. Silver,
Forest Entomology & Pathology
Laboratory,
Victoria, B.C.
October 11, 1961.

Appendix X

INTERDEPARTMENTAL COMMITTEE ON FOREST SPRAYING

OPERATIONS

Spraying of Logs in Water Storage for Protection from Ambrosia Beetles (British Columbia)

November 22, 1961

H. A. Richmond

During the spring of 1961 some seventy-five million f.b.m. of sawlogs were sprayed for protection from ambrosia beetle attack. This volume represents about 375 booms, each boom covering an area of slightly less than one acre.

The insecticide used was Benzenehexachloride, at a concentration of one pound gamma isomer per Imperial gallon (the "gamma" isomer being the active ingredient in this insecticide). It was applied at a rate of 10 gallons (10 lbs. gamma) per boom. Since it is applied as a concentrate, no dilution is necessary and hence no emulsifier is employed. Without an emulsifier it will not mix with the water over which it is sprayed but remains as a slight oil slick which soon dissipates.

Spray was applied by helicopter flying at a speed of 30 m.p.h. and at a height of 20 feet above the logs. The swath width was about 45 feet, two passes being necessary for coverage of each boom. The machine carried 40 gallons and could, therefore, spray 4 booms per trip. Average time for each load was 15 minutes which included taxiing, loading, and refueling. The cost averaged 23¢ per thousand f.b.m.

The previously used method of hand spraying employed a fire-pump with garden hoses with which each log was sprayed individually. This required a large volume of spray and necessitated its dilution with water. To permit this dilution an emulsifier was necessary. A 3-man team could spray 3 booms in 8 hours.

Intensive tests on the effect of this spray on caged fish were conducted by the Department of Fisheries in 1960. Results showed that spray containing an emulsifier affected the fish immediately and mortality occurred as deep as 6 feet during the ensuing 48 hours. Non-emulsified spray showed no effect on any fish during the first 2 hours after spraying and mortality was observed to a depth of 18 inches during the ensuing 48 hours.

Because any form of this spray is toxic to fish the following precautions are taken:

(a) Areas to be sprayed are reported to, and inspected by the Department of Fisheries prior to spraying.

(b) Skin divers check under the booms for fish immediately before and after the spray application.

(c) The dead-line for spray termination is set as April 15 to avoid the sea-ward migration of salmon smolts.

(d) No spraying is allowed in river estuaries or shallow water where young salmon congregate.

(e) No spraying is allowed without approved direction and supervision.

Protection afforded was 100% as compared to unsprayed checks which suffered attack as high as 70% of the logs.

Losses due to attack by ambrosia beetle on logs in water storage were measured by an extensive mill study to range from $1.35 to $5.00 per thousand f.b.m., according to grading rules which vary with the market for which the lumber is graded. Spraying of felled and bucked logs in the woods has proved unsatisfactory due to the physical problem of surface coverage of the logs as they occur amongst the enormous accumulations of slash typical of such operations.

1962 Proposals

It is anticipated that the 1962 program will be about the same and involve the same companies and locations as in 1961 as follows:

Rayonier Corporation Canada Ltd., Cowichan Lake

Crown Zellerbach Canada Ltd., Cowichan Lake, Nanaimo Lake and Comox Lake

B.C. Forest Products, Cowichan Lake

Tahsis Company Ltd., Tahsis Inlet

Total estimated volume for 1962, seventy-five million board feet.

Appendix XI

Aerial Spray Operation Against the White Pine Weevil, Kirkwood Area, 1961, and Outlook for 1962

W. A. Reeks

The Ontario Department of Lands and Forests conducted aerial spray operations against the white pine weevil in white pine plantations in the Kirkwood Management Unit near Thessalon, in 1961.

Status of White Pine Weevil Populations in 1961

Plantations cover approximately 14,300 acres in the Kirkwood Management Unit. An undetermined acreage, possibly one sixth of the total, has been planted to white pine. The oldest white pine plantations were established in 1929, and these have suffered from neglect and weevil attack for many years. In 1960, the incidence of current weevil attack in two of the 1929 plantations averaged 10.6 and 20.9 per cent. In younger plantations (about 10 years old) the percentage of attack ranged from a trace in heavy shade to 37 per cent in stands with no overstory.

The forest manager therefore decided to take steps in 1961 aimed at protecting the younger plantings. Although spraying white pines older than 20 years of age is not generally considered economical, plans were made to spray the 1929 plantations in the hope that this would lower the risk of increased infestations in the younger adjacent plantations. Concurrently, long-term plans were made for protecting the younger plantations by direct methods, i.e. by clipping infested leaders and by hand-spraying.

Results of the Kirkwood Spraying

All of the 1929 plantations, covering approximately 400 acres, were sprayed in 1961. The spray material consisted of 1.6 gallons of 25% D.D.T. emulsion in 2.4 gallons of No. 2 fuel oil per acre delivered from a Stearman aircraft owned by Northcana. The spray was applied from Apr. 24 to Apr. 30. An accident almost demolished one aircraft and another was called in to complete the job.

From the standpoint of hazards to wildlife, the above dosage would be considered high under natural forest conditions. On the other hand, the adopted dosage had hitherto been effectively used elsewhere with fixed-wing aircraft, and local authorities reported that populations of game birds, song birds, and game animals were negligible in the area. It should be noted that spraying was done before song birds had migrated into the area, and there are no streams in the sprayed area.

The laboratory didn't have the staff to study the effectiveness of this operation intensively, but observations were made at a survey level. Mr. C. Kirby and field technicians made some observations on effectiveness, and more checking will be done in the late fall of 1961.

About 100 spray assessment cards were put out immediately prior to the operation. All cards showed evidence of spray deposit, but the droplet size appeared to be large. This was not surprising, because it was noted that all the screens had been removed from the spray jets. Although the final assessment of the operation, based on weevil damage to new leaders, has not been made, superficial observations would suggest that the percentage of infested tips on the sprayed trees may prove to be less than one per cent.

Prospects for 1962

It is unlikely that the above type of operation will be repeated in the area, but the laboratory will make observations to determine the effectiveness of the 1961 operation over a period of two or three years.

The forest manager of the Kirkwood Unit is likely to attempt weevil control over several hundred acres by hand spraying and clipping in 1962. Either method has more merit than the type of operation conducted in 1961 because the cost with prison labour is about half that involving aerial applications.

Sault Ste. Marie, Ont.
September 29, 1961.

Subject: Summary statements on forest insect infestations experimental or commercial control programs in 1961 and prospective control programs in 1962.

History

(a) A small area of white spruce in Elkwater Provincial Park in the Cypress Hills in southeastern Alberta has been infested with the spruce budworm *Choristoneura fumiferana* (Clem.) and the spruce coneworm *Dioryctria reniculella* (Grote) since 1957. The amount of defoliation gradually became more intense until in 1961 severe defoliation was occurring in small patches throughout the infested area. In 1958 the provincial parks people were concerned about the damage being done and we examined the area and recommended that they hold off spraying for at least a year.

The amount of defoliation declined in 1959 but began to increase again in 1960. In 1961 we reported to the parks people that dead tops were beginning to appear and suggested that if the number of insects remained high in the spring of 1962 spraying might be necessary in order to prevent further damage. The decision to spray or not to spray will be made by the Provincial Parks Committee sometime this fall or winter.

Area

The infested spruce lies in the valleys of the Battle and Graburn creeks and extends into Saskatchewan. The maximum area of infestation in Alberta does not exceed 12 square miles, and the area where dead tops are noticeable and where spraying would be recommended does not exceed 5 square miles and lies along the valley bottoms. The area is a high grassy plateau approximately 4,500 feet above sea level cut by deep ravines in which the spruce and pine occur.

Status

Please refer to the attached map.

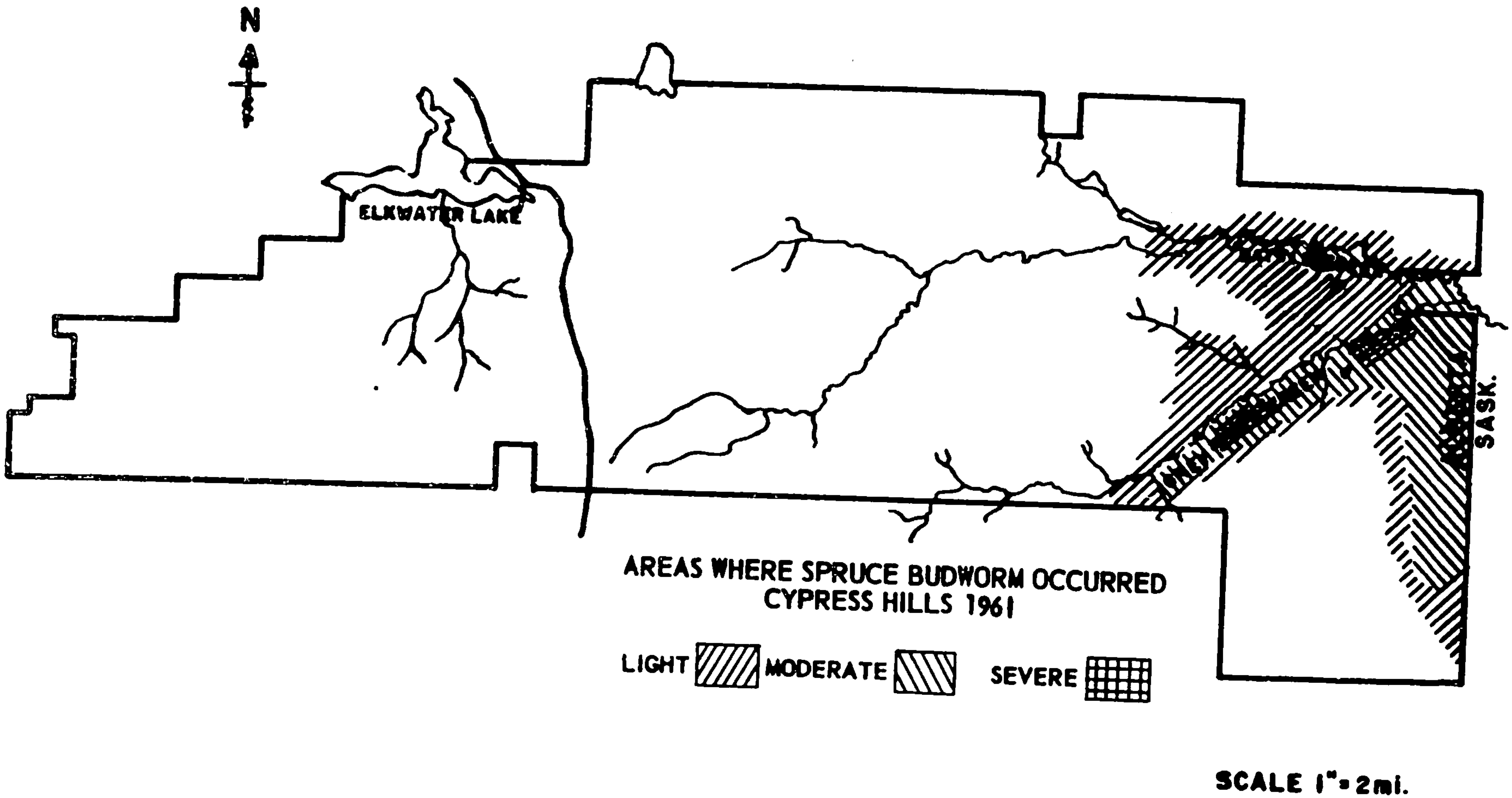
Animal Life

One small lake occurs near the edge of the infestation but can be easily avoided. Two small creeks run through the area. These creeks run southeast into Saskatchewan and Montana draining via the Milk River into the Missouri. Some sport fishing is done in the Battle Creek especially on the Saskatchewan side.

A large number of cattle are grazed in the Park during the summer months. One rancher lives near the western boundary of the park and may have milking cows.

C.E. Brown
Calgary, Alberta
September, 1961

ELKWATER PROVINCIAL PARK



Appendix XIII

Summary Statement on Forest Insect Infestations, Experimental or Commercial Control Programs in 1961 and Prospective Control Programs in 1962, in the Interior of British Columbia.

D. A. Ross

1. Ambrosia beetles, Trypodendron lineatum (Oliv.)

(a) Status of infestations:

Ambrosia beetle attack was severe on decked conifer logs near Malakwa, Froth Creek, Thunder River and Grizzly Lake, 12 miles northwest of Clearwater, and near Cranberry Creek, in 1961. A few scattered severe infestations may be expected in 1962.

(b) Control operations:

No experimental control operations were carried out in the Interior in 1961, however an observer from the Forest Entomology Laboratory at Vernon watched the spray operations against ambrosia beetles at Froth Creek (Diamond Mills Ltd.).

Apparently the first attack of beetles at Froth Creek occurred in the last week of April. The next wave of attack, much greater than the first, began about May 14. The spray project was held up until May 16 because of the late arrival of part of the equipment. Some 2400 gallons of solution (1 gal. BHC, 1 gal. diesel fuel to 24 gal. water) were sprayed on five million board feet of decked sawlogs. The spray was applied with a Terry fire pump and a 1000-gallon tank mounted on the flat deck of a truck.

On May 23 countless numbers of dead ambrosia beetles lay on the treated logs. Limited samples of beetles that had penetrated into the logs indicated that about 90 per cent were killed by the spray. The living beetles in the samples all had burrowed an inch or more vertically into the wood; presumably these were from the first flight and had escaped the effects of the insecticide.

Some 10 days to two weeks after spraying, some of these treated logs were dumped into the North Thompson River and floated 17 miles to the mill at Avola. All of the sprayed logs had been river run to Avola within eight weeks.

(c) It is not feasible to predict the need for chemical control of ambrosia beetles in the Interior in 1962.

2. Douglas-fir tussock moth, Orgyia pseudotsugata (McD.)

(a) Status of infestation:

The current Douglas-fir tussock moth epidemic is confined to Okanagan Valley; moderately to severely defoliated trees have been observed at a dozen points between Okanagan Landing and Armstrong. Infestations ranged in size from single isolated trees, to small open-grown groves around agricultural buildings, to dense stands of Douglas fir with infestations up to 20 acres in extent.

Diseased late instar larvae and pupae were discovered in each of the larger infestations, nevertheless severe defoliation may be expected in some of these stands in 1962.

(b) No chemical control of tussock moth was carried out in 1961.

(c) We are prepared to recommend a DDT spray to control the tussock moth if our advice is requested. There will be further consideration on experimental use of some of the virus stock held in reserve at Victoria.

3. Douglas fir beetle, Dendroctonus pseudotsugae Hopk.

(a) Status of infestations: Infestations again were numerous and widespread in 1961.

(b) Control operations:

S. M. Simpson Ltd., of Kelowna carried out a trap tree program against Douglas-fir beetles in the spring of 1961. Stumps of the infested trees and cull logs were sprayed with ethylene dibromide in September. The success of the chemical program has not yet been assessed. Boundary Sawmills also had a trap tree program but did not supplement it with chemical control.

(c) Pondosa Pine Ltd. is considering a trap tree program on its Tree Farm License in 1962, and probably will use ethylene dibromide against beetle broods in stumps and cull logs.

4. Round-headed woodborers, Monochamus spp. Tetropium velutinum Lec., etc.

There is increasing likelihood of ethylene dibromide being used to control round-headed wood borers in log decks during the next few years.

5. Satin moth, Stilpnotia salicis (L.)

(a) Status of infestations:

Satin moth infestations increased in the Okanagan and in the upper Nicola Valley. Severe defoliation of poplars may be expected in some localities in these areas in 1962.

(b) Control operations:

None were carried out in 1961. It is likely that some motel operators will wish to spray trees around their buildings in 1962.

(c) No specific control operations are contemplated in 1962, however it is likely that some poplar groves on private property will be sprayed with DDT.

Vernon,
October 5, 1961.